SOUTH LABURNUM AVENUE CORRIDOR STUDY

Between Thornhurst Street and US 60 | Henrico County, VA

Final Report

April 2022

STARS VDOT

South Laburnum Avenue Corridor Study

Between Thornhurst Street and US 60 | Henrico County, Virginia

April 2022 | Final Report

Prepared for

VDOT

1401 East Broad Street, Richmond, VA 23219

Prepared by

Kimley»Horn

1700 Willow Lawn Drive, Suite 200, Richmond, VA 23230

List of Acronyms

AADT – Annual Average Daily Traffic

CMF – Crash Modification Factor

CDBG – Community Development Block Grants

EPDO – Equivalent Property Damage Only

FI – Fatal and Injury

GRTC – Greater Richmond Transit Company

HCM – Highway Capacity Manual

LOS – Level of Service

MOE – Measure of Effectiveness

PDO – Property Damage Only

PSI – Potential for Safety Improvement

RRTPO – Richmond Regional Transportation Planning Organization

SPF – Safety Performance Function

SPS – Statewide Planning System

STARS – Strategically Targeted and Affordable Roadway Solutions

SWG – Study Work Group

SYIP – Six Year Improvement Plan

TAZ – Traffic Analysis Zone

TDM – Travel Demand Model

TMC – Turning Movement Count

TOSAM – Traffic Operations and Safety Analysis Manual

TSN – Targeted Safety Need

VDOT – Virginia Department of Transportation

VJuST – VDOT Junction Screening Tool

VTrans – Virginia's Transportation Plan

TABLE OF CONTENTS

List of Tables

List of Figures

APPENDICES

Appendix A – Framework Document

Appendix B – Existing and Future Land Use

Appendix C – Data Collection

C-1 – Turning Movement Counts

C-2 – Tube Counts

Appendix D – Existing Conditions Volume Development

D-1 – Existing Conditions Volume Development Presentation

D-2 – Peak Hour Determination

Appendix E – Existing Conditions Meeting Presentation

Appendix F – Existing Safety Analysis and Access Management Review

F-1 – Intersection Pie Charts

F-2 – Collision Diagrams

F-3 – Crash Summaries

F-4 – Pedestrian and Bicycle Crash Map

F-5 – Existing Access Management Review

Appendix G – Existing Conditions Traffic Analysis

G-1 – Model Calibration Assumptions Document

G-2 – Sample Size Determination

G-3 – Delay and LOS Summary

G-4 – Queue Length Summary

G-5 – Synchro and SimTraffic Output

1 INTRODUCTION

1.1 Background

The Virginia Department of Transportation (VDOT) identified the South Laburnum Avenue corridor in Henrico County for study under the Strategically Targeted and Affordable Roadway Solutions (STARS) program. The STARS program uses a data-driven process to identify candidate projects with critical traffic and safety challenges. The South Laburnum Avenue corridor ranked highly within the Richmond District, with several locations of heavy congestion and high crash frequency. The STARS program then seeks to develop comprehensive, innovative transportation solutions to relieve congestion bottlenecks and resolve safety issues. The goals of STARS studies include:

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

This study is entitled the South Laburnum Avenue Corridor Study and will be referred to as the Study in this report.

1.2 Purpose of Study

The purpose of this project was to evaluate existing operational and safety deficiencies in the South Laburnum Avenue corridor and to develop potential projects to improve operations and safety. The primary goal of the STARS program is to identify targeted improvements that met project needs and could be programmed into the VDOT Six-Year Improvement Program (SYIP). Consideration was given to the likelihood that recommended improvements would perform favorably in the SMART SCALE project prioritization process or other transportation funding programs. The study corridor falls along a Virginia's Transportation Plan (VTrans) Priority 1 Location, and the primary needs identified for this study include:

- Capacity Preservation
- Transportation Demand Management
- Bicycle Access
- Safety Improvement

The following goals were identified to address the VTrans needs along the corridor:

- Improve operations at congested locations along South Laburnum Avenue
- Improve safety at signalized intersections
- Evaluate safety impacts of vehicle access at unsignalized intersections and driveways
- Consider innovative intersection designs to preserve capacity and improve safety
- Improve access for pedestrians and cyclists throughout the corridor
- Consider transit improvements to address Transportation Demand Management needs

Known operational and safety deficiencies in the study area included the following:

- Operational issues for the eastbound approach at Eastbound I-64 ramps (AM and PM peak hours)
- Recurring safety issues between the Eastbound I-64 Ramps and Jan Road, especially at the intersection of South Laburnum Avenue and Gay Avenue
- Disconnected pedestrian facilities along the study corridor
- Access management concerns on the northern and southern ends of the study corridor

Additional operational and safety deficiencies were identified following the existing and No-Build conditions analyses.

1.3 Study Work Group

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

- VDOT
- Henrico County
- Greater Richmond Transit Company (GRTC)
- Richmond Regional Transportation Planning Organization (RRTPO)
- Kimley-Horn and Associates

A framework document was developed prior to commencing the Study and outlines the methods and assumptions. The framework document was signed by the agencies in the SWG, and is provided in ***Appendix A***.

1.4 Study Area

The study area limits along South Laburnum Avenue extend between Thornhurst Street and US 60 (Williamsburg Road) and total approximately 1.7 miles in length. South Laburnum Avenue is a four-lane divided roadway with a 45 mile per hour speed limit within the study area. South Laburnum Avenue is classified as an "Other Principal Arterial."

South Laburnum Avenue serves as an important transportation corridor for Henrico County and the City of Richmond, and it continues to accommodate a wide array of users with varying trip purposes. The various trip purposes in the study area include, but are not limited to, the following:

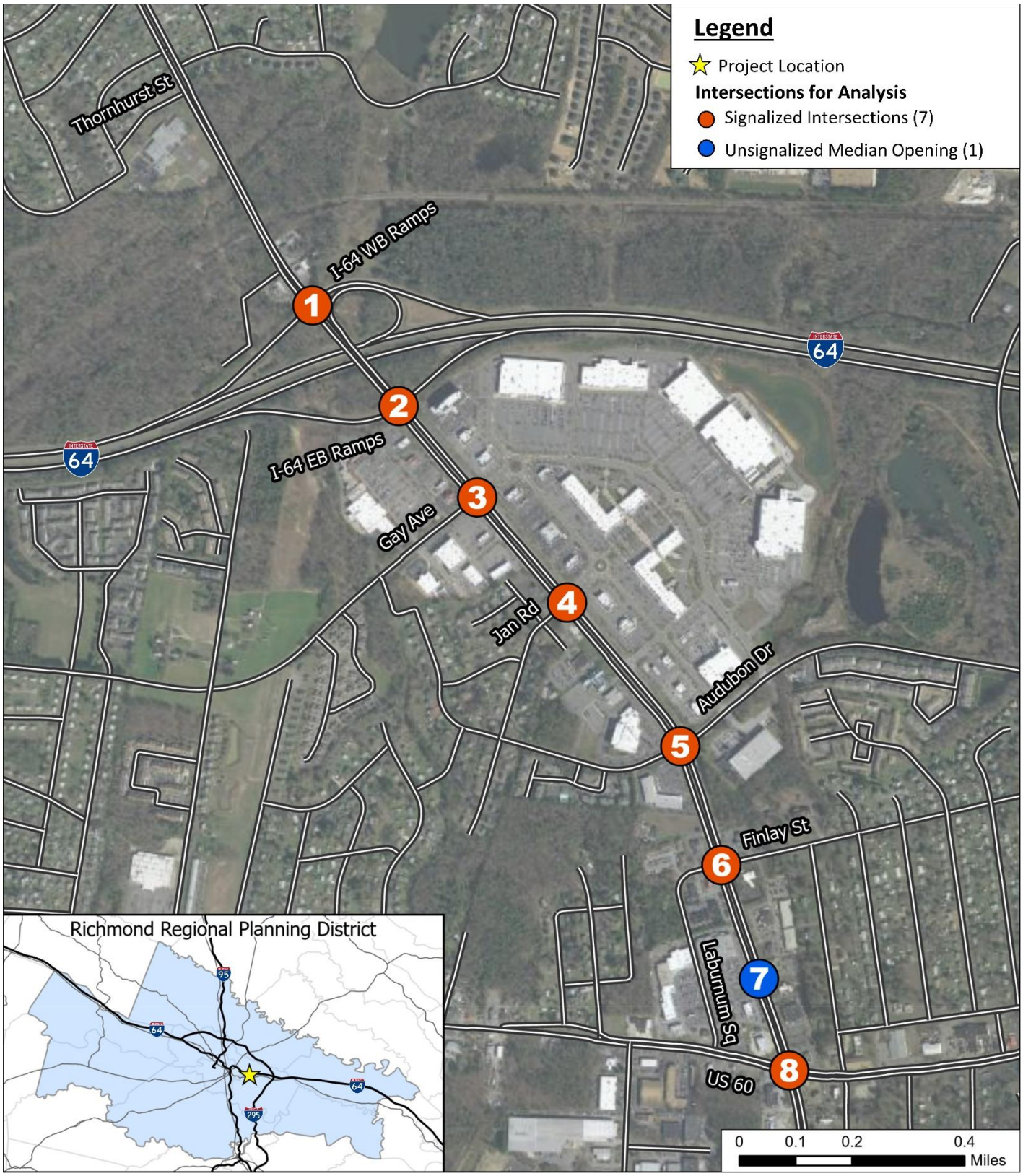
- Employment commuting
- Local residential and shopping access
- Local business access
- Major highway access (I-64)
- Richmond International Airport access

The study area includes eight at-grade intersections along South Laburnum Avenue. The eight intersections are listed below and shown in ***Figure 1***.

1.4.1 Study Area Intersections

1. Westbound I-64 Ramps (signalized)
2. Eastbound I-64 Ramps (signalized)
3. Gay Avenue (signalized)
4. Jan Road (signalized)
5. Audubon Drive (signalized)
6. Finlay Street (signalized)
7. Laburnum Square Shopping Center (unsignalized)
8. US 60 (Williamsburg Road) (signalized)

Figure 1: Study Area Location



2 Data Collection and Inventory

The following sections summarize field observations and data that was collected for this study. All assumptions pertaining to traffic data collection and processing are based on the direction and guidance provided in the VDOT *Traffic Operations and Safety Analysis Manual* (TOSAM) Version 2.0.

2.1 Description of the Study Area

Field reconnaissance of existing conditions in the study area revealed that the corridor is located within a suburban setting with a mix of level and rolling terrain. A railroad track crosses South Laburnum Avenue between the Westbound I-64 Ramps and Thornhurst Street. The following sections provide a summary of the physical attributes of I-64 and South Laburnum Avenue within the study area.

2.1.1 Interstate 64

I-64 is classified as an interstate and intersects regionally with I-295. Within the study area, I-64 interchanges with South Laburnum Avenue. The interstate is a six-lane, divided roadway with three 12-foot lanes in each travel direction separated by a variable width grass median. I-64 is oriented in a general northwest-southeast direction with a posted speed limit of 65 mph through the South Laburnum Avenue interchange. For the purposes of this Study, the corridor was considered to have an east-west alignment and is referred to only as I-64. Mainline I-64 was not analyzed as part of this Study, only the ramp termini that intersect with South Laburnum Avenue.

2.1.2 South Laburnum Avenue

Within the study area, South Laburnum Avenue is a four-lane divided roadway with a posted speed of 45 mph and varies between four and five lanes between Gay Avenue and Laburnum Square. The two northbound travel lanes are separated from the two southbound travel lanes by a variable width concrete median north of the Westbound I-64 Ramps and a variable width grass median south of the Westbound I-64 Ramps. According to VDOT's 2014 Functional Classification Map, South Laburnum Avenue is classified as an "Other Principal Arterial" between the Westbound I-64 Ramps and US 60 (Williamsburg Road).

2.2 Relevant Studies and Plans

The following relevant studies and plans were collected and reviewed to identify previous recommendations along the study corridor:

- STARS Route 60 (Williamsburg Road) Corridor Study (2020)
  - Included analysis and recommendations for the intersection of South Laburnum Avenue and US 60
  - The accompanying Williamsburg Road Ped and Transit Improvements Project was submitted in SMART SCALE Round 4
- Northbound and Southbound South Laburnum Avenue Sidewalk projects
  - Henrico County applied for and received Revenue Sharing funds, which are incorporated in the Six Year Improvement Plan (SYIP) FY2025 and FY2026
- Gay Avenue Sidewalk Project
  - Project completion is anticipated February 2022
- South Laburnum Avenue Transit Shelter Upgrades
  - Funded by Community Development Block Grants (CDBG) funds

2.3 Land Use and Zoning

The Code of Virginia requires localities to adopt a comprehensive plan that considers existing and projected conditions for the physical development of jurisdictions. Existing and Future land use maps for Henrico County can be found in ***Appendix B***.

The South Laburnum Avenue corridor is primarily commercial with connections to residential and industrial areas. The White Oak Village Shopping Center, Willow Oaks Shopping Center, Laburnum Square Shopping Center, and other commercial developments are notable traffic generators along the corridor. Residential neighborhoods can be accessed via Thornhurst Street, Gay Avenue, and Jan Road to the west, and Finlay Street and Audubon Drive to the east. South Laburnum Avenue connects to I-64 towards the north of the corridor and US 60 to the south, which are common commuter routes to and from the City of Richmond.

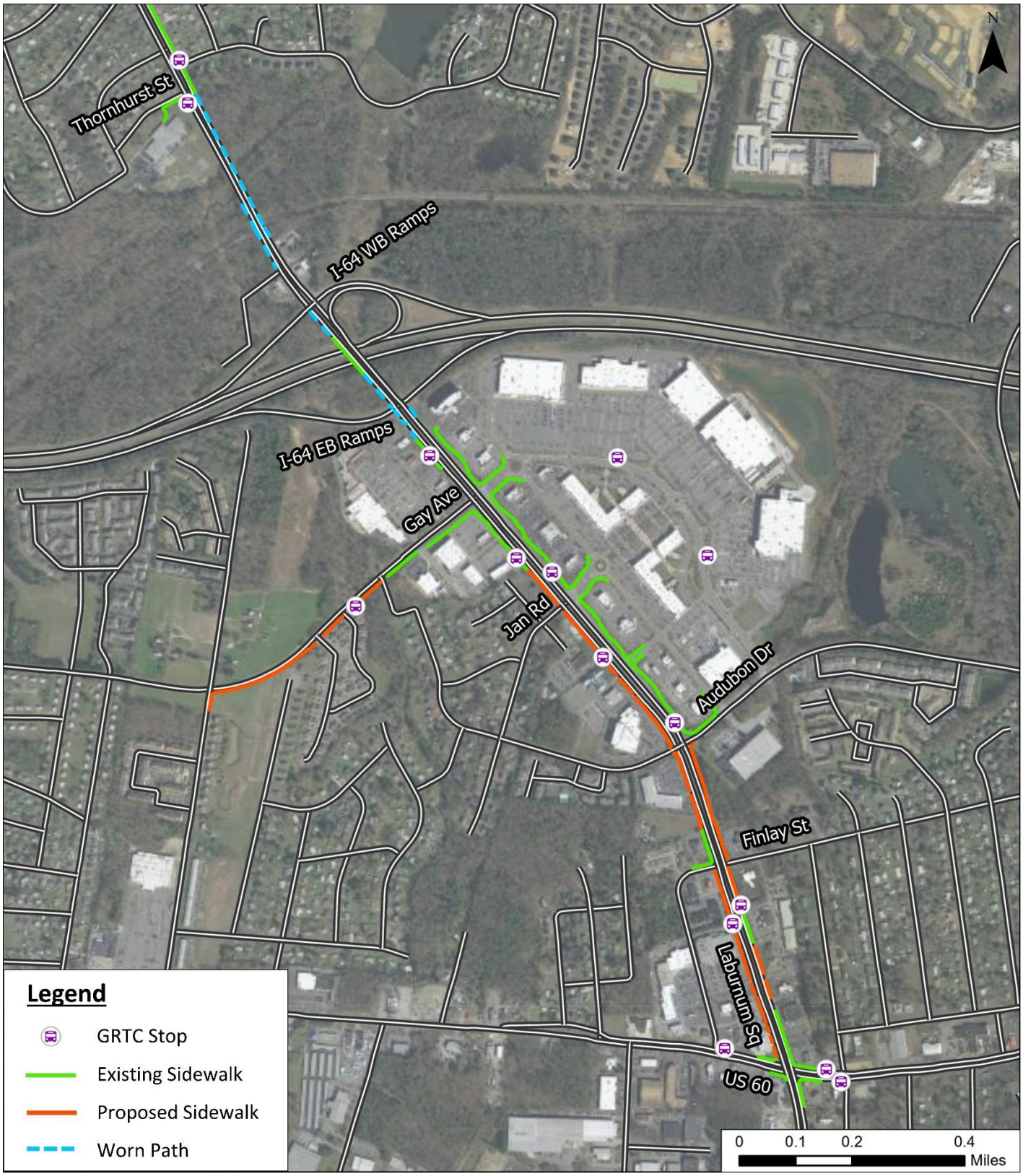
The Henrico County 2026 Comprehensive Plan identifies the development of urban residential and office space adjacent to the study corridor in the northeast quadrant of Gay Avenue and Millers Lane. The plan also identifies planned industrial space located adjacent to South Laburnum Avenue between the Norfolk Southern Railroad and I-64.

2.4 Pedestrian, Bicycle, and Transit Connections

The study area is well-served by transit, with bus stops located throughout the study corridor. GRTC routes 7A (Nine Mile/Airport Henrico), 7B (Nine Mile/Laburnum/Airport Henrico), 91 (Laburnum Connector), 56 (South Laburnum) and 28x (White Oak Village Express) serve the South Laburnum Avenue corridor and connect riders to destinations such as the Richmond International Airport, downtown Richmond, and Henrico County west of Richmond. Existing bus stops include varying amenities and some lack direct connection to sidewalks. Henrico County plans to upgrade bus stops at Gay Avenue and Finlay Street (at the Bank of America) using Community Development Block Grants (CDBG) funds.

Most of northbound and southbound South Laburnum Avenue lacks sidewalks to the north of Gay Avenue. However, worn paths along the side of the road provide evidence of pedestrian activity and existing demand for pedestrian travel along the corridor. While sidewalks and pedestrian accommodations are more common south of Gay Avenue, there are existing gaps in the sidewalk along this section of the corridor. Henrico County has plans to address some of the existing gaps in the sidewalk network. The County received Revenue Sharing funds for fiscal years 2025 and 2026 to construct sidewalks along South Laburnum Avenue between US 60 and Audubon Drive on the northbound side and between Gay Avenue and US 60 on the southbound side. These proposed sidewalks, along with upgrades to pedestrian accommodations, such as curb ramps and pedestrian signal heads, aim to improve the pedestrian experience and better connect existing pedestrian facilities. ***Figure 2*** shows existing and proposed pedestrian facilities and GRTC bus stop locations.

Figure 2: Study Area Pedestrian and Transit Facilities



2.5 Field Review Observations

A preliminary field review of the study area was conducted on January 19, 2021 to verify existing conditions, confirm traffic control devices, and observe peak hour traffic conditions and driver behavior. In addition to the field review, existing traffic volume data was collected from a combination of turning movement counts and vehicle classification tube counts. Pedestrian and bicycle activity were captured at each study intersection. Mid-block crossings were not counted.

VDOT provided crash data, existing traffic signal timing plans, and roadway design plans. The following observations were made during the field review:

- Long queues at the I-64 Eastbound Ramps (AM and PM) and Gay Avenue (PM) cause vehicles to run red lights and/or block intersections.

Queue from northbound South Laburnum Avenue at the Eastbound I-64 Ramps extending through Gay Avenue (PM peak period)

Queue from northbound South Laburnum Avenue at Gay Avenue extending through Jan Road (PM peak period)

- High volume of heavy vehicles along corridor. Tight turning radii at multiple intersections make it difficult for trucks to navigate.

Heavy vehicle traffic northbound and southbound between Finlay Street and US 60 (Williamsburg Road)

Curb damage at Audubon Drive

- Lack of advanced signing, as well as obstructed visibility of the westbound I-64 directional signs for vehicles travelling northbound on South Laburnum Avenue.

Advanced interstate sign for I-64 East headed northbound on South Laburnum Avenue just south of the Eastbound I-64 Ramps. There is a lack of advanced signing for I-64 West.

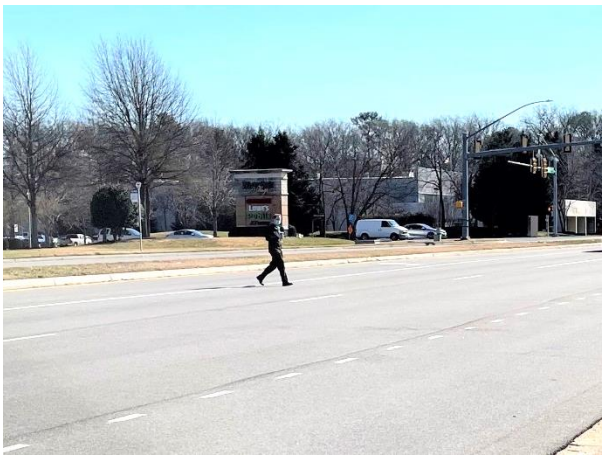
Partially obscured directional sign to westbound I-64 on northbound South Laburnum Avenue

- Frequent pedestrian activity was observed along the corridor.

