

# GREENVILLE AVENUE (US 11) CORRIDOR IMPROVEMENT STUDY

CITY OF STAUNTON and AUGUSTA COUNTY, VIRGINIA

December 2019 | Final





# Greenville Avenue (US 11) Corridor Improvement Study

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Prepared for:



Prepared by:



In Association With:



## LIST OF ACRONYMS

ADT – Average Daily Traffic

AADT – Annual Average Daily Traffic

HCM – Highway Capacity Manual

LOS – Level of Service

PDO – Property Damage Only

RNS – Roadway Network System

TMC – Turning Movement Count

TOSAM – Traffic Operations and Safety Analysis Manual

STARS – Strategically Targeted Affordable Roadway Solutions

SWG – Study Work Group

SYIP – Six-Year Improvement Plan

VDOT – Virginia Department of Transportation

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# 1 INTRODUCTION

## 1.1 Background and Study Initiation

The Virginia Department of Transportation (VDOT) identified the Greenville Avenue (US 11) Corridor from the Route 262 interchange in Augusta County to the Commerce Road intersection in the City of Staunton for study under the Strategically Targeted Affordable Roadway Solutions (STARS) program. The STARS program uses a data-driven process to identify candidate projects with critical traffic and safety challenges.

The Greenville Avenue corridor ranked highly within the Staunton District with several locations identified as high crash locations. The STARS program then seeks to develop comprehensive, innovative transportation solutions to resolve safety issues and improve traffic operations. The goals of STARS studies include:

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

This study is titled the Greenville Avenue (US 11) Corridor Improvement Study and will be referred to as the Study in this report. Greenville Avenue is considered to run north/south and other roads are considered to run east/west for the purpose of this Study.

## 1.2 Purpose of Study

The purpose of this project is to evaluate existing operational and safety deficiencies within the Greenville Avenue corridor and to develop potential projects to improve operations and safety. The primary goal of the STARS program is to identify targeted improvements that meet project needs and that could be programmed into the VDOT Six-Year Improvement Program (SYIP). Consideration is given to the likelihood that recommended improvements would perform favorably in the SMART SCALE project prioritization process or other transportation funding programs. The primary needs for this Study include the following:

- Improve safety at signalized intersections with potential for safety improvement
- Evaluate safety impacts of vehicle access at unsignalized intersections and median crossovers
- Improve access for pedestrians throughout the corridor
- Improve and maintain traffic operations throughout the study corridor while mitigating safety issues

## 1.3 Study Work Group

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

- VDOT
- Augusta County
- City of Staunton
- BRITE Bus Transit Service
- Staunton Augusta Waynesboro Metropolitan Organization (SAWMPO)
- Kimley-Horn and Associates
- T3 Design Corporation

## 1.4 Study Area

The study corridor consists of a 2.1-mile segment of Greenville Avenue (US 11) from the Route 262 interchange in Augusta County to the intersection with Commerce Road in the City of Staunton. In the project kick-off meeting on October 31, 2018, it was agreed upon to extend the study limits approximately 0.5 miles south of the Route 262 interchange, with the intent to conduct a high-level review to identify systematic improvements that could be considered for incorporation into the County's Comprehensive Plan.

The geometry and functional classification of Greenville Avenue varies as follows within the study area:

- To the south of the Route 262 interchange: Three-lane collector road with a center two-way left-turn lane. The 2017 average annual daily traffic (AADT) is 5,500 vehicles per day (vpd), and the posted speed limit is 45 mph.
- From the north of the Route 262 interchange to Orchard Hill Road: Four-lane divided principal arterial. The 2017 AADT is 14,000 vpd, and the speed limit is 40 mph.
- From Orchard Hill Road to Richmond Avenue: Five-lane principal arterial with a center two-way left-turn lane. The AADT ranges from 11,000 vpd to 14,000 vpd, and the speed limit varies from 35 to 40 mph.
- From Richmond Avenue to Commerce Road/East Johnson Street: Four-lane divided minor arterial. The 2017 AADT is 16,000 vpd, and the speed limit is 25 mph.

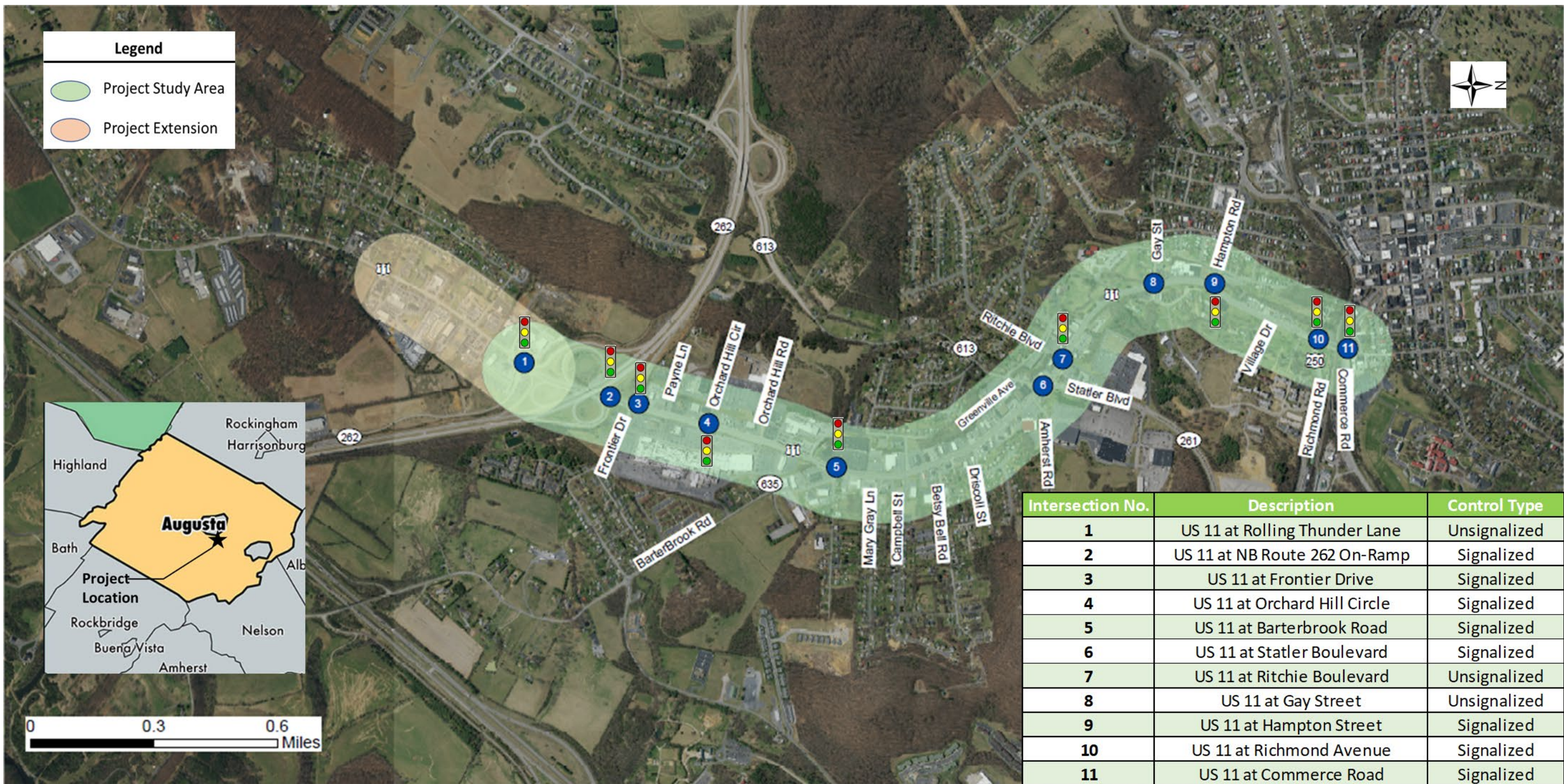
Greenville Avenue serves as a local/regional commercial corridor, as well as an entrance gateway for the City of Staunton. Also, the corridor is a part of the BRITE Transit 250 Connector Route. It accommodates a wide array of users with varying trip purposes, including, but not limited to, the following:

- Employment commuting
- Local residential and shopping access
- Local business access
- Major highway access (Route 262 and I-81)

The study area for the Greenville Avenue corridor is shown in [Figure 1](#). The following intersections were included in the study area:

1. US 11 at Rolling Thunder Lane (Unsignalized)
2. US 11 at NB Route 262 On-Ramp (Signalized)
3. US 11 at Frontier Drive (Signalized)
4. US 11 at Orchard Hill Circle (Signalized)
5. US 11 at Barterbrook Road (Signalized)
6. US 11 at Statler Boulevard (Signalized)
7. US 11 at Ritchie Boulevard (Unsignalized)
8. US 11 at Gay Street (Unsignalized)
9. US 11 at Hampton Street (Signalized)
10. US 11 at Richmond Avenue (Signalized)
11. US 11 at Commerce Road (Signalized)

Figure 1: Project Study Area





## 2 DATA COLLECTION AND INVENTORY

Traffic volume counts were performed by Peggy Malone and Associates on November 14 and 29, 2018. Existing traffic volume data was collected from a combination of turning movement counts and tube counts. A preliminary field review of the study area was conducted on February 27 and February 28, 2019 to observe geometric conditions, traffic control devices, peak hour traffic conditions, driver behavior and pedestrian movements.

The following sections summarize collected data and field review observations. All assumptions about data collection and processing are based on the directions and guidance provided in the VDOT *Traffic Operations and Safety Analysis Manual (TOSAM)*.

### 2.1 Traffic Volume Data

Turning movement count (TMC) data was conducted between 7:00 AM and 7:00 PM at the following intersections:

1. US 11 at Rolling Thunder Lane (Unsignalized)
2. US 11 at NB Route 262 On-Ramp (Signalized)
3. US 11 at Frontier Drive (Signalized)
4. US 11 at Orchard Hill Circle (Signalized)
5. US 11 at Barterbrook Road (Signalized)
6. US 11 at Statler Boulevard (Signalized)
7. US 11 at Ritchie Boulevard (Unsignalized)
8. US 11 at Gay Street (Unsignalized)
9. US 11 at Hampton Street (Signalized)
10. US 11 at Richmond Avenue (Signalized)
11. US 11 at Commerce Road (Signalized)

The turning movement counts at each intersection included truck and pedestrian counts. In addition, 24-hour counts were also collected at the following three locations:

- Between Route 262 and City of Staunton Limits
- Between City of Staunton Limits and Statler Boulevard
- Between Richmond Avenue and Commerce Road

Table 1 summarizes average daily traffic (ADT) volumes at these three locations. The traffic data is provided in Appendix A.

Table 1: Average Daily Traffic Volumes

US 11	ADT (Average Daily Traffic)
Between Route 262 to City Limits	12,900
Between City Limits to Statler Blvd	16,000
Between Richmond Ave and Commerce Rd	9,850

### 2.2 Field Review

The following observations related to traffic operations, safety, and pedestrian movements were noted:

- The PM peak hour traffic volumes and queue lengths were notably higher than the AM peak hour.
- Queuing for through and left-turn movements on the eastbound approach of the US 11 at Commerce Road/East John Street intersection blocked the right turn lane.



Northbound approach of US 11 at Commerce Road intersection – PM peak



Eastbound approach at the US 11 at Commerce Road intersection – PM peak



Northbound and eastbound approaches of US 11 at Commerce Road intersection



Northbound and westbound approaches of US 11 at Route 262 NB Off-Ramp intersection

- A rear-end crash was observed during the AM peak hour on February 28, 2019 involving two vehicles turning right onto Greenville Avenue from the Route 262 northbound off-ramp.



**Rear-End crash at NB Route 262 Off-Ramp**

- Significant pedestrian activity was observed throughout the day.

- Curb ramps are either missing or are non-ADA compliant throughout the corridor.



**Uneven sidewalk surface on east side of the Hampton Street intersection**



**Sidewalk encroached by a utility pole on west side of the Richmond Avenue intersection**

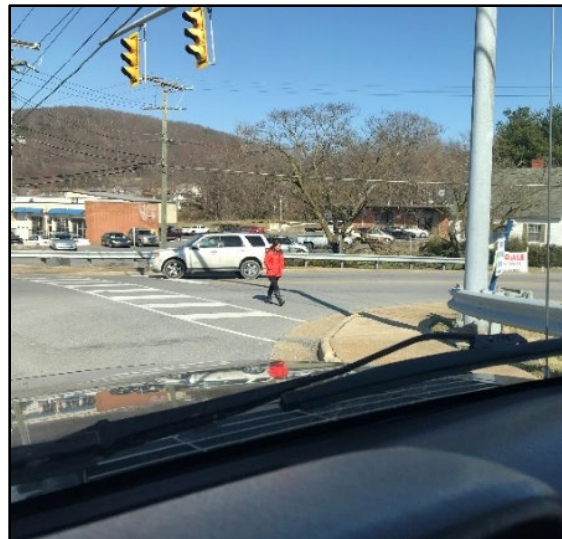
### 2.3 Existing Roadway Geometry

The study intersection lane configurations and signal phasing were recorded and verified during the field review. *Figure 2* summarizes the existing lane configurations, including storage and taper lengths for left-and right-turn storage bays, as well as posted speed limits for all study area intersections.

### 2.4 Land Use

The existing (2019) land use maps published by Augusta County and the City of Staunton are provided in *Appendix B*. These maps show that the parcels adjacent to the study corridor are designated for commercial use. There are a few parcels that are designated for low density residential use. The parcels on the east side of the corridor from the City limits to Betsy Bell Road and on the west side of Greenville Avenue between Hampton Street and Garber Street are designated for higher education or for institutional use. A parcel near the southeast corner of the Greenville Avenue and Commerce Road intersection is designated for heavy industrial use.

Augusta County and the City of Staunton established guidelines and recommendations for the evaluation of development in the City and released future land use maps in their respective comprehensive plans. These maps are provided in *Appendix B* and designate the parcels surrounding Greenville Avenue in the study area as either business or residential use. The parcel designated for heavy industrial use in the existing map is designated for traditional neighborhood development in the future land use map.



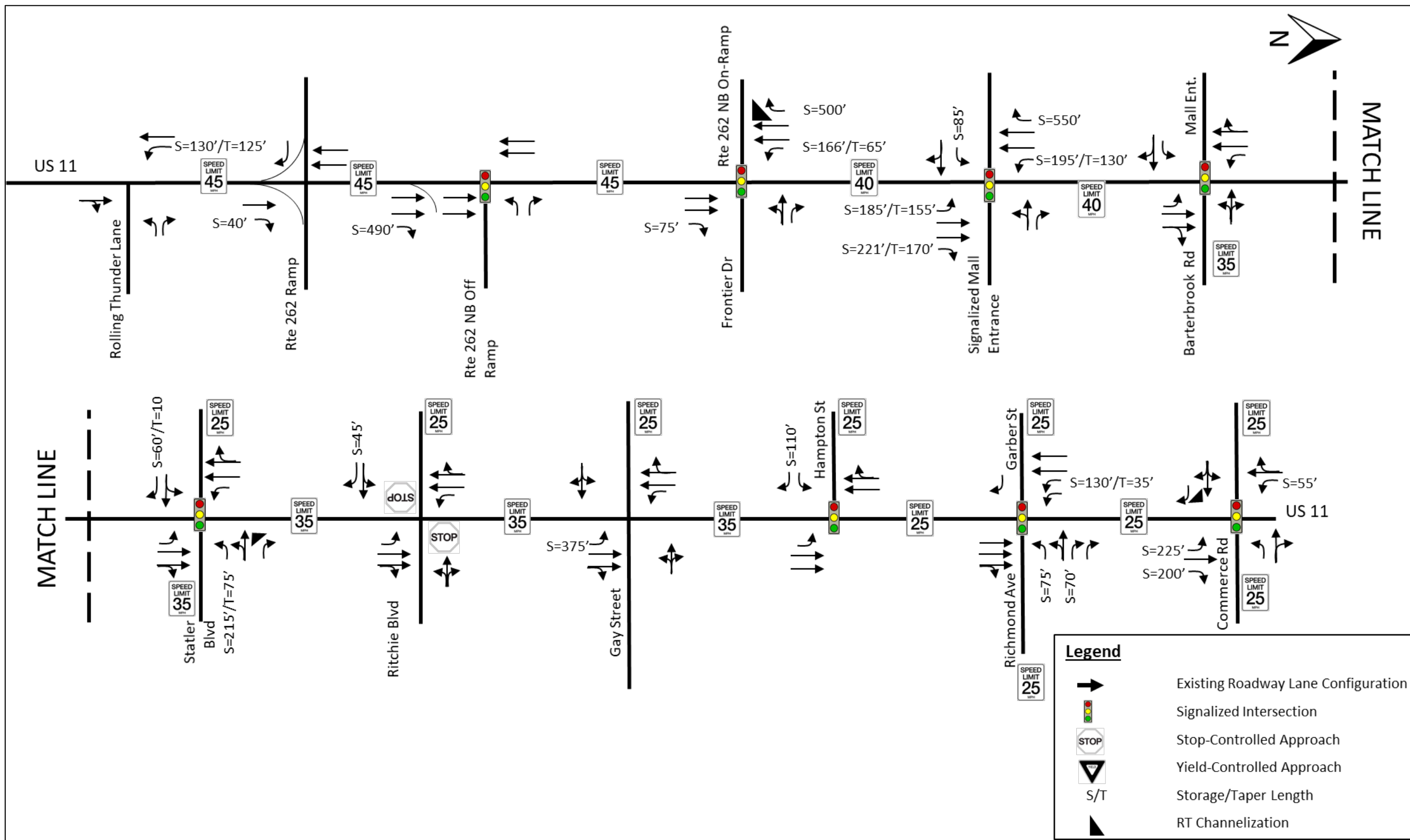
**Pedestrian crossing US 11 on north side of the Gay Street intersection**



**Pedestrian using sidewalk on the west side of US 11 to the north of Ritchie Boulevard**

- The field reviewer had to run to cross US 11 at Gay Street as there was no gap in the conflicting traffic.
- The pavement surface and markings are generally in bad condition, but specifically between Route 262 interchange and Barterbrook Road and Richmond Road and Commerce Road.
- Sidewalk surface on the east side of the Hampton Street intersection is deteriorated, uneven, and has debris.
- At several locations, utility poles or fire hydrants are located within the sidewalk.

Figure 2: Existing Lane Configurations



## 2.5 Traffic Volume Parameters

### 2.5.1 Peak Hour Determination

A network-wide peak hour was developed for both the AM and PM peak periods. The AM and PM peak hours for the study area were determined by first reviewing the individual intersection peak hours. Traffic volumes during each hour were then compared to the traffic volumes during the peak hour at each location. The hours that captured the highest percentage of overall traffic in the network when compared to individual peaks were identified as the peak hours for the Study.

The network-wide peak hours were determined to be 7:30 AM-8:30 AM and 4:30 PM-5:30 PM. These peak hours captured more than 98 percent of the total traffic volumes observed during the individual peak hours. The peak hour determination summary tables are provided in [Appendix C](#).

### 2.5.2 Traffic Volume Balancing

Traffic volumes were balanced, where appropriate, throughout the study area in preparation for the existing conditions operations analyses. The following assumptions were used to balance traffic volumes for the AM and PM peak hours:

The difference in traffic volumes between the two adjacent intersections should not be greater than 25 vehicles or 10% if there are no driveways or median crossovers that may potentially generate traffic volume:

- When balancing, review the driveway type, i.e., low volume residential entrances or commercial entrances.
- U-turn volumes should not be adjusted, unless U-turns occurred at intersections with a “No U-Turn” or “No Turns” sign.

