PROJECT PIPELINE

LY-23-07 | Lynchburg

Langhorne Road | Halsey Road to Tate Springs Road

DRPT Virginia Department of Rail and Public Transportation

Office of INTERMODAL Planning and Investment

VDOT Virginia Department of Transportation

Langhorne Road from Halsey Road to Tate Springs Road

Final Report

August 2024

Prepared for

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Chapter 1 – Needs Evaluation and Diagnosis

Introduction

Project Pipeline is a performance-based planning program to identify cost-effective solutions to multimodal transportation needs in Virginia. Through this planning process, projects and solutions may be considered for funding through programs, including SMART SCALE, revenue sharing, interstate funding, and others. Visit the Project Pipeline webpage for additional information: vaprojectpipeline.org.

This study focuses on concepts targeting identified needs including congestion mitigation, safety improvement, pedestrian and bicycle infrastructure along the corridor, and transit access. The objectives of Project Pipeline are shown below in Figure 1.

Figure 1: Project Pipeline Objectives

Background

The Office of Intermodal Planning and Investment (OIPI) prepared the VTrans Virginia's statewide transportation plan for the Commonwealth Transportation Board (CTB) in which mid-term needs (0 - 10 years) were identified for different categories listed in Table 1. This study focuses on addressing needs identified in VTrans, and those previously identified by the localities.

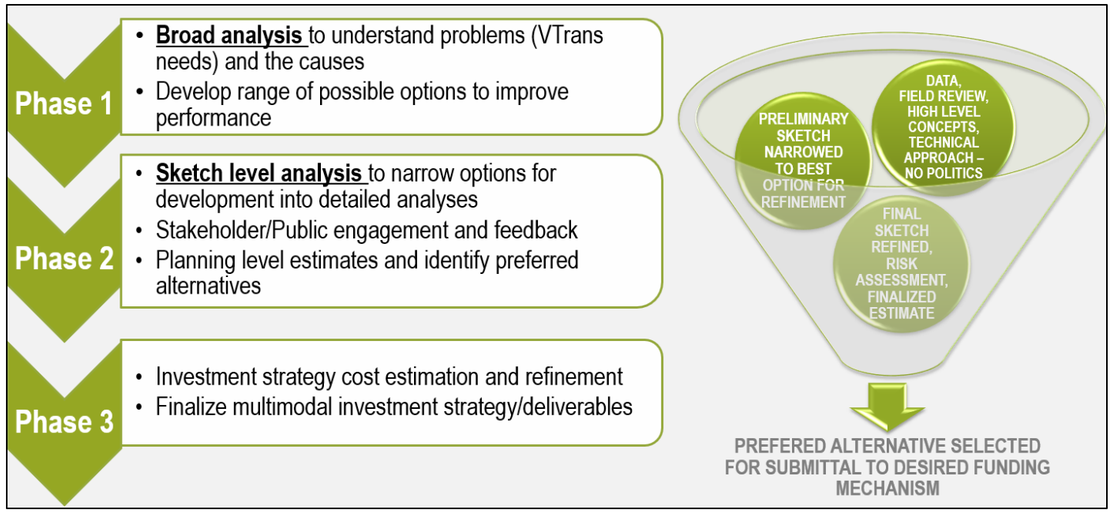
Table 1: List of VTrans Needs

VTrans Needs
Safety Improvement
Transportation Demand Management
Congestion Mitigation
Pedestrian Safety Improvement
Transit Access
Capacity Preservation
Bicycle Access

Methodology

The study is broken down into three phases. Phase I is the problem diagnosis and brainstorming alternatives, Phase II is the alternative evaluation and sketch level analysis, and Phase III is the investment strategy and cost estimates. Details on methods and solutions for each study phase are outlined below in Figure 2.

Figure 2: Study Phase Methods and Solutions



The study team is broken down into Technical Teams to improve the efficiency and effectiveness of the study process through extensive collaboration and synchronicity. To achieve the intended efficiency and consistency, it is generally expected that the same Technical Team will be responsible for all studies within a district for the duration of the cycle.