Pedestrian heading southbound on South Laburnum Avenue at the Eastbound I-64 Ramps

Pedestrians crossing South Laburnum Avenue at Gay Avenue

Pedestrians boarding a GRTC bus headed northbound on South Laburnum Avenue



Pedestrian crossing South Laburnum Avenue just north of Audubon Drive

Pedestrian crossing South Laburnum Avenue just north of Jan Road

Pedestrians crossing South Laburnum Avenue at US 60 (Williamsburg Road)

- Inadequate pedestrian accommodations along the corridor including missing sidewalks, non-compliant curb ramps, worn crosswalks, inaccessible pedestrian push buttons, a lack of connectivity (sidewalks and marked pedestrian crossings) between transit stops, and a lack of lighting at intersections and transit stops.

Worn path headed southbound on South Laburnum Avenue approaching the Eastbound I-64 Ramps

Sidewalk ending on Southbound Laburnum Avenue prior the intersection of Gay Avenue

Worn path headed southbound on South Laburnum Avenue approaching Jan Road

No sidewalk or lighting at GRTC transit stop located just south of Finlay Street

Pedestrian push button not accessible via sidewalk at Finlay Street

Lack of detectable warning surface on curb ramp at US 60 (Williamsburg Road)

A paved-over crosswalk serving Adams Elementary School at Thornhurst Street was identified during field observations. At the Existing Conditions Meeting on March 30, 2021, Henrico County noted that this crosswalk was purposefully paved over due to safety concerns of having a midblock crossing with a vehicular speed limit of 45 miles per hour.

- Closely spaced driveway openings along the corridor.

Closely spaced driveways on southbound South Laburnum Avenue north of the Westbound I-64 Ramps

Closely spaced driveways on southbound South Laburnum Avenue between Laburnum Square and US 60 (Williamsburg Road)

- Paved-over or faded puppy tracks at various locations

Southbound and westbound at Jan Road

Southbound and westbound Labrunum Avenue at US 60

2.5.1 Field Observations Recommendations

Several issues observed in the field could be mitigated by low-cost strategies:

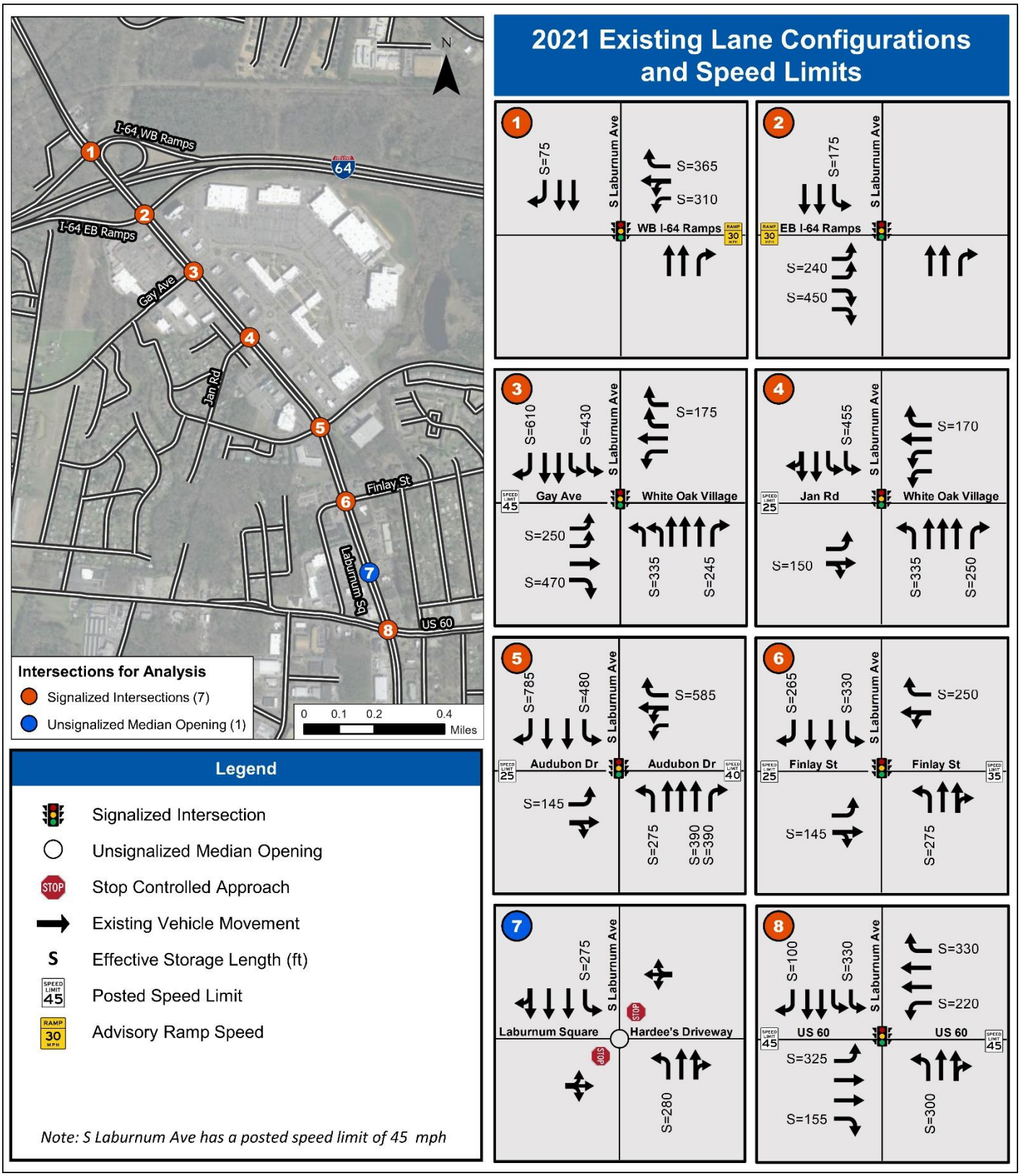
- **Railroad Crossing:** Evaluate and upgrade (if necessary) the existing railroad crossing signage and pavement markings along northbound and southbound South Laburnum Avenue
- **Westbound I-64 Ramps:** Install a pole-mounted R3-2 no left-turn sign for the southbound approach; trim trees obscuring the northbound overhead directional sign to westbound I-64
  - Signage was installed and trees trimmed prior to the submission of this report
- **Eastbound I-64 Ramps:** Replace the existing pole-mounted R3-2 no left turn sign for the southbound approach with a pole-mounted R3-18 no U-turn no left turn sign. This signage would eliminate the potential for a yellow trap for northbound U-turns.

  - Signage was installed prior to the submission of this report
- **Gay Avenue:** Repair malfunctioning phase 2 pedestrian pushbutton on southeast quadrant
  - Henrico County fixed the pushbutton following the Existing Conditions Meeting on March 30, 2021
- **Jan Road:** Install puppy tracks for dual southbound and westbound left-turn lanes
- **Finlay Street:** Extend phase 2 pedestrian clearance interval to accommodate a walking speed of 3.5 ft/sec. Existing clearance interval (5 seconds) is insufficient to cross the 45 ft leg.

2.6 Existing Roadway Geometry

The existing roadway geometry in the study area was reviewed and documented during the field review. South Laburnum Avenue is considered to run north/south and other roads are considered to run east/west for the purpose of this Study. South Laburnum Avenue is a multi-lane corridor generally characterized as having two through lanes in the southbound direction and two-to-three lanes in the northbound direction for most of its length within the study area. ***Figure 3*** summarizes the existing lane configurations, including the effective storage lengths for the left and right turn storage bays, and peak hour factors for all study area intersections. The speed limit along South Laburnum Avenue in the study area is 45 mph. The side streets at Laburnum Square were assumed to have a speed limit of 15 mph to be consistent with the other driveway entrances in the study corridor.

Figure 3: 2021 Existing Lane Configurations and Speed Limits



2.7 Traffic Data

All data collection efforts occurred during a Tuesday, Wednesday, or Thursday. VDOT and Henrico County provided existing traffic signal timing and design plans. All traffic data is provided in ***Appendix C***.

Turning Movement Counts

14-hour TMCs were collected on Tuesday, January 19, 2021 from 6:00 AM to 8:00 PM at the following locations:

- South Laburnum Avenue at Thornhurst Street
- South Laburnum Avenue at Westbound I-64 Ramps
- South Laburnum Avenue at Eastbound I-64 Ramps
- South Laburnum Avenue at Gay Avenue/White Oak Village
- South Laburnum Avenue at Jan Road/White Oak Village
- South Laburnum Avenue at Henrico Fire Station
- South Laburnum Avenue at Audubon Drive
- South Laburnum Avenue at Finlay Street
- South Laburnum Avenue at Laburnum Square
- South Laburnum Avenue at US 60 (Williamsburg Road)

Tube Counts

48-hour tube counts were collected from Tuesday, January 19, 2021 through Thursday, January 21, 2021 at the following locations:

- South Laburnum Avenue between Eastbound I-64 Ramps and Gay Avenue
- South Laburnum Avenue between Audubon Drive and Finlay Street
- South Laburnum Avenue between Laburnum Square and US 60 (Williamsburg Road)

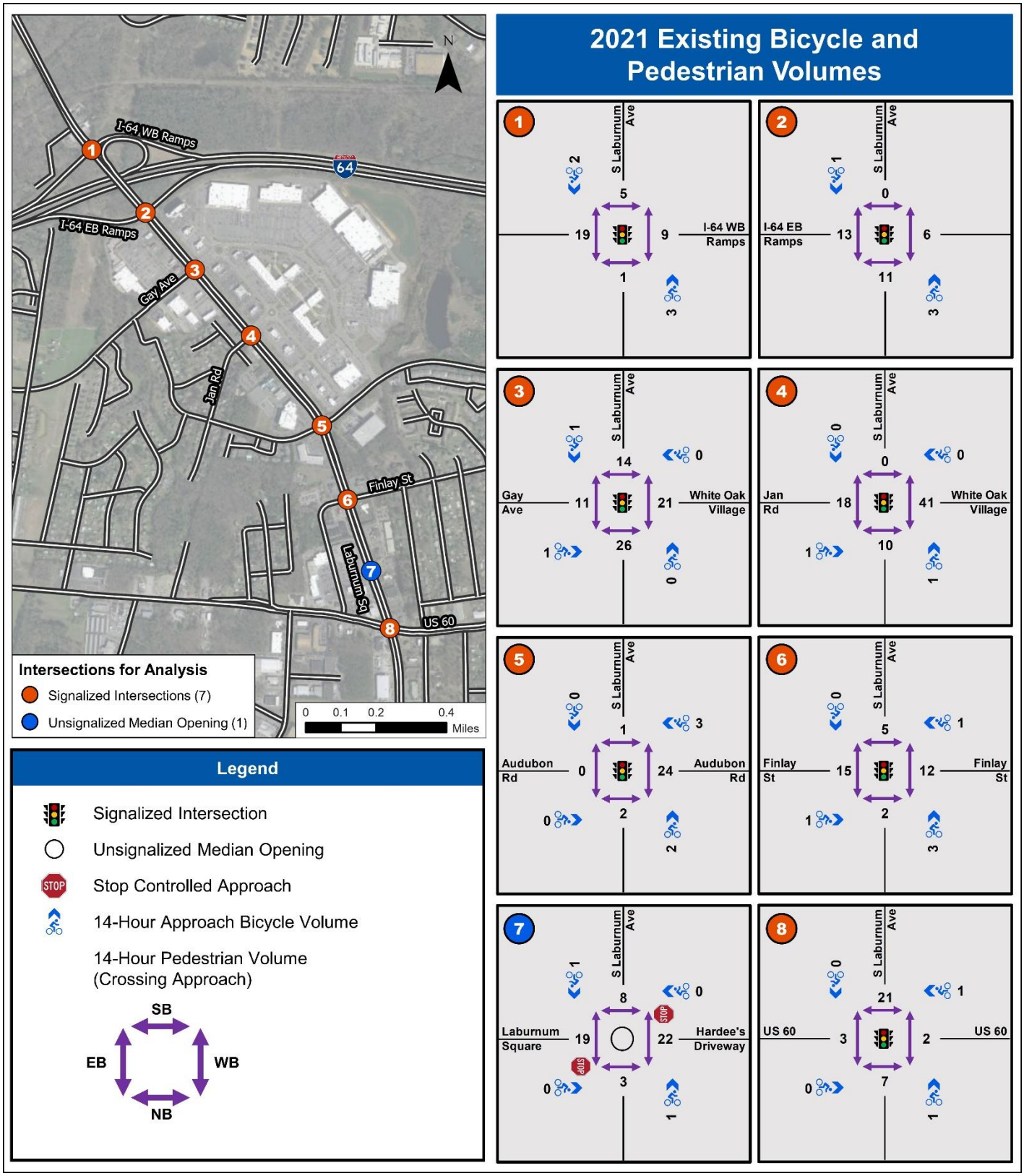
Pedestrian and Bicycle Counts

Pedestrian and bicycle activity was captured at each study intersection as part of the TMC collection. Mid-block crossings were not counted. 14-hour bicycle and pedestrian volumes at each intersection are presented in ***Figure 4***.

Transit Ridership

GRTC provided 2020 and 2019 transit ridership data by stop (both riders on and riders off) and time of day for routes 7A/7B, 28x, 56, and 91.

Figure 4: 2021 Existing 14-Hour Pedestrian and Bicycle Volumes



2.7.1 COVID-19 Adjustments

Existing traffic counts were validated using historical tube count data from 2019 and turning movement counts (TMCs) from 2018 to adjust for variations in traffic due to COVID-19. Trends were identified for cars and trucks, AM and PM peak hours, and directional travel on the study corridor. Existing count data, which on aggregate fell in line with regional COVID-19 traffic trends, was adjusted using the factors listed in ***Table 1***. A summary of the COVID-19 recommendations was provided to the SWG on February 17, 2021 and is provided in ***Appendix D***. The SWG agreed with these recommendations on March 4, 2021.

Table 1: COVID-19 Traffic Adjustment Factors

AM Peak Hour Adjustment Factors	PM Peak Hour Adjustment Factors
1.35 factor applied to northbound travel	1.05 factor applied to northbound travel
1.15 factor applied to southbound travel	1.15 factor applied to southbound travel
Factors were only applied to cars, as no clear trends were identified for reduced truck travel	

2.7.2 Peak Hour Determination

A network-wide peak hour was determined for the AM and PM peak periods based on peak hours calculated for each study intersection. The hours that captured the highest percentage of overall traffic in the network was selected as the network peak hour. The peak hour determination summary tables are provided in ***Appendix D***. The network peak hours were determined to be from 7:15 AM to 8:15 AM and 4:45 PM to 5:45 PM.

2.7.3 Heavy Vehicle Percentages and Peak Hour Factors

Heavy vehicle percentages were calculated for each movement, and peak hour factors were calculated for each intersection during the AM and PM peak hours. The calculated AM and PM peak hour heavy vehicle percentages and peak hour factors in the study area are summarized in ***Figure 5***.

2.7.4 Traffic Volume Balancing

Figure 6 shows the 2021 existing traffic volumes at each study intersection. Traffic volumes were balanced for intersections between Westbound I-64 Ramps and US 60. Raw traffic volumes were not adjusted more than ten percent, where possible.

U-turns are prohibited at several locations along the corridor. U-turn volumes that were counted during the AM and PM peak hours were disregarded at the following locations:

- Southbound South Laburnum Avenue at Gay Avenue
- Northbound South Laburnum Avenue at Laburnum Square

Figure 5: 2021 Existing Heavy Vehicle Percentages and Peak Hour Factors

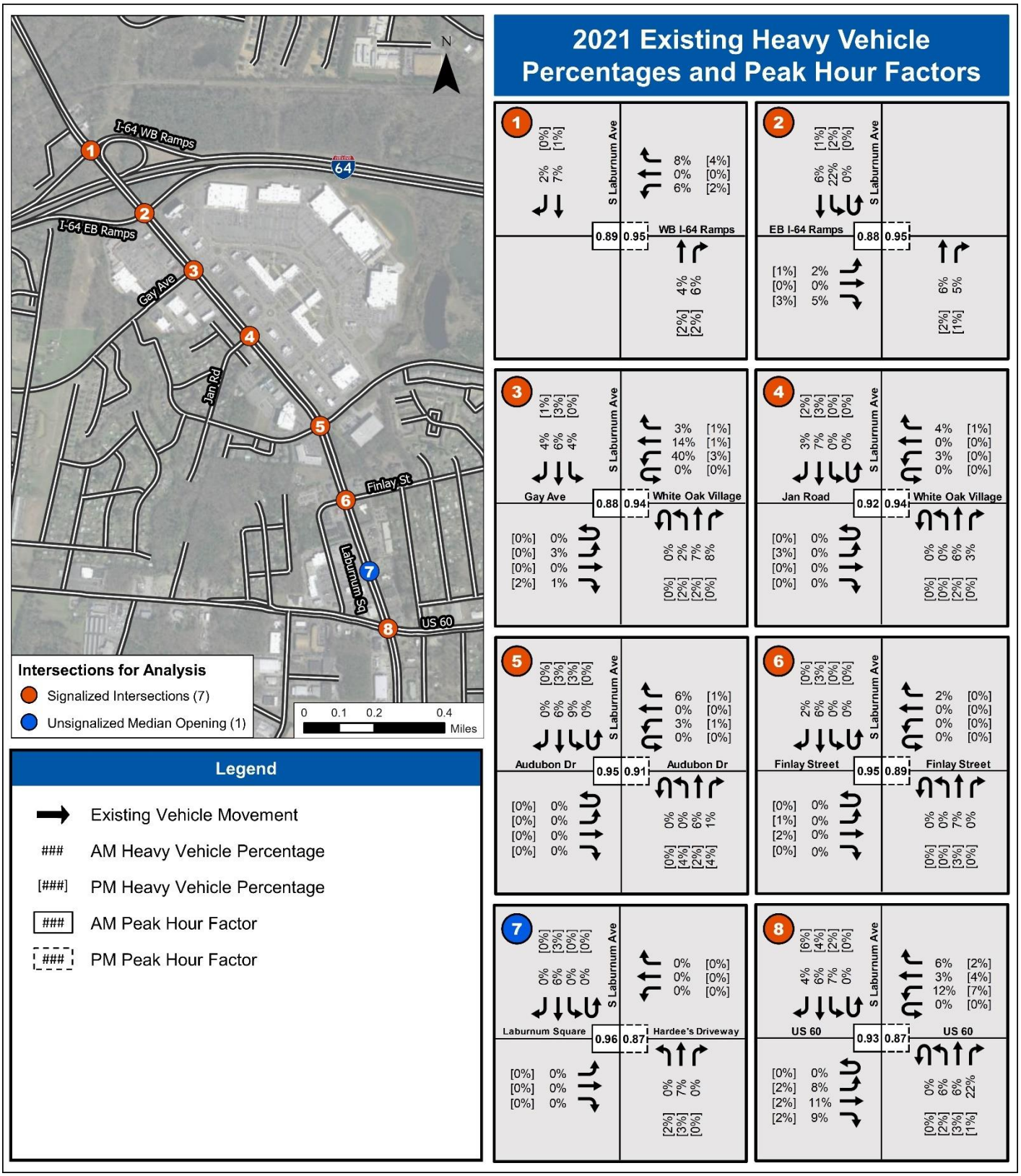
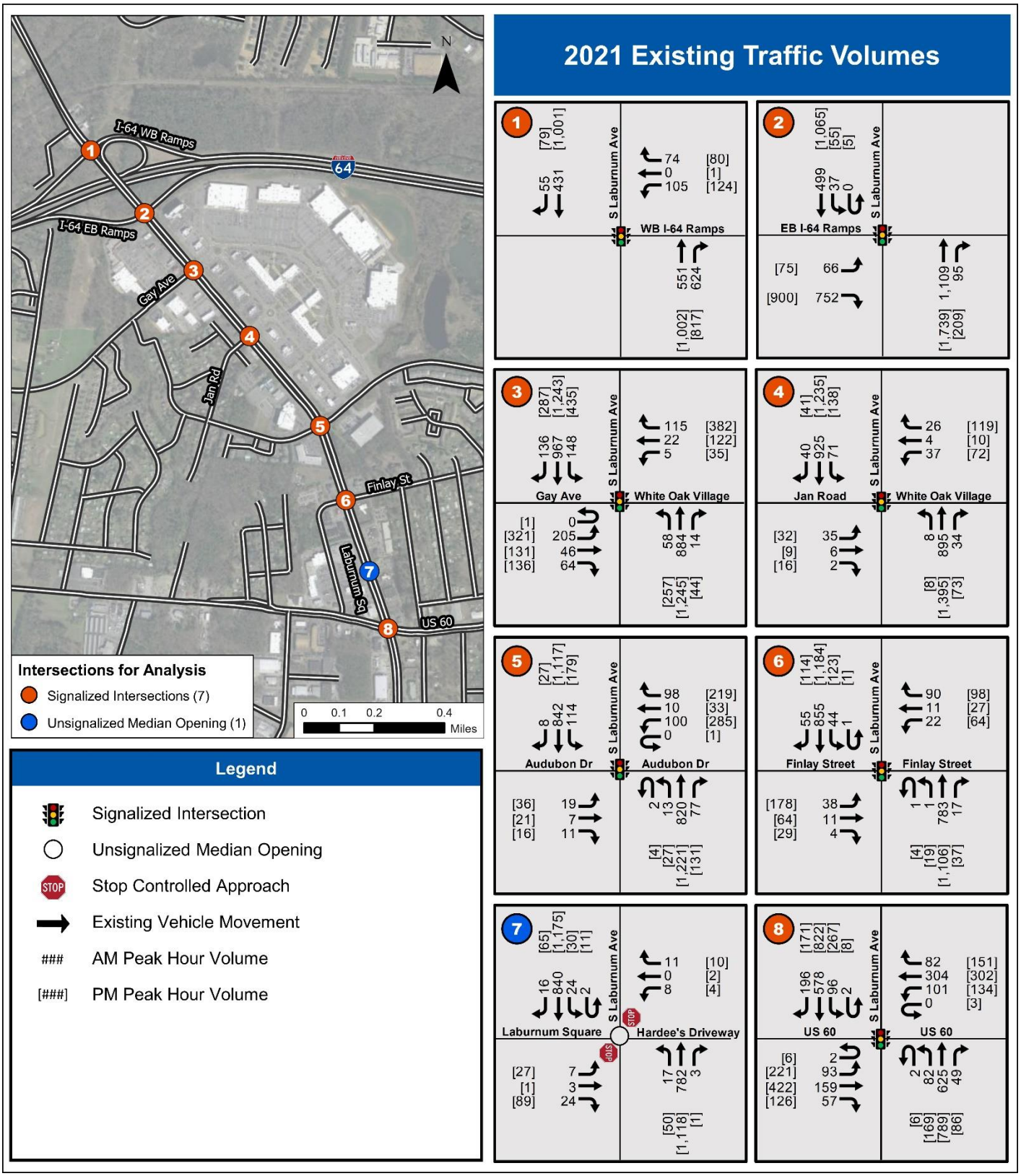


Figure 6: 2021 Existing Traffic Volumes



3 Existing Conditions Analysis

The study team conducted a multifaceted analysis of the existing conditions of the study corridor, which included a safety analysis, access management review, traffic operations analysis, and review of pedestrian, bicycle, and transit activity. The results of the existing conditions analysis were presented to the study work group on March 30, 2021. The Existing Conditions Meeting presentation can be found in ***Appendix E***.