The following U-turn volumes were removed because they occurred at locations with a “No U-Turn” sign:

- Southbound U-turn at NB 262 Off-Ramp [1 in PM]
- Southbound U-turn at Signalized Mall Entrance [2 in PM]

The following left-turn volumes were added to through volumes because they occurred at locations with a “No Turns” sign:

- Eastbound left-turn at Richmond Avenue [1 in PM]
- Northbound left-turn at Richmond Avenue [1 in AM; 1 in PM]

Peak hour traffic volumes were balanced between study intersections, except at locations where imbalances existed due to the presence of significant roads or driveways. Traffic volume imbalances were maintained at the following locations:

- Northbound and southbound Greenville Avenue between Route 262 On/Off-ramps
- Northbound Greenville Avenue between Signalized Mall Entrance and Frontier Drive
- Northbound and southbound Greenville Avenue between Barterbrook Road and Signalized Mall Entrance
- Southbound Greenville Avenue between Ritchie Boulevard and Gay Street
- Southbound Greenville Avenue between Gay Street and Hampton Street

The balanced 2018 AM and PM peak hour traffic volumes at the study intersections are presented in [Figure 3](#).

### 2.5.3 Heavy Vehicle Percentages and Peak Hour Factors

Heavy vehicle percentages were calculated for each movement at all study area intersections during the AM and PM peak hours. The calculations were based on raw traffic count data. Likewise, intersection-wide peak hour factors were calculated at all study area intersections during the AM and PM peak hours. The calculations were based on raw traffic data.

The 2018 AM and PM peak hour heavy vehicle percentages and peak hour factors are summarized in [Figure 4](#).

## 2.6 Pedestrian and Transit Data

The traffic volume data collected in November 2018 included pedestrian counts at each of the study intersections. Mid-block crossings were not counted. The total number of pedestrians crossing the intersection during the 12-hour count period and AM peak hour and PM peak hour are summarized in [Figure 5](#) along with the locations of pedestrian crossings. During the 12-hour counts, pedestrian activity was observed at the following locations:

- Two to three pedestrians per hour crossing the west side of Greenville Avenue between the Richmond Avenue and Gay Street intersections.
- One pedestrian per hour crossing Statler Boulevard on the west side of Greenville Avenue.
- One pedestrian per hour crossing on the east side of Greenville Avenue at the Gay Street intersection.
- One pedestrian per hour crossing on the east side of Greenville Avenue at the Ritchie Boulevard intersection.

Greenville Avenue is currently served by BRITE bus routes. There are 12 bus stops on both sides of Greenville Avenue within the study area. The BRITE bus service runs from Monday to Saturday along Greenville Avenue from the Staunton Mall to north of the Commerce Road intersection. Based on the ridership data provided by BRITE from October 2018, about total 85 passengers per week use this service from Monday to Friday, and about 11 passengers use the service on Saturdays.

A Saturday night trolley runs along Greenville Avenue from Ritchie Boulevard to the north of Commerce Road. Based on the ridership data collected in 2018, a total of 1,732 passengers use this service annually. The existing BRITE bus stops and BRITE bus routes are summarized in [Figure 6](#).

Figure 3: 2018 Existing Conditions Balanced Traffic Volumes

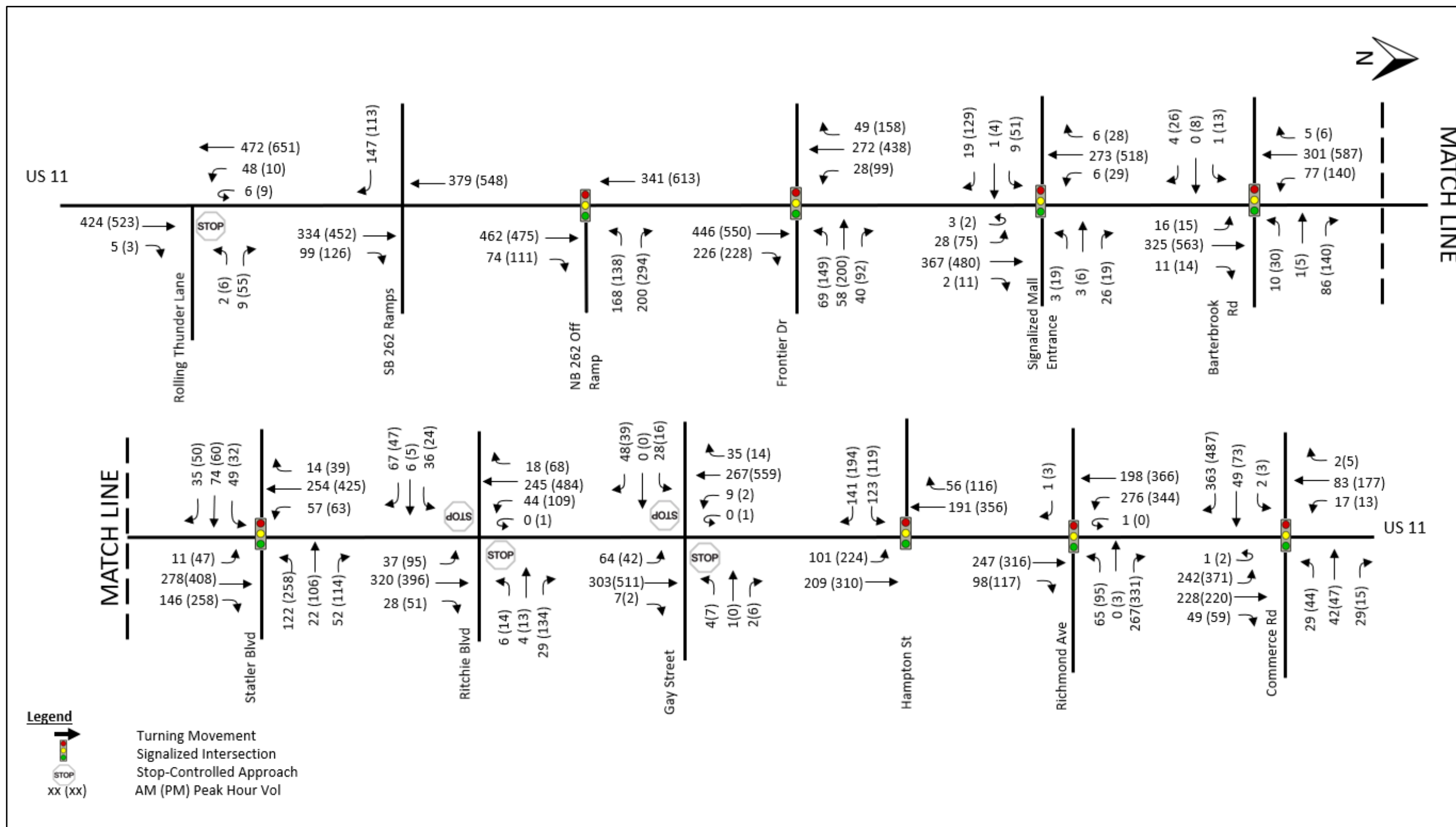


Figure 4: 2018 Existing Conditions Heavy Vehicle Percentages and Peak Hour Factors

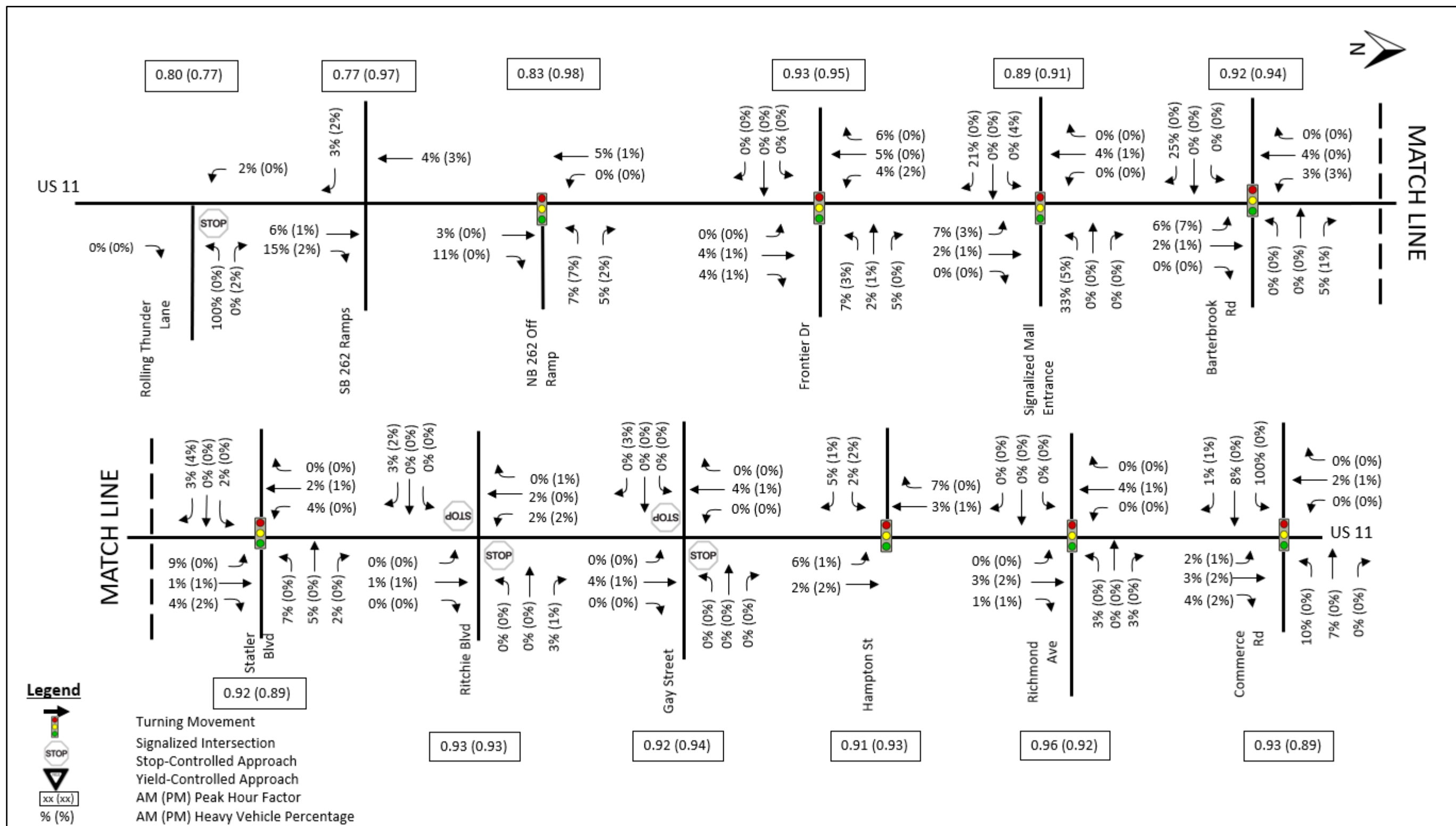


Figure 5: 2018 Existing Pedestrian Counts

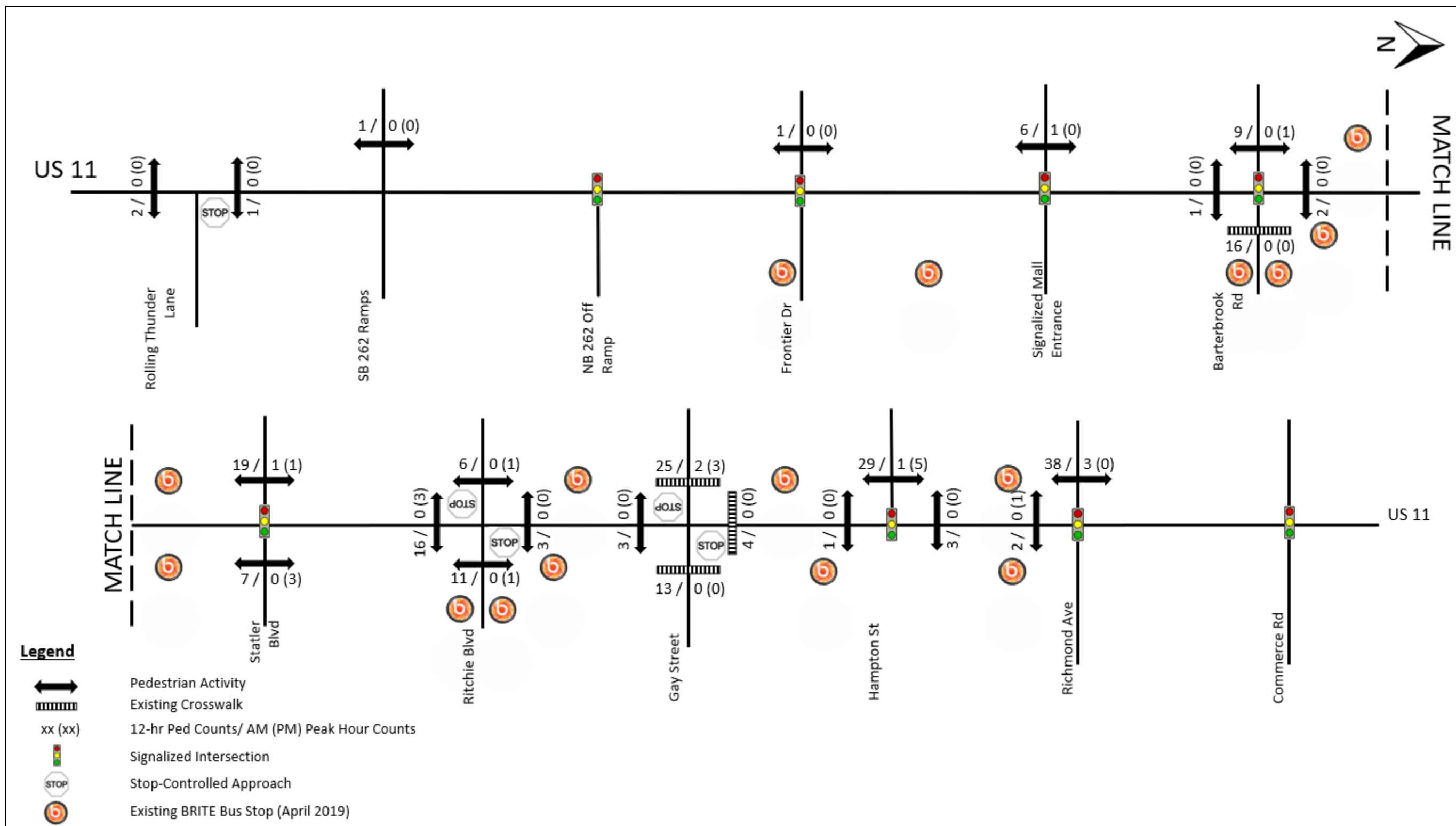
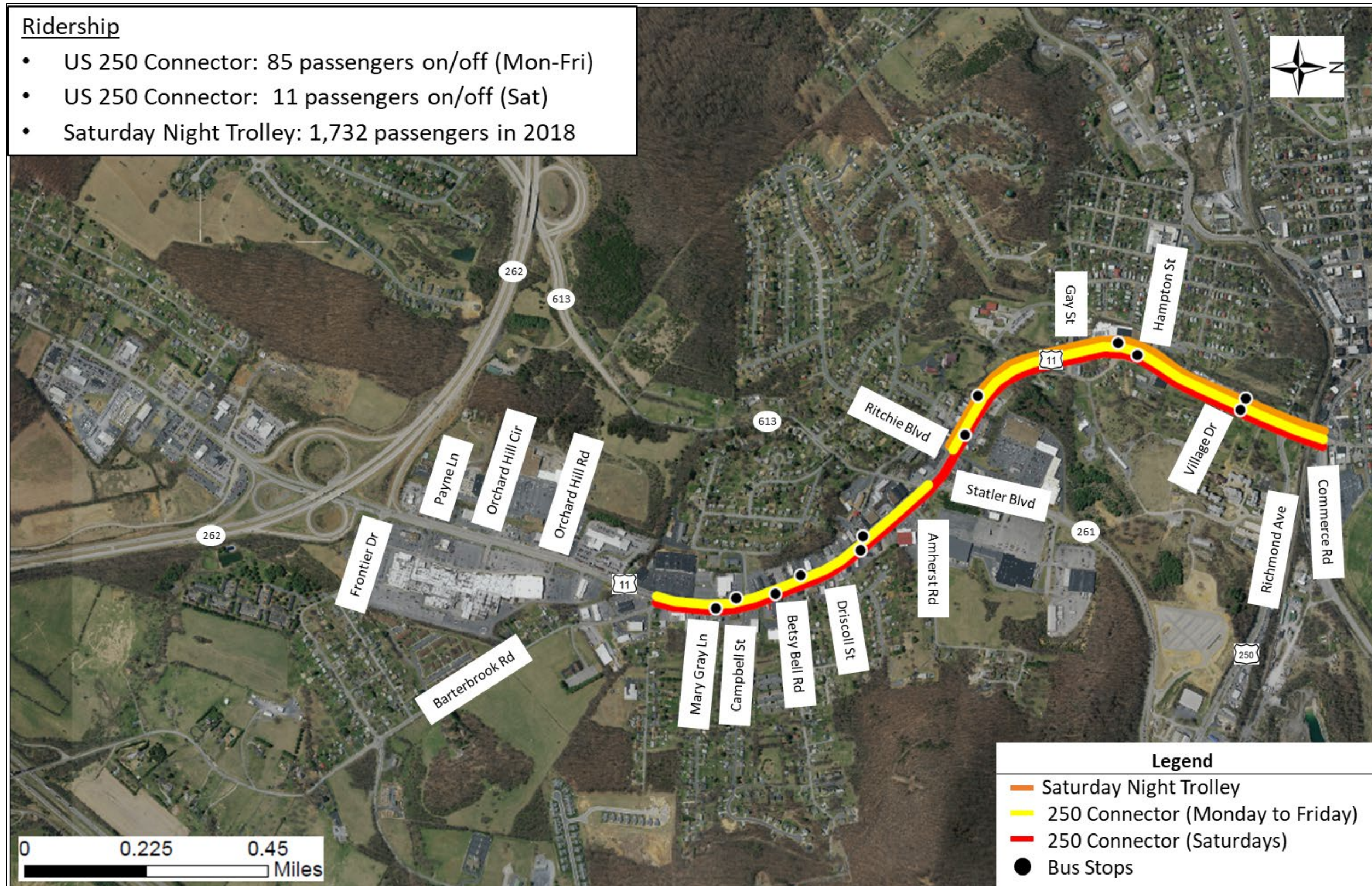


Figure 6: BRITE Routes and Ridership





## 2.7 Access Spacing

The *VDOT Road Design Manual* provides access management design standards for entrances and intersections along roadways that aim to provide access to land usage while preserving the flow of traffic. These standards are based on a roadway’s functional classification and posted speed limit. The access management standards applicable to the Greenville Avenue study corridor are listed in [Table 2](#).

Table 2: Access Management Design Standards

Description	Minimum Spacing Standard (feet)		
	South of Route 262	Between Route 262 and Richmond Ave	Between Richmond Ave and Commerce Rd
Spacing between Signalized Intersection and Other Signalized Intersection	660	1,320	880
Spacing between Unsignalized Intersection/Full Median Crossover and Signalized Intersection/Unsignalized Intersection/Full Median Crossover	440	1,050	660
Spacing between Full Access Entrance or Directional Median and Any Intersection, Full Access Entrance, or Median Crossover	335	565	355
Spacing between Partial Access Entrance and Any Entrance, Intersection, or Median Crossover	250	305	200

Although entrance spacing on the east side is generally closer to minimum standards than the west side, spacing is sub-standard along the entire study corridor, specifically at the following locations:

- Both sides to the south of Route 262 interchange (Auto dealership, DMV office)
- West side between Orchard Hill Circle and Barterbrook Road
- Both sides between Campbell Street and Statler Boulevard
- West side between Hampton Street and Commerce Road

In addition to sub-standard spacing, there are wide entrances that exceed VDOT standards along the corridor, and the high density of entrances create significant conflict points within the road.

The existing access spacing was documented throughout the study area, and the maps are provided in [Appendix D](#).