Each Technical Team will include certain leadership and technical roles that will be needed for each study, including the following:

- VDOT District Planning Project Manager – Provides leadership and direction; has overall responsibility for the study progress and outcomes.
- Consultant Team Manager – Provides direct support to the VDOT District Planning Project Manager; coordinates the work and technical efforts of consultant staff.
- District Planning Staff – Provides technical input regarding capacity, forecasting, land use, multimodal, and planning.
- District Traffic Engineering Staff – Provide technical input regarding safety and operations.
- Consultant Team Technical Staff – Provides multidisciplinary input, analysis, technical support, and expertise for the identified VTrans need categories.

A sample organizational chart, including the roles, responsibilities, and structure of a Technical Team is shown below in Figure 3.

Figure 3. Structure of a Technical Team

Additional team members and roles should be considered where appropriate. Certain roles may not be necessary for all studies. However, the following roles may contribute to study success during different stages and/or for different types of study areas, as shown in Table 2.

Table 2. Roles and Responsibilities for the Technical Team and SWGs

Phase	Responsibility	Role					
		OIPI/Program Support	District	Consultant	DRPT	Locality	VDOT Central Office
Study Selection & Initiation	Identify Study Needs and Priorities		X		X	X	
	Coordinate with CTB Members	X	X				
	Approve final study locations	X					
	Data Collection Planning		X				
	Data Dashboards	X					
	Assign Consultants & Issue Consultant Task Orders	X					X
Phase 1	Initiate Study & Hold Kickoff Meeting		X	X	X		
	Prepare Framework Document		X	X			
	Approve Framework Document		X		X	X	
	Provide Existing Data		X		X	X	
	Collect New Data			X			
	Coordinate with local leaders					X	
	Conduct & Support Initial Public Outreach (if desired)	X	X	X		X	X
	Diagnose Existing Needs			X			
	Brainstorm & Develop Preliminary Alternatives		X	X	X		X
	Present Diagnosis & Alternatives to SWG			X			
	Provide Feedback and Input on Analysis & Alternatives					X	
	Develop Phase 2 Scope of Work			X			
	Approve Scope & Issue Consultant Task Orders	X					X
Phase 2	Conduct Detailed Analysis of Alternatives			X			
	Develop Refinements to Alternatives		X	X	X		X
	Present Alternative Analysis Findings to SWG		X	X			
	Provide Feedback on Alternatives				X	X	X
	Prepare Planning Level Cost Estimates			X			
	Conduct & Support Public Outreach on Alternatives	X	X	X		X	
	Concurrence on Preferred Alternative(s)		X		X	X	X
	Develop Phase 3 Scope of Work			X			
	Approve Scope & Issue Consultant Task Orders	X					X
Phase 3	Conduct Alternative Risk Assessment		X	X			X
	Develop Practical Concept Design & Address Risk of Preferred Alternative		X	X			
	Prepare Cost Estimate with Workbook			X			
	Document Assumptions & Basis of Cost			X			
	Review & Concur with Concept & Estimate		X		X		X
Investment, Application, & Closeout	Prepare Final Study Deliverables, Design Packages, and Estimates			X			
	Apply for Funding of Preferred Alternative(s)				X	X	
	Application Support	X	X	X			
	Submit and Documentation and All Related Work			X			
	Review and approve final deliverables for public visibility		X		X		
	Program Closeout and Summary	X					

Study Area

The Langhorne Road corridor, between Halsey Road and Tate Springs Road (East), is located in Lynchburg, Virginia. It is classified as a minor arterial with a posted speed limit of 35 miles per hour (mph) within the study area. There are 31 crossovers within this 0.90-mile corridor along Langhorne Road. The Langhorne Road corridor study limits are shown in Figure 4.

Figure 4: Langhorne Road Study Area Map

VTrans is Virginia's statewide transportation plan. It identifies and prioritizes locations with transportation needs using data-informed transparent processes. The policy for identifying VTrans mid-term needs establishes multimodal need categories that correspond to the Commonwealth Transportation Board-adopted VTrans visions, goals, and objectives.[1] Each need category has one or more performance measures and thresholds to identify one or more needs. Visit the VTrans policy guide for additional information: https://vtrans.org/resources/VTrans_Policy_Guide_v6.pdf.