The intent of the existing conditions analysis to provide a general understanding of the baseline conditions as a starting point for developing future multimodal improvement strategies.

3.1 Safety Analysis

The study area intersections were assigned to intersections using intersection influence areas. Generally, the intersection influence areas extended to the back of tapers for turn lanes on each approach; however, crash attributes were reviewed, and influence areas were extended as needed to include intersection-related crashes beyond these limits. Additional safety analysis materials such as intersection pie charts, collision diagrams, crash summary tables, and a pedestrian and bicycle crash map are included in ***Appendix F***.

The following data sources were used to assess safety within the study corridor and identify crash patterns:

- Latest five years of crash data obtained from VDOT Crash Database (January 1, 2015 – December 31, 2019)
- Potential for Safety Improvement (PSI) and Targeted Safety Need (TSN) locations

The following sections provide a summary of the crashes that occurred within the project area during the five-year crash reporting period.

3.1.1 Summary of Study Area Crashes

Over the five-year period, 500 crashes were reported in the study area. Of the reported crashes, there was one fatal crash, 135 injury crashes, and 364 crashes involving property damage only (PDO). A crash density heat map is shown in ***Figure 7*** and a yearly summary of crashes by crash severity is shown in ***Table 2***. Crash severity is coded using the KABCO scale, which is defined using the following classifications:

- K – Fatal Injury
- A – Suspected Serious Injury
- B – Suspected Minor Injury
- C – Possible Injury
- PDO – Property Damage Only

Figure 7: Crash Density Heat Map (2015-2019)

Table 2: Study Area Crashes by Crash Severity

Year	Number of Crashes					
	K	A	B	C	PDO	Total
2015	0	1	21	0	70	92
2016	0	3	25	1	70	99
2017	1	0	28	4	80	113
2018	0	1	23	2	73	99
2019	0	2	21	3	71	97
Total	**1**	**7**	**118**	**10**	**364**	**500**

A yearly summary of crash type is shown in ***Table 3***. Rear-end (49%) and angle (30%) crashes comprised the majority of study area crashes. The "Other" category included the following crash types from FR-300 reports: Non-Collision, Backed Into, and Other.

Table 3: Study Area Crashes by Crash Type

Year	Number of Crashes							
	Rear End	Angle	Sideswipe	Head On	Fixed Object – Off Road	Pedestrian	Other	Total
2015	43	20	18	3	3	3	2	92
2016	48	37	11	0	2	0	1	99
2017	49	36	21	0	2	1	4	113
2018	57	27	10	1	1	0	3	99
2019	50	29*	10	1	2	1	4	97
Total	**247**	**149**	**70**	**5**	**10**	**5**	**14**	**500**

* One angle crash involved a bicycle

The crash that resulted in a fatality occurred at Audubon Drive and involved a vehicle traveling northbound on South Laburnum Avenue that disregarded the traffic signal and struck a vehicle making a left turn from eastbound Audubon Drive.

More crashes occurred during the off-peak period (10 AM to 3 PM) than the morning peak period (6 AM to 9 AM) or the evening peak period (3 PM to 6 PM). At total of 340 occurred during the off-peak period (68%), while 41 crashes occurred in the morning peak period (8%), and 119 occurred in the evening peak period (24%).

3.1.2 PSI Segments

All intersection and roadway segments within the VDOT linear referencing system (LRS) are evaluated annually for the potential for safety improvement (PSI) based on the Highway Safety Manual (HSM) methodology by VDOT. The crash frequency, severity of crashes, volume, and length of segment are contributing factors in the predicative analysis. Crash predictions, based on the safety performance function (SPF) crash data files, are made for intersection and segments. The top 100 intersections and

100 miles of segments are published by VDOT for each district on an annual basis. VDOT also identifies Targeted Safety Need (TSN) locations, which are intersections or segments that have been identified as PSI locations for three or more of the last five years.

While none of the study intersections were identified as PSI intersections, eight PSI segments were identified within the study area. Crash data showed that most crashes within the TSN segments were intersection related. The eight PSI segments were also TSN segments. ***Table 4*** summarizes the 2018 TSN segments within and adjacent to the study area.

Table 4: TSN Segments

Location	2018 PSI Rank
South Laburnum Avenue from Gillies Creek to median opening north of Westbound I-64 Ramps	355
South Laburnum Avenue from Eastbound I-64 Ramps to Gay Avenue	7
South Laburnum Avenue from Gay Avenue to just north of Jan Road	13
South Laburnum Avenue from just north of Jan Road to Jan Road	168
South Laburnum Avenue from Jan Road to Audubon Drive	252
South Laburnum Avenue from just north of Finlay Street to Finlay Street	311
South Laburnum Avenue from Finlay Street to US 60 (Williamsburg Road)	17*
US 60 (Williamsburg Road) from South Laburnum Avenue to just east of Glen Alden Drive	172

* Segment overlaps with PSI segment 227

Crash characteristics at locations adjacent to high ranking TSN segments are:

South Laburnum Avenue at the Norfolk Southern Railroad Crossing

- 11 crashes occurred at the railroad crossing
- The predominant collision type was rear ends (73%)
  - Rear ends were likely due to vehicles slowing down while crossing the railroad tracks. Field observations revealed this behavior.

South Laburnum Avenue at Eastbound I-64 Ramps

- 76 crashes occurred at this intersection
- Predominant collision types included rear ends (63%), angle (17%), and sideswipes (17%)
- The majority (46%) of the angle crashes were related to southbound left turns failing to yield to northbound traffic during the protected-permissive left turn phase
- The most prominent crash hotspots occurred northbound – mostly related to congestion
- 10 of the 40 angle crashes (25%) were due to motorists that disregarded the traffic signal

South Laburnum Avenue at Gay Avenue

- 148 crashes occurred at this intersection
- Predominant collision types included rear ends (51%) and angle (28%)
- Typical patterns involved vehicles making a southbound left into White Oak Village running red lights or colliding with vehicles that had not cleared the intersection

- Most northbound crashes were congestion-related rear ends
- Sideswipes that occurred in the southbound direction were often due to attempted lane changes

South Laburnum Avenue at Jan Road

- 32 crashes occurred at this intersection
- Predominant collision types included rear ends (44%) and angle (22%)
- Three of the six angle crashes that occurred in the intersection were caused by vehicles that ran red lights
- Rear ends happened near stoplights due to vehicles failing to stop in time

South Laburnum Avenue at Audubon Drive

- 61 crashes occurred at this intersection
- Predominant collision types included rear ends (49%) and angle (26%)
- Of the 16 angle crashes, seven mentioned disregarding the traffic signal (45%), three of which specifically cited running red lights

South Laburnum Avenue at Finlay Street

- 40 crashes occurred at this intersection
- Predominant collision types included rear ends (65%) and angle (23%)
- Of the 9 angle crashes, four mentioned disregarding the traffic signal (44%), three of which specifically cited running red lights

South Laburnum Avenue at Laburnum Square

- 34 crashes occurred at this intersection
- Predominant collision types included angle (76%) and rear ends (12%)
- 20 of the 26 angle crashes (77%) were from vehicles on the side streets attempting to travel through or make a left turn

3.1.3 Equivalent Property Damage Only (EPDO) Crashes

Equivalent Property Damage Only (EPDO) is a metric developed by FHWA to identify sites with potential for safety improvement based on crash cost by severity relative to the cost of a property damage only crash. EPDO scores were calculated for each intersection based on the following score. EPDO scores were based on fatal and injury crashes only, with a higher weight given to more severe crashes.

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

The intersections with the highest EPDO scores are listed in ***Table 5***. Gay Avenue has the highest EPDO score along the corridor and has twice as many crashes than any other intersection along the study corridor. Despite a relatively lower number of total crashes, Audubon Drive has the second highest EPDO score, implying that there is a higher number of severe crashes compared to other intersections within the study corridor. The only fatal crash along the corridor occurred at Audubon Drive. Four of the five highest EPDO scores are also adjacent to TSN segments.

Table 5: EPDO and Crashes

Intersection	2015-2019 Total Crashes*	EPDO (Fatal + Injury Only)	EPDO (All Crashes)
Gay Avenue/White Oak Village	145	395	506
Audubon Drive	60	380	416
Eastbound I-64 Ramps	74	265	319
US 60 (Williamsburg Road)	74	245	301
Westbound I-64 Ramps	28	240	259

* Driving while under the influence of alcohol crashes were removed from the data to be consistent with SMART SCALE methodology

3.1.4 Pedestrian and Bicycle Involved Crashes

Crashes involving a pedestrian or bicyclist were analyzed to evaluate corridor safety specific to those modes. Five pedestrian crashes and one bicycle crash were reported along the study corridor during the 2015 to 2019 analysis period. The bicycle crash and one pedestrian crash resulted in a suspected serious injury (A) while the remaining four pedestrian crashes resulted in suspected minor injuries (B).

All pedestrian crashes occurred at signalized intersections: two occurred at Gay Avenue; two at Jan Road; and one at US 60. A pedestrian crash at Gay Avenue and two crashes at Jan Road occurred at their respective intersections while the pedestrian was crossing a leg of the intersection that had a crosswalk.

The single bicycle crash occurred at the Westbound I-64 ramps. A westbound vehicle making a left turn onto southbound South Laburnum Avenue collided with a bicyclist who ran a red light travelling northbound on South Laburnum Avenue. The pedestrian and bicycle crashes in the summary area are summarized by injury type in ***Table 6***. A map of pedestrian and bicycle crashes is included in ***Appendix F***.

Table 6: Study Area Pedestrian and Bicycle Crashes

Severity	Number of Crashes	
	Pedestrian	Bicycle
K	0	0
A	1	1
B	4	0
C	0	0
PDO	0	0
Total	**5**	**1**

3.2 Access Management Review

The *VDOT Road Design Manual* provides access management design standards for entrances and intersections along roadways, which aim to provide access to land uses while preserving the flow of traffic. The standards are based on the functional classification and posted speed limit of the roadway. The South Laburnum Avenue corridor is classified as an “Other Principal Arterial” with a speed limit of 45 mph. While South Laburnum Avenue is maintained by Henrico County, VDOT spacing standards were

used to help guide future access management improvements. The VDOT access management guidance applicable to South Laburnum Avenue in the study area are listed in ***Table 7*** and ***Table 8***.

Table 7: VDOT Access Management Design Standards – Intersections and Median Crossovers

Highway Functional Classification	Legal Speed Limit (mph)	Minimum Spacing (Distance) in Feet			
		Type 1 (Signalized)	Type 2 (Unsignalized/ Full Crossover)	Type 3 (Full Access/ Directional Crossover)	Type 4 (Partial Access)
Principal Arterial	45	1,320	1,050	565	305

Source: *VDOT Road Design Manual* (Appendix F, Section 2)

Table 8: VDOT Access Management Design Standards – Accesses Near Interchange Areas

Lane Type	Minimum Spacing (Distance) in Feet	
	X (Right-In/Right-Out)	Y (Four-Legged Intersection)
Multilane	750	1,320

Source: *VDOT Road Design Manual* (Appendix F, Section 2)

Appendix F of the VDOT Road Design Manual define the access points as:

- **Type 1 (Signalized Intersection Spacing)** – applies to spacing from one signalized intersection to another, regardless of the number of intersection legs.
- **Type 2 (Unsignalized Intersection/Full Crossover Spacing)** – applies to spacing from unsignalized intersections to other signalized and unsignalized intersections. Full median crossovers qualify as unsignalized intersections, but three-leg intersections do not.
- **Type 3 (Full Access/Directional Crossover Spacing)** – applies to spacing from full access/directional crossovers to other signalized intersections, unsignalized intersections, full accesses, and directional median crossovers. Three-leg unsignalized accesses qualify if no turning movements are restricted. If restricted, the three-leg unsignalized access do not qualify.
- **Type 4 (Partial Access Spacing)** – applies to spacing from partial access to other signalized intersections, unsignalized intersections, full accesses, directional crossovers, and partial accesses. Partial accesses include right-in/right-out and can be one-way or two-way. Three-leg accesses with restricted movements qualify.
- **X (Right-In/Right-Out)** – Distance to the first access on the right from end of off-ramp terminal or distance from last access on the right to start of on-ramp terminal; right-in/right-out only
- **Y (Four-Legged Intersection)** – Distance to first four-legged intersection measured from the end of the off-ramp terminal or from the start of the terminal for the on-ramp

Henrico County traffic engineering policies were also reviewed for access management design standards. The Henrico County access management standards applicable to South Laburnum Avenue in the study area and the assumed VDOT type equivalent are listed in ***Table 9***.

Table 9: Henrico County Access Management Design Standards

Classification	Minimum Spacing (Distance) in Feet		
	Signalized Intersection	Median Break	Access Point
VDOT Appendix F Equivalent	**Type 1**	**Type 2**	**Type 4**
Major Arterial	1,320	800	250

Source: *Henrico County Traffic Engineering Policies* (Intersection Design and Private Access at the intersection of a Public Road)

Table 10 summarizes the access points along the corridor. The study corridor has a total of 56 access points, 70% of which do not meet VDOT spacing standards for intersections, crossovers, and access points near interchanges. The complete existing access management review is provided in ***Appendix F***.

Table 10: Access Point Type and Spacing

Access Point Type	Access Management Spacing Met?		Total
	Yes	No	
Signalized	2	4	6
Unsignalized/Full Crossover	1	2	3
Full Access/Directional Crossover	1	1	2
Partial Access	13	32*	45
Total	**17**	**39**	**56**

* 35 partial access points meet Henrico County spacing standards

3.3 Traffic Analysis Assumptions

A traffic operations analysis was conducted to evaluate the overall performance of the study corridor under existing (2021) AM and PM peak hour conditions. Existing conditions were modeled using Synchro 10 and SimTraffic 10.

The existing AM and PM Synchro models were developed based on the existing roadway geometry, collected traffic count data, and appropriate GRTC bus service schedules. Inputs and analysis methodologies were consistent with the VDOT *Traffic Operations and Safety Analysis Manual (TOSAM),* Version 2.0. Intersection control for all signalized study intersections is actuated-coordinated. The AM and PM peak hour existing conditions SimTraffic models were calibrated based on the simulated traffic volumes and queue lengths according to the guidance and direction provided in the *TOSAM*. A detailed list of the calibration assumptions is provided in ***Appendix G***.

3.4 Level of Service Criteria

The intersection Level of Service (LOS) is a qualitative measure that describes a driver's perception of the operating conditions. LOS ratings range from A to F. LOS A indicates little or no congestion and LOS F indicates severe congestion, unstable traffic flow, and/or stop-and-go conditions.

Table 11 summarizes the LOS corresponding to the delay at unsignalized and signalized intersections as specified in the HCM. The delay criteria for LOS differs slightly for unsignalized and signalized intersections due to driver expectations and behavior. For signalized intersections, LOS is calculated as the lost travel time caused by vehicles waiting at a traffic signal. For unsignalized intersections, LOS is calculated by determining the number of gaps that are available in the conflicting traffic stream, since the LOS analysis assumes that the traffic on the mainline is not affected by traffic on the side street.

Table 11: Level of Service Criteria

Level of Service	Control Delay (seconds/vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤ 10.0	≤ 10.0
B	> 10.0 to 20.0	> 10.0 to 15.0
C	> 20.0 to 35.0	> 15.0 to 25.0
D	> 35.0 to 55.0	> 25.0 to 35.0
E	> 55.0 to 80.0	> 35.0 to 50.0
F	≥ 80.0	≥ 50.0

HCM 6th Edition Exhibit 19-8 (Signalized Intersections), Exhibit 20-1 (Unsignalized Intersections)

3.5 Traffic Analysis Results

Ten simulations were conducted for both the AM and PM models. The VDOT *Sample Size Determination Tool* was used to confirm the number of SimTraffic model runs necessary. The *Sample Size Determination Tool* results and full Synchro and SimTraffic reports are included in ***Appendix G***.

The following measures of effectiveness were selected to quantitatively report the performance of each study intersection:

- Control delay (seconds per vehicle) and LOS
- Maximum queue length (feet)

Figure 8 and ***Figure 9*** show depictive representations of the control delay and queue length for each study intersection during the AM and PM peak hours. Tables summarizing the delay and queue by lane group, approach, and intersection are provided in ***Appendix G***.

Figure 8: 2021 Existing Peak Hour Control Delay and LOS

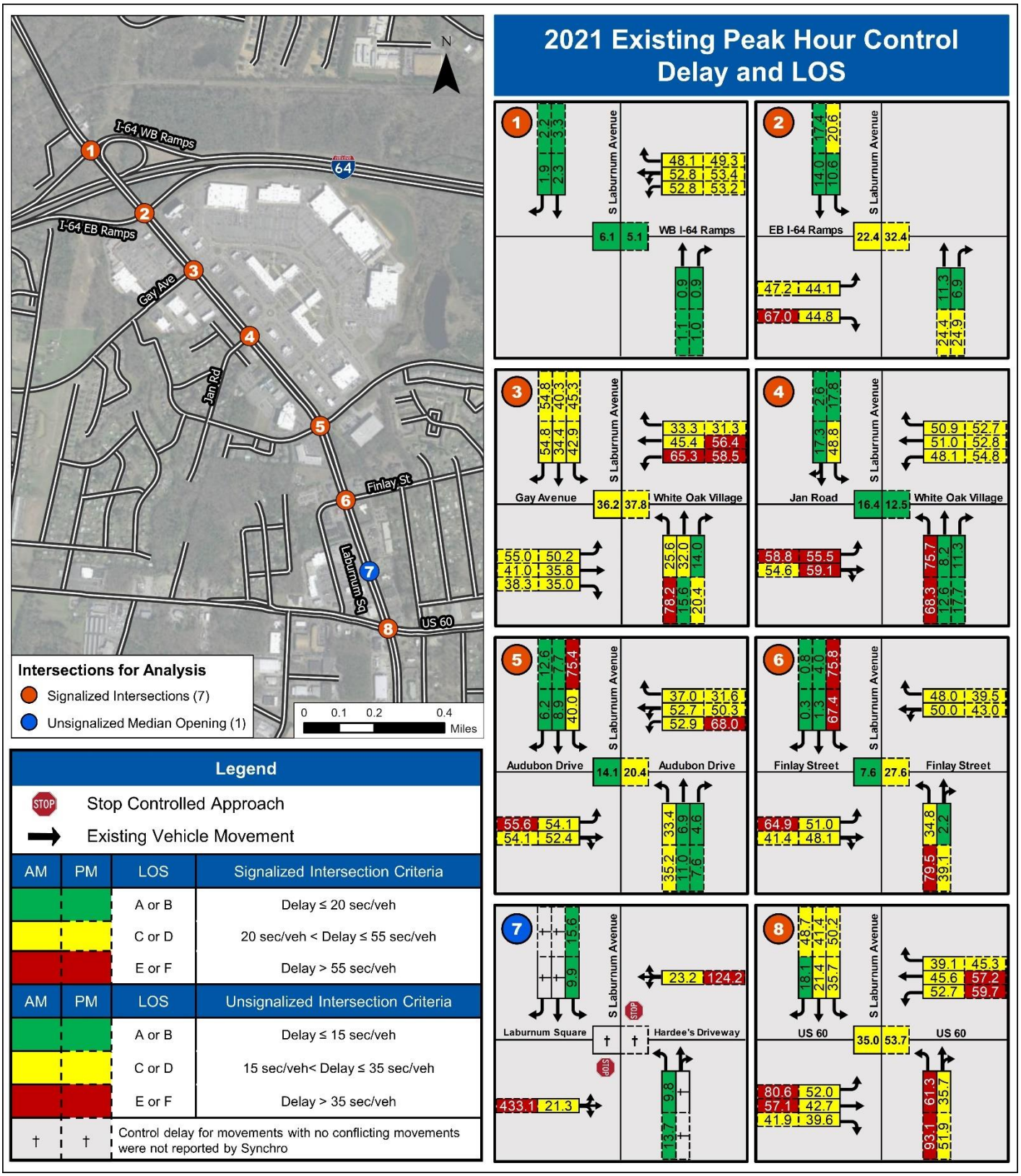
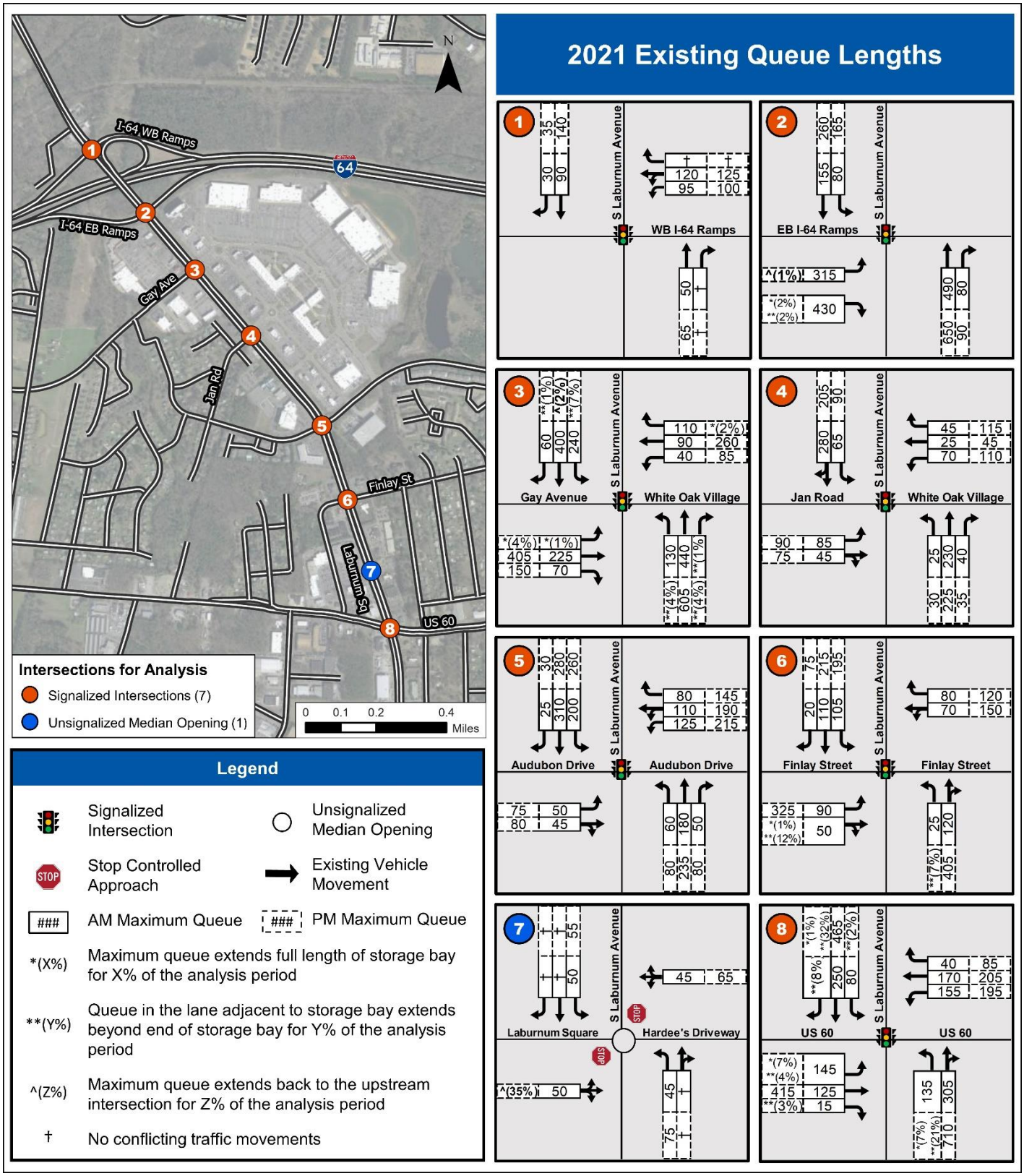


Figure 9: 2021 Existing Queue Lengths



3.5.1 Control Delay and Level of Service

The HCM 2000 methodology was selected to analyze all signalized intersections, and the HCM 2010 methodology was selected to analyze the one unsignalized intersection. Under existing conditions, signalized intersections operated at an overall LOS C or better except at the following locations:

- Gay Avenue (AM and PM)
- US 60 (Williamsburg Road) (PM)

The following approaches operated at an LOS of E or F under existing conditions:

- Eastbound at Eastbound I-64 Ramps (PM peak hour)
- Eastbound at Jan Road (AM and PM peak hour)
- Eastbound at Finlay Street (PM peak hour)
- Eastbound and westbound at Laburnum Square (PM peak hour)
- Eastbound and northbound at US 60 (PM peak hour)

3.5.2 Queue Length

Queue length measures how efficiently each intersection processes traffic and indicates whether turn lanes have adequate storage to accommodate turning vehicles. No queue length was reported for movements without conflicting traffic volumes. Where intersections or lane blockages occur, queue lengths are reported in ***Figure 9*** as follows:

- *(X%) – Maximum queue extends full length of storage bay for X% of the analysis period
- **(Y%) – Queue in the lane adjacent to storage bay extends beyond end of storage bay for Y% of the analysis period
- ^(Z%) – Maximum queue extends back to the upstream intersection Z% of the analysis period

Under existing conditions, the following intersection approaches experienced notable observed queuing during the AM and/or PM peak hours:

- Eastbound right at Eastbound I-64 Ramps (AM peak hour)
- Northbound through at Eastbound I-64 Ramps (AM and PM peak hour)
- Eastbound through at Gay Avenue (PM peak hour)
- Northbound through at Gay Avenue (AM and PM peak hour)
  - The queue blocked the left and right turn lanes for 4% of the PM peak hour
- Southbound through at Gay Avenue (AM and PM peak hour)
  - The queue blocked the left turn lane for 7% of the PM peak hour and the right turn lane for 1% of the PM peak hour
- Northbound through/right at Finlay Street (PM peak hour)
  - The queue blocked the left turn lane for 7% of the PM peak hour

Additionally, long queues extended the full length of the storage lane and/or blocked adjacent lanes at the following locations:

- Eastbound left at Finlay Street extended the full length of the storage lane for 12% of the PM peak hour and blocked the through/right lane
- Eastbound left at US 60 extended the full length of the storage lane for 7% of the PM peak hour and was blocked by the through lane queue for 4% of the PM peak hour

- Northbound left at US 60 extended the full length of the storage lane for 7% of the PM peak hour and was blocked by the through lane queue for 21% of the PM peak hour
- Southbound through at US 60 blocked the left and right turn lanes for 32% of the PM peak hour

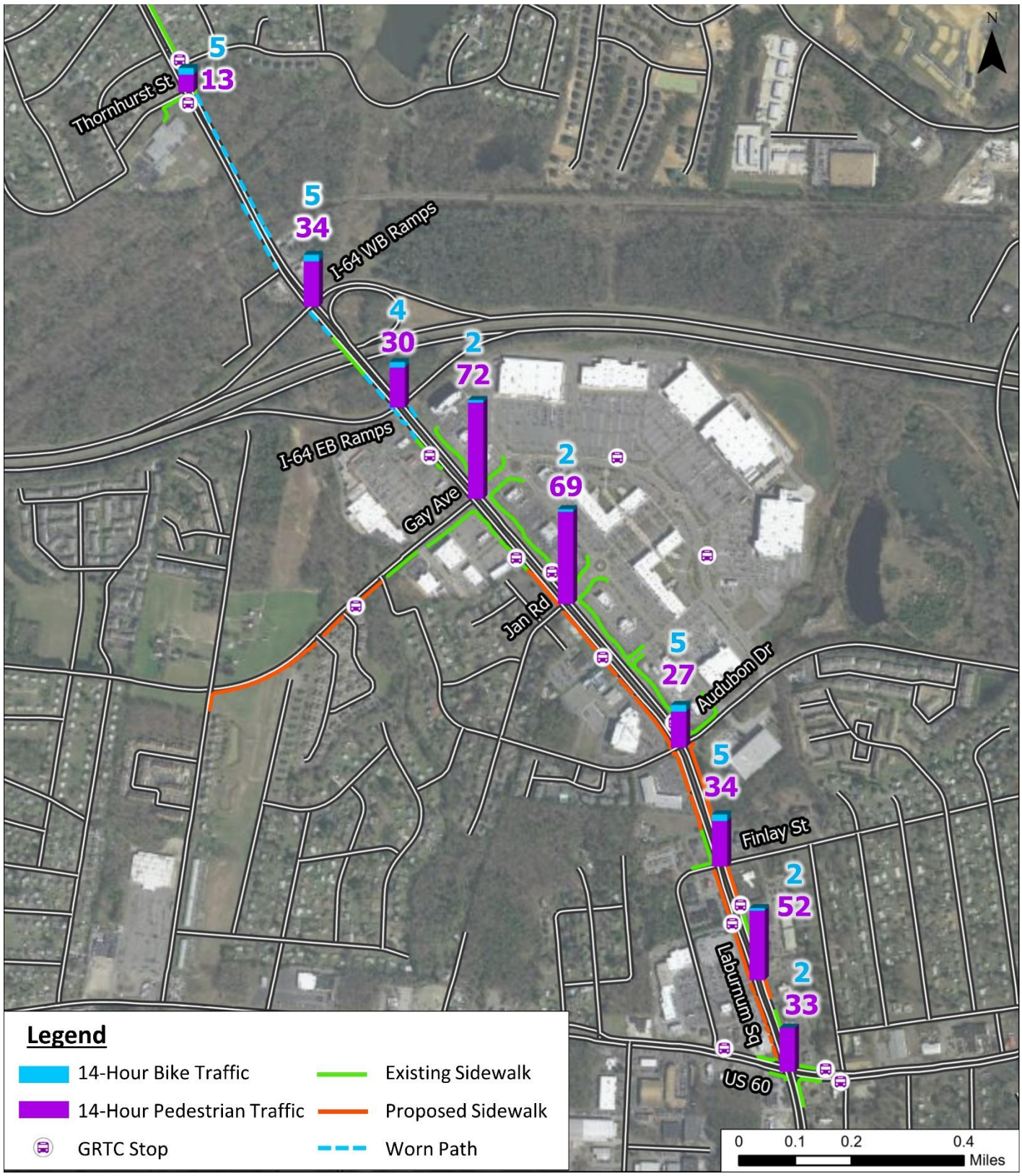
3.6 Pedestrian, Bicycle, and Transit Activity

The pedestrian data collected showed pedestrian and bicycle activity throughout the corridor, with the highest pedestrian transit activity along South Laburnum Avenue between Gay Avenue and Jan Road. While not captured in the pedestrian and bicycle counts, the study team observed several pedestrians crossing in the middle of the block, most notably across South Laburnum Avenue between Gay Avenue and Jan Road. Bicycle activity was less prominent than pedestrian activity, which could be attributed to the data being collected in the middle of January. The study team observed pedestrian activity along all segments of the corridor, regardless of the existing facilities and accommodations. ***Figure 10*** shows the existing pedestrian and bicycle activity along the study corridor.

A preliminary review of 2020 GRTC ridership data showed that routes 7A/7B and 91 had the highest ridership along the corridor, with riders most frequently using the bus stops at Jan Road, Laburnum Square, and Gay Avenue. Overall ridership in 2020 throughout the corridor remained steady when compared to 2019 ridership data, while ridership on routes 56 and 28x declined (Route 28x was discontinued during the COVID-19 pandemic). The preservation of ridership through the pandemic suggests that there is significant transit dependence in the study area.

Pedestrian and bicycle data collection, field observations, and transit ridership data suggest notable pedestrian and transit activity within the corridor and point to the need for pedestrian and transit facility improvements.

Figure 10: 2021 Existing 14-Hour Pedestrian and Bicycle Activity



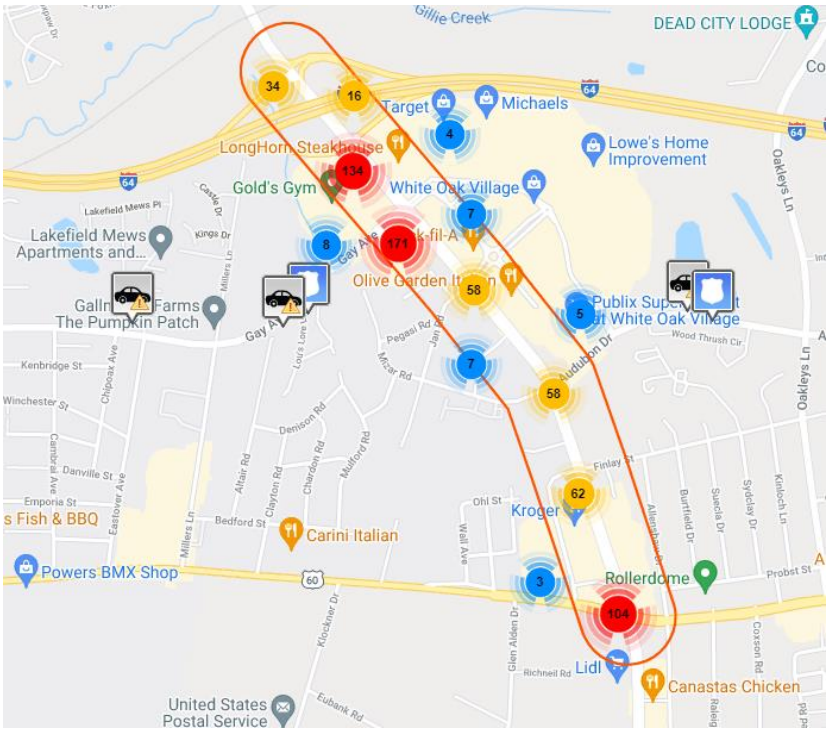
3.7 Existing Conditions MetroQuest Survey Feedback

The South Laburnum Avenue MetroQuest survey was held from March 27 to April 23, 2021 to collect feedback on existing traffic, safety, transit, and bicycle and pedestrian issues within the study corridor. Feedback from the survey is summarized in ***Appendix G***.

535 people participated in the survey. Participants ranked traffic congestion and vehicular safety as the two most important issues along the corridor. Additionally, sidewalks, crosswalks, and pedestrian signals were identified as the greatest facilities needed.

Figure 11 displays locations within the study corridor where respondents indicated a congestion, mobility, or safety issue. The highest number of markers were located at the Eastbound I-64 Ramps and Gay Avenue.

Figure 11: MetroQuest Survey Map Markers



EASTBOUND I-64 RAMPS

- Survey participants noted that drivers use the drop lane to eastbound I-64 as a bypass lane, or are unaware that it drops, which causes last minute lane changes and creates backups
- Nearly 65% of crashes were rear-ends, many of which occurred northbound

GAY AVENUE

- Survey participants noted that traffic at westbound Gay Avenue backs up through the traffic circle at White Oak Village
- Survey participants noted that many vehicles run red lights
- Survey participants noted that missing crosswalks to/from White Oak Village
- Typical patterns involved vehicles making a southbound left into White Oak Village running red lights or colliding with vehicles that had not cleared the intersection

3.8 Existing Conditions Summary

Key takeaways from the existing conditions analysis include the following:

- Rear end and angle crashes were most predominant along the corridor. Most rear end crashes were related to congestion.
- All pedestrian and bicycle crashes occurred at or near signalized intersections.
- Pedestrian activity occurred along the entire study corridor regardless of the existing facilities and accommodations.
  - Transit stops were primarily accessed by pedestrians and cyclists and were at times disconnected from safe walking and biking facilities.
- Sub-optimal coordination between signals on the corridor termini contributed to poor traffic operations, notably queues that extended to upstream intersections.
- Limited wayfinding signage exists to guide motorists onto I-64 from South Laburnum Avenue.
- 70% of the 56 access points along the commercialized corridor do not meet VDOT spacing standards.

4 TRAFFIC FORECASTING

To understand future traffic conditions in the study area and assess the long-term benefits of proposed improvements, traffic volumes were forecasted for 2045 traffic conditions. The following sections describe the methodology for developing traffic growth rates and projecting future traffic volumes for the study area. Traffic forecasting growth rates are summarized in ***Appendix H.***

4.1 Traffic Growth Rate Development

The following sources were reviewed to determine the growth rates to apply to existing traffic volumes to forecast future (2045) traffic volumes:

- **Richmond TPO Regional Travel Demand Model (TDM)**
  Outputs from the Richmond TPO Regional TDM, which included base year data from 2017 and future year data from 2045, were adjusted using NCHRP-765 methodologies that incorporate project-specific and VDOT project traffic count data to calibrate future volume projections. Using the adjusted future year (2045) TDM output and existing available count data, linear growth rates for the study area were developed.

- **Historical traffic count data**
  Historical traffic count data were sourced primarily from official VDOT historical AADT counts. Trends were identified between years of significant development or regression, outliers were removed, and a linear regression analysis was performed to produce linear growth rates for segments throughout the study area.

- **STARS US 60 (Williamsburg Road) Study**
  The STARS US 60 Study overlaps the STARS South Laburnum Avenue Study at the intersection of US 60 and South Laburnum Avenue. Final approved growth rates from the STARS US 60 study were reviewed and compared to the 2017-2045 Richmond TPO Regional TDM and historical data. Growth rates were developed for the US 60 corridor to forecast future 2030 traffic volumes.

- **Socioeconomic data**
  Population and employment data from traffic analysis zones (TAZ) in the 2017-2045 Richmond TPO Regional TDM were reviewed and compared to the linear traffic growth rates developed with the 2017-2045 Richmond TPO Regional TDM.

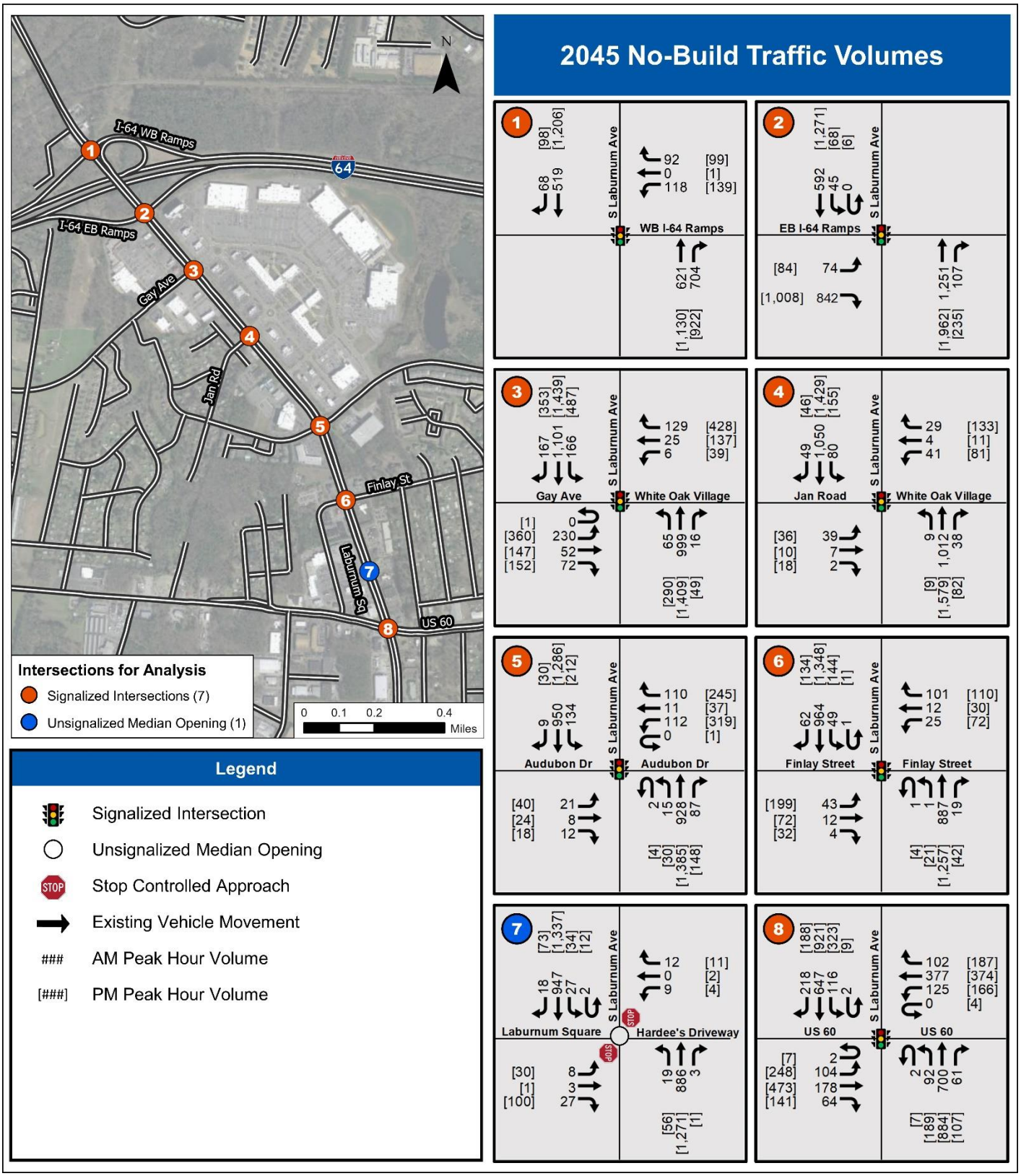
Except for the segment of South Laburnum Avenue north of I-64, historical traffic volumes showed flat growth along the corridor over the past 20 years due to nominal changes in population and employment. However, future trends identified in the TDM indicate a change in this pattern for the coming years. The Richmond TPO Regional TDM projected traffic growth at around 0.50% per year throughout the study corridor from US 60 to I-64 and 1.00% north of I-64. The SWG reviewed the traffic forecasts and growth rates on May 12, 2021, and reached consensus to apply the following:

- 1.00% linear growth rate applied to traffic on South Laburnum Avenue north of I-64
- 0.50% linear growth rate applied to traffic on South Laburnum Avenue and side streets between I-64 and US 60
- 0.50% linear growth rate applied to traffic on the western leg of South Laburnum Avenue and US 60
- 1.00% linear growth rate applied to traffic on the eastern leg of South Laburnum Avenue and US 60

4.2 Projected 2045 Traffic Volumes

Linear traffic growth rates were applied to the 2019 existing traffic volumes to generate projected 2045 traffic volumes. The projected traffic volumes were balanced throughout the study network using the same methodology as ***Section 2.7.4***. The projected 2045 AM and PM peak hour traffic volumes are summarized in ***Figure 12***.

Figure 12: 2045 No-Build Traffic Volumes



5 No-Build Conditions Analysis

Traffic operational analyses were conducted to evaluate the overall performance of the study corridor under No-Build (2045) AM and PM peak hour conditions. The intent of the No-Build conditions analyses was to provide a general understanding of the baseline future traffic conditions as a starting point for developing future improvement strategies. No-Build conditions were modeled using Synchro 10 and SimTraffic 10.

5.1 Background Improvements

Henrico County has plans for multiple improvements within the study area. The following improvements are projected to be completed before 2045 and were included in the No-Build Synchro models:

- US 60 (Williamsburg Road Pedestrian and Transit Improvements) – SMART SCALE funds
- South Laburnum Avenue Sidewalk Projects (between Gay Avenue and US 60) – Revenue Sharing funds

The No-Build Synchro models incorporated new pedestrian signal timings along South Laburnum Avenue between Gay Avenue and US 60 and revised lane geometries at South Laburnum Ave and US 60 to account for these funded projects.

5.2 Traffic Analysis Assumptions

The existing conditions Synchro models were used as a basis to develop the No-Build models for the AM and PM peak hour conditions. The only geometric or traffic signal timing changes made to the models within the study area were those listed in ***Section 5.1***. ***Appendix I*** details the background improvements included in the No-Build (2045) models.

The models were updated with the projected 2045 No-Build traffic volumes. Traffic signal cycle lengths and splits were assumed to be consistent with existing conditions. No-Build inputs and analysis methodologies were applied consistently with the *TOSAM*.

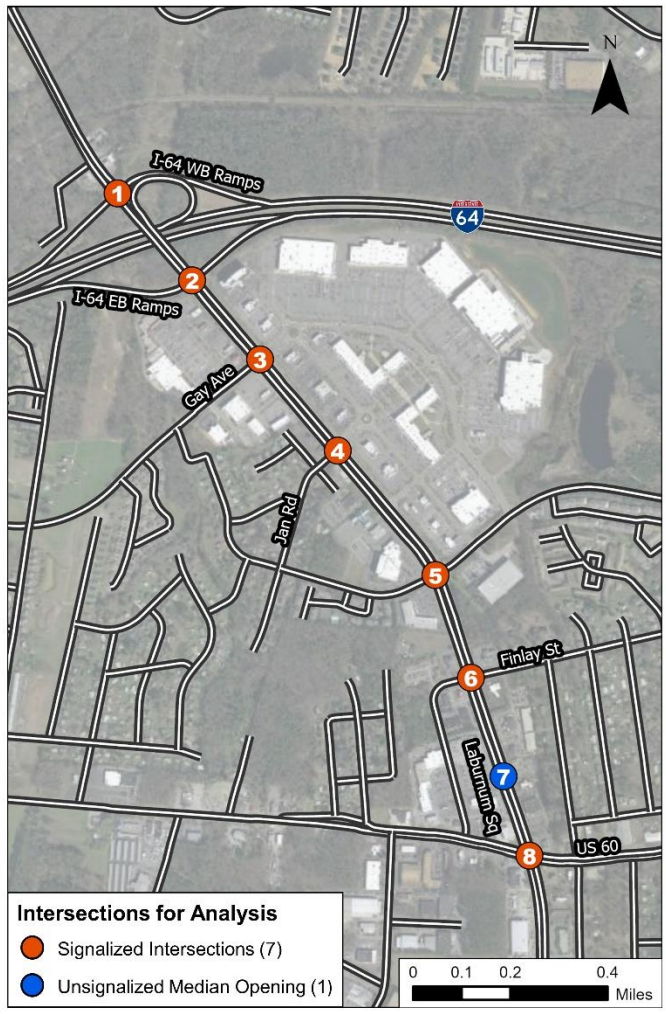
5.3 Traffic Analysis Results

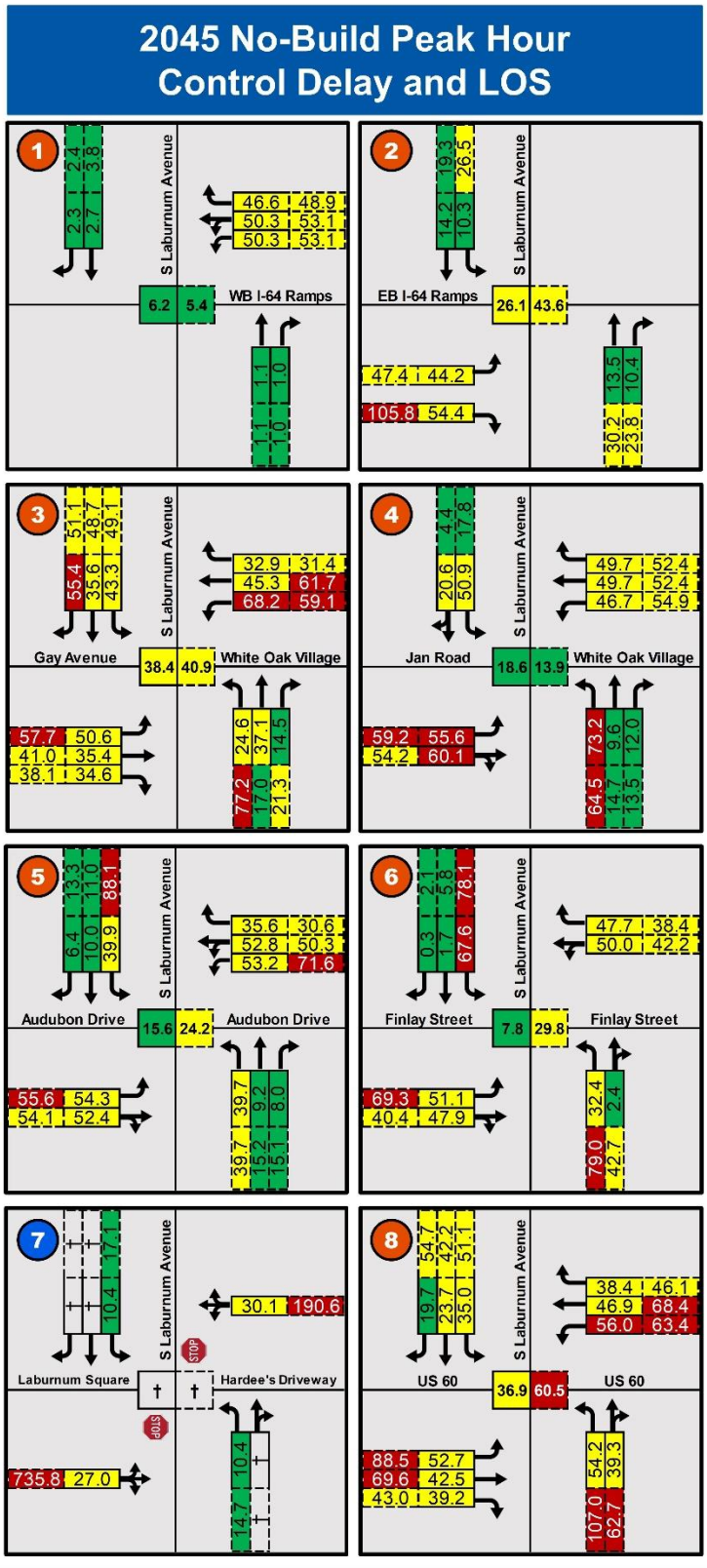
Ten simulations were conducted for both the AM and PM No-Build models. The same measures as the existing conditions analysis were reported for the No-Build analysis:

- Control delay (seconds per vehicle) and LOS
- Maximum queue length (feet)

Figure 13 and ***Figure 14*** show depictive representations of the control delay and queue length for each study intersection during the AM and PM peak hours. Tables summarizing the delay and queue by lane group, approach, and intersection are provided in ***Appendix I***.

Figure 13: 2045 No-Build Peak Hour Control Delay and LOS





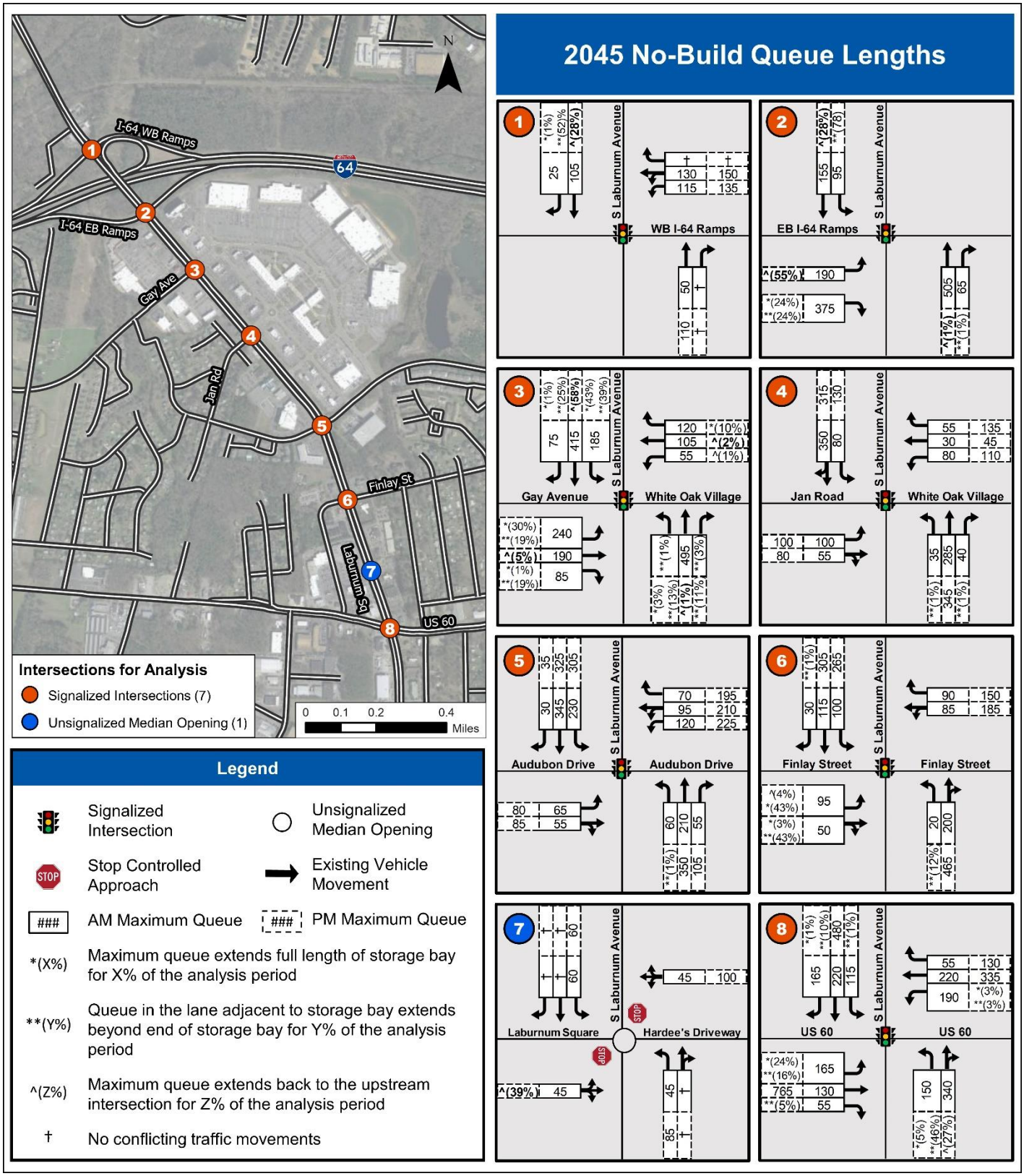
Legend

STOP Stop Controlled Approach

Existing Vehicle Movement

AM	PM	LOS	Signalized Intersection Criteria
		A or B	Delay ≤ 20 sec/veh
		C or D	20 sec/veh < Delay ≤ 55 sec/veh
		E or F	Delay > 55 sec/veh
AM	PM	LOS	Unsignalized Intersection Criteria
		A or B	Delay ≤ 15 sec/veh
		C or D	15 sec/veh< Delay ≤ 35 sec/veh
		E or F	Delay > 35 sec/veh
†	†	Control delay for movements with no conflicting movements were not reported by Synchro	

Figure 14: 2045 No-Build Queue Lengths



5.3.1 Control Delay and Level of Service

HCM 2000 methodology was selected to analyze all signalized intersections, and HCM 2010 methodology was selected to analyze the one unsignalized intersection. Under No-Build conditions, signalized intersections operated at an overall LOS C or better except at the following locations:

- I-64 Eastbound Ramps (PM)
- Gay Avenue (AM and PM)
- US 60 (Williamsburg Road) (AM and PM)

The following approaches operated at an LOS of E or F under No-Build conditions:

- Eastbound at I-64 Eastbound Ramps (PM peak hour)
- Eastbound at Jan Road (AM and PM peak hour)
- Eastbound at Finlay Street (PM peak hour)
- Eastbound, westbound, and northbound at US 60 (Williamsburg Road) (PM peak hour)

5.3.2 Queue Length

Queue length measures how efficiently each intersection processes traffic and indicates whether turn lanes have adequate storage to accommodate turning vehicles. No queue length was reported for movements without conflicting traffic volumes. Under No-Build conditions, the following intersection approaches experienced notable queueing during the AM and/or PM peak hours:

- **Southbound through at Westbound I-64 Ramps (PM peak hour)**
  - The queue blocked the right turn lane for 52% of the PM peak hour
- **Eastbound I-64 Ramps**
  - Northbound through (AM and PM peak hour)
  - Southbound through (PM peak hour)
    - The queue blocked the left turn lane for 78% of the PM peak hour
- **Gay Avenue**
  - Northbound through (PM peak hour)
    - The queue blocked the left turn lane for 13% of the PM peak hour and the right turn lane for 11% of the PM peak hour
  - Southbound left (PM peak hour)
    - The queue spilled back onto southbound South Laburnum Avenue which caused queues to extend out of the network on southbound South Laburnum Avenue and eastbound on Eastbound I-64 Ramps

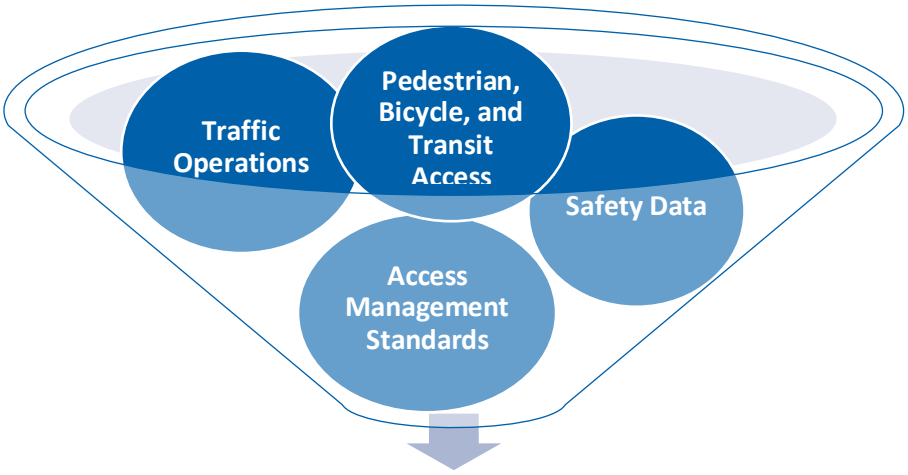
Additionally, long queues extended the full length of the storage lane and/or blocked adjacent lanes at the following locations:

- Eastbound right turn at Eastbound I-64 Ramps extended the full length of the storage lane for 24% of the PM peak hour
- Southbound left turn at Gay Avenue extended the full length of the storage lane for 43% of the PM peak hour and was blocked by the through lane queue for 39% of the PM peak hour
- Eastbound left turn at Gay Avenue extended the full length of the storage lane for 30% of the PM peak hour and blocked the through/right lane
- Eastbound left turn at Finlay Street extended the full length of the storage lane for 43% of the PM peak hour
- Eastbound left turn at US 60 extended the full length of the storage lane for 24% of the PM peak hour and was blocked by the through lane queue for 16% of the PM peak hour
- Northbound left turn at US 60 extended the full length of the storage lane for 5% of the PM peak hour and was blocked by the through lane queue for 46% of the PM peak hour

6 Concept Development and Screening

Improvement concepts were developed to address safety, access, geometric, and operational deficiencies along the study corridor identified in the field review, Existing and No-Build analyses, as well as documented by the public in the MetroQuest survey. Concepts were vetted through internal meetings, shared with the SWG at a concept development meeting and the public via a second MetroQuest survey, and then screened based on operational analyses results and feedback from the SWG. Based on the screening results, final concepts were agreed upon during a SWG concept development virtual meeting and follow-up email communication. Further traffic and safety analysis, conceptual design, cost estimates, and approximate schedules were developed for these preferred improvement projects. ***Figure 15*** summarizes the components that were considered to develop preliminary concepts.

Figure 15: Concept Development Process



6.1 Improvements Concept Screening

Potential corridor-wide improvements that consisted of signing, pavement markings, signal timing, and multimodal facilities were first considered and are summarized in ***Table 12***. Based on an initial review, the study team recommended to conduct a RRFB/HAWK warrant analysis at South Laburnum Avenue and Thornhurst Street with new pedestrian count data once the latest IIM-TE-384 (Pedestrian Crossing Accommodations at Unsignalized Approaches) is released.

Improvements were also considered for each intersection that consisted of both traditional capacity improvements, such as additional turn lanes, and innovative intersection improvements. Innovative intersections improve traffic operations and safety by modifying the way vehicles, bicyclists, and pedestrians navigate an intersection compared to a traditional design. ***Table 13*** summarizes the potential intersection concepts considered. Each concept was analyzed using Synchro 10 to evaluate the operational benefits of the improvements. The change in delay was calculated for each approach to compare traffic operations to No-Build conditions. Experienced travel time (ETT) was calculated following methodologies provided in the HCM 6th Edition for innovative intersection designs that involved diverting traffic movements to other intersections.

Table 12: Potential Corridor-Wide Concepts Considered

Improvement	Description	Recommended Alternative
Signal retiming and corridor optimization	Signal retiming and optimization along study corridor	Yes
	Memorandum of Understanding and traffic signal performance measures	Yes
Signing and pavement markings	Install pavement markings, wayfinding signages, and right turn on red prohibition signage from Gay Avenue to I-64 Eastbound Ramps	Yes
Sidewalk and access management	Connect sidewalk from Thornhurst Street to Gay Avenue along both sides of South Laburnum Avenue; close driveways near the I-64 Westbound Ramps; and install crosswalk along the southbound approach at the intersection with the I-64 Westbound Ramps	Yes
	Pedestrian crossing at Thornhurst St	No*
Bus stop amenities	Upgrade GRTC bus stops along the corridor	Yes
Park and ride lot	Expand and continue to formalize the GRTC Park and Ride Lot located in White Oak Village	Yes
Bicycle infrastructure	Buffered bike lane and/or shared-used path on Millers Lane-Gay Avenue corridor	Yes**

*It is recommended to conduct a RRFB/HAWK warrant analysis with new pedestrian count data.
**Design dependent on the recommendations proposed in the Henrico County Bicycle Master Plan.

Table 13: Potential Intersection Concepts Considered

Intersection	Concept	Recommended Alternative
I-64 Westbound Ramps	Reconfigure channelized westbound right turn lane	Yes
I-64 Eastbound Ramps	Northbound shared through/right lane	No
Gay Avenue	Extend southbound left turn lane	Yes
	Thru-Cut	Yes
	Signing, safety, and access management improvements	Yes
Jan Road	Puppy tracks, striping, and pedestrian accommodations	Yes
	Bowtie	No
	Thru-Cut	Yes
Audubon Drive	Puppy tracks, striping, and pedestrian accommodations	Yes
	Quadrant Roadway	No
	Bowtie	No
	Restricted Crossing U-Turn (RCUT)	No
	Thru-Cut	No
Finlay Street	Conventional turn lane improvements	Yes
	Thru-Cut	No
Laburnum Square	Sidewalk and buffer space improvements	No
	Directional northbound/southbound median opening	Yes
	Directional southbound median opening	No
	Full closure	No

Crash modification factors (CMFs) were reviewed to determine the potential safety benefits of each alternative. CMFs were selected from the approved list of CMFs applied during the VDOT SMART SCALE safety scoring process. An anticipated safety benefit was estimated based on the reduction in vehicular conflict points for configurations without an approved CMF.

6.2 Concept Development Meetings

The SWG participated in a concept development meeting on August 4, 2021 to review the traffic analysis results, safety benefits, and geometric considerations for each potential concept. Each concept was compared against the optimized No-Build condition. The meeting presentation is provided in ***Appendix J***. The agreed-upon preferred alternatives are summarized in ***Table 12*** and ***Table 13***.

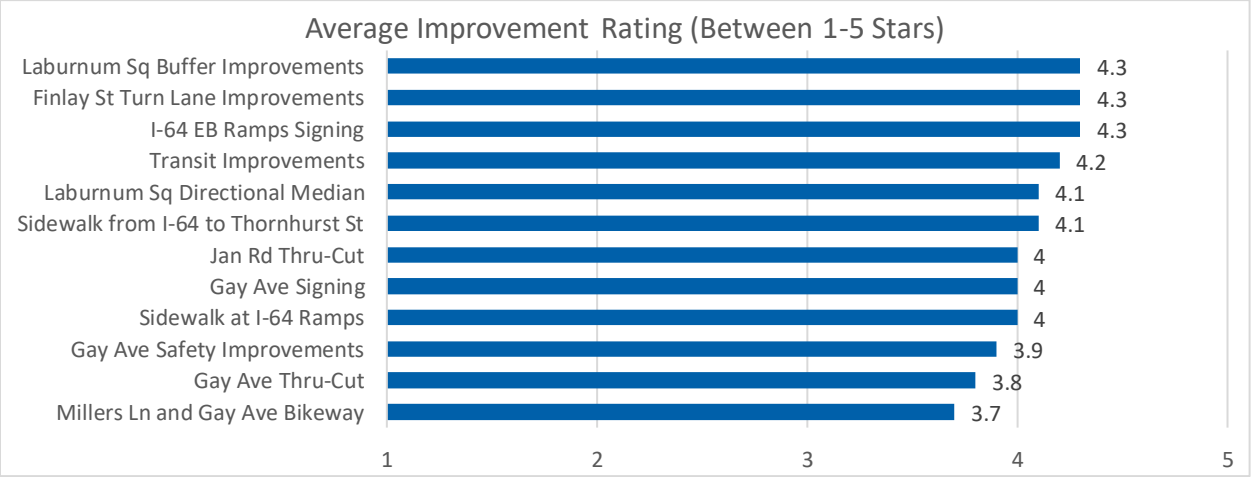
A subset of the SWG participated in a concept development meeting focused on transit-related improvements on November 10, 2021. Recommended improvements at each transit stop were made based on daily ridership and referenced Henrico County's suggested ridership threshold of 7-10 daily boardings for a bench and around 15 daily boardings for a shelter. Materials from the meeting are provided in ***Appendix J***. The following improvements to bus stops along the corridor were proposed:

- Install a boarding/alighting pad, bench, and waste receptacles at GRTC stop #1478 (Thornhurst Street) as well as connect the stop to sidewalk
- Install a boarding/alighting pad, shelter, bench, and waste receptacles at GRTC stops #1474 (Sheraton Hotel), #1472 (Laburnum Square), and #3371 (Finlay Street).

6.3 Concept Screening MetroQuest Survey Feedback

The second MetroQuest Survey was held from October 22 to November 24, 2021 to collect feedback on potential traditional and innovative intersection concepts within the study corridor. The survey provided the SWG with an understanding of how the public viewed each concept before selecting a preferred option. ***Figure 16*** summarizes the average score for each concept presented. A 5.0 score represents highly favorable and a score of 0.0 represents highly unfavorable. The public was in favor of all concepts (indicated by a score ≥ 3.0). Survey results for each concept are summarized in ***Appendix J***.

Figure 16: Average Improvement Concept MetroQuest Rating



7 Recommendations and Build Conditions Analysis

Access management, pedestrian and transit access, and roadway recommendations were identified based on crash history, roadway geometry (horizontal and vertical alignment, turn lane storage lengths, shoulder widths), bicyclist, pedestrian, and transit rider needs, and existing driveway and median opening spacing. Recommendations include signing and pavement markings, sidewalk and access management improvements, signal retiming and optimization, bus stop upgrades and intersection reconfigurations.

Corridor-wide and intersection improvements recommended within the study area are summarized in ***Table 14*** and ***Table 15***, respectively. Additional details for each concept, including safety benefits and cost, are provided in ***Appendix K.*** Planning-level cost estimates were developed using quantities presented in 2022 dollars. A detailed, design-level cost estimate should be prepared once an improvement is advanced to the design phase.

Table 14: Recommended Corridor-Wide Improvements

Improvement	Description
Signal retiming and optimization	Signal retiming and optimization along study corridor
Sidewalk and access management	Connect sidewalk from Thornhurst Street to Gay Avenue along both sides South Laburnum Avenue; close driveways near I-64 Westbound Ramps; and install a crosswalk along the southbound approach at the intersection with the I-64 Westbound Ramps
Bus stop amenities	Install a boarding/alighting pad, bench, and waste receptacles at GRTC stop #1478 (Thornhurst Street) as well as connect the stop to sidewalk. Install a boarding/alighting pad, shelter, bench, and waste receptacles at GRTC stops #1474 (Sheraton Hotel), #1472 (Laburnum Square), and #3371 (Finlay Street).

Table 15: Recommended Intersection Improvements

Intersection	Recommendation
Thornhurst Street	Conduct RRFB/HAWK warrant analysis
I-64 Westbound Ramps	Reconfigure channelized westbound right turn lane
Gay Avenue	Signing, marking, and pedestrian accommodation improvements
	Extend southbound left turn lane
	Thru-Cut
Jan Road	Striping, marking, and pedestrian accommodation improvements
	Thru-Cut
Audubon Drive	Striping, marking, and pedestrian accommodation improvements
Finlay Street	Westbound turn lane reconfiguration
Laburnum Square	Directional median

Corridor-wide signal retiming and optimization

This recommendation includes the retiming, corridor optimization, and calculation of clearance intervals for traffic signals on South Laburnum Avenue from the I-64 westbound ramps to US 60. Due to the prevalence of congestion-related and red-light-running related crashes along the corridor, it is anticipated for the signal timing improvements and clearance interval revisions to provide a safety benefit throughout the corridor. Furthermore, the retiming and optimization effort is expected to improve travel times along the corridor.

Bus Stop Improvements

The proposed transit improvements include the installation of loading pads, benches, shelters, and waste receptacles. The daily ridership at each stop was referenced when making a recommendation for the proposed types of amenities.

GRTC Stop	Max Daily Boardings	Max Daily Alightings	Recommended Amenities			
			Boarding / Alighting Pad	Bench	Trash Can	Shelter
Stop 1464: Laburnum & Finlay	14	4	✔	✔	✔	✔
Stop 1478: Laburnum & Thornhurst	11	67	✔	✔	✔	
Stop 1474: Laburnum & Sheraton Hotel	11	32	✔	✔	✔	✔
Stop 1472: Laburnum & Laburnum Square	13	29	✔	✔	✔	✔

Note: Maximum daily values from May 2019 or January 2021 GRTC ridership reports

South Laburnum Avenue at Thornhurst Street

The study team recommends for the County to conduct a warrant analysis for the implementation of a Rapid Rectangular Flashing Beacon (RRFB) or High-Intensity Activated Crosswalk (HAWK) beacon to provide a signalized crossing for pedestrians across South Laburnum Avenue once the latest IIM-TE-384 (Pedestrian Crossing Accommodations at Unsignalized Approaches) is released. Existing condition pedestrian counts were taken when classes were remote at Adams Elementary School and lacked accurate data for pedestrian activity. New counts should be taken on a school day without inclement or unreasonably cold weather to support the warrant effort.

The study team recommends considering a lighting evaluation following IIM TE-390 guidance at the intersection of South Laburnum Avenue and the I-64 westbound ramps and the I-64 eastbound ramps.

Sidewalk From Thornhurst Street to Gay Avenue

Constructing a sidewalk from Thornhurst Street to Gay Avenue will increase pedestrian safety and connectivity between the northern and southern end of the corridor. Sidewalk is recommended on both sides of South Laburnum Avenue based on observed desired paths and the presence of few opportunities to provide a signalized crossing of South Laburnum Avenue between Thornhurst Street and the I-64 westbound ramps. At the I-64 westbound ramps, the sidewalk will transition to only running along southbound South Laburnum Avenue and will connect to the existing sidewalk on the bridge over I-64. There is insufficient space to provide sidewalk over I-64 along northbound South Laburnum Avenue without modifications to the bridge.

South Laburnum Avenue at I-64 Westbound Ramps

The study team recommends removing the channelized westbound right turn from the I-64 westbound off-ramp. This recommendation is anticipated to reduce the number of angle and rear end collisions related to the merge from the right turn lane to northbound South Laburnum Avenue. Furthermore, it complements the sidewalk improvements on South Laburnum Avenue and reduces the number of conflict points between vehicles and pedestrians.

South Laburnum Avenue at Gay Avenue

It is intended for the southbound left-turn lane extension concept and signing, safety, and access management improvement concept to be implemented together. Henrico County suggested that the proposed bump out be installed with plastic flex-posts to better accommodate six mainline through lanes on South Laburnum Avenue if the County were to further acquire right-of-way.

The Thru-Cut concept is anticipated to provide greater operational and safety benefits than the conventional alternatives. This recommendation includes the extension of the southbound left-turn lane and the incorporation of the signing, safety, and access management improvements other than the right turn on red signage. The Thru-Cut requires a two-stage signalized pedestrian crossing across South Laburnum Avenue on the northbound approach.

South Laburnum Avenue at Jan Road

The conventional improvements at Jan Road include an improved pedestrian crossing across the northbound approach, a new pedestrian crossing across the southbound approach, and puppy tracks for the dual southbound and westbound left turns.

The Thru-Cut requires for a two-stage signalized crossing across South Laburnum Avenue on the northbound and southbound approaches.

South Laburnum Avenue at Audubon Drive

The recommended striping, curb radius extension, and pedestrian improvements are anticipated to improve navigation for vehicles making westbound left turns and trucks making northbound right turns and improve pedestrian safety.

South Laburnum Avenue at Finlay Street

The recommended reconfiguration of the westbound approach and the addition of protected side street left-turn phases with flashing yellow arrows are anticipated to improve safety, especially for movements from the side street.

The recommendation can also incorporate upgrades made to GRTC Stop #1464 and Stop #1472, which includes installing a landing pad, shelter, bench, and waste receptacles.

South Laburnum Avenue at Laburnum Square

The recommendation will remove through movements and left turns from the side streets and is expected to reduce crashes related to these movements.

South Laburnum Avenue at US 60 (Williamsburg Road)

Although failing traffic operations are expected to by 2045, this study did not identify additional improvements at the intersection because it was the focus of the pervious STARS US 60 study. However, the signal retiming and optimization improvement is expected to improve operations at the intersection.

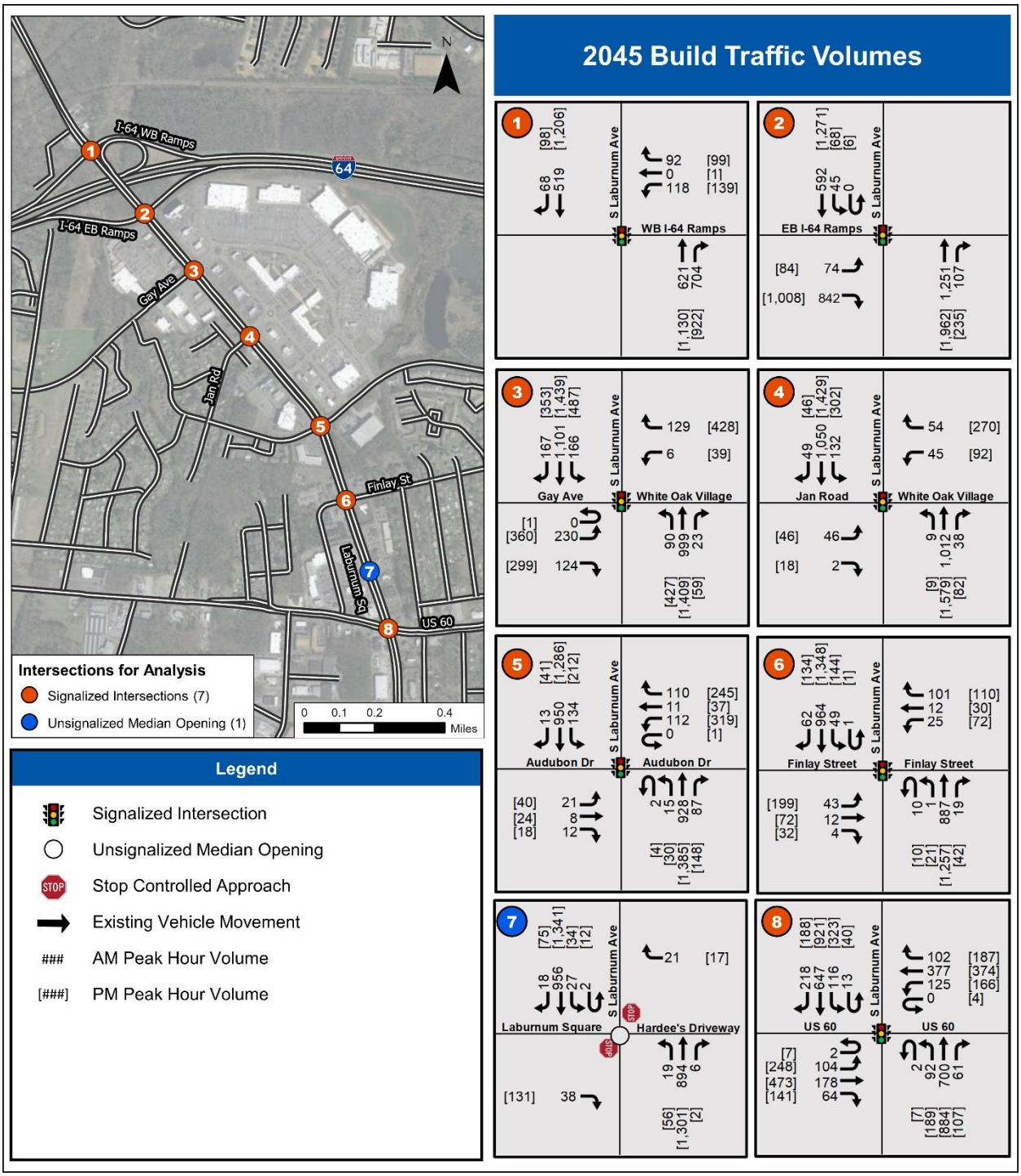
7.1 Traffic Analysis Assumptions

Traffic operational analyses were conducted to evaluate the overall performance of the study corridor under Build (2045) AM and PM peak hour conditions. The intent of the Build conditions analysis was to evaluate the effectiveness of the selected improvement projects and understand how the improvement projects work in conjunction with one another. Build conditions were modeled using Synchro 10 and SimTraffic 10.

Roadway geometric and traffic signal timing adjustments were made to reflect the improvement projects set forth in the preferred Build alternative. The models were also updated with rerouted future traffic volumes to account for traffic movement restrictions. At intersections where proposed through traffic is restricted, through vehicles were assumed to turn left or right to use adjacent streets to reach their destination. The projected 2045 AM and PM peak hour traffic volumes for the Build conditions are summarized in ***Figure 17***.

Traffic signal splits were optimized at all signalized intersections for the Build conditions analysis; however, Build conditions cycle lengths were kept the same as Existing and No-Build conditions.

Figure 17: 2045 Build Traffic Volumes



7.2 Traffic Analysis Results

The Build (2045) condition intersection analysis results are summarized in the following section of the report. Two measures of effectiveness (MOEs) were selected to measure the quantitative performance of the study area intersections:

- Control delay – measured in seconds per vehicle (Synchro 10)
- Maximum queue length by movement – measured in feet (SimTraffic 10)

Figure 18 and ***Figure 19*** show depictive representations of the control delay and queue length for each study intersection during the AM and PM peak hours. Tables summarizing the delay and queue by lane group, approach, and intersection are provided in ***Appendix L***.

Figure 18: 2045 Build Peak Hour Control Delay and LOS

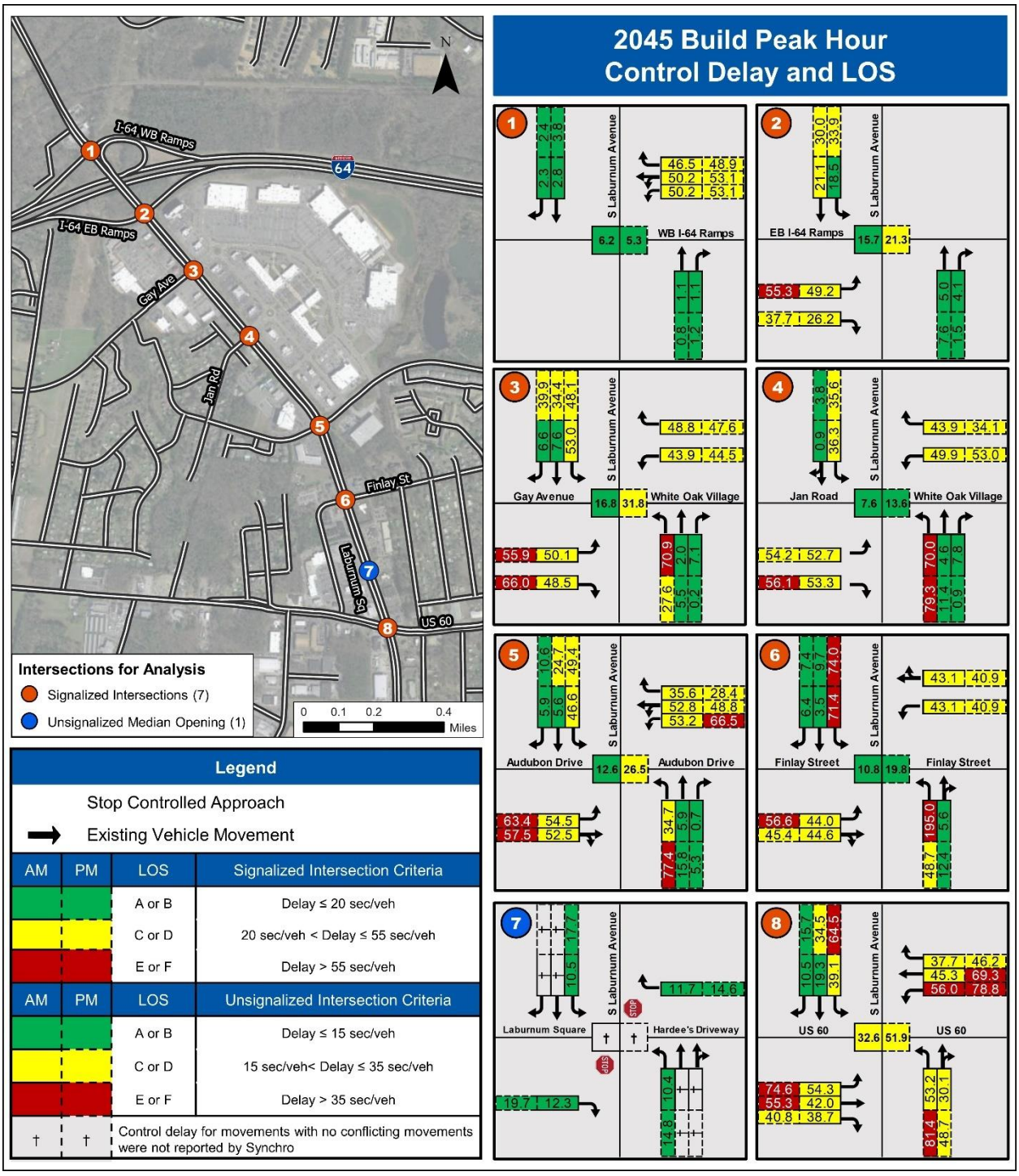
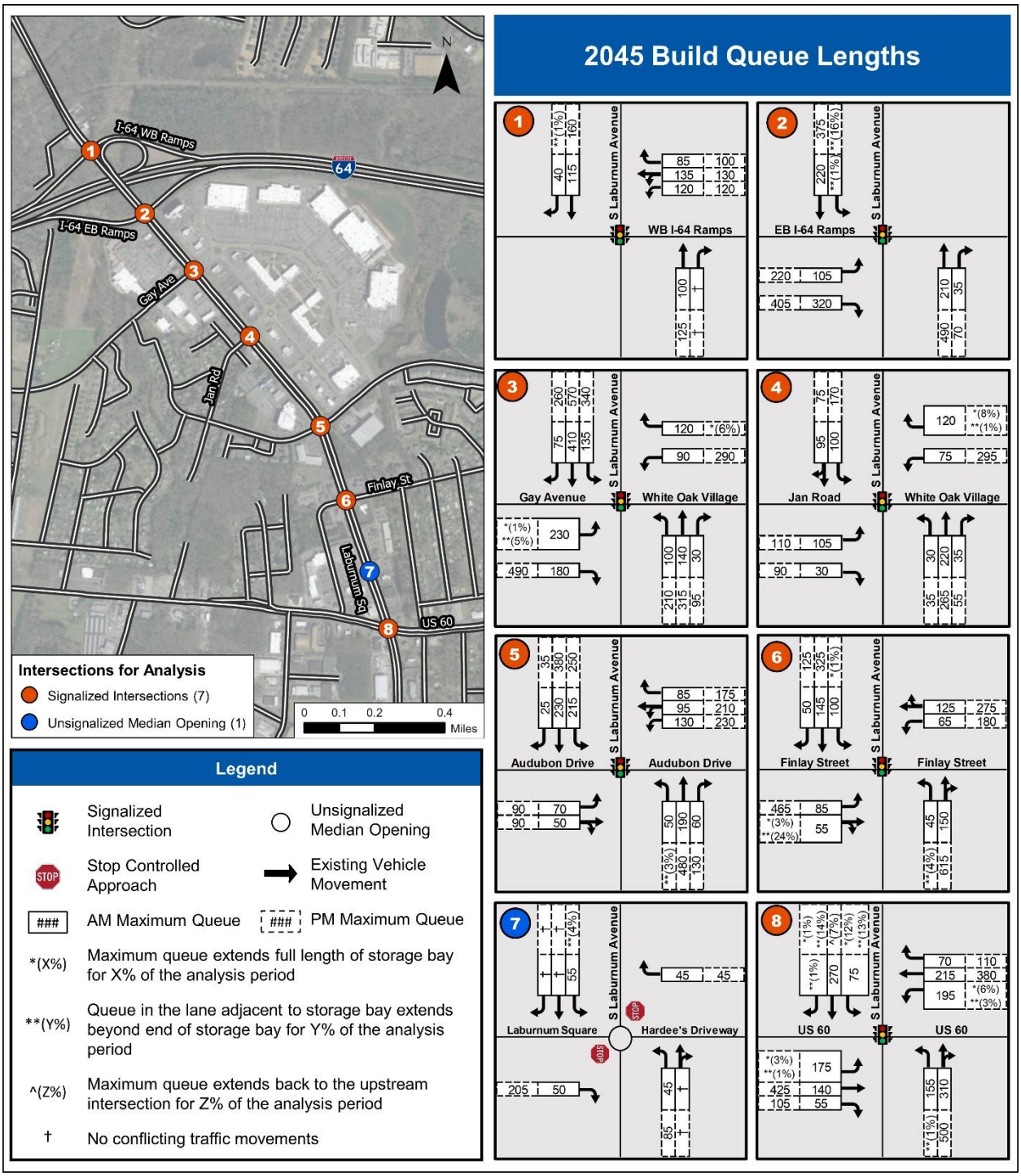


Figure 19: 2045 Build Peak Hour Queue Lengths



7.2.1 Control Delay and Level of Service

HCM 2000 methodology was selected to analyze all signalized intersections, and HCM 2010 methodology was selected to analyze the one unsignalized intersection. The proposed corridor signal retiming and optimization and intersection alternatives largely improved traffic operations throughout the corridor. Under Build conditions, all signalized intersections operated at an overall LOS D or better. ***Table 16*** provides a comparison between No-Build and Build results for approaches with a LOS E or F in either No-Build or Build conditions. All other approaches in the Build condition operate at a LOS D or better. ***Table 17*** and ***Table 18*** provide a comparison between intersection delay results in the No-Build and Build conditions.

Table 16: 2045 No-Build and Build Level of Service Comparison

Intersection	Approach	Peak Hour	2045 Level of Service	
			No-Build	Build
I-64 Eastbound Ramps	Eastbound	PM	F	D
Gay Avenue	Eastbound	PM	D	E
Jan Road	Eastbound	PM	E	D
Audubon Drive	Eastbound	AM	D	E
Finlay Street	Eastbound	PM	E	D
US 60	Eastbound	PM	E	E
	Westbound	PM	E	E
	Northbound	PM	E	D

Table 17: AM Peak Hour Intersection Delay Reduction

South Laburnum Avenue Intersection	Overall Intersection Delay (seconds per vehicle)		
	No-Build (2045)	Build (2045)	Percent Change
I-64 Westbound Ramps	6.2	6.2	0%
I-64 Eastbound Ramps	26.1	15.7	-40%
Gay Avenue	38.4	16.8	-56%
Jan Road	18.6	7.6	-59%
Audubon Drive	15.6	12.6	-19%
Finlay Street	7.8	10.8	+38%
Laburnum Square	--	--	--
US 60	36.9	32.6	-12%

Table 18: PM Peak Hour Intersection Delay Reduction

South Laburnum Avenue Intersection	Overall Intersection Delay (seconds per vehicle)		
	No-Build (2045)	Build (2045)	Percent Change
I-64 Westbound Ramps	5.4	5.3	-2%
I-64 Eastbound Ramps	43.6	21.3	-51%
Gay Avenue	40.9	31.8	-22%
Jan Road	13.9	13.6	-2%
Audubon Drive	24.2	26.5	+10%
Finlay Street	29.8	19.8	-34%
Laburnum Square	--	--	--
US 60	60.5	51.9	-14%

7.2.2 Queue Length

Queue length measures how efficiently each intersection processes traffic and indicates whether turn lanes have adequate storage to accommodate turning vehicles. No queue length was reported for movements without conflicting traffic volumes.

The following list summarizes notable queue results from the Build conditions analysis. ***Appendix L*** provides detailed Build condition queue results.

- **Eastbound I-64 Ramps**
  - Southbound left turn was blocked by the southbound through for 16% of the PM peak hour. Under No-Build conditions, the left turn lane was blocked 78% of the PM peak hour.
- **Gay Avenue**
  - Eastbound left turn was blocked by the right turn lane queue for 5% of the PM peak hour. Under No-Build conditions, the left turn was blocked by the right turn lane queue for 19% of the PM peak hour.
  - Westbound right turn extended the full length of the storage lane for 6% of the PM peak hour. Under No-Build conditions, the right turn extended the full length of storage for 10% of the PM peak hour.
- **Jan Road**
  - Westbound right turn extended the full length of the storage lane for 8% of the PM peak hour.
- **Finlay Street**
  - Eastbound through/right turn was blocked by the left turn lane queue for 24% of the PM peak hour. Under No-Build conditions, the lane was blocked for 43% of the PM peak hour.
- **US 60 (Williamsburg Road)**
  - Westbound left turn extended the full length of the storage lane for 6% of the PM peak hour. Under No-Build conditions, the queue extended the full length of storage for 3% of the PM peak hour.
  - Southbound right turn was blocked by the southbound through for 14% of the PM peak hour. Under No-Build conditions, the right turn lane was blocked for 10% of the PM peak hour.
  - Southbound through queue extended to the upstream intersection (Laburnum Square) for 7% of the PM peak hour.
  - Southbound left turn extended the full length of the storage lane for 12% of the PM peak hour and was blocked by the through lane queue for 13% of the PM peak hour. Under No-Build conditions, the left turn was blocked by the through lane queue for 1% of the PM peak hour.

7.2.3 Travel Time Analysis

Travel time analyses were conducted using SimTraffic results to analyze mobility throughout the study corridor under existing (2021), No-Build (2045), and Build (2045) conditions. The analyses evaluated how well the Study recommendations addressed the need to improve progression and operations on South Laburnum Avenue from US 60 (Williamsburg Road) to the I-64 westbound ramps. The travel time was recorded for each analysis period and summarized in relation to segments of the corridor with recommended improvements.

Table 19 summarizes the corridor-wide travel time across all three scenarios for the AM and PM peak hours. Both directions of travel were projected to experience a decrease in travel time in both peak hours compared to No-Build conditions. The northbound corridor travel time was projected to decrease by approximately 24 percent in the AM and 51 percent in the PM, while the southbound corridor-wide travel time was projected to decrease by approximately 9 percent in the AM and 60 percent in the PM.

Table 19: South Laburnum Avenue Corridor Travel Time Comparison

Direction	AM Peak Hour Travel Time				PM Peak Hour Travel Time			
	Existing (sec)	No-Build (sec)	Build (sec)	Percent Change	Existing (sec)	No-Build (sec)	Build (sec)	Percent Change
Northbound	231.1	249.9	190.3	-23.8%	360.4	545.0	264.2	-51.5%
Southbound	197.4	209.2	190.8	-8.8%	268.6	753.2	301.4	-60.0%

Table 20 compares the No-Build (2045) travel time on South Laburnum Avenue to the travel time if only signal timing and optimization improvements were to be made to the corridor; in other words, this model does not include other Build recommendations. The travel time results for the "Optimized" corridor still show significant improvements compared to No-Build conditions and further highlight the anticipated benefits of implementing a corridor-wide traffic signal retiming and optimization project.

Table 20: South Laburnum Avenue Corridor Travel Time Comparison – Optimized Network Only

Direction	AM Peak Hour Travel Time				PM Peak Hour Travel Time			
	Existing (sec)	No-Build (sec)	Optimized (sec)	Percent Change	Existing (sec)	No-Build (sec)	Optimized (sec)	Percent Change
Northbound	231.1	249.9	199.0	-20.4%	360.4	545.0	327.7	-39.9%
Southbound	197.4	209.2	194.0	-7.3%	268.6	753.2	312.2	-58.6%

7.3 Build Conditions Safety Analysis

The applicable CMFs and potential safety benefit of each recommended improvement, expressed as a reduction in fatal and injury (F+I) crashes, is documented in ***Table 21***. The best applicable CMF was applied to fatal and injury crashes within the influence area of each intersection. A reduction in crashes is expected at all intersections where improvements are recommended.

Table 21: Projected Reductions in Fatal and Injury Crashes

Intersection	EPDO (F+I Crashes Only)	CMF	F+I Crash Reduction
Gay Avenue	395	0.91 (Thru-Cut)	3.1
Jan Road	80	0.91 (Thru-Cut)	0.7
Finlay Street	80	0.85 (Left-Turn Lane Realignment)	1.2
Laburnum Square	185	0.4 (Directional Median)	6.6

The following safety benefits are expected at locations where no CMF is available:

- **Corridor Signal Retiming and Optimization:** Reduced congestion-related collisions and reduced red-light running collisions.
- **South Laburnum Avenue Sidewalk Improvements:** Increased pedestrian safety along South Laburnum Avenue; reduced conflict points along South Laburnum Avenue north of the I-64 westbound ramps; and reduced collisions related to the merging movement on the westbound right turn at the I-64 westbound ramps.
- **Audubon Drive Striping and Marking Improvements:** Reduced left turn angle collisions.

8 Conceptual Design and Cost

Conceptual designs, planning-level cost estimates, and schedule estimates were developed for each recommendation. Conceptual designs were developed in MicroStation for improvement projects along the South Laburnum Avenue corridor in accordance with the following applicable guidelines:

- A Policy on Geometric Design of Highways and Streets (AASHTO 2018)
- Guide for the Development of Bicycle Facilities (AASHTO 2012)
- VDOT Road Design Manual (Issued January 2005, Revised July 2021)
- VDOT Road and Bridge Standards (VDOT 2016, latest revisions)
- Manual on Uniform Traffic Control Devices (MUTCD 2009)
- 2011 Virginia Supplement to the MUTCD

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

A refined planning-level cost estimate, in 2022 dollars, was developed for each recommendation. A 25 percent preliminary engineering (PE) cost was estimated as a percentage of construction contract total. For projects with anticipated right-of-way and/or utility impacts, right-of-way and utility relocation costs were estimated on a project-by-project basis based on the size and complexity of the project, as well as the existing right-of-way limits. Right-of-way estimates utilized publicly available real estate data to generate estimated land values and included allowances for negotiations, allowances, damages, and acquisition consultants. Utility costs were created using VDOT's PCES cost estimating tool. Major items construction costs were estimated based on recent bid costs from VDOT and County projects. In addition, the construction cost included an additional 20 percent contingency of the base construction cost for unaccounted for items, 5 percent for construction contract contingency, 25 percent for a total construction phase contingency, and 20 percent for construction engineering and inspection (CEI).

The corridor-wide signal retiming and optimization project is estimated to cost between $105,000 - $140,000 based on the assumed cost of $15,000 - $20,000 per traffic signal to retime and optimize the corridor. The final cost will depend on VDOT and the County's decision to make any upgrades to traffic signal controllers, ATSPM, fiber optic communications. Therefore, it is recommended to reassess the estimated costs prior to submitting funding applications.

Bus stop upgrades recommended throughout the corridor have estimated costs ranging between $3,500 (landing pad, bench, and trash can) and $25,000 (for aforementioned infrastructure and a new transit shelter) depending on the sophistication of the amenities provided and right-of-way and utility impacts. The bus stop upgrades can be incorporated with funding applications for other improvements along the corridor or be treated as a separate improvement of a suite of bus stop upgrades. ***Table 22*** summarizes the preliminary engineering (PE); right-of-way and utility relocation (RW); construction (CN); and total planning level cost estimates for each improvement project. A detailed breakdown of the planning-level cost estimates is provided in ***Appendix K***.

Table 22: Planning Level Cost Estimates

Improvement	Cost Estimate (2022 Dollars)			
	PE	RW	CN	Total
Sidewalk from Thornhurst Street to I-64 Eastbound Ramps	$1,576,800	$1,231,242	$7,216,267	$10,024,309
Gay Avenue Thru-Cut	$865,200	$2,086,200	$2,325,471	$5,276,871
Gay Avenue Conventional Improvements	$696,000	$346,800	$1,543,423	$2,586,223
Jan Road Thru-Cut	$721,200	$1,663,200	$1,651,381	$4,035,781
Jan Road Conventional Improvements	$756,000	$148,800	$1,807,962	$2,712,762
Audubon Drive Conventional Improvements				
Finlay Street Reconfiguration				
Laburnum Square Directional Median				

The conventional improvements at Jan Road and Audubon Drive, reconfiguration at Finlay Street, and directional median at Laburnum Square have significantly lower costs than the other recommended alternatives. Therefore, the costs for these four low-cost projects were combined into one package for cost-effective implementation. However, these alternatives could be implemented individually using local funds if available.

Figure 20 through ***Figure 27*** present the final preferred alternatives sketches.

Figure 20: Thornhurst Street to Gay Avenue Sidewalk and Access Management Improvements

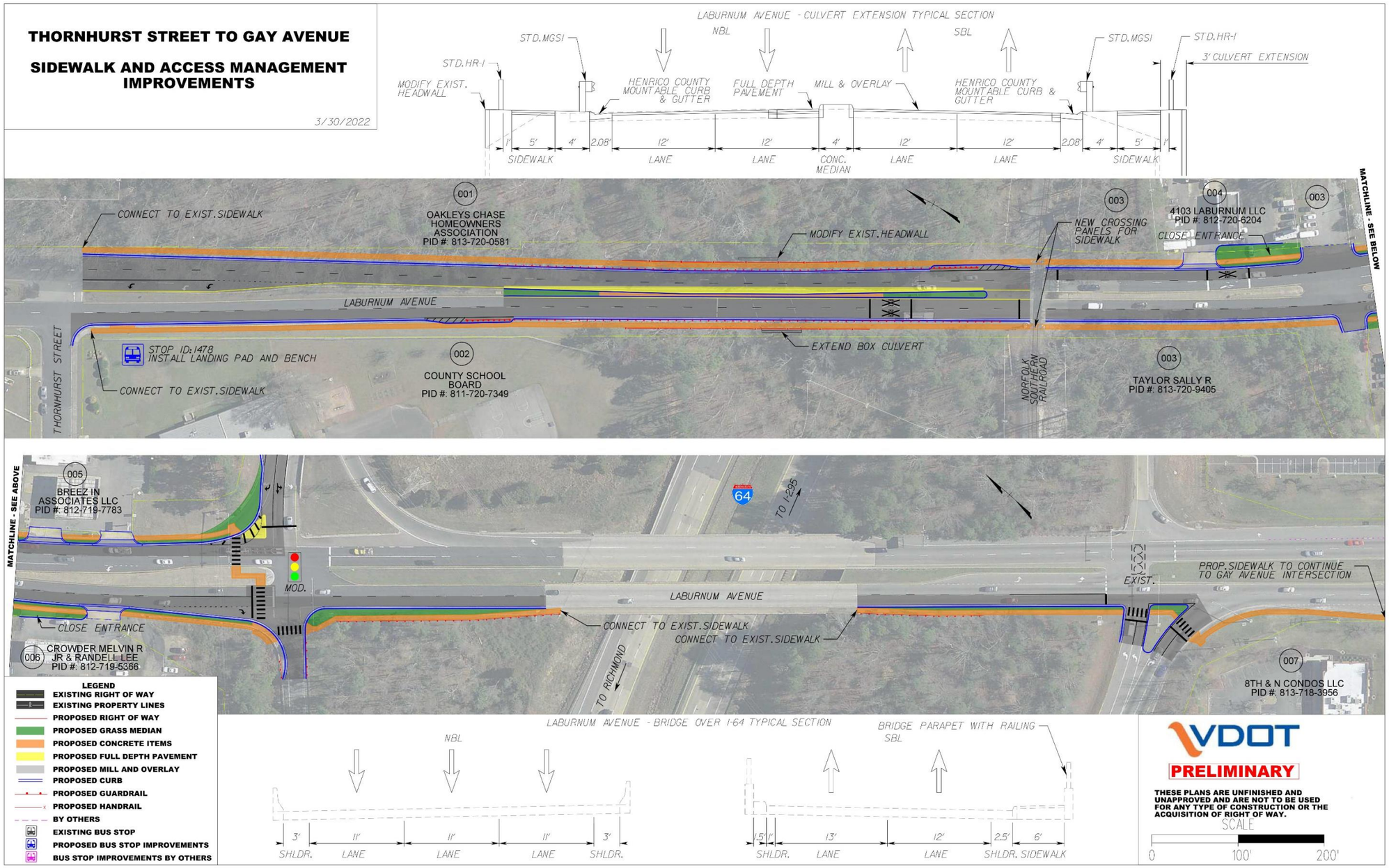


Figure 21: Laburnum Avenue and Gay Avenue Conventional Improvements

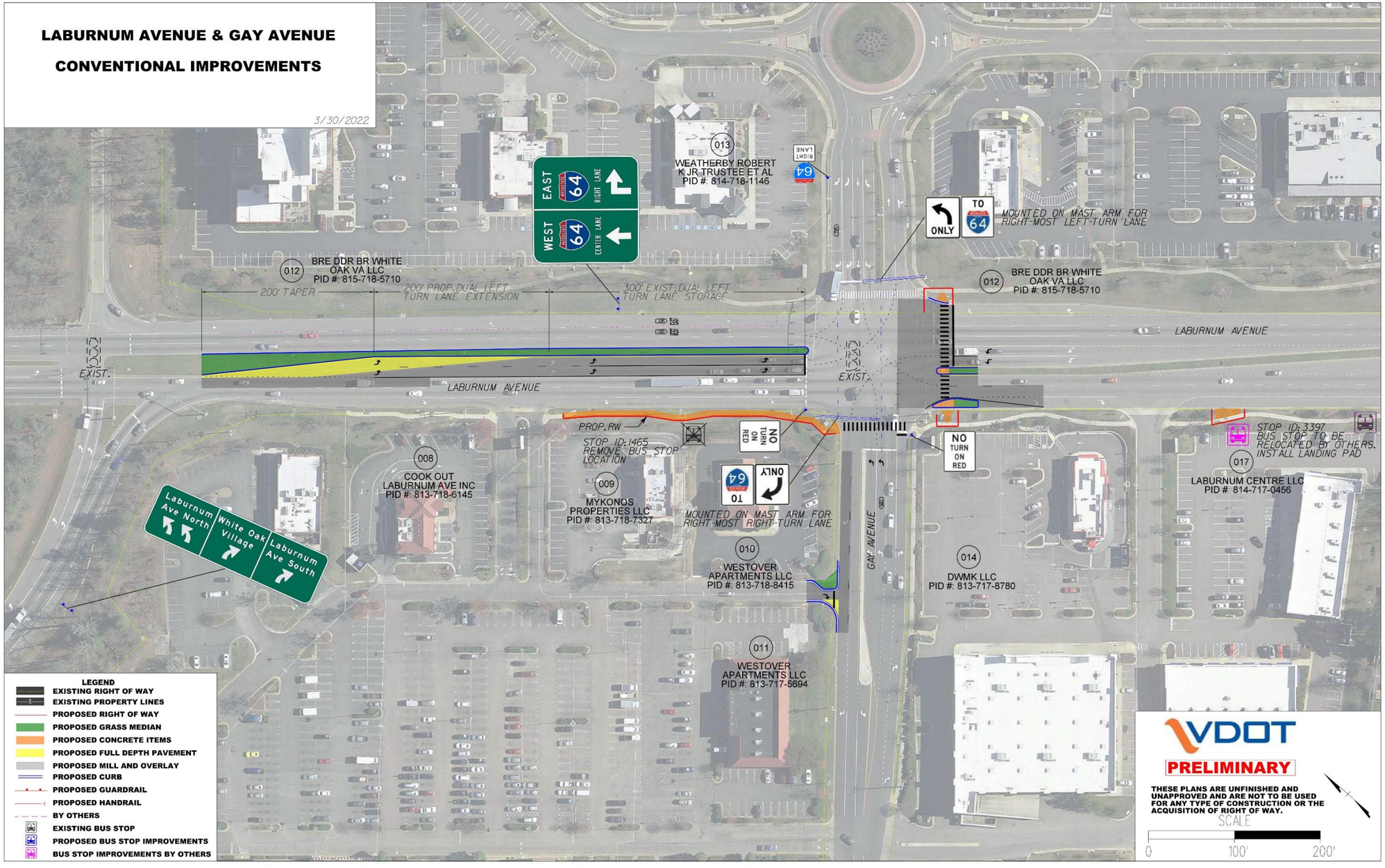


Figure 22: Laburnum Avenue and Gay Avenue Thru-Cut

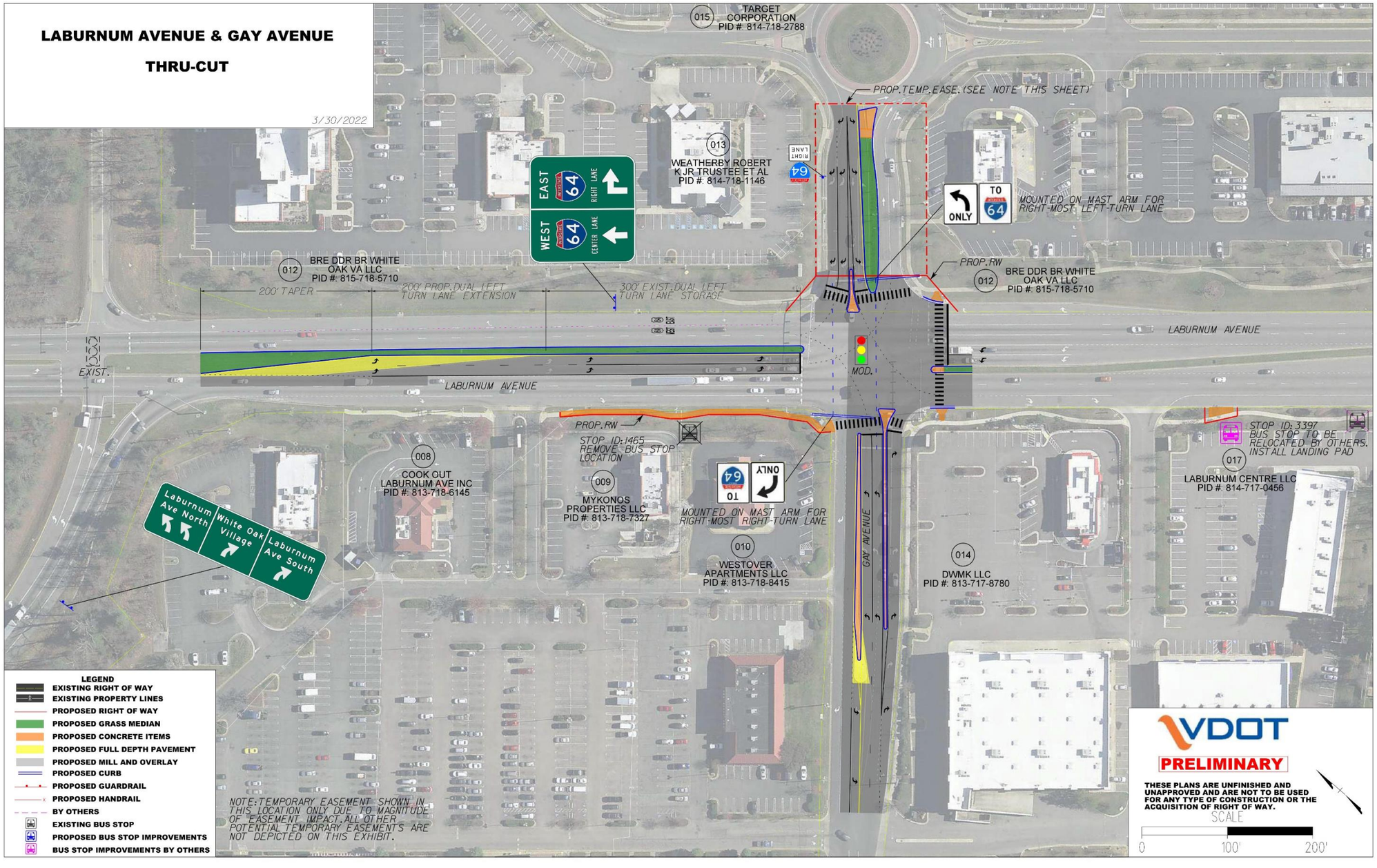


Figure 23: Laburnum Avenue and Jan Road Pavement Marking and Pedestrian Improvements

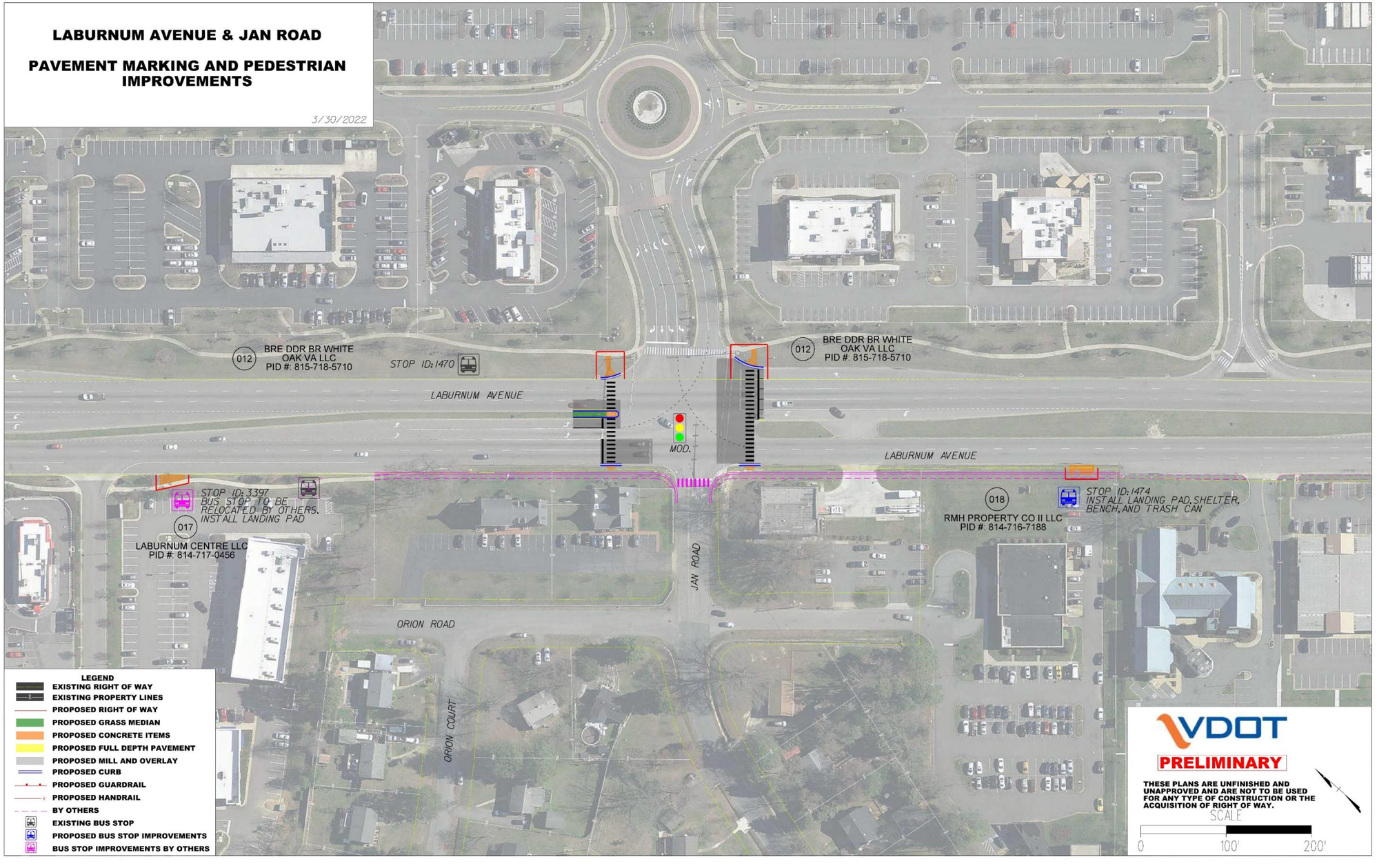


Figure 24: Laburnum Avenue and Jan Road Thru-Cut

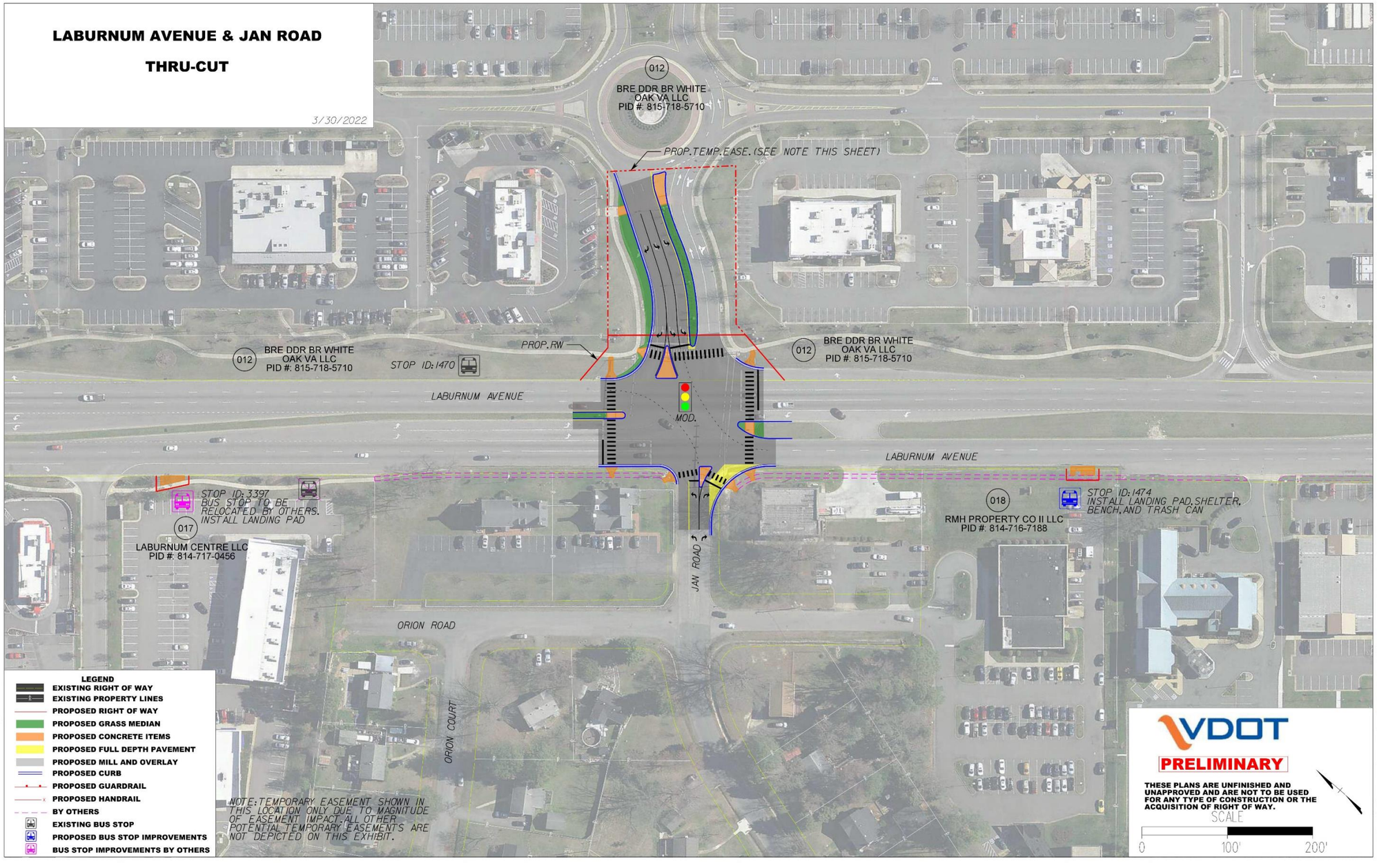


Figure 25: Laburnum Avenue and Audubon Drive Pavement Marking and Curb Radius Improvements

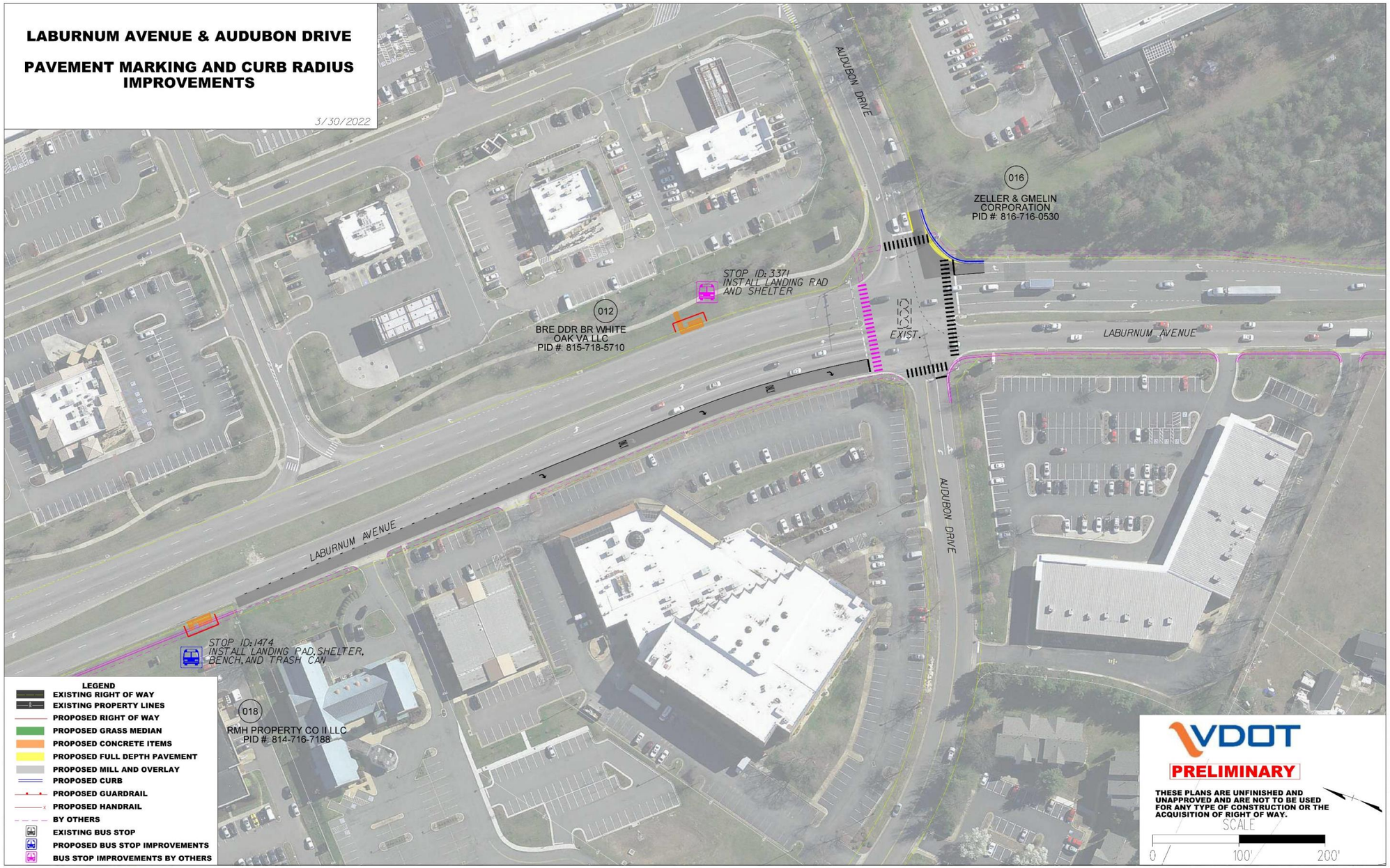


Figure 26: Laburnum Avenue and Finlay Street Turn Lane Improvements

Figure 27: Laburnum Avenue and Laburnum Square Directional Median

9 Project Implementation

This study should be used as a planning tool to achieve the next steps of programming, designing, and constructing the identified safety, multimodal, and operational improvements within the study area. To continue the progress from this study, Henrico County, VDOT, and GRTC officials should coordinate with regional stakeholders to pursue the advancement and funding of the recommendations outline in this study.

9.1 Preparing Projects for Advancement

The SWG participated in a Project Implementation Plan meeting on December 16, 2021 to review the recommended improvements and discuss the next steps to fund and implement the projects. During the meeting, Henrico County staff shared their plans to use one SMART SCALE pre-application slot for a recommendation coming from the STARS South Laburnum Avenue Study. The SWG prioritized the South Laburnum Avenue Sidewalk Improvements from Thornhurst Street to I-64 and the Thru-Cut Project at Gay Avenue as the highest-priority projects to consider for submitting a SMART SCALE application. The County also shared their intent to submit a second project from this study for Central Virginia Transportation Authority (CVTA) funds through Plan RVA or to coordinate with GRTC to leverage one of GRTC's SMART SCALE application slots. The list of recommendations and project summary sheets including a brief project description, planning level cost estimate, and planning level schedule estimate are provided in ***Appendix M***.

9.2 Applying for Funding

The following funding sources may be considered to advance the recommendations identified in this plan:

- **Central Virginia Transportation Authority (CVTA) –** The regional authority that provides funding opportunities for priority transportation investments in Central Virginia.
- **Congestion Mitigation and Air Quality (CMAQ) -** A federal program that allocates funding to surface transportation projects that improve air quality by reducing congestion.
- **Highway Safety Improvement Program (HSIP) -** A federal program that provides funding for improvements that correct or improve safety on a section of roadway or at an intersection that experience high crash incidents.
- **Revenue Sharing –** A state program that provides a dollar-for-dollar state match to local funds for construction, reconstruction, improvement, and/or maintenance transportation projects.
- **SMART SCALE** – A state program that allocates funding to transportation projects based on congestion mitigation, economic development, accessibility, safety, environmental quality, and land use.
- **Community Development Block Grants (CDBG)** – A federal program that provides funding opportunities for transportation projects that aim to develop viable urban communities by providing a suitable living environment and expanding economic activities, principally for persons of low- and moderate-income.
- **Transportation Alternatives (TA) –** A federal program that provides funding opportunities for pedestrian and bicycle facilities and requires a 20% match of local funds.