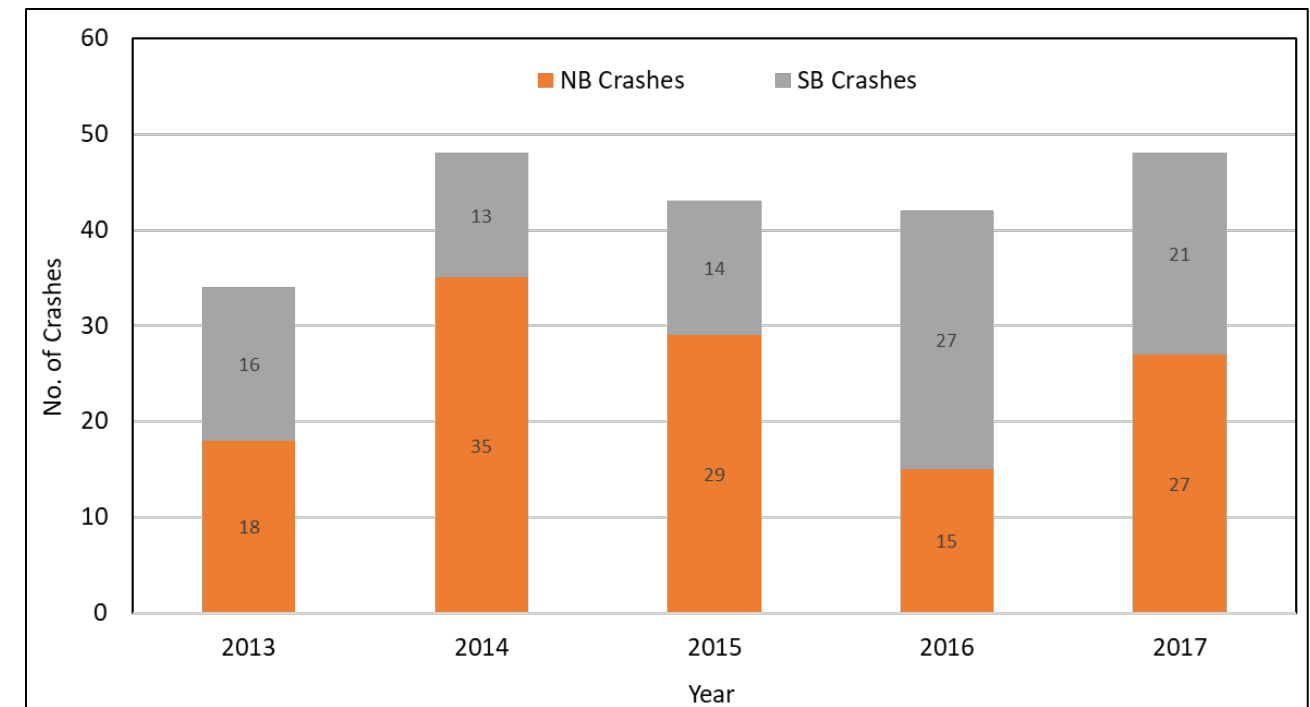
## 2.8 Crash Analysis

Crash statistics for the study area were used to evaluate corridor safety and identify crash patterns. Crash data for the latest available five years from January 1, 2013 to December 31, 2017 was downloaded from the VDOT TED Online Crash Analysis Tableau. The following section provides a summary of crashes that occurred within the study area.

### 2.8.1 Summary of Study Area Crashes

Over the five-year period, 215 crashes were reported along Greenville Avenue, out of which 124 occurred in the northbound direction and 91 in the southbound direction. The annual crash frequency over the five-year period is shown in [Figure 7](#). The number of crashes increased between 2013 to 2014 by 40 percent and then remained relatively consistent for the next four years. On average the crash frequency was 43 crashes per year. [Figure 7](#) shows that generally, crash frequency in the northbound direction remained higher than in the southbound direction, except in 2016.

Figure 7: Annual Crash Frequency along Greenville Avenue



[Figure 8](#) summarizes total crashes by severity. Out of 215 total crashes, 94 (43.7%) were Property Damage Only (PDO), 120 (60%) were injury crashes (of all severity types) involving 204 person injuries, and one involved a fatality. The fatal crash occurred on October 10, 2016 at 1:30 PM at the US 11 at Payne Lane intersection and involved one fatality and five injuries. The crash was an angle collision that occurred when a southbound vehicle turned left from US 11 into the shopping mall driveway and failed to yield to a northbound through vehicle. The crash occurred in daylight and under dry surface conditions.

Figure 8: Total Crashes by Severity

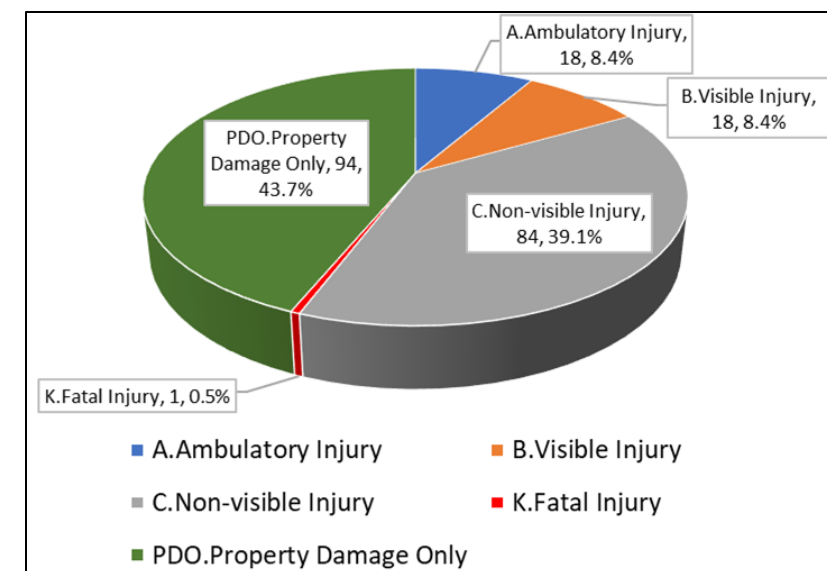


Figure 9 summarizes total crashes by type. The most prevalent crash type along the study corridor was angle collisions, with 101 out of 215, or 46.9 percent. The next most common crash types were 61 rear-end crashes (28.3%), and sideswipe same direction, accounting for 22 (10.2%) crashes. There were also 10 (4.7%) fixed-object and eight (3.7%) deer-related crashes.

There was one pedestrian crash that occurred about 0.25 miles south of Statler Road between Betsy Bell Road and Driscoll Street. The pedestrian was crossing US 11 when it was struck by a vehicle turning left from a driveway. The crash occurred on November 17, 2016 during daylight and dry surface conditions.

The relatively high number of angle crashes are common in this type of urban/commercial corridor with closely spaced intersections, median crossovers, and driveways, because drivers turning left from the mainline or entering the mainline from a side street or driveway can misjudge the adequacy of gaps in opposing traffic or misjudge oncoming traffic speeds.

Also, rear-end crashes are typical in this type of corridor with closely spaced signalized intersections and driveways, combined with a lack of auxiliary lanes where turning vehicles can complete their maneuvers out of the main flow of traffic.

Figure 9: Total Crashes by Type

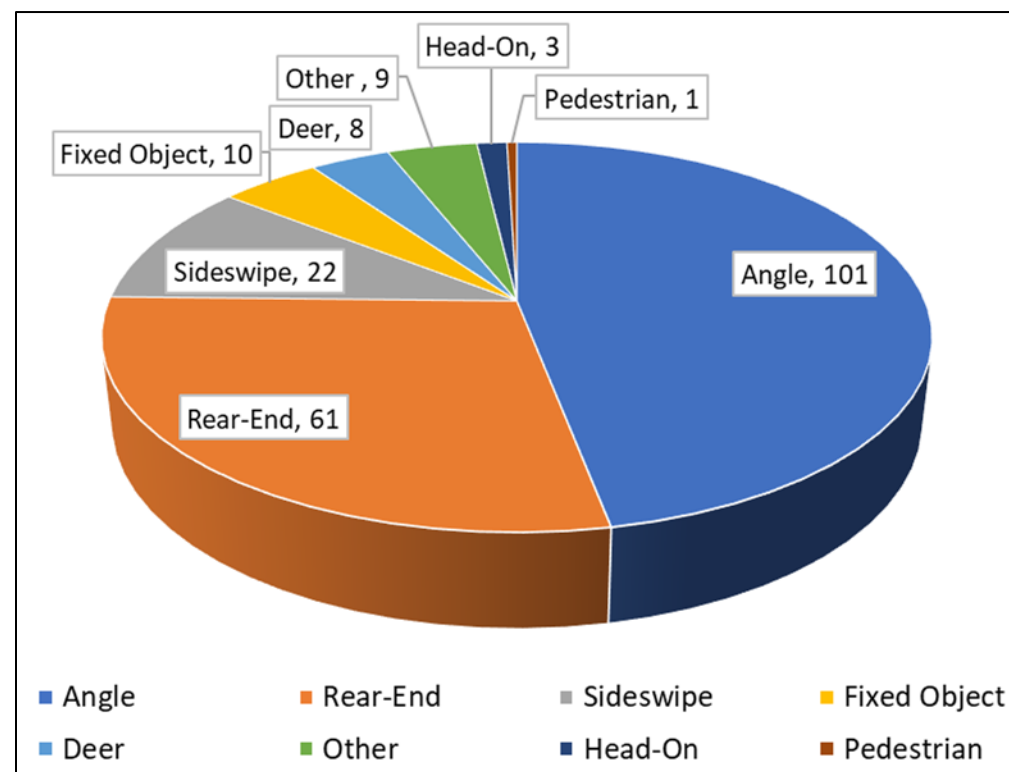


Figure 10 summarizes crashes by time of the day. The majority of crashes, 119 (55.3%), occurred from 12:00 PM to 6:00 PM. This corresponds with the highest traffic period for the corridor.

Figure 10: Total Crashes by Time of the Day

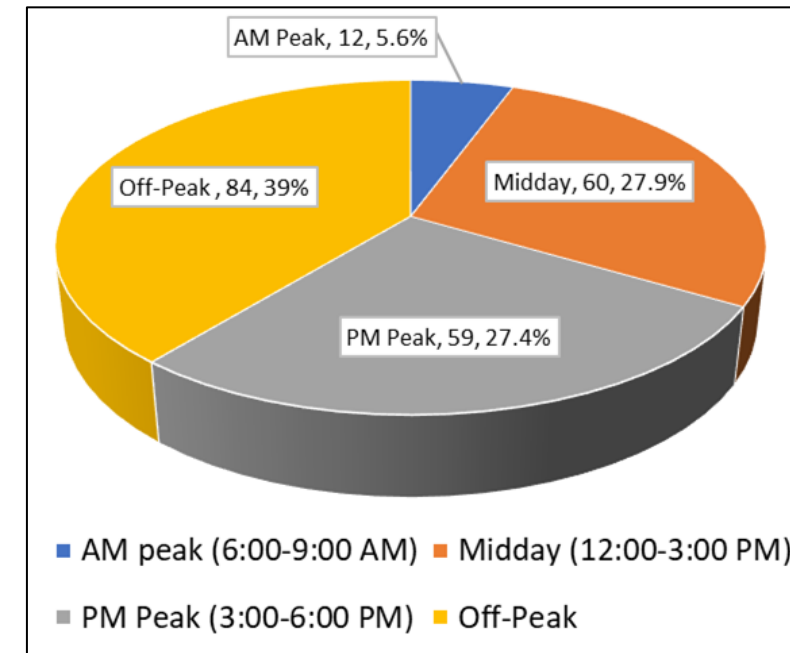


Figure 11 summarizes crashes by lighting conditions. A majority of crashes 174 (81%) occurred in daylight, while less than a third occurring after dark or at dawn/dusk.

Figure 11: Total Crashes by Lighting Conditions

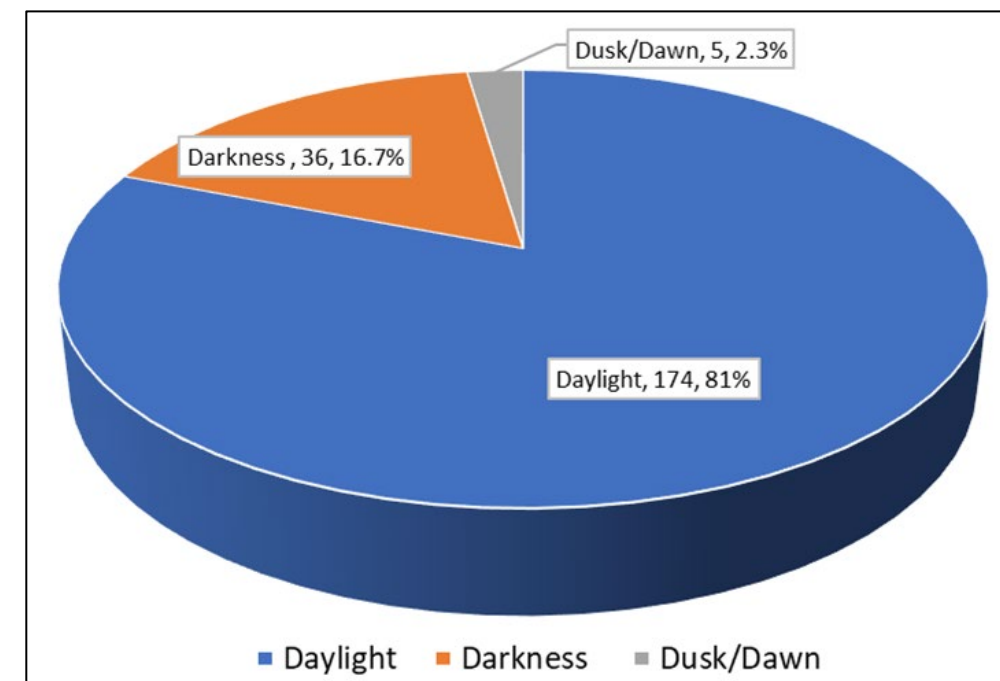
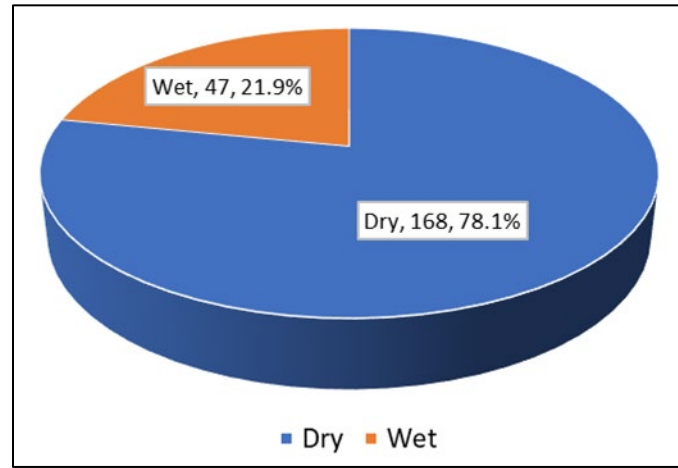


Figure 12 summarizes crashes by surface conditions. The majority of crashes occurred under dry surface conditions, indicating that weather and pavement surface conditions were not typically causal factors for crashes.

Figure 12: Total Crashes by Surface Conditions



To identify crash hotspots and contributing factors along US 11 northbound and southbound, five-year crash data was aggregated by 0.25-mile segments and then plotted by type. Figure 13 plots the northbound direction and Figure 14 plots the southbound direction. In both directions, crashes are concentrated from Orchard Hill Circle to Ritchie Boulevard (MP 236 to 237.25) and then from Richmond Avenue to Commerce Road (MP 237.5 to 238).

Figure 13: Crash Frequency by ¼ mile – Northbound US 11



Figure 14: Crash Frequency by ¼ mile – Southbound US 11



### 2.8.2 Crash Analysis by Intersection

The study area crashes were assigned to intersections using an intersection influence area of a 250-foot radius. The intersection-related crashes include crashes on mainline northbound and southbound US 11, as well as on the side streets within the influence area. [Table 3](#) summarizes the number of crashes by intersection and crash severity.

**Table 3: Crashes by Intersection and Crash Severity**

Intersection Description	Control Type	Number of Crashes					
		K	A	B	C	PDO	Total
US 11 & SB Route 262 Off-Ramp	Unsignalized	0	0	1	0	3	4
US 11 & NB Route 262 Off-Ramp	Signalized	0	0	2	0	5	7
US 11 & Frontier Drive	Signalized	0	1	4	0	12	17
US 11 & Payne Lane	Unsignalized	1	0	4	1	14	20
US 11 & Orchard Hill Circle/ Signalized Mall Entrance	Signalized	0	0	4	1	4	9
US 11 & Barterbrook Road	Signalized	0	6	1	10	3	20
US 11 & Statler Boulevard	Signalized	0	3	0	15	4	22
US 11 & Ritchie Boulevard	Unsignalized	0	1	1	12	4	18
US 11 & Gay Street	Unsignalized	0	0	0	0	1	1
US 11 & Hampton Street	Signalized	0	0	1	9	10	20
US 11 & Richmond Avenue	Signalized	0	1	0	15	12	28
US 11 & Commerce Road	Signalized	0	6	1	24	13	44
<b>Total</b>		<b>1</b>	<b>18</b>	<b>19</b>	<b>87</b>	<b>85</b>	<b>210</b>

The number of crashes at the study intersections identified within top 100 potential for safety improvement (PSI) in Staunton District are as follows:

- US 11 at Commerce Road (Rank: 17) – 44 crashes
- US 11 at Barterbrook Road (Rank: 36) – 20 crashes
- US 11 at Richmond Avenue (Rank: 42) – 28 crashes

Out of the 124 total injury crashes, 64 (51%) occurred at the intersections listed above. In addition, the intersections of US 11 at Commerce Road and US 11 at Barterbrook Road have the highest (12 out of 18) Type A (ambulatory injury) crashes. One fatality crash occurred at the intersection of US 11 at Payne Lane.

[Table 4](#) summarizes crashes by type for each study intersection. A summary of notable crash patterns is listed below.

- US 11 at Payne Lane and US 11 at Ritchie Boulevard - over 75 percent of the crashes were angle collisions. Both intersections are unsignalized intersections with median crossovers providing access to high volume commercial developments on both sides of US 11.

**Table 4: Crashes by Intersection and Crash Type**

Intersection Description	Control Type	Number of Crashes						Total
		Angle	Rear End	Head On	Sideswipe - Same Direction	Fixed Object - Off Road	Other	
US 11 & SB Route 262 Off-Ramp	Unsignalized	0	1	0	1	2	0	4
US 11 & NB Route 262 Off-Ramp	Signalized	3	3	0	0	0	1	7
US 11 & Frontier Drive	Signalized	13	4	0	0	0	0	17
US 11 & Payne Lane	Unsignalized	15	2	1	2	0	0	20
US 11 & Orchard Hill Circle/ Signalized Mall Entrance	Signalized	3	3	0	2	1	0	9
US 11 & Barterbrook Road	Signalized	9	8	1	2	0	0	20
US 11 & Statler Boulevard	Signalized	3	13	0	1	0	5	22
US 11 & Ritchie Boulevard	Unsignalized	14	2	0	1	0	1	18
US 11 & Gay Street	Unsignalized	0	0	0	0	0	1	1
US 11 & Hampton Street	Signalized	6	11	0	1	0	2	20
US 11 & Richmond Avenue	Signalized	10	8	0	5	3	2	28
US 11 & Commerce Road	Signalized	12	22	0	6	2	2	44
<b>Total</b>		<b>88</b>	<b>77</b>	<b>2</b>	<b>21</b>	<b>8</b>	<b>14</b>	<b>210</b>

- US 11 at Frontier Drive intersection - Four out of 13 angle crashes involved vehicles making an illegal left turn onto the Route 262 northbound on-ramp.
- US 11 at Barterbrook Road – Out of 9 angle crashes, four were left turn collisions that occurred when mainline left turns failed to yield to conflicting through vehicles.
- US 11 at Hampton Street – Out of 20 total crashes, 11 (55%) were rear-end collisions. The southbound right turn volume is relatively high but lacks a dedicated right turn lane. Out of six angle crashes, four involved mainline left turns in conflict with through vehicles.
- US 11 at Commerce Road – Out of 22 rear-end crashes, 18 (82%) involved eastbound right turns at the “Yield” approach on East Johnson Street.