The mid-term needs, as identified in VTrans for the Langhorne Road corridor, were identified as "Very High" for Bicycle Access and Transportation Demand Management, "High" for Safety Improvement and "Medium" for Pedestrian Access, Pedestrian Safety Improvement and Transit Access, as shown in

These mid-term needs, identified in VTrans, are prioritized on a tier from 1 to 4, with 1 being the most critical and 4 being the least critical. The segments ranked as "Priority 1" represent those with multiple categories identified as high in need.

Table 3. VTrans Needs in Study Area

VTRANS IDENTIFIED NEEDS	PRIORITIES
Bicycle Access	Very High
Capacity Preservation	None
Congestion Mitigation	None
IEDA (UDA) Access	None
Pedestrian Access	Medium
Safety Improvement	High
Pedestrian Safety Improvement	Medium
Reliability	None
Rail On-time Performance	None
Transit Access	Medium
Transit Access for Equity Emphasis Areas	None
Transportation Demand Management	Very High

These mid-term needs, identified in VTrans, are prioritized on a tier from 1 to 4, with 1 being the most critical and 4 being the least critical. The segments ranked as "Priority 1" represent those with multiple categories identified as high in need. Figure 5 presents a map of the study area with the 2019 VTrans mid-term needs prioritized for district construction.

Figure 6 presents an overview of the diagnosis and problem identification for the Old Forest Road corridor. A field visit was conducted July 14, 2023 and Appendix A includes detailed notes for the corridor and each of the study intersections.

[1] Commonwealth Transportation Board, Actions to Approve the 2019 VTrans Vision, Goals, Objectives, Guiding Principles and the 2019 Mid-term Needs Identification Methodology and Accept the 2019 Mid-term Needs, January 15, 2020

