RIVERSIDE DRIVE (US 58 BUSINESS)

CORRIDOR IMPROVEMENT STUDY

City of Danville, Virginia

FINAL REPORT

December 20, 2019

STARS VDOT

RIVERSIDE DRIVE CORRIDOR IMPROVEMENT STUDY

City of Danville, Virginia

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List of Acronyms

AADT: Average Annual Daily Traffic

AASHTO: American Association of State Highway and Transportation Officials

CLRP: Constrained Long-Range Transportation Plan

CMF: Crash Modification Factor

DGP: District Grants Program

EPDO: Equivalent Property Damage Only

HPPP: High-Priority Projects Program

HSIP: Highway Safety Improvement Program

LOS: Level of Service

MUTCD: Manual on Uniform Traffic Control Devices

PDO: Property Damage Only Crash

PSAP: Pedestrian Safety Action Plan

PSI: Potential for Safety Improvement

RCUT: Restricted Crossing U-Turn

SPS: Statewide Planning System

STARS: Strategically Targeted Affordable Roadway Solutions

TA: Transportation Alternatives

TOSAM: Traffic Operations and Safety Analysis Manual

VDOT: Virginia Department of Transportation

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1 INTRODUCTION

1.1 Background

Through the Strategically Targeted Affordable Roadway Solutions (STARS) program, the Virginia Department of Transportation (VDOT) identifies corridors with safety and congestion challenges and develops solutions that can be programmed into VDOT's Six-Year Improvement Program or funded through other federal and state programs.

VDOT identified Riverside Drive (US Route 58 Business) in the City of Danville as a STARS corridor because of safety and access concerns. The corridor has a high density of signalized intersections, unsignalized median openings, and driveways. Five of the 11 signalized intersections and most of the corridor segments are included in VDOT's lists of intersections and segments with potential for safety improvements, based on crash data from 2013 to 2017.

1.2 Purpose of Study

The Riverside Drive Corridor Improvement Study ("the study") conducted safety and operational analyses and developed recommendations to better manage access, improve safety, and address operational issues in the study area.

1.3 Study Work Group

A study work group guided the study and shaped the development of improvement concepts. The group provided input reflecting local and institutional knowledge through meetings throughout the study timeline. The group reviewed the analysis methodologies, assumptions, and results, and reviewed and approved the recommendations. Study work group members included representatives from multiple agencies with a variety of expertise areas, including traffic engineering, transit operations, regional and local multimodal transportation planning, roadway design, local land use, and community development.

Study work group members represented:

- City of Danville Community Development
- City of Danville Public Works
- City of Danville Parks & Recreation
- Danville Transit
- West Piedmont Planning District Commission
- VDOT Lynchburg District
- VDOT Central Office

A consultant team of EPR, P.C. and Kimley-Horn and Associates led the study and facilitated the study work group meetings.

1.4 Study Area

US Route 58 is a 508-mile long east-west highway that runs from Virginia Beach, VA to Harrogate, TN. Within the Danville city limits, Riverside Drive is designated as US Route 58 Business and is a key corridor for moving traffic between the eastern and western sides of the City. It also provides access to commercial properties. The Riverside Drive Corridor Improvement Study focused on the 3.2-mile section of Riverside Drive between (and including) the intersection with North Main Street to the east and the unsignalized intersection at the Honda dealership entrance and Riverview Dental Care west of Piedmont Drive. **Figure 1** shows the limits of the study area.

The 11 signalized intersections in the study area (listed below from west to east) are shown in **Figure 1**.

1. Park Ave
2. Riverview Dr/ Wild Wings Ln
3. Riverside Center entrance/ K-mart entrance
4. Westover Dr/ Exchange St
5. Old Riverside Dr/ Barter St
6. Mt Cross Rd
7. Piney Forest Rd
8. Audubon Dr
9. Arnett Blvd/ Union St
10. Locust Ln/ Henry Rd
11. Main St

Figure 1 also shows the locations of 14 unsignalized intersections and/or median openings. The study area also includes two grade-separated interchanges – at Piedmont Drive and Central Boulevard.

1.5 Study Area Characteristics

Suburban strip development characterizes the majority of the study corridor. The section between Piedmont Drive and Arnett Boulevard has grassy medians, frequent signalized intersections and median openings, and a high density of driveways. The eastbound direction has three travel lanes throughout this section. The westbound direction has two travel lanes east of Central Boulevard and three travel lanes between Piedmont Drive and Central Boulevard. Adjacent land uses are primarily single-use retail stores and restaurants with large parking lots between the right-of-way and the buildings. This section of the study area is within the City's Piedmont Drive/Mt. Cross Road Planning Area. Many businesses along Riverside Drive have closed or turned over to different uses, including the K-Mart across from Riverside Center, and shops and restaurants within the Danville Plaza shopping center across from Mount Cross Road, which is now used by Dan River Church. According to the study work group, growth in retail, services, and other businesses in the River District and in the shopping centers near Holt Garrison Parkway and Old Mount Cross Road have pulled business activity away from Riverside Drive.

In the eastern section between Arnett Boulevard and Main Street, adjacent development is limited. Access points are limited to a few signalized intersections with roads that provide access to residential neighborhoods. East of Locust Lane, Riverside Drive has two travel lanes in each direction with no median separation. This section of Riverside Drive forms the boundary between the City's North Main Planning Area to the north and the River District Planning Area to the south. The North Main area is largely residential in nature. The City has identified the land on the south side formerly used for the textile mill as an area for redevelopment opportunities and recently constructed a YMCA with access to the Riverwalk Trail.

West of Piedmont Drive, the typical section of Riverside Drive changes to wider shoulders and setbacks. Adjacent development in this section is also limited. This small westernmost section of the study area is within the City's Westover Planning Area. The posted speed limit is 40 miles per hour in the western portion of the corridor and decreases to 35 miles per hour just east of Audubon Drive. VDOT classifies Riverside Drive as an *Other Principal Arterial* (i.e. a principal arterial that is not an interstate, freeway, or expressway) through the entire study area.

Much of the area along the southern side of the roadway is within the 100-year floodplain. In 2018, the City experienced several major storm events and several properties along Riverside Drive flooded.

FIGURE 1: PROJECT STUDY AREA MAP

2 Data Collection and Inventory

The project team collected traffic volume data from a combination of peak hour intersection turning movement counts and 48-hour tube counts. The project team also collected historical traffic volume information and crash data from VDOT, bus stop passenger counts from Danville Transit, and existing traffic signal timing plans from the City. The City also provided project sketches for upcoming road improvements and trail extension projects and GIS shapefiles of bus routes and stops, buildings, parcels, parks, and utilities.

The project team conducted a field review on February 26-27, 2019 to gather additional geometric and operational data, observe traffic patterns, and identify areas with potential operational or safety issues.

The following sections summarize the collected data. Observations from the field review are presented with the discussion of safety deficiencies later in *Section 3.2*.

2.1 Existing Roadway Geometry

The horizontal and vertical alignment of Riverside Drive is generally straight. There are no sharp or steep curves. The terrain is generally flat, except east of Highland Ct, where portions of the road contain guardrails or fences along the back edge of the sidewalk.

Figure 2 shows the existing lane configurations, effective storage lengths for left- and right-turn storage bays, and posted speed limits for the 25 at-grade intersections within the study area. The project team assumed a 25 mile per hour speed limit for roads without a posted speed limit.

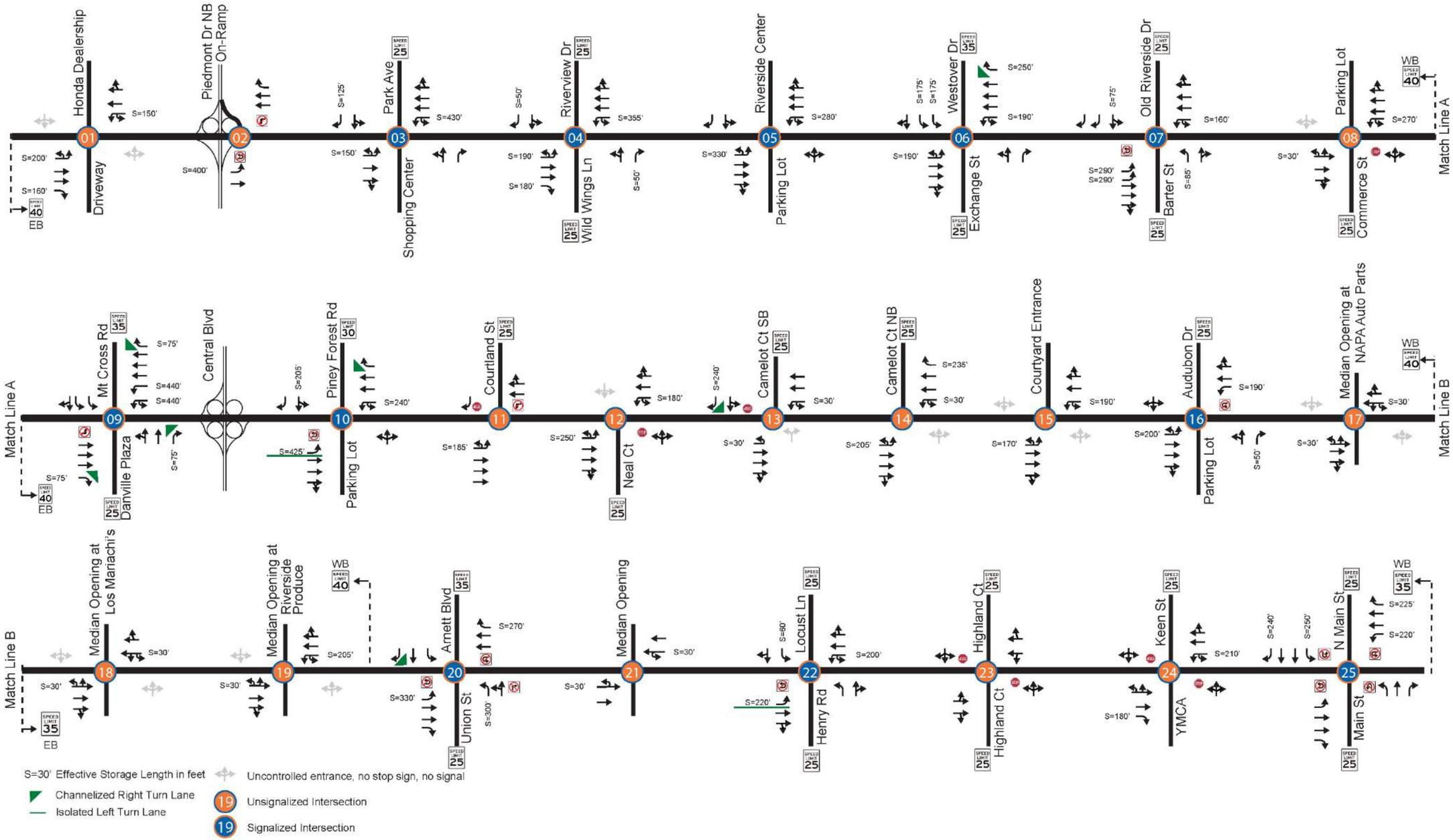
2.2 Land Use

The Existing Land Use map from the City's 2030 Comprehensive Plan shows a mixture of General Commercial, Retail & Service, Office/Professional, and Light Industry along Riverside Drive west of Arnett Blvd. East of Arnett Blvd, the existing land use is generally Single Family Residential to the north and Heavy Industry to the south. The Heavy Industry land was used for the textile mill.

The City's 2030 Comprehensive Plan shows the adjacent properties along Riverside Drive west of Arnett Blvd as Regional Commercial future land use. East of Arnett Blvd, the future land use is Medium Density Residential, and the site formerly used for the textile mill has Light Industrial future land use.

The Existing and Future Land Use maps from the City's 2030 Comprehensive Plan are provided in **Appendix A.**

FIGURE 2: EXISTING LANE CONFIGURATIONS



2.3 Local and Regional Planning Context

2.3.1 Entrance Corridors

The City's 2030 Comprehensive Plan contains a goal to enhance the major transportation corridors and entrance gateways. Riverside Drive, Westover Drive, Mt. Cross Road, and Piney Forest Road are identified as principal entrance corridors.

2.3.2 Existing and Planned Trails

The Riverwalk Trail runs along the northern bank of the Dan River, south of the Riverside Drive corridor. **Figure 3** shows a map of the Riverwalk Trail. Trailheads close to the Riverside Drive study corridor include:

- Robertson Bridge trailhead
- Trade Street trailhead
- Sandy Creek Park trailhead
- Biscuitville trailhead
- Union Street Overlook trailhead
- Danville YMCA trailhead

The Biscuitville trailhead is also a Zagster bike share station, shown in the photo in **Figure 4**.

The City's Riverwalk Trail is part of a much larger Beaches-to-Bluegrass Trail envisioned to connect several existing trails and parks throughout Southside Virginia from Virginia Beach to Cumberland Gap. In 2015, the Virginia Department of Conservation and Recreation and VDOT developed the Beaches-to-Bluegrass Trail Master Plan. While a specific alignment for an off-road trail connection from the Riverwalk Trail west to Martinsville has yet to be identified, the Beaches-to-Bluegrass Trail Master Plan recommends an interim on-road route on Westover Drive, where shared lane markings currently exist.[1]

FIGURE 3: RIVERWALK TRAIL MAP

2.3.3 Southern Virginia Megasite at Berry Hill

The 3,528-acre publicly-owned Southern Virginia Megasite at Berry Hill is located about 10 miles west of the Riverside Drive study corridor as shown in **Figure 5**. The Megasite is owned by Pittsylvania County, the City of Danville, and the Southern Virginia Regional Alliance, who are readying and marketing it to industrial businesses interested in locating on the east coast. The public entities have invested over $100 million in infrastructure, including water, sewer, electric, broadband, natural gas pipeline, and rail access. The entities have also ensured that permitting and zoning is ready for industrial users.[2]

Prior transportation analyses projected 2,500 employees by 2018 (Megasite projected start year) and 11,500 employees by 2040 (Megasite design year).[3] In March 2017, the City and County broke ground at Berry Hill for Phase I,[4] and the Southern Power natural gas electric plant was planned to occupy a portion of the site. In January 2019, Southern Power backed out of the deal, but other prospects have shown interest in the property.[5] Dominion Energy is currently planning to construct a power plant here by April 2022 and is projected to be the first tenant at the Megasite.[6]

In 2018, the Danville Metropolitan Planning Organization submitted a SMART SCALE application for a connector road extending from the existing interchange of Oak Ridge Farms Road and the Danville Expressway west to tie in with Berry Hill Road to serve the Megasite. This project scored extremely well in the economic development factors and is expected to be funded with the High Priority Projects Program in Fiscal Year 2020.[7]

FIGURE 4: PHOTO OF ZAGSTER BIKE SHARE STATION AT BISCUITVILLE

2.3.4 Pedestrian Safety

VDOT identified Riverside Drive as a Pedestrian Safety Priority Corridor in the statewide Pedestrian Safety Action Plan (PSAP). The PSAP recommends installing pedestrian signal heads and countdown signals, high

[1] The City is currently studying the feasibility of striping on-road bicycle lanes on Westover Drive to strengthen this connection.
[2] https://sovamegasite.org/mega-site-overview
[3] VDOT (2015). *US 58 Bypass/ Route 311 Interchange Justification Report*.
[4] Crane (2017). "A Milestone: With Berry Hill Industrial Park groundbreaking, hopes to attract thousands of jobs." Accessed 20 Dec 2019 from https://www.godanriver.com/business/with-berry-hill-industrial-park-groundbreaking-hopes-to-attract-thousands/article_d1a77766-1023-11e7-a3e3-031d07047fe7.html.
[5] McMiller (2019). "$250 million Berry Hill Industrial Park Project canceled." Accessed 6 Feb 2019 from https://wset.com/news/local/250-million-berry-hill-industrial-park-project-canceled.
[6] Ayers (2019). "Dominion looks to invest $330 million in Pittsylvania County with power plant, solar farm." Accessed 20 Dec 2019 from https://www.newsadvance.com/business/dominion-looks-to-invest-million-in-pittsylvania-county-with-power/article_4622913f-148f-5d9f-9726-08d879f80e47.html.
[7] VDOT (2019). *SMART SCALE Project Scores: Fiscal Year 2020 Cohort.* Accessed 6 Feb 2019 from http://vasmartscale.org/documents/20190115/7scorebook2020p.pdf.

visibility crosswalk materials and patterns, modification of medians to median islands, and Pedestrian Hybrid Beacons at midblock crossings. The PSAP highlights the area between Central Blvd and Audubon Dr as an area of emphasis.

2.3.5 Arterial Preservation

VDOT has designated Riverside Drive as a *Mobility Preservation Segment* in its *Arterial Preservation Program*. VDOT's focus on these segments is to preserve mobility by minimizing delays for through traffic whenever access changes are proposed.

FIGURE 5: SOUTHERN VIRGINIA MEGASITE AT BERRY HILL MAP

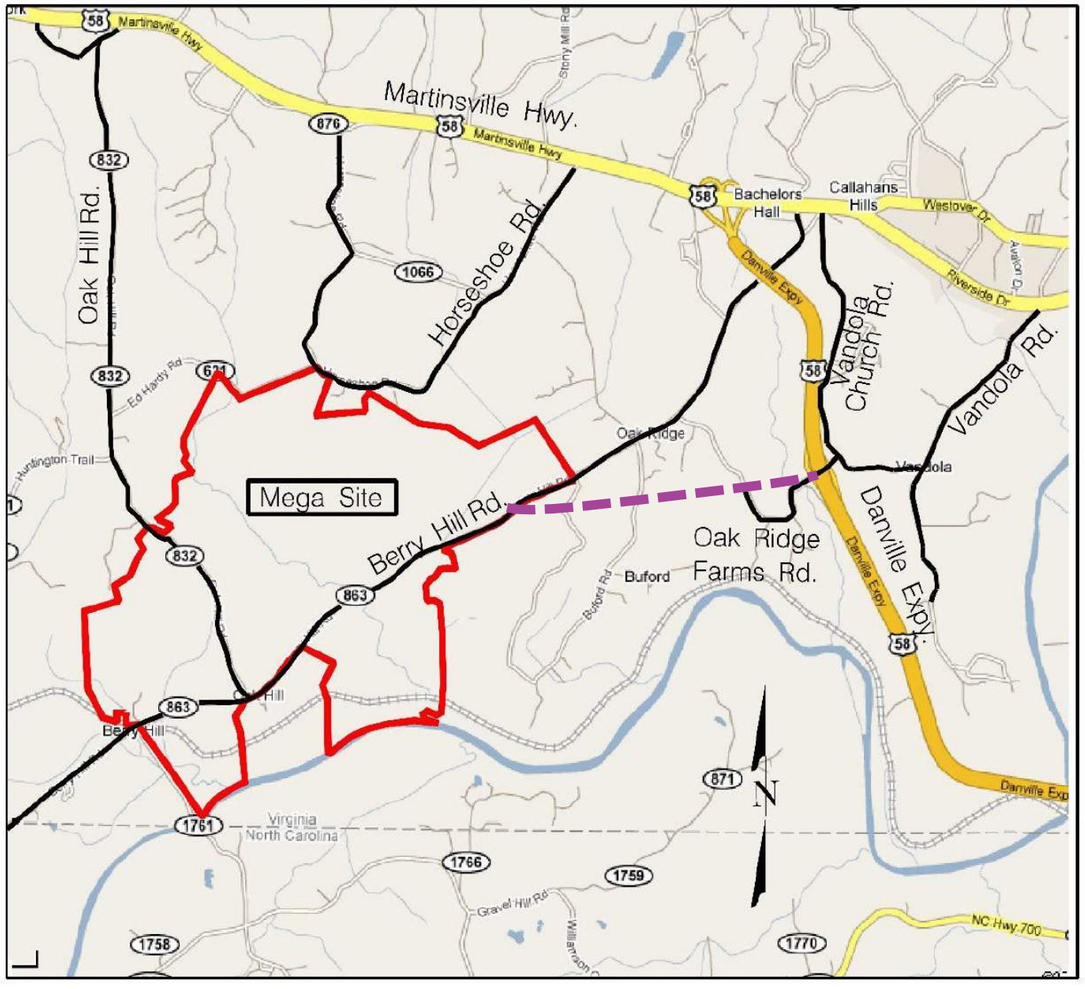


Image Source: Southern Virginia Mega Site at Berry Hill Transportation Update (Dewberry, 2018). Connector road added for illustrative purposes.

2.4 Traffic Volume Data

The project team collected historical traffic volumes through Year 2017 (latest available at time of data collection) from VDOT's traffic data. The project team collected 48-hour tube counts at five locations and midday (11:00 AM to 1:00 PM) and PM (4:00 PM to 6:00 PM) peak period intersection turning movement counts at the 25 intersections within the study area. Data was collected on December 4-6, 2018 and is reported in 15-minute increments. **Appendix B** contains the traffic count data.

2.4.1 Daily Traffic Volumes

Figure 6 shows the 2017 average annual daily traffic (AADT) volumes ((vehicles per day) from VDOT traffic data. **Figure 7** shows the 24-hour daily traffic collected in December 2018 at the five tube count locations. The daily traffic shown in **Figure 7** is an average of the 48-hour raw counts. The section of Riverside Drive between Mount Cross Road and the Central Boulevard ramps has the highest traffic volumes, carrying almost 34,000 vehicle per day and roughly 1,400 vehicles in each direction in the PM peak hour. Traffic volumes drop off to less than 15,000 vehicles per day east of Arnett Blvd and west of Westover Drive.

2.4.2 Peak Hour Determination

The 48-hour tube counts confirmed traffic volumes prior to 11:00 AM are not as heavy as the midday and PM periods. As a result, the study work group suggested the project team analyze a midday instead of an AM peak hour.

The project team examined the turning movement counts to identify the midday and PM peak hours of each intersection and for the network as a whole. The network-wide peak hour considers the tube counts and intersection turning movement counts.

The project team identified 12:00 to 1:00 PM as the midday peak hour and 4:30 to 5:30 PM as the PM peak hour. Peak hour determination tables are provided in **Appendix C.**

2.4.3 Heavy Vehicle Percentages and Peak Hour Factors

The project team calculated heavy vehicle percentages for each movement and intersection-wide peak hour factors at all study intersections during the midday and PM peak hours based on raw traffic data.

2.4.4 Traffic Volume Balancing

The project team examined the differences in turning movement volumes between intersections and balanced the volumes to reflect reasonable differences based on the number of driveways and adjacent land uses. **Figure** 8 presents the balanced 2018 midday and PM peak hour turning movement volumes at all 25 intersections within the study area.

2.5 Crash Data

The project team collected crash data from VDOT's "Crashtools8_2" Tableau workbook. At the time of the data download (February 2019), six years of crash data were available: January 1, 2013 through December 31, 2018. **Figures 9** and **10** show the number of crashes by crash type for each quarter-mile segment within the Riverside Drive study corridor within this six year time frame. **Figure 9** displays this information for the eastbound direction and **Figure 10** displays the information for the westbound direction. A closer examination of the crashes at each intersection and segment is documented in Section 3: Existing Conditions Analysis.

FIGURE 6: 2017 BIDIRECTIONAL AVERAGE ANNUAL DAILY TRAFFIC VOLUMES FROM VDOT TRAFFIC DATA

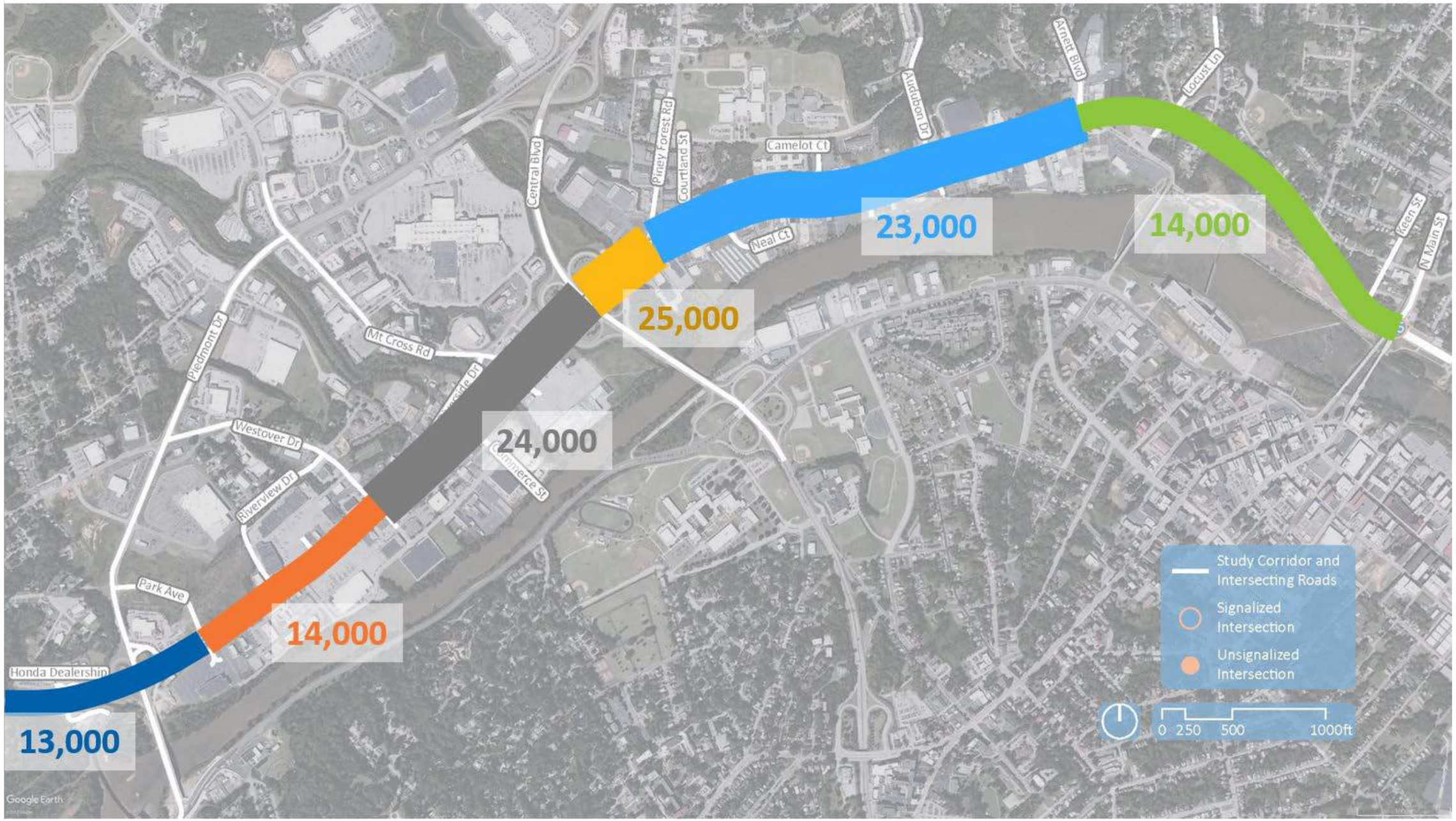


FIGURE 7: 24-HOUR DAILY TRAFFIC COUNTS COLLECTED IN DECEMBER 2018 (AVERAGED FROM 48-HOUR DATA COLLECTION)

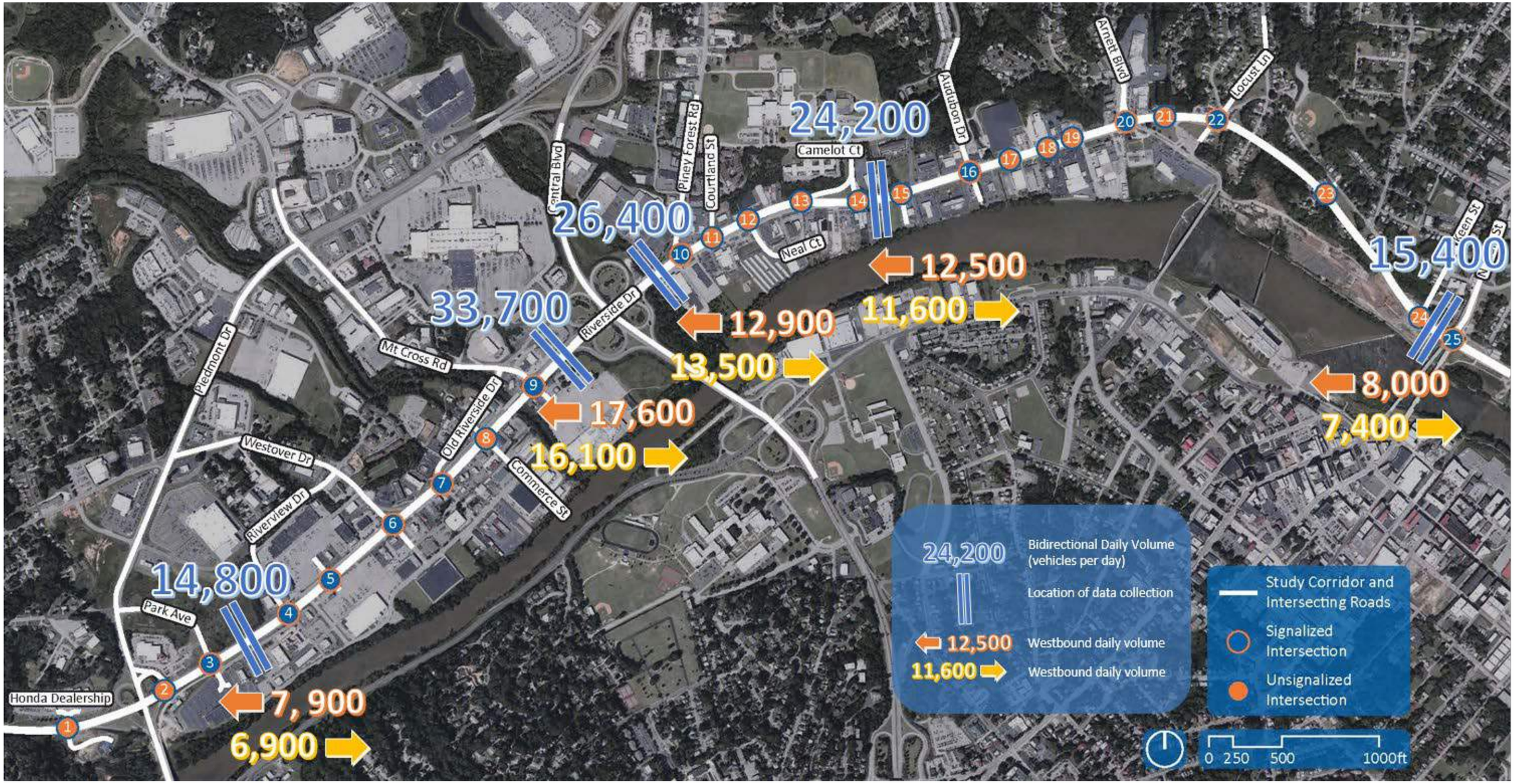


FIGURE 8: 2018 EXISTING MIDDAY AND PM PEAK HOUR TURNING MOVEMENT VOLUMES

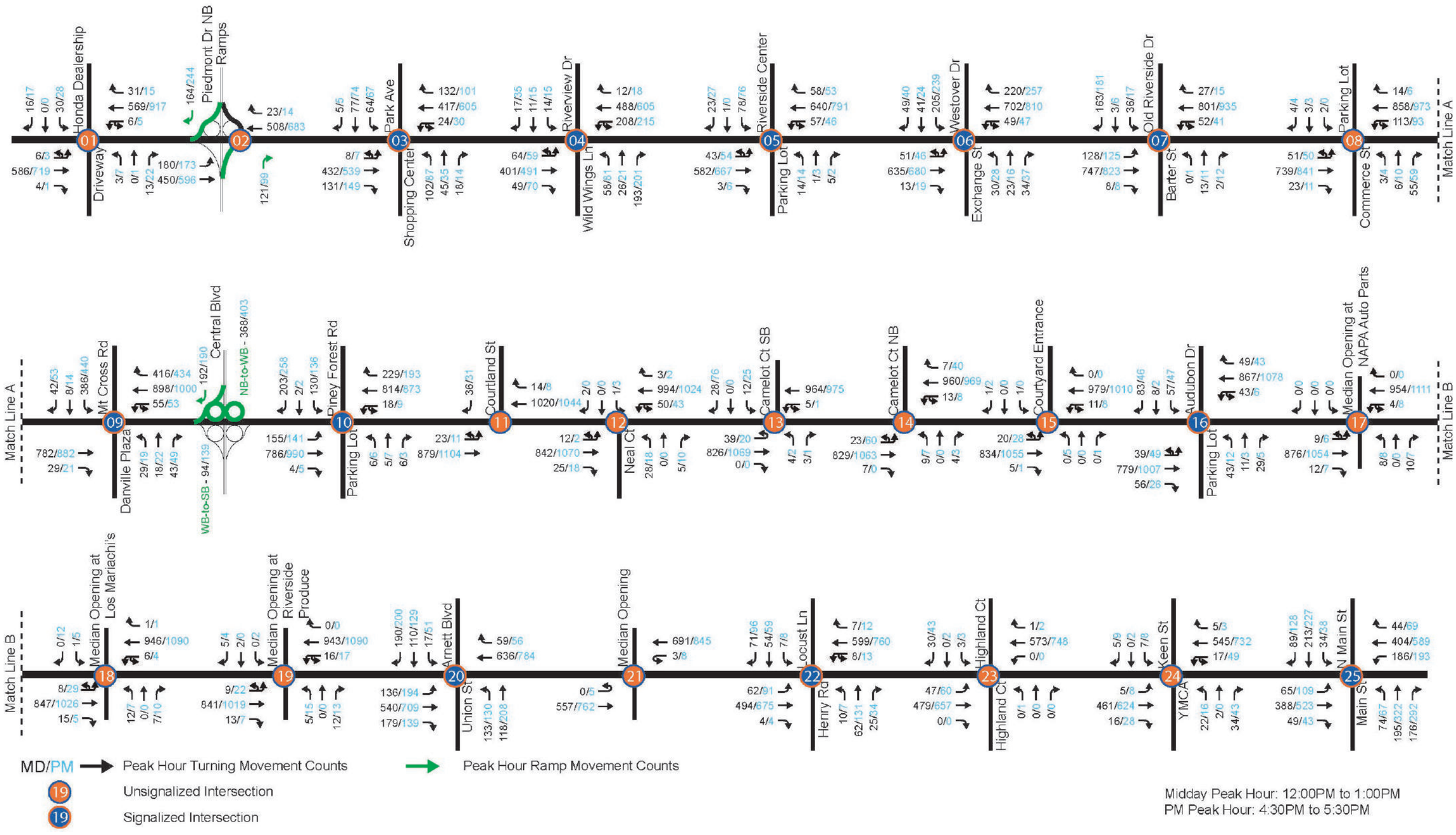


FIGURE 9: EASTBOUND CRASH HISTOGRAM

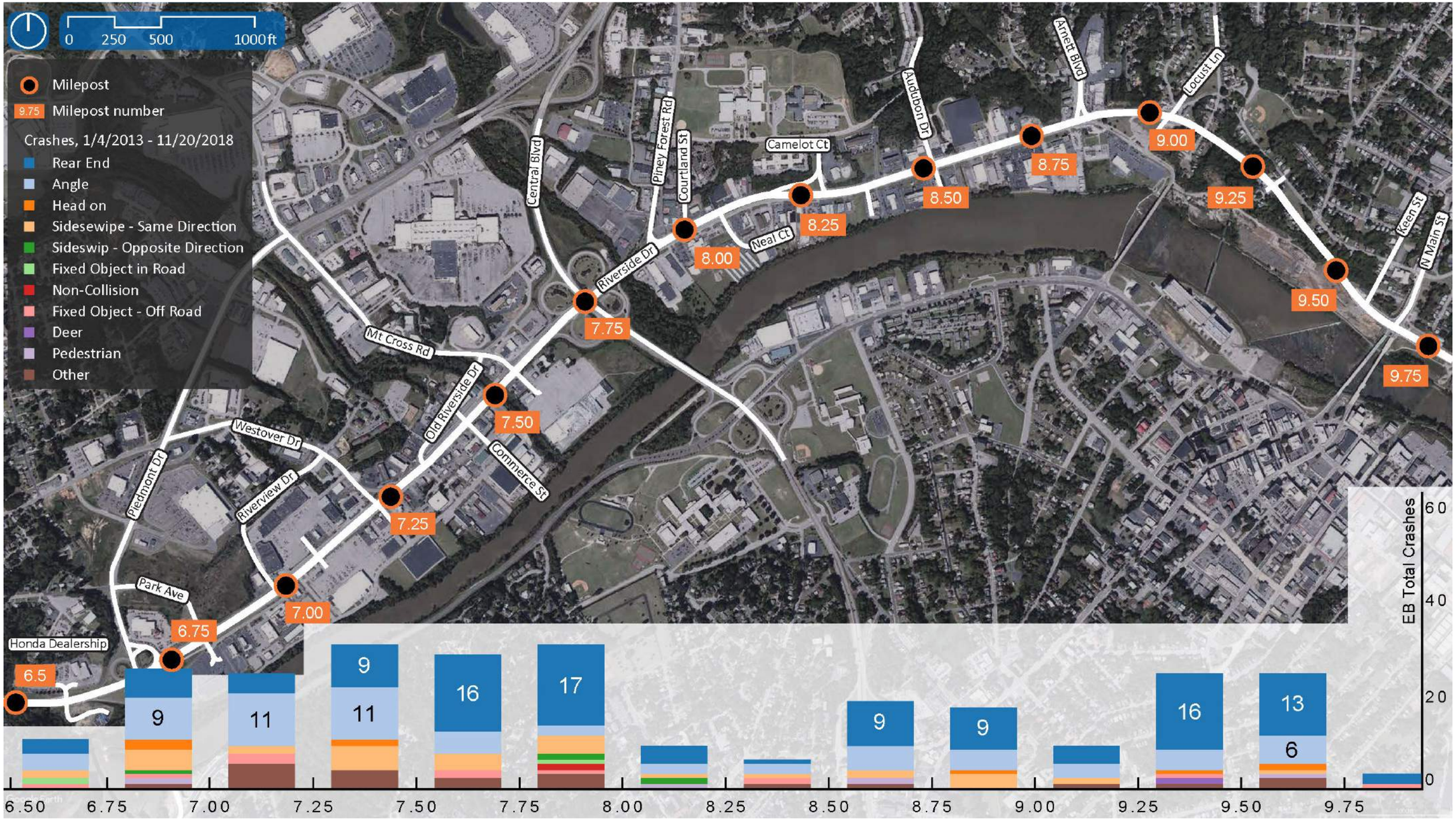
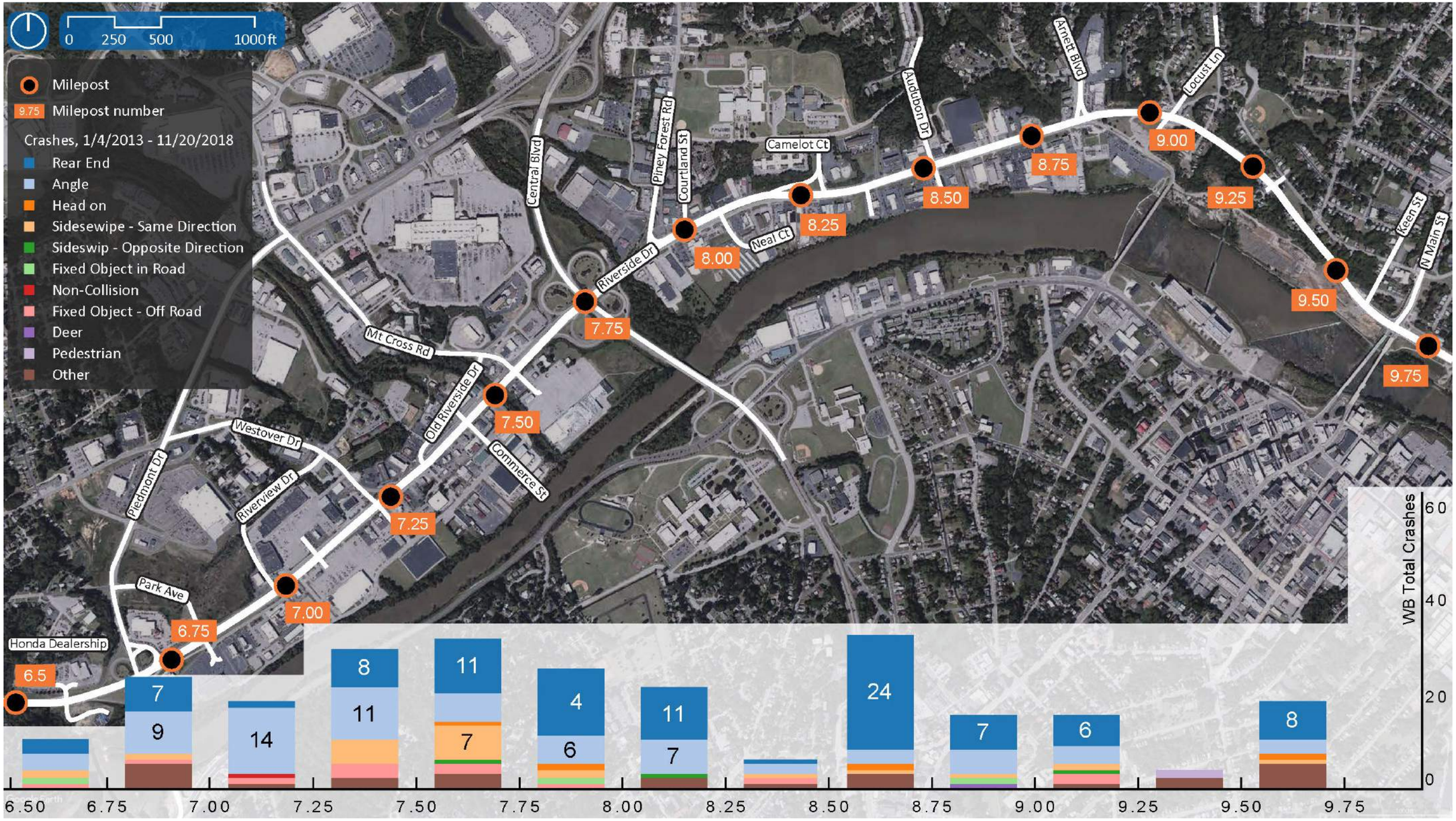


FIGURE 10: WESTBOUND CRASH HISTOGRAM



2.6 Access Spacing

Most of the Riverside Drive corridor is characterized by closely spaced intersections, frequent median openings, and continuous commercial entrances. The VDOT Road Design Manual provides spacing standards for different types of intersections and access points, which ensure an appropriate balance of providing access to adjacent land uses and maintaining the flow of traffic, based on a roadway's functional classification and posted speed limit. By managing the location, spacing, and design of entrances and intersections, planners and designers can reduce the number of conflict points, traffic congestion, and crashes. Businesses benefit from access management because more efficient traffic flow expands their market area.

VDOT classifies Riverside Drive as an *Other Principal Arterial* throughout the study area. VDOT's Access Management Design Standards indicate Principal and Minor Arterials should have "limited or partial" access control because the functional purpose of these roads is "high mobility, low to moderate access."[8]

The access management standards applicable to Riverside Drive are listed in **Table 1**. The project team documented the existing access spacing throughout the study area and identified areas where the current access spacing does not meet the standards outlined in **Table 1**. These figures are provided in **Appendix D**.

The spacing of commercial entrances along most of the Riverside Drive study corridor does not meet the access spacing standards. In many areas, especially along the south side of the road, commercial entrances are spaced less than 200 feet apart, sometimes less than 100 feet apart, while 305 feet is the minimum allowable spacing.

TABLE 1: VDOT ACCESS SPACING STANDARDS

Description of Type of Access Points				Minimum Spacing Distance (feet)
From	**Signalized Intersections**	To	**Other Signalized Intersections**	**1,320**
From	**Unsignalized Intersections & Full Median Crossovers**	To	**Signalized or Unsignalized Intersections & Full Median Crossovers**	**1,050**
From	**Full Access Entrances or Directional Median Crossovers**	To	**Other Full Access Entrances and Any Intersection or Median Crossover**	**565**
From	**Partial Access One- or Two-Way Entrances**	To	**Any Type of Entrance, Intersection, or Median Crossover**	**305**
From	**Start/End of Ramp Terminal**	To	**Any Intersection, Full Access Entrance, or Full Median Crossover**	**1,320**
From	**Start/End of Ramp Terminal**	To	**Directional Median Crossover**	**990**
From	**Start/End of Ramp Terminal**	To	**Right-in/Right-Out Partial Access Entrance**	**750**

Source: VDOT Road Design Manual, Appendix F: Access Management Design Standards for Entrances and Intersections, Table 2.2: Minimum Spacing Standards for Commercial Entrances, Intersections, and Median Crossovers, and Table 2-3: Minimum Spacing Standards for Intersections and Commercial Entrances Near Interchange Areas on Multilane Crossroads. Spacing above based on Principal Arterial with 35 to 45 mph legal speed limit.

[8] VDOT Road Design Manual Appendix F. Pg. F-11.

3 Existing Conditions Analysis

Two types of analysis were conducted to assess the existing conditions of the Riverside Drive corridor:

1. Peak Hour Traffic Operations Analysis: identifies locations where peak hour congestion is occurring and serves as a baseline for conducting an analysis of future conditions
2. Crash Analysis: identifies locations of crash clusters and fatal crashes and possible causal factors

The results of the analyses reveal that safety issues are currently more pressing than congestion issues. In general, most of the Riverside Drive corridor does not experience significant congestion (i.e. none of the intersections operate at LOS E or D overall) during the peak hours, but crash clusters, including crashes resulting in injuries occur at various locations throughout the corridor. Multiple pedestrian fatalities have occurred within the study corridor, in addition to motorist fatalities. The following sections describe the peak hour traffic operations and crash analyses and results in more detail.

3.1 Peak Hour Traffic Operations Analysis

The project team analyzed traffic operations during the midday and PM peak hours to understand where congestion is currently occurring and identify locations where demand is close to exceeding capacity. This analysis provides a baseline for conducting the analysis of future conditions. The operations analysis was conducted using Synchro and SimTraffic, Version 9.

3.1.1 Measures of Effectiveness

The traffic operations analysis produced two measures of effectiveness for evaluating operating conditions in the peak hours:

1. Control Delay: the delay drivers experience at a traffic control device (e.g. traffic signal or stop sign) – reported for each individual turning or through movement and for each intersection overall.
2. Maximum Queue Lengths: the maximum length of the queue for each turning or through movement recorded during the 10 simulation runs.

Control Delay is an output from Synchro using the HCM 2000 reports, since the HCM 2010 methodology cannot report results for U-turns. Maximum Queue Lengths are reported from SimTraffic. 95th percentile queue lengths from SimTraffic were also considered in some instances, as discussed in the analysis results. All outputs from Synchro and SimTraffic are provided in **Appendix H.**

Figures 11 and **12** provide the results of the analysis of existing peak hour traffic conditions. **Figure 11** shows the average control delays (in seconds per vehicle). The delays correspond to levels of service, represented with letter grades A through F, as further explained in the following section. **Figure 12** provides the maximum queue lengths (in feet) for each intersection movement and indicates movements where the maximum queue length exceeds the existing (i.e. full-width) and effective (full-width plus half of the taper[9]) storage bay lengths.

3.1.2 Level of Service Criteria

Level of Service (LOS) is a concept that describes how well a transportation facility operates from the traveler's perspective. The *Highway Capacity Manual 6th Edition* defines six levels of service, ranging from A to F. LOS A represents the best operating conditions from the traveler's perspective, and LOS F the worst. For cost, environmental impact, and other reasons, roadways are typically designed not to provide LOS A conditions during peak periods, but instead to provide some lower LOS that balances individual travelers' desires against society's desires and financial resources.[10]

Control delay is the service measure that defines LOS for motorized vehicles at intersections. **Table 2** lists the LOS thresholds for motorized vehicles at signalized and unsignalized intersections.

Table 2: Level of Service Criteria for Signalized and Unsignalized Intersections

LOS	Control Delay (seconds per vehicle) at **Signalized Intersections**	Control Delay (seconds per vehicle) at **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

*If the volume-to-capacity ratio is greater than 1.0, the LOS is F, even if delay is less than 80 seconds at signalized intersections or 50 seconds at unsignalized intersections.

3.1.3 Traffic Operations Analysis Results

3.1.3.1 Control Delay and Level of Service Results

Overall, there are no significant congestion issues within the study corridor limits. All 25 intersections operate at LOS D or better in both peak hours. Most (23 of the 25) intersections operate at LOS C or better in both peak hours. The two intersections that operate at LOS D in the PM peak hour are at:

- Arnett Boulevard/Union Street
- North Main Street

North Main Street is the only intersection where the eastbound and westbound through movements operate at LOS D in the PM peak hour. At all other intersections, the mainline through movements operate at LOS C or better in both peak hours. The traffic signals along Riverside Drive are coordinated with 120-second cycle lengths, providing long green bands for mainline through movements to progress through the corridor. The project team confirmed the progression quality during the field review. During the travel time runs, the test car hit an average of three red lights over the entire corridor in each direction during peak and non-peak periods.

Vehicles at most of the signalized side streets experience LOS D or E in the peak hours because of the long cycle lengths and long green bands. Vehicles waiting at signalized intersections to turn left from the mainline also experience LOS D or E. The westbound left turn movements at Westover Drive and at Piney Forest Road are the only signalized movements that experience LOS F. Even with these high delays, the queues cleared within one cycle during peak hour field observations. Most movements at unsignalized intersections operate at LOS C or better, except the southbound approach from the Honda Dealership at Intersection #1, which operates at LOS F in the PM peak hour.

[9] Existing and effective storage lengths on commercial entrances are equal (i.e. taper lengths on these types of approaches were assumed to be zero).

[10] Transportation Research Board, 2016. *Highway Capacity Manual, 6th Edition: A Guide for Multimodal Mobility Analysis*. Washington, D.C.

3.1.3.2 Maximum Queue Length Results

The maximum queue lengths exceed the effective storage length in several locations, as indicated in red in **Figure 12**. At many of these locations, there is only a small amount (less than 50 feet) of storage available, and a queue of only three cars will exceed the available storage length.

At some intersections, the storage length on the side-street approach is limited because there is another intersection within 100 feet of the intersection with Riverside Drive. This occurs at many intersections along the study corridor. The queue lengths that exceed the effective storage length at the following locations are a result of this situation:

- Northbound approach of Park Avenue (Intersection #3)
- Northbound approach of Wild Wings Lane (Intersection #4)
- Northbound approach of the Kmart entrance (Intersection #5)
- Southbound approach of Old Riverside Drive (Intersection #7)
- Southbound approach at Commerce Street (Intersection #8)
- Northbound approach at Piney Forest Road (Intersection #10)
- Northbound approach at Audubon Drive (Intersection #16)
- Northbound approach at the NAPA Auto Parts entrance (Intersection #17)
- Southbound approach at the Los Mariachi's entrance (Intersection #18)
- Northbound and southbound approaches at the Riverside Produce entrance (Intersection #19)
- Southbound approach of Arnett Boulevard (Intersection #20)
- Southbound approach of Locust Lane (Intersection #22)

Most of these locations are commercial entrances with approaches or storage bays less than 50 feet long. Here, the queue lengths represent 3-4 vehicles waiting to exit commercial businesses, where the entrance throat distance only provides for 1-2 vehicles to queue back. **These queuing issues are not a result of congestion; they are a result of inadequate access spacing.**

Placing an entrance or intersection on a side-street too close to an intersection with major roadway presents safety and operational issues. Vehicles can back up onto the major roadway or block entrances, and drivers must watch for turning vehicles at more than one location simultaneously. VDOT requires a minimum of 225 feet between the edge of pavement of a major roadway and the nearest edge of an entrance on the minor side-street to prevent blocking entrances and causing backups.[11]

Additionally, some of the median openings do not have storage lanes, and only 25 feet within the median opening is available for vehicles to wait to turn left or make a U-turn. When more than one vehicle is waiting to turn at these locations, the queue length exceeds the available storage length. The queue lengths that exceed the effective storage length at the following locations are a result of this situation:

- Eastbound and westbound left turns at the Camelot Court exit (Intersection #13)
- Westbound left turns at the Camelot Court entrance (Intersection #14)
- Eastbound left turns at the median opening at NAPA Auto Parts (Intersection #17)
- Eastbound and westbound left turns at the median opening at Los Mariachi's (Intersection #18)
- Eastbound left turns at the median opening at Riverside Produce (Intersection #19)
- Eastbound and westbound left turns at the median opening at Intersection #21 (between Arnett Boulevard and Locust Lane

These queuing issues are not a result of congestion; they are a result of the lack of left turn lanes at median openings.

The locations where peak hour queues most exceed the available storage length are:

- Northbound Wild Wings Lane at Intersection #4: The shared left turn and through lane queue is over 300 feet long (roughly 13 vehicles long) in both midday and PM peak hours. There is only 50 feet of storage before the intersection with the frontage road, and vehicles consistently block the frontage road and Sheetz entrance.
- Southbound Locust Lane at Intersection #22: There is only 60 feet along Locust Lane between the intersection with Riverside Drive and Alpine Drive. The queue of vehicles going straight or turning right is over three times as long as the available storage in both midday and PM peak hours.
- Southbound Mount Cross Road at Intersection #9: Despite having two left turn lanes, the 440 vehicles turning left in the PM peak hour queue back and block the upstream intersection with Old Riverside Drive. This blockage occurs in the midday peak hour too.
- Southbound Arnett Boulevard at Intersection #20: Southbound vehicles on Arnett Blvd access the Auto Villa car dealership on the northeast corner through a median opening only 100 feet north of Riverside Drive. Southbound vehicles at the Riverside Drive intersection consistently queue back past this median opening.

[11] VDOT Road Design Manual Appendix F: Access Management Design Standards for Entrances and Intersections.

FIGURE 11: 2018 EXISTING PEAK HOUR TRAFFIC OPERATING CONDITIONS – CONTROL DELAYS (SECONDS PER VEHICLE) AND LEVELS OF SERVICE

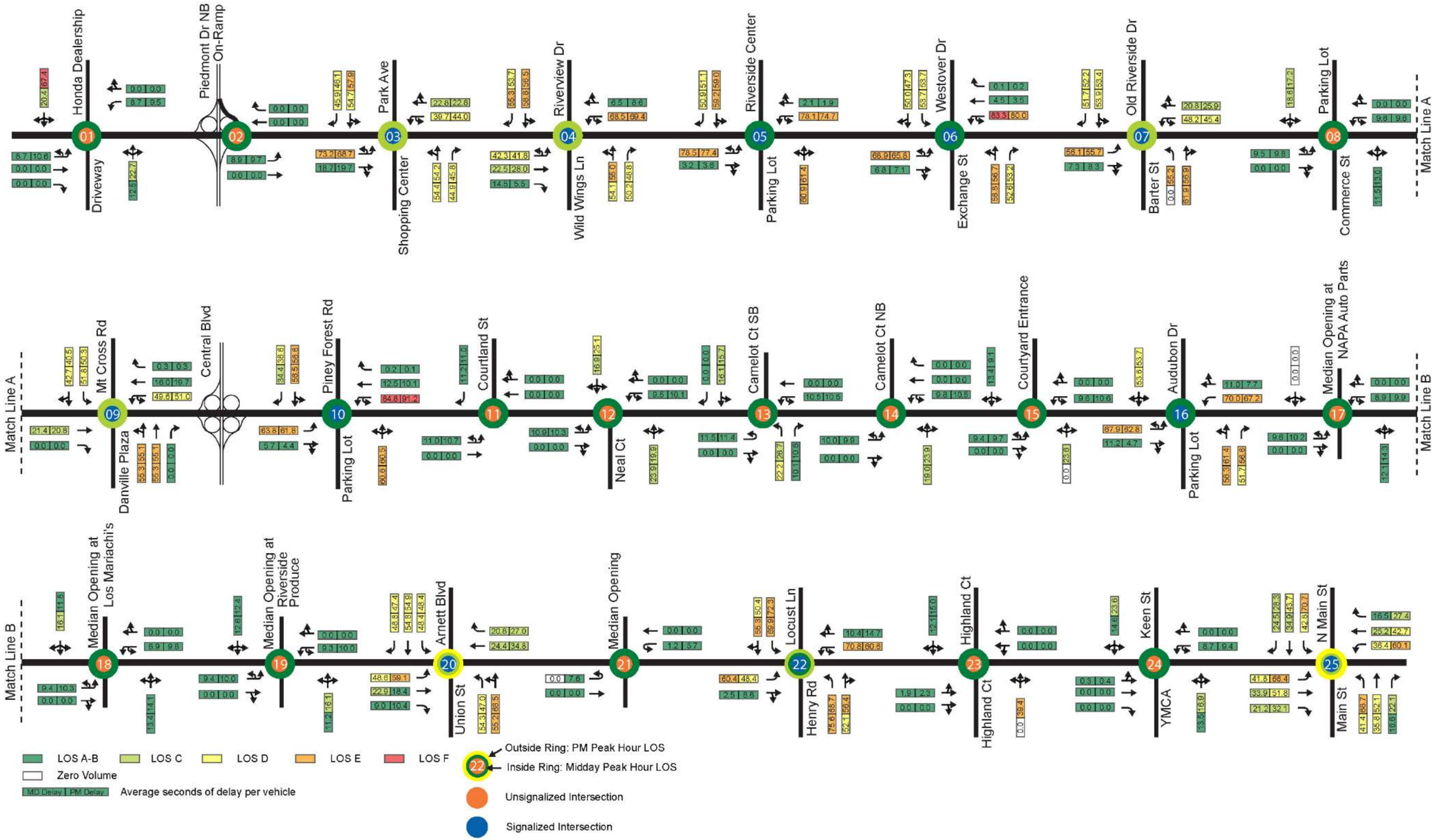
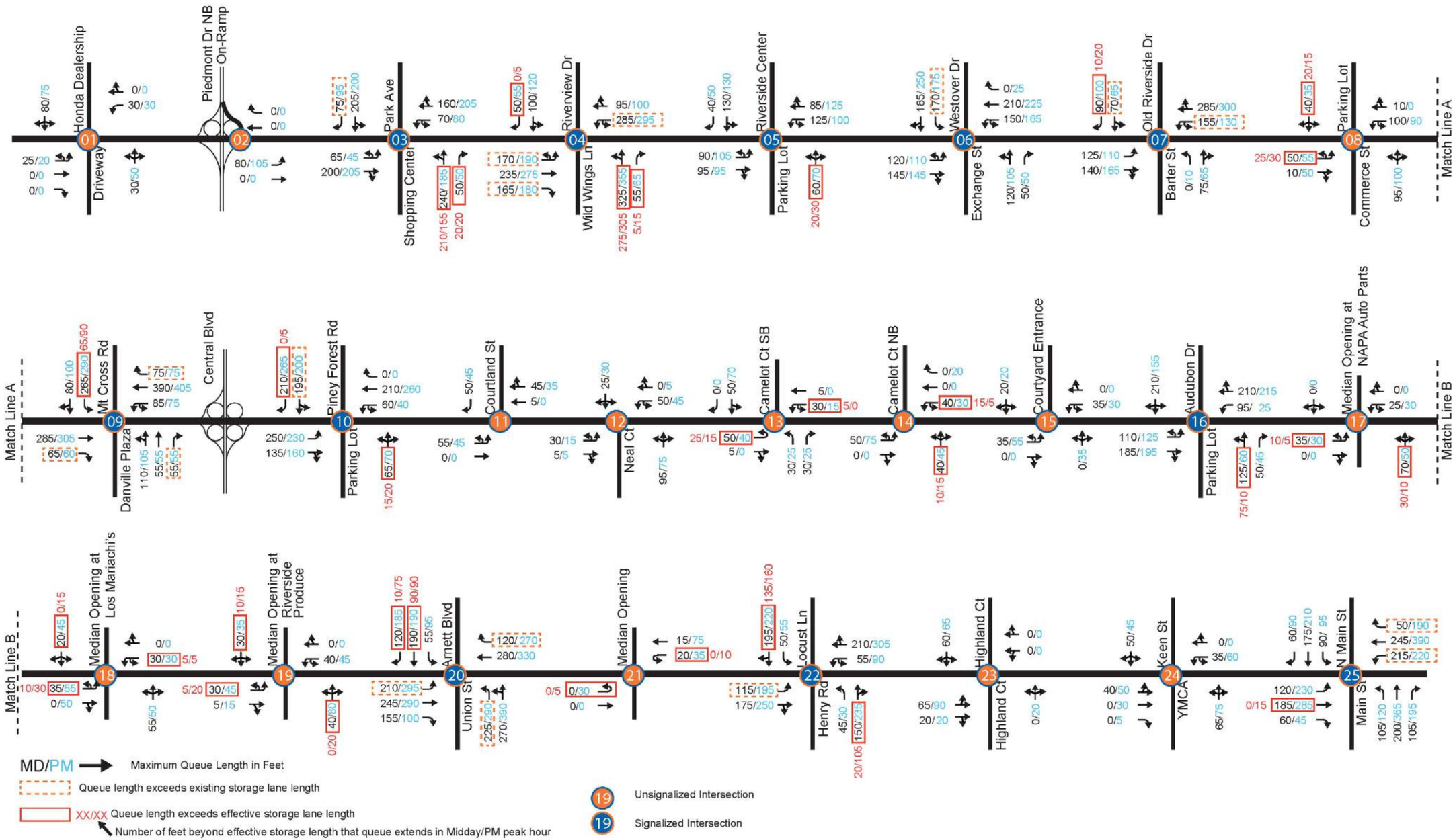


FIGURE 12: 2018 EXISTING PEAK HOUR TRAFFIC OPERATING CONDITIONS – MAXIMUM QUEUE LENGTHS (FEET)



3.2 Crash Analysis and Identified Deficiencies

The project team prepared a series of crash maps showing the location, crash type (e.g. rear-end, angle, etc), and severity of crashes from 2013 through 2018[12] for each quarter-mile segment of the study corridor. These maps are provided in **Appendix E**. The project team examined the crash maps and identified safety deficiencies based on crash patterns and field observations. The following sections describe the deficiencies for each segment. Each quarter-mile segment is defined by the mileposts from VDOT's Tableau crash data.

3.2.1 Segment 1: Mileposts 6.5 to 6.75

Despite the deficient spacing between the off-ramp from Piedmont Dr and the Honda Dealership entrance, few crashes occurred at the merge point. A few mostly property-damage only (PDO) angle crashes occurred at the Honda Dealership entrance.

One fatal crash occurred, where an eastbound vehicle ran off-road, hit the curb, traveled over the grass, and into the retaining pond. One of the passengers died two weeks after the crash occurred. The crash occurred at 11:30 am on a dry, clear Friday in March 2013. The crash data indicate no evidence of driver distraction or alcohol intoxication, but the occupants were not wearing seat belts. One other fixed object crash occurred in this segment, resulting in an injury, when the driver hit the light pole in the road median.

The crash data does not indicate a crash cluster within this segment, and no safety deficiencies were identified.

3.2.2 Segment 2: Mileposts 6.75 to 7.0

At the Park Avenue intersection (Intersection #3), there is a cluster of angle crashes. Six of the nine angle crashes resulted from vehicles running red lights. The most severe injuries occurred from angle crashes involving the northbound approach. The frontage road on the south side of the road is only 30 feet from the Riverside Drive entrance, providing space for only 1-2 vehicles to queue. The queue then wraps around the frontage road stop sign. The project team observed the queues clearing at this location in one cycle.

There is a cluster of angle crashes on the south side of the Riverview Drive/Wild Wings Lane intersection (Intersection #4). Many of these crashes involve running red lights. There are several conflicting movements occurring at this location that could contribute to crash potential:

- Northbound right turns, especially when turning right on red
- Eastbound throughs
- Westbound-to-eastbound U-turns
- Eastbound vehicles turning into the Cook-Out entrance, which is only 110 feet from the intersection
- People waiting at the bus stop in front of the Cook-Out

The project team observed a pedestrian crossing Riverside Drive at this location at 10:15 am.

3.2.3 Segment 3: Mileposts 7.0 to 7.25

A fatal crash occurred at Intersection #5. At 11:00 am on Sunday June 14, 2015, the driver of a westbound vehicle disobeyed the traffic signal and turned left into the K-Mart shopping center, colliding with an eastbound vehicle coming through the intersection.

There is a cluster of angle crashes at the Westover Drive intersection (Intersection #6), many of which involve failing to obey red lights. The Hardee's on the south side of the road has two access points, one only 75 feet from the Westover Drive intersection. The project team observed a pedestrian attempting to cross Riverside Drive in front of the Pizza Hut at 12:30 pm.

3.2.4 Segment 4: Mileposts 7.25 to 7.5

The intersection of Old Riverside Drive (Intersection #7) has the highest potential for safety improvement (PSI) in the study corridor and is #6 in the VDOT Lynchburg District. There are clusters of crashes occurring here, including angle, rear-end, sideswipe, and other.

The dual-lane southbound right turn does not have a sign prohibiting right turns on red. When allowed at all, right turns are typically only allowed from the right-most right turn lane. The skew angle of this approach makes it difficult to see oncoming westbound vehicles. The project team observed several instances where vehicles from both southbound right turn lanes made a right turn on red in front of oncoming westbound vehicles. The frequent driveway spacing on the south side of the road increases the potential conflict points in advance of and after this intersection.

3.2.5 Segment 5: Mileposts 7.5 to 7.75

The Mount Cross Road intersection (Intersection #8) also has a high PSI ranking. The crash map shows clusters of rear-end, angle, and sideswipe crashes. The segment between Mount Cross Road and Central Boulevard has the highest traffic volumes in the study corridor. The westbound right turn and southbound left turn are heavy movements, each serving over 400 vehicles in the PM peak hour.

The access spacing on the north side of Riverside Drive between the Central Blvd and Mt Cross Rd is grossly deficient. The lack of spacing between the Central Blvd off-ramp and the access road to Tower Dr does not provide enough distance for vehicles to change lanes and slow down. Multiple driveway cuts to the businesses on the northeast quadrant create additional conflict points within the weave area. The short westbound right turn lane serves a very heavy movement. When a vehicle in the right-most through lane blocks this turn lane, vehicles stack back to the off-ramp.

3.2.6 Segment 6: Mileposts 7.75 to 8.0

The Piney Forest Road intersection (Intersection #9) is included in the top 100 PSI intersections in the VDOT Lynchburg District. It contains clusters of rear-end crashes on both approaches. These crashes are not concentrated during the peak hours; they are distributed throughout the day between 10 am and 5 pm. Like other intersections, there are entrances to businesses within the functional area of the intersection. At the Piney Forest Road intersection, the entrance to the Highlander Restaurant Lodge and Pub on the north side of the road is 250 feet away from the intersection, and the entrance to the Mr. Tire Auto Service Center on the south side of the road is 150 feet away. The project team did not identify any other observable safety issues at this intersection, despite the clusters of rear-end crashes.

The project team observed a pedestrian crossing Riverside Drive east of Piney Forest Road, near the location of a pedestrian crash at the eastbound approach to the Courtland Street intersection.

3.2.7 Segment 7: Mileposts 8.0 to 8.25

This segment, including the intersections of Courtland Street and Neal Court, is part of the emphasis area for the Pedestrian Safety Priority Corridor identified in the PSAP. Multiple pedestrian crashes have occurred here. A fatal

[12] Crash data from VDOT's *Crash Tools 8.2* Tableau Dataset, accessed on 2/18/2019.

crash involving a pedestrian occurred at Neal Court. A vehicle turning left from Neal Court struck a pedestrian that was trying to cross Riverside Drive.

The unsignalized intersection at Neal Court is a complicated intersection. Drivers attempting to turn left from Neal Court must look for a gap in three lanes of traffic in each direction. The median width allows storage for one vehicle in each direction. If there is more than one vehicle waiting to turn across the median, they must wait in the turn lane or they will block the paths of other vehicles. A driver waiting in the median for a gap in oncoming traffic must pull forward to allow a driver from the opposite direction to wait without blocking their view, and there are no pavement markings to distinguish the space for vehicles in each direction.

Westbound traffic at the height of the PM peak hour can be a constant flow, and eastbound vehicles waiting to make a left turn or a U-turn can have difficulty finding a gap at multiple median openings in this section. The frequent driveway openings require drivers waiting to turn to look multiple places (at oncoming through traffic and driveways across the street) to avoid potential collisions.

3.2.8 Segment 8: Mileposts 8.25 to 8.50

This segment, including the intersections of Camelot Court and the Courtyard entrance, is also part of the emphasis area for the Pedestrian Safety Priority Corridor identified in the PSAP. A fatal pedestrian crash occurred at the Career Development Center entrance, across from the western (westbound) Camelot Court exit. An eastbound vehicle struck and killed a pedestrian attempting to cross Riverside Drive.

The same complexities of the Neal Court intersection are present at the Camelot Court median breaks, including median width storage, potential for vehicles to block other drivers' views, difficulty finding gaps in westbound traffic during the height of the PM peak hour, and high driveway density requiring drivers to look multiple places to avoid potential collisions.

3.2.9 Segment 9: Mileposts 8.50 to 8.75

The Audubon Drive intersection (Intersection #16) has the largest cluster of rear-end crashes in the corridor, which occur primarily along the westbound approach. The westbound rear-end crashes occur throughout the day and are not concentrated during the PM peak period when westbound approach volumes are heaviest. The 10:00 am to 11:00 am hour contained the most crashes, and the project team observed a pedestrian crossing Riverside Drive just to the east (in front of Nikki's Restaurant) at 10:15 am. The north side of the westbound approach has wide swaths of open access right up to the intersection, which create conflict points within the functional area of the intersection and could be a contributing factor to the crash cluster. City staff indicated westbound drivers will use the open access area as a right turn lane to go around vehicles waiting to go through. This may also be a contributing factor to the crash cluster. VDOT awarded Revenue Sharing funds to the City for a project to pave and stripe this area as a right turn lane and to mark pedestrian crosswalks. The City is waiting to perform project design to incorporate relevant recommendations from this Corridor Improvement Study.

During the site visit, the project team observed stop-and-go westbound traffic for 20 minutes in the PM peak hour during which vehicles waiting in the median to turn could not find a gap in oncoming traffic.

A hotel is currently being constructed on the site of an old warehouse on the north side of the road. The hotel site plans show one access point on Riverside Drive at the existing median break. The site plans do not show access along Audubon Drive.

Flooding, while an issue throughout the study corridor, is particularly problematic at the Audubon Drive intersection. The Apple Branch flows from north to south, crosses Riverside Drive about 250 feet east of Audubon Drive, and empties into the Dan River. In 2018, Hurricane Michael and other flash flood events caused the Apple Branch to overflow its banks and flood the surrounding area, including several buildings. The City is pursuing several funding opportunities to create a new system that would prevent future flooding by intercepting surcharge and pulling some of the load from Apple Branch. The City is currently conceptualizing this idea and identifying opportunities.

The three median breaks between Audubon Drive and Arnett Boulevard have generally low side-street and turning volumes. The same median storage issues exist here as at the other unsignalized median openings. Additionally, the median openings lack left turn lanes. Drivers in the left turn lane slow down to make a left turn through the median, which can create a potential rear-end conflict with a through vehicle from behind if the driver of the rear vehicle does not expect the front vehicle to turn.

3.2.10 Segment 10: Mileposts 8.75 to 9.0

Despite the unusual geometry of the Arnett Blvd/ Union St intersection (Intersection #20), most of the crashes at this intersection are mostly property damage only, less severe than the crashes at other intersections. The median break on the northern leg is less than 100 feet from the intersection. Entrances on all approaches the are very close to the intersection. The median break to the east is only 360 feet from the Arnett Blvd intersection.

3.2.11 Segment 11: Mileposts 9.0 to 9.25

There is a cluster of injury angle crashes at the southbound approach of the Locust Lane intersection (Intersection #22). Parked vehicles at Riverside Motors on the northeast corner block the southbound approach sight line to the left, which makes it difficult for southbound right turn vehicles to see oncoming westbound vehicles when trying to turn right on red. Drivers must pull up beyond the stop bar very close to the intersection to see oncoming vehicles.

At the height of the PM peak hour, westbound vehicles queue back more than 300 feet to the Farrar Street bridge. The project team experienced stop-and-go westbound traffic at the height of the PM peak hour during field observations.

3.2.12 Segment 12: Mileposts 9.25 to 9.5

Highland Court (Intersection #23) provides access to a residential neighborhood. The eastbound left turn volume is high relative to the residential land uses. The project team observed eastbound left turning vehicles using Highland Court as a cut-through route to areas to the north along Arnett Blvd and Main Street. There is a cluster of injury rear-end crashes in the eastbound direction; almost all involved eastbound left turns. As eastbound vehicles approach this intersection, they crest a hill, which shortens the sight distance. There is no eastbound left turn lane for vehicles to wait in. Drivers may not expect to encounter stopped vehicles in the left lane as they crest the hill, and this may be a contributing factor to the rear-end crash cluster. Additionally, a pedestrian crash occurred at this intersection, resulting in an injury.

3.2.13 Segment 13: Mileposts 9.5 to 9.75

At the unsignalized Keen Street intersection (Intersection #24), several injury crashes resulted from vehicles attempting to turn left from the YMCA. Several factors may be contributing to crash potential at this location including a steep northbound approach grade increases the effort and time for vehicles to accelerate from a stop, and northbound left turning vehicles must find gaps between eastbound through vehicles coming down the hill, westbound through vehicles coming up the hill, and pedestrians crossing in the marked crosswalks.

This intersection has marked crosswalks with pedestrian warning signs, but the wide cross-section, topography, and proximity of the Main Street intersection do not create an environment where drivers expect to encounter and stop for pedestrians. The downslope along Riverside Drive and the multiple car threat situation make driver compliance to stop for pedestrians difficult. The long crosswalks without median refuge are intimidating for pedestrians to cross without signal control or flashing beacons.

At the Main Street intersection (Intersection #25), a fatal bicycle crash occurred when a southbound bicyclist collided with an eastbound vehicle. The southbound approach has a downgrade. However, the project team did not identify any observable safety issues at this location.

4 Future 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 2035 traffic conditions. The following sections describe the methodology for developing traffic growth rates and projecting future traffic volumes for the study area.

4.1 Future Traffic Growth Rates

Average annual daily traffic (AADT) volumes have steadily decreased on the corridor since 2001. It is uncertain if the historical trend of decline will continue or the City will experience economic growth which could fuel traffic volume growth. The project team reviewed several sources of historical and projected traffic growth:

- VDOT's historical average annual traffic volumes (2001 through 2017)
- VDOT's Statewide Planning System (SPS) existing (2017) and future (2045) traffic volume projections
- Danville Regional Travel Demand Model outputs[13] and calculated annual growth rates for each segment of the study corridor and intersecting roads

The historical AADT volumes show negative or very small (less than 0.5 percent per year) growth rates. The VDOT SPS projections show annual rates of change of 0.5 percent or less for the Riverside Drive study segment. Intersecting roads for which SPS projections are available range from 0.19 percent (Central Blvd) to 1.12 percent (Piedmont Dr) per year. The regional travel demand model shows average annual growth rates of less than 0.5 percent per year for all study segments of Riverside Drive and the intersecting roads that are included in the model.

The project team and study work group reviewed the available growth rates and considered the impacts of several other historical and future factors including:

- Timing of construction and opening of the Danville Expressway
- The winding down and shut down of the Dan River Mill
- Kmart and other business closings in the Riverside Drive corridor
- The Great Recession's impacts on travel patterns and traffic volumes
- Future employment levels at the Southern Virginia Mega Site at Berry Hill and new connector road included in FY 2020 SMART SCALE funding scenario
- Averett University North Campus expansion plans
- Prior studies along Mount Cross Road north of Riverside Drive
- Possibility of a casino being built within the City of Danville

Based on the information and considerations listed above, the study work group agreed the following linear growth rates are acceptable:

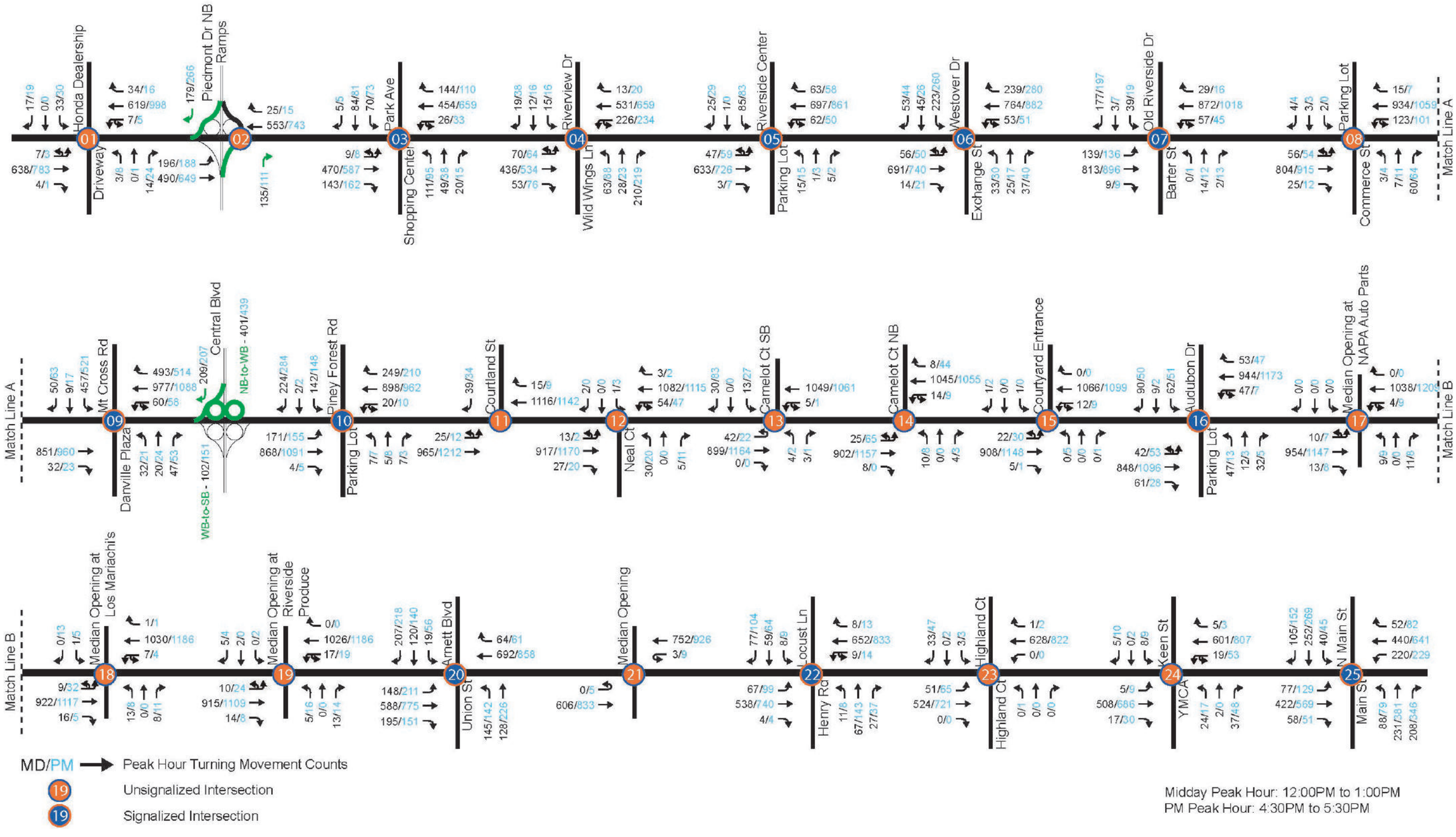
- 0.5 percent per year for the Riverside Drive corridor
- 1.0 percent per year for Mount Cross Road and Main Street
- 0.5 percent per year for all other intersecting streets

4.2 Projected 2035 Traffic Volumes

The project team applied the linear traffic growth rates to the 2018 existing midday and PM peak hour turning movement volumes to generate projected 2035 traffic volumes. **Figure 13** shows the 2035 peak hour turning movement volumes for the Future No-Build analysis.

[13] The latest version of the Danville Regional Travel Demand Model was released in March 2019 and includes existing Year 2016 and future Year 2045.

FIGURE 13: 2035 FUTURE NO-BUILD MIDDAY AND PM PEAK HOUR TURNING MOVEMENT VOLUMES



5 Future No-Build Conditions Analysis

Traffic operational analyses were conducted to evaluate the overall performance of the study corridor under No-Build (2035) midday and PM peak hour conditions and identify any significant differences from the existing conditions. The No-Build conditions analyses provide a general understanding of baseline future traffic conditions as a starting point for comparing against future improvement strategies. No-Build conditions were modeled using Synchro and SimTraffic, Version 9.

5.1 Traffic Analysis Assumptions

The existing conditions Synchro models were used as a basis to develop the No-Build models for the AM and PM peak hour conditions. No geometric or traffic signal timing changes were made to the existing Synchro models. The models were updated with projected 2035 No-Build traffic volumes. No background improvements were modeled as part of the No-Build analysis. Inputs, analysis methodologies, and calibration approaches were consistent with the TOSAM.

5.2 Traffic Analysis Results

Figures 14 and **15** provide the results of the analysis of future No-Build peak hour traffic conditions. **Figure 14** shows the average control delays and corresponding levels of service. **Figure 15** provides the maximum queue lengths and indicates movements where the maximum queue length exceeds the existing and effective storage bay lengths.

Similar to the existing conditions analysis, the future No-Build analysis reveals no significant congestion issues within the study corridor limits. All 25 intersections operate at LOS D or better in both peak hours. The same 23 of the 25 intersections operate at LOS C or better in both peak hours. The same three intersections operate at LOS D in the PM peak hour. East-west through movements experience excellent progression because of long green bands. Vehicles waiting at side-streets or waiting to turn left from Riverside Drive experience LOS D, E, or F due to the 120-second cycle lengths. The same queuing issues from existing conditions exist, which are primarily a result of inadequate access spacing and the lack of left turn lanes at median openings. The specific conditions described in Section 3.1.3 are also true in the No-Build conditions, with slightly longer delays and queue lengths.

FIGURE 14: 2035 FUTURE NO-BUILD PEAK HOUR TRAFFIC OPERATING CONDITIONS – CONTROL DELAYS (SECONDS PER VEHICLE) AND LEVELS OF SERVICE

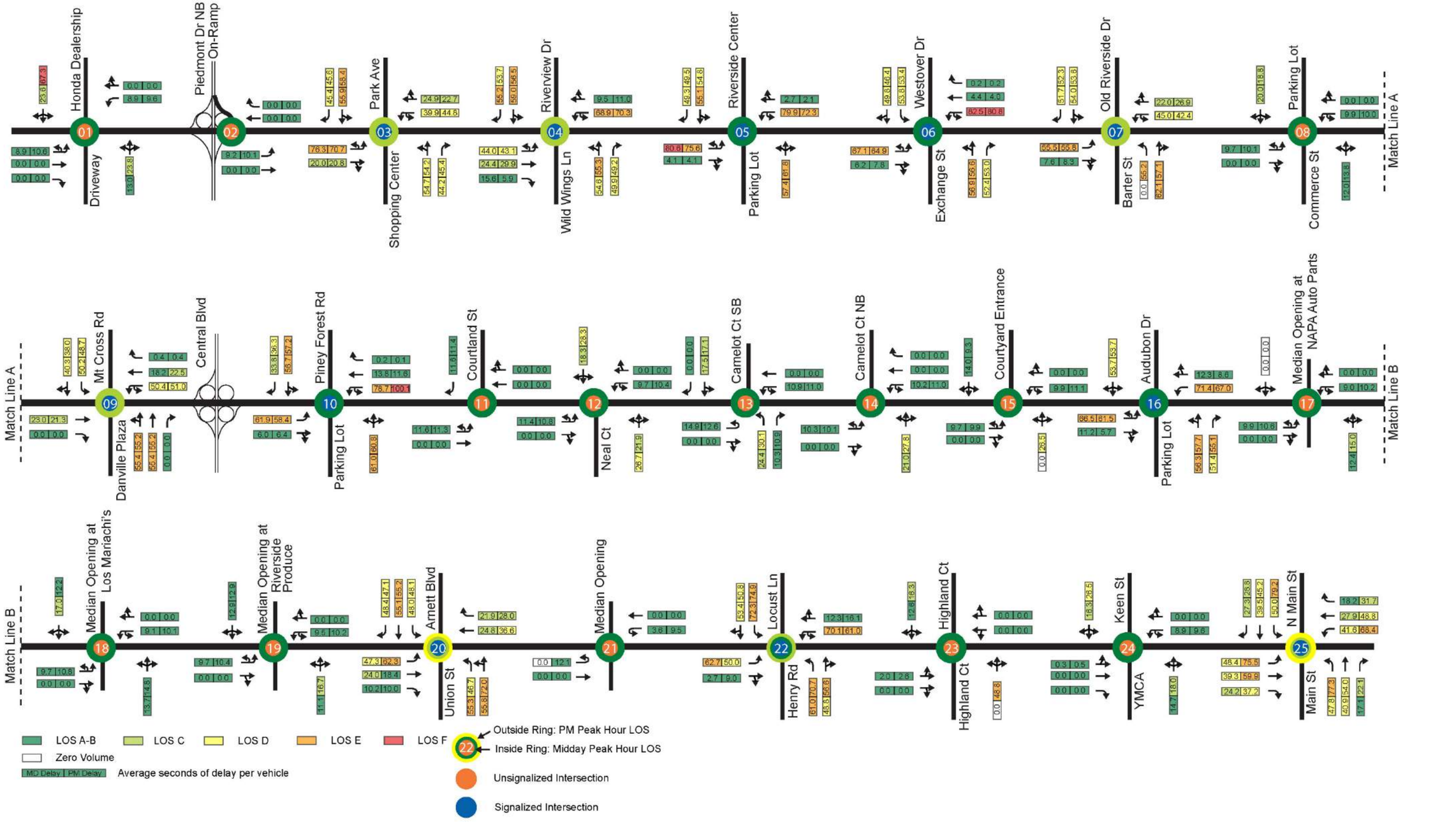
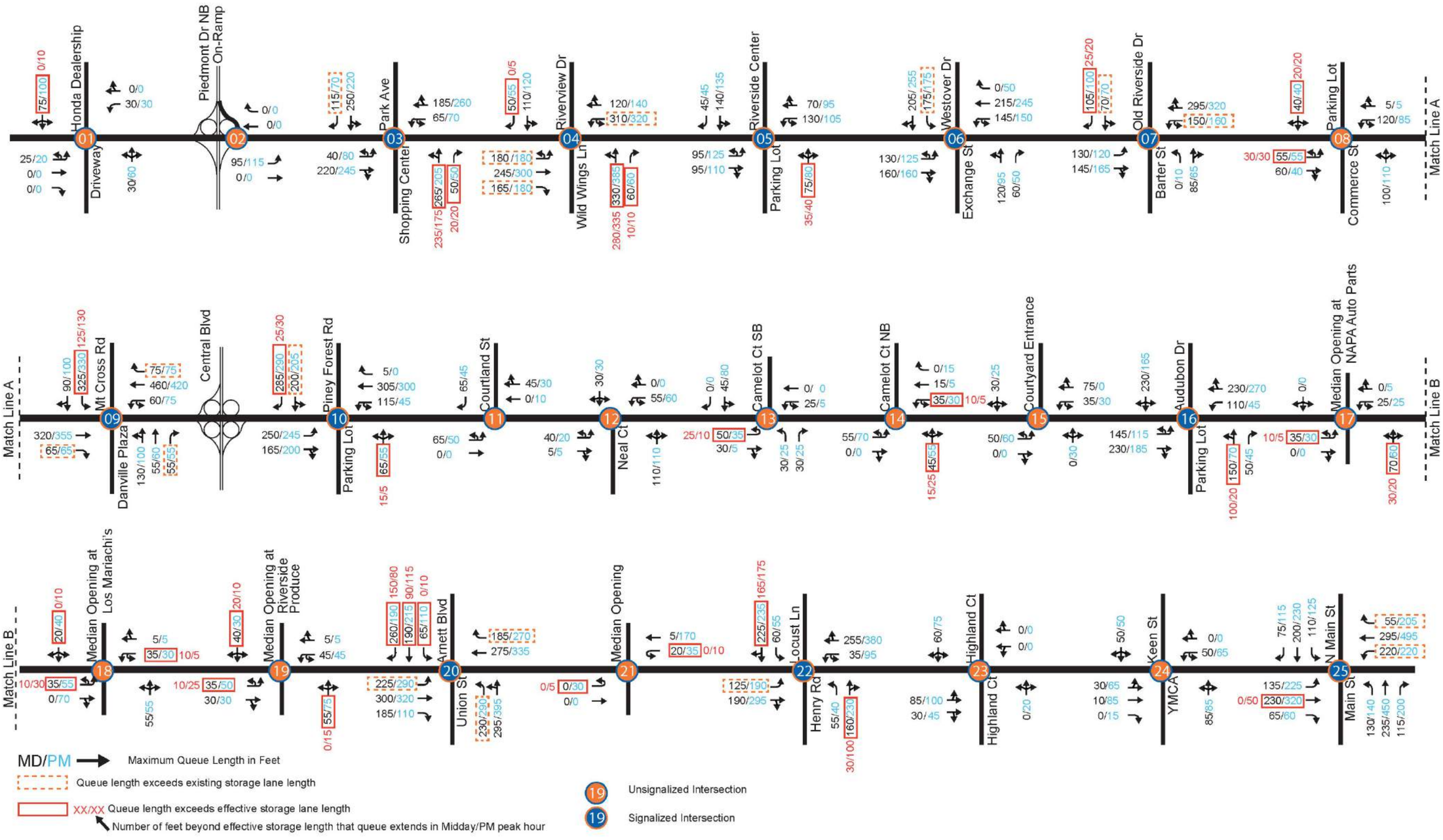


FIGURE 15: 2035 FUTURE NO-BUILD PEAK HOUR TRAFFIC OPERATING CONDITIONS – MAXIMUM QUEUE LENGTHS (FEET)



6 Developing and Screening the Potential Improvements

The analysis of existing and future No-Build conditions confirmed the deficiencies in Riverside Drive corridor are primarily related to pedestrian and motorist safety and access spacing. Since there are no significant congestion issues within the study corridor limits (as explained in Sections 3.1.3 and 5.2), the project team and study work group developed a range of potential improvements to address the safety and access spacing deficiencies. The study work group discussed the benefits and feasibility of the potential improvements and selected the improvements to be included in the study recommendations.

6.1 Developing the Potential Improvements

The project team and study work group developed a range of potential improvements to improve deficiencies based on three major themes:

1. Improving safety
2. Improving access spacing
3. Accommodating pedestrian and transit activity

The three major themes are interrelated, and many of the potential improvements address more than one theme. For example, converting a full median crossover to a directional median opening would both improve access spacing and decrease the number of conflict points (as illustrated in **Figure 16**), which decreases the potential for crashes and improves safety. Similarly, constructing sidewalks and installing crosswalks and pedestrian countdown signals would both accommodate pedestrian activity and address the history of pedestrian fatalities.

Table 3 lists the potential improvements that were identified and considered at each location. In general, the potential improvements included:

- Constructing sidewalks along Riverside Drive
- Installing crosswalks and pedestrian countdown signals at signalized intersections
- Modifying intersection and median opening to improve access spacing and address safety deficiencies
- Installing pedestrian hybrid beacons at select unsignalized intersections
- Modifying off-ramps to improve access spacing, minimize conflicts, and improve sight distance

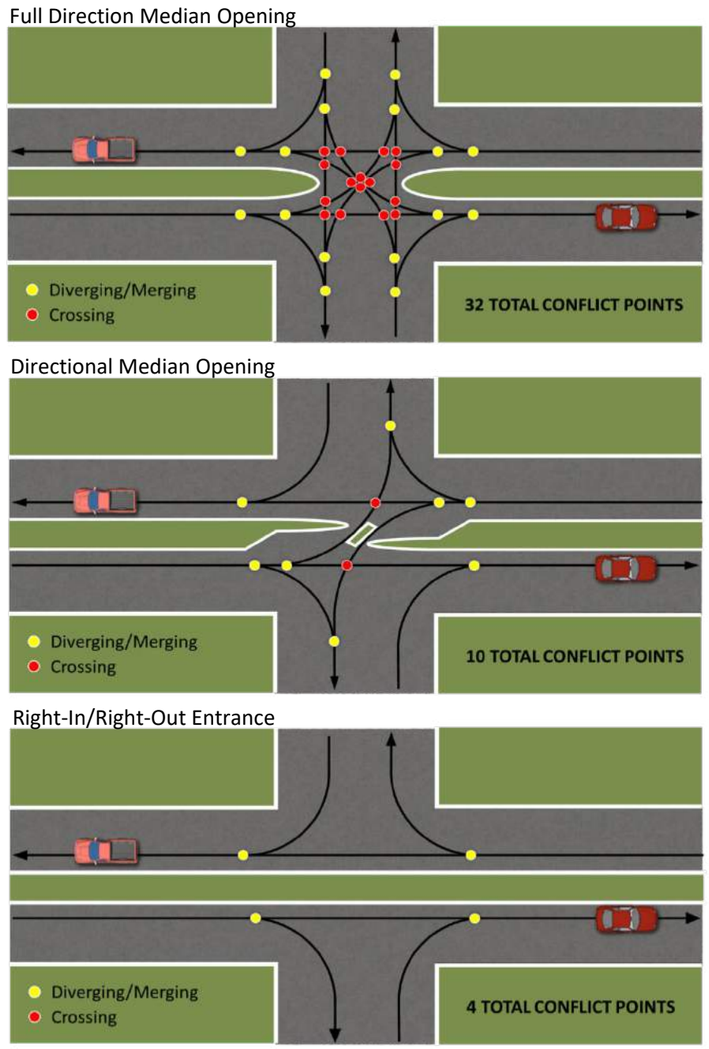
6.2 Screening the Potential Improvements

The study work group considered and discussed the potential improvements at several meetings to determine the improvements that should be included in the study recommendations. The group considered several factors including:

- Crash history, including crash type, crash severity, and location of crash clusters
- Reduction of conflict points
- Crash modification factors and other potential qualitative safety benefits
- Improvements to access spacing consistent with the VDOT access spacing standards
- Improvements to meet VDOT geometric design criteria (e.g. turn lane length)
- Feasibility of implementation and construction
- Magnitude of cost

The presentations from these meetings incorporated the initial improvement sketches, safety benefits, and other information, and are provided in **Appendix F**.

Figure 16: Conflict Point Diagrams by Type of Median Opening



Improving traffic operations was not a key focus of the potential improvements. The project team analyzed the potential improvements in Synchro and SimTraffic to determine the operational impacts of the potential improvements and made adjustments, if necessary, so that the potential improvements would not result in operational issues. The analysis of traffic operations is described in more detail in Section 7.4.

Table 3 identifies the improvements the study work group selected as recommendations. Table endnotes provide additional explanations of the improvements.

TABLE 3: POTENTIAL IMPROVEMENTS AND STUDY RECOMMENDATIONS

Location or Nearest Intersection	Potential Improvement	Study Recommendation?
Corridor-wide	Construct sidewalk or multi-use path between edge of traveled way and edge of right-of-way	Yes (1),(2)
	Add marked crosswalks and pedestrian countdown signals at all signalized intersections	Yes (3),(4)
	Convert the third travel lane in each direction to provide a wider buffer and wider sidewalk or multi-use path	No
	Provide left turn lanes at all median openings.	Yes, at all locations where median openings will remain open.
	Recalculate the yellow and all-red times and optimize the traffic signals	Yes
	Install a flashing yellow arrow and adjust the left turn phasing mode for eastbound and westbound left turns from protected only to protected/permissive	No (5)
Int 1: Honda Dealership	Construct an island to prohibit vehicles exiting the Honda dealership from turning left	No
	Realign the ramp from southbound Piedmont Drive to westbound Riverside Drive to intersect at 90 degrees. Install a STOP sign and stop bar for ramp traffic.	Yes
Int 3: Park Ave	Construct a turnaround loon to accommodate larger vehicles making westbound-to-eastbound U-turns	No
Int 4: Riverview Dr	Convert the Riverview Dr/Wild Wings Ln intersection to a signalized Restricted Crossing U-Turn (RCUT) intersection	Yes
Int 5: Riverside Center	Convert the Riverside Center/Kmart entrance intersection to a signalized RCUT intersection	Yes
Int 6: Westover Dr	Construct a bus bay at the Hardee's bus stop	Yes
	Remove the existing westbound channelized right turn ramp	Yes
	Install a turnaround loon to accommodate larger vehicles making eastbound-to-westbound U-turns	No
Int 7: Old Riverside Dr	Close Old Riverside Drive access to Riverside Drive	No
	Convert the Old Riverside Drive intersection to a signalized RCUT intersection	Yes
	Convert the Old Riverside Dr intersection to a full Median U-Turn intersection	No
	Convert the Old Riverside Dr intersection to a partial Median U-Turn intersection	No
	Close Barter Street access to Riverside Drive	No
Int 7: Old Riverside Dr	Prohibit Old Riverside Dr southbound right-turn-on-red from both lanes	Yes
Int 8: Commerce St	Convert Commerce St intersection to an unsignalized RCUT	Yes
Int 9: Mt Cross Rd	Convert the two intersections of Mount Cross Rd at Riverside Dr and Mount Cross Rd at Old Riverside Dr to a double roundabout	No
Int 9: Mt Cross Rd	Convert the second westbound left turn lane to a through lane. Restripe the westbound approach to provide a westbound right turn lane that extends back to the Central Blvd off-ramp	Yes
	Close the entrance to the connector road to Tower Dr	Yes
	Install a new traffic signal at the southbound Central Blvd off-ramp	Yes
Int 10: Piney Forest Rd	Create a split southbound stop bar	No
	Prohibit southbound right turns on red	No (6)
	Install a turnaround loon to accommodate larger vehicles making westbound-to-eastbound U-turns	No
Int 11: Courtland St	Close the existing median opening	Yes
	Install a pedestrian hybrid beacon	No
Int 12: Neal Ct	Convert the existing full median opening into an unsignalized RCUT intersection	Yes
	Install a pedestrian hybrid beacon	Yes
Int 13: Camelot Ct exit	Close the existing median opening	Yes
Int 13 and 14: Camelot Ct	Directionalize the two Camelot Ct entrance and exit median openings	No
Int 14: Camelot Ct entrance	Convert the existing full median opening into an unsignalized RCUT intersection	Yes
Int 15: Courtyard entrance	Convert the existing full median opening into an unsignalized RCUT intersection	No
	Close the existing median opening	Yes
Int 16: Audubon Dr	Add a westbound right turn lane	Yes
	Install a bus bay at the Biscuitville bus stop	Yes
	Install a turnaround loon to accommodate larger vehicles making eastbound-to-westbound U-turns	No
Int 17: Median Opening at NAPA Auto Parts	Close the existing median opening	Yes
Int 18: Median Opening at Los Mariachi's	Convert the existing full median opening into an unsignalized RCUT intersection	Yes
	Close the existing median opening	No
Int 19: Median Opening at Riverside Produce	Close the existing median opening	Yes
	Convert the existing full median opening into an unsignalized RCUT intersection	No
Int 20: Arnett Blvd	Remove the No U-Turn sign along the eastbound approach to allow passenger cars to make eastbound-to-westbound U-turns	Yes (7)
	Construct a turnaround loon to accommodate larger vehicles making eastbound-to-westbound U-turns	No
Int 22: Locust Ln	Close the median opening between Arnett Boulevard and Locust Lane to address the access spacing deficiency and eliminate conflict points.	Yes
	Realign Alpine Dr and Henry Rd to provide more space between the intersections	No

	Move the stop bars on the eastbound and westbound approaches back to accommodate the new crosswalks. Move the stop bar on the southbound approach forward to improve sight distance.	Yes
	Close the Highland Court approach completely	No
	Convert the Highland Court approach to right-in/right-out only access by constructing a median barrier	Yes
	Install a pedestrian hybrid beacon or rectangular rapid flashing beacons and realign the crosswalks to provide median refuge.	No (8)
	Remove crosswalks at the uncontrolled intersection	Yes (8)
	Convert the existing full median opening into an unsignalized RCUT intersection	No
	Install a new traffic signal at Keen St	No
	Construct a new eastbound turn lane for left turns and U-turns to allow turning vehicles to slow down and wait for a gap in oncoming traffic without blocking through vehicles.	Yes

Table Endnotes:

(1) The study work group discussed constructing sidewalks and/or shared-use paths on both sides of Riverside Drive for the entire length of the study corridor. For most of the study corridor, the recommendations include constructing sidewalks on both sides of Riverside Drive. Sidewalks are only recommended on the north side of Riverside Drive through the Central Boulevard interchange area because the bridge across Sandy Creek has a shoulder on the north side that can accommodate pedestrians without bridge widening. Constructing sidewalks on the south side would require bridge work that would significantly increase construction costs.

(2) The study work group considered constructing a shared-use path along one side of Riverside Drive to accommodate bicyclists traveling in both directions and a sidewalk along the other side. The shared-use path was not included in the recommendations because of the frequency of entrances, which introduces more conflict points. The Riverwalk Trail runs parallel to Riverside Drive less than 0.2 miles to the south and provides a shared-use path for bicyclists and other non-motorized users. The recommendations from this project include enhancing connections to the Riverwalk Trail from Riverside Drive at Audubon Drive and at Park Avenue.

(3) The project team tested different ways to modify the traffic signals to provide enough time for pedestrians to cross Riverside Drive, including lengthening the side-street minimum green times to accommodate one-stage and two-stage pedestrian crossings. Another way to accommodate the pedestrian crossing time without extending the minimum green times is to allow the signal to come out of coordination when a pedestrian pushes the push-button and extend the side-street green time just for that cycle. After the pedestrian phase end, the traffic signal would fall back into coordination.

(4) Crosswalks and pedestrian countdown signals are recommended at all intersection legs at most signalized intersections in the study corridor, except at the Arnett Boulevard intersection due to the skewed angle of the Union Street approach. Crosswalks across the signalized RCUTs should be installed with the "Z" crossing treatment, illustrated in **Figure 17**.

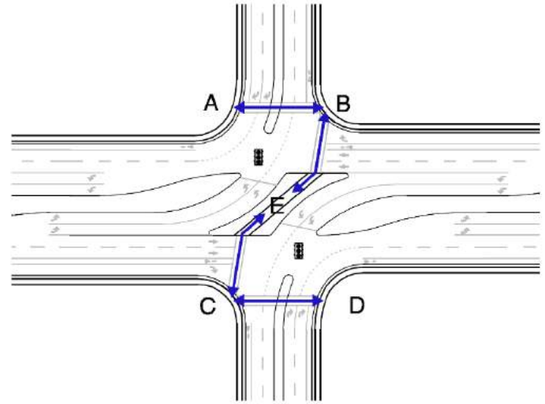
(5) The project team examined the feasibility of converting the protected-only eastbound and westbound left turn phasing modes to protected/permitted to allowing vehicles waiting to turn left from Riverside Drive to proceed if there is a gap in oncoming traffic. Most of the intersections do not have adequate sight distance for vehicles waiting in the left turn lane to safely identify adequate gaps in oncoming traffic. Vehicles waiting in the opposing left turn lane obstruct drivers' sight lines because of the large median offset. Protected-permissive left turns may be possible at the following intersections but were not included in the recommendations.

- Riverside Drive at Park Avenue – eastbound and Westbound
- Riverside Drive at Mt Cross Road – Westbound
- Riverside Drive at Locust Lane – Eastbound and Westbound
- Riverside Drive at N Main Street - Westbound

(6) The crash data indicated a few crashes at the Piney Forest Rd intersection that involved southbound right turns, and the southbound right turn volumes exceed 200 vehicles per hour in both midday and PM peak hours. A complete prohibition of right turns on red is unnecessary. However, the recommendations include installing a No Right Turn on Red blank-out sign next to the southbound signal head on the mast arm that would illuminate when a pedestrian pushes the button to cross the western leg of Riverside Drive. This sign is expected to prevent conflicts between crossing pedestrians and right turning vehicles who may not look to the right when stopped at a red light.

(7) Section 21-50 of the Danville City Code prohibits drivers from making U-turns at signalized intersection. Several of the recommended improvements will require motorists to make a U-turn at signalized intersections. The City will need to update the code to allow drivers to make a U-turn unless expressly prohibited with signage.

(8) The Main Street intersection is 300 feet to the east of the Keen Street intersection. The study work group agreed the crosswalks at the Main Street intersection provide more protection for pedestrians because they are signal-controlled and well-lit.



7 Recommended Improvements

The study work group determined which improvements should be included in the study recommendations to best improve safety, improve access spacing, and accommodate pedestrian and transit activity, as described in the previous sections. The project team developed more detailed drawings and conducted an additional analysis to finalize the recommendations, quantify the benefits, and develop planning-level cost estimates.

7.1 Recommended Projects

The recommended improvements are identified in Table 3 in the previous section in black text.

The project team grouped the recommended improvements into seven projects that can be implemented alone or in combination with others. The seven projects are listed below and based on the segments of the study corridor that they cover. The projects are ranked in a recommended order for implementation based on general consideration of the intersection and segment PSI rankings, crash severities and crash types, location of pedestrian crashes, transit boardings and alightings, and adjacent land uses.

1. Westover Drive to Mount Cross Road
2. Piney Forest Road to Audubon Drive
3. Central Boulevard Interchange Area
4. Park Avenue to Westover Drive
5. Audubon Drive to Arnett Boulevard
6. Piedmont Drive Ramp Realignment
7. Arnett Boulevard to Main Street

The improvements within each of the seven projects are described and illustrated in the project summary sheets in Appendix G. Subsequent sections describe the safety and access spacing benefits and the impacts to traffic operations.

7.2 Safety Benefits

One way to quantify the safety benefits of an improvement is to calculate the expected reduction in the number of crashes once the improvement is implemented. The Highway Safety Manual defines a method for calculating the expected reduction in crashes using crash modification factors (CMFs). Crash modification factors are ratios that estimate the degree to which a particular treatment (i.e. countermeasure or treatment) would reduce the number of crashes. The CMF ratio compares the expected average crash frequencies before and after a treatment is implemented. CMFs less than 1.0 indicate a treatment would reduce the crash frequency. CMFs more than 1.0 indicate a treatment would increase the crash frequency. A CMF of 1.0 indicates a treatment would have no change in the expected crash frequency.

$$CMF = \frac{\text{Expected Average Crash Frequency } \textit{after} \text{ treatment is implemented}}{\text{Expected Average Crash Frequency } \textit{before} \text{ treatment is implemented}}$$

VDOT maintains a list of planning level CMFs for SMART SCALE project scoring. The planning level CMFs indicate the expected reduction in the number of fatality (F) and injury (I) crashes, weighted by the "equivalent property damage only" (EPDO) crash value scale, shown in **Table 4**.

The project team conducted the planning level CMF analysis in accordance with the SMART SCALE scoring methodology. The project team used five years of crash data from January 1, 2013 through December 31, 2017. Crashes involving alcohol were excluded from the analysis. Each crash was assigned to either an intersection or a segment. Only one CMF per intersection was selected, even though the recommendations include multiple improvements with CMFs at many of the intersections. **Table 5** shows the results from the planning level CMF analysis. Intersections and locations are listed from west to east.

The southbound Piedmont Drive off-ramp intersection is not included in **Table 5** because none of the crashes that occurred within the off-ramp merge area between 2013 and 2017 resulted in a fatality or injury. The recommended ramp realignment and new stop sign are expected to reduce crashes; however, this is not reflected in the SMART SCALE CMF methodology.

As further described in Sections 2.6, 7.3, and 7.5, the consolidation of median openings and entrances is needed to bring the Riverside Drive corridor closer to meeting access spacing standards. Each access point creates conflict points, which represent the potential for crashes to occur. Addressing the access spacing deficiencies will reduce the number of conflict points, thereby reducing crash potential. The sidewalks, crosswalks, pedestrian countdown signals, and pedestrian hybrid beacons will improve pedestrian safety, providing much needed designated paths for walking along and crossing Riverside Drive. Although these safety improvements are not quantified in terms of crash reductions, they will address the identified deficiencies.

Table 4: Equivalent Property Damage Only Crash Value Scale

Crash Severity	Crash Value
K (Fatality)	85
A (Severe Injury)	85
B (Moderate Injury)	10
C (Minor Injury)	5

Source: SMART SCALE Technical Guide, Revised February 21, 2018

TABLE 5: EXPECTED CRASH REDUCTIONS

Intersection/Location	2013 2017 EPDO (FI)	CMF Description	CMF	EPDO (FI) Reduction
Park Ave	120	Improve at-grade crossing	0.85	18
Riverview Dr	55	Signal control to signalized RCUT	0.80	11
Riverside Center	190	Signal control to signalized RCUT	0.80	38
Westover Dr	290	Improve at-grade crossing	0.85	44
Old Riverside Dr	145	Signal control to signalized RCUT	0.80	29
Commerce St	50	Two-way stop control to RCUT	0.65	18
Mount Cross Rd	340	New turn lane (none present)	0.85	51
Southbound Central Blvd off-ramp intersection	5	New signal – Convert stop/yield control to signal	0.65	2
Westbound segment between Piney Forest Rd and southbound Central Blvd off-ramp	25	Add sidewalk	0.90	3
Piney Forest Rd	270	Improve at-grade crossing	0.85	41
Courtland St	25	Close median opening (allow right-in/right-out only)	0.40	15
Neal Ct	95	Two-way stop control to RCUT	0.65	33
Camelot Ct exit	20	Close median opening (allow right-in/right-out only)	0.40	12
Camelot Ct entrance	10	Two-way stop control to RCUT	0.65	4
Audubon Dr	310	Reduce driveway density (eliminate/close)	0.70	93
Median Opening at NAPA Auto Parts	5	Close median opening (allow right-in/right-out only)	0.40	3
Median Opening at Los Mariachi's	25	Two-way stop control to RCUT	0.65	9
Median Opening at Riverside Produce	5	Close median opening (allow right-in/right-out only)	0.40	3
Arnett Blvd	115	Improve at-grade crossing	0.85	17
Median Opening between Arnett Blvd and Locust Ln	5	Close median opening (allow right-in/right-out only)	0.40	3
Locust Ln	50	Improve at-grade crossing	0.85	8
Highland Ct	70	Provide median (right-in/right-out only)	0.40	42
Keen St	100	New turn lane (none present)	0.85	15

7.3 Improvements to Access Spacing

As explained in Section 2.6 and shown in the access spacing maps in **Appendix D**, the spacing between median openings does not meet the VDOT access spacing standards over most of the study corridor. The recommendations improve the spacing of median openings and bring the study corridor closer to meeting VDOT's standards. **Table 6** shows how the recommendations improve access spacing in the corridor.

TABLE 6: IMPROVEMENTS TO ACCESS SPACING

From	To	Access Spacing Improvements
Honda Dealership	Southbound Piedmont Dr off-ramp	Access spacing standards require a minimum of 1,320 feet between the end of a ramp terminal and any median crossover. Currently there is only 60 feet between the off-ramp terminal and the median crossover at the Honda Dealership. The recommended ramp realignment will increase the distance between the off-ramp terminal and the median crossover to 450 feet.
Old Riverside Drive	Mount Cross Road	The distance between these Old Riverside Drive and Commerce Street is 625 feet. The distance between Commerce Street and Mount Cross Road is 730 feet. The spacing standards require a minimum of 1,050 feet between a full direction median opening and any other intersection. Once Commerce Street is converted to an unsignalized RCUT, the currently deficient spacing will meet the minimum spacing requirement of 565 feet between a directional median opening and any other intersection.
Piney Forest Road	Audubon Drive	Currently the spacing between the median openings on this segment does not meet VDOT's minimum spacing requirements. Once the RCUTs and median closures are implemented, this segment will meet the minimum spacing of 565 feet between a directional median opening and any other intersection.
Audubon Drive	Arnett Boulevard	Currently the spacing between the median openings on this segment does not meet VDOT's minimum spacing requirements. Once the RCUTs and median closures are implemented, this segment will meet the minimum spacing requirement of 565 feet between a directional median opening and any other intersection.
Arnett Boulevard	Locust Lane	Currently the spacing between the median opening and the signalized intersections does not meet VDOT's minimum spacing requirements. Once the RCUTs and median closures are implemented, this segment will meet the minimum spacing requirement of 565 feet between a directional median opening and any other intersection.

The VDOT access spacing standards do not clearly explain whether the minimum spacing between a signalized RCUT and another signalized intersection is different from the minimum spacing between two typical signalized intersections where no movements are restricted.

7.4 Impacts to Traffic Operations

The project team analyzed the recommended improvements in Synchro to ensure they would not produce any major operational issues. The lane configurations of the recommended improvements are shown in **Figure 18**. **Figure 19** shows the peak hour turning movement volumes at each intersection, including rerouted volumes from the modified intersection configurations.[14]

The analysis confirmed that **most of the recommended improvements are not projected to adversely impact traffic operations on Riverside Drive**. Overall traffic operating conditions are expected to slightly improve after the recommended improvements are implemented, with a few exceptions on the side-streets that are discussed below. The delays and LOS for the future Build scenario are shown in **Figure 20**.[15] The maximum queue lengths are shown in **Figure 21**. Cycle lengths were kept at 120 seconds, yellow and all-red phases were adjusted based on intersection geometry, and the phase splits were optimized. Yellow and all-red timing adjustments are provided in **Appendix J**.

7.4.1 Control Delays and Levels of Service

The traffic analysis indicates there is minimal change in the traffic operating conditions between the future No-Build scenario and the scenario with the recommended improvements (i.e. the future Build scenario). Just like in the future No-Build scenario, 23 of the 25 intersections are projected to operate at LOS C or better in both peak hours in the future Build scenario. The intersections of Riverside Drive at Arnett Boulevard and at Main Street are projected to operate at LOS D once the recommendations are implemented, which is the same level of service as in the existing and future No-Build scenarios.

Levels of service for individual turning movements are expected to stay the same or improve, except for the northbound and southbound through movements at Arnett Boulevard and the southbound left turn at Locust Lane. The analysis indicates these movements could degrade from LOS E to LOS F in the PM peak hour.

- At the intersection of Riverside Drive and Arnett Boulevard, the northbound and southbound through movements serve 226 and 140 vehicles, respectively, in the PM peak hour, which together represent 13 percent of the volumes entering the intersection. The recommendations include lengthening the all-red time on the northbound and southbound movements and reallocating green time to the eastbound approach to accommodate the rerouted U-turns. The smaller green times for the northbound and southbound approaches cause the level of service for the through movements to worsen from LOS E to LOS F in the PM peak hour. The northbound through movement delay increases from 55 seconds to 81 seconds, and the queue length increases by 15 feet (less than one car length). The southbound through movement delay increases from 72 seconds to 82 seconds, and the queue length increases by 70 feet (about three cars). Despite these degradations, the overall level of service for the intersection remains at LOS D.
- At the intersection of Locust Lane, the southbound left turn serves nine vehicles in the PM peak hour, which is less than one percent of the volumes entering the intersection. The signal timing was adjusted in the testing of the recommendations, and green time was reallocated from the southbound left turn to other higher volume movements. These signal adjustments caused the southbound left turn delay to increase from 74 seconds to 120 seconds. The queue length increases from 55 feet to 130 feet. Despite these degradations, the southbound approach remains at LOS D, and the intersection overall remains at LOS C.

7.4.2 Maximum Queue Lengths

As explained in Section 3.1.3.2, many of the existing queuing issues are primarily a result of inadequate access spacing and the lack of left turn lanes at median openings.

The recommendations generally improve queue lengths on approaches where geometric changes are proposed. The recommendations include providing left turn lanes at all median openings throughout the study corridor. The new left turn lanes eliminate the problems of eastbound and westbound left turn queue lengths exceeding the effective storage length at all locations where this occurred in the Existing and No Build conditions.

The peak hour westbound left turn maximum queues at the Riverview Drive/Wild Wings Lane intersection exceed the existing full-width storage length in the Existing and future No Build scenarios. The additional U-turns from the RCUTs are expected to lengthen these maximum queues by two or three cars, which will slightly exceed the effective queue storage length. The 95th percentile queue lengths reported in the SimTraffic output sheets do not exceed the effective storage length.

As explained in Section 3.1.3.2, many of the side-street queue issues are the result of an entrance or intersection on a side-street being located too close to the intersection with Riverside Drive. The proposed RCUTs will improve queue lengths on some side-streets by eliminating the left turns and through movements. Many of the locations where the side-street queues exceed the effective storage length, shown in red in **Figure 21**, are the same locations that have this issue in the Existing conditions. The project team considered possibilities for closing and relocating some of these entrances and side-street intersections to lengthen the distance and better conform to VDOT's standards. However, these entrances and intersections need to be maintained to provide parcel access. While this study does not provide recommendations to address the side-street queue issues at these specific intersections, Section 7.6 provides policy recommendations to ensure future entrances and intersections are designed and approved in conformance with VDOT standards during the City's rezoning and site review approval processes.

The recommendations include replacing the traffic signals where signalized RCUTs are recommended so the eastbound and westbound approaches can operate independently. The planning level cost estimates include the signal replacement in the cost. The traffic operations analysis only modeled the operations with one controller. Two separate controllers are recommended and will result in improved operational performance.

The peak hour maximum queue lengths at the proposed new westbound right turn lane at Audubon Drive will slightly exceed the effective storage length, however the 95th percentile queue lengths do not exceed the effective storage length.

Queue lengths on approaches without geometric recommendations are generally similar or slightly (less than one car length) longer than the queue lengths in the future No Build scenario. One exception to this occurs at the Park Avenue intersection, where the vehicles rerouted from the RCUTs will lengthen the northbound approach queues by three or four cars.

The impacts to traffic operations described above are relatively minor compared to the safety benefits of reducing the number of conflict points and reducing the expected crashes. Despite the minor impacts to the traffic

[14] Note: The future Build analysis of traffic operations was performed as a series of tests on individual or select groupings of intersections. The project team did not model all recommended improvements together in one Synchro model. The tests on the individual and select groupings of intersections allowed the project team to quickly test a variety of possible treatments and confirm that the treatments would not significantly affect traffic operations. The future Build analysis results provided in this section are a compilation of the individual tests.

[15] The delays and LOS shown in **Figure 21** are reported from the Synchro model outputs, which are available in **Appendix H**. The results do not account for the extra distance travel time that side-street vehicles turning left or going straight will encounter by traveling to the next intersection and making a U-turn.

operations, the proposed changes described in previous sections and illustrated in the project summary sheets in **Appendix G** are recommended because of the improvements to safety.

FIGURE 18: LANE CONFIGURATIONS WITH RECOMMENDED IMPROVEMENTS

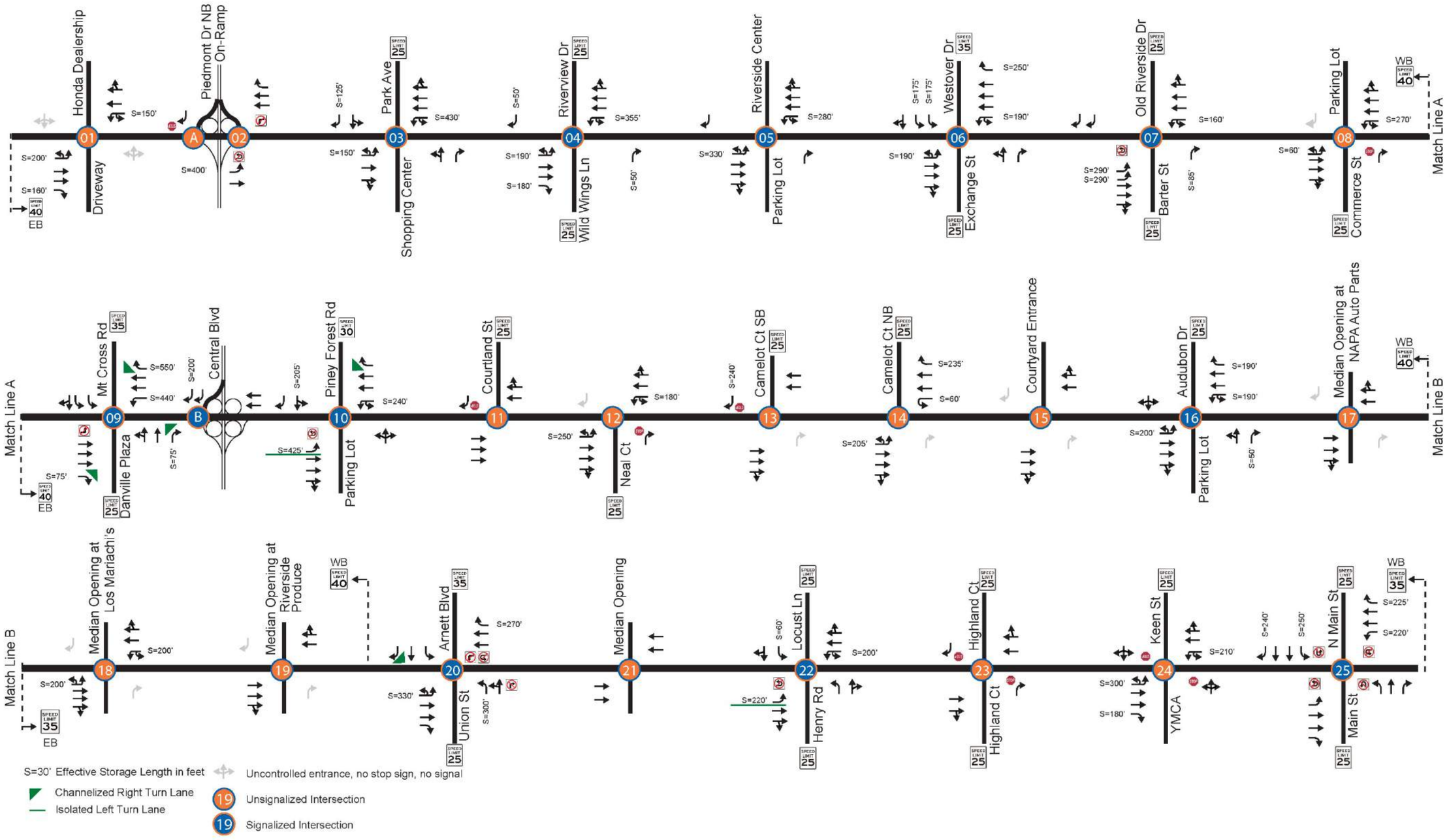


FIGURE 19: 2035 FUTURE MIDDAY AND PM PEAK HOUR TURNING MOVEMENT VOLUMES WITH RECOMMENDED IMPROVEMENTS

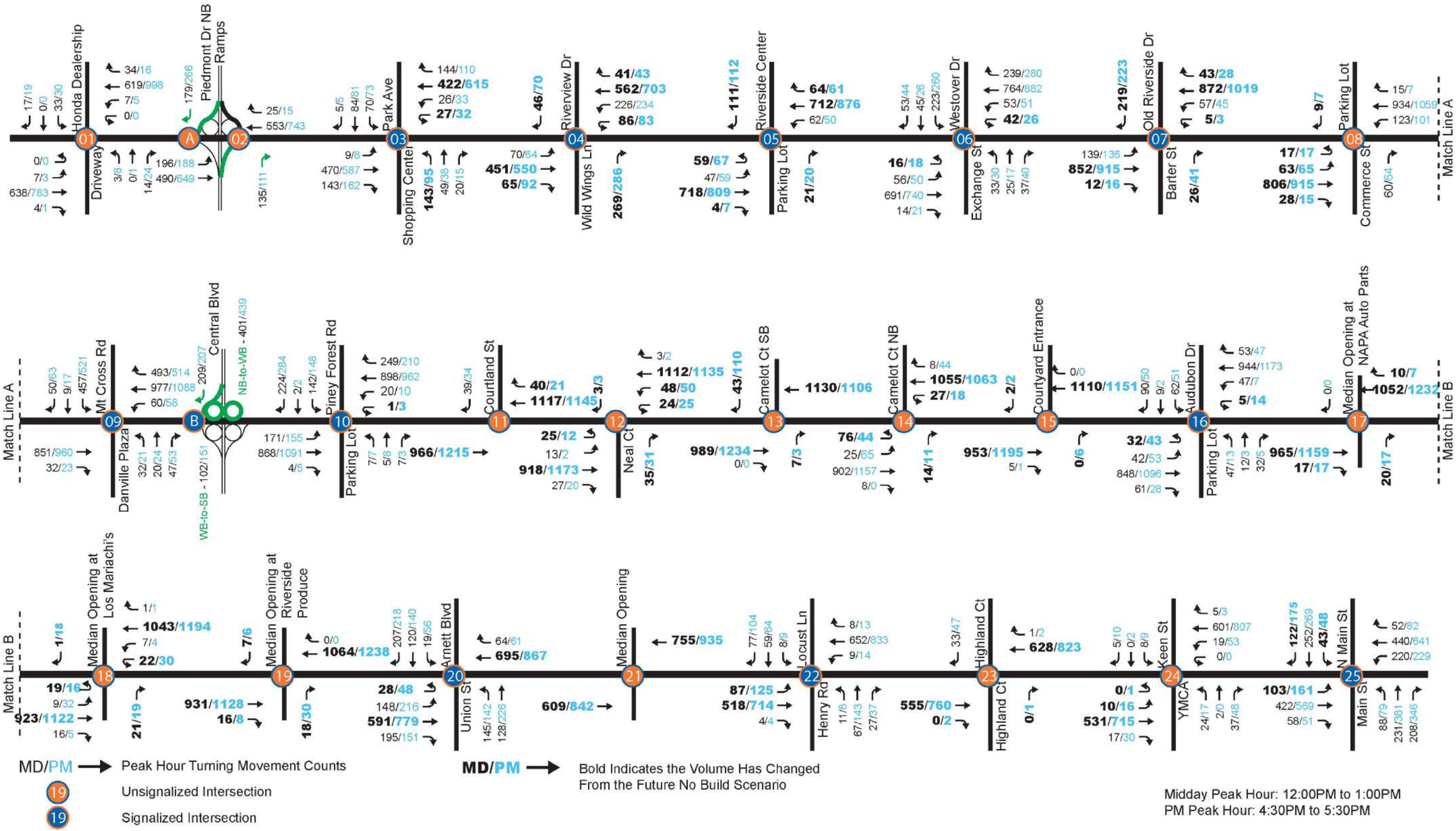


FIGURE 20: 2035 FUTURE PEAK HOUR TRAFFIC OPERATING CONDITIONS WITH RECOMMENDED IMPROVEMENTS – CONTROL DELAYS (SECONDS PER VEHICLE) AND LEVELS OF SERVICE

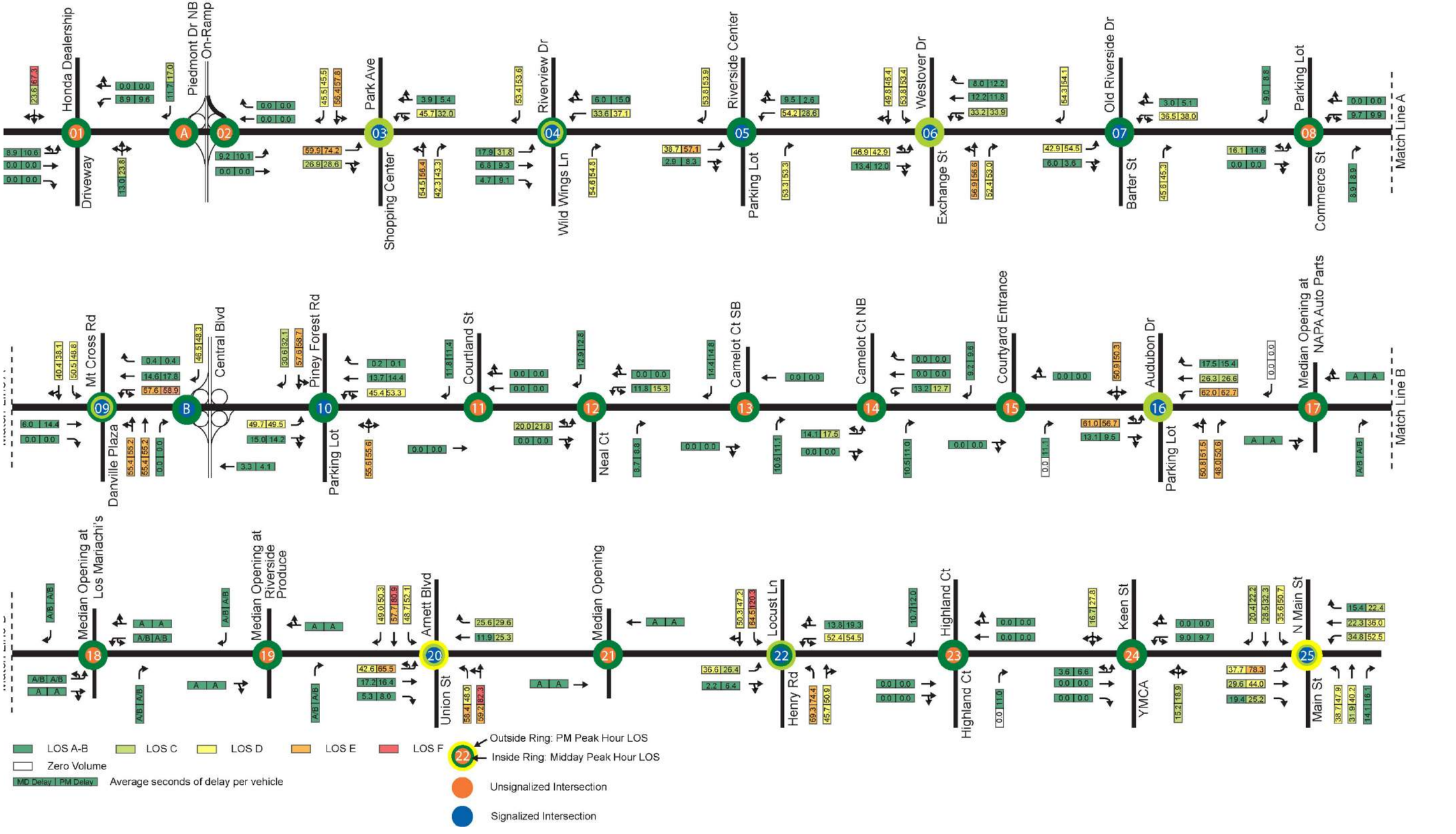
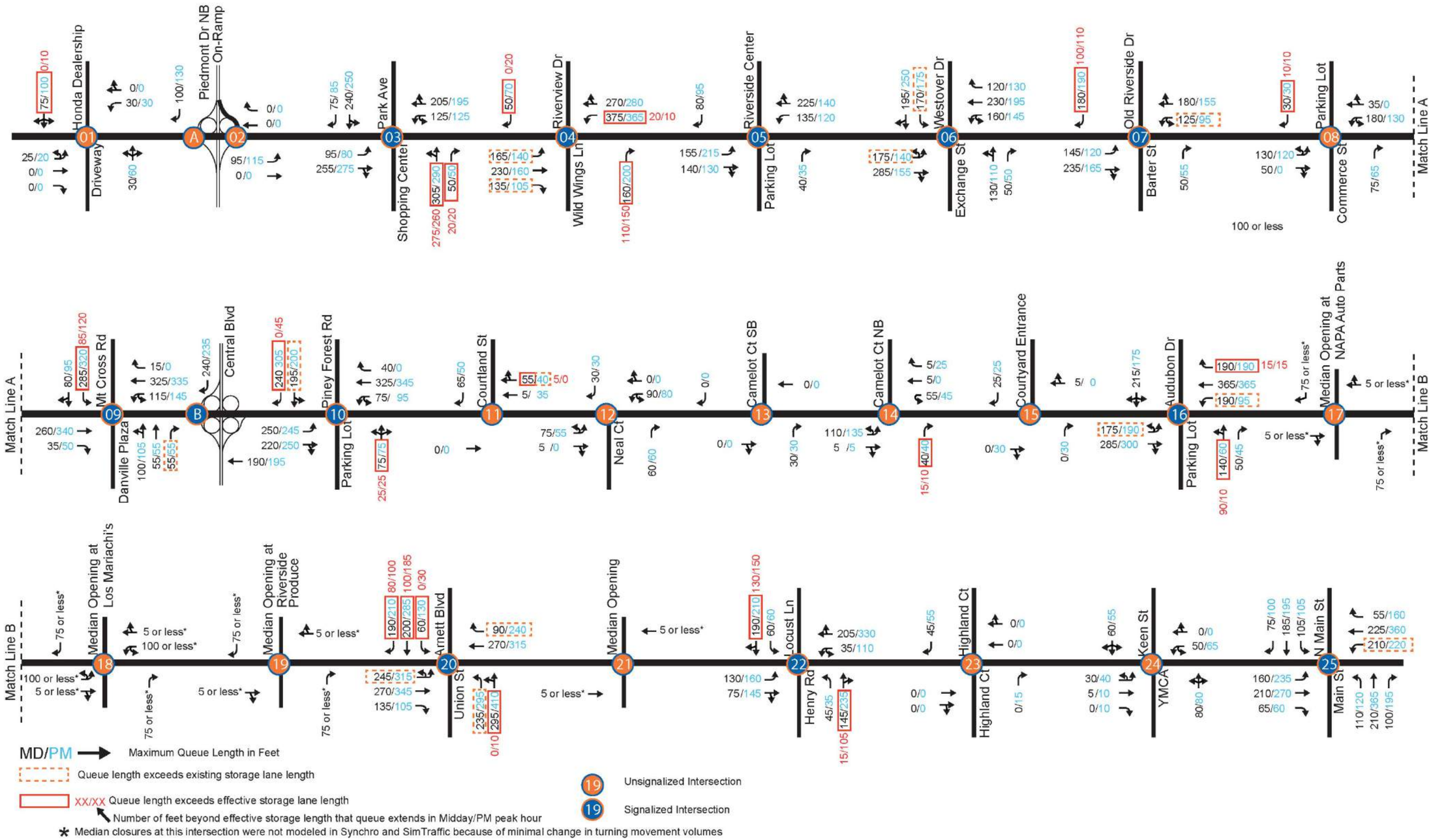


FIGURE 21: 2035 FUTURE PEAK HOUR TRAFFIC OPERATING CONDITIONS WITH RECOMMENDED IMPROVEMENTS – MAXIMUM QUEUE LENGTHS (FEET)



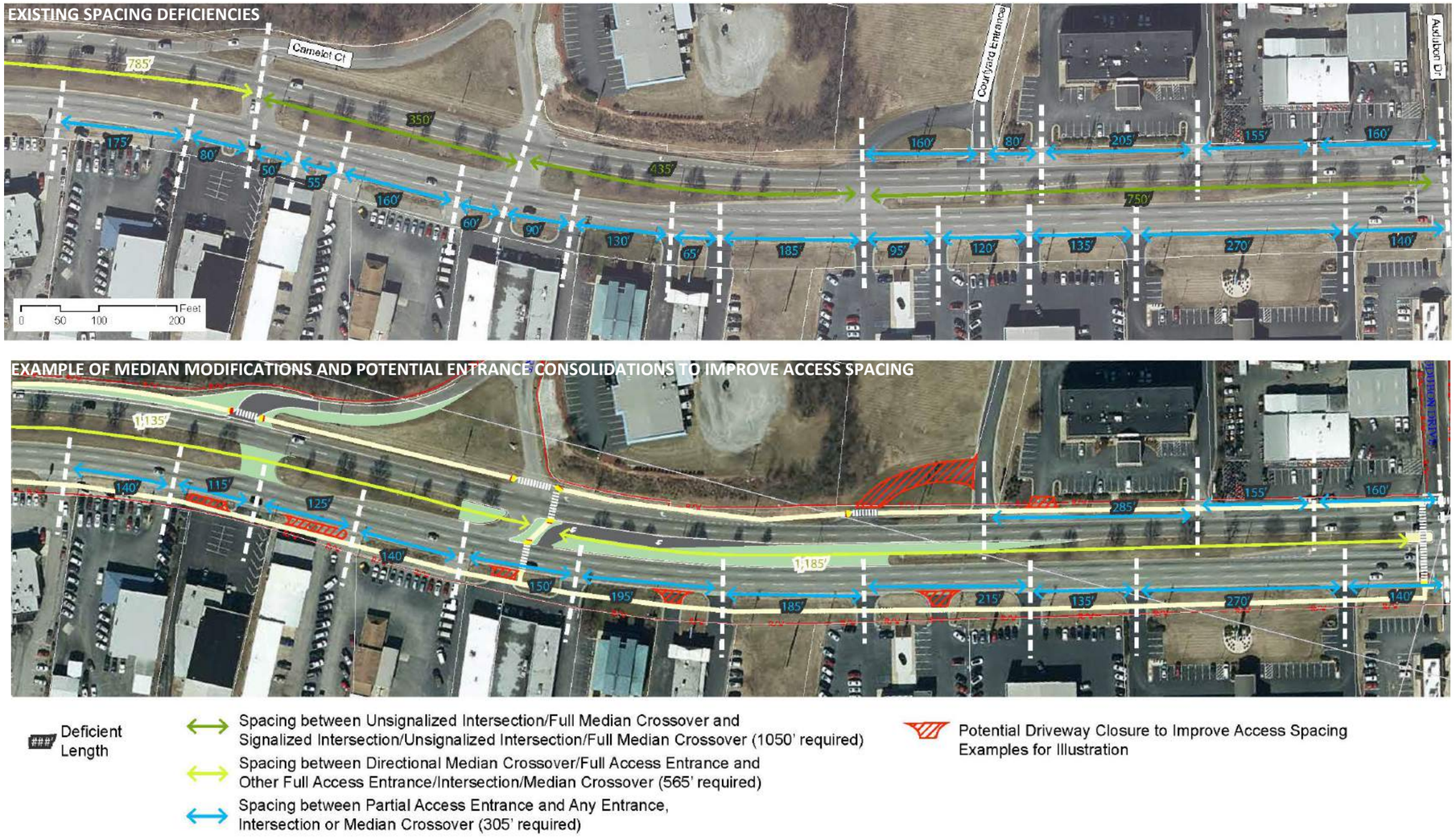
7.5 Entrance Spacing

The recommendations focus on addressing access spacing deficiencies for the median openings along the study corridor. As explained in Section 2.6, the spacing of commercial entrances along most of the study corridor does not meet the VDOT access spacing standards. The access spacing maps in **Appendix D** identify the deficiencies in commercial entrance spacing. The study work group discussed the issue of entrance spacing in the development of potential improvements. The recommendations listed in **Table 3** specifically identify two entrances to be closed.

Other entrances throughout the corridor will need to be consolidated to address the access spacing deficiencies. It is important to address this consolidation prior to constructing the recommended sidewalk to minimize the locations of conflict between pedestrians and turning vehicles. Entrance consolidation will involve conversations with property owners to better understand site circulation patterns and determine the best arrangement of entrance locations.

Figure 22 shows an example of how entrances could be consolidated to more closely conform to the requirements while still maintaining one access point per parcel. Spacing between entrances, shown in blue, is closer to the required 305 feet.

FIGURE 22: EXAMPLE OF ENTRANCE CONSOLIDATIONS TO IMPROVE ACCESS SPACING



7.6 Policy Recommendations

While the previous sections describe physical improvements to modify and close existing median openings and entrances, it is important to ensure that the City approve new entrances and access points in conformance with VDOT's spacing standards. This study recommends the City adopt a policy to follow VDOT's access spacing standards and access management design standards when considering and approving new entrances and access points during rezoning and site plan review processes.

8 Conceptual Design, Costs, and Schedules

The project team developed conceptual designs, planning-level cost estimates, and schedule estimates for the seven projects listed in Section 7.1. The project summary sheets in **Appendix G** provide this information for each project, as well as a description of the recommended improvements, a conceptual illustration, a location map, summaries of the safety benefits, and traffic operations results.

8.1 Conceptual Design

The project team developed the conceptual designs in accordance with the following applicable guidelines:

- A Policy on Geometric Design of Highways and Streets (AASHTO 2018)
- VDOT Road Design Manual (Issued January 2005, Revised July 2016)
- VDOT Road and Bridge Standards (VDOT 2016, latest revisions)
- Manual on Uniform Traffic Control Devices (MUTCD 2009)
- 2011 Virginia Supplement to the MUTCD

8.2 Planning-Level Cost Estimates

A refined planning-level cost estimate was developed for all selected improvement projects. The following assumptions were made in the development of the costs:

- A 20 percent preliminary engineering cost was estimated as a percentage of construction costs, including contingency. The preliminary engineering estimate was completed using 2024 dollars.
- For projects with anticipated right-of-way and/or utility impacts, those costs were estimated on a project-by-project basis based on the size and complexity of the project, as well as per inspection of the existing right-of-way limits as shown in the GIS parcel layer.
- The right-of-way and utility cost estimates are based on 2028 dollars.
- Construction costs were estimated using a combination of VDOT's Project Cost Estimating System (version 9.00), VDOT Transportation and Mobility Planning Division's Statewide Planning Level Cost Estimate Spreadsheet, and recent historical bid costs.
- The construction cost estimates include an additional 30 percent "unidentified project risk" and 20 percent for construction engineering and inspection.
- The construction costs estimates are based on 2030 dollars.

Table 7 summarizes the preliminary engineering, right-of-way and utility relocation, construction, and total planning level cost estimates for each improvement project. A more detailed breakdown of the planning-level cost estimates is provided in **Appendix I**.

Table 7: Planning-Level Cost Estimates

Project	Cost Estimate (Construction Year 2030)			
	Preliminary Engineering	Right-of-Way and Utilities	Construction	Total
1: Westover Drive to Mount Cross Road	$2,019,000	$411,000	$13,118,000	$15,548,000
2: Piney Forest Road to Audubon Drive	$1,136,000	$1,006,000	$7,377,000	$9,519,000
3: Central Boulevard Interchange Area	$534,000	$33,000	$2,775,000	$3,342,000
4: Park Avenue to Westover Drive	$954,000	$1,397,000	$6,195,000	$8,546,000
5: Audubon Drive to Arnett Boulevard	$596,000	$229,000	$3,873,000	$4,698,000
6: Piedmont Drive Ramp Realignment	$339,000	$0	$1,099,000	$1,438,000
7: Arnett Boulevard to Main Street	$1,270,000	$1,697,000	$8,244,000	$11,211,000

8.3 Schedule Estimates

The project team developed schedule estimates for each project. **Table 8** summarized the projected timeframes for the Preliminary Engineering, Right-of-Way and Utilities, and Construction phases of each project.

Table 8: Schedule Estimates

Project	Schedule Estimate (months)			
	Preliminary Engineering	Right-of-Way and Utilities	Construction	Total
1: Westover Drive to Mount Cross Road	24	12	36	72
2: Piney Forest Road to Audubon Drive	24	12	24	60
3: Central Boulevard Interchange Area	24	12	12	48
4: Park Avenue to Westover Drive	24	12	18	54
5: Audubon Drive to Arnett Boulevard	24	12	24	60
6: Piedmont Drive Ramp Realignment	2	1	5	8
7: Arnett Boulevard to Main Street	24	12	26	62

9 PROJECT ADVANCEMENT

This study should be used as a planning tool to achieve the next steps of planning, programming, designing, and constructing the identified safety and operational improvements in the study corridor. To build upon the efforts of this study, the City of Danville should continue to coordinate with the Danville MPO, VDOT, and other stakeholders. To advance these projects beyond the planning stage, members of the study work group should use the following steps.

Prepare Projects for Advancement

The City should conduct outreach meetings for further vetting of the proposed projects, as needed. These outreach meetings should include additional stakeholders that were not in the study work group. Other stakeholders may include business owners on the corridor and City of Danville residents.

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

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

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. All Riverside Drive improvement projects are candidate projects for Revenue Sharing.
- 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. All Riverside Drive improvement projects are candidate projects for HSIP.
- 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.
- Transportation Alternatives (TA): a program that federal funding for creative projects that integrate transportation into our communities and environment. Funding is applicable for projects that improve non-motorized transportation, enhance the public's traveling experience, revitalize communities, and improve quality of life. Six of the seven Riverside Drive improvement projects are candidate projects for TA funding. The Piedmont Drive ramp realignment project is the only project that would not be eligible.

While the cost estimates provided in Section 8.2 include the improvements for segments of Riverside Drive, there may be opportunities to separate discrete elements of the projects for targeting specific funding sources. An example of this could be to complete segments of sidewalk improvements, including the pedestrian bridges, using revenue share or transportation alternative funding. Similarly, RCUT improvements could be targeted to future HSIP funding. Also, if parcels along the corridor require zoning action with redevelopment, then opportunities could arise to have a developer modify site access and/or construct sidewalks across their frontage.