The crash patterns identified at signalized and unsignalized intersections were considered during the concept development process. Patterns of rear-end crashes at signalized intersections can be targeted by operational improvements that reduce delay and queuing. At unsignalized intersections, angle and head-on crashes can be targeted by the various access management treatments that limit left-turn and through movements from the side street and some or all left-turn movements from the major street.

The collision diagrams depicting crashes along 0.25-mile segments by type, severity, and other relevant information are provided in [Appendix E](#).

### 3 EXISTING CONDITIONS ANALYSIS

The intent of the existing conditions analyses was to provide a general understanding of the baseline traffic conditions as a starting point for developing future improvement strategies. The base Synchro model for existing conditions was obtained from VDOT and was modified with the following changes:

- Add the study intersections within the City of Staunton limits
- Updated left and right turn lane storage lengths
- Updated existing conditions traffic volumes, peak hour factors, and heavy vehicle percentages
- Signal timing and phasing (obtained from VDOT and the City of Staunton)
- Detector location, verified based on field review, where possible

Based on the review of the turning movement counts, the PM peak hour traffic volume was determined to represent worst case conditions at all intersections; therefore, traffic operational analyses were conducted to evaluate the overall performance of the study corridor under PM peak hour conditions only.

#### 3.1 Traffic Analysis Results

Traffic analysis results for existing conditions are summarized in the following section of the report. Two measures of effectiveness were selected to quantify performance at the study area intersections:

- Control delay by lane group, approach, and intersection – measured in seconds per vehicle [Synchro 10]
- 95<sup>th</sup> percentile queue length by lane group – measured in feet [Synchro 10]

Delay and level of service (LOS) were reported based on Highway Capacity Manual (HCM 2000) methodology for all intersections, except for the intersections of US 11 at Gay Street and US 11 at Ritchie Boulevard were reported using HCM 6 methodology.

##### 3.1.1 Level of Service Criteria

Level of Service (LOS) was used to supplement control delay results from Synchro 10 based on the criteria outlined in HCM 6 and HCM 2000. LOS is a quality measure describing operating conditions and the driver’s perception of those conditions. LOS A indicates a condition of little or no congestion whereas LOS F indicates a condition of severe congestion, unstable traffic flow, and stop-and-go conditions. *Table 5* summarizes the delay thresholds associated with each LOS category for signalized and unsignalized intersections. If intersection traffic volume exceeds capacity, LOS F is automatically reported.

Table 5: Signalized and Unsignalized Intersection LOS Criteria

LOS	Control Delay (sec/veh)	
	Signalized Intersections	Unsignalized Intersections
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

##### 3.1.2 Control Delay and LOS Results

A table summarizing the existing conditions control delay and LOS results by lane group, approach, and intersection at each study area intersection is provided in *Appendix F*. A representation of the control delay and LOS results within the study area for the PM peak hour is shown in *Figure 15*. The corresponding Synchro output sheets are included in *Appendix F*.

All movements at the study interactions operate at LOS D or better, except for the following:

- Intersection of US 11 at Ritchie Boulevard – Eastbound shared through/left turn operates at LOS F.
- Intersection of US 11 at Richmond Avenue – Northbound shared through/right turn and westbound shared through/left turn both operate at LOS E.
- Intersection of US 11 at Commerce Road – All movements at this intersection operate at LOS E or LOS F, except for the northbound approach. The overall intersection operates at LOS F.

Control delay and LOS were not reported at several unsignalized intersection movements due to the limitations of HCM methodology for the given lane configuration.

##### 3.1.3 95<sup>th</sup> Percentile Queue Length Results

A table summarizing the existing conditions 95<sup>th</sup> percentile queue lengths by lane group at each intersection within the study area is provided in *Appendix F*. *Figure 16* depicts the queue results in the study area for the PM peak hour. The corresponding Synchro output sheets are included in *Appendix F*.

Queue lengths that exceeds available storage or that extend to the upstream intersection are shown in red.

Figure 15: 2018 Existing Conditions – PM Peak Hour Control Delay and LOS

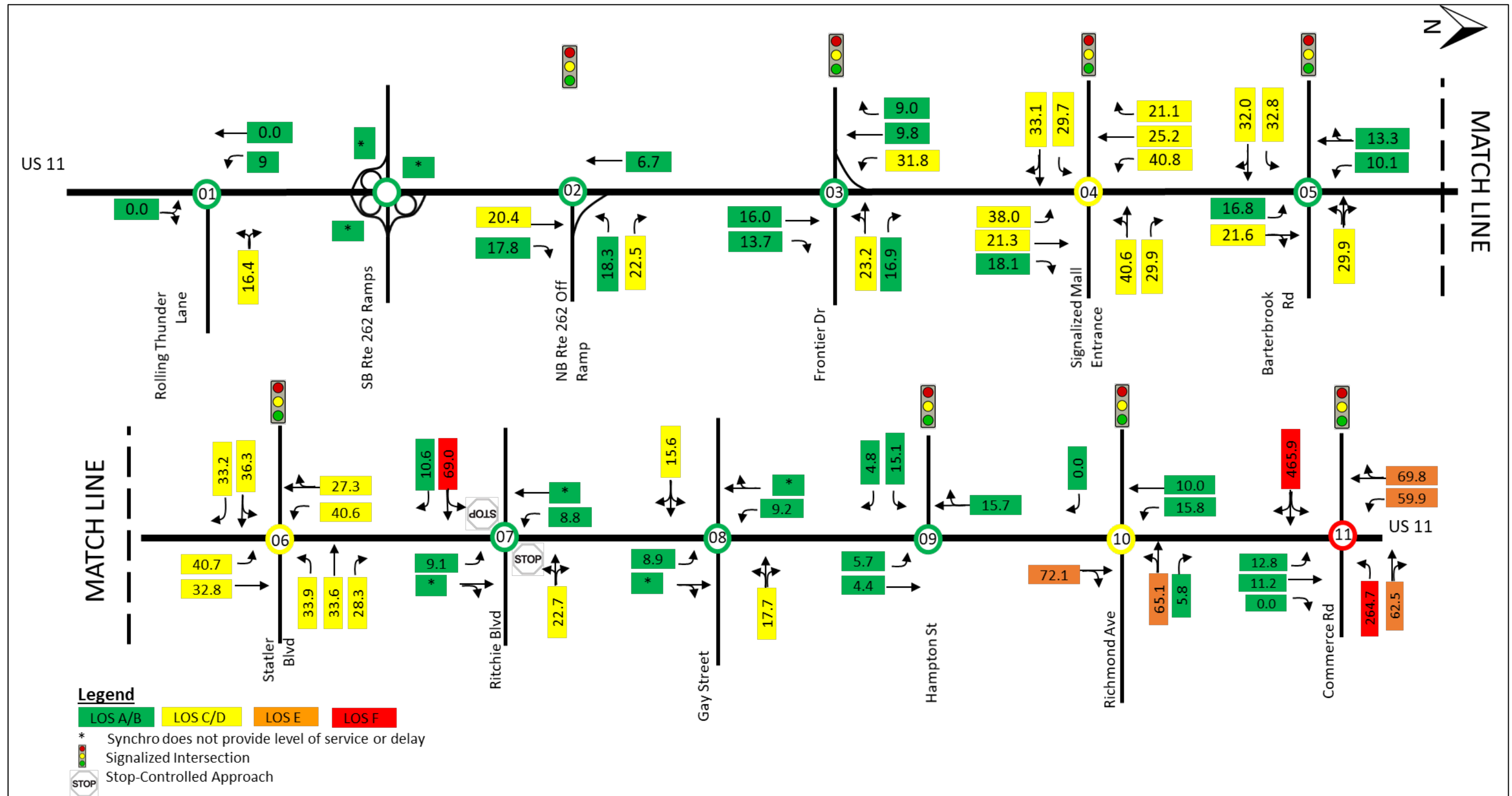
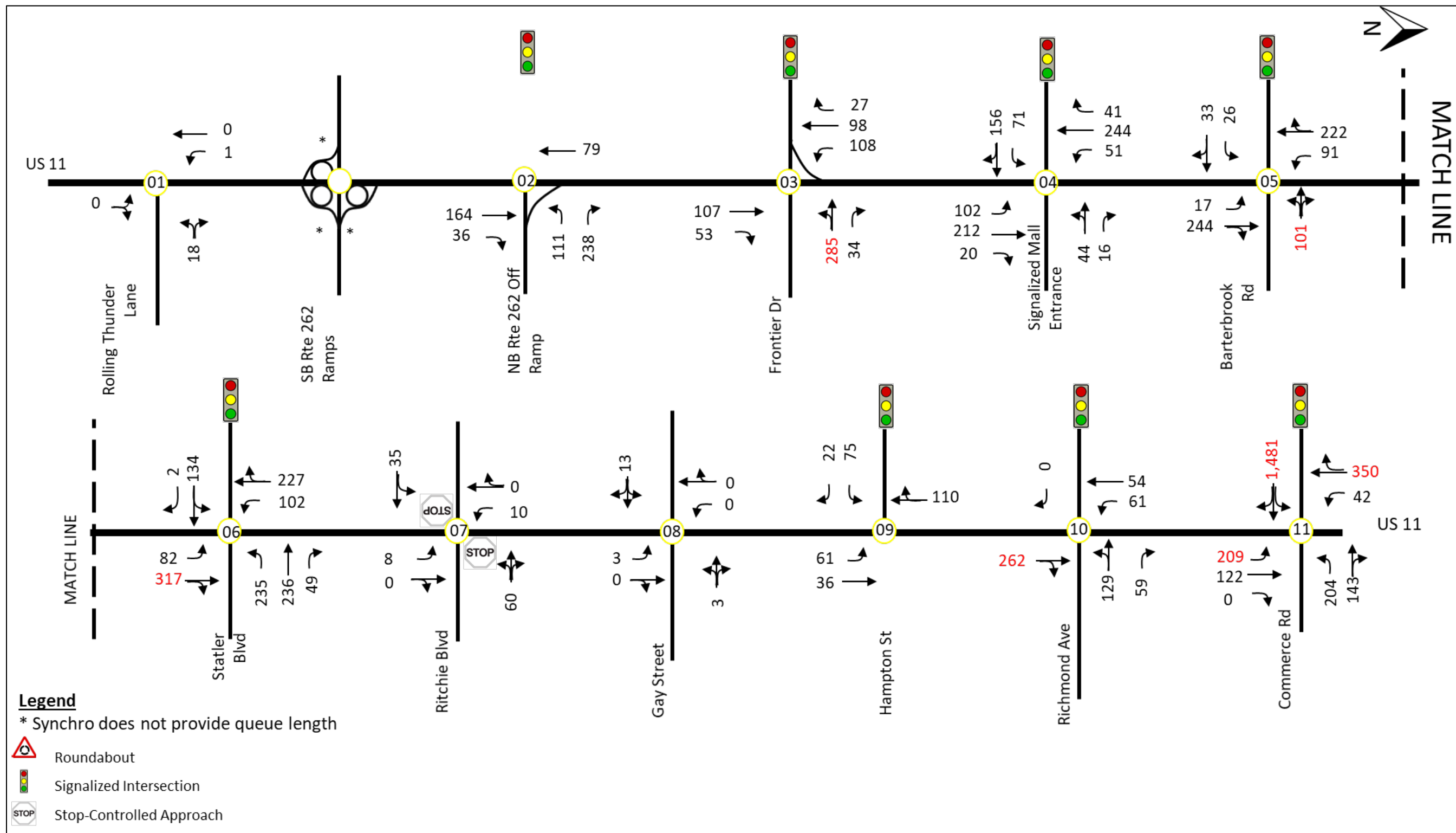




Figure 16: 2018 Existing Conditions – PM 95<sup>th</sup> Percentile Queue Length



## 4 TRAFFIC FORECASTING

To understand future traffic conditions in the study area and assess the long-term benefits of proposed improvements, traffic volumes were forecasted for 2030 traffic conditions. A one percent (1.0%) annual traffic growth rate provided by VDOT was applied to the existing year (2018) PM peak hour volumes over a 12 year-period to obtain the projected 2030 traffic volumes.

In addition to the background growth, new trips generated due to the expansion of the existing Dodge dealership and construction of the hotel in the southeast corner of the Route 262 interchange were added to the background volumes to obtain total 2030 traffic volumes. The new trips generated by both developments were also provided by VDOT.

The technical memorandum for the annual traffic growth rate calculation and the new trip calculations are included in [Appendix G](#). [Figure 17](#) presents 2030 no-build traffic volumes for PM peak hour conditions.

## 5 NO-BUILD CONDITIONS ANALYSIS

Traffic operational analyses were conducted to evaluate the overall performance of the study corridor under no-build (2030) PM peak hour conditions. The intent of the no-build conditions analysis was to provide a general understanding of the baseline future traffic conditions as a starting point for developing future improvement strategies.

### 5.1 Background Improvements

A hybrid roundabout at the intersection of US 11 at Richmond Avenue is planned to be constructed as a part of the Richmond Avenue Road Diet project. The project is funded through SMART SCALE. [Figure 17](#) depicts roundabout traffic control for the intersection of US 11 at Richmond Avenue for no-build conditions.

### 5.2 Traffic Analysis Assumptions

The existing conditions Synchro model was used as a basis to develop the no-build model for the PM peak hour conditions. No geometric or traffic signal timing changes were made to the no-build Synchro model, except for the roundabout at the US 11 at Richmond Avenue intersection and modification of signal timing/phasing at the intersection of US 11 at Commerce Road.

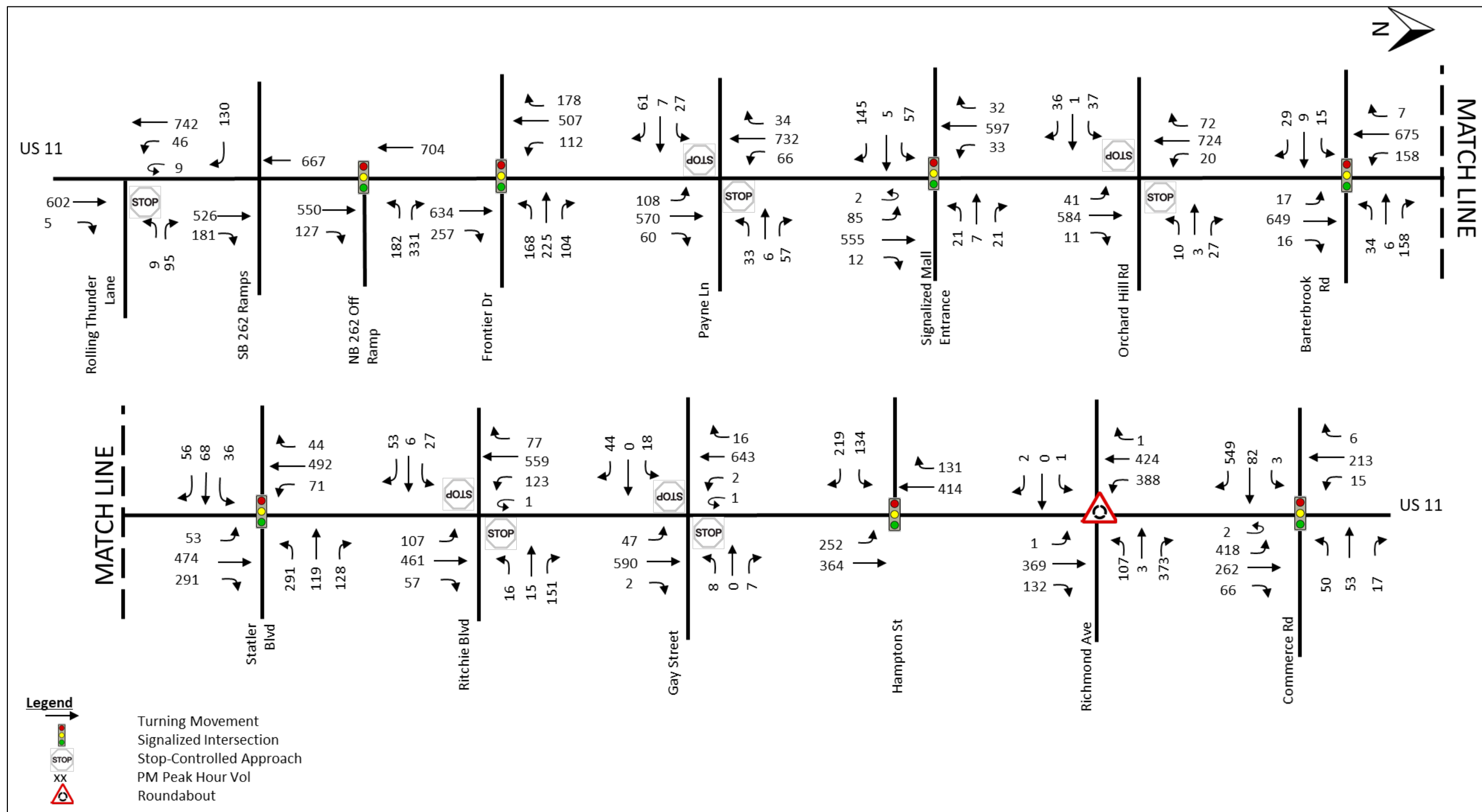
The intersections of US 11 at Richmond Avenue and US 11 at Commerce Road currently operate with a single controller. However, with the construction of a roundabout at the US 11 at Richmond Avenue intersection, signal timing and phasing modifications are expected at the US 11 at Commerce Road intersection. During the existing conditions meeting, the SWG identified access management and safety issues at the intersections of US 11 at Payne Lane and US 11 at Orchard Hill Road. Additional traffic counts were conducted, and the two way stop-controlled intersections were added to the no-build synchro model. The model was updated with projected 2030 no-build traffic volumes. Inputs and analysis methodologies were consistent with the TOSAM.

[Table 6](#) summarizes the delay thresholds associated with each LOS category for roundabouts that were analyzed under future traffic conditions.

Table 6: Roundabout LOS Criteria

LOS	Control Delay (sec/veh)
	Roundabout
A	≤ 10
B	> 10 - 15
C	> 15 - 25
D	> 25 - 35
E	> 35 - 50
F	> 50

Figure 17: 2030 No-Build Traffic Volumes



### 5.3 Traffic Analysis Results

A table summarizing control delay and LOS results by lane group, approach, and intersection at each study area intersection is provided in [Appendix H](#). Control delay and LOS results are shown graphically in [Figure 18](#). The corresponding Synchro and SIDRA output sheets are included in [Appendix H](#).

#### 5.3.1 Control Delay and LOS Results

With the construction of a roundabout at the intersection of US 11 at Richmond Avenue, all movements at the intersection operate at LOS B or better. Similarly, with signal timing and phasing modifications at the intersection of US 11 at Commerce Road, all movements operate at LOS D or better.

All movements at the remaining study intersections operate at LOS D or better, except for the stop-controlled approaches at the following intersections:

- US 11 at Payne Lane
- US 11 at Orchard Hill Road
- US 11 at Ritchie Boulevard

The eastbound and westbound approaches at these three intersections operate at LOS E or LOS F.

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#### 5.3.2 95<sup>th</sup> Percentile Queue Length Results

A table summarizing 95<sup>th</sup> percentile queue lengths for no-build conditions by lane group is provided in [Appendix H](#). A graphic representation of the queue results is shown in [Figure 19](#). The corresponding Synchro and SIDRA output sheets are included in [Appendix H](#). In [Figure 19](#), any 95<sup>th</sup> percentile queue lengths that extend beyond available storage or that spillback to the upstream intersection are depicted in red.

As shown in [Figure 19](#), the following movements experience queue spillback:

##### US 11 at Frontier Drive:

- The 95<sup>th</sup> percentile queue length for the westbound through/left turns extends by 110 feet.

##### US 11 at Barterbrook Road:

- The 95<sup>th</sup> percentile queue length for the westbound through/left/right turns extends to the upstream intersection.

##### US 11 at Statler Boulevard:

- The 95<sup>th</sup> percentile queue lengths for the northbound and southbound through/right turns extend to the upstream intersections. The northbound approach has relatively high right turn volumes but lacks an auxiliary lane.
- The 95<sup>th</sup> percentile queue length for the northbound left turn extends beyond the existing storage length by 40 feet.

##### US 11 at Commerce Road:

- The 95<sup>th</sup> percentile queue lengths for the northbound left turn and southbound through/right turn extend to the upstream intersections.

- On the eastbound approach, the queue length reduces by 50 percent compared to existing conditions due to the signal timing/phasing modifications, but it still extends to the upstream intersections and driveways.

Figure 18: 2030 No-Build Conditions – PM Control Delay and LOS

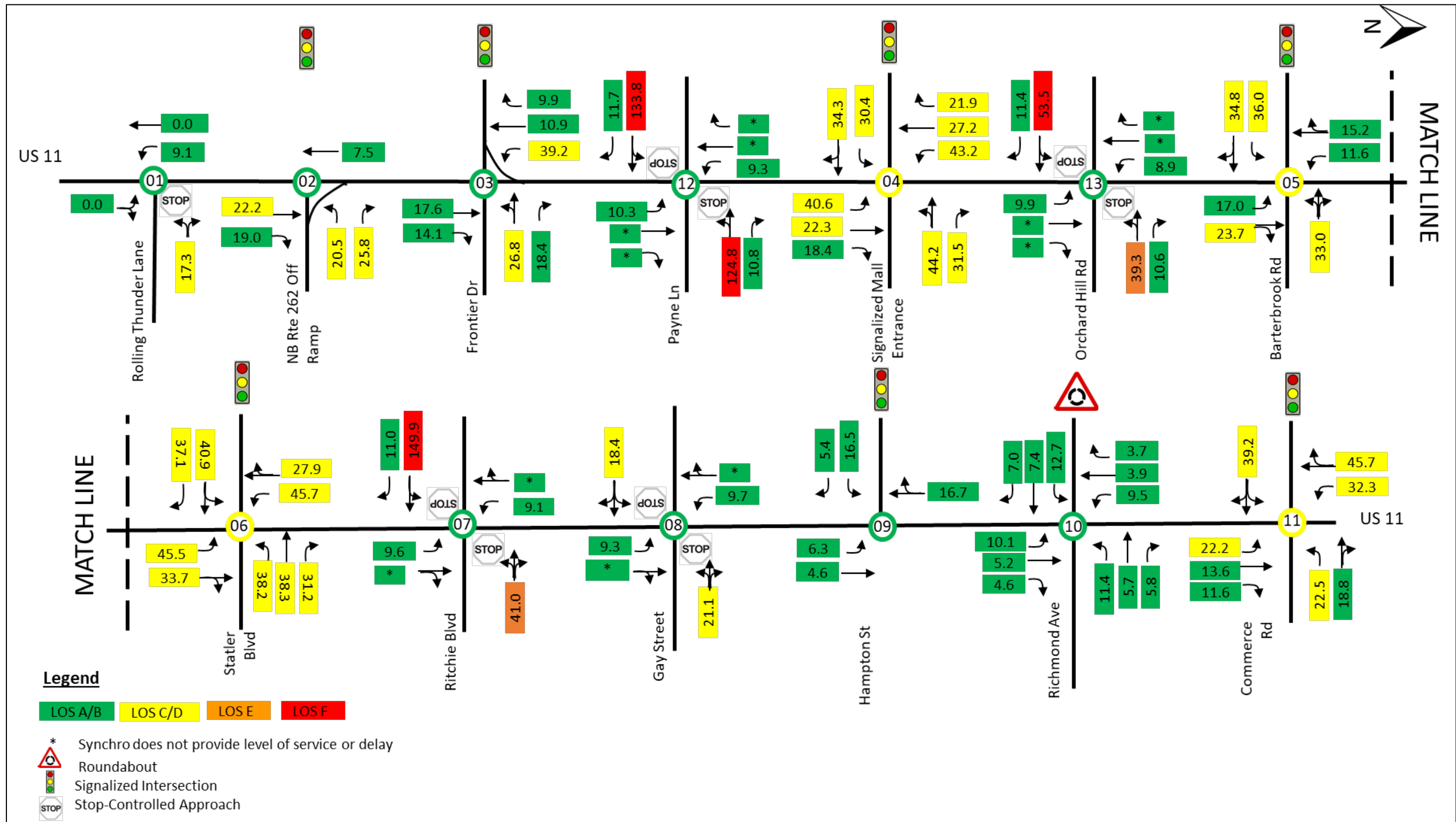
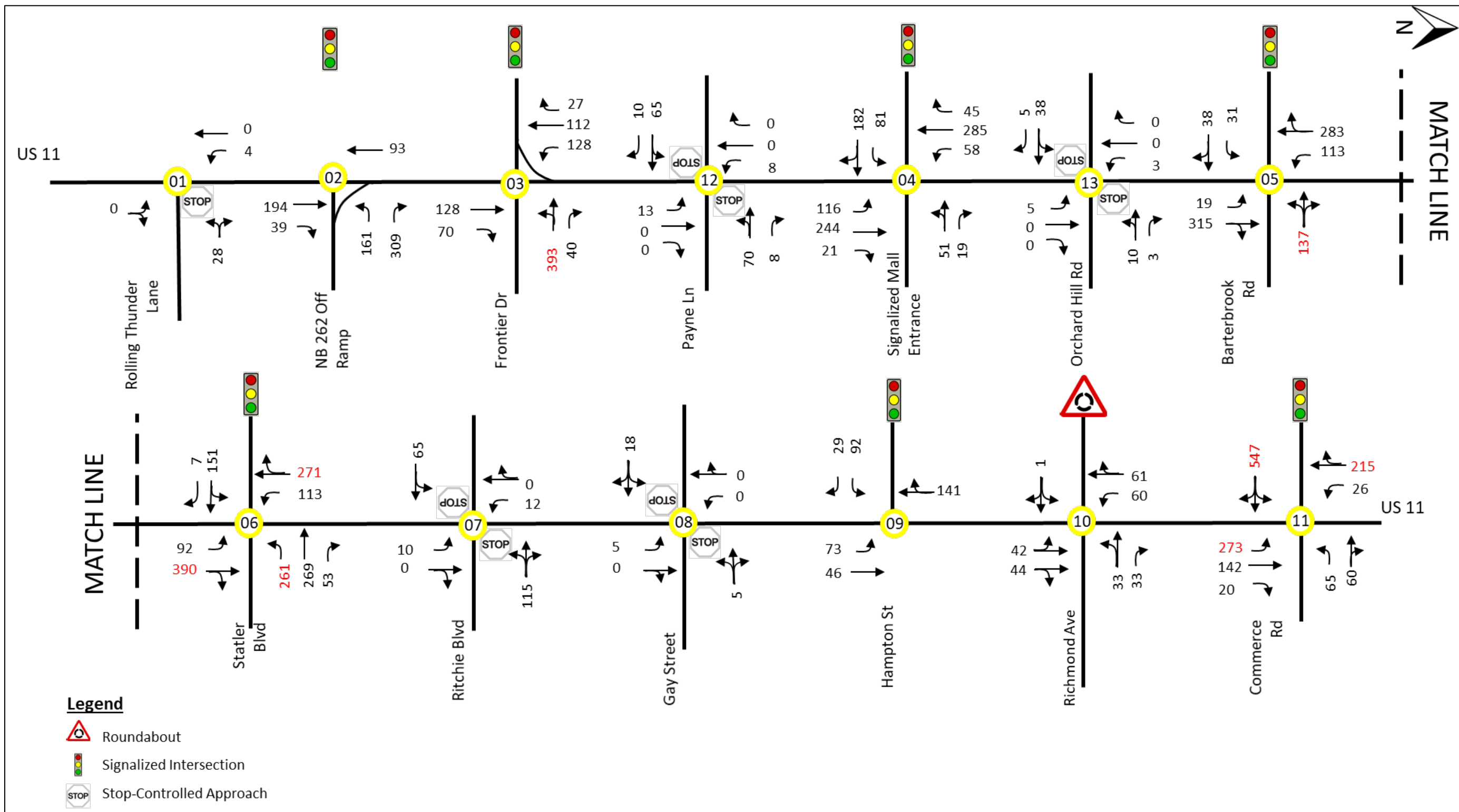


Figure 19: 2030 No-Build Conditions – PM 95<sup>th</sup> Percentile Queue Lengths

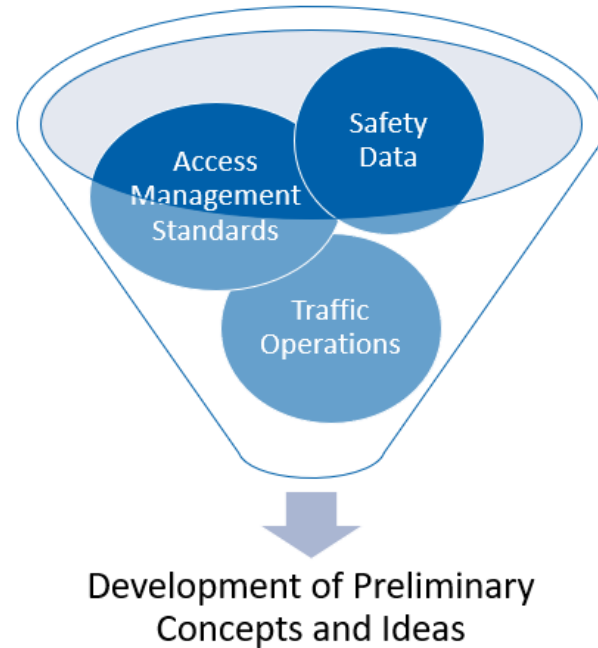


## 6 IMPROVEMENT SCREENING AND ANALYSIS

Improvement project concepts were developed to address safety, geometric, and operational deficiencies along the study corridor identified in the existing and no-build analyses, as well as during the field review. Improvement project concepts were vetted through internal meetings, and shared with the Study Work Group (SWG) at a concept development meeting, then screened based on safety and operational analyses and feedback on feasibility from the SWG. Based on the screening results, final improvement projects were selected. More detailed analysis, design, cost estimates, and schedule estimates were then developed for these improvement projects.

### 6.1 Concept Development

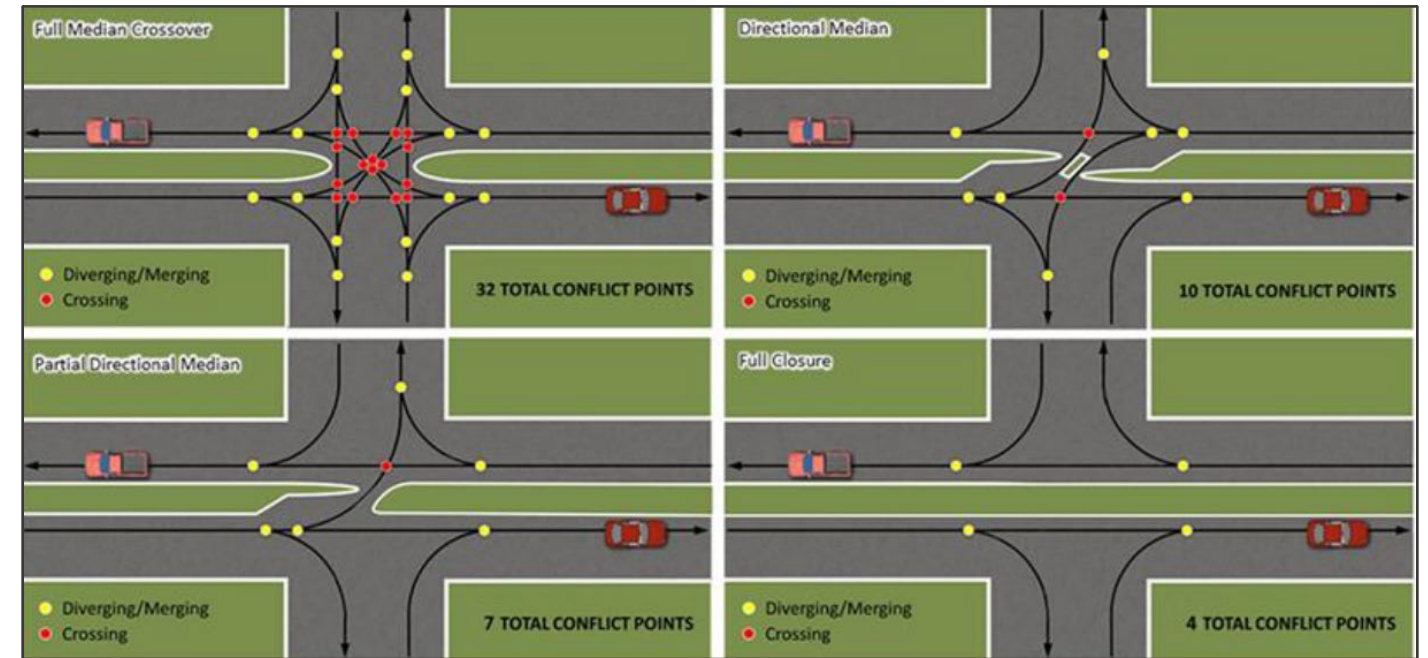
The SWG participated in a concept development meeting on June 18, 2019. During this meeting, the preliminary improvement concepts were shared, screened, and additional concepts were identified through further brainstorming. The concepts discussed during this meeting focused on three key objectives:



#### 6.1.1 Preliminary Concepts Screening

Based on the results of the existing and no-build conditions analyses, the SWG identified different improvement concepts at various locations along the corridor. Existing access management spacing and crash data were evaluated and documented in [Sections 2.7](#) and [2.8](#). The SWG focused on addressing vehicular safety and pedestrian-related issues along the corridor. Crosswalks with pedestrian phasing at the signalized intersections and midblock crosswalks with Rectangular Rapid Flashing Beacon (RRFB) were proposed to address pedestrian safety issues. The SWG also focused on addressing deficient spacing for unsignalized intersections and full median crossovers. The proposed full median closures or conversion to directional median openings aim to address existing safety issues by reducing the number and severity of potential conflict points. [Figure 20](#) illustrates the change in the number and type of conflict points between four intersection types.

Figure 20: Conflict Points by Unsignalized Intersection Type



The SWG discussed the preliminary operations analysis results, safety concerns, and geometric constraints for each proposed improvement and determined which concepts should move forward to further design and analysis. These improvements are identified in [Table 7](#).

In addition to identifying specific improvements at the study intersections and corridor, the following general high level improvements were proposed for further consideration:

- Improve access management to the south of Route 262 interchange by consolidating commercial driveways, providing interparcel connections where feasible, and installing partial or full median closures along US 11 to restrict left turns to/from driveways and mainline. This improvement will require further access management study.
- Incorporate access management strategies into local comprehensive plan and zone ordinance to encourage consolidation of commercial entrances, shared entrances and parking, and interparcel connections as corridor properties redevelop in the future to the north of Route 262 interchange.
- Upgrade/install curb ramps and sidewalk according to ADA compliance throughout the corridor where necessary.
- Refurbish pavement markings throughout the corridor where needed.
- Replace existing “Protected/Permissive” left turn signal heads on US 11 with Flashing Yellow Arrows.
- Update the yellow and red time clearance intervals at corridor signals to conform to the requirement of VDOTIIM TE-306.1.
- Extend the existing sidewalk network south from the City limits to the intersection of Frontier Drive.

For the proposed alternatives with partial and full median closures, AutoTurn was used to evaluate the vehicle path maneuvers to determine the largest vehicle that can make a left turn or U-turn when re-routing vehicles for restricted movements. The AutoTurn evaluation supports the following results:

- WB-62 is the largest vehicle that can make left turns from northbound US 11 onto Payne Lane.
- WB-40 is the largest vehicle that can make the U-turns at all intersections within the existing US 11 footprint.

It was discussed with VDOT and agreed upon that the vehicles larger than WB-40 can utilize the Route 262 interchange and proposed roundabout at the US 11 at Richmond Avenue intersection. It was also discussed that vehicles larger than WB-40 will alter their existing routes to accommodate the proposed median closures. The AutoTurn graphics for all locations are provided in [Appendix I](#).

### 6.1.2 Final Concept Approval

Based on further discussion and feedback from the SWG, revisions were made and improvements were advanced for future consideration and implementation. The proposed improvements were split into short-term and long-term based on the time and funding required for their completion and implementation. These proposed concepts are summarized in [Table 8](#) and were carried further for additional analysis.

At the US 11 at Payne Lane intersection, two concepts are proposed. Only one of two concepts can be implemented. The short-term improvement proposed at the Amherst Road intersection was implemented by the City at the time of the preparation of this report.

Table 7: Improvement Concepts Screening

Intersection-Specific	Concept Number	Improvement	Advance to Build Conditions Analysis
0.5 miles south of Route 262 Interchange	1	Consolidate some driveways on the west side of US 11	No
	2	Close north driveway to auto repair shop	No
US 11 at Rolling Thunder Ln	1	Extend median to restrict left turns out of Rolling Thunder Lane - concrete median	Yes
	2	Extend median to convert Rolling Thunder Lane to right-in/right-out - painted median	No
US 11 at Frontier Dr	1	Install an overhead sign in advance of the Rte 262 NB on-ramp	Yes
		Extend median on the NB approach to discourage NBL turn from NBT lane	Yes
US 11 at Payne Ln	1	Directional median opening to allow NBL and SBL only	Yes
	2	Directional median opening to allow NBL only	Yes
US 11 at Orchard Hill Rd	1	Close north driveway to Hertz on the west side of US 11	Yes
	2	Directional median opening to allow NBL and SBL only	Yes
		Full median closure and re-route left turns to the adjacent intersections	No
US 11 at Barterbrook Rd	1	Install median at Orchard Hill Road to restrict left turns out of auto dealership driveway	Yes
		Restrict right turns out of the CVS Pharmacy on the east side of US 11	Yes
	2	Extend right turn lane to the intersection approach Change side streets' split phase to concurrent phase	Yes
US 11 at Amherst Rd	1	Close the south entrance to the mall (opposite to Barterbrook Road) and re-route left turns to the north entrance	No
		Eliminate stop bar at the NB approach	Yes
US 11 at Statler Blvd	1	Close the north entrance to staunton bowling lanes on US 11 NB	No
		Extend the sidewalk on the east side of US from the south of Amherst Rd to Statler Blvd	Yes
		Convert entrance to LLC Computers from US 11 SB to right-in/right-out	Yes
		Install crosswalks on the east, west, and north sides of the intersection with pedestrian phasing	Yes
		Replace span wires with mast arms	Yes
		Eliminate WB channelized right turn and convert to conventional right turn	No
US 11 at Ritchie Blvd	1	Restripe one lane on EB Statler Blvd and shift Old Greenville Rd EB approach	No
		Directional median opening to allow NBL and SBL only	Yes
US 11 at Gay St	1	Full median closure and re-route left turns to the adjacent intersections	No
		Install ADA-compliant ramps on all four approaches of the intersection	Yes
US 11 at Hampton St	1	Convert SBTR to SBR only lane	Yes
		2	Install a roundabout
US 11 at Commerce Rd	1	Eliminate EBTL and convert to EBR only and install traffic signal for EBR	Yes
		2	Install a mini roundabout
Corridor-Specific	Concept Number	Improvement	Advance to Build Conditions Analysis
US 11 from Orchard Hill Rd to Barterbrook Rd	1	Extend median at Orchard Hill Road to Barterbrook Road	Yes
US 11 from Betsy Bell Rd to Driscoll St	1	Install 95 ft median and provide midblock crosswalk with ped refuge	Yes
US 11 from Statler Blvd to Richmond Avenue	1	Access management: - Intermittent median closure from Ritchie Blvd to Richmond Avenue - Bike lanes on both sides of US 11	Yes
		2	Road diet + access management: - Three-lane section along US 11 from Statler Blvd to Richmond Avenue - Intermittent median closure from Ritchie Blvd to Richmond Avenue - Bike lanes on both sides of US 11 - Shoulders on both sides of US 11



Table 8: Improvement Concepts Advanced to the Build Conditions Analysis

Intersection-Specific	Type of Improvement	Concept #/ Short-Term/ Long-Term	Proposed Improvement
US 11 at Rolling Thunder Ln	Access Management	Short-Term	Convert Rolling Thunder Ln to Right-Out only, but permitting SB left turns from US 11
US 11 at Frontier Dr	Signage	Short-Term	Install an overhead sign in advance of the Route 262 NB on-ramp
	Traffic Signal Operations		Extend median and install straight thru green arrow on the NB approach
US 11 at Payne Ln	Access Management	Concept 1 Short-Term	Directional median opening - Restrict left turns from Payne Ln and the Mall Entrance
	Access Management	Concept 2 Short-Term	Directional median opening - Restrict left turns from Payne Ln, the Mall Entrance, and SB US 11
US 11 at Orchard Hill Rd	Access Management	Short-Term	Close north driveway to Hertz on the west side of US 11
			Directional median opening - Restrict left turns from Orchard Hill Rd and the Mall Entrance
US 11 at Barterbrook Rd	Traffic Signal Operations	Short-Term	Replace existing heads for left turns from US 11 with Flashing Yellow Arrow Install pedestrian crosswalks and signal heads Change existing side street "Split" phase to Concurrent phase
	Access Management	Long-Term	Restrict right turns out of the the CVS Pharmacy driveway onto US 11 NB Extend right turn lane to the intersection approach
US 11 at Amherst Rd	Pavement Markings	Short-Term	Remove stop bar at the NB approach Install "do not block the box" pavement marking Provide separate storage for US 11 SB left turns
	Pedestrian Facility	Long-Term	Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd
US 11 at Statler Blvd	Access Management/ Traffic Signal Operations/ Pedestrian Facility/ Pavement Markings	Short-Term	Convert entrance to LLC Computers on the west side of US 11 to RI/RO Install puppy tracks for EB thru traffic to the inside lane on EB Statler Blvd
	Access Management/ Traffic Signal Operations/ Pedestrian Facility/ Pavement Markings	Long-Term	Extend existing island for WBR turns and signalize WBR turns Replace span wire with mast arms Install Crosswalks with Pedestrian signal heads Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd Install a raised median and extend to Ritchie Blvd
US 11 at Ritchie Blvd	Access Management	Short-Term	Directional median opening to allow NBL and SBL only
US 11 at Gay St	Pedestrian Facility	Short-Term	Install ADA-compliant ramps on all four approaches Refurbish pedestrian crosswalk markings
	Pedestrian Facility	Long-Term	Install pedestrian refuge in the median
US 11 at Hampton St	Intersection Capacity/ Pedestrian Facility	Short-Term	Convert SBTR to SBR only lane
			Install crosswalk on the west side with pedestrian phasing
US 11 at Commerce Rd	Traffic Signal Operations	Short-Term	Eliminate EBTL and convert to EBR only Install traffic signal for EBR Replace Existing heads for left turns from US 11 with Flashing Yellow Arrow (Further evaluation is required)
	Traffic Control	Long-Term	Convert signal to a hybrid roundabout
Corridor-Specific		Short-Term/ Long-Term	Proposed Improvement
US 11 from Orchard Hill Rd to Barterbrook Rd	Access Management	Short-Term	Extend median at Orchard Hill Road to Barterbrook Rd
US 11 from Betsy Bell Rd to Driscoll St	Pedestrian Facility	Short-Term	Install 95 ft median and provide midblock crosswalk with ped refuge Consider installing Rectangular Rapid Flashing Beacons, if warranted
US 11 from Statler Blvd to Richmond Ave	Access Management	Concept 1 Long-Term	Access management: - Intermittent median closure from Ritchie Blvd to Richmond Ave - Bike lanes on both sides of US 11
	Access Management	Concept 2 Long-Term	Road diet + access management: - Three-lane section along US 11 from Statler Blvd to Richmond Ave - Intermittent median closure from Ritchie Blvd to Richmond Ave - Protected or buffered bike lanes on both sides of US 11

## 7 PREFERRED BUILD CONDITIONS ANALYSIS

Traffic operational and safety analyses were conducted to evaluate the overall performance of the study corridor under build (2030) PM peak hour conditions. The intent of the build conditions analysis was to evaluate the effectiveness of the selected improvement concepts and understand how the improvement projects work in conjunction with one another to mitigate crashes and congestions. Traffic operations analysis was performed using Synchro 10 and SIDRA 8.

### 7.1 Safety Analysis

The effectiveness of the proposed improvements was determined in mitigating crashes along the study corridor. Crash modification factors (CMFs) were used to determine the potential safety benefits of the recommended improvements. The best applicable CMF was applied to crashes in the influence area of each intersection and along the corridor rather than applying multiple CMFs. This method is consistent with the methodology used during the SMART SCALE scoring process. However, the influence areas used in SMART SCALE are likely to differ from those selected for this Study since influence areas were extended as needed based on types and descriptions of nearby crashes.

CMFs were chosen from the approved list used for the Commonwealth of Virginia's SMART SCALE safety scoring process (2018 SMART SCALE Version 3.0 CMF). Since the CMFs for pavement marking and road diet were not available in the SMART SCALE list, they were obtained from FHWA CMF Clearinghouse. The CMFs used for SMART SCALE are applicable to all crash types, but only applied to fatal and injury (FI) crashes.

Equivalent property damage only (EPDO) scores were calculated for each intersection influence area based on the following scale. The EPDO scores were based on fatal and injury crashes only.

- K (fatality) = 85
- A (Disabling Injury) = 85
- B (Evident Injury) = 10
- C (Possible Injury) = 5

The applicable CMFs and potential safety benefits of the proposed improvements are documented in [Table 9](#). A reduction in fatal and injury crashes is projected at all intersections except for the intersection of US 11 at Rolling Thunder Lane. This intersection did not have any crash during the study period examined.

The largest reductions in EPDO crashes are projected at the following intersections:

- US 11 at Barterbrook Road
- US 11 at Statler Road
- US 11 at Commerce Road
- US 11 from Ritchie Boulevard to Commerce Road with Road diet concept

Table 9: Projected Reductions in EPDO Crashes along US 11

Intersection-Specific	Type of Improvement	Proposed Improvement	Existing Crashes (2013-2017)				EPDO (Fi)	Proposed Improvements	
			K	A	B	C		CMF Applied	EPDO Reduction
US 11 at Rolling Thunder Ln	Access Management	Convert Rolling Thunder Ln to Right-Out	0	0	0	0	0	0.75	0
US 11 at Frontier Dr	Signage	Install an overhead sign in advance of the Route 262 NB on-ramp	0	1	4	0	125	-	-
	Traffic Signal Operations	Extend median and install straight thru green arrow on the NB approach						0.85	19
US 11 at Payne Ln	Access Management	Directional median opening - Restrict left turns from Payne Ln and the Mall Entrance	1	0	4	1	130	0.79	27
	Access Management	Directional median opening - Restrict left turns from Payne Ln, the Mall Entrance, and SB US 11						0.71	38
US 11 at Orchard Hill Rd	Access Management	Close north driveway to Hertz on the west side of US 11	0	1	0	0	85	0.72	24
		Directional median opening - Restrict left turns from Orchard Hill Rd and the Mall Entrance						0.79	18
US 11 at Barterbrook Rd	Traffic Signal Operations	Replace existing heads for left turns from US 11 with Flashing Yellow Arrow Install pedestrian crosswalks and signal heads Change existing side street "Split" phase to Concurrent phase	0	6	1	10	570	0.63	208
	Access Management	Restrict right turns out of the the CVS Pharmacy driveway onto US 11 NB Extend right turn lane to the intersection approach						0.40	339
US 11 at Amherst Rd	Pavement Markings	Remove stop bar at the NB approach Install "do not block the box" pavement marking Provide separate storage for US 11 SB left turns	0	0	0	6	30	N/A	N/A
	Pedestrian Facility	Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd						0.9	3
US 11 at Statler Blvd	Access Management/ Traffic Signal Operations/ Pedestrian Facility/ Pavement Markings	Convert entrance to LLC Computers on the west side of US 11 to RI/RO Replace Existing heads for left turns from US 11 with Flashing Yellow Arrow Install Crosswalks with Pedestrian signal heads Install puppy tracks for EB thru traffic to the inside lane on EB Statler Blvd	0	3	0	15	330	0.48	173
	Access Management/ Traffic Signal Operations/ Pedestrian Facility/ Pavement Markings	Extend existing island for WBR turns and signalize WBR turns Replace span wire with mast arms Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd Install a raised median and extend to Ritchie Blvd						0.43	189
US 11 at Ritchie Blvd	Access Management	Directional median opening to allow NBL and SBL only	0	1	1	12	155	0.79	33
US 11 at Gay St	Pedestrian Facility	Install ADA-compliant ramps on all four approaches	0	0	0	0	0	0.85	0
	Pedestrian Facility	Install pedestrian refuge in the median							
US 11 at Hampton St	Intersection Capacity/ Pedestrian Facility	Convert SBTR to SBR only lane Install crosswalk on the west side with pedestrian phasing	0	0	1	9	55	N/A	N/A
								0.85	8
US 11 at Commerce Rd	Traffic Signal Operations	Eliminate EBTL and convert to EBR only Install traffic signal for EBR Install FYA for left turns from US 11	0	6	1	24	640	0.59	262
	Traffic Control	Convert signal to a hybrid roundabout						0.4	384
Corridor-Specific		Proposed Improvement	Existing Crashes (2013-2017)				EPDO (Fi)	CMF Applied	EPDO Reduction
US 11 from Orchard Hill Rd to Barterbrook Rd	Access Management	Extend median at Orchard Hill Road to Barterbrook Rd	0	0	0	2	10	0.4	6
US 11 from Betsy Bell Rd to Driscoll St	Pedestrian Facility	Install 95 ft median and provide midblock crosswalk with ped refuge	0	1	0	4	105	0.85	16
US 11 from Statler Blvd to Richmond Ave	Access Management	Access management: - Intermittent median closure from Ritchie Blvd to Richmond Ave - Bike lanes on both sides of US 11	0	2	3	28	340	0.79	71
	Access Management	Road diet + access management: - Three-lane section along US 11 from Statler Blvd to Richmond Ave - Intermittent median closure from Ritchie Blvd to Richmond Ave - Bike lanes on both sides of US 11 - Shoulders on both sides of US 11	0	2	3	28	340	0.55	153

## 7.2 Traffic Operations Analysis Assumptions

The no-build conditions Synchro models were used as a basis to develop the build models for the PM peak hour conditions. Roadway geometry and traffic signal timing adjustments were made to reflect the improvement strategies set forth in the preferred build alternatives in addition to the following changes:

- The yellow change and red clearance intervals were updated
- All existing “Protected/Permissive” left turn phases on US 11 were updated to Flashing Yellow Arrow operation in Synchro
- Pedestrian signal timings were defined

The models were updated with the re-routed future traffic volumes to account for changing traffic patterns primarily due to the access management improvements in the preferred build alternatives. Re-routing method was determined based on the results from AutoTurn analysis results. At intersections with directional median openings or restricted movements, left-turn and through vehicles were re-routed to turn left at the nearest intersection if feasible. [Table 10](#) summarizes the re-routing method for restricted movements and the percentage of vehicles re-routed to the designated intersection.

**Table 10: Vehicle Re-Routing Method for Build Condition**

Intersection	Restricted Movement	Re-routing Method	Percentage
US 11 at Rolling Thunder Ln	WBL	Turn right and U-turn at the intersection of US 11 and Frontier Drive	100%
US 11 at Payne Lane (Partial median closure)	WBL	Turn left at the intersection of US 11 and Frontier Drive	90%
		Turn left at the intersection of US 11 and the Mall Entrance	10%
	WBT	Turn left at the intersection of US 11 and the Mall Entrance then turn right onto Payne Lane	100%
	EBL & EBT	Turn right and U-turn at the intersection of US 11 and Frontier Drive	98%
Take cloverleaf loop ramps at Route 262		2%	
US 11 at Payne Lane (Partial median closure for EB/WB/WB/SB left)	WBL/WBT/EBL/EBT	Same as in Concept 1	
	SBL	Turn left at the intersection of US 11 and Frontier Drive	60%
		Turn left at the intersection of US 11 and the Mall Entrance	40%
US 11 at Orchard Hill Road	WBL	Turn left at the intersection of US 11 and the Mall Entrance	100%
	WBT	WB through at the US 11 and Orchard Hill Rd intersection	100%
	EBL	Turn EBL at the intersection of US 11 at Orchard Hill Cir	90%
		SB Left turn and U-turn at the intersection of US 11 and Frontier Dr	8%
	Take cloverleaf roop ramps at Route 262	2%	
EBT	EB through at the intersection of US 11 at Orchard Hill Rd	100%	
US 11 at Ritchie Boulevard	WBL	Turn left at the intersection of US 11 and Statler Boulevard	50%
		Turn right and U-turn at the allowable intersection/left-turn lane	50%
	WBT	WB through at the intersection of US 11 and Statler Boulevard	50%
		Turn right and U-turn at the allowable intersection/left-turn lane	50%
	EBL	Turn right and U-turn at the intersection of US 11 and Statler Boulevard EB left turn from the intersection of US 11 at Statler Blvd	70% 30%
EBT	EBT at the US 11 at Statler Blvd intersection	100%	
US 11 at Commerce Road	EBL & EBT	Turn right and U-turn at the intersection of US 11 and Richmond Avenue	100%

The 2030 projected and re-routed traffic volumes for Concept1 is presented in [Figure 21](#) and Concept 2 is presented in [Figure 22](#). The difference between [Figure 22](#) and [Figure 22](#) is the re-routing of traffic volume due to Concept 1 and Concept 2 at the intersections of US 11 at Payne Lane and US 11 at Commerce Road. Following is the re-routing of traffic volume at two intersections in concepts 1 and 2.

### Intersection of US 11 at Payne Lane

Concept 1 (Figure 33) - Left turns from side streets (Payne Lane and Mall Entrance) are restricted. The eastbound left turns from Payne Lane are re-routed via eastbound right turns and then as southbound U-turns at the intersection of US 11 at Frontier Drive. Restricted left turns from Mall Entrance are re-routed via westbound left turns from the intersections of US 11 at Frontier Drive and US 11 at signalized Mall Entrance.

Concept 2 (Figure 34) – Left turns from side streets (Payne Lane and Mall Entrance) and southbound US 11 are restricted. The eastbound and westbound side streets left turns are re-routed as in Concept 1. Southbound left turns from US 11 are re-routed via left turns from Signalized Mall Entrance and from Mall Entrance opposite to Orchard Hill Road.

### Intersection of US 11 at Commerce Road

Concept 1 (Figure 33) - Eastbound left turns and through traffic from Greenville Avenue (Johnson Street) are restricted and re-routed via eastbound right turns and as southbound U-turn from the intersection of US 11 at Richmond Avenue.

Concept 2 (Figure 34) – There is no restriction of movements in Concept 2.

Figure 21: 2030 Build Traffic Volumes - Concept 1

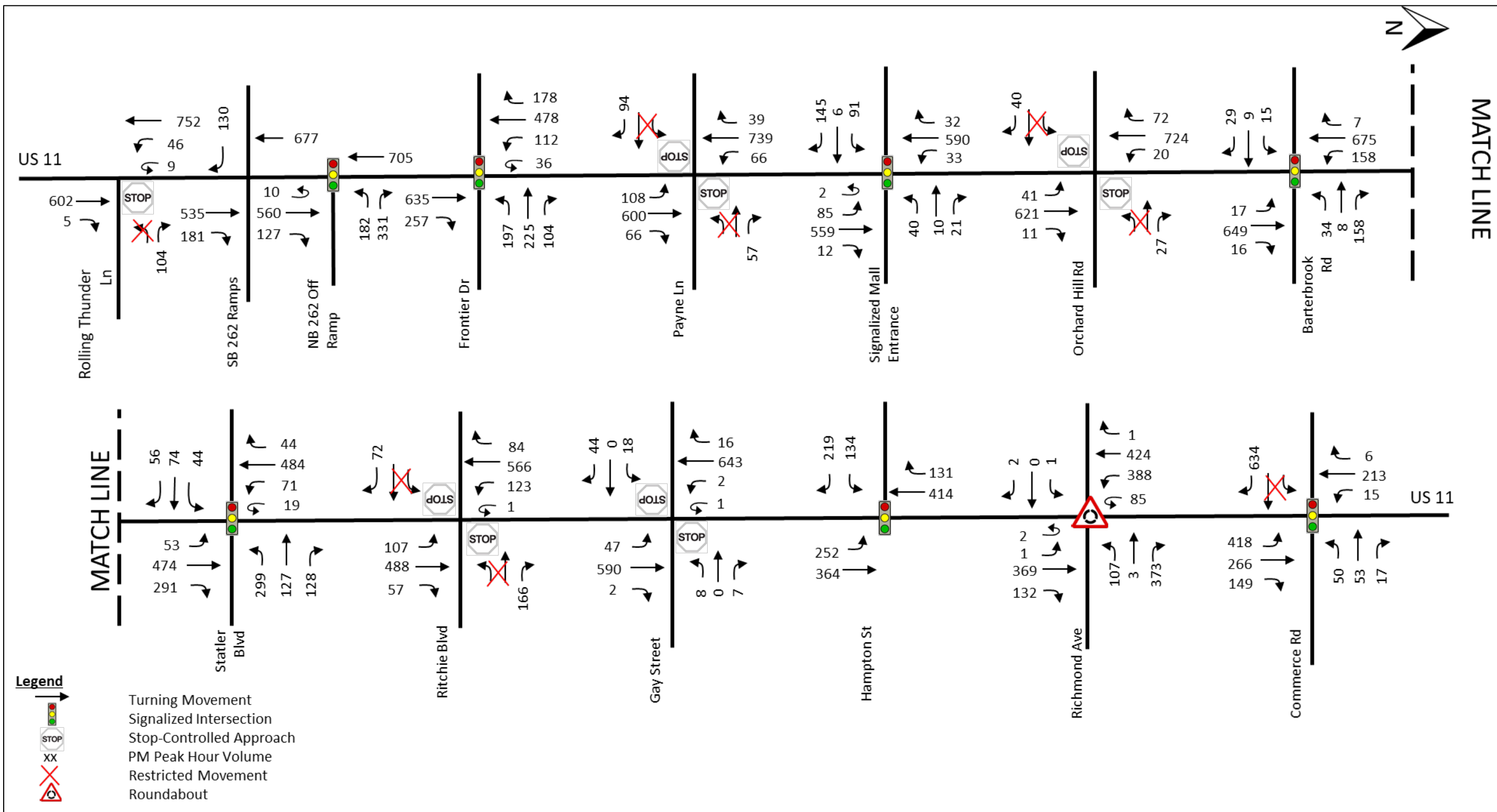
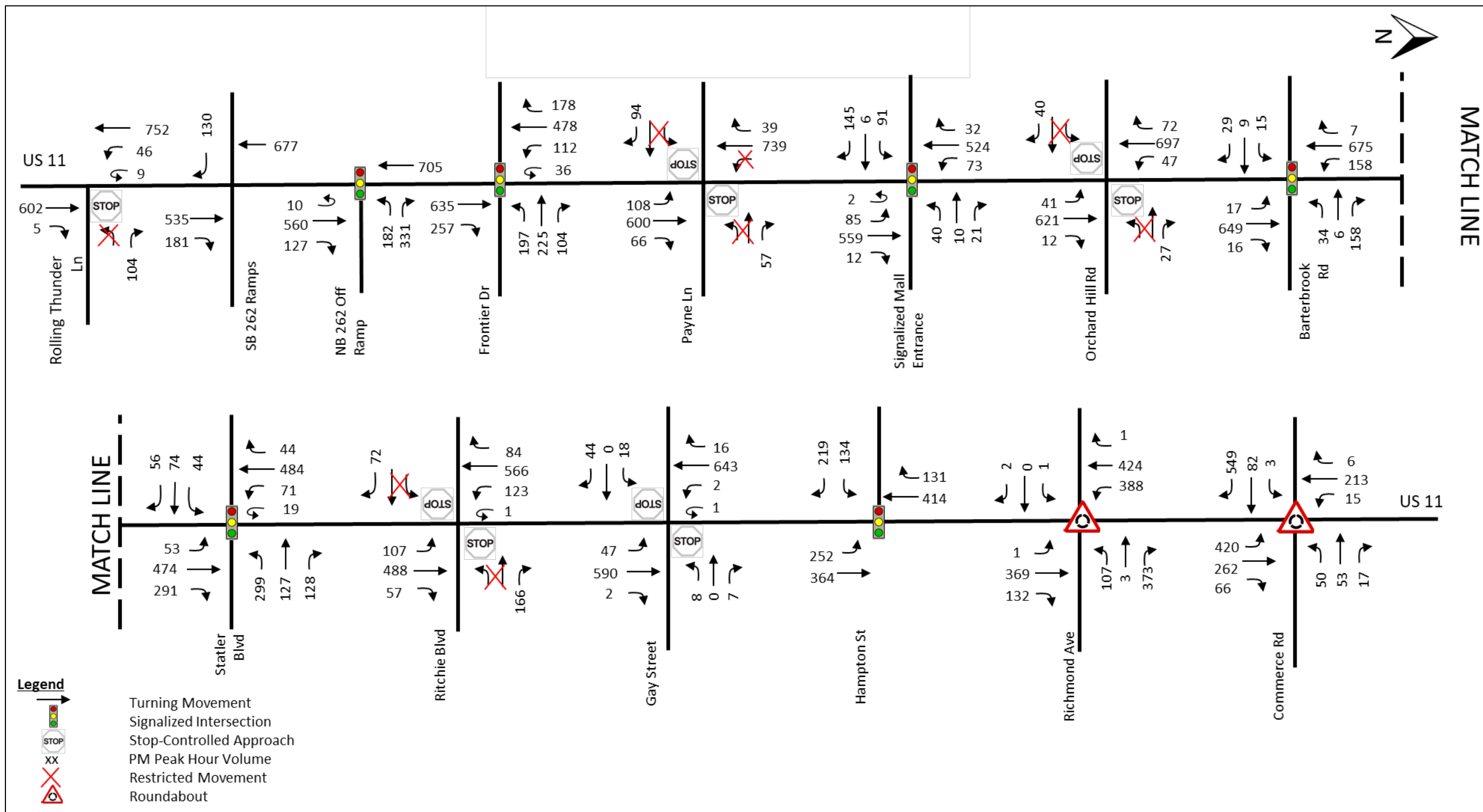


Figure 22: 2030 Build Traffic Volumes - Concept 2



## 7.2 Traffic Analysis Results

The build conditions traffic analysis results are summarized in the following section of the report. The same methodologies used to analyze the existing and no-build conditions were also used to analyze the build conditions. Refer to [Table 5](#) for the delay thresholds associated with each LOS category for signalized and unsignalized intersections.

### 7.2.1 Control Delay and LOS Results

Capacity analysis results indicate that all movements at the study intersections operate at LOS D or better for the build conditions. The intersections evaluated for more than one concept operate at LOS D or better for both concepts. [Figure 23](#) and [Figure 24](#) show a depictive representation of the control delay and LOS results for Concept 1 and Concept 2 analyses, respectively.

**Experienced Travel Time (ETT)** – At the intersections with partial median closures, side street left turns and through traffic are re-routed to the adjacent intersections. The additional delays for the left turns and through traffic were calculated to account for the additional distance traveled. The delay was calculated based on the methodology provided in Chapter 23 of the *HCM 6*. According to this methodology, left turns and through traffic entering from minor street onto a major street due to median closure incur additional travel time, called experienced travel time (ETT). Following is the ETT at the study intersections:

- US 11 at Payne Lane - The eastbound left turns and through movements experience 64.2 sec/veh of delay at LOS E. The overall intersection operates at LOS B at 17.2 sec/veh delay.
- US 11 at Ritchie Boulevard –The eastbound left turns experience 69.3 sec/veh delay at LOS E and the westbound left turns experience 78.9 sec/veh delay at LOS E. Both eastbound and westbound through movements operate at LOS D. The overall intersection operates at LOS A at 8.7 sec/veh delay.
- US 11 at Commerce Road – The eastbound left turns and through movements experience approximately 75 sec/veh delay at LOS E. The overall intersection operates at LOS C with 31.5 sec/veh delay.

#### US 11 at Commerce Road Intersection

The intersection of US 11 at Commerce Road was evaluated for two concepts. In Concept 1, with the elimination of eastbound left turns and through movements and optimization of signal timings, the LOS on the eastbound approach improves from LOS D to LOS C when compared to the no-build conditions. The overall intersection operates at LOS B.

In Concept 2 as a roundabout, all movements operate at LOS B or better and the overall intersection operates at LOS B.

[Table 11](#) presents a comparison of the delay and LOS for the no-build and build conditions for the intersections with re-routed traffic due to partial median closures from adjacent intersections. The analysis results indicate that there is a minimal or no increase in delay at these intersections due to re-routing of vehicles. At the intersection of US 11 at Frontier Drive, the overall intersection declines from LOS B to LOS C. While, at the intersection of US 11 at Statler Boulevard, the overall intersection declines from LOS C to LOD D.

Tables summarizing build conditions control delay and LOS results by lane group, approach, and intersection are provided in [Appendix J](#). The corresponding Synchro and SIDRA output sheets are included in [Appendix J](#).

Table 11: LOS Results for Intersections with Re-routed Vehicles

Intersection Number and Description	Type of Control	Lane Group	Northbound		Southbound		Eastbound		Westbound		Overall
			PM		PM		PM		PM		
			Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	Delay (sec/veh)	LOS	
3. US 11 (Greenville Ave) & Frontier Dr	No-Build	Left	-	-	39.2	D	-	-	26.8	C	Delay (s/veh)
		Through	17.6	B	10.9	B	-	-	-	-	17.8
		Right	14.1	B	9.9	A	-	-	18.4	B	LOS
		Approach	16.6	B	14.7	B	0.0	A	25.1	C	B
	EBL Re-routed from Payne Ln EBL Re-routed from Orchard Hill Rd	Left	-	-	37.6	D	-	-	32.9	C	Delay (s/veh)
		Through	20.6	C	12.2	B	-	-	-	-	21.1
		Right	16.6	B	11.1	B	-	-	21.2	C	LOS
		Approach	19.5	B	16.7	B	-	-	30.6	C	C
	EBL Re-routed from Payne Ln EBL Re-routed from Orchard Hill Rd	Left	-	-	36.8	D	-	-	32.8	C	Delay (s/veh)
		Through	20.1	C	11.9	B	-	-	-	-	20.7
		Right	16.3	B	10.8	B	-	-	20.8	C	LOS
		Approach	19.0	B	16.3	B	-	-	30.4	C	C
4. US 11 (Greenville Ave) & Orchard Hill Cir	No-Build	Left	40.6	D	43.2	D	30.4	C	44.2	D	Delay (s/veh)
		Through	22.3	C	27.2	C	34.3	C	31.5	C	27.5
		Right	18.4	B	21.9	C	-	-	38.8	D	LOS
		Approach	24.7	C	27.7	C	33.2	C	-	-	C
	WBL Re-routed from Payne Ln EBL/WBL Re-routed from Orchard Hill Rd	Left	40.5	D	41.8	D	29.6	C	39.5	D	Delay (s/veh)
		Through	23.5	C	28.3	C	32.8	C	32.1	C	28.3
		Right	19.3	B	22.6	C	-	-	-	-	LOS
		Approach	25.7	C	27.8	C	31.6	C	37.3	D	C
	WBL/SBL Re-routed from Payne Ln EBL/WBL Re-routed from Orchard Hill Rd	Left	36.6	D	36.0	D	27.0	C	42.3	D	Delay (s/veh)
		Through	26.7	C	27.0	C	29.8	C	28.6	C	28.4
		Right	21.2	C	22.2	C	-	-	38.2	D	LOS
		Approach	27.9	C	27.8	C	28.7	C	-	-	C
13. US 11 (Greenville Ave) & Orchard Hill Rd	No-Build	Left	9.9	A	8.9	A	53.5	F	39.3	E	Delay (s/veh)
		Through	*	*	*	*	-	-	-	-	2.4
		Right	*	*	*	*	11.4	B	10.6	B	LOS
		Approach	0.6	A	0.2	A	33.0	D	19.9	C	-
	SBL Re-routed from Payne Ln	Left	9.9	A	9.1	A	-	-	-	-	Delay (s/veh)
		Through	*	*	*	*	-	-	-	-	0.8
		Right	*	*	*	*	11.4	B	10.7	B	LOS
		Approach	0.6	-	0.2	-	11.4	B	10.7	B	-
6. US 11 (Greenville Ave) & Statler Blvd	No-Build	Left	45.5	D	45.7	D	40.9	D	38.2	D	Delay (s/veh)
		Through	33.7	C	27.9	C	37.1	D	38.3	D	34.1
		Right	-	-	-	-	39.6	D	36.6	D	LOS
		Approach	34.5	C	30.0	C	-	-	-	-	C
	EBL/WBL Re-routed from Ritchie Blvd	Left	48.7	D	49.6	D	43.1	D	40.1	D	Delay (s/veh)
		Through	36.0	C	28.3	C	37.9	D	40.2	D	36.0
		Right	-	-	-	-	41.4	D	31.8	D	LOS
		Approach	36.8	C	31.4	C	-	-	38.2	D	D

Figure 23: 2030 Build Conditions LOS Results – Concept 1

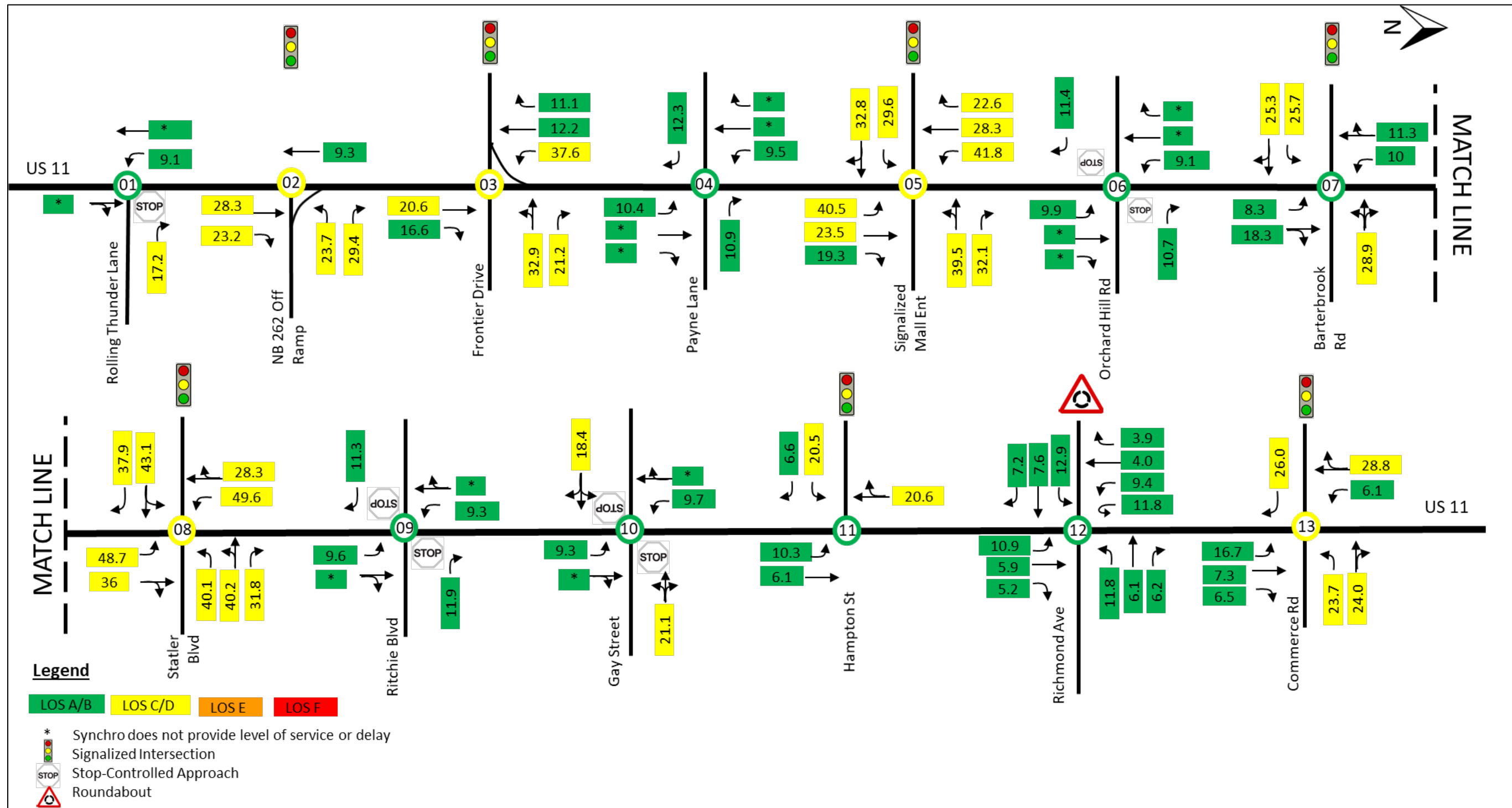
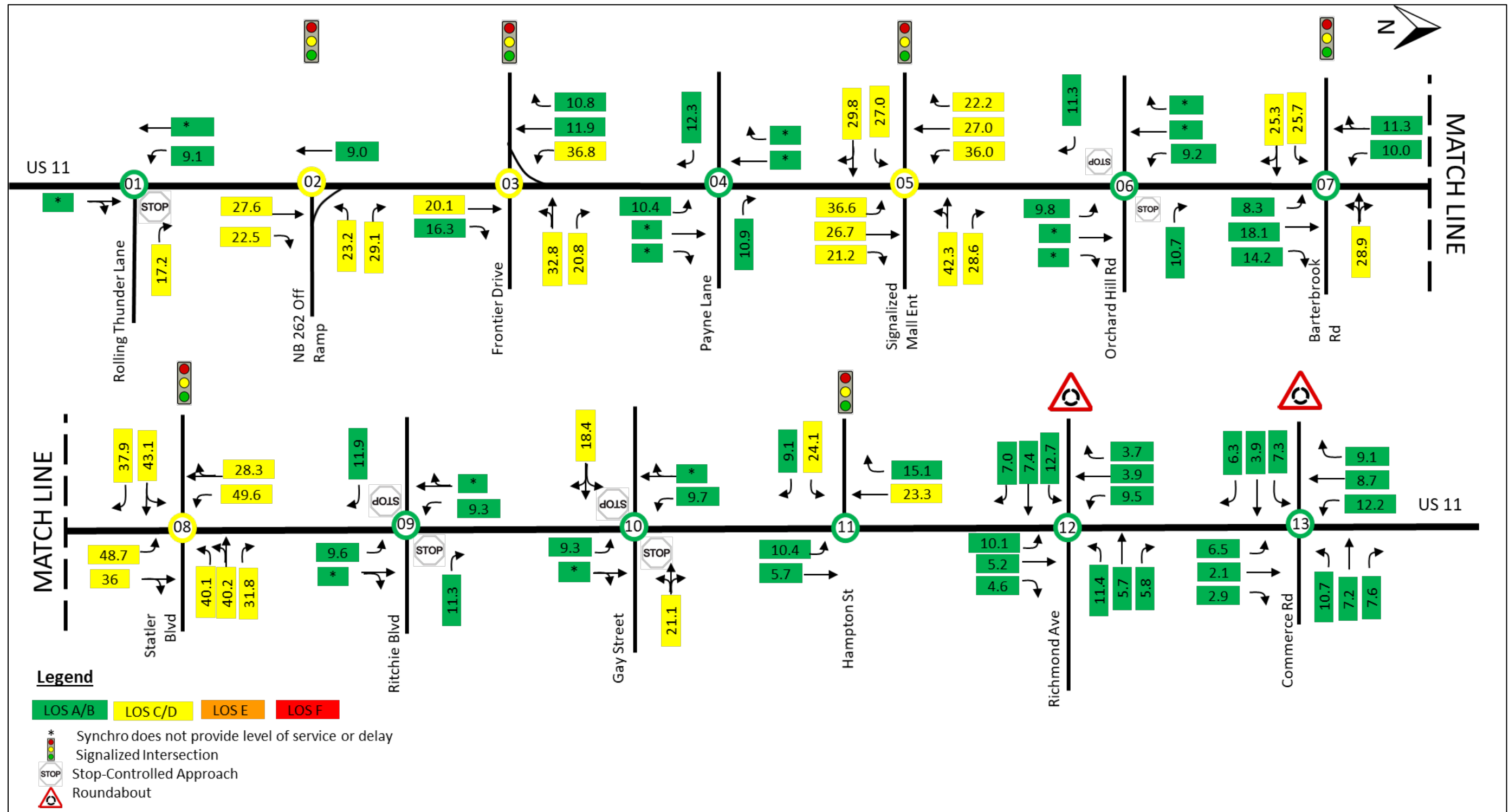




Figure 24: 2030 Build Conditions LOS Results – Concept 2



Road Diet Analysis – From Ritchie Boulevard to Richmond Avenue

Operations analysis were also conducted for the road diet concept from Ritchie Boulevard to Richmond Avenue for the impacted intersections. The analysis was performed with one lane in the northbound direction and one lane in the southbound direction on US 11. The analysis was performed for the study intersection only and not at the corridor level. *Table 12* presents delay and LOS results for intersections included for the road diet concept.

Table 12: LOS Results for Road Diet Concept

Intersection Number and Description	Type of Control	Lane Group	Northbound		Southbound		Eastbound		Westbound		Overall
			PM		PM		PM		PM		
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	
7. US 11 (Greenville Ave) & Ritchie Blvd	Two-Way Stop	Left	9.3	A	9.6	A	-	-	-	-	Delay (s/veh)
		Through	*	*	*	*	-	-	-	-	3.1
		Right	14.3	B	11.8	B	14.3	B	11.8	B	LOS
		Approach	1.5	-	1.6	-	14.3	B	11.8	B	-
8. US 11 (Greenville Ave) & Gay St	Two-Way Stop	Left	9.3	A	*	*	26.8	D	32.0	D	Delay (s/veh)
		Through	*	*	*	*	26.8	D	32.0	D	1.9
		Right	0.7	-	0.0	-	26.8	D	32.0	D	LOS
		Approach	0.7	-	0.0	-	26.8	D	32.0	D	-
9. US 11 (Greenville Ave) & Hampton St	Signal	Left	10.4	A	-	-	24.1	C	-	-	Delay (s/veh)
		Through	6.5	A	23.3	C	-	-	-	-	14.4
		Right	-	-	15.0	B	9.1	A	-	-	LOS
		Approach	8.1	A	21.3	C	14.8	B	-	-	B

The analysis results indicate that all intersections operate at LOS D or better with the proposed road diet.

Additional Analysis

At VDOT’s request, additional analysis was performed for the following improvements:

- US 11 at Barterbrook Road – Lane configuration modified to through/left turn lane and exclusive right turn lane
- US 11 at Statler Boulevard – Dual left turn lanes, a dedicated through and a right turn lane on the westbound approach on Statler Boulevard
- US 11 at Richmond Avenue and US 11 at Commerce Road – Two alternatives were evaluated for the immediate short-term improvement. The first alternative included changing existing signal phasing and optimizing signal timings. This alternative will require signal head modifications. The second alternative involved retiming signal with existing phasing. Since this is an immediate improvement, the analysis was performed for the existing traffic conditions.

*Table 13* presents delay and LOS results for additional analysis. The analysis results are summarized below.

- US 11 at Barterbrook Road – There is a minimal or no difference in delay and level of service with lane modification on the eastbound approach as compared to the existing lane configuration.
- US 11 at Statler Boulevard – With dual left turn lanes on the westbound approach on Statler Boulevard, the overall intersection improves from LOS D to LOS C. The overall intersection delay reduces by 5.2 sec/veh.
- US 11 at Richmond Avenue/US 11 at Commerce Road – In both alternatives, all movements at the intersection of US 11 at Richmond Avenue and US 11 at Commerce Road operate at LOS D or better as compared to the existing conditions where several movements operate at LOS E or F.

Table 13: LOS Results for Additional Analysis

Intersection	Type of Control	Lane Group	Northbound		Southbound		Eastbound		Westbound		Overall
			PM		PM		PM		PM		
			Delay	LOS	Delay	LOS	Delay	LOS	Delay	LOS	
5. US 11 (Greenville Ave) & Barterbrook Rd EB Approach Modified	Signal	Left	8.3	A	10.0	A	25.8	C	28.8	C	Delay (s/veh)
		Through	18.3	B	11.3	B	25.1	C	28.8	C	16.2
		Right	-	-	-	-	-	-	-	-	LOS
		Approach	18.1	B	11.0	B	25.4	C	28.8	C	B
6. US 11 (Greenville Ave) & Statler Blvd Dual SBL Turns	Signal	Left	44.0	D	44.7	D	38.8	D	35.5	D	Delay (s/veh)
		Through	32.9	C	26.1	C	34.4	C	36.0	D	33.0
		Right	33.7	C	28.8	C	37.4	D	35.4	D	LOS
		Approach	33.7	C	28.8	C	37.4	D	35.4	D	C
10. US 11 (Greenville Ave) & Richmond Ave	Signal (Phasing Modification)	Left	-	-	20.3	C	0.0	A	19.7	B	Delay
		Through	22.2	C	5.3	A	0.0	A	19.7	B	14.1
		Right	-	-	-	-	0.0	A	5.5	A	LOS
		Approach	22.2	C	12.6	B	0.0	A	0.7	A	B
	Signal (Signal Timing Optimization-No Change in Phasing)	Left	-	-	6.1	A	-	-	43.1	D	Delay
		Through	46.8	D	4.0	A	-	-	43.1	D	18.7
		Right	-	-	-	-	0.0	A	4.4	A	LOS
		Approach	46.8	D	5.0	A	0.0	A	13.2	B	B
11. US 11 (Greenville Ave) & Commerce Rd Signal Timing Optimization	Signal (Phasing Modification)	Left	31.6	C	20.5	C	32.8	C	24.5	C	Delay
		Through	17.5	B	24.0	C	32.8	C	19.7	B	28.3
		Right	32.9	C	23.8	C	32.8	C	21.7	C	C
		Approach	26.9	C	23.8	C	32.8	C	21.7	C	-
	Signal (Signal Timing Optimization-No Change in Phasing)	Left	20.0	B	35.0	D	48.8	D	47.1	D	Delay
		Through	16.7	B	46.7	D	48.8	D	26.0	C	34.3
		Right	13.7	B	45.9	D	48.8	D	34.7	C	LOS
		Approach	18.3	B	45.9	D	48.8	D	34.7	C	C

The corresponding Synchro output sheets are included in *Appendix J*.

### 7.2.2 95th Percentile Queue Length

Tables summarizing 95<sup>th</sup> percentile queue lengths for the build conditions by lane group are provided in [Appendix J](#). A graphical representation of the queue length results is shown in [Figure 25](#) and [Figure 26](#) for Concepts 1 and 2, respectively. The queue lengths that extend beyond available storage or that spillback to the upstream intersection are depicted in red. The corresponding Synchro and SIDRA output sheets are included in [Appendix J](#).

The noted increase or decrease in queue length due to proposed improvements as compared to the no-build conditions is summarized below.

#### US 11 at Frontier Drive:

- Due to re-routing of left turns from the intersections of US 11 at Payne Lane and US 11 at Orchard Hill Road, the 95<sup>th</sup> percentile queue length for the following movements have noticeably increased as compared to the no-build conditions:
  - Southbound Left Turn – The queue length increases from 128 feet to 180 feet. However, the queue can be accommodated within the existing storage length.
  - Westbound Left-Turn/Through Movement – The queue length increases from 393 feet to 432 feet.

#### US 11 at Orchard Hill Road/Signalized Mall Entrance:

- Due to re-routing of southbound left turns from the US 11 at Payne Lane intersection in Concept 2, the southbound 95<sup>th</sup> percentile queue length increases from 60 feet to 100 feet. The queue length can be accommodated within the existing storage length of 195 feet.

#### US 11 at Barterbrook Road:

- With signal phasing and timing optimization, 95<sup>th</sup> percentile queue length for northbound and southbound through movement reduces by 100 feet.
- Queue length for the westbound shared left/through/right turning movement reduces by 40 feet.

#### US 11 at Statler Boulevard:

- The queue length for the northbound and southbound through movements on US 11 reduces by 30 feet.
- The queue length for the westbound left turns increases by 9 ft as compared to no-build conditions. As in the no-build conditions, the queue extends beyond the existing storage length by approximately by three vehicle lengths or 55 feet.

#### US 11 at Hampton Street

- In Concept 2 with a lane drop on the southbound approach, the queue length for southbound through movement increases from 140 feet to 300 feet. However, the queue does not extend to the upstream intersection of West Village Drive.

#### US 11 at Commerce Road

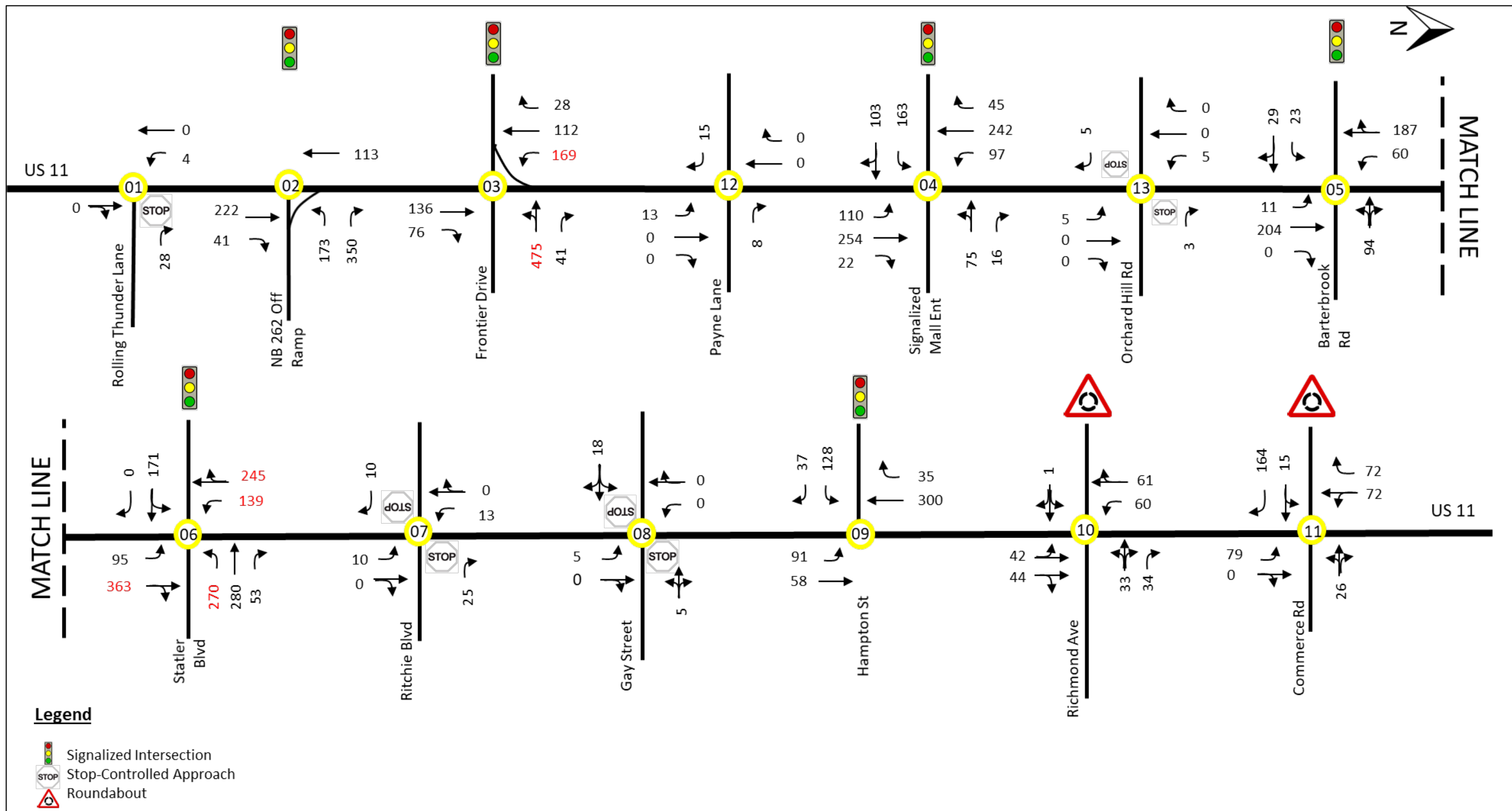
- In Concept 1 with the elimination of eastbound left turn/through movement and signal phasing and timing optimization, the queue length on the eastbound approach reduces from 550 feet to 100 feet.
- In Concept 2 with a roundabout, the following queue length reduction is projected:
  - Northbound left-turn – The queue length reduces by 200 feet
  - Southbound through/left-turn – The queue length reduces by 145 feet

- Eastbound right turn – The queue length reduces by 390 feet

Figure 25: 2030 Build Conditions Concept 1 – PM 95<sup>th</sup> Percentile Queue Lengths



Figure 26: 2030 Build Conditions Concept 2 – PM 95<sup>th</sup> Percentile Queue Lengths



## 8 CONCEPTUAL DESIGN COST AND SCHEDULE

Conceptual designs, planning-level cost estimates, and schedule estimates were developed for each selected improvement project. One-page summary sheets were developed for each project and are provided in [Appendix K](#). Each summary sheet includes a project description, project sketch, location map, planning-level cost estimate, schedule estimate, and a summary of the projected operations and safety benefits.

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### 8.1 Conceptual Design

Conceptual designs were developed in MicroStation for improvement projects along the US 11 corridor in accordance with the following applicable guidelines:

- A Policy on Geometric Design of Highways and Streets (AASHTO 2011)
- VDOT Road Design Manual (Issued January 2005, Revised January 2019)
- VDOT Road and Bridge Standards (VDOT 2016, latest revisions)
- Manual on Uniform Traffic Control Devices (MUTCD 2009)
- 2011 Virginia Supplement to the MUTCD
- Design Manual for the Henrico County Department of Public Works

Design criteria and guidance from these documents were applied to roadways within the project limits based on functional classification and roadway design speeds.

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### 8.2 Planning Level Cost Estimates

A refined planning-level cost estimate, in 2019 dollars, was developed for all selected improvement projects. A 20 percent preliminary engineering (PE) cost was estimated as a percentage of construction costs, including contingency. For projects with anticipated right-of-way and/or utility impacts, right-of-way and utility relocation costs were estimated on a project-by-project basis based on the size and complexity of the project, as well as the existing right-of-way limits. Construction (CN) costs were estimated using a combination of PCES, the 2015 version of Transportation and Mobility Planning Division Statewide Planning Level Cost Estimate Spreadsheet, and recent bid costs. In addition, the construction cost included an additional 20 percent contingency of the base roadway construction cost and 20 percent for construction engineering and inspection (CEI). [Table 14](#) presents planning cost estimates for each project.

### 8.3 Schedule Estimates

All schedule estimates were developed for the proposed projects based on the complexity and type. [Table 14](#) presents planning schedule for each project.

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Table 14: Planning Level Cost Estimates and Schedule

Intersection-Specific	Proposed Improvement	Summary Sheet Reference See Appendix K	Cost Estimate (2019 dollars)					Schedule Estimate (months)			
			PE	CEI	RW	CN	TOTAL	PE	RW	CN	TOTAL
US 11 at Rolling Thunder Ln	Convert Rolling Thunder Ln to Right-Out	Cost for all improvements are covered in Sheet 1	13,100	13,770	9,000	68,350	104,220	4	4	1	9
US 11 at Frontier Dr	Install an overhead sign in advance of the Route 262 NB on-ramp Extend median and install straight thru green arrow on the NB approach		23,100	30,770	16,000	153,350	223,220	4	4	3	21
US 11 at Payne Ln	Directional median opening - Restrict left turns from Payne Ln and the Mall Entrance	Cost for all improvements are covered in Sheet 3	5,900	4,000	--	19,600	29,500	6	--	3	9
	Directional median opening - Restrict left turns from Payne Ln, the Mall Entrance, and SB US 11	Cost for all improvements are covered in Sheet 4	28,000	26,000	--	130,000	184,000	12	--	6	18
US 11 at Orchard Hill Rd	Close north driveway to Hertz on the west side of US 11	Cost for all improvements are covered in Sheet 5. Short term improvements costs are included in the long term cost estimate	31,180	29,180	7,000	145,880	213,240	8	5	4	17
	Directional median opening - Restrict left turns from Orchard Hill Rd and the Mall Entrance		42,205	33,305	--	165,960	241,470	7	4	3	14
US 11 at Barterbrook Rd	Replace existing heads for left turns from US 11 with Flashing Yellow Arrow Install pedestrian crosswalks and signal heads Change existing side street "Split" phase to Concurrent phase	Cost for all improvements are covered in Sheet 5. Short term improvements costs are included in the long term cost estimate	40,560	38,560	--	192,790	271,910	7	4	3	14
	Restrict right turns out of the the CVS Pharmacy driveway onto US 11 NB Extend right turn lane to the intersection approach		77,490	86,390	18,000	432,460	614,340	10	5	6	21
US 11 at Amherst Rd	Remove stop bar at the NB approach Install "do not block the box" pavement marking Provide separate storage for US 11 SB left turns	Cost for all improvements are covered in Sheet 6. Short term improvements costs are included in the long term cost estimate	8,955	6,955	--	34,775	50,685	6	4	3	13
	Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd		11,655	10,655	--	52,770	75,080	9	8	12	29
US 11 at Statler Blvd	Convert entrance to LLC Computers on the west side of US 11 to RI/RO Replace Existing heads for left turns from US 11 with Flashing Yellow Arrow Install Crosswalks with Pedestrian signal heads Install puppy tracks for EB thru traffic to the inside lane on EB Statler Blvd	Cost for all improvements are covered in Sheet 7	4,040	3,540	--	17,700	25,280	6	4	3	13
	Extend existing island for WBR turns and signalize WBR turns Replace span wire with mast arms Install a sidewalk on the east side of US 11 between Amherst Road and Statler Blvd Install a raised median and extend to Ritchie Blvd	Cost for this improvement is covered in Sheets 8 and 10	35,000	35,000	--	402,000	472,000	24	12	12	48
US 11 at Ritchie Blvd	Directional median opening to allow NBL and SBL only	Cost for this improvement is covered in Sheets 8 and 10	12,500	10,500	--	50,000	73,000	6	5	4	15
US 11 at Gay St	Install ADA-compliant ramps on all four approaches	Cost for all improvements are covered in Sheet 7, 9, and 11	5,020	4,520	--	23,000	32,540	3	2	2	7
	Install pedestrian refuge in the median	Cost for all improvements are covered in Sheet 7 and 11 & 11 (cumulative)	11,000	10,500	--	48,000	69,500	6	5	4	15
US 11 at Hampton St	Convert SBTR to SBR only lane	Cost for all improvements are covered in Sheet 7, 9, and 11	4,640	4,140	--	20,690	29,470	3	2	3	8
	Install crosswalk on the west side with pedestrian phasing		4,800	4,300	--	21,110	30,210	3	1	2	6
US 11 at Commerce Rd	Eliminate EBTL and convert to EBR only Install traffic signal for EBR Replace Existing heads for left turns from US 11 with Flashing Yellow Arrow	Cost for all improvements are covered in Sheet 12 (short-term)	84,000	57,000	--	284,000	425,000	5	3	4	12
	Convert signal to a hybrid roundabout	Cost for all improvements are covered in Sheet 12 (Long Term)	524,000	381,000	470,000	2,476,000	3,851,000	24	12	18	54
Corridor-wide	Proposed Improvement	Summary Sheet Reference	Cost Estimate (2019 dollars)					Schedule Estimate (months)			
US 11 from Orchard Hill Rd to Barterbrook Rd	Extend median at Orchard Hill Road to Barterbrook Rd	Cost for this improvement is covered in Sheet 5. Costs shown on this row are for use as a stand alone project.	140,940	115,940	--	582,710	839,590	11	8	6	25
US 11 from Betsy Bell Rd to Driscoll St	Install 95 ft median and provide midblock crosswalk with ped refuge	Cost for all improvements are covered in Sheet 6.	23,345	22,345	--	111,230	156,920	9	4	6	19
US 11 from Statler Blvd to Richmond Ave	Access management: - Intermittent median closure from Ritchie Blvd to Richmond Ave - Bike lanes on both sides of US 11	Cost for this improvement is covered in Sheets 8 and 9	165,000	165,000	--	600,000	930,000	24	12	12	48
	Road diet + access management: - Three-lane section along US 11 from Statler Blvd to Richmond Ave - Intermittent median closure from Ritchie Blvd to Richmond Ave - Bike lanes on both sides of US 11 - Shoulders on both sides of US 11	Cost for all improvements are covered in Sheets 10 and 11	231,500	228,500	--	918,500	1,378,500	24	12	12	48

\* = Stand alone cost already included into the total in Summary Sheet

## 9 PROJECT ADVANCEMENT

This Study should be used as a planning tool to achieve the next steps of planning, programming, designing, and constructing the identified safety and operational improvements in the study corridor. To build upon the efforts of this Study, Staunton District should continue to coordinate with City of Staunton, Augusta County, BRITE Bus Transit Service, and other stakeholders. As further developments are made along the US 11 corridor regarding transit, pedestrian access, and vehicle usage, the stakeholders should reevaluate the proposed projects from this Study. To advance these projects beyond the planning stage, members of the SWG should use the following steps:

### *Prepare Projects for Advancement*

A public outreach meeting was organized by VDOT on October 24, 2019 at Bessie Weller Elementary School to present the proposed improvement concepts to all stakeholders, including the residents and business owners in the area. The District should however conduct additional outreach meetings for further vetting of the proposed projects, as needed. These outreach meetings should include additional stakeholders that were not in the SWG or in the first meeting.

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

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

### *Apply for Funding*

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

- Revenue Sharing – a program that provides a dollar for dollar state match to local funds for transportation projects. Projects eligible for Revenue Sharing funds include construction, reconstruction, improvement, and maintenance projects.
- Highway Safety Improvement Program (HSIP) – a program that provides funding for improvements that correct or improve safety on a section of roadway or intersection with a high incidence of crashes. Although all US 11 improvement projects are candidate projects for HSIP, the intersections of US 11 at Barterbrook Road, US 11 at Statler Boulevard, and US 11 at Commerce Road have the highest projected crash reduction based on the recommended improvements.
- SMART SCALE – a program that allocates funding from the construction District Grants Program (DGP) and High-Priority Projects Program (HPPP) to transportation projects. SMART SCALE uses a scoring process that evaluates, scores, and ranks project applications based on six measures: congestion mitigation, economic development, accessibility, safety, environmental quality, and land use. All proposed projects included in this Study are eligible for SMART SCALE funding.