STAPLES MILL ROAD
SMALL AREA PLAN

FEBRUARY 2022

TECHNICAL MEMO

EXISTING AND FUTURE NO-BUILD CONDITIONS

KITTELSON & ASSOCIATES FOR VDOT

CONTENTS

1.0 INTRODUCTION

Staples Mill Road (Route 33) is a key connector between Henrico County and Richmond, VA. Staples Mill Road runs from Richmond north through the Henrico County neighborhoods Dumbarton, Laurel, Glen Allen, and Innsbrook. Staples Mill Road serves as a regional crossroads via interchanges with Interstate 64 (I-64) near the Richmond City boundary and Interstate 295 (I-295) near the Henrico County boundary with Hanover County. Additionally, the Amtrak Richmond Staples Mill Station provides regional connections throughout the northeast.

As development occurs along and near the Staples Mill Road corridor, investments are needed to ensure safe and comfortable travel for all roadway users. A small area plan focused on transit-oriented development and safety surrounding Staples Mill Road is being developed through public engagement, present conditions analysis, and future plans.

The Study Area

The study area includes 3.7 miles of Staples Mill Road and the surrounding County, as shown in **Figure 1**. The total study area includes approximately 12 square miles of Henrico County. The study area is bordered by W. Broad Street (Route 250) to the west, Hungary Road to the north, Brook Road (Route 1) to the east, and Dumbarton Road/I-64/Dickens Road to the south.

Staples Mill Road is classified as a principal arterial between Dumbarton Road and Hungary Road, within the study area. Staples Mill Road, W. Broad Street, Brook Road, and E. Parham Road also fall within the National Highway System (NHS) and serve as key links connecting Henrico County with

KEY TERMS>>

- **Principal Arterial:** In urban areas, these roads serve the major activity centers of a metropolitan area and provide continuity for major rural corridors to accommodate trips entering and leaving an urban area.
- **National Highway System (NHS):** This is the network of strategic highways within the United States that serves major airports, ports, rail or truck terminals, railway stations, pipeline terminals, or other strategic transport facilities.

I-64, I-295, and I-95. Interstate 64 runs from Staunton, VA east through Richmond to Virginia Beach. It connects the Commonwealth's two major north-south interstates: I-81 and I-95. I-295 links Henrico County with neighboring counties (e.g., Hanover, Chesterfield) and cities (e.g., Hopewell). Interstate 95 connects Virginia to destinations along the eastern seaboard from Maine to Miami.

The Study

The purpose of this study is to inform the implementation of Henrico County's Transit Oriented Development (TOD) Concept study for the Amtrak Station and immediately surrounding area along Staples Mill Road. The vision of the Staples Mill TOD Concept is to enhance existing land uses and multimodal development surrounding the Staples Mill Road Amtrak Station, and to modify the Staples Mill Road cross-section to improve level of service for walking, bicycling, and transit.

The study will engage Henrico County, the City of Richmond, the Virginia Department of Rail and Public Transportation (DRPT), and other stakeholders to evaluate automobile, transit, bicycle, and pedestrian travel conditions

throughout the Staples Mill Road Small Area. The study will assess future travel projections and development patterns. It will also build on recommendations from Henrico County's TOD concept to develop, study, and recommend transportation solutions to help meet the vision and goals.

The study vision is for Staples Mill Road to develop as a Complete Street that supports development and provides safe and comfortable travel for all uses and users of the roadway. [1] The study vision is supported by five study goals:

1. **Improve safety and comfort**
2. **Manage congestion**
3. **Support economic development**
4. **Foster community and environmental health**
5. **Reflect community character**

The purpose of the study is to provide safe and comfortable travel for all uses of the roadway by developing a series of short-, mid-, and long-term community-supported transportation solutions. Local government and transportation agencies can use transportation solutions to apply for funding through a variety of programs such as SMART SCALE.

Study Stakeholders

This study is supported by a stakeholder group made up of representatives from Henrico County, City of Richmond, Federal Highway Administration (FHWA), Greater Richmond Transit Company (GRTC), Richmond Regional Transportation Planning Organization (RRTPO), and Virginia Department of Rail and Public Transportation (DRPT).

Public Engagement

In addition to engaging agency stakeholders, the community is being engaged throughout the project through online surveys, the project website, community stakeholder interviews, and two public meetings.

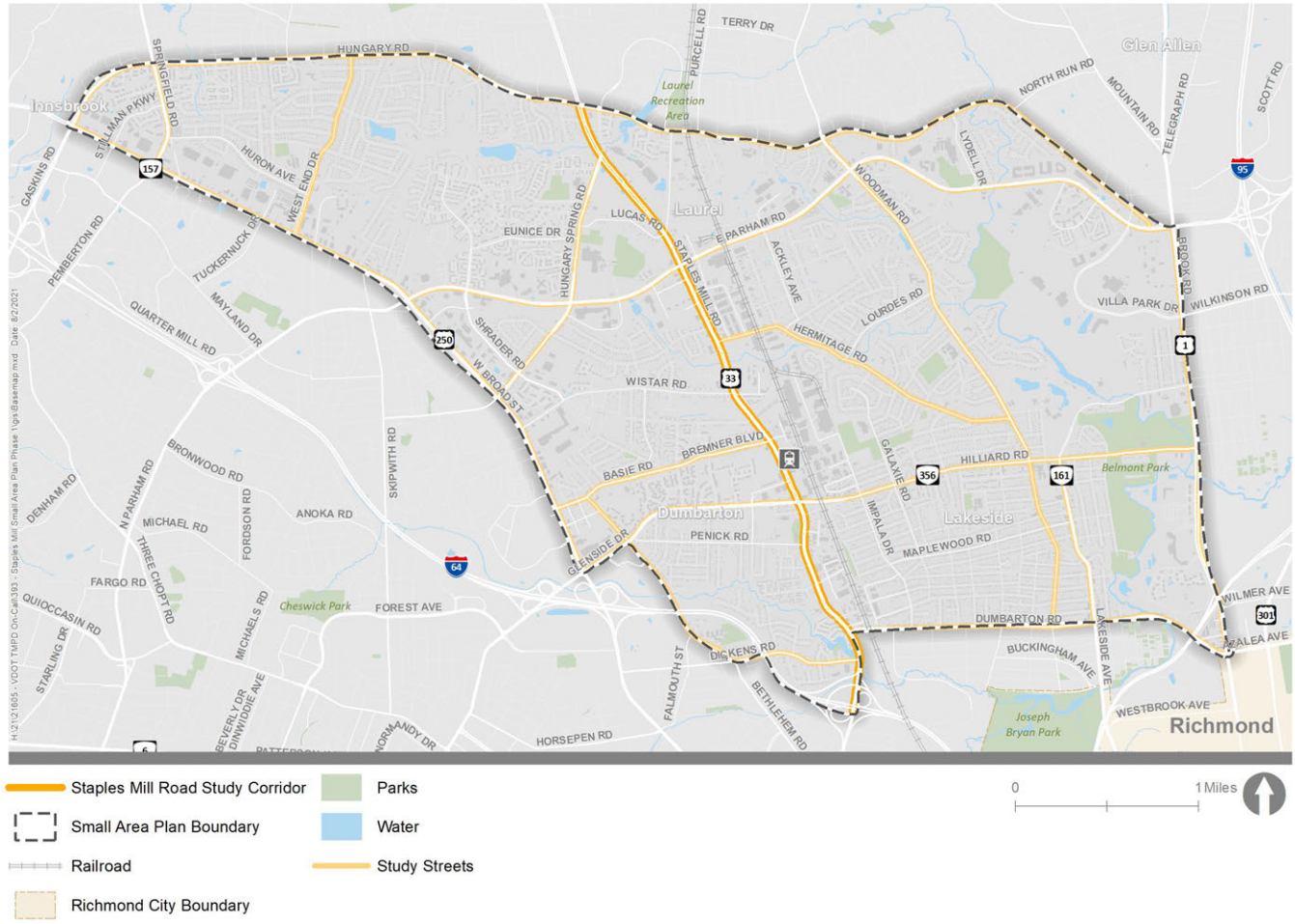
Community feedback will be gathered and reported through two Public Engagement memorandums. These documents will be posted to the project website after each public meeting.

This Technical Memorandum

This document discusses existing conditions throughout the study area utilizing data from a variety of sources, including land use data, transportation data, transit ridership information, and crash history. The data will be complemented by input received from stakeholders, key community groups, and members of the public through meetings and surveys. Information from the data analysis and community engagement will inform the measures that will be used to evaluate alternative solutions later in the study process.

[1] Complete Streets are designed for all users. They are designed to prioritize safety, comfort, and access for all people who use the street. (Smart Growth America)

Figure 1. Staples Mill Road Small Area Plan Boundary



Source: Kittelson 2021

2.0 SOCIOECONOMIC CONTEXT

This section presents the socioeconomic characteristics of the Staples Mill Road Small Area Plan boundary (the study area) and its associated neighborhoods.

2.1 The Study Area

Table 1 compares demographic characteristics of the study area to the Richmond Metropolitan Statistical Area (MSA) and Virginia as a whole. The study area has slightly lower percentages of zero-car households as well as lower percentages of households living below 100% of the poverty line than the Richmond MSA and Commonwealth.

The study area, Richmond MSA, and Commonwealth generally have similar work commute mode shares. The study area has slightly higher percentages of people driving to work (single occupancy vehicles and carpooling) and slightly lower percentages of people taking transit, biking, and walking to work compared to the Richmond MSA and Commonwealth. The transit mode category has the largest range in mode shares, with slightly lower percentages of people in the study area taking transit (1.2%) than in the Richmond MSA (2.3%) and Commonwealth (4.2%). The average commute time for transit riders in the study area is nearly twice as long as the average commute time for people driving in the study area.

Table 1. Demographics of Staples Mill Road Small Area Plan Boundary, Richmond MSA, and Commonwealth of Virginia

	Small Area Plan Boundary	Richmond MSA	Virginia
Zero Car Households[1]	6.4%	7.7%	6.5%
Households living below 100% of the Poverty Line[1]	10.6%	12.6%	11.8%
	Commute Mode to Work[1]		
Single Occupancy Vehicle	79.1%	79.9%	77.6%
Carpool	11.8%	9.2%	9.2%
Transit[2]	1.2%	2.3%	4.2%
Bike	0.3%	0.5%	0.4%
Walk	1.4%	1.8%	2.3%
Motorcycle	0%	0.1%	0.1%
Other Means or Worked at Home	6.2%	6.1%	6.2%
	Average Commute Time to Work (minutes)[1]		
Single Occupancy Vehicle	22	26	28
Carpool	23	28	31
Public Transit[3]	37	42	53

[1] Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

[2] The American Community Survey includes taxicabs with transit for the commute mode to work

[3] The American Community Survey excludes taxicabs from transit for the average commute time to work (in minutes)

2.2 Study Area Neighborhoods

The 12-square-mile study area includes 5 distinct neighborhoods and 26 census block groups. Some of these subareas exhibit different characteristics when compared to the full study area and Richmond MSA. The following sections provide additional information on these subareas.

Population Density

Figure 2 summarizes population density per square mile. Most of the census block groups west of Staples Mill Road have a higher population density than the Richmond MSA. Neighborhoods west of Staples Mill Road with the highest population density are south of Wistar Road and north of Hilliard Road (Dumbarton), and west of West End Drive (Innsbrook).

The highest concentration of population density east of Staples Mill Road is south of Hilliard Road and north of Dumbarton Road (Lakeside). The census block groups in this area also have a higher population density than the Richmond MSA.

Employment Density

Figure 3 shows that neighborhoods with higher population density generally have higher employment density. Census block groups west of Staples Mill Road with higher employment density are located near Tuckernuck Square Shopping Center, Parham Doctors' Hospital, and Dumbarton Square Shopping Center.

The east side of Staples Mill Road generally has more residential, industrial, and open space uses that correspond with lower employment density. The area east of the corridor with higher population density corresponds with the area with higher employment density (Lakeside).

Zero Car Households

Figure 4 shows the percentage of zero-car households in the study area and highlights block groups with a higher percentage of zero car households than the Richmond MSA. The block groups with a higher percentage of households without access to a vehicle are largely located in the neighborhoods along Staples Mill Road (Dumbarton, Lakeside, Laurel).

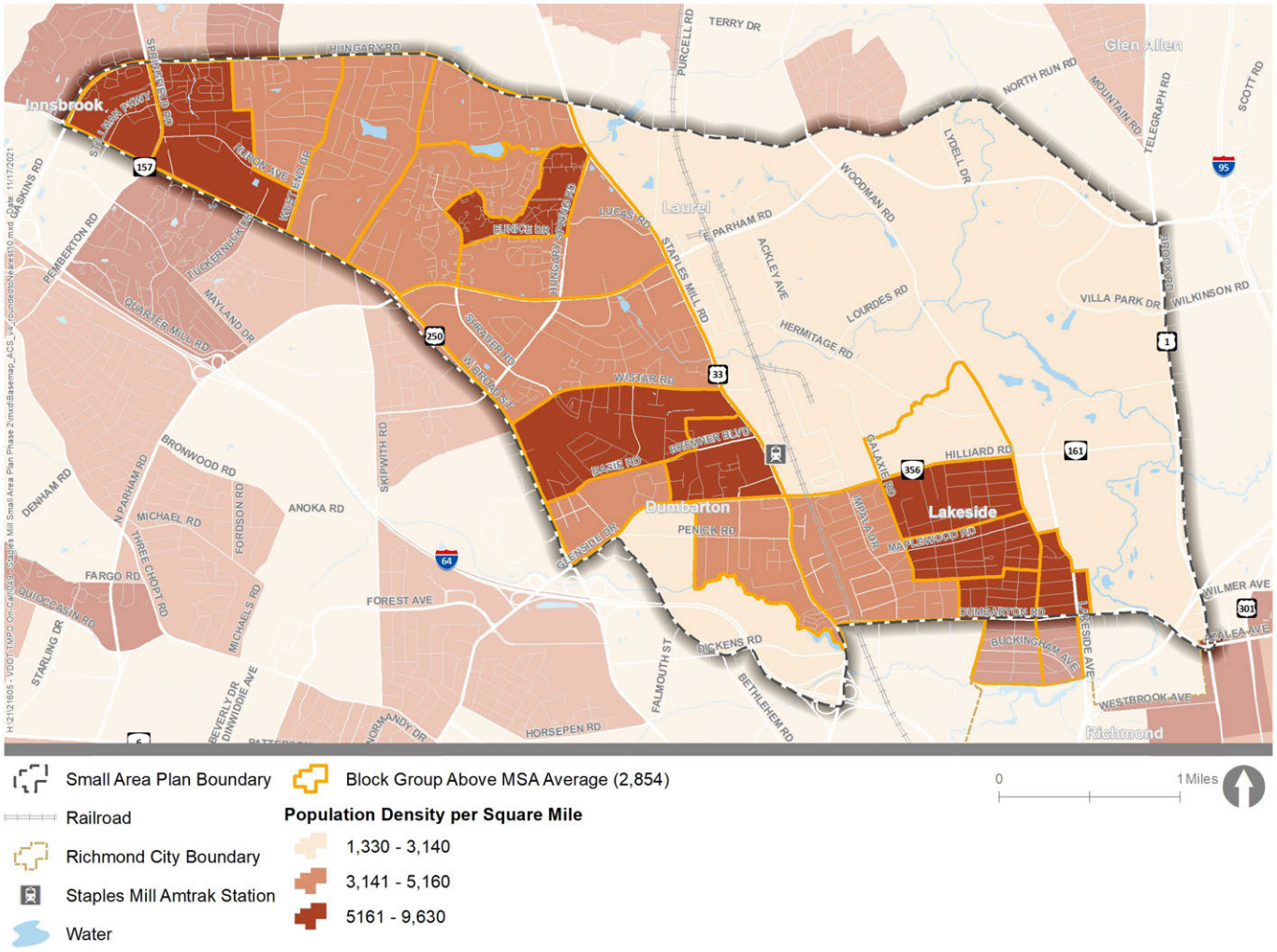
Median Household Income

Figure 5 summarizes median household income and highlights block groups with a lower median household income than the Richmond MSA. Most of the block groups in the study area have a lower median household income than the Richmond MSA. Block groups with the lowest median household incomes generally align with the block groups with a higher percentage of zero-car households.

Population Living Below 100% of the Federal Poverty Line

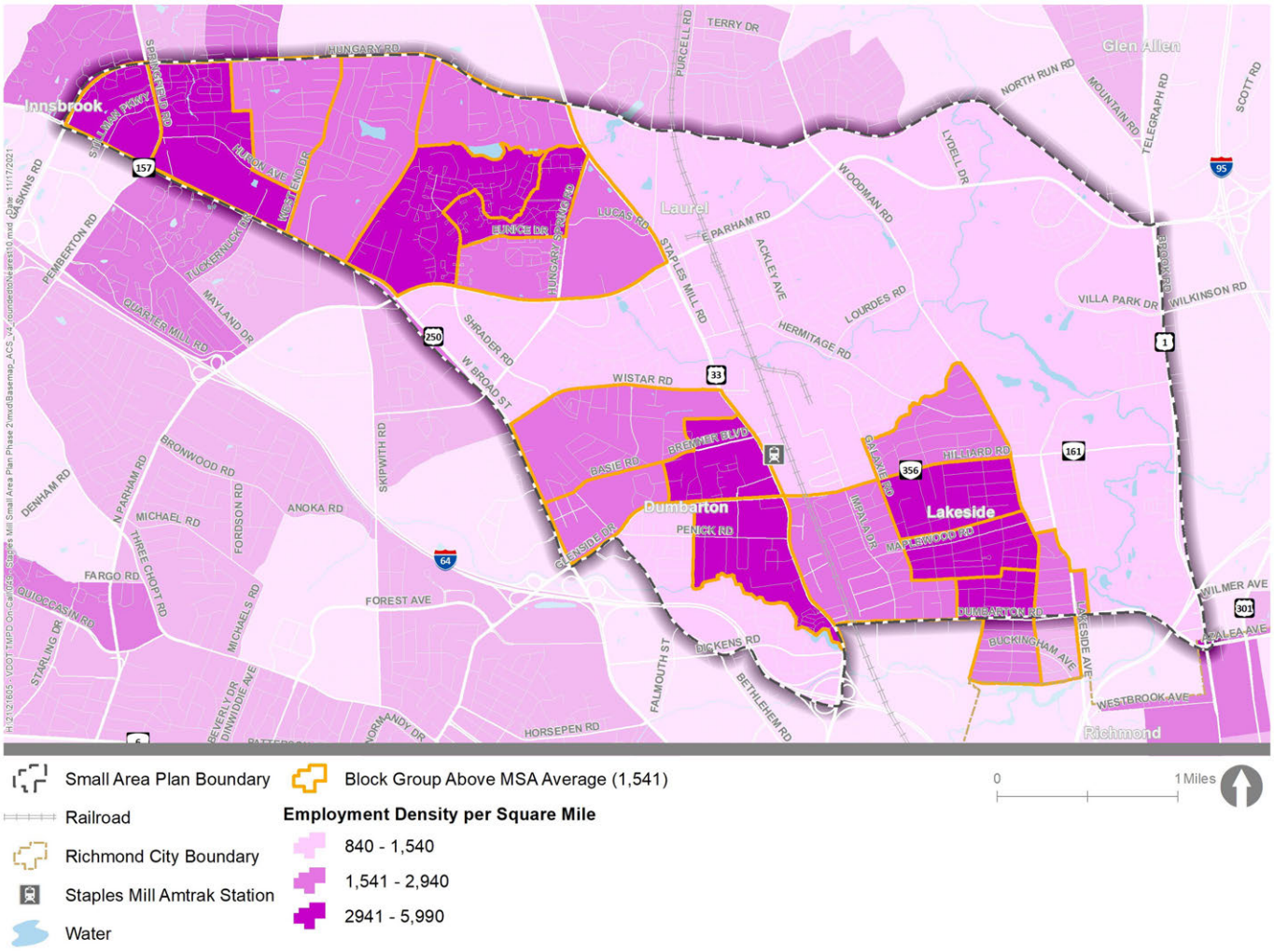
Figure 6 highlights census block groups with a higher percentage of people living below 100% of the poverty line than the Richmond MSA. The populations living below 100% of the federal poverty line are dispersed throughout the study area, with a high concentration in the neighborhoods located along Staples Mill Road.

Figure 2. Study Area Population Density per Square Mile



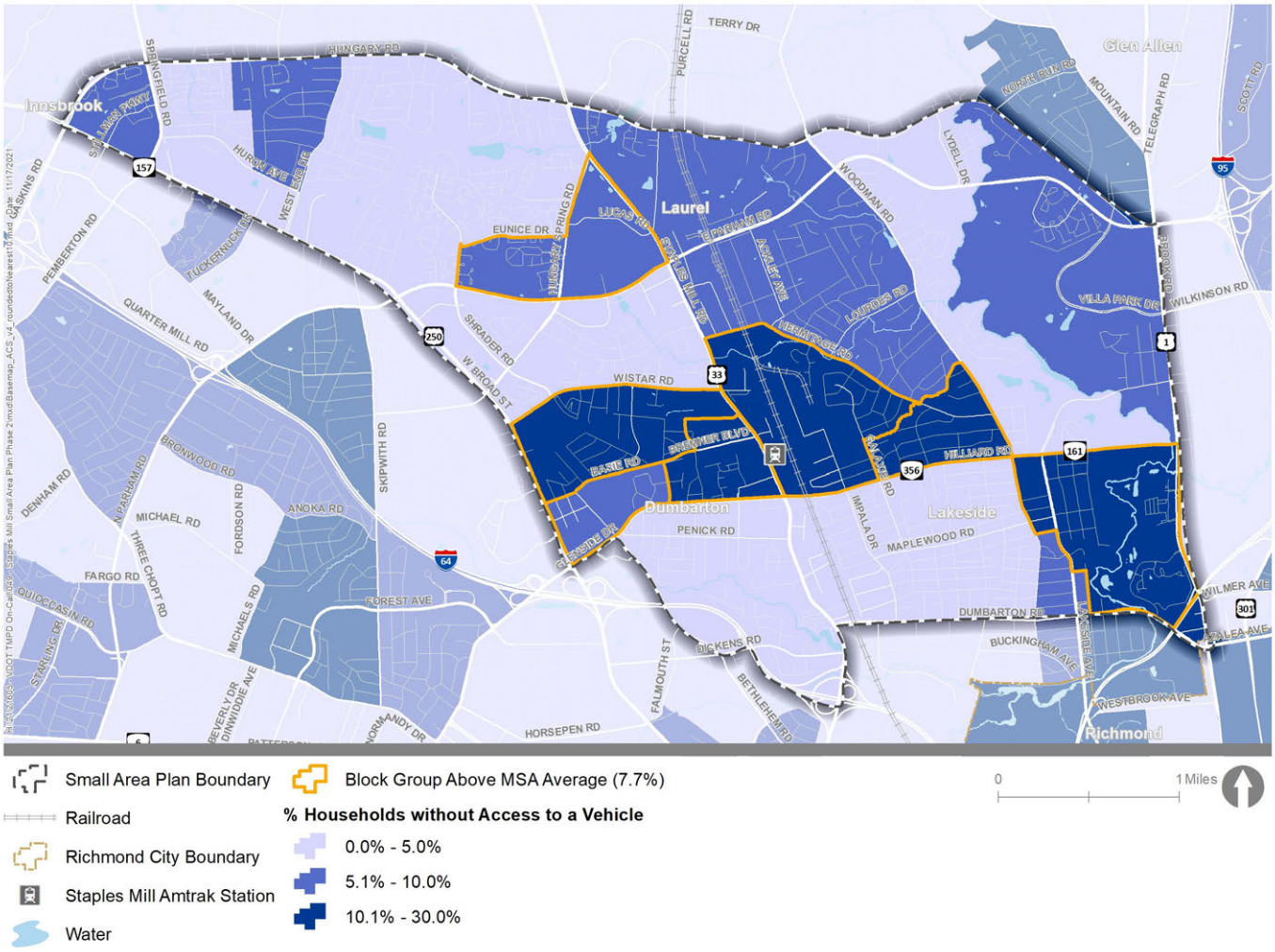
Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

Figure 3. Study Area Employment Density per Square Mile



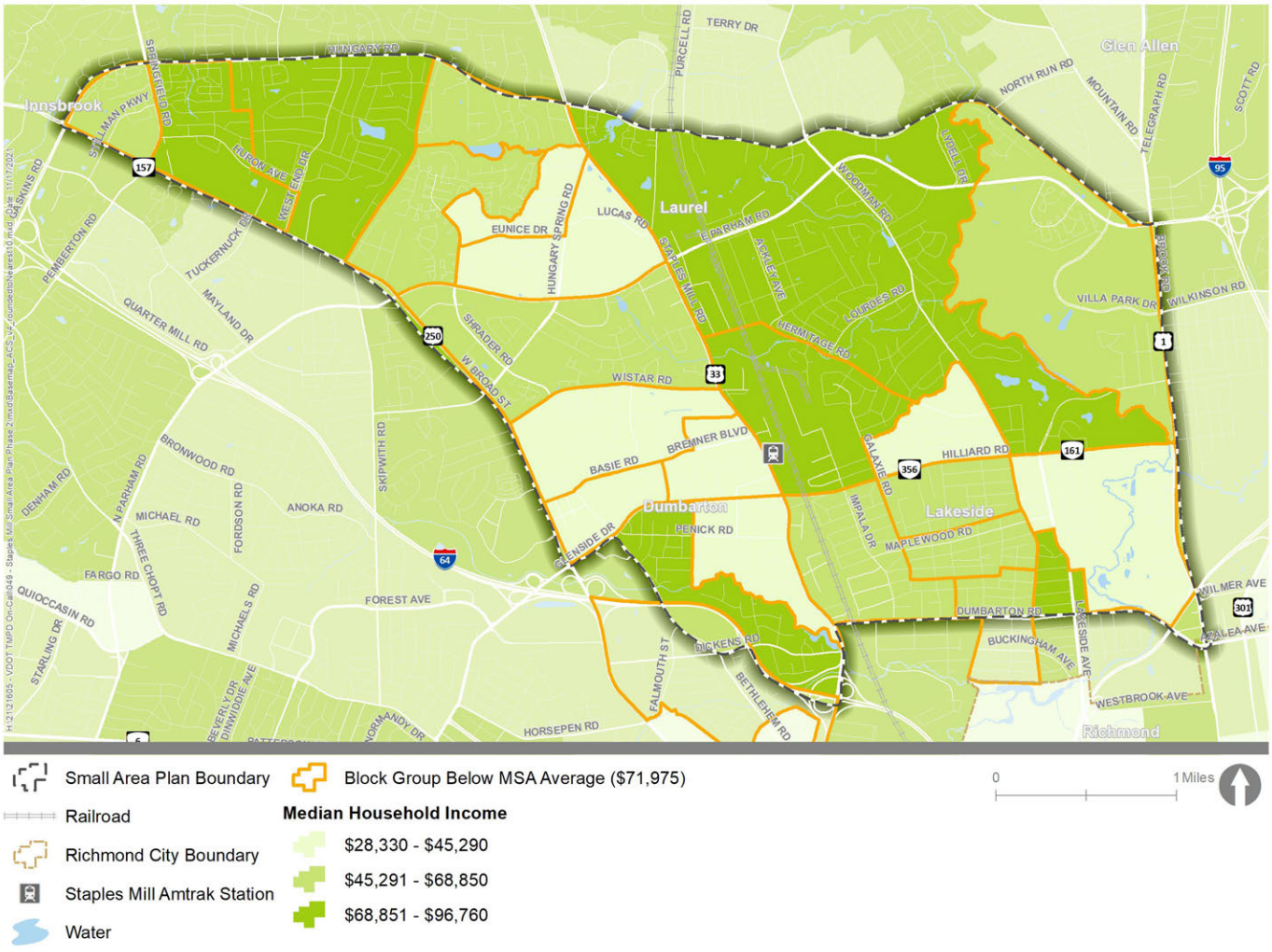
Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

Figure 4. Study Area Zero Car Households



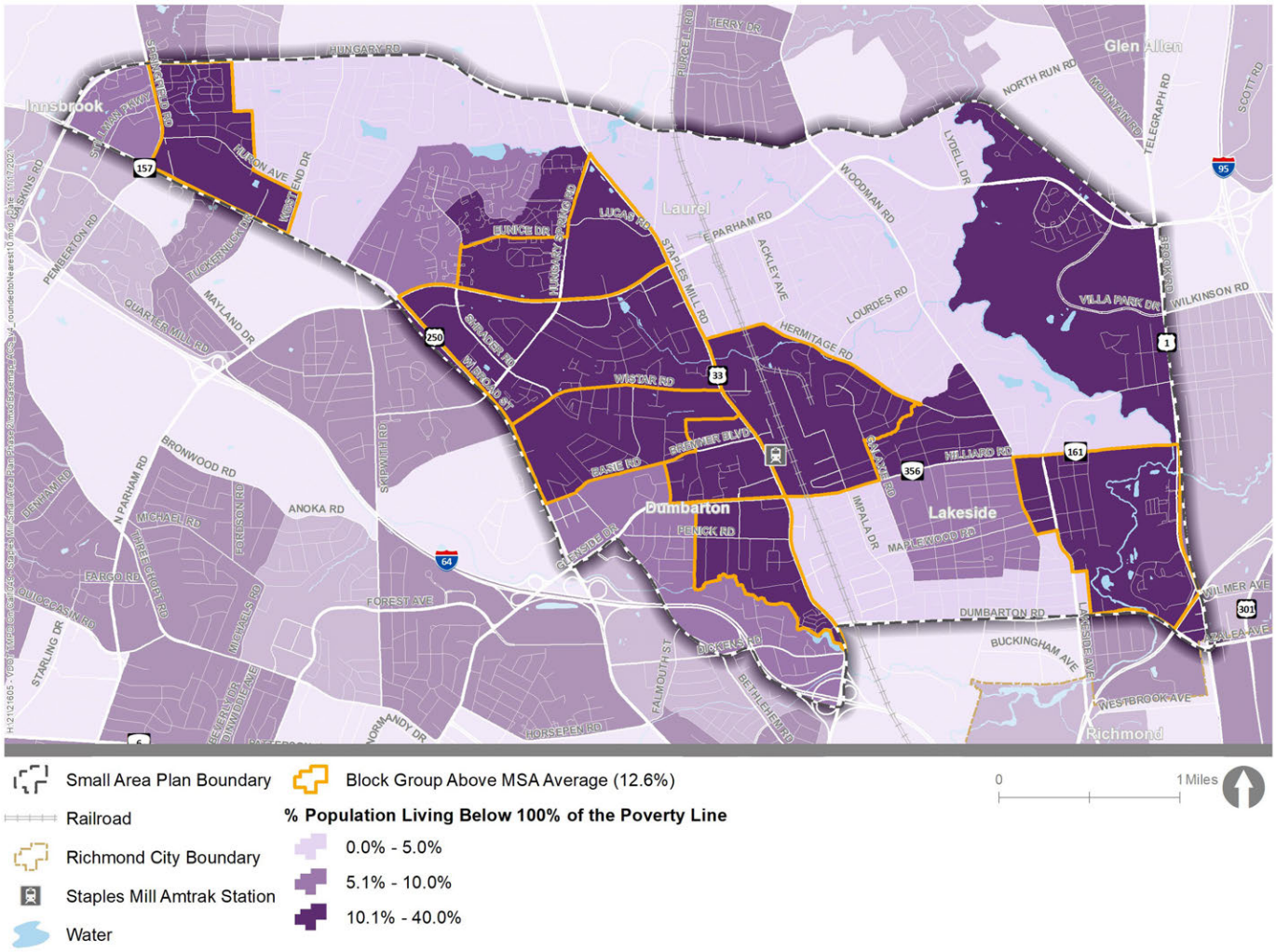
Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

Figure 5. Study Area Median Household Income



Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

Figure 6. Study Area Population Living Below 100% of the Poverty Line



Source: American Community Survey, 5-Year Estimates 2019 (census block group level)

3.0 LAND USE CONTEXT

This section summarizes the approach and findings of the land use context analysis. The material below discusses existing land use patterns and planned future land use in the study area.

3.1 Existing Land Use

The Staples Mill Road corridor and surrounding neighborhoods serve as a gateway between Richmond and Henrico County. Staples Mill Road and other principal arterials in the study area (Broad Street, Brook Road, Parham Road) provide an important regional role, connecting local jurisdictions with regional and statewide destinations via surrounding interstates (I-64, I-295, and I-95).

Figure 7 summarizes existing land uses in the study area by acre, and **Figure 8** illustrates the existing land uses within the study area.

Existing Land Use Data

Parcel-level zoning data for 2021 were obtained from Henrico County. These data include each parcel's land use code.

Existing Land Use

The land use mix, neighborhood types and population groups served by the study area all contribute to its character. Traveling along Staples Mill Road from the study area's northern terminus at Hungary Road to its southern terminus at I-64, it is possible to observe a range of land use contexts. Busy commercial shopping centers, industrial hubs, single-family residential neighborhoods, pockets of multi-family residential, and educational destinations such as Hermitage High School can be found along the length of the corridor.

The Staples Mill Road corridor and surrounding study area comprise a mix of land uses, with single family residential uses representing 40% of the 12-square-mile study area (**Figure 7**). Nearly all the industrial uses in the study area are located along Staples Mill Road (**Figure 8**). The west side of Staples Mill Road is primarily fronted by commercial and industrial uses, and the east side of the road is primarily fronted by single family residential and industrial uses. Parham Road intersects with and connects Staples Mill Road with concentrations of institutional uses, such as Henrico County's Western Government Center and Reynolds Community College.

Other significant commercial corridors in the study area include Broad Street, Brook Road, and Lakeside Avenue. The land uses set back from these corridors include single- and multi-family residential neighborhoods of various densities and ages.

Figure 7. Composition of Existing Land Use within Small Area Plan Boundary

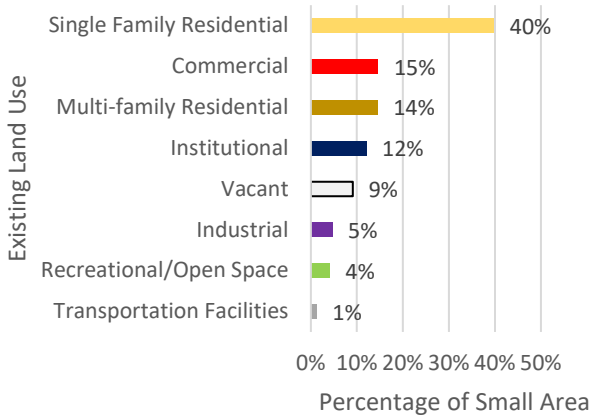
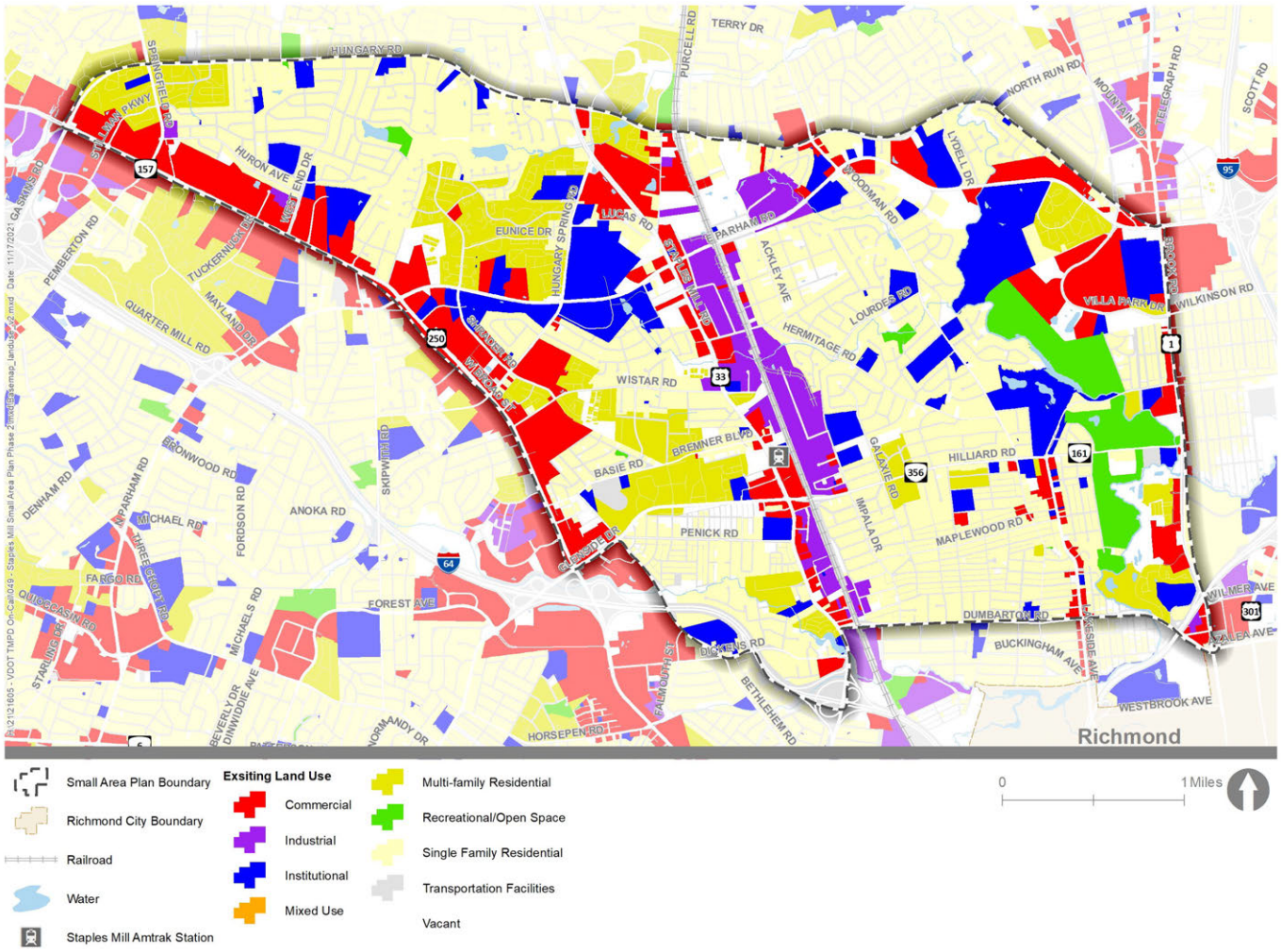


Figure 8. Existing Land Use



Source: Henrico County, Kittelson 2021

Activity Generators

Table 2 summarizes activity generators in the study area, which are shown in more detail in **Figure 9**.

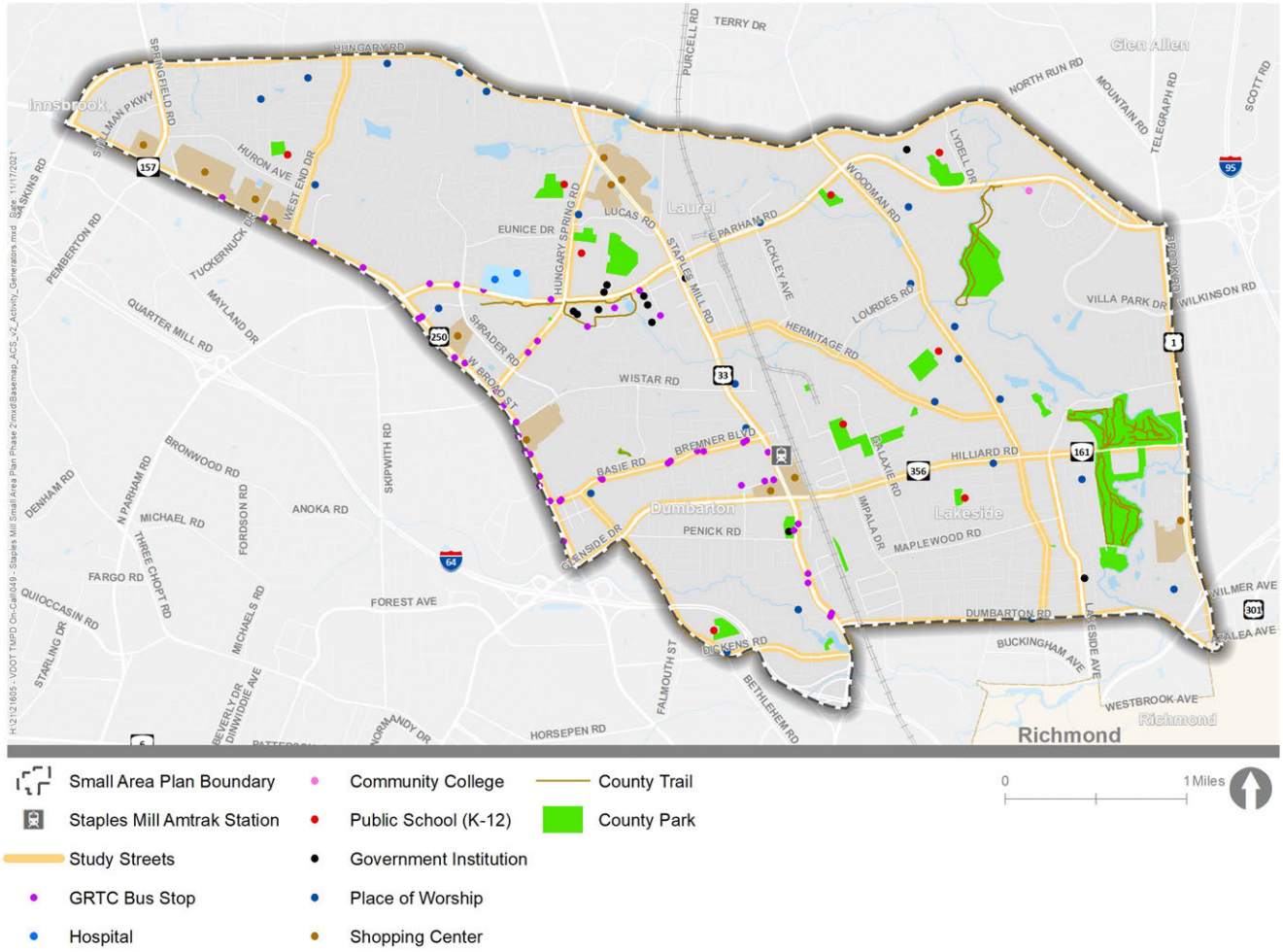
Key activity centers along Staples Mill Road include the Richmond Staples Mill Road Amtrak Station and various shopping centers (e.g., Staples Mill Marketplace, Dumbarton Square Shopping Center).

Important activity centers near the Staples Mill Road corridor include Dumbarton Elementary School, Holladay Elementary School, Hermitage High School, Henrico County's Western Government Center, and Parham Doctors' Hospital.

Table 2. Activity Generators within the Staples Mill Road Small Area Plan Boundary

Activity Generator Type	Generators in Study Area	Generators located on Staples Mill Road
Public Schools	10	Hermitage High School
Shopping Centers	12	Dumbarton Square Shopping Center Staples Mill Marketplace Staples Mill Plaza Staples Mill Shopping Center Staples Mill Square
Places of Worship	23	Agape International Ministries Bonnie Brea Church of Christ Lighthouse Baptist
Government Institutions	13	Henrico Police Athletic League Henrico Recreation and Parks
County Parks	23	None
Colleges	1	None
GRTC Bus Stops	47	11 GRTC Bus Stops

Figure 9. Activity Generators



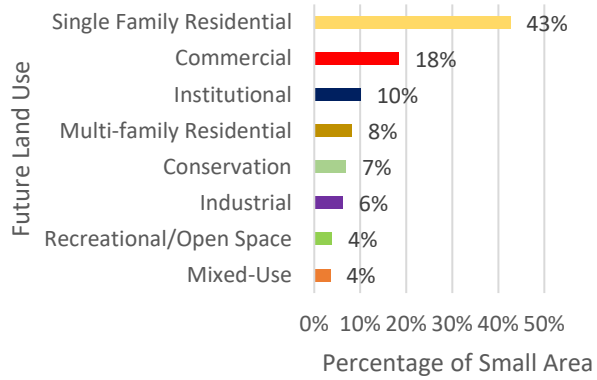
Source: Kittelson 2021

3.2 Future Land Use

The future land use vision for the study area is documented in Henrico County's Comprehensive Plan. The vision emphasizes the unique role that Staples Mill Road plays as a commercial and industrial corridor and paves the way for more mixed use and open space in the study area.

Figure 10 and **Figure 11** show the generalized future land use for Henrico County in the study area.

Figure 10. Composition of Future Land Use within Small Area Plan Boundary



Future Land Use Data

Future land use, enterprise zone, and opportunity zone data were obtained from Henrico County. These data included planned future developments located within the study area.

Future Land Use (2026)

Figure 11 shows the future land use for the study area**.** Planned future land uses reflect and expand on existing land uses. The area surrounding the railroad tracks east of Staples Mill Road is slated for continued, increased industrial use, and most of the parcels fronting Staples Mill Road area are planned for increased commercial use. Many of today's multi-family residential communities are planned to partially transition to mixed-use development. New open space corridors are planned to intersect with Staples Mill Road north of the Richmond Staples Mill Road Amtrak Station.

Zoning Overlap Districts

Figure 12 shows the special use districts that are guiding development in the study area:

- Enterprise Zones
- Opportunity Zones

Both zones use different incentives to stimulate job growth and business development.

Enterprise Zones

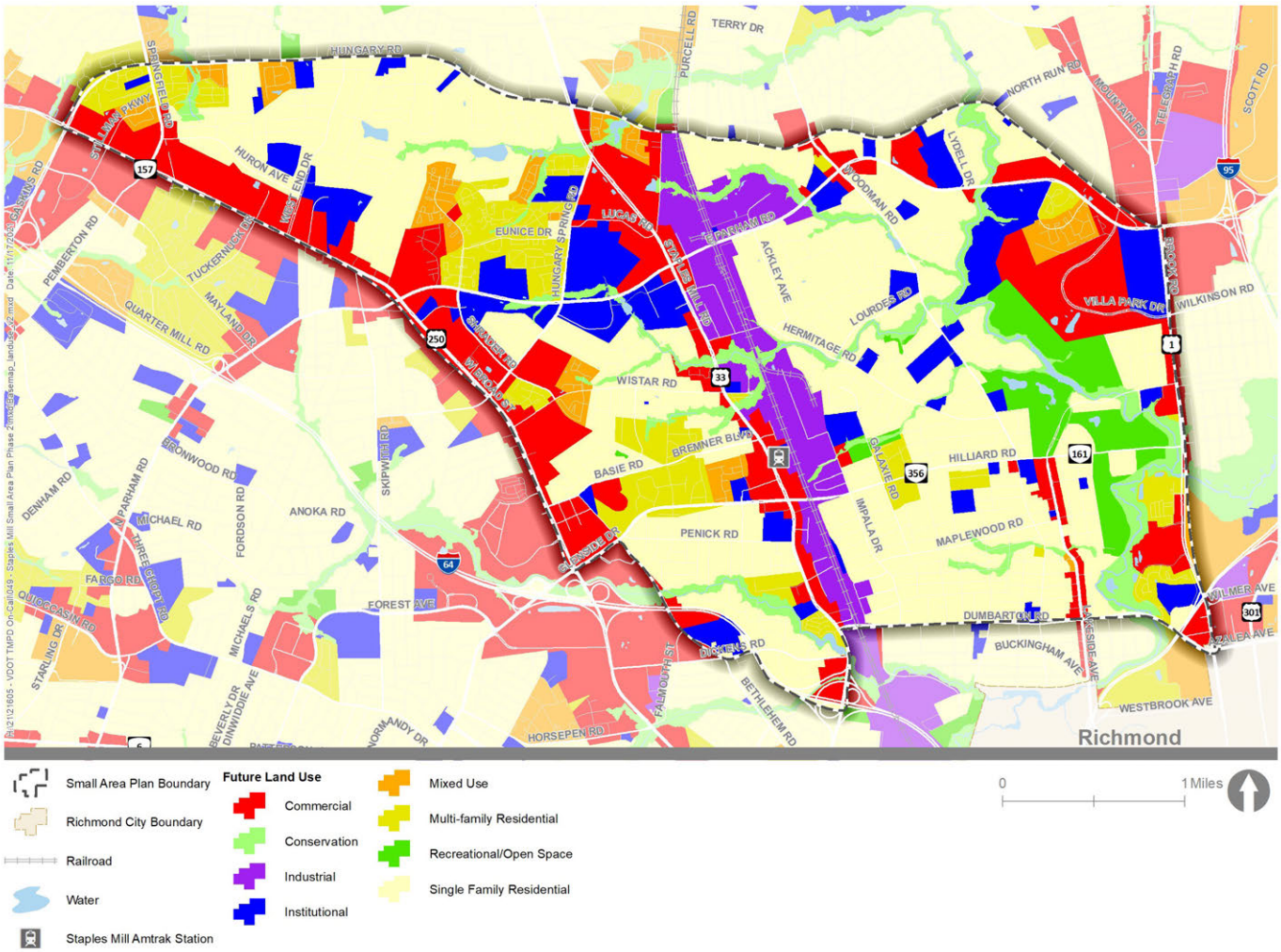
A designated enterprise zone can be found on the east side of Staples Mill Road between E. Parham Road and Dumbarton Road. This enterprise zone includes the Richmond Staples Mill Road Amtrak Station.

Additional enterprise zone corridors include Lakeside Avenue and Brook Road.

Opportunity Zones

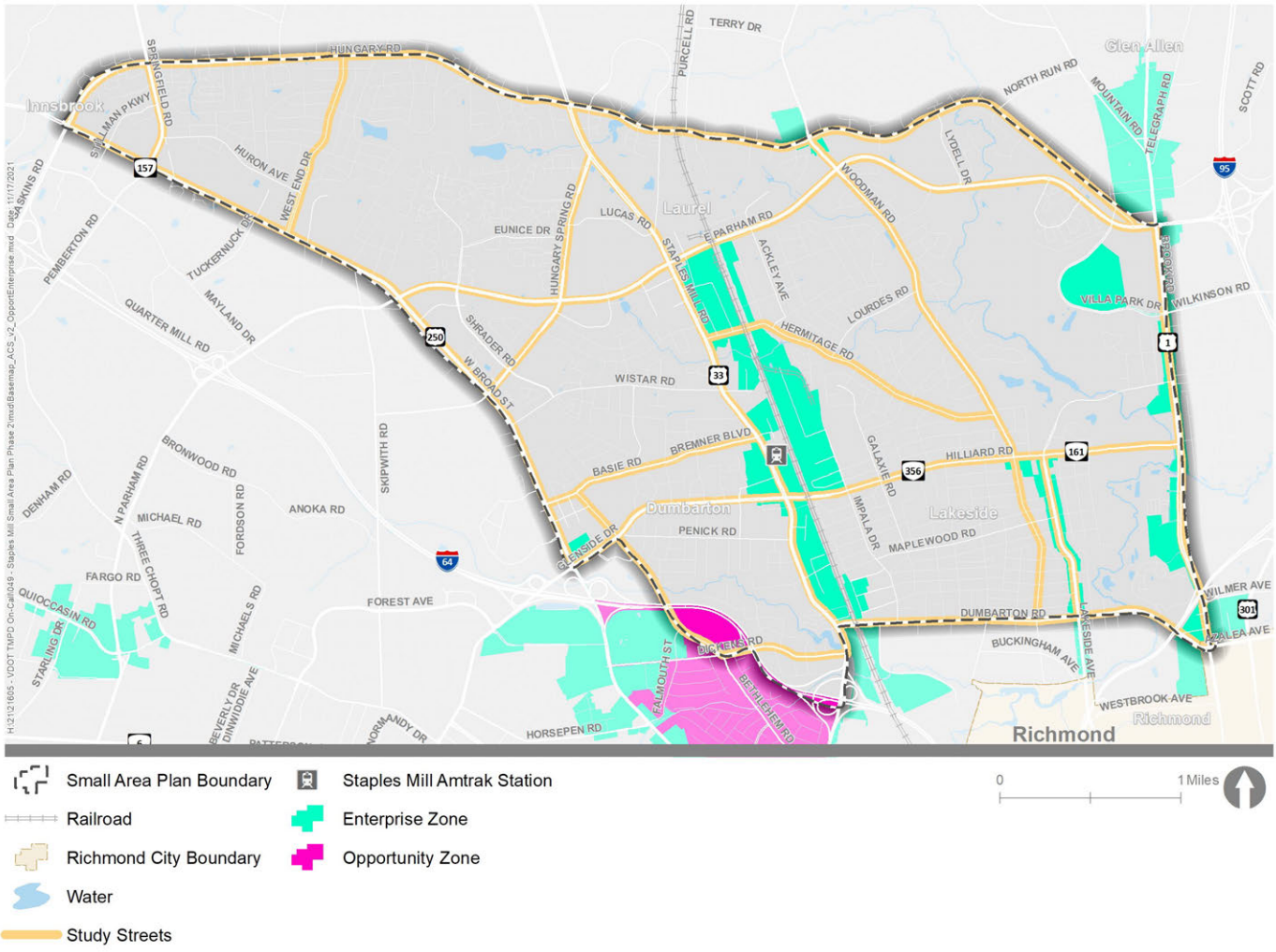
Libbie Mill, the Brookfield Office Park, and Broad Street Area constitute the opportunity zone located at the southwestern end of the study area. This opportunity zone helped catalyze the ongoing Libbie Mill development. Libbie Mill is a mixed-use development located south of the study area which has grown to include nearly 200,000 square feet of commercial, retail, and restaurant space as well as over 200 townhomes and over 300 apartments. In-process development at Libbie Mill includes over 300 additional apartments, and future planned development includes two additional major mixed-use sites.

Figure 11. 2026 Future Land Use



Source: Henrico County, Kittelson 2021

Figure 12. Enterprise and Opportunity Zones in the Study Area



Source: Henrico County, Kittelson 2021

4.0 INTERSECTION OPERATIONS

This section summarizes the approach and findings for the traffic operations analysis under existing and future no-build conditions. **Table 3** displays the major transportation facilities (study streets) for this study, and **Figure 13** shows the average annual daily traffic volumes for the study streets.

KEY TERMS>>

- **Operations Analysis:** An evaluation of how a roadway or set of roadways function under existing and/or anticipated traffic and geometric conditions.
- **Peak Hour:** The time of day when demand for a transportation facility is highest and the ease with which vehicles can move through the transportation facility is most limited. Weekdays typically have two peak hours (AM and PM), while weekends have a single peak hour.

4.1 Data Collection

Traffic counts were compiled for 34 study intersections from three data sources. AM Peak and PM Peak traffic volumes collected for the Route 250 (W. Broad Street) and Route 33 Corridor Improvement STARS studies were used for 11 of the study intersections. AM Peak and PM Peak traffic counts were collected for the remaining 23 intersections in February 2021. Midday traffic counts for 11 Staples Mill Road intersections were also collected in February 2021.

Table 4 and **Figure 14** present the study intersections and traffic count sources. The traffic counts can be found in **Attachment A**.

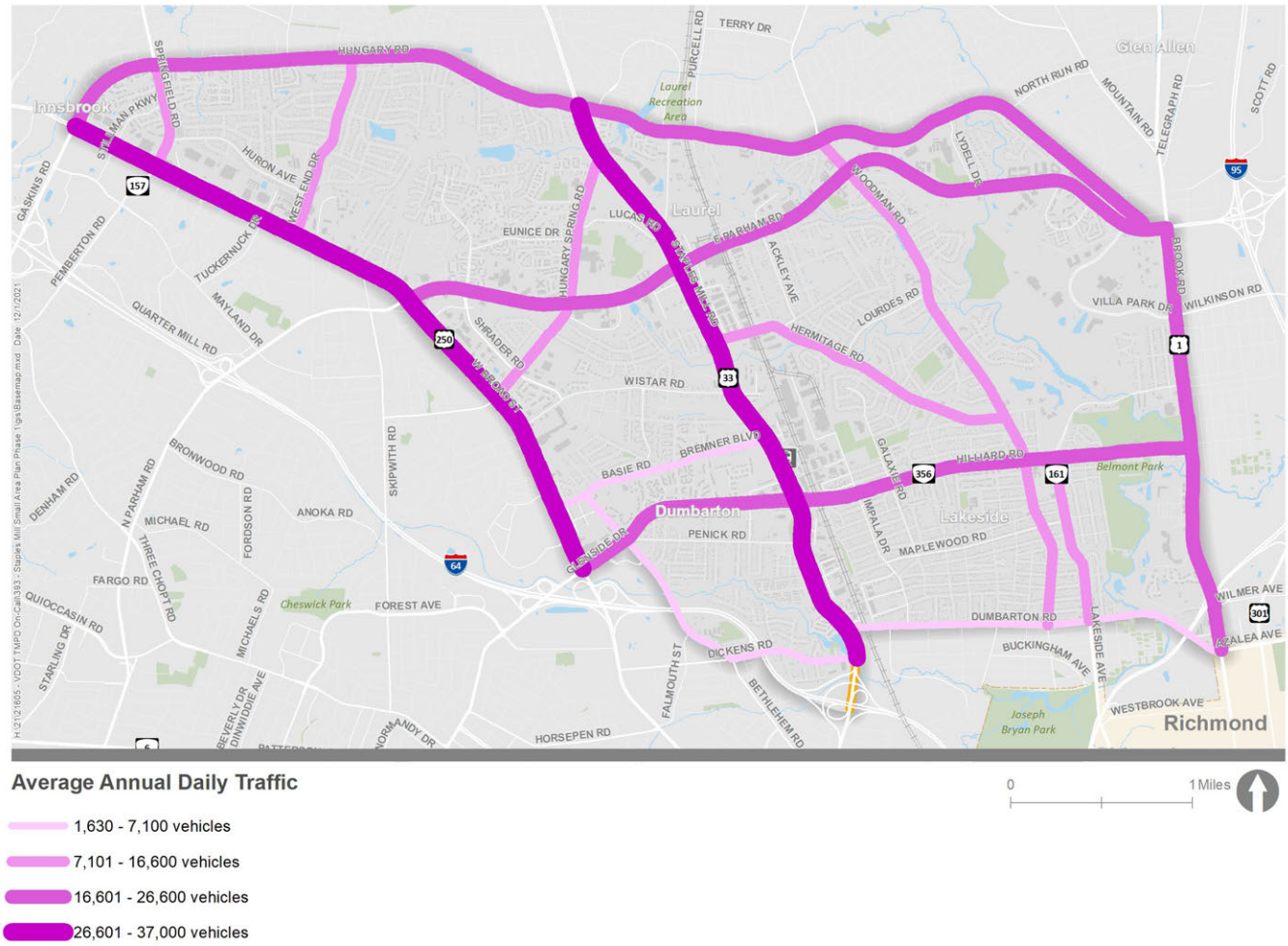
Table 3. Study Area Roadway Facilities

Roadway	Classification[1]	Number of Lanes	Speed Limit (mph)	Average Annual Daily Traffic[2]	Median
Basie Rd/Bremner Blvd	Major Collector	2	35	3,500–4,400	No
Bethlehem Rd	Major Collector	2	35	3,900–4,900	No
Brook Rd (Rte. 1)	Other Principal Arterial	4–6	45	15,700–23,800	Yes
Dickens Rd	Major Collector	2–4	35	4,400–7,100	No
Dumbarton Rd	Minor Arterial	4	35	10,600–16,300	Partial
E. Parham Rd	Other Principal Arterial	4	45	21,800–26,600	Yes
Gaskins Rd/Hungary Rd	Minor Arterial	4–5	45	5,400–21,800	Partial
Glenside Dr/Hilliard Rd (Rte. 356)	Minor Arterial	4–5	40	6,800–19,400	Partial
Hermitage Rd	Major Collector/ Minor Arterial	2	35/25	2,300–9,600	No
Hungary Spring Rd	Major Collector	4–5	35	12,000–12,600	Partial
Lakeside Ave (Rte. 161)	Minor Arterial	4	35	13,600	Yes
Springfield Rd (Rte. 157)	Major Collector	4	45	16,600	Yes
Staples Mill Rd (Rte. 33)	Other Principal Arterial	4–6	55/45	27,500–36,900	Yes
W. Broad St (Rte. 250)	Other Principal Arterial	6	45	33,000–37,000	Yes
West End Dr	Major Collector	2–4	35	9,000–10,600	Partial
Woodman Rd	Minor Arterial	2–4	45	8,300–16,600	Partial

[1] Classifications based on VDOT's 2014 Functional Classification Map.

[2] Average Annual Daily Traffic (AADT) based on VDOT's Virginia Roads Traffic Volume Map

Figure 13. Study Streets Average Annual Daily Traffic Volumes

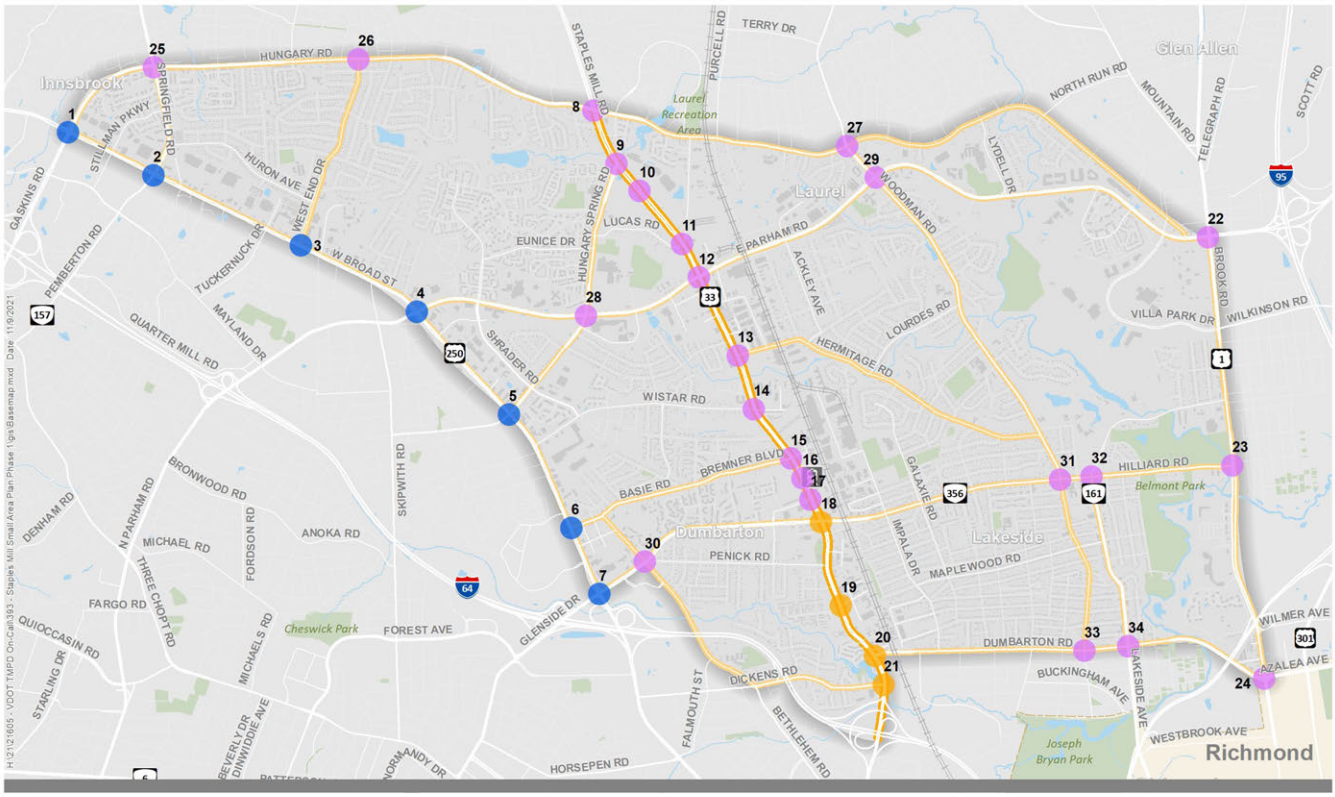


Source: VDOT, Henrico County, Kittelson 2021

Table 4. Study Intersections and Traffic Count Sources

ID	Intersection	Data Source	Peak Periods		
			AM	PM	SAT
1	W. Broad St and Gaskins Rd	Route 250 (W. Broad Street) STARS Study	x	x	
2	W. Broad St and Pemberton Rd/Springfield Rd	Route 250 (W. Broad Street) STARS Study	x	x	
3	W. Broad St and West End Dr/Commercial Ent.	Route 250 (W. Broad Street) STARS Study	x	x	
4	W. Broad St and N. Parham Rd/E. Parham Rd	Route 250 (W. Broad Street) STARS Study	x	x	
5	W. Broad St and Hungary Spring Rd	Route 250 (W. Broad Street) STARS Study	x	x	
6	W. Broad St and Bethlehem Rd/Ent. to Volvo	Route 250 (W. Broad Street) STARS Study	x	x	
7	W. Broad St and Glenside Dr	Route 250 (W. Broad Street) STARS Study	x	x	
8	Staples Mill Rd and Hungary Rd	February 2021 Traffic Counts	x	x	
9	Staples Mill Rd and Hungary Spring Rd	February 2021 Traffic Counts	x	x	
10	Staples Mill Rd and Staples Mill Square Shopping Center	February 2021 Traffic Counts	x	x	
11	Staples Mill Rd and Old Staples Mill Rd/Lucas Rd	February 2021 Traffic Counts	x	x	
12	Staples Mill Rd and E. Parham Rd	February 2021 Traffic Counts	x	x	x
13	Staples Mill Rd and Hermitage Rd/Commercial Ent.	February 2021 Traffic Counts	x	x	x
14	Staples Mill Rd and Wistar Rd	February 2021 Traffic Counts	x	x	x
15	Staples Mill Rd and Bremner Blvd.	February 2021 Traffic Counts	x	x	x
16	Staples Mill Rd and Amtrak Station	February 2021 Traffic Counts	x	x	x
17	Staples Mill Rd/Ent. To Dumbarton Square S.C.	February 2021 Traffic Counts	x	x	x
18	Staples Mill Rd and Hilliard Rd/Glenside Dr	Route 33 (Staples Mill Road) STARS Study	x	x	x
19	Staples Mill Rd and Aspen Ave./Townhouse Rd	Route 33 (Staples Mill Road) STARS Study	x	x	x
20	Staples Mill Rd and Dumbarton Rd/Wharfside Rd	Route 33 (Staples Mill Road) STARS Study	x	x	x
21	Staples Mill Rd and Dickens Rd/Ent. To Comcast	Route 33 (Staples Mill Road) STARS Study	x	x	x
22	Brook Rd and E. Parham Rd/E. Parham Rd	February 2021 Traffic Counts	x	x	
23	Brook Rd and Hillard Rd/Hilliard Ave.	February 2021 Traffic Counts	x	x	
24	Brook Rd and Dumbarton Rd/Azalea Ave	February 2021 Traffic Counts	x	x	
25	Springfield Rd and Gaskins Rd/Hungary Rd	February 2021 Traffic Counts	x	x	
26	Hungary Rd and West End Dr	February 2021 Traffic Counts	x	x	
27	Hungary Rd and Woodman Rd	February 2021 Traffic Counts	x	x	
28	E. Parham Rd and Hungary Spring Rd	February 2021 Traffic Counts	x	x	
29	E. Parham Rd and Woodman Rd	February 2021 Traffic Counts	x	x	
30	Glenside Dr and Bethlehem Rd	February 2021 Traffic Counts	x	x	
31	Hilliard Rd and Hermitage Rd	February 2021 Traffic Counts	x	x	
32	Lakeside Ave and Hilliard Rd	February 2021 Traffic Counts	x	x	
33	Dumbarton Rd and Hermitage Rd/Westlake Ave	February 2021 Traffic Counts	x	x	
34	Lakeside Ave and Dumbarton Rd	February 2021 Traffic Counts	x	x	

Figure 14. Study Intersections and Traffic Count Sources



Source: Kittelson 2021

4.2 Existing Conditions

Intersection-specific peak hours were used for the existing conditions analysis. AM peak hours were observed between 7:15 a.m. and 8:45 a.m. PM peak hours were observed between 4:45 p.m. and 6:00 p.m. Saturday midday peak hours were observed between 11:00 a.m. and 2:45 p.m.

Traffic operations analyses were performed at study area intersections in accordance with the *Highway Capacity Manual* (HCM), Sixth Edition using SYNCHRO 10. **Table 5**, **Figure 15**, **Figure 16**, and **Figure 17** summarize the operational analysis for the study intersections under weekday AM, weekday PM, and Saturday midday peak hour existing traffic conditions. The full analysis can be found in **Attachment B**.

Most of the study intersections perform acceptably during each of the peak hours studied. Exceptions are described below.

AM Existing Conditions

Four intersections operate at level of service (LOS) E or F:

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive
- Lakeside Avenue/Dumbarton Road

Six intersections have movements that are at capacity (v/c ratio greater than 1):

- W. Broad Street/Gaskins Road
- W. Broad Street/Pemberton Road/Springfield Road
- W. Broad Street/Parham Road
- W. Broad Street/Glenside Drive
- Staples Mill Road/Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive

These intersections are located along the W. Broad Street and Staples Mill Road Corridors (**Table 5**).

KEY TERMS>>

- **Delay:** The amount of time it takes vehicles to pass through an intersection (reported in seconds).
- **Level of Service (LOS):** A performance metric communicating quality of intersection service. For vehicles, LOS D indicates acceptable quality in urban conditions, while LOS scores of E–F indicate poor quality.
- **Volume to capacity (v/c) ratio:** A ratio comparing the number of vehicles traveling through an intersection at a given point in time to the maximum capacity of the intersection. A v/c score of 1 or higher means that an intersection has reached capacity.
- **95th percentile queue length:** The worst-case queue length (number of vehicles waiting in a lane) during a given time. These queues have only a 5 percent probability of being exceeded.

PM Existing Conditions

Eight intersections operate at LOS E or F:

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Glenside Drive
- Staples Mill Road/Hilliard Road/Glenside Drive
- Brook Road/Dumbarton Road/Azalea Avenue
- Springfield Road/Gaskins Road/Hungary Road
- Hungary Road/Woodman Road
- Lakeside Avenue/Dumbarton Road

Thirteen intersections have movements that are at capacity (v/c ratio greater than 1):

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Hungary Spring Road
- W. Broad Street/Bethlehem Road/Entrance to Volvo
- W. Broad Street/Glenside Drive
- Staples Mill Road/Hungary Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive
- Brook Road/Dumbarton Road/Azalea Avenue
- Springfield Road/Gaskins Road/Hungary Road
- Hungary Road/Woodman Road
- Glenside Drive/Bethlehem Road
- Lakeside Avenue/Dumbarton Road

Most of these intersections are located along the W. Broad Street, Staples Mill Road, Gaskins Road/Hungary Road, and Glenside Drive corridors (**Table 5**).

Saturday Existing Conditions

The westbound through-right movement at Staples Mill Road/Hilliard Road/Glenside Drive is at capacity during all three peak periods.

Table 5. Existing Conditions Operational Analysis

Intersection	Peak hour	Overall Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
W. Broad Street/Gaskins Road (#1)	AM Peak	126.9 (F)	Gaskins Road (WBR)	489.8 (F)	1.94	11
	PM Peak	90.4 (F)	Gaskins Road (WBR)	488.0 (F)	1.94	16
W. Broad Street/Pemberton Road/Springfield Road (#2)	AM Peak	34.2 (C)	Springfield Road (WBL)	95.4 (F)	1.01	13
	PM Peak	36.8 (D)	W. Broad Street (SBL)	76.9 (E)	0.79	8
W. Broad Street/West End Drive/Commercial Entrance (#3)	AM Peak	24.3 (C)	W. Broad Street (NBL)	55.9 (E)	0.42	3
	PM Peak	25.9 (C)	W. Broad Street (SBL)	66.8 (E)	0.84	15
W. Broad Street/N. Parham Road/E. Parham Road (#4)	AM Peak	61.3 (E)	E. Parham Road (WBR)	157.3 (F)	1.19	5
	PM Peak	79.1 (E)	E. Parham Road (WBR)	290.3 (F)	1.52	16
W. Broad Street/Hungary Spring Road (#5)	AM Peak	41.4 (D)	Hungary Spring Road (EBT)	87.0 (F)	0.93	17
	PM Peak	47.0 (D)	Hungary Spring Road (EBT)	162.2 (F)	1.16	20
W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)	AM Peak	11.4 (B)	W. Broad Street (NBL)	66.5 (E)	0.53	2
	PM Peak	17.2 (B)	Bethlehem Road (WBR)	134.0 (F)	1.03	4
W. Broad Street/Glenside Drive (#7)	AM Peak	47.6 (D)	Glenside Drive (WBT)	116.3 (F)	1.10	20
	PM Peak	68.1 (E)	Glenside Drive (EBL)	151.8 (F)	1.16	26
Staples Mill Road/Hungary Road (#8)	AM Peak	40.7 (D)	Hungary Road (WBL)	85.4 (F)	0.45	2
	PM Peak	54.5 (D)	Hungary Road (WBT/R)	116.0 (F)	1.02	22
Staples Mill Road/Hungary Spring Road (#9)	AM Peak	27.4 (C)	Staples Mill Road (SBL)	56.6 (E)	0.37	3
	PM Peak	36.4 (D)	Staples Mill Road (NBL)	63.9 (E)	0.78	12
Staples Mill Road/Staples Mill Square Shopping Center (#10)	AM Peak	21.1 (C)	Staples Mill Road (SBL)	58.2 (E)	0.61	6
	PM Peak	33.1 (C)	Staples Mill Road (SBL)	78.9 (E)	0.85	13

[1] Average intersection delay, LOS reported only for signalized intersections. Orange highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, level of service, v/c, and 95th percentile queues represent the worst-performing metric at each intersection Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

Intersection	Peak hour	Overall Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
Staples Mill Road/Old Staples Mill Road/Lucas Road (#11)	AM Peak	34.7 (C)	Staples Mill Road (SBL)	64.0 (E)	0.68	8
	PM Peak	30.0 (C)	Staples Mill Road (SBL)	60.0 (E)	0.65	7
Staples Mill Road/E. Parham Road (#12)	AM Peak	48.7 (D)	E. Parham Road (WBL)	102.6 (F)	1.03	15
	PM Peak	52.5 (D)	E. Parham Road (WBL)	90.7 (F)	0.97	12
	Saturday Midday	33.2 (C)	E. Parham Road (EBT)	41.9 (D)	0.81	11
Staples Mill Road/Hermitage Road/Commercial Entrance (#13)	AM Peak	20.7 (C)	Hermitage Road (WBL/T)	87.4 (F)	0.93	17
	PM Peak	22.3 (C)	Staples Mill Road (SBL)	65.8 (E)	0.56	11
	Saturday Midday	15.8 (B)	Hermitage Road (WBL/T)	43.4 (D)	0.64	6
Staples Mill Road/Wistar Road (#14)	AM Peak	16.0 (B)	Staples Mill Road (SBL)	61.2 (E)	0.43	3
	PM Peak	20.3 (C)	Wistar Road (EBL/T)	77.4 (E)	0.87	13
	Saturday Midday	13.7 (B)	Staples Mill Road (SBL)	48.4 (D)	0.40	2
Staples Mill Road/Bremner Boulevard (#15)	AM Peak	18.3 (B)	Bremner Boulevard (WBL/T)	84.4 (F)	0.77	6
	PM Peak	20.1 (C)	Bremner Boulevard (EBL/T)	64.3 (E)	0.69	8
	Saturday Midday	16.5 (B)	Bremner Boulevard (EBL/T)	43.4 (D)	0.59	5
Staples Mill Road/Amtrak Station (#16)	AM Peak	4.6 (A)	Staples Mill Road (SBL)	64.3 (E)	0.21	1
	PM Peak	4.7 (A)	Staples Mill Road (SBL)	66.2 (E)	0.29	1
	Saturday Midday	6.0 (A)	Staples Mill Road (NB U-turn)	47.3 (D)	0.37	2
Staples Mill Road/Crockett Street/Entrance to Dumbarton Square (#17)	AM Peak	11.9 (B)	Staples Mill Road (NBL)	60.1 (E)	0.42	3
	PM Peak	16.5 (B)	Staples Mill Road (NBL)	59.7 (E)	0.56	4
	Saturday Midday	19.9 (B)	Staples Mill Road (NBL)	43.7 (D)	0.64	6

[1] Average intersection delay, LOS reported only for signalized intersections. Orange highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, level of service, v/c, and 95th percentile queues represent the worst-performing metric at each intersection Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

Intersection	Peak hour	Overall Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
Staples Mill Road/Hilliard Road/Glenside Drive (#18)	AM Peak	66.7 (E)	Hilliard Road (WBT/R)	221.9 (F)	1.34	26
	PM Peak	68.2 (E)	Hilliard Road (WBT/R)	179.9 (F)	1.22	18
	Saturday Midday	51.0 (D)	Hilliard Road (WBT/R)	166.1 (F)	1.22	12
Staples Mill Road/Aspen Avenue/Townhouse Road (#19)	AM Peak	14.9 (B)	Aspen Avenue (WBL/T/R)	61.2 (E)	0.61	6
	PM Peak	29.1 (C)	Aspen Avenue (EBL/T/R)	98.2 (F)	0.89	7
	Saturday Midday	11.5 (B)	Aspen Avenue (WBL/T/R)	41.2 (D)	0.44	3
Staples Mill Road/Dumbarton Road/Wharfside Road (#20)	AM Peak	33.9 (C)	Staples Mill Road (SBL)	81.9 (F)	0.93	18
	PM Peak	34.8 (C)	Staples Mill Road (SBL)	64.9 (E)	0.89	22
	Saturday Midday	17.7 (B)	Wharfside Road (EBL)	40.0 (D)	0.11	1
Staples Mill Road/Dickens Road/Entrance to Comcast (#21)	AM Peak	24.0 (C)	Staples Mill Road (NBL)	58.8 (E)	0.33	2
	PM Peak	36.2 (D)	Dickens Road (EBL)	71.6 (E)	0.93	19
	Saturday Midday	12.2 (B)	Entrance to Comcast (WBL/T)	45.5 (D)	0.36	1
Brook Road/E. Parham Road (#22)	AM Peak	40.9 (D)	Brook Road (SBL)	64.5 (E)	0.86	9
	PM Peak	42.5 (D)	Brook Road (SBL)	67.5 (E)	0.88	12
Brook Road/Hilliard Road/Hilliard Avenue (#23)	AM Peak	30.1 (C)	Hilliard Avenue (WBL)	56.7 (E)	0.63	8
	PM Peak	21.3 (C)	Brook Road (NBL)	70.0 (E)	0.87	12
Brook Road/Dumbarton Road/Azalea Avenue (#24)	AM Peak	43.8 (D)	Azalea Avenue (WBL)	70.7 (E)	0.80	11
	PM Peak	58.4 (E)	Brook Road (SBL)	104.5 (F)	1.05	33
Springfield Road/Gaskins Road/Hungary Road (#25)	AM Peak	42.9 (D)	Springfield Road (NBL)	55.7 (E)	0.58	5
	PM Peak	101.3 (F)	Hungary Road (EBT)	207.0 (F)	1.34	30
Hungary Road/West End Drive (#26)	AM Peak	12.1 (B)	West End Drive (NBL)	23.9 (C)	0.54	6
	PM Peak	36.5 (D)	Hungary Road (WBL)	63.2 (E)	0.88	18

[1] Average intersection delay, LOS reported only for signalized intersections. Orange highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, level of service, v/c, and 95th percentile queues represent the worst-performing metric at each intersection Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

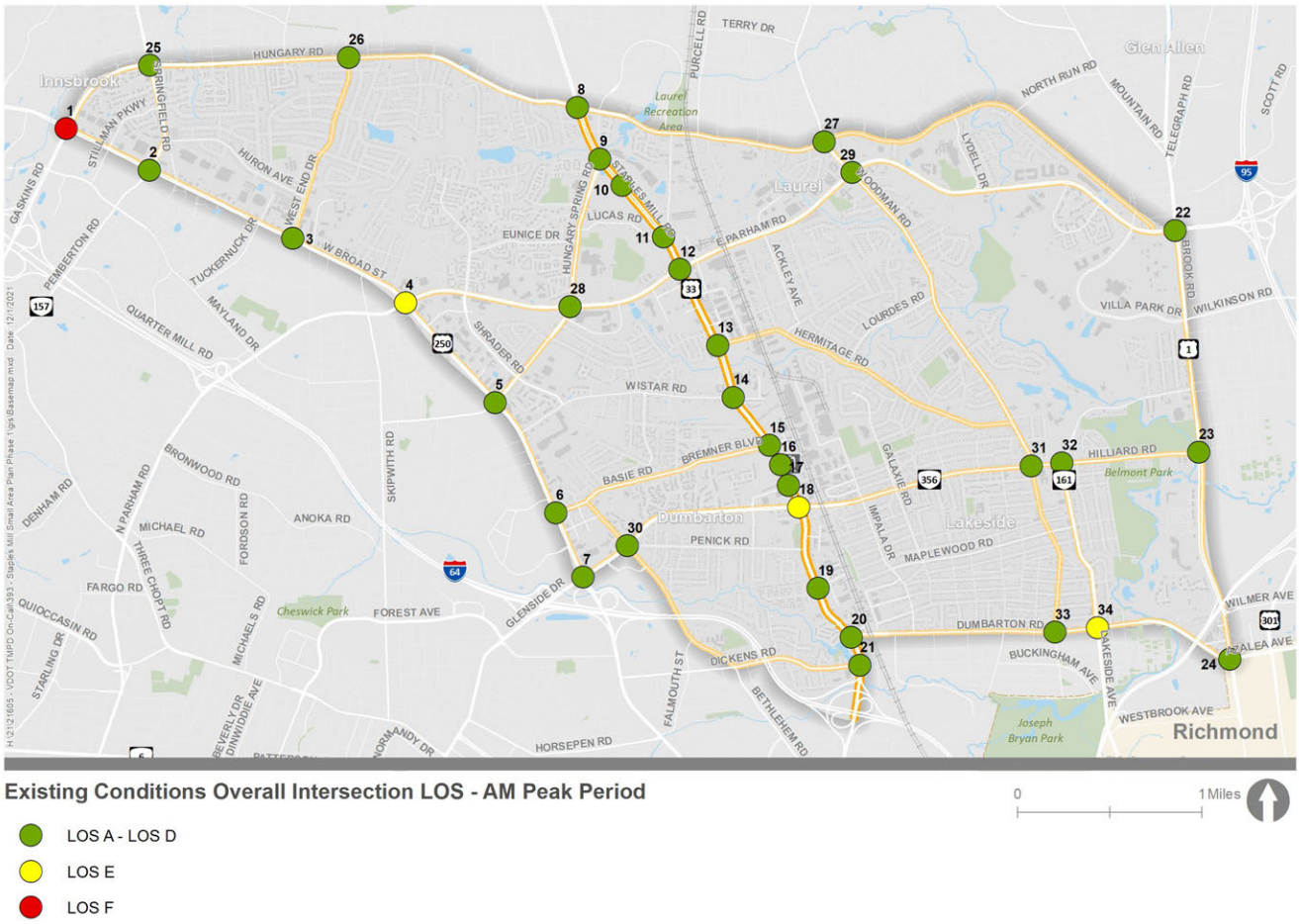
Intersection	Peak hour	Overall Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
Hungary Road/Woodman Road (#27)	AM Peak	21.1 (C)	Woodman Road (SBL)	33.6 (C)	0.81	3
	PM Peak	57.1 (E)	Hungary Road (WBT/R)	87.2 (F)	1.00	29
E. Parham Road/Hungary Spring Road (#28)	AM Peak	19.2 (B)	Hungary Spring Road (NBR)	26.1 (C)	0.69	3
	PM Peak	19.4 (B)	Hungary Spring Road (NBR)	24.0 (C)	0.67	3
E. Parham Road/Woodman Road (#29)	AM Peak	22.4 (C)	Woodman Road (SBR)	27.4 (C)	0.82	10
	PM Peak	26.2 (C)	E. Parham Road (EBL)	35.5 (D)	0.92	22
Glenside Drive/Bethlehem Road (#30)	AM Peak	29.2 (C)	Bethlehem Road (NBL/T)	42.2 (D)	0.64	5
	PM Peak	52.2 (D)	Bethlehem Road (SBL/T)	421.1 (F)	1.77	11
Hilliard Road/Hermitage Road (#31)	AM Peak	43.0 (D)	Hilliard Road (EBL)	103.2 (F)	0.87	7
	PM Peak	42.5 (D)	Hilliard Road (EBL)	83.4 (F)	0.87	10
Lakeside Avenue/Hilliard Road (#32)	AM Peak	39.9 (D)	Hilliard Road (EBL)	73.8 (E)	0.83	17
	PM Peak	37.9 (D)	Hilliard Road (EBL)	59.3 (E)	0.82	25
Dumbarton Road/Hermitage Road/Westlake Avenue (#33)	AM Peak	5.1 (A)	Hermitage Road (SBL/T/R)	17.7 (B)	0.31	3
	PM Peak	7.5 (A)	Westlake Avenue (SBL/T/R)	18.1 (B)	0.29	3
Lakeside Avenue/Dumbarton Road (#34)	AM Peak	64.3 (E)	Lakeside Avenue (NBL)	106.9 (F)	0.93	16
	PM Peak	56.3 (E)	Lakeside Avenue (NBL)	237.6 (F)	1.32	14

[1] Average intersection delay, LOS reported only for signalized intersections. Orange highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, level of service, v/c, and 95th percentile queues represent the worst-performing metric at each intersection Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

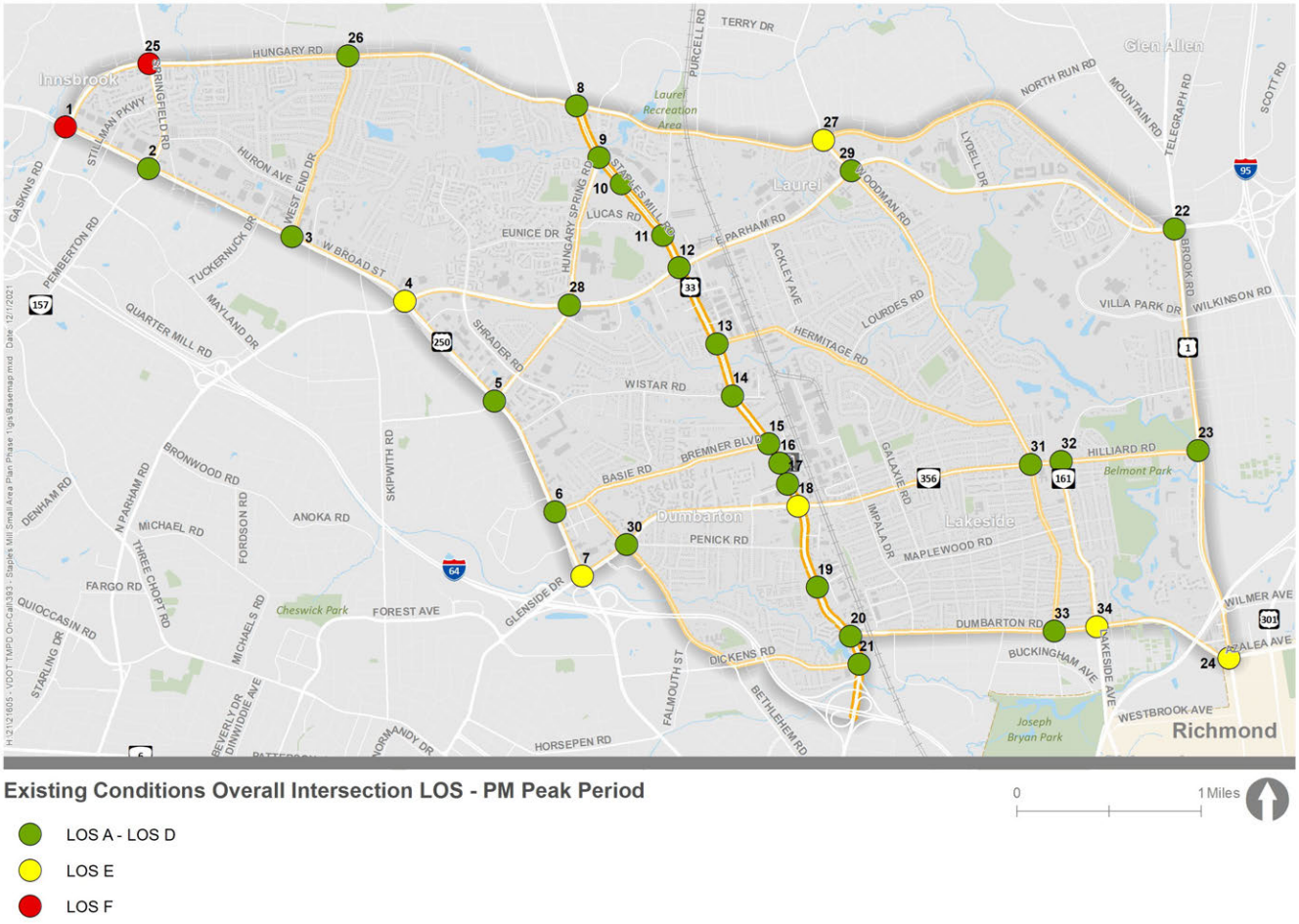
[3] 95th percentile queues rounded up to the nearest whole number

Figure 15. Existing Conditions Operational Analysis—AM Peak Period



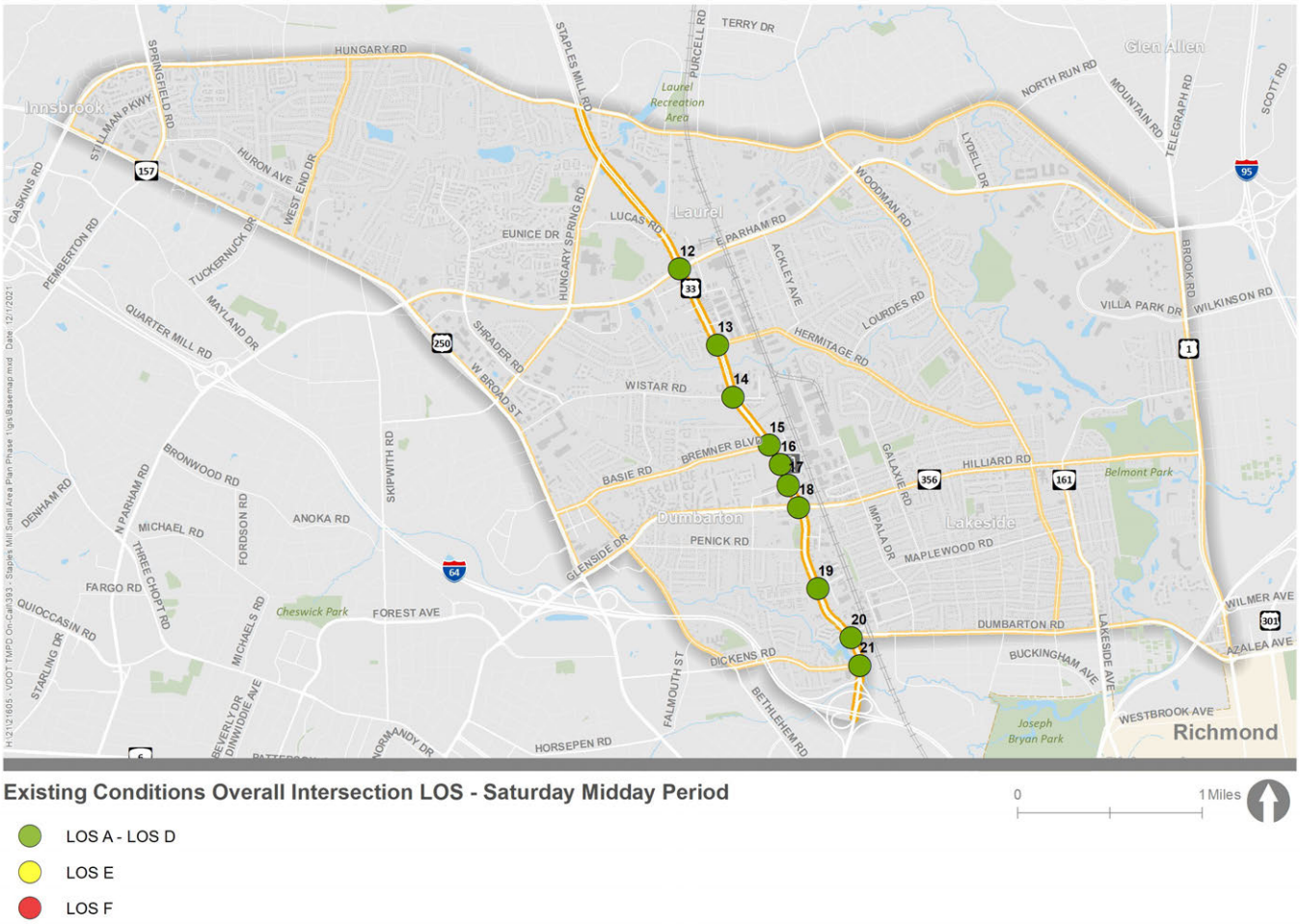
Source: Kittelson 2021

Figure 16. Existing Conditions Operational Analysis—PM Peak Period



Source: Kittelson 2021

Figure 17. Existing Conditions Operational Analysis—Saturday Midday Period



Source: Kittelson 2021

4.3 Future No-Build Conditions

In addition to considering existing traffic operations, future traffic operations at the study intersections were analyzed. Future design year and growth rates were identified to estimate and assess the influence of increased traffic volumes on the study intersections.

The following materials were reviewed to estimate annual growth rates:

- STARS Route 33 Report
- I-64 at Gaskins Road Interchange Modification Report (2020)
- I-64 at Parham Road Interchange Modification Report (2020)
- US 250 (Short Pump) Corridor Study (2020)
- VDOT Historic Traffic Volumes for Henrico County
- VDOT 2045 AADT projections from Statewide Planning System Data
- Near- and long-term development in the Richmond region

The future operations analysis assumed a design year of 2040 and future background traffic volume annual growth of 0.6 percent on Staples Mill Road (Route 33), 0.7 percent on Broad Street (Route 250), 0.7 percent on Brook Road (Route 1), 0.7 percent on Gaskins Road/Hungary Road, 0.4 percent on E. Parham Road, and 0.4 percent on other study streets.

To provide an estimate of how the existing transportation network could operate in a "no build" scenario, the analysis assumed that no changes would be made to the existing transportation network.

KEY TERMS>>

- **Design Year:** Future year used to assess how existing traffic volumes will grow and influence a transportation network
- **Growth Rate:** Rate of growth applied to existing traffic counts to estimate how traffic volumes could increase in the future

Traffic operations analyses were performed at study area intersections in accordance with the *Highway Capacity Manual* (HCM), Sixth Edition using SYNCHRO 10. **Table 6**, **Figure 18**, **Figure 19**, and **Figure 20** summarize the operational analysis for the study intersections under the weekday AM, weekday PM, and Saturday midday peak hour future no-build traffic conditions. The full analysis can be found in **Attachment C**.

Most of the intersections studied are forecast to perform acceptably during each of the peak hours studied with exceptions described below.

AM Future Conditions

Five intersections are predicted to operate at LOS E or F:

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Glenside Road
- Staples Mill Road/Hilliard Road/Glenside Drive
- Lakeside Avenue/Dumbarton Road

Seven intersections have movements that are at capacity (v/c ratio greater than 1):

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Glenside Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive

- Staples Mill Road/Dumbarton Road/Wharfside Road
- Springfield Road/Gaskins Road/Hungary Road

These intersections are located along the W. Broad Street, Staples Mill Road, and Gaskins Road/Hungary Road corridors (**Table 6**).

PM Future Conditions

Eleven intersections are predicted to operate at LOS E or F:

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Glenside Drive
- Staples Mill Road/Hungary Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive
- Brook Road/Dumbarton Road/Azalea Avenue
- Springfield Road/Gaskins Road/Hungary Road
- Hungary Road/Woodman Road
- Lakeside Avenue/Dumbarton Road
- Glenside Drive/Bethlehem Road

Sixteen intersections have movements that are at capacity (v/c ratio greater than 1):

- W. Broad Street/Gaskins Road
- W. Broad Street/Parham Road
- W. Broad Street/Hungary Spring Road
- W. Broad Street/Bethlehem Road/Entrance to Volvo
- W. Broad Street/Glenside Road
- Staples Mill Road/Hungary Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Hilliard Road/Glenside Drive
- Staples Mill Road/Dumbarton Road/Wharfside Road
- Brook Road/Dumbarton Road/Azalea Avenue
- Springfield Road/Gaskins Road/Hungary Road
- Hungary Road/West End Drive
- Hungary Road/Woodman Road
- Glenside Drive/Bethlehem Road
- Hilliard Road/Hermitage Road
- Lakeside Avenue/Dumbarton Road

Most of these intersections are located along the W. Broad Street, Staples Mill Road, Gaskins Road/Hungary Road, Hilliard Road/Glenside Drive, and Dumbarton Road corridors (Table 6).

Saturday Future Conditions

One intersection is predicted to operate at LOS E (Staples Mill Road/Hilliard Road/Glenside Drive). The westbound through-right movement at this intersection is at capacity during all three peak periods.

Table 6. Future No-Build Conditions Operational Analysis

Intersection	Peak hour	Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
W. Broad Street/Gaskins Road (#1)	AM Peak	161.7 (F)	Gaskins Road (WBR)	604.9 (F)	2.20	16
	PM Peak	120.3 (F)	Gaskins Road (WBR)	602.7 (F)	2.20	21
W. Broad Street/Pemberton Road/Springfield Road (#2)	AM Peak	33.6 (C)	Springfield Road (WBL)	91.0 (F)	0.99	14
	PM Peak	41.8 (D)	W. Broad Street (SBL)	80.9 (F)	0.80	9
W. Broad Street/West End Drive/Commercial Entrance (#3)	AM Peak	26.1 (C)	W. Broad Street (NBL)	56.1 (E)	0.46	3
	PM Peak	30.8 (C)	W. Broad Street (SBL)	71.1 (E)	0.88	18
W. Broad Street/N. Parham Road/E. Parham Road (#4)	AM Peak	73.3 (E)	E. Parham Road (WBR)	186.6 (F)	1.26	5
	PM Peak	100.9 (F)	E. Parham Road (WBR)	348.8 (F)	1.65	20
W. Broad Street/Hungary Spring Road (#5)	AM Peak	46.9 (D)	Hungary Spring Road (WBL)	114.1 (F)	0.16	21
	PM Peak	54.9 (D)	Hungary Spring Road (EBT)	194.6 (F)	1.25	21
W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)	AM Peak	12.1 (B)	W. Broad Street (NBL)	66.0 (E)	0.54	2
	PM Peak	19.5 (B)	Bethlehem Road (WBR)	158.4 (F)	1.11	4
W. Broad Street/Glenside Drive (#7)	AM Peak	55.7 (E)	Glenside Drive (WBT)	153.3 (F)	1.20	22
	PM Peak	89.8 (F)	Glenside Drive (WBT)	186.1 (F)	1.27	23
Staples Mill Road/Hungary Road (#8)	AM Peak	44.1 (D)	Hungary Road (WBL)	82.6 (F)	0.46	2
	PM Peak	64.0 (E)	Hungary Road (WBT/R)	160.8 (F)	1.16	27
Staples Mill Road/Hungary Spring Road (#9)	AM Peak	29.0 (C)	Staples Mill Road (SBL)	57.0 (E)	0.41	3
	PM Peak	39.2 (D)	Staples Mill Road (NBL)	68.5 (E)	0.83	14
Staples Mill Road/Staples Mill Square Shopping Center (#10)	AM Peak	22.1 (C)	Staples Mill Road (SBL)	61.5 (E)	0.66	6
	PM Peak	36.8 (D)	Staples Mill Road (SBL)	101.8 (F)	0.95	15
Staples Mill Road/Old Staples Mill Road/Lucas Road (#11)	AM Peak	39.8 (D)	Staples Mill Road (SBL)	74.3 (E)	0.76	9
	PM Peak	36.1 (D)	Staples Mill Road (SBL)	63.4 (E)	0.69	8
Staples Mill Road/E. Parham Road (#12)	AM Peak	52.3 (D)	E. Parham Road (WBL)	115.9 (F)	1.08	16
	PM Peak	69.9 (E)	E. Parham Road (WBL)	111.2 (F)	1.04	13
	Saturday Midday	37.9 (D)	E. Parham Road (EBT)	44.1 (D)	0.85	12
Staples Mill Road/Hermitage Road/Commercial Entrance (#13)	AM Peak	22.0 (C)	Hermitage Road (WBL/T)	100.0 (F)	0.98	18
	PM Peak	24.4 (C)	Staples Mill Road (SBL)	70.4 (E)	0.82	13
	Saturday Midday	17.5 (B)	Hermitage Road (WBL/T)	43.0 (D)	0.69	9

[1]Average intersection delay, LOS reported only for signalized intersections. Yellow highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, LOS, v/c, and 95th percentile queues represent the worst-performing metric at each intersection. Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

Intersection	Peak hour	Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
Staples Mill Road/Wistar Road (#14)	AM Peak	17.3 (B)	Wistar Road (EBL/T)	58 (E)	0.67	8
	PM Peak	21.1 (C)	Wistar Road (EBL/T)	77.4 (E)	0.87	13
	Saturday Midday	14.4 (B)	Staples Mill Road (SBL)	47.4 (D)	0.39	2
Staples Mill Road/Bremner Boulevard (#15)	AM Peak	19.8 (B)	Bremner Boulevard (WBL/T)	93.0 (F)	0.81	7
	PM Peak	22.2 (C)	Staples Mill Road (NBL)	68.3 (E)	0.76	10
	Saturday Midday	17.4 (B)	Bremner Boulevard (EBL/T)	45.1 (D)	0.62	5
Staples Mill Road/Amtrak Station (#16)	AM Peak	3.9 (A)	Staples Mill Road (SBL)	64.3 (E)	0.21	1
	PM Peak	3.7 (A)	Staples Mill Road (SBL)	66.2 (E)	0.29	1
	Saturday Midday	5.2 (A)	Staples Mill Road (SBL)	46.3 (D)	0.33	1
Staples Mill Road/Crockett Street/Entrance to Dumbarton Square (#17)	AM Peak	12.8 (B)	Staples Mill Road (NBL)	59.9 (E)	0.46	3
	PM Peak	17.6 (B)	Staples Mill Road (NBL)	59.8 (E)	0.6	4
	Saturday Midday	21.1 (C)	Staples Mill Road (NBL)	47.3 (D)	0.7	6
Staples Mill Road/Hilliard Road/Glenside Drive (#18)	AM Peak	73.0 (E)	Hilliard Road (WBT/R)	242.0 (F)	1.39	29
	PM Peak	88.9 (F)	Hilliard Road (WBT/R)	204.6 (F)	1.29	20
	Saturday Midday	60.1 (E)	Hilliard Road (WBT/R)	201.8 (F)	1.31	13
Staples Mill Road/Aspen Avenue/Townhouse Road (#19)	AM Peak	16.2 (B)	Aspen Avenue (EBL/T/R)	65.6 (E)	0.69	8
	PM Peak	19.4 (B)	Aspen Avenue (WBL/T/R)	67.6 (E)	0.75	10
	Saturday Midday	11.8 (B)	Aspen Avenue (WBL/T/R)	41.8 (D)	0.48	3
Staples Mill Road/Dumbarton Road/Wharfside Road (#20)	AM Peak	40.2 (D)	Staples Mill Road (SBL)	104.4 (F)	1.01	21
	PM Peak	44.1 (D)	Staples Mill Road (NBR)	79.3 (E)	1.04	40
	Saturday Midday	18.5 (B)	Staples Mill Road (SBL)	40.2 (D)	0.71	9
Staples Mill Road/Dickens Road/Entrance to Comcast (#21)	AM Peak	35.0 (D)	Staples Mill Road (NBL)	59.5 (E)	0.38	2
	PM Peak	31.2 (C)	Staples Mill Road (NBL)	187.1 (F)	0.80	2
	Saturday Midday	12.9 (B)	Entrance to Comcast (WBL/T)	46.5 (D)	0.39	2
Brook Road/E. Parham Road (#22)	AM Peak	40.9 (D)	Brook Road (SBL)	65.5 (E)	0.87	11
	PM Peak	46.1 (D)	Brook Road (SBL)	87.5 (F)	0.98	15
Brook Road/Hilliard Road/Hilliard Avenue (#23)	AM Peak	30.3 (C)	Hilliard Avenue (WBL)	57.9 (E)	0.65	8
	PM Peak	31.7 (C)	Brook Road (NBL)	64.9 (E)	0.82	15
Brook Road/Dumbarton Road/Azalea Avenue (#24)	AM Peak	46.2 (D)	Azalea Avenue (WBL)	71.2 (E)	0.81	12
	PM Peak	69.0 (E)	Brook Road (SBL)	155.2 (F)	1.19	39
Springfield Road/Gaskins Road/Hungary Road (#25)	AM Peak	52.2 (D)	Hungary Road (WBT)	86.6 (F)	1.04	26
	PM Peak	135.6 (F)	Hungary Road (EBT)	277.2 (F)	1.50	35

[1]Average intersection delay, LOS reported only for signalized intersections. Yellow highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, LOS, v/c, and 95th percentile queues represent the worst-performing metric at each intersection. Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

Intersection	Peak hour	Intersection delay (sec) and level of service[1]	Worst-performing movement			
			Movement	Delay (sec) and level of service[2]	v/c[2]	95th percentile queues (vehicles)[3]
Hungary Road/West End Drive (#26)	AM Peak	13.6 (B)	West End Drive (NBL)	24.2 (C)	0.56	6
	PM Peak	49.0 (D)	Hungary Road (WBL)	92.3 (F)	1.00	21
Hungary Road/Woodman Road (#27)	AM Peak	22.5 (C)	Woodman Road (NBL)	35.6 (D)	0.79	6
	PM Peak	72.4 (E)	Hungary Road (WBT/R)	135.1 (F)	1.15	34
E. Parham Road/Hungary Spring Road (#28)	AM Peak	20.0 (B)	Hungary Spring Road (NBR)	26.9 (C)	0.70	3
	PM Peak	21.1 (C)	Hungary Spring Road (NBR)	25.4 (C)	0.69	3
E. Parham Road/Woodman Road (#29)	AM Peak	21.3 (C)	E. Parham Road (WBT)	25.3 (C)	0.79	14
	PM Peak	32.0 (C)	E. Parham Road (EBL)	49.3 (D)	0.96	25
Glenside Drive/Bethlehem Road (#30)	AM Peak	28.2 (C)	Bethlehem Road (SBL/T)	42.1 (D)	0.78	9
	PM Peak	62.1 (E)	Bethlehem Road (SBL/T)	488.4 (F)	1.92	12
Hilliard Road/Hermitage Road (#31)	AM Peak	40.1 (D)	Hilliard Road (EBL)	92.6 (F)	0.83	8
	PM Peak	45.5 (D)	Hermitage Road (SBL)	92.4 (F)	1.03	24
Lakeside Avenue/Hilliard Road (#32)	AM Peak	43.2 (D)	Hilliard Road (EBL)	89.6 (F)	0.91	18
	PM Peak	41.3 (D)	Hilliard Road (EBL)	76.4 (E)	0.92	29
Dumbarton Road/Hermitage Road/Westlake Avenue (#33)	AM Peak	5.5 (A)	Hermitage Road (SBL/T/R)	17.9 (B)	0.36	3
	PM Peak	7.9 (A)	Westlake Avenue (SBL/T/R)	18.4 (B)	0.30	4
Lakeside Avenue/Dumbarton Road (#34)	AM Peak	63.6 (E)	Lakeside Avenue (NBL)	105.3 (F)	0.93	17
	PM Peak	63.5 (E)	Lakeside Avenue (NBL)	247.7 (F)	1.35	14

[1] Average intersection delay, LOS reported only for signalized intersections. Yellow highlighted cells represent intersections operating with an overall LOS E or F.

[2] Reported delay, LOS, v/c, and 95th percentile queues represent the worst-performing metric at each intersection. Blue highlighted cells represent intersections with movements exceeding capacity (v/c > 1.0).

[3] 95th percentile queues rounded up to the nearest whole number

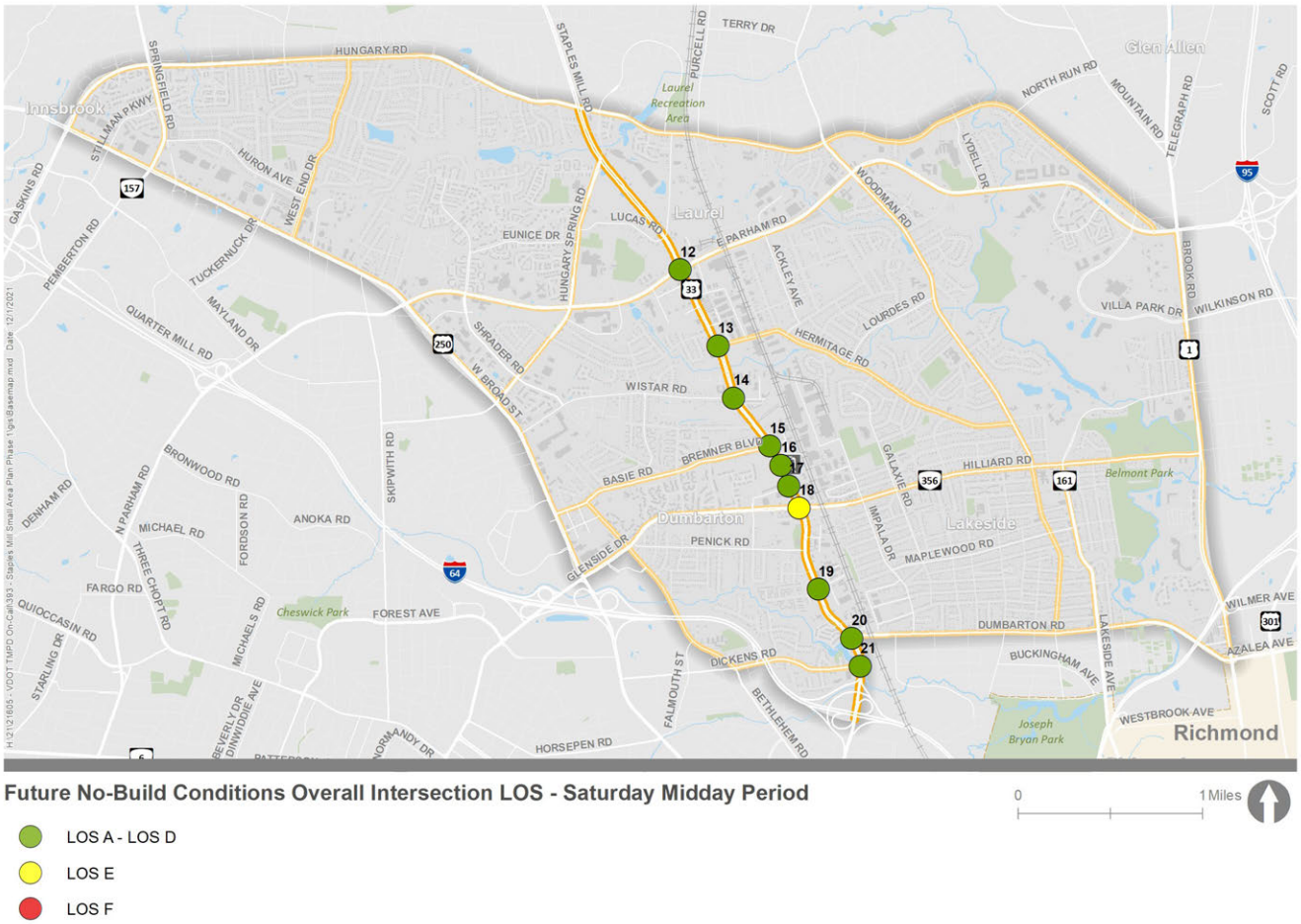
Figure 18. Future No-Build Conditions Operational Analysis—AM Peak Period

Source: Kittelson 2021

Figure 19. Future No-Build Conditions Operational Analysis—PM Peak Period

Source: Kittelson 2021

Figure 20. Future No-Build Conditions Operational Analysis—Saturday Midday Period



Source: Kittelson 2021

5.0 BICYCLE AND PEDESTRIAN FACILITIES

This section presents existing and proposed bicycle and pedestrian facilities throughout the study area.

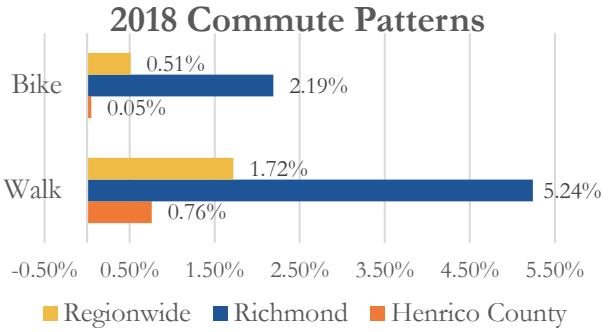
5.1 Existing Bicycle and Pedestrian Facilities

Multimodal transportation facilities, such as bicycle and pedestrian infrastructure, allow visitors and residents to travel freely without dependence on vehicles. A mix of transportation options allows users to make transportation decisions that align with their needs and circumstances.

The study area boundary has limited bicycle and pedestrian infrastructure. The lack of bicycle and pedestrian infrastructure creates uncomfortable conditions for people traveling to, from, and throughout the study area by walking or biking. Furthermore, several neighborhoods in the study area have higher percentages of zero-car households that lack comfortable transportation alternatives to personal vehicles.

Census data from 2018 shows that bicycle and pedestrian commuting in Henrico County is below the regionwide numbers for walking and biking (**Figure 21**). Low percentages of walking and biking commutes may be attributed in part to the lack of bicycle and pedestrian infrastructure. The interstate highways surrounding the study also limit options for walking or biking between employment centers in Henrico County and Richmond.

Figure 21. 2018 ACS Commute Patterns for Walking and Biking



Source: Plan RVA, Richmond Regional Bicycle and Pedestrian Plan

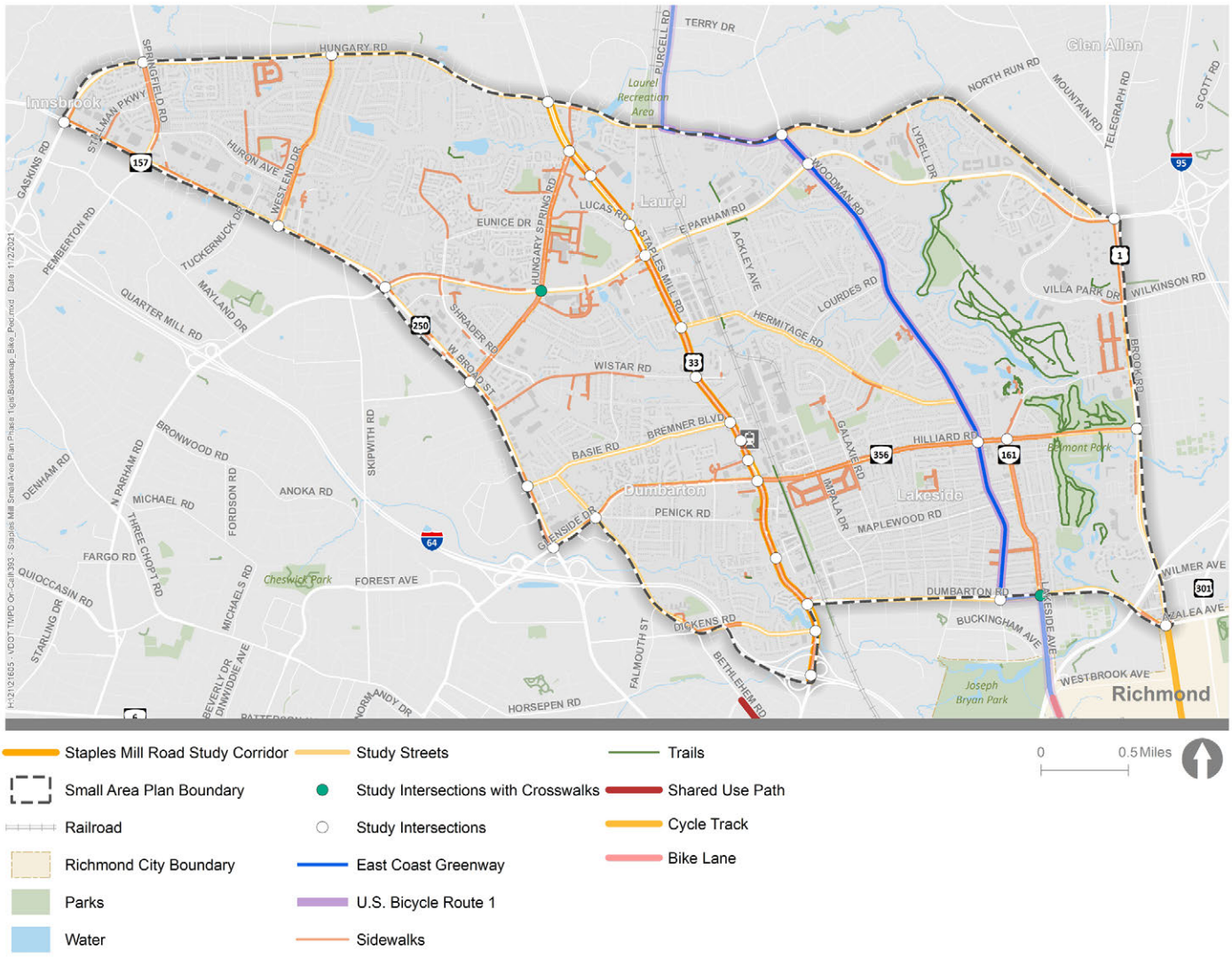
Existing Bicycle and Pedestrian Facilities Data

Street-level bicycle and pedestrian facility data were obtained from the City of Richmond and Henrico County for 2021. These data were supplemented with field observations from a spring 2021 field visit.

Additionally, several plans and studies were reviewed to better understand ongoing efforts near the study area. Henrico County's Comprehensive Plan was completed in 2009 and is currently being updated. The plan had a horizon year of 2026 and had limited plans related to biking and walking. Other plans and studies were reviewed to obtain a broader context of biking and walking activity in and surrounding Henrico County, including Connect RVA 2045, the Richmond Regional Active Transportation Plan Update, and the Richmond Regional Bicycle and Pedestrian Plan (scheduled to be updated and completed in early 2022).

Figure 22 displays existing bicycle and pedestrian facilities within and surrounding the study area.

Figure 22. Existing Bicycle and Pedestrian Facilities



Source: Richmond Regional Transportation Planning Organization, Kittelson 2021

Existing Pedestrian Facilities

Pedestrian facilities are limited throughout the study area. Many study streets lack sidewalks and just 2 out of 34 study intersections have marked crosswalks. While personal vehicles are the primary mode for most users traveling to, from, and throughout the study area, transit also plays a significant role in the transportation network. The Amtrak station located within the study area serves as a major regional transit connection. By 2030, the Staples Mill Road Amtrak station plans to accommodate six new round-trip trains, further increasing the need for safe and convenient connections to the station. Pedestrian infrastructure is a critical component in connecting to other modes, especially transit. All users, regardless of transportation mode, are pedestrians for some portion of their journey, whether to or from a parking lot, bus stop, or bicycle trail.

The pedestrian facilities shown in **Figure 22** include:

1. **The East Coast Greenway**
2. **Sidewalks**
3. **Trails**

East Coast Greenway

The East Coast Greenway connects 3,000 miles from Maine to Florida, serving people walking, biking, and traveling by non-vehicular mode. The Greenway provides a mix of off-road and on-road facilities and connects the study area to Lawrenceville to the south and Alexandria to the north. The Greenway splits into two route options in Richmond, with the spine route continuing south to North Carolina and the Historic Coastal Route heading southwest through Jamestown and Williamsburg.

Through the study area, the Greenway provides an on-road facility that travels north from Richmond along Lakeside Avenue, Dumbarton Road, Hermitage Road, and Woodman Road.

Sidewalks and Crosswalks

Sidewalks and crosswalks are limited throughout the study area. Only two of the study intersections provide crosswalks for people walking, including Dumbarton Road and Lakeside Avenue and E. Parham Road and Hungary Spring Road. As shown in **Figure 23**, existing crossings at E. Parham Road and Hungary Spring Road are skewed, provide poor sight distance, and lack pedestrian refuges.

Figure 23. Skewed Crosswalk at E. Parham Road and Hungary Spring Road

Source: Kittelson and Associates

Sidewalks are provided along the following study streets:

1. **Staples Mill Road**
2. **Hungary Spring Road**
3. **Portions of Hilliard Road**
4. **Lakeside Avenue**
5. **Portions of West End Drive**
6. **Portion of Glenside Drive**

7. **Portion of E. Parham Road**
8. **Portion of W. Broad Street**
9. **Portions of Springfield Road**
10. **Portions of Brook Road (Route 1)**

Although sidewalks are provided along the entire length of Staples Mill Road, none of the study intersections have marked crosswalks to facilitate pedestrian crossings at intersections. Additionally, the existing sidewalks lack proper maintenance and improved ADA accessibility. **Figure 24** shows an abrupt sidewalk end near Hilliard Road, along Staples Mill Road at the Family Dollar. Without a continuous sidewalk or safe crosswalks, pedestrians experience unsafe and uncomfortable conditions. **Figure 25** displays overgrown shrubs and poor maintenance that poses ADA challenges on the sidewalk near the Dumbarton Square Shopping Center.

VDOT is conducting ongoing pedestrian improvement projects at several signalized intersections in the study area, including Staples Mill Road at Mountain Road, Hungary Road, and Hungary Springs Road. VDOT is also implementing signalized intersection improvements and sidewalk connections along Broad Street between Gaskins Road and Parham Road.

Figure 24 Sidewalk Gaps on Staples Mill Road near Hilliard Road

Source: Google Maps

Figure 25. Poor Sidewalk Conditions and ADA Accessibility on Staples Mill Road near the Dumbarton Square Shopping Center

Source: Google Maps

Trails

Several trails are shown in **Figure 22** near Reynolds Community College, the Lewis Ginter Botanical Garden, the Lakeside Park Club, the Belmont Recreation Center, and Belmont Park.

However, most of the trails shown in **Figure 26** belong to golf courses or the botanical garden facility.

Figure 26. Path at the Belmont Golf Course

Source: Henrico County

Existing Bicycle Facilities

Bicycle facilities are also limited in the study area. **Figure 22** displays the existing bicycle facilities within and surrounding the study area. In addition to the pedestrian facilities outlined in the previous section that double as bicycle facilities (e.g. East Coast Greenway and trails), additional bicycle facilities include:

1. **The U.S. Bicycle Route 1**
2. **Nearby Bicycle Facilities:**
   - **Brook Road Cycle track**
   - **Bethlehem Road Shared Use Path**
   - **Hermitage Road Bike lanes**

U.S. Bicycle Route 1

The U.S. Bicycle Route 1 follows the East Coast Greenway Trail and for 274 miles through 21 Virginia localities. Through the study area, U.S. Bicycle Route 1 provides an on-road facility that travels north from Richmond along Lakeside Avenue, Dumbarton Road, Hermitage Road, and Woodman Road.

Nearby Bicycle Facilities

The RVA Bikeways map shows several existing bicycle facilities just south of the study area, including Brook Road and Hermitage Road. **Figure 27** shows the bicycle lane and intersection treatment along Brook Road. The bicycle facility ends south of the study area at Dumbarton Road.

Figure 28 displays the striped bicycle lane on Hermitage Road that runs from Brook Road, along the Brookland Parkway, and north on Hermitage Road to I-95.

Although there are no bicycle facilities within the study area, surrounding bicycle facilities provide an opportunity to connect people biking from the study area to Richmond. These connections will enhance the safety, comfort, and feasibility of bicycle trips to, from, and within the study area.

Figure 27. Intersection Treatment on Brook Road at West Laburnum Avenue

Source: Sportsbackers.org

Figure 28. Striped Bicycle Lane on Hermitage Road

Source: Sportsbackers.org

Bicycle Level of Stress

The Richmond Regional Transportation Planning Organization (RRTPO) conducted a level of stress (LOS) bicycle analysis on all the streets within the Study Area. **Figure 29** displays the results of the LOS analysis. The map shows four levels of stress, from 1 (lowest stress) to 4 (highest stress). The LOS scores were assigned based on the type of bicycle separation, posted speed limit, number of travel lanes, and the average annual daily traffic.

As shown in the map, low speed, low volume local neighborhood roads scored mostly LOS 1. Conversely, the major collectors and arterials in the study area, such as E. Parham Road, Staples Mill Road, Hilliard Road, Brook Road, and W. Broad Street all scored LOS 4, indicating very high stress for people biking. These high stress streets (LOS 3 and 4) create barriers for people biking across the study area. The clusters of low stress streets (LOS 1 and 2) are disconnected from the rest of the network by these high stress street barriers.

Figure 29 also shows major community destinations. These destinations are located mostly along high stress streets, emphasizing the need for safer and more comfortable bicycle facilities that will connect riders to desired destinations.

Options for decreasing the level of stress on LOS 3 and 4 streets include:

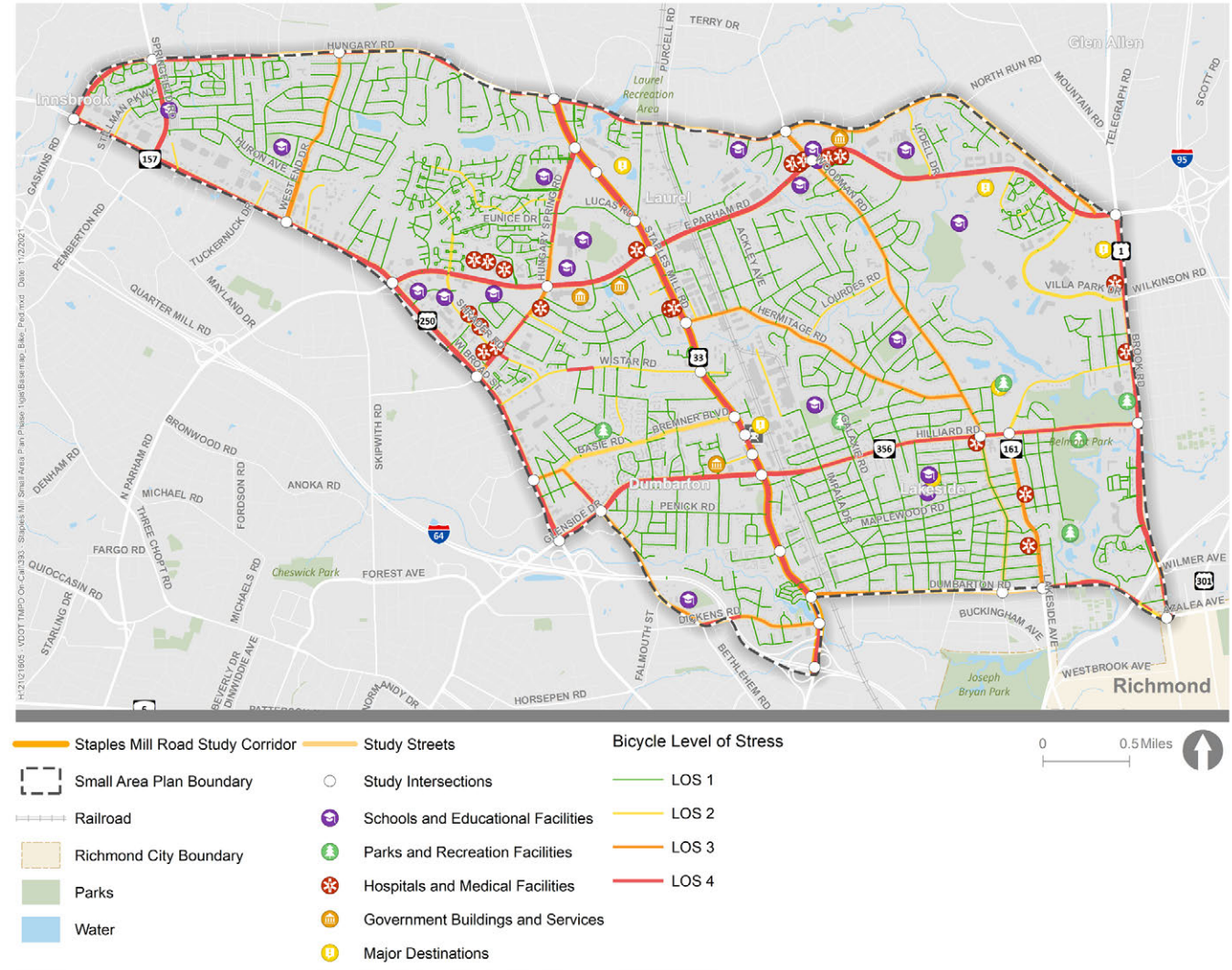
- Decreasing roadway speed through traffic calming.
- Decreasing roadway volumes and widths through lane reallocations (e.g., road diets).
- Adding separated bicycle facilities (e.g., cycle tracks, shared use paths).

Bicycle and Pedestrian Crashes

Crash history is an important component of understanding existing bicycle and pedestrian activity in the study area. **Figure 30** and **Figure 31** display pedestrian and bicycle crash history, respectively, from 2015-2020. Most reported crashes that occurred in the study area took place along the major streets, including Brook Road, Staples Mill Road, Hungary Spring Road, and W. Broad Street. There were 11 fatal pedestrian crashes and 1 fatal bicycle crash from 2015–2020.

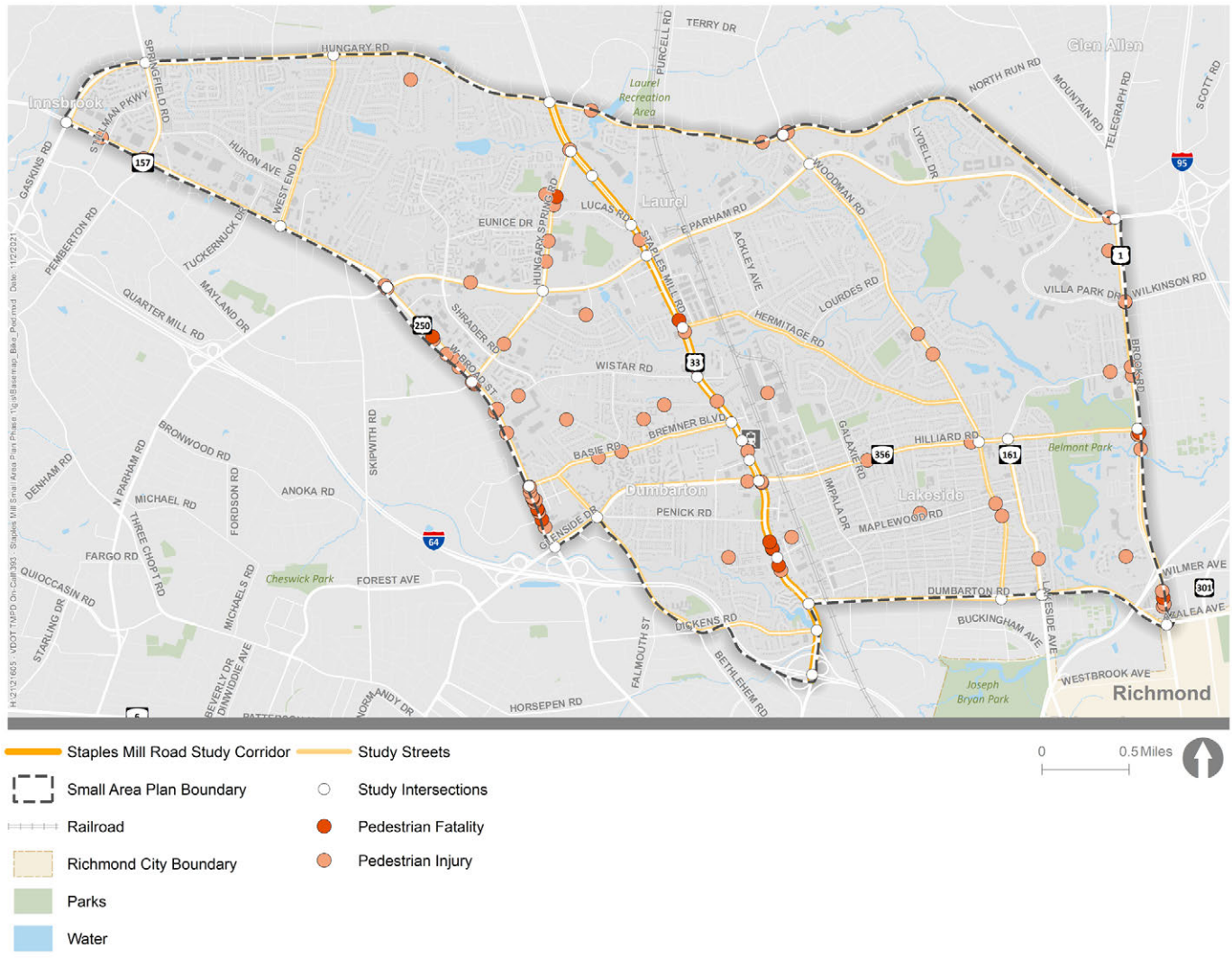
In 2020, crash history was reviewed and crash hot spot and systemic analyses were conducted to proactively identify locations with high risk and known crash problems. This information was used to inform and update the VDOT Pedestrian Safety Action Plan (PSAP). The plan identifies Broad Street (top 0.1%) and Brook Road (top 1%) as priority corridors based on crash history.

Figure 29. Existing Bicycle Level of Stress, Network Gaps, and Community Destinations



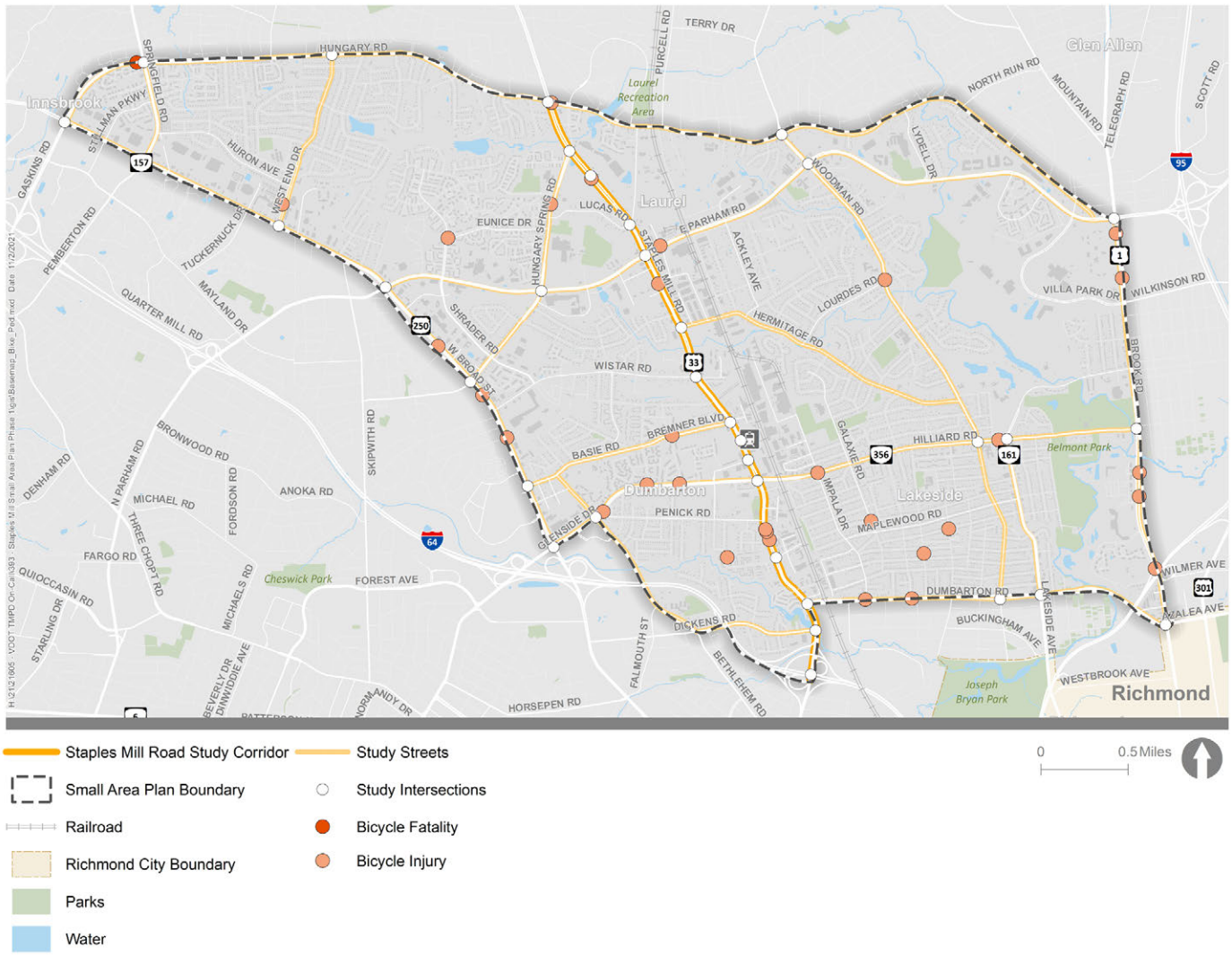
Source: Richmond Regional Transportation Planning Organization, Kittelson 2021

Figure 30. 2015–2020 Pedestrian Crashes



Source: VDOT, Kittelson 2021

Figure 31. 2015–2020 Bicycle Crashes



Source: VDOT, Kittelson 2021

5.2 Proposed Bicycle and Pedestrian Facilities

The City of Richmond and Henrico County share a long-term vision to provide a connected, continuous, and comfortable non-motorized network. Given the limited bicycle and pedestrian infrastructure within the study area, there is significant opportunity to expand the multimodal network and create safer and more comfortable conditions for people biking and walking. **Figure 32** shows the proposed bicycle and pedestrian facilities, as presented by the Richmond Regional Transportation Planning Organization (RRTPO) for the draft Richmond Regional Bicycle and Pedestrian Plan. The map shows the following proposed facilities:

1. **Shared Use Path**
2. **Sidewalks**
3. **Other Facilities**
4. **The Fall Line Trail**

Proposed Bicycle and Pedestrian Facilities Data

Proposed bicycle and pedestrian facility data for 2021 were obtained from the City of Richmond and Henrico County.

Shared Use Path

Figure 32 displays the proposed shared use path expansion in the study area. The map shows some overlap with the proposed Fall Line Trail. The map also shows the proposed alignment for the Lakeside Community Trail segment of the Fall Line Trail that runs from Lakeside Avenue north to Hilliard Road. The shared use path alignment follows along the Upham Brook and will provide connections to and from Belmont Park and the Lakeside Recreation area. **Figure 32** displays the Hilliard Road/Brook Road shared use path project alignment that is part of the Fall Line Trail. This alignment runs from Hilliard Road along Brook Road and Villa Park Drive.

In addition, **Figure 32** shows the following proposed shared use path plans:

1. **Shared use path from the proposed Fall Line Trail to the Reynolds Community College from Villa Park Drive and through the Jefferson Lakeside Country Club**
2. **Trolley Line Trail on Darracott Road from Villa Park Drive to E. Parham Road**

Sidewalks

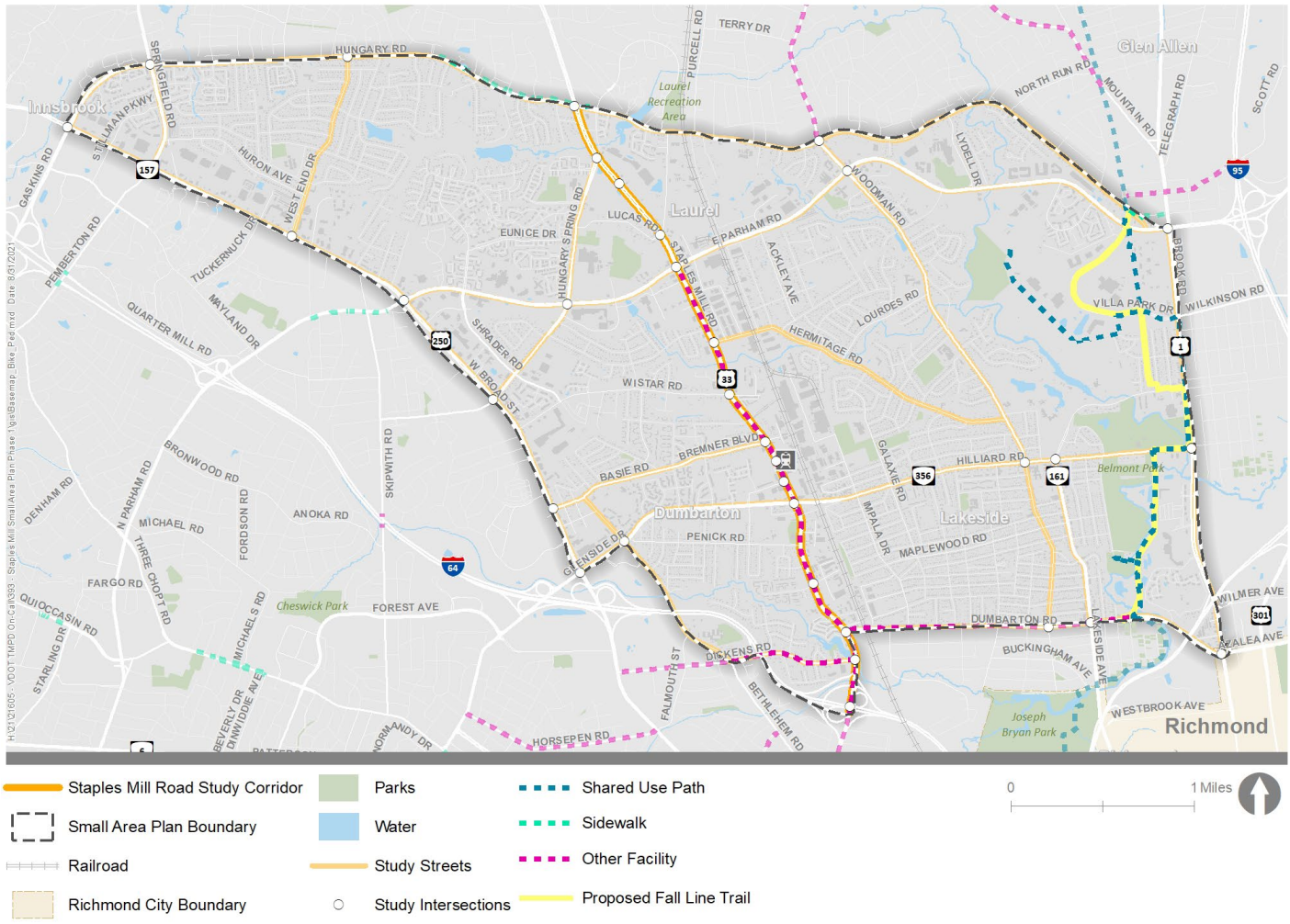
The draft Richmond Regional Bicycle and Pedestrian Plan shows proposed sidewalk improvements on Hungary Road between Staples Mill Road and Hardings Way (**Figure 32)**.

Other Facilities

Figure 32 displays several facilities that are unspecified in the draft Richmond Regional Bicycle and Pedestrian Plan. General bicycle and pedestrian facilities proposed in the study area include:

1. **Dumbarton Road multimodal safety improvement project from Staples Mill Road to Gillespie Avenue**
2. **Dickens Road multimodal safety improvement project from Staples Mill Road to W. Broad Street**
3. **Staples Mill Road from W. Broad Street to E. Parham Road**

Figure 32. Proposed Bicycle and Pedestrian Facilities



Source: City of Richmond, Henrico County, Kittelson 2021

Fall Line Trail

The Fall Line Trail is a proposed 43-mile-long multiuse paved path connecting Ashland to Petersburg, as shown in **Figure 33**. The path generally follows U.S. Route 1 and crosses over multiple municipalities, including Henrico, Hanover, and Chesterfield counties, the town of Ashland, and the cities of Richmond, Colonial Heights, and Petersburg.

Proposed plans for the Fall Line Trail through the study area include:

1. **Lakeside Community Trail Phases 1–3 (1.6 miles) from Spring Park to Hilliard Road**
2. **Brook/Hilliard Road Diet (0.5 miles) from Belmont Golf Course to Lakeside Avenue**
3. **Villa Park Phase (1.1 miles) from Lakeside Boulevard to E. Parham Road**
4. **Longdale Trail (3.2 miles) from E. Parham Road to Woodman Road Extension**

Figure 33. Proposed Fall Line Trail

Source: Falllineva.org

6.0 TRANSIT FACILITIES

Nine Greater Richmond Transit Company (GRTC) routes operate along various corridors in the Staples Mill Road study area. Seven of these GRTC routes are local, and two are express routes.

6.1 Route Descriptions

Five local routes serve stops on Brook Road. One local route serves stops on W. Broad Street. One local route and two express routes serve stops on Staples Mill Road.

Brook Road Routes

Five local GRTC routes serve stops on Brook Road on the east side of the study area. These routes serve a stop north of Dumbarton Road/Azalea Avenue near Brookhill Azalea Shopping Center:

- Route 1A: Chamberlayne/Hull/Midlothian
- Route 1B: Chamberlayne/Hull/Warwick
- Route 1CL Chamberlayne/Hull/Elkhardt
- Route 14: Hermitage/East Main
- Route 93: Azalea Connector

Route 93 also serves stops on Brook Road north of I-95 near Brook Run Shopping Center and The Atlantic at Brook Run Apartments.

W. Broad Street Route

One local GRTC route serves stops along W. Broad Street on the west side of the study area. Route 19: Pemberton connects Short Pump in Henrico County to the west side of the study area and Monument Avenue Park and the Pulse Bus Rapid Transit (BRT) line in Richmond.

Staples Mill Road Routes

One local route and two express routes serve stops on Staples Mill Road between Dumbarton Road and E. Parham Road:

- Route 18: Henrico Government Center
- Route 23x: Glenside/Parham Express
- Route 27x: Glenside Express

Route 18 connects Henrico Government Center to the Pulse BRT line in Richmond.

Express Routes 23x and 27x historically provided express service between downtown Richmond and park-and-rides in Henrico County (Parham Road Park & Ride and Glenside Park & Ride). Both express routes were consolidated in September 2021 with Express Route 29x in response to ongoing ridership changes related to the COVID-19 pandemic.[2] Route 29x does not stop in the study area but connects the Gaskins Road Park & Ride located northwest of the study area to downtown Richmond.

The following section provides a brief description of the pre-pandemic (i.e., 2019) alignment, frequency, and service span for each GRTC route that interacts with Staples Mill Road. It also provides a summary of pre-pandemic (i.e., 2019) ridership along Staples Mill Road.

[2] http://ridegrtc.com/news-initiatives/news-updates/grtc-service-updates-september-12-2021

6.2 Route Ridership

The three GRTC routes that provide transit service along Staples Mill Road between E. Parham Road and the I-64 interchange include:

- Route 18: Henrico Government Center (local)
- Route 23x: Glenside/Parham Express
- Route 27x: Glenside Express

Table 7 details each route's level of service. **Figure 34** illustrates the routes that operate on and intersect with Staples Mill Road. It also shows average weekday stop-level ridership data between March 2019 and May 2019 (boardings and alightings).

The sections below provide an overview of each route that operates along the corridor.

Route 18: Henrico Government Center

Route 18 connects residents to the government offices located primarily west of Staples Mills Road. This route also serves Dumbarton Shopping Center and Staples Mill Shopping Center within the study area.

Route 18 provides service on weekdays only, with buses arriving every 60 minutes during all service hours. Route 18 serves 11 GRTC stops on the Staples Mill Road corridor between E. Parham Road and I-64.

Route 23x: Glenside/Parham Express

Route 23x offers limited-stop express service from downtown Richmond to park and rides in Henrico County during weekday peak hours only.

Route 23x buses arrive every 65 minutes during weekday peak hours. Route 23x serves three GRTC stops on Staples Mill Road between Glenside Drive/Hilliard Road and I-64.

Route 27x: Glenside Express

Route 27x offers express service from downtown to park-and-rides during weekday peak hours only.

Route 27x buses generally arrive every 70 minutes during weekday peak hours. Route 27x serves six GRTC stops on Staples Mill Road between Glenside Drive/Hilliard Road and I-64. Route 27x and 23x follow similar alignments to provide more frequent express service.

Average Weekday Ridership

The three routes that operate along Staples Mill Road serve stops between I-64 and Glenside Road/Hilliard Drive. Route 18 serves additional stops on Staples Mill Road between Glenside Road/Hilliard Drive and E. Parham Road. **Figure 34** shows average weekday boardings and alightings at Staples Mill Road transit stops.

Staples Mill Road transit stops generally have fewer transit riders than other stops in the study area, including the Glenside Park & Ride Lot and several transit stops on W. Broad Street and Brook Road (**Table 9**).

Table 7. Service Characteristics of Staples Mill Road GRTC Bus Routes

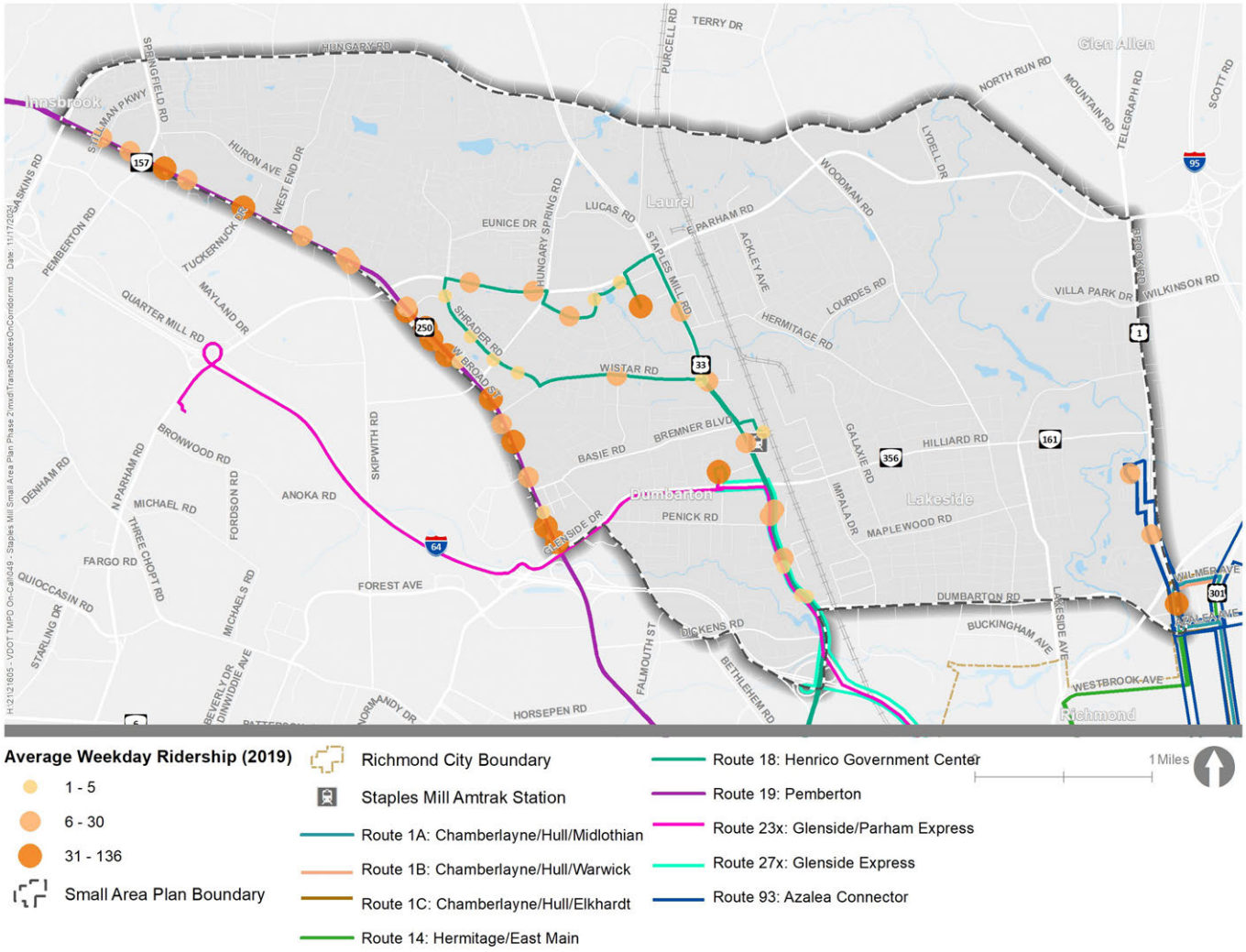
Route #	Route extents within Staples Mill Road study area			Weekday		Saturday		Sunday/Holiday	
				Daytime/ Morning	Afternoon	Daytime	Evening	Daytime	Evening
18	I-64 interchange	E. Parham Road	Service Span	6:30 a.m. to 7:27 p.m.		No service	No service	No service	No service
			Headway (min)	60					
23x	I-64 interchange	Hilliard Road/Glenside Drive	Service Span	5:28 p.m. to 6:08 p.m.		No service	No service	No service	No service
			Headway (min)	From Downtown to Park & Ride Lots during weekday peak hours only					
27x	I-64 interchange	Hilliard Road/Glenside Drive	Service Span	6:55 a.m. to 8:25 a.m.	4:00 p.m. to 4:55 p.m.	No service	No service	No service	No service
			Headway (min)	70	55				

Source: Greater Richmond Transit Company, Kittelson 2021

Table 8. Average Weekday Ridership at Study Area Bus Stops (2019)

Stop Number	Location	Average Weekday Ridership
2008	Glenside & Cloverdale (Parking Lot)	136
429	Broad & Glenside	52
408	Broad & Cardinal	51
3464	Brook & Walmart Neighborhood Market	49
420	Broad & Emerywood	48
1328	Henrico Human Services	32
3529	Broad & Springfield	24
409	Broad & Carousel	24
488	Broad & Tuckernuck	23
426	Broad at Fountain Square	21
422	Broad & Enterprise	19
481	Broad & Sunnybrook	19
3764	Broad & Stillman	13
491	Broad at Westland Shopping Center	13
3583	Atlantic at Brook Run Apartments	12
437	Broad & Homeview	12
394	Broad & Bethlehem	12
410	Broad & Carousel	11
479	Broad & Sundance	10
3810	Prince Henry at Henrico Government Center	10
496	Broad & Wistar	10
3802	Staples Mill & Wistar	9
3763	Broad & Springfield	9
3803	Staples Mill & Heisler	8
2203	Staples Mill & Aspen	8
3806	Wistar & Wistar Village	7
2202	Staples Mill & Amtrak	7
1993	Parham & Health South Hospital	7
471	Broad & Skipwith	6
3584	Brook & Brook Run	6
1996	Parham & Hungary Spring	6
2220	Staples Mill & Talley	6
2219	Staples Mill & Talley	5
472	Broad & Skipwith	5
3813	Staples Mill & Amtrak Richmond Station	5
2222	Staples Mill & Townhouse	5
1246	Henrico Juvenile and Domestic Relation Courts	4
3805	Shrader & Cardinal	3
3809	Prince Henry at Administration Building	3
2214	Staples Mill & Northside	2
2213	Staples Mill & Hamlet Apt	2
421	Broad & Enterprise	1
3527	Broad & Deep Run	1
3812	Shrader & Hungary Spring	1
3801	Wistar & Staples Mill	1
3811	Shrader & Carousel	1
3804	Shrader & Enterprise	1

Figure 34. Transit Route and Ridership Information



Source: Greater Richmond Transit Company, Kittelson 2021

6.3 Transit Facilities

The study area includes 47 transit stops, 11 of which are located on Staples Mill Road. The remaining 36 stops are primarily located along the western boundary study area (i.e., W. Broad Street) and serve shopping centers such as Costco, Fountain Square Shopping Mall, Merchant's Walk, Sam's Club/Kroger/Lowe's, Tuckernuck Plaza, and Tuckernuck Square Shopping Center. **Table 9** and **Table 10** summarize bus stop siting and amenity characteristics for GRTC stops on Staples Mill Road.

Table 9. Staples Mill Road Bus Stop Characteristics—Siting

Nearest Crossing Opportunity	
Intersection	10 (91%)
Parking lot	1 (9%)
Nearest Intersection is Signalized	
Yes	5 (45%)
No	5 (45%)
Parking lot	1 (10%)
Bus Stop Position	
Curb	10 (91%)
Parking lot curb	1 (9%)
Bus Stop Position	
Far side	3 (27%)
Mid-block	1 (9%)
Near side	6 (55%)
Parking lot curb	1 (9%)

Source: Kittelson 2021

As seen in **Table 9**, passengers at these stops often wait alongside traffic moving 45 mph or faster, as most stops are located on the curb or along narrow, substandard sidewalks (**Figure 35**).

Figure 35. Substandard Sidewalk with Loose Gravel

At almost half of all Staples Mill Road stops (45%), the nearest opportunity to cross the corridor is not at a signalized crossing. Even signalized crossings have poor facilities, shown in **Figure 36**, where a signal exists but a crosswalk does not. As shown in **Table 10**, nearly all bus stops on the corridor have neither lighting, seating, nor shelter.

Table 10. Staples Mill Road Bus Stop Characteristics – Amenities

Characteristic	Yes (% of corr. stops)	No (% of corr. stops)
Lighting	3 (27%)	8 (73%)
Shelter	0 (0%)	11 (100%)
Seating	1 (10%)	10 (90%)
Trash can	2 (18%)	9 (82%)

Characteristic	Yes (% of corr. stops)	No (% of corr. stops)
Bike rack	2 (18%)	9 (82%)
Route schedule/map information posted	0 (0%)	11 (100%)
Wheelchair obstacle[1]	7 (64%)	4 (36%)
Not near a sidewalk[2]	0 (0%)	11 (100%)
Stop doesn't connect to the sidewalk[2]	0 (0%)	11 (100%)

Source: Kittelson 2021

[1] Obstacles include utility pole blocking sidewalk and lack of ADA-accessible curb ramps or sidewalks

[2] A bus stop is "near a sidewalk" if it is within 20 feet of a sidewalk.

In general, transit stops along the Staples Mill Road corridor present challenges for wheelchair accessibility, such as lack of accessible curb ramps, shown in **Figure 37.**

Figure 36. Challenges for Wheelchair Accessibility

Seven of 11 corridor bus stops (64%) have obstacles impeding access by wheelchair users.

The corridor bus stops that do have ADA accessible curb ramps do not have marked crosswalks (**Figure 37**).

Figure 37. ADA Accessible Curb Ramps

Although all corridor bus stops are located near or connected to a sidewalk, transit riders do not have a safe means to cross Staples Mill Road to access bus stops or destinations across the road from bus stops (**Figure 38**).

Figure 38. Staples Mills Road Bus Stop with Sidewalk Access and without a Marked Crosswalk (Staples Mill & Amtrak, stop ID 2202)

6.4 Proposed Transit Facilities

While there are some gaps in the existing transit system, ConnectRVA outlines future projects that will expand and enhance transit service in the Richmond region. The constrained plan outlined in ConnectRVA includes over $400 million dollars allocated for transit projects. Transit projects outlined in the plan include bus rapid transit, enhanced transit, and a new transit transfer center.

Plans for bus rapid transit would build on the existing 7.6 miles of The Pulse BRT located in Downtown Richmond. The plans include a 15.7-mile dedicated transit route from Downtown Richmond to Ashland along US-1, as shown in **Figure 39**.

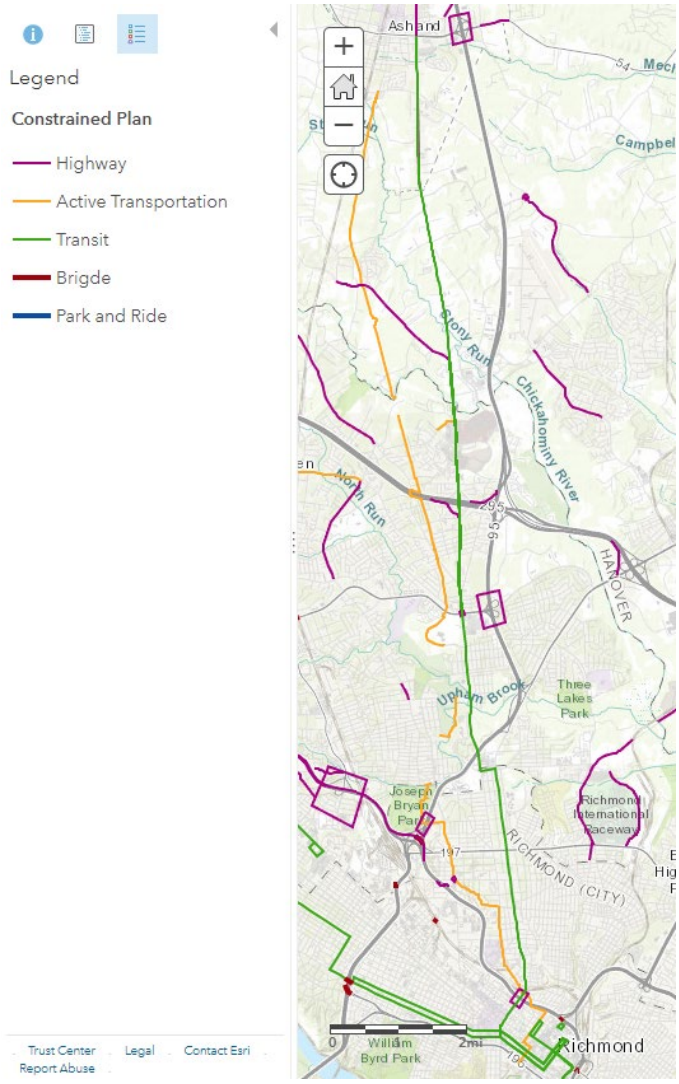
This project was selected based on its total score for each goal outlined in ConnectRVA:

- **Safety**
- **Mobility**
- **Equity and Accessibility**
- **Economic Development**
- **Environmental/Land Use**

The project ranked highest for the safety and equity/accessibility goals. The project is anticipated to cost approximately $54 million dollars and is slated for implementation in the fiscal year term 2028-2033.

This project would run along the study area's eastern boundary and could influence travel to, from, and throughout the area. The BRT plans would significantly enhance access to both Ashland and Downtown Richmond from the study area.

Figure 39 ConnectRVA Bus Rapid Transit Plans on US-1



7.0 SAFETY

This section summarizes the approach and findings of the crash analysis. The material below discusses study area crash patterns and trends; network screening; and the systemic safety evaluation.

7.1 Key Findings

Crash Patterns and Trends

- Nearly all (88%) of crashes were intersection crashes.
- Over three quarters of reported crashes were angle crashes (41% - 1,584 crashes) and rear end crashes (38% - 1,488 crashes).
- Injuries and fatalities accounted for 30% of reported crashes (1,171 crashes).

The following crash types exhibited higher proportions of fatalities and/or injuries than other reported crash types:

- Angle crashes (33%, or 522 crashes, resulting in fatality or injury)
- Head on crashes (59%, or 48 crashes, resulting in fatality or injury)
- Pedestrian crashes (100%, or 64 crashes, resulting in fatality or injury)

Network Screening and Systemic Findings

- The roadway network was screened using (1) the Equivalent Property Damage Only (EPDO) safety performance measure and (2) a risk-based analysis to determine roadway characteristics potentially associated with high crash locations.
- The EPDO performance measure identifies locations that have exhibited a combined greater severity and frequency of crashes than other locations. It gives more weight to locations at which more severe crashes have occurred.

KEY TERMS>>

- **Network Screening—**Evaluating the entire street network to identify high-crash locations based on number of crashes, severity of crashes, and traffic volume.
- **Systemic Analysis—**Identifying common characteristics associated with high-crash locations and prioritizing locations based on common characteristics and crash history.

Common characteristics of high-crash intersections identified through the systemic analysis included:

- High-speed (45 mph or more) streets intersecting with lower speed (40 mph or less) streets
- High-speed (45 mph or more) streets intersecting with high-speed (45 mph or more) streets
- Wide (5 or more lanes) streets intersecting with narrower (4 or fewer lanes) streets
- High volume (10,000 or more ADT) streets intersecting with high volume (10,000 or more ADT) streets
- High volume (10,000 or more ADT) streets intersecting with mid- to low-volume (9,000 or fewer ADT) streets
- Interstate on- and off-ramps near the approaches to the intersection
- Commercial entrance or minor residential drive on one approach to the intersection
- Horizontal curves on intersection approaches
- Skewed intersection geometry
- Offset opposing streets on minor intersection approaches
- No marked crossings for pedestrians

Common characteristics of high-crash segments identified through the systemic analysis included:

- High posted speeds (45 or more mph)
- Wide roadway cross-sections (5 or more lanes)
- Very high volumes (20,000 or more ADT)
- Frequent driveways/curb cuts
- Horizontal curves

The following priority locations were identified:

- W. Broad Street/Gaskins Road (#1)
- W. Broad Street/Pemberton Road/Springfield Road (#2)
- W. Broad Street/West End Drive/Commercial Entrance (#3)
- W. Broad Street/N. Parham Road/E. Parham Road (#4)
- W. Broad Street/Hungary Spring Road (#5)
- W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)
- W. Broad Street/Glenside Drive (#7)
- Staples Mill Road/Hungary Road (#8)
- Staples Mill Road/Hungary Spring Road (#9)
- Staples Mill Road/E. Parham Road (#12)
- Staples Mill Road/Hermitage Road/Commercial Entrance (#13)
- Staples Mill Road/Wistar Road (#14)
- Staples Mill Road/Hilliard Road/Glenside Drive (#18)
- Staples Mill Road/Dumbarton Road/Wharfside Road (#20)
- Staples Mill Road/Dickens Road/Entrance to Comcast (#21)
- Brook Road/Hilliard Road/Hilliard Avenue (#23)
- Brook Road/Dumbarton Avenue/Azalea Avenue (#24)
- Springfield Road/Gaskins Road/Hungary Road (#25)
- Hungary Road/Woodman Drive (#27)
- E. Parham Road/Hungary Spring Road (#28)
- E. Parham Road/Woodman Road (#29)
- Glenside Drive/Bethlehem Road (#30)
- Lakeside Avenue/Dumbarton Road (#34)

7.2 Study Area Crash Patterns and Trends

The following section presents study area crash trends and patterns. Findings from this section will be used to inform considerations for countermeasures and multimodal transportation solutions that could be effective in the study area.

Data and Approach

The most recent five years of complete crash data available for study streets in the study area were obtained and analyzed from VDOT's database. The crash data came from January 1, 2016 to December 31, 2020, and there were 3,865 reported crashes in this period. The location data were used to geocode and map the crashes in GIS software.

Findings

Crash patterns and trends in the corridor data were identified by evaluating the following:

1. **Crash severity**
2. **Crash type**
3. **Lighting**
4. **Weather condition**
5. **Year**

Most of the crashes in the study area were intersection crashes (3,417 crashes – 88%). Just 12% of study area crashes (448 crashes) were segment crashes.

Severity

Table 11 summarizes the reported crashes by severity. Injury crashes are organized by severe injuries, other visible injuries, and injuries involving a complaint of pain but no visible injury.

- More than two-thirds (70 percent) of crashes recorded resulted in property damage only.
- 21 (1 percent) crashes resulted in a fatality, and 99 crashes (2 percent) resulted in severe injury.

Table 11. Crash Severity, January 2016–December 2020

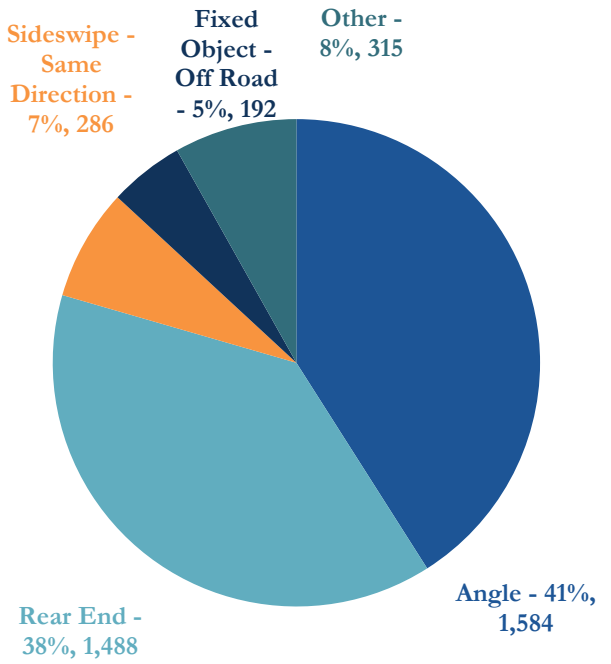
Crash Severity	Crash Count
Fatal	21 (1%)
Injury (severe)	99 (2%)
Injury (other visible)	976 (25%)
Injury (complaint of pain)	75 (2%)
Property damage only (PDO)	2,694 (70%)

Source: VDOT, Kittelson 2021.

Crash Type

Figure 40 identifies the crash types of the reported crashes. In the five years of data analyzed, less than three percent of reported crashes involved pedestrians (69 crashes) and bicyclists (25 crashes). The rest of the reported crashes involved motor vehicles or motor vehicles and other objects. Angle and rear-end were the top two crash types.

Figure 40. Vehicle Crash Types, January 2016–December 2020



* "Other" includes Head On (81), Pedestrian (64), Other (59), Fixed Object (32), Sideswipe – Opposite Direction (23), Deer (21), Non-Collision (16), Backed Into (13), Other Animal (6). The 25 bicycle crashes are included in the other crashes types: rear end (5), angle (12), head on (4), and other (4).

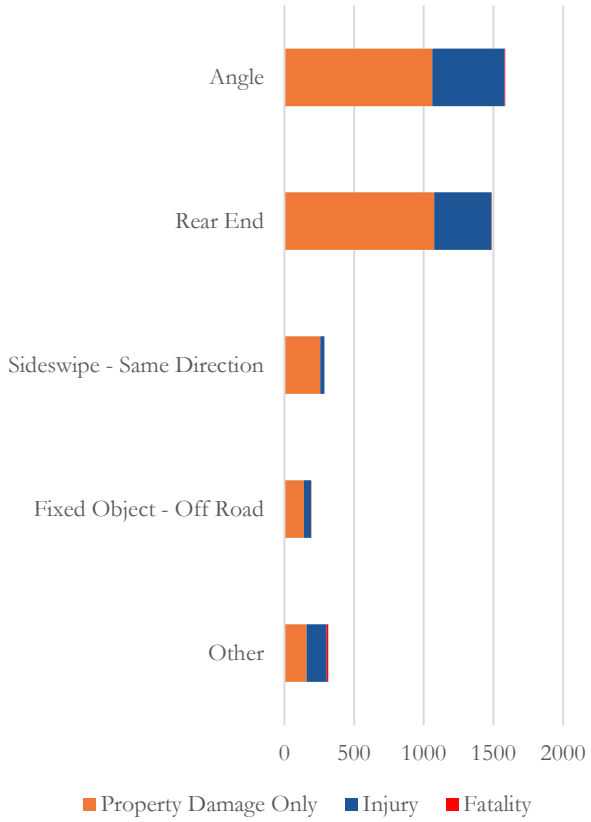
Source: VDOT, Kittelson 2021.

- Angle (41 percent) and rear end (38 percent) crashes represent the largest proportions of crash types, and more than half of all crash types

Figure 41 summarizes reported crashes by crash type and severity. Three crash types had a higher proportion of injuries or fatalities than exhibited in total reported crashes for the study area (30 percent all crashes resulted in injury or fatality).

- Of 1,584 angle crashes, 33 percent resulted in injury or fatality.
- Of 81 head on crashes, 59 percent resulted in injury or fatality.
- Of 64 pedestrian crashes, 100 percent resulted in injury or fatality.

Figure 41. Reported Crashes by Crash Type and Severity, January 2016–December 2020



* "Other" includes Head On (81), Pedestrian (64), Other (59), Fixed Object (32), Sideswipe – Opposite Direction (23), Deer (21), Non-Collision (16), Backed Into (13), Other Animal (6).

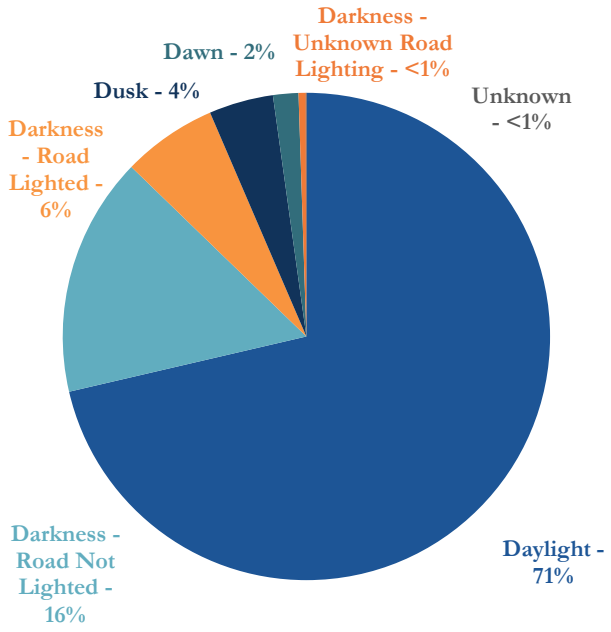
Source: VDOT, Kittelson 2021.

- Of 64 total pedestrian crashes, 12 (19 percent) resulted in a fatality. This is a much higher proportion of fatalities than exhibited in total reported crashes for the study area (1 percent of study area crashes resulted in a fatality).
- Of 25 total bicycle crashes, 1 (4 percent) resulted in a fatality and 23 (92 percent) resulted in injury. This is a much higher proportion of fatalities than exhibited in total reported crashes for the study area (1 percent of study area crashes resulted in a fatality).

Lighting

Figure 42 displays the study area crash count by reported lighting condition.

Figure 42. Percent of Reported Crashes by Lighting, January 2016–December 2020



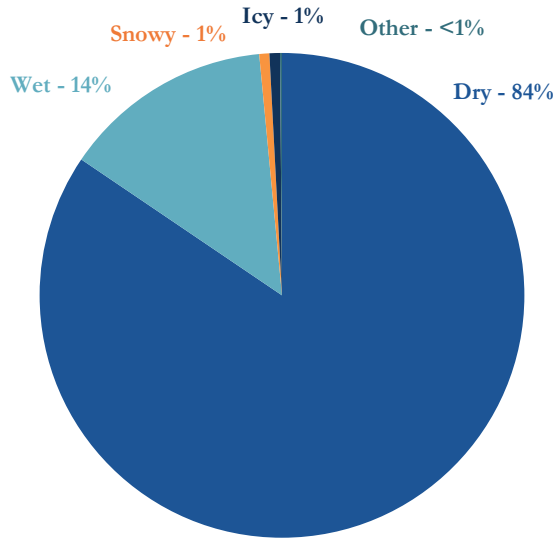
Source: VDOT, Kittelson 2021.

- The majority of crashes (71 percent) occurred under daylight conditions.
- Of the crashes that occurred in dark conditions, more crashes occurred in locations without street lights (16 percent).
- Injury crashes that occurred under dark conditions (33 percent) were slightly overrepresented compared to all crashes (31 percent).

Roadway Surface Condition

Figure 43 displays the study area crash count by reported roadway surface condition. The majority of crashes (84 percent) occurred under dry conditions.

Figure 43. Crashes by Roadway Surface Condition, January 2016–December 2020



Source: VDOT, Kittelson 2021.

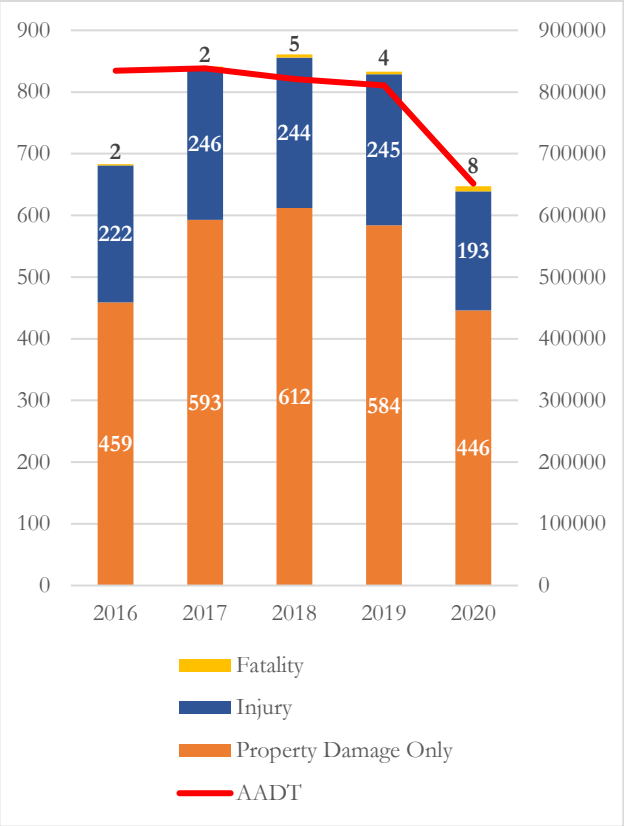
Crash Year

Figure 44 summarizes the crash count and severity of crashes by year.

- 2018 had the highest crash count (861).
- The number of annual crashes has generally increased since 2016.

However, the number of crashes decreased in 2020 as a result of restricted travel associated with the COVID-19 pandemic. There was a higher percentage of fatal crashes in 2020 than in the previous four years. A more detailed review is recommended, but the increase in fatal crashes could be attributed to a reported increase in speeding during the pandemic.

Figure 44. Crashes by Year, January 2016 – December 2020



Source: VDOT, Kittelson 2021.

Districtwide Ranking

Using the latest *Highway Safety Manual (HSM)* methods, a roadway network screening process identifies intersections and segments with potential for safety improvement (PSI). Comparisons of actual- to predicted-crash frequencies are used in network screening to provide district engineers with a list of top 100 intersections and top 100 miles of roadway segments drawn from those locations that are above the Safety Performance Function (SPF). The most recent years three years of crash data is used to calculate the PSI. The PSI is the expected number of crashes for the site minus the predicted number of crashes based on the SPF for that facility type. As with SPFs, the PSI is calculated for total crashes and fatal plus injury crashes. A site with a positive PSI warrants examination, and those with highest PSI values should be considered high priority.[3]

This comparison allows cities and counties to identify local hot spots relative to peers. A number one ranking indicates the worst performer relative to other peers in the group. Intersections or segments that have a positive PSI value in three or more years are further highlighted as target safety need (TSN) locations. This section presents relevant PSI and TSN rankings between 2016 and 2020.

Eight intersections in the study area were highlighted as PSI intersections, as shown in **Figure 45**:

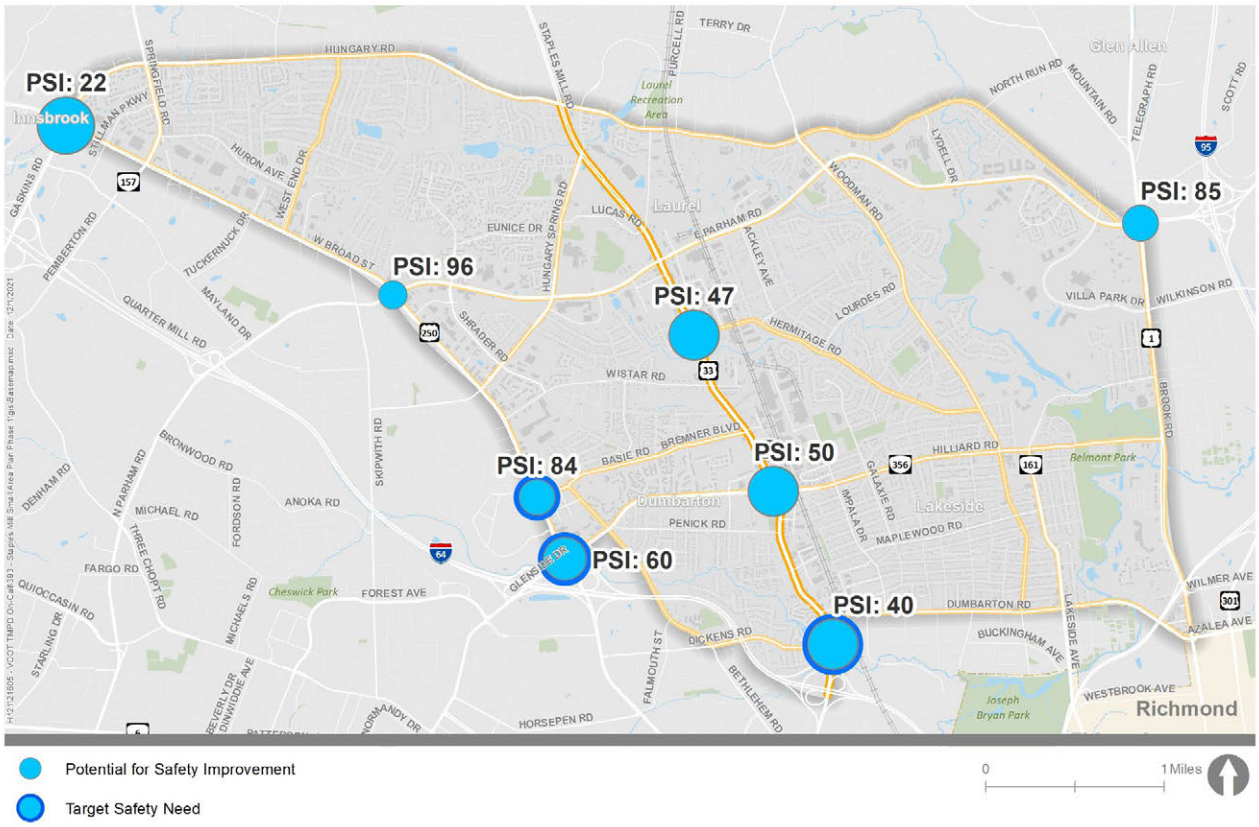
- W. Broad Street and Gaskins Road (District PSI Rank: 22; TSN: Yes)
- Staples Mill Road and Dickens Road (District PSI Rank: 40; TSN: Yes)
- Staples Mill Road and Hermitage Road (District PSI Rank: 47; TSN: No)
- Staples Mill Road and Dumbarton Road (District PSI Rank: 50; TSN: No)
- W. Broad Street and Glenside Road (District PSI Rank: 60; TSN: Yes)
- W. Broad Street and Bethlehem Road (District PSI Rank: 84; TSN: No)
- Brook Road and E. Parham Road (District PSI Rank: 85; TSN: No)
- W. Broad Street and E. Parham Road (District PSI Rank: 96; TSN: No)

There are five study streets with PSI segments, as shown in **Figure 46**:

- W. Broad Street
- Staples Mill Road
- Brook Road (Route 1)
- E. Parham Road
- Glenside Drive/Hilliard Road

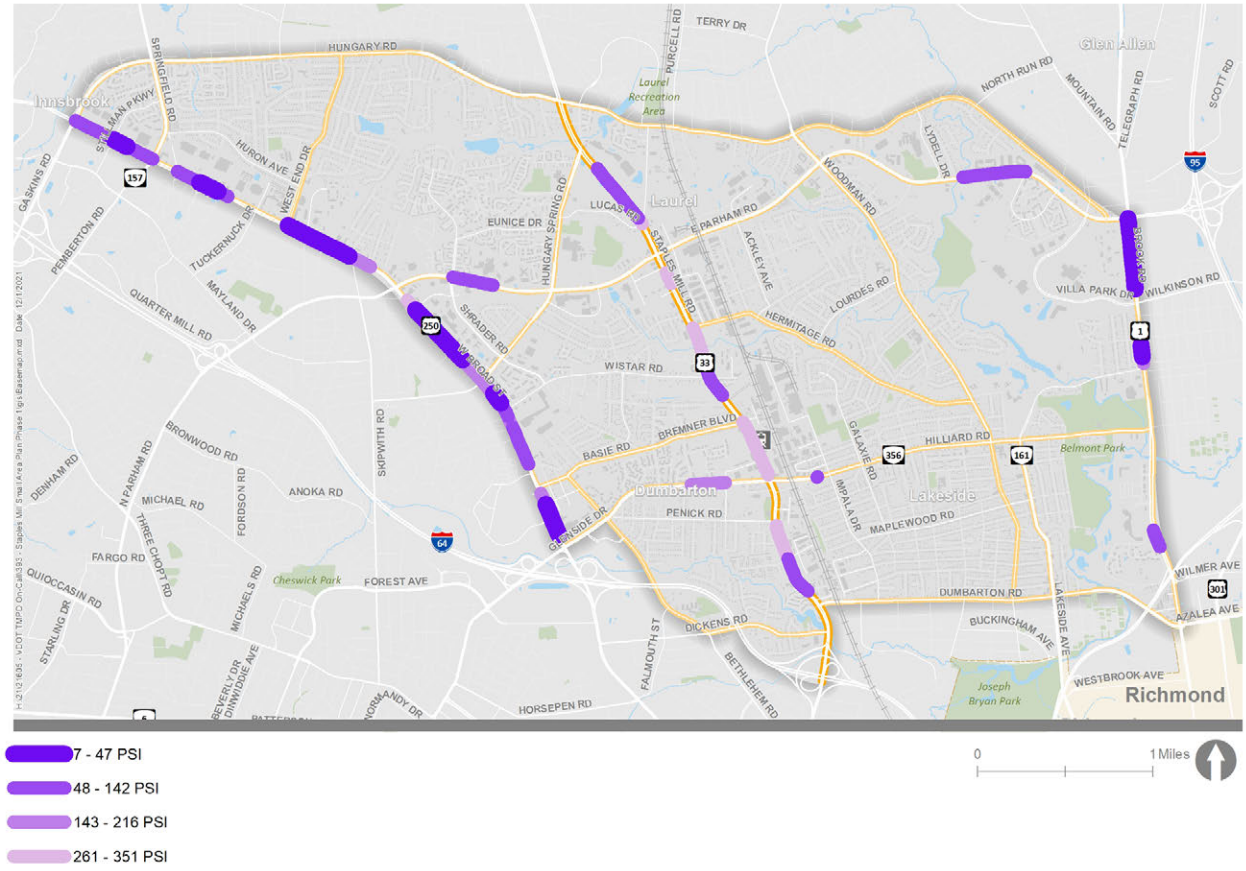
[3] https://safety.fhwa.dot.gov/hsip/reports/pdf/2017/va.pdf

Figure 45. Potential for Safety Improvement (PSI) Intersections



Source: VDOT, Kittelson 2021.

Figure 46. Potential for Safety Improvements (PSI) Segments



Source: VDOT, Kittelson 2021.

7.3 Network Screening and Systemic Findings

This section describes the network screening and systemic evaluation of the study streets within the study area. This section first describes the data and approach used to screen the study area roadway network and identify potential systemic crash characteristics.

Data and Approach

The high-priority safety intersections were identified using the EPDO network screening performance measure from the HSM. The EPDO screening calculation was performed for all intersections along study streets in the study area. The EPDO performance measure is described below.

Equivalent Property Damage Only

The EPDO performance measure assigns weighting factors to crashes by severity relative to PDO crashes. The weighting factors used for the network screening are based on the crash costs by severity used for Caltrans' Highway Safety Improvement Program Benefit Calculator Tool. Crash costs vary based on location type: signalized intersection, unsignalized intersection, or roadway. The weights for each crash severity by location type are shown in **Table 12**.

Table 12. Crash Weights by Severity and Location Type

Crash Weights by Severity: Location Type	Signalized Intersection	Unsignalized Intersection
Fatal	126	200
Injury (Severe)	126	200
Injury (Other Visible)	10.86	10.86
Injury (Complaint of Pain)	6.13	6.13
Property Damage Only (PDO)	1	1

Source: Caltrans, Highway Safety Improvement Program Benefit Calculator Tool, 2016.

The weights generally reflect an order of magnitude difference between the societal costs of fatal and severe injury collisions and non-severe injury collisions. The weighting factors intentionally weigh fatal and severe injuries equally to recognize that the difference between a severe injury crash and a fatal crash is often more of a function of the individuals involved—therefore, both represent locations for priority improvements.

The crash weights vary by location type due to the relative costs associated with the crash severity at those location types. Hence, fatal or severe crashes at an unsignalized intersection result in more persons injured or more severely injured in a fatal or severe injury crash and as a result have a higher average cost than at a signalized intersection.

Reported crashes were first coded by severity. Crashes within 250 feet of an intersection were then spatially joined and summarized in ArcGIS to develop the total number of crashes by severity at each intersection. Where intersections were less than 500 feet from each other, crashes were

assigned to the nearest intersection. Crashes occurring more than 250 feet from an intersection were excluded from the intersection analysis.

The EPDO score for intersections was calculated by multiplying each crash severity total by its associated weight (by intersection type) and summing the results, using the following formula:

> EPDO Score = Fatal weight * # of fatal crashes + severe injury weight * # of severe injury crashes + other visible injury weight * # of other visible injury crashes + complaint of pain injury weight * # of complaint of pain injury weight crashes + PDO crashes

The EPDO score was then annualized by dividing the score by the number of years (five) of crash data used in the analysis.

Identifying Common Characteristics of High-Crash Intersections

A risk-based analysis of the priority locations identified through the intersection network screening was applied. In this instance, risk is defined as common traffic or physical characteristics shared by the priority intersections.

To determine common crash characteristics for intersections, the following roadway characteristics for priority sites were reviewed:

- Number of vehicle lanes
- Posted speed
- Median presence
- Driveway and curb cut presence
- Intersection control type
- Dedicated left- or right-turn lane presence
- Intersection geometry (e.g., presence of offset approaches or intersection skew, number of approaches)
- Presence of marked crosswalks

For the highest-scoring intersections, roadway characteristic data was collected through a review of aerial imagery and a field visit. This included assessing the number of approaches, shoulder widths, and turn lane configurations, among other items.

Consistent trends were identified across the priority locations that could be tied to a roadway characteristic. These were documented as common crash characteristics. Common characteristics of high-crash intersections are discussed in the findings section below.

Intersection Findings

After calculating the network screening performance measures, priority intersections were identified using the annualized EPDO scores. For intersection locations, the EPDO scores ranged from 0 (no crashes during the 5-year time frame analyzed) to 132.1. **Figure 47** shows the results of the EPDO scoring by quintile (top 20 percent of intersections to bottom 20 percent of intersections) for roadway intersection locations.

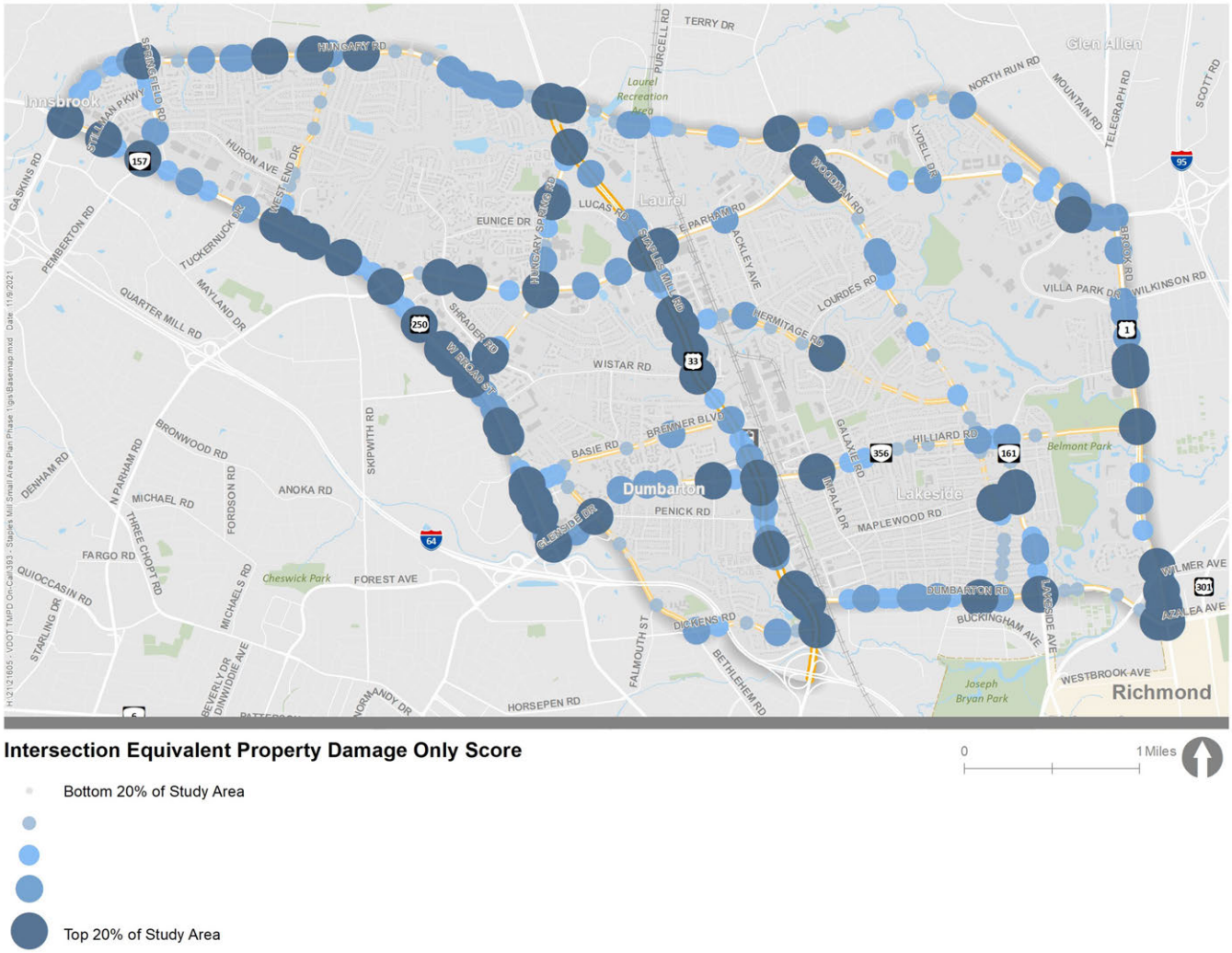
Of the 34 study intersections, 23 were identified as Tier 1 Intersections or intersections with EPDO scores in the top 20 percent of all intersections on study streets in the study area. A list of priority intersections was developed using the highest-scoring EPDO intersections. The complete list of study intersections is given, along with their corresponding EPDO scores, in **Table 13.**

Table 13. Intersection EPDO Scoring results

Study Intersection	Annualized Equivalent PDO Score	Tier 1 Intersection
Staples Mill Road/Hilliard Road/Glenside Drive (#18)	132.1	Yes
W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)	119.9	Yes
W. Broad Street/N. Parham Road/E. Parham Road (#4)	116.46	Yes
Glenside Drive/Bethlehem Road (#30)	106.52	Yes
W. Broad Street/Pemberton Road/Springfield Road (#2)	100.44	Yes
Springfield Road/Gaskins Road/Hungary Road (#25)	99.54	Yes
W. Broad Street/Glenside Drive (#7)	91.92	Yes
Staples Mill Road/Hungary Road (#8)	87.38	Yes
W. Broad Street/Gaskins Road (#1)	85.9	Yes
Staples Mill Road/Dickens Road/Entrance to Comcast (#21)	83.06	Yes
E. Parham Road/Hungary Spring Road (#28)	79.8	Yes
Hungary Road/Woodman Drive (#27)	69.3	Yes
Lakeside Avenue/Dumbarton Road (#34)	67.24	Yes
W. Broad Street/Hungary Spring Road (#5)	63.98	Yes
E. Parham Road/Woodman Road (#29)	58.92	Yes
W. Broad Street/West End Drive/Commercial Entrance (#3)	54.98	Yes
Staples Mill Road/Wistar Road (#14)	54.1	Yes
Brook Road/Hilliard Road/Hilliard Avenue (#23)	53.6	Yes
Staples Mill Road/Dumbarton Road/Wharfside Road (#20)	52.12	Yes
Staples Mill Road/Hermitage Road/Commercial Entrance (#13)	48.94	Yes
Staples Mill Road/E. Parham Road (#12)	47.68	Yes
Brook Road/Dumbarton Road/Azalea Avenue (#24)	47.32	Yes
Staples Mill Road/Hungary Spring Road (#9)	46.64	Yes
Brook Road/E. Parham Road (#22)	40.8	No
Staples Mill Road/Aspen Avenue/Townhouse Road (#19)	31.54	No
Hilliard Road/Hermitage Road (#31)	19.58	No
Staples Mill Road/Old Staples Mill Road/Lucas Road (#11)	17.66	No
Hungary Road/West End Drive (#26)	16.86	No
Lakeside Avenue/Hilliard Road (#32)	16.24	No
Staples Mill Road/Staples Mill Square Shopping Center (#10)	15.44	No
Staples Mill Road/Bremner Boulevard (#15)	15.26	No
Dumbarton Road/Hermitage Road/Westlake Avenue (#33)	14.24	No
Staples Mill Road/Crockett Street/Entrance to Dumbarton Square (#17)	12.08	No
Staples Mill Road/Amtrak Station (#16)	5.54	No

Source: VDOT, Kittelson 2021.

Figure 47. Intersection EPDO Scoring Results



Source: VDOT, Kittelson 2021.

Common Characteristics of High-Crash Intersections

Based on the review of the identified trends in roadway characteristics that were indicative of more crashes in the priority intersections, the following common characteristics were identified:

- Signalized intersections
- High-speed (45 mph or more) streets intersecting with lower speed (40 mph or less) streets
- High-speed (45 mph or more) streets intersecting with high-speed (45 mph or more) streets
- Wide (5 lanes or more) streets intersecting with narrower (4 lanes or fewer) streets
- High volume (10,000 ADT or more) streets intersecting with high volume (10,000 ADT or more) streets
- High volume (10,000 ADT or more) streets intersecting with mid- to low-volume (9 ADT or fewer) streets
- Interstate on- and off-ramps near the approaches to the intersection
- Commercial entrance or minor residential drive on one approach to the intersection
- Horizontal curves on intersection approaches
- Skewed intersection geometry
- Offset opposing streets on minor intersection approaches
- No marked crossings for pedestrians

Segment Findings

The same process was repeated to calculate the EPDO scores for the roadway segments. For segment locations, the EPDO scores ranged from 0 (no crashes during the 5-year time frame analyzed) to 140.1. **Figure 48** shows the results of the EPDO scoring by quartile (top 25 percent of segments to bottom 25 percent of segments) for roadway segments.

A list of priority segments was developed using the highest-scoring EPDO segments. The complete list of priority segments is given, along with their corresponding EPDO scores, in **Table 14**.

Table 14. Segment EPDO Scoring results

Segment	Annualized Equivalent PDO Score
E. Parham Road (Landmark Road to Sanctuary Drive)	140.1
Broad Street (Hollybrook Avenue to Wistar Road)	129.7
Staples Mill Road (Hungary Spring Road to Glenside Drive)	75.0
Broad Street (Gaskins Road to Skipwith Road)	66.3
Staples Mill Road (Penick Road to Dickens Road)	60.5
Springfield Road (Hungary Road to Broad Street)	54.0
E. Parham Road (Shrader Road to Staples Mill Road)	42.4
Brook Road (E. Parham Road to Hilliard Road)	41.3
Glenside Drive (Aspen View Drive to Impala Drive)	7.52
Hungary Road (Fairlake Lane to Danielsdale Drive)	5.54

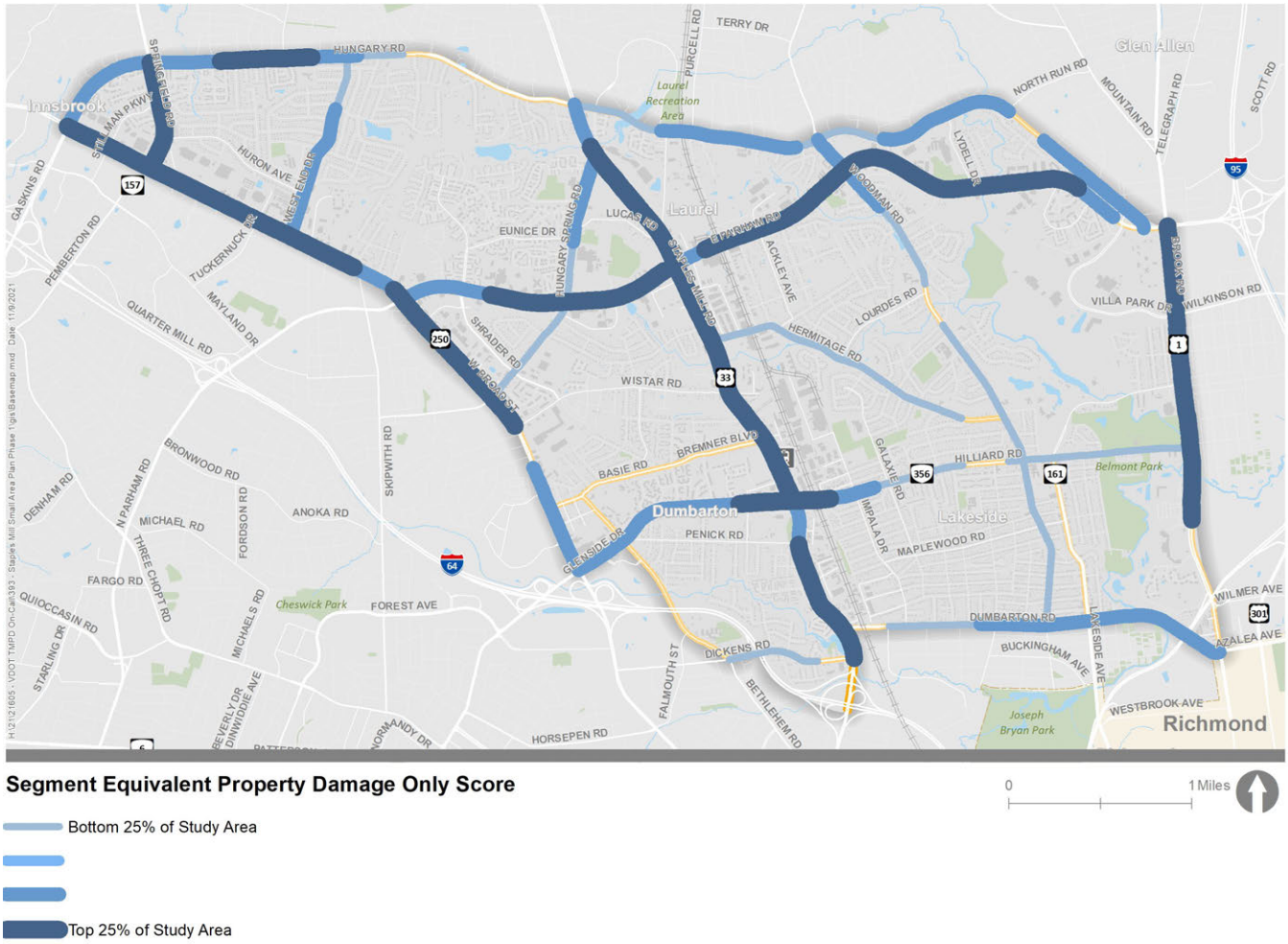
Source: VDOT, Kittelson 2021.

Common Characteristics of High-Crash Segments

Based on the review of the identified trends in roadway characteristics that were indicative of more crashes in the priority segments, the following common characteristics were identified:

- High posted speeds (45 mph or more)
- Wide roadway cross-sections (5 lanes or more)
- Very high volumes (20,000 ADT or more)
- Frequent driveways/curb cuts
- Horizontal curves

Figure 48. Segment EPDO Scoring Results



Source: VDOT, Kittelson 2021.

7.4 Priority Locations

Priority Intersections

Since most the crashes in the study area were intersection crashes (3,417 crashes, 88 percent), priority intersections were drawn from the network screening. The following 23 intersections were selected as priority locations because they had EPDO scores in the top 20 percent of intersections in the study area (**Figure 49**):

- W. Broad Street/Gaskins Road (#1)
- W. Broad Street/Pemberton Road/Springfield Road (#2)
- W. Broad Street/West End Drive/Commercial Entrance (#3)
- W. Broad Street/N. Parham Road/E. Parham Road (#4)
- W. Broad Street/Hungary Spring Road (#5)
- W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)
- W. Broad Street/Glenside Drive (#7)
- Staples Mill Road/Hungary Road (#8)
- Staples Mill Road/Hungary Spring Road (#9)
- Staples Mill Road/E. Parham Road (#12)
- Staples Mill Road/Hermitage Road/Commercial Entrance (#13)
- Staples Mill Road/Wistar Road (#14)
- Staples Mill Road/Hilliard Road/Glenside Drive (#18)
- Staples Mill Road/Dumbarton Road/Wharfside Road (#20)
- Staples Mill Road/Dickens Road/Entrance to Comcast (#21)
- Brook Road/Hilliard Road/Hilliard Avenue (#23)
- Brook Road/Dumbarton Avenue/Azalea Avenue (#24)
- Springfield Road/Gaskins Road/Hungary Road (#25)
- Hungary Road/Woodman Drive (#27)
- E. Parham Road/Hungary Spring Road (#28)
- E. Parham Road/Woodman Road (#29)
- Glenside Drive/Bethlehem Road (#30)
- Lakeside Avenue/Dumbarton Road (#34)

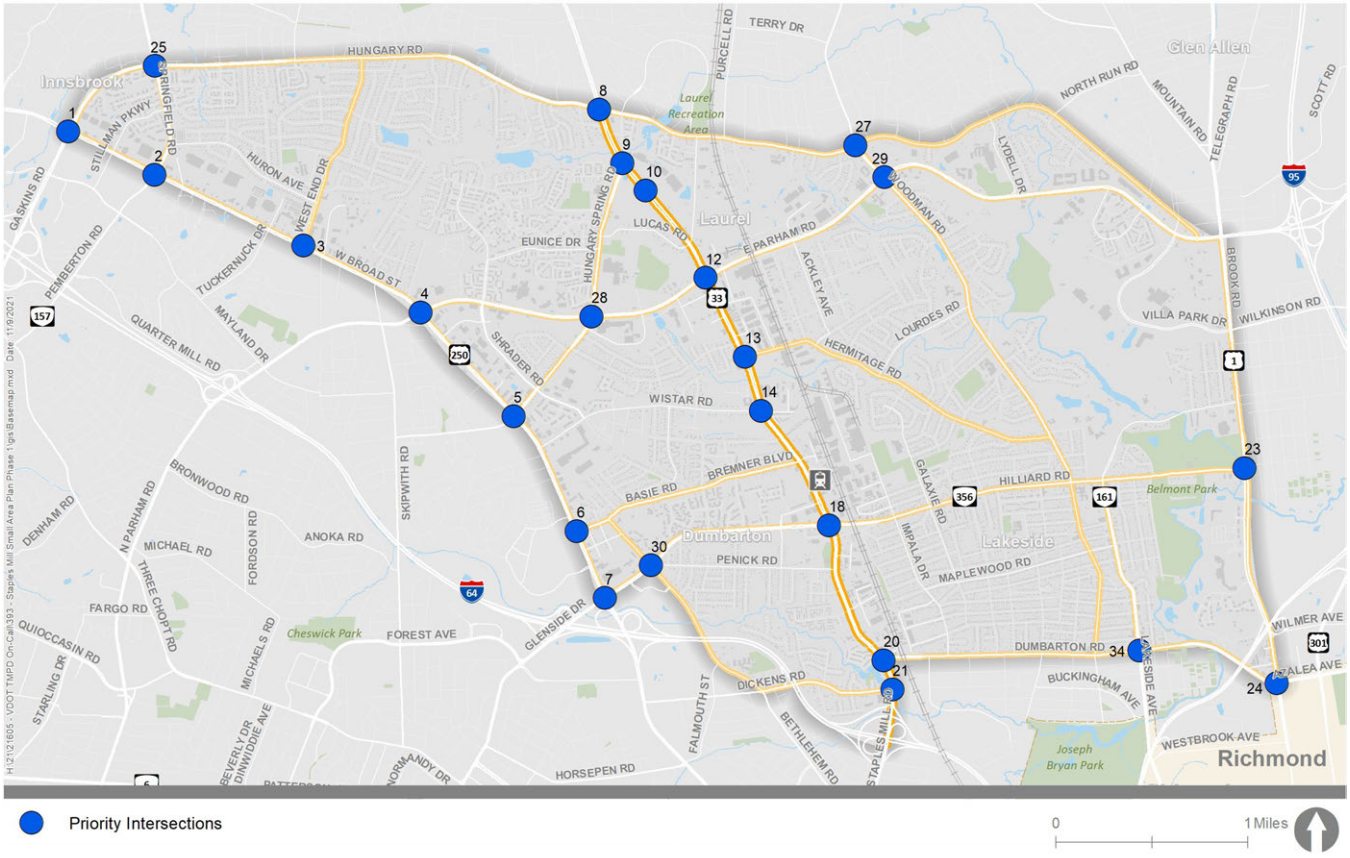
Location-Specific Analysis Approach

To help inform selection of the focus sites, the area-wide crash pattern and trends analysis was refined to focus on the individual priority intersections. This approach allows for a more nuanced understanding of how each priority intersection's safety performance varies across the study area. This refined understanding of the individual crash patterns and trends for each location will assist in developing a crash profile for each site that can be used to select appropriate safety treatments to improve safety performance.

This extraction process resulted in a focused crash data set of 1,137 priority intersection-related crashes. These 1,137 crashes at 23 intersections account for 29 percent of all reported crashes in the study area.

Of these 1,137 crashes, 33 were fatal or severe injury crashes, accounting for 28 percent of all reported fatal and severe injury crashes in the study area. More detailed summaries of key crash characteristics are discussed below.

Figure 49. Priority Intersection Locations



Source: Kittelson 2021

Priority Locations Findings

This section discusses crash trends at the priority intersections, highlighting notable differences between patterns in a specific intersection and the corridor-wide patterns previously discussed. The analysis includes the following considerations:

- Crash severity
- Crash type
- Crash lighting conditions
- Crash weather condition
- Crash year

Crash Severity

Table 15 summarizes reported crashes by priority intersection and severity.

- 21 of the 23 identified priority intersections have at least one fatal or severe injury crash.
- The intersection with the highest total number of crashes (Staples Mill Road and E. Parham Road) had 84 crashes between January 2016 and December 2020.

Crash Type

The most common crash types area-wide are the following:

1. **Angle crashes (42 percent)**
2. **Rear-end crashes (42 percent)—Typical for signalized intersections and/or corridors**

Figure 50 summarizes crash types at each of the priority intersections.

Rear end crashes represent a higher proportion of crashes compared to the area-wide average at four of the priority intersections:

- W. Broad Street and N. Parham Road/E. Parham Road
- Staples Mill Road and E. Parham Road
- Staples Mill Road and Hilliard Road/Glenside Road
- Brook Road and Hilliard Road/Hilliard Avenue

Angle crashes represent a higher proportion of crashes compared to the corridor-wide average at two of the priority intersections:

- W. Broad Street and Gaskins Road
- W. Broad Street and Glenside Drive

One or more pedestrian-involved crashes occurred at nine of the priority intersections:

- W. Broad Street and Pemberton Road/Springfield Road
- W. Broad Street and West End Drive/Commercial Entrance
- W. Broad Street and N. Parham Road/E. Parham Road
- W. Broad Street and Hungary Spring Road
- W. Broad Street and Bethlehem Road/Entrance to Volvo
- Staples Mill Road and Hungary Spring Road
- Staples Mill Road and Hermitage Road/Commercial Entrance
- Staples Mill Road and Hilliard Road/Glenside Drive
- Brook Road and Hilliard Road/Hilliard Avenue

One bicycle-involved crash occurred at three of the priority intersections:

- Staples Mill Road/Hungary Road
- Staples Mill Road/Dickens Road/Entrance to Comcast
- Springfield Road/Gaskins Road/Hungary Road

Crash Lighting Conditions

As already discussed, most crashes in the study area occur during daylight conditions. **Figure 51** summarizes crashes by lighting condition at each of the priority intersections.

Daylight crashes represented the highest proportion of crashes on the priority intersections.

Fourteen of the priority intersections had a higher proportion of dark condition crashes compared to the area-wide proportion:

- W. Broad Street/Gaskins Road
- W. Broad Street/Pemberton Road/Springfield Road
- W. Broad Street/West End Drive/Commercial Entrance
- W. Broad Street/Hungary Spring Road
- W. Broad Street/Bethlehem Road/Entrance to Volvo
- W. Broad Street/Glenside Drive
- Staples Mill Road/Hungary Road
- Staples Mill Road/Hungary Spring Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Hermitage Road/Commercial Entrance
- Staples Mill Road/Hilliard Road/Glenside Drive
- Springfield Road/Gaskins Road/Hungary Road
- Hungary Road/Woodman Drive
- E. Parham Road/Hungary Spring Road

Crash Roadway Surface Condition

As already reported, most crashes in the study area involved dry roadway surface conditions. **Figure 52** summarizes crashes by roadway surface condition at each of the priority intersections.

Dry roadway surface conditions characterized the highest proportion of crashes on the priority intersections.

Nine of the priority intersections had a higher proportion of wet (rain/snow/ice) condition crashes compared to the area-wide proportion:

- W. Broad Street/West End Drive/Commercial Entrance
- W. Broad Street/Glenside Drive
- Staples Mill Road/Hungary Road
- Staples Mill Road/Hungary Spring Road
- Staples Mill Road/E. Parham Road
- Staples Mill Road/Wistar Road
- Staples Mill Road/Dickens Road/Entrance to Comcast
- Brook Road/Hilliard Road/Hilliard Avenue
- E. Parham Road/Woodman Road

Crash Year

Figure 53 summarizes crashes by year at each of the priority intersections.

Crash Diagrams

Geocoded crash data from VDOT's database was used to develop crash diagrams for the 23 priority intersections. The crash diagrams will be used to inform the process for identifying potential safety countermeasures and capital improvements during upcoming project tasks.

The detailed crash diagrams can be found in **Attachment D.**

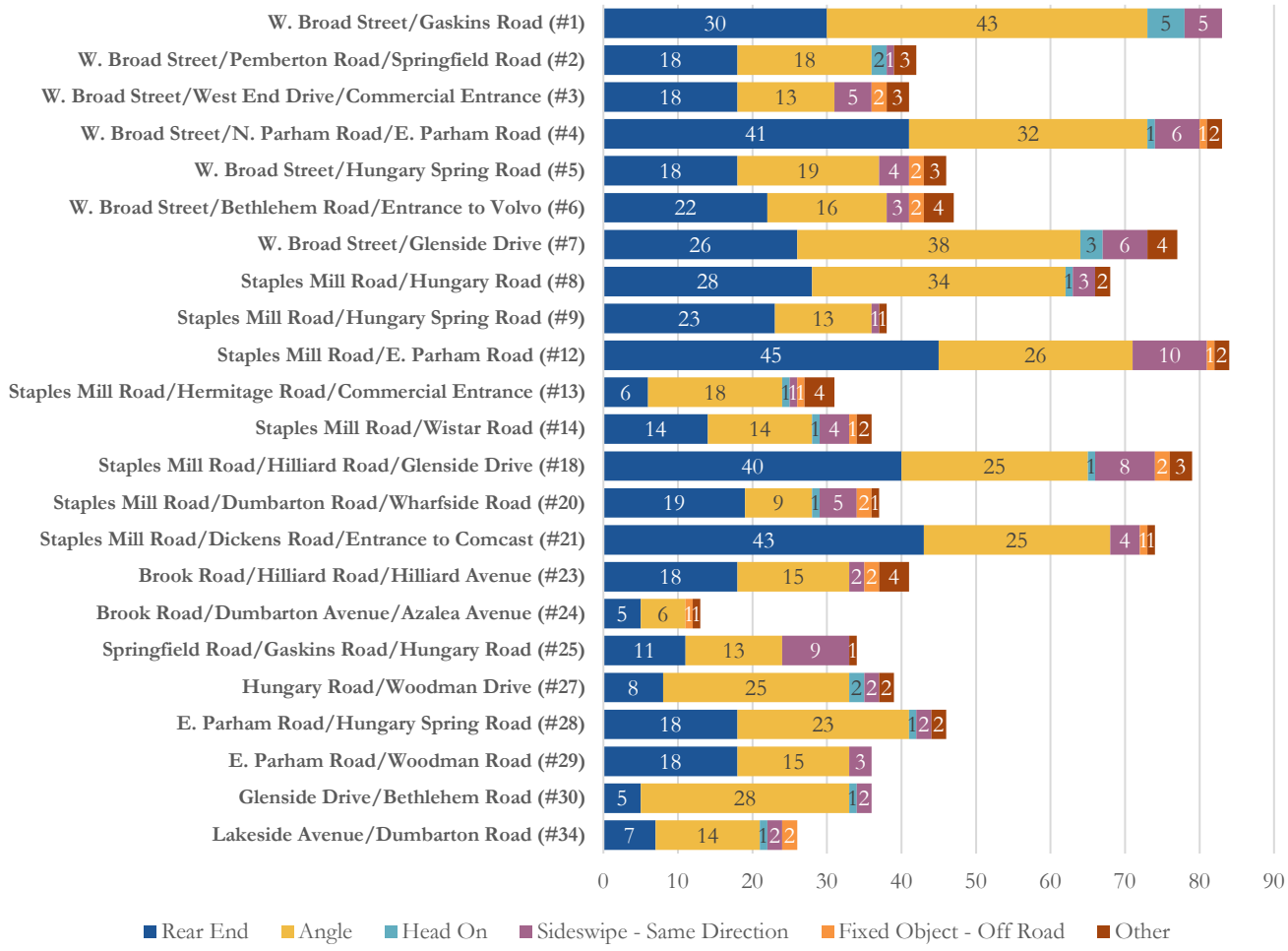
Table 15. Priority Locations Crashes by Intersection and Severity, January 2015 to December 2020

Intersection	Fatal Crashes	Severe Injury Crashes	Other Visible Injury Crashes	Complaint of Pain Injury Crashes	PDO Crashes	Total Crashes
W. Broad Street/Gaskins Road (#1)	0	0	34	2	47	83
W. Broad Street/Pemberton Road/Springfield Road (#2)	0	3	7	1	31	42
W. Broad Street/West End Drive/Commercial Entrance (#3)	0	1	10	2	28	41
W. Broad Street/N. Parham Road/E. Parham Road (#4)	0	2	23	4	54	83
W. Broad Street/Hungary Spring Road (#5)	0	1	15	0	30	46
W. Broad Street/Bethlehem Road/Entrance to Volvo (#6)	0	3	18	0	26	47
W. Broad Street/Glenside Drive (#7)	0	1	24	1	51	77
Staples Mill Road/Hungary Road (#8)	0	1	24	2	41	68
Staples Mill Road/Hungary Spring Road (#9)	0	1	8	1	28	38
Staples Mill Road/E. Parham Road (#12)	0	0	14	3	67	84
Staples Mill Road/Hermitage Road/Commercial Entrance (#13)	1	0	9	0	21	31
Staples Mill Road/Wistar Road (#14)	0	1	10	0	25	36
Staples Mill Road/Hilliard Road/Glenside Drive (#18)	1	2	21	2	53	79
Staples Mill Road/Dumbarton Road/Wharfside Road (#20)	0	1	10	0	26	37
Staples Mill Road/Dickens Road/Entrance to Comcast (#21)	0	1	21	2	50	74
Brook Road/Hilliard Road/Hilliard Avenue (#23)	1	0	8	2	30	41
Brook Road/Dumbarton Avenue/Azalea Avenue (#24)	0	2	3	0	8	13
Springfield Road/Gaskins Road/Hungary Road (#25)	1	2	9	0	22	34

Intersection	Fatal Crashes	Severe Injury Crashes	Other Visible Injury Crashes	Complaint of Pain Injury Crashes	PDO Crashes	Total Crashes
Hungary Road/Woodman Drive (#27)	0	1	11	0	27	39
E. Parham Road/Hungary Spring Road (#28)	0	1	14	1	30	46
E. Parham Road/Woodman Road (#29)	0	1	5	2	28	36
Glenside Drive/Bethlehem Road (#30)	0	2	10	0	24	36
Lakeside Avenue/Dumbarton Road (#34)	1	1	5	0	19	26

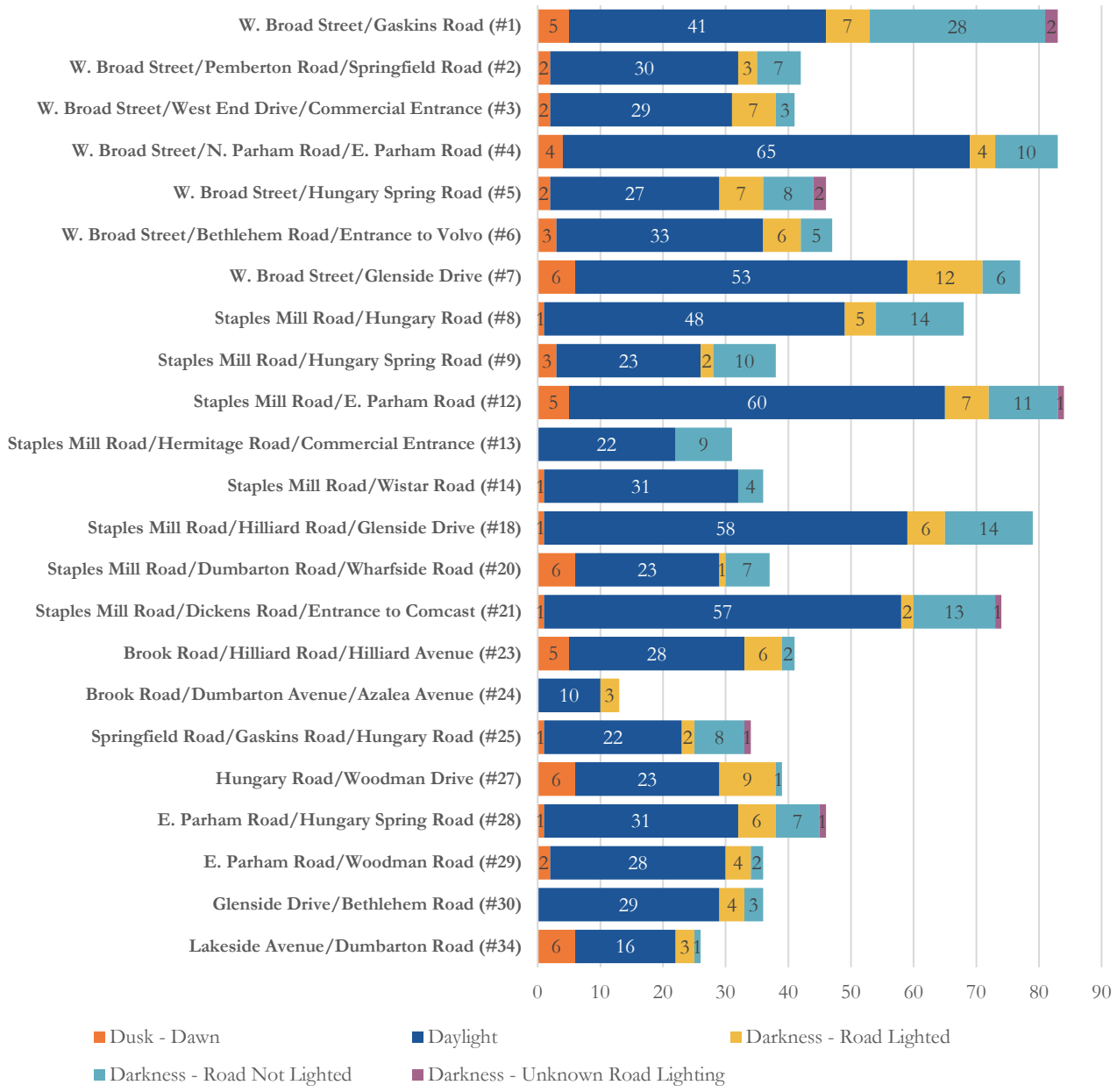
Source: VDOT, Kittelson, 2021.

Figure 50. Priority Locations Crash Type by Intersection, January 2015 to December 2020



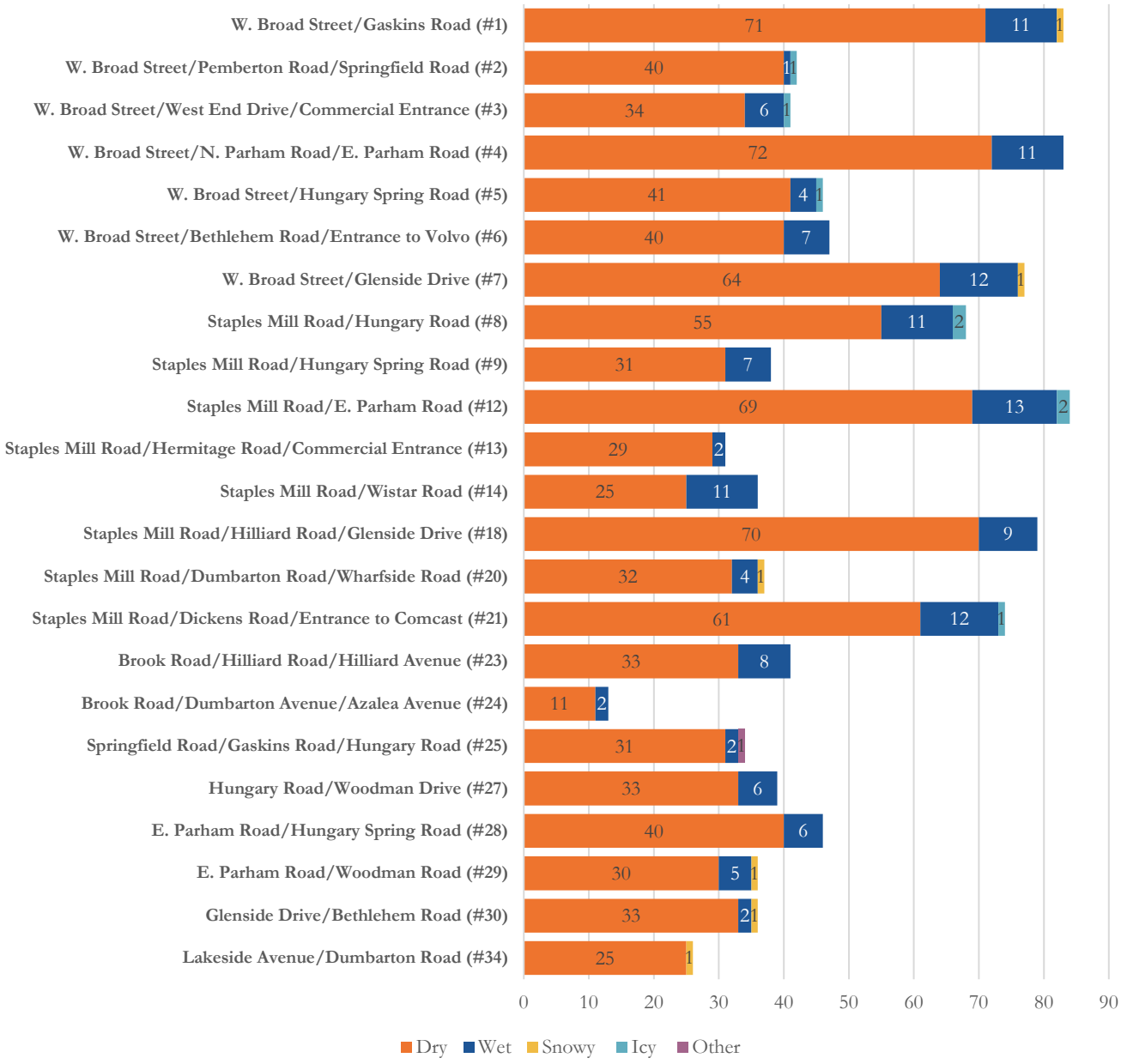
Source: VDOT, Kittelson, 2021.

Figure 51. Reported Crashes by Lighting Condition, January 2016 to December 2020



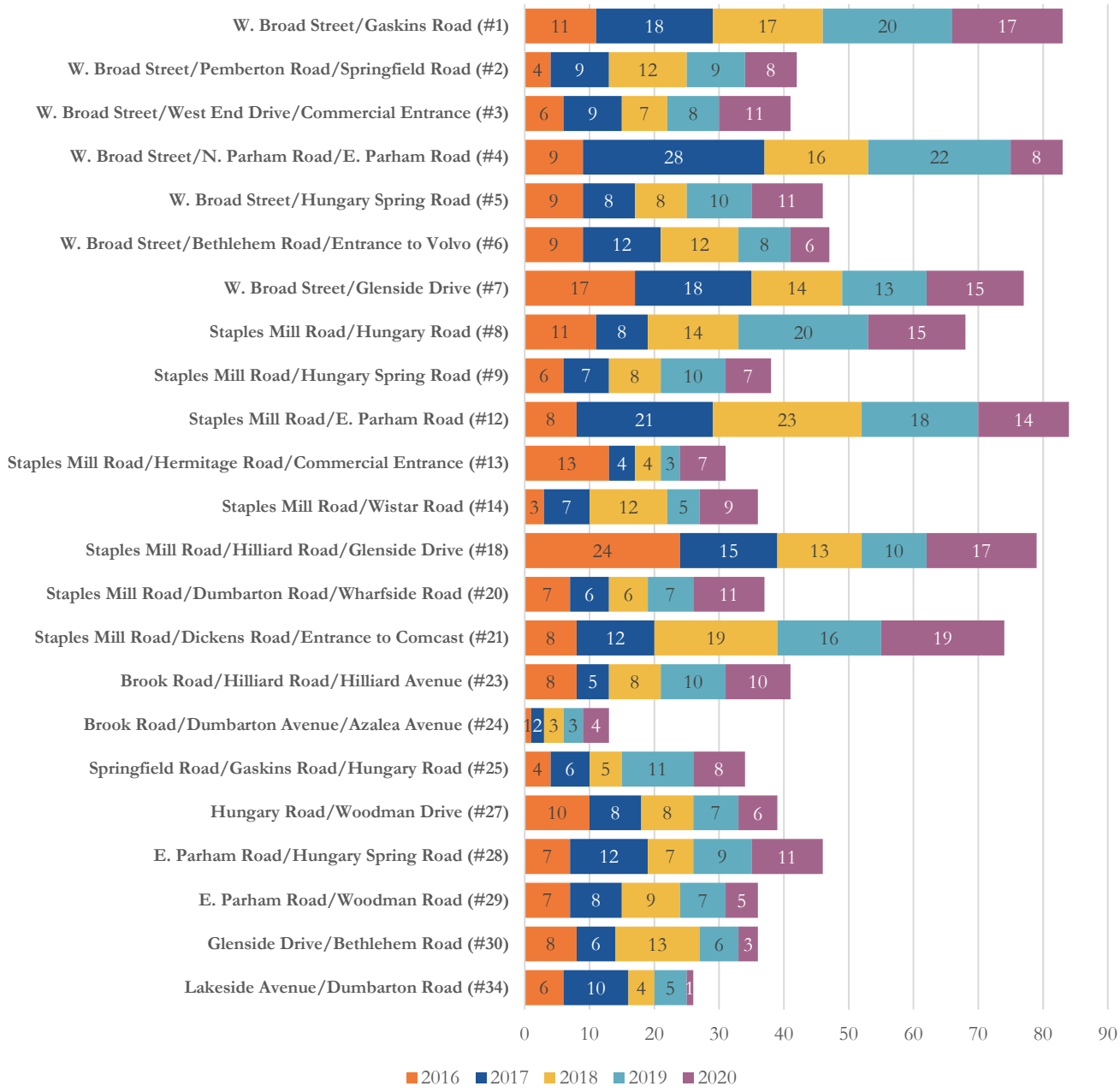
Source: VDOT, Kittelson, 2021.

Figure 52. Reported Crashes by Roadway Surface Condition, January 2016 to December 2020



Source: VDOT, Kittelson, 2021.

Figure 53. Reported Crashes by Crash Year, January 2016 to December 2020



Source: VDOT, Kittelson, 2021.

8.0 CONCLUSION AND NEXT STEPS

The findings in this memorandum will inform the processes for refining the study goals, objectives, and evaluation criteria. Insights from the existing conditions analysis can be used to develop potential transportation alternatives that will help meet the vision and goals of the study. These short-, mid- and long-term transportation alternatives will be evaluated and revised based on the study evaluation measures and community input.

Attachment A Traffic Counts

Attachment B Existing Traffic Conditions Analysis

Attachment C Future No-Build Traffic Conditions Analysis

Attachment D Crash Diagrams