Figure 5: 2019 VTrans Prioritized Mid-term Needs in the Study Area

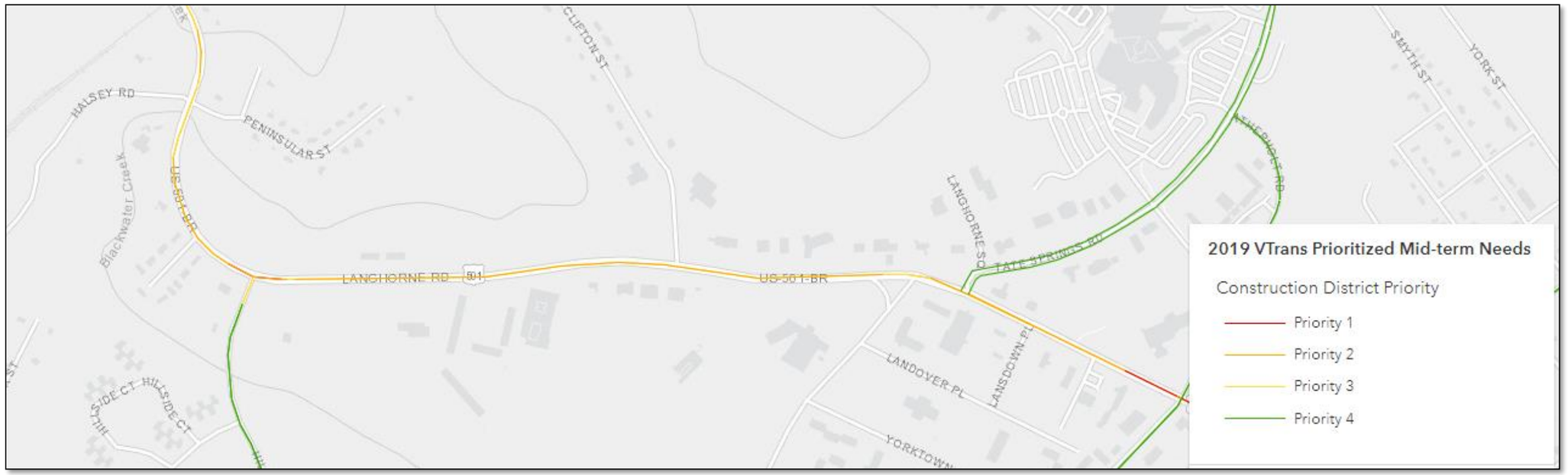
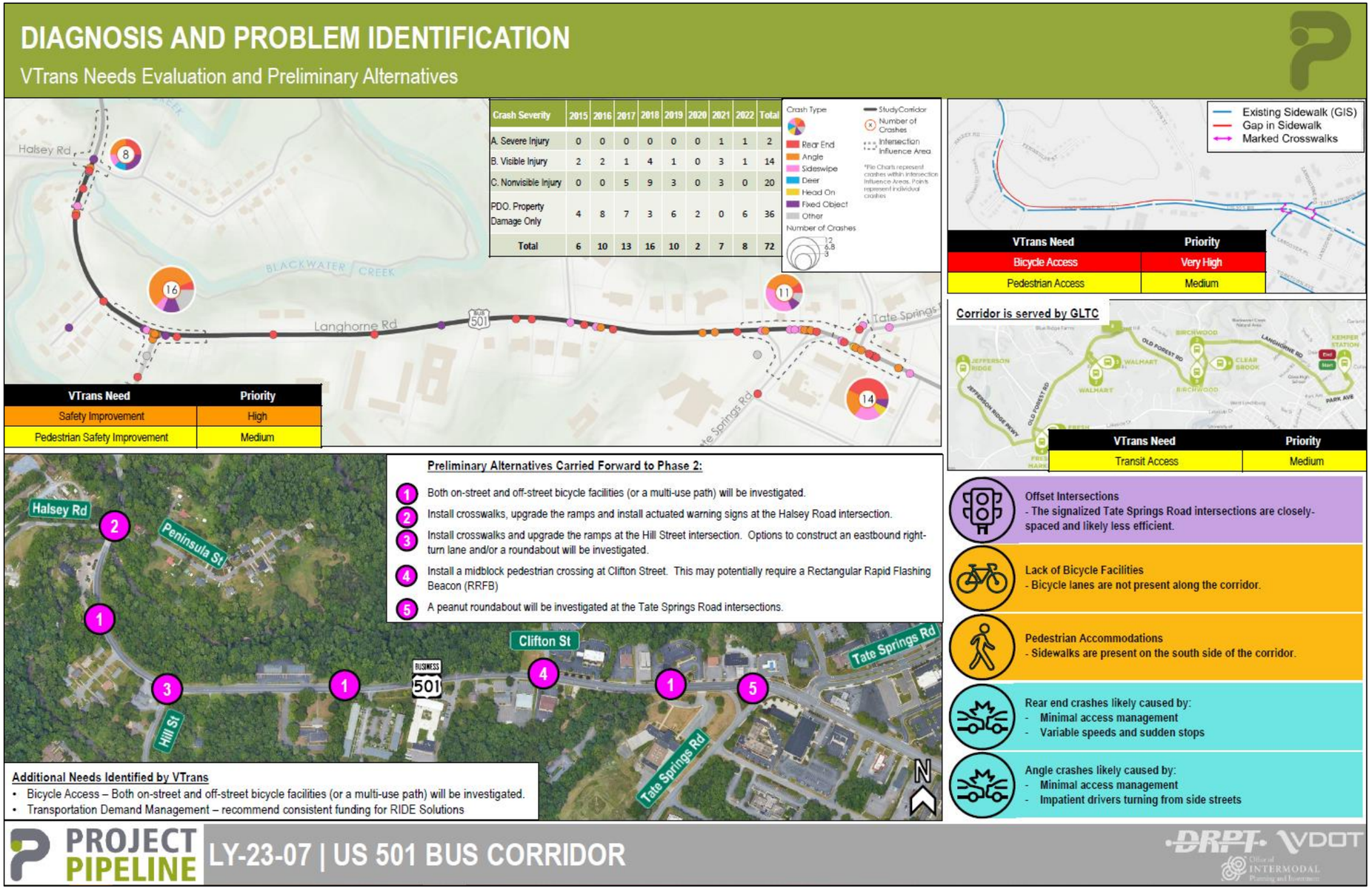


Figure 6. Diagnosis and Problem Identification Overview for US 501 Business (Langhorne Road) from Peninsular Street to Tate Springs Road



Previous Study Efforts

As discussed in the stakeholder meeting held on September 5, 2023, there was a traffic impact study (TIS) prepared by EPR for the Centra Hospital (Centra Health Holy Cross Property Traffic Impact Study; May 2023). This study was for the rezoning of the property in the southwest corner of the Langhorne Road and Tate Springs Road (West) intersection and included 125,170 square feet of medical space with an anticipated opening date in 2025. The study area included the two Tate Springs Road intersections along Langhorne Road (in addition to others not included in this LY-23-07 corridor study). Ultimately, the TIS recommended signal timing optimization and improvements at the site entrance along Langhorne Road (west of Tate Springs Road).

FHWA STEAP Tool Analysis

The FHWA Screening for Equity Analysis of Projects (STEAP) Tool was reviewed for the corridor and surrounding areas. This tool is used to discover the key population metrics and needs of the study area to raise awareness of equity needs in the selection of alternatives. The data source used for the analysis was the American Community Survey 2016 – 2020 and a 0.5-mile radius was used for the analysis buffer. The results of the STEAP Tool analysis are presented below:

- The majority of the population (55%) within the study area is between ages 18 and 64 as shown in Figure 7.
- There is a high personal vehicle ownership, with 54% of households owning one vehicle, 23% owning two vehicles and 8% owning three or more vehicles. Only 15% of households do not own a personal vehicle as shown in Figure 8.
- When compared to the City of Lynchburg as a whole and the Commonwealth of Virginia, the study area has a lower than average number of veterans; however, it is has a greater number people with disabilities, households with no computers and number of households without internet connection, as shown in Figure 10.
- Of all the households in the study area, 15% have household income less than $15,000, as shown in Figure 11.

Figure 7. STEAP Tool Analysis Population by Age Group

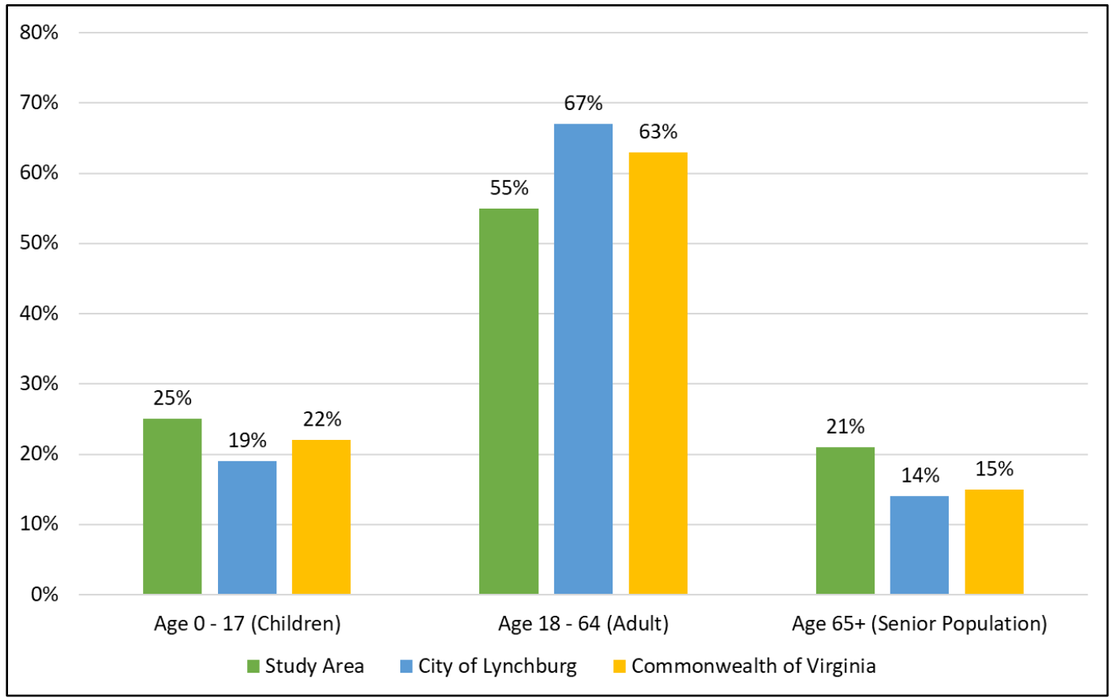


Figure 8. STEAP Tool Analysis Vehicle Ownership

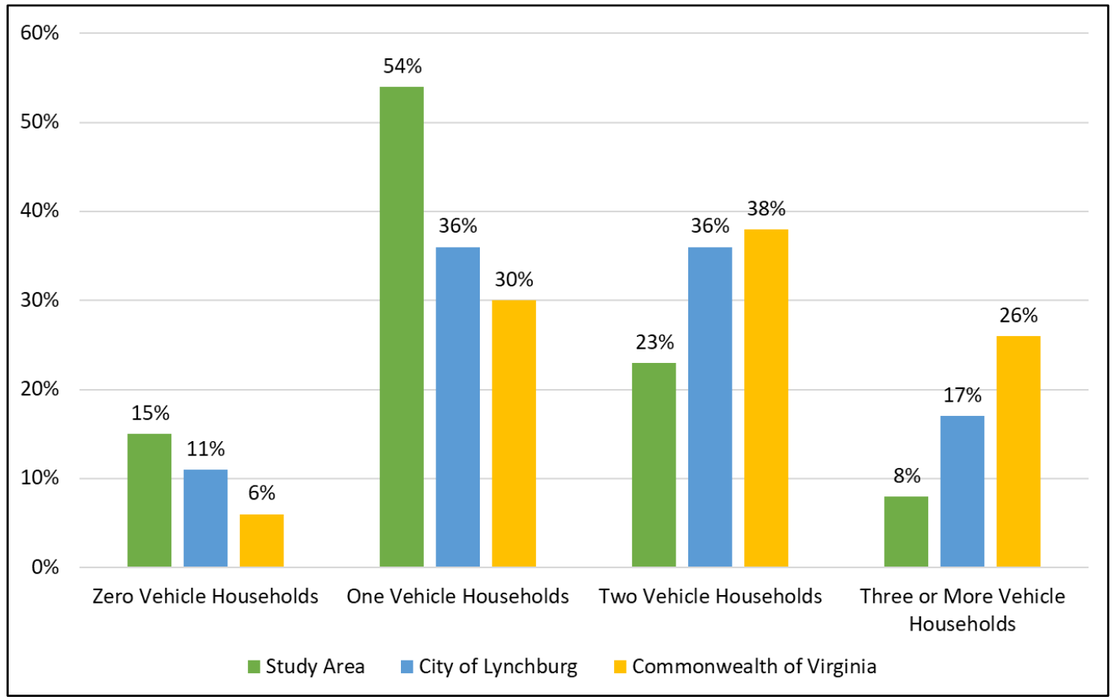


Figure 9. STEAP Tool Analysis Ability to Speak English in a Non-English Speaking/Bilingual Home

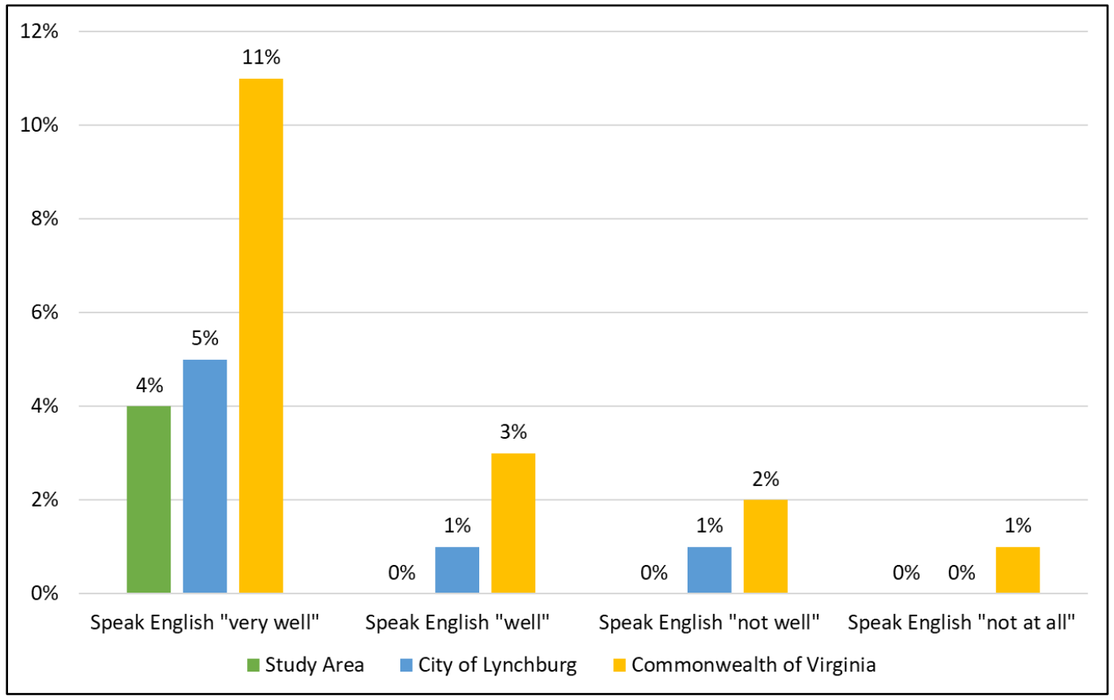


Figure 10. STEAP Tool Analysis Vulnerable Populations

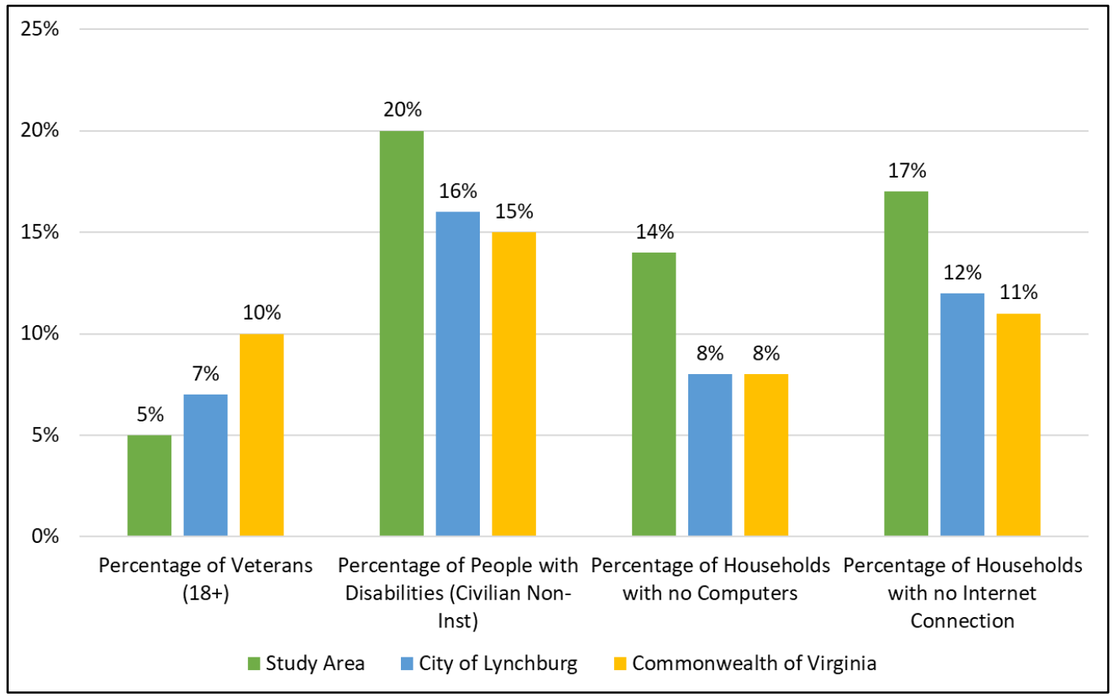
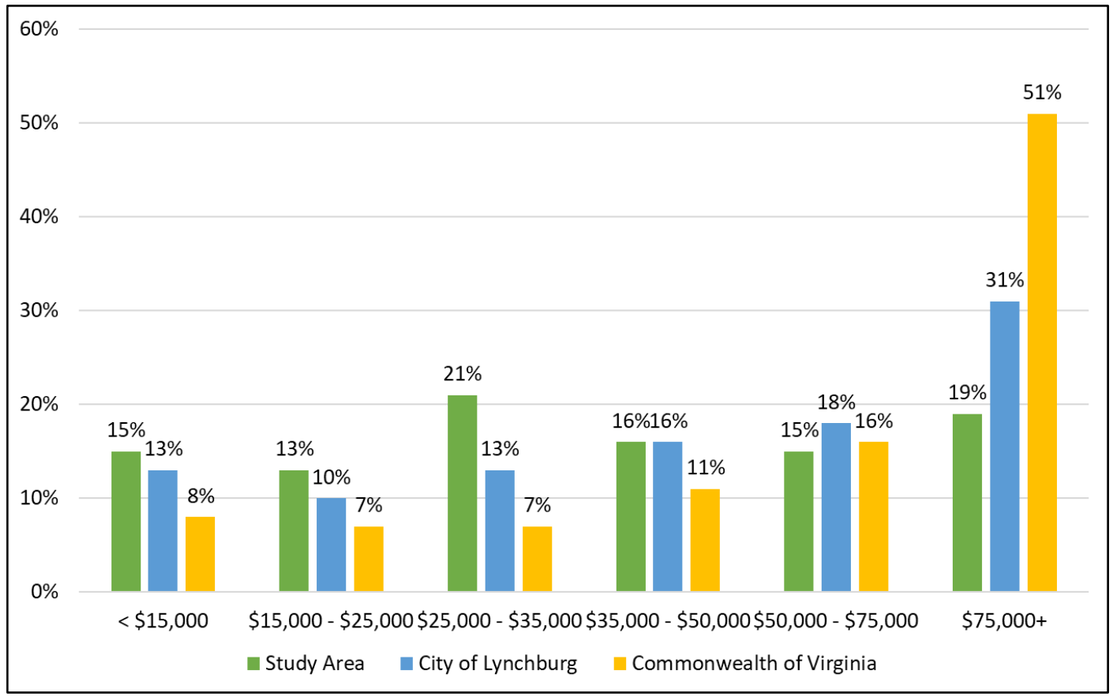


Figure 11. STEAP Tool Analysis Household Income



Traffic Operations and Accessibility

Traffic operational analysis was performed using Synchro 11 and/or Sidra Intersection 8 software for all study intersections along the Langhorne Road corridor. Inputs and analysis methodologies are consistent with the VDOT Traffic Operations and Safety Analysis Manual (TOSAM) guidelines. Both AM and PM peak hour analyses were performed for the existing year 2023 and future diagnosis year 2045.

Traffic Data

The traffic data for the study area was obtained from turning movement counts collected on Tuesday, May 23, 2023 between 7:00 AM and 7:00 PM. The corridor AM peak hour was determined to be 7:45 AM to 8:45 AM and the corridor PM peak hour was determined to be 4:15 PM to 5:15 PM. The intersection turning movement volumes are shown in Figure 12.

Measures of Effectiveness

There are many measures of effectiveness (MOE) in traffic operations analysis to quantify operational and safety objectives and provide a basis for evaluating the performance of a transportation network. Several MOEs for intersection analyses can be reported from the Synchro software, VDOT Junction Screening Tool (VJuST), and SIDRA. For the purposes of this study, guidance for reporting MOEs for signalized and unsignalized intersections was obtained from Chapter 4 of the VDOT TOSAM. A summary of the MOEs evaluated for the study intersections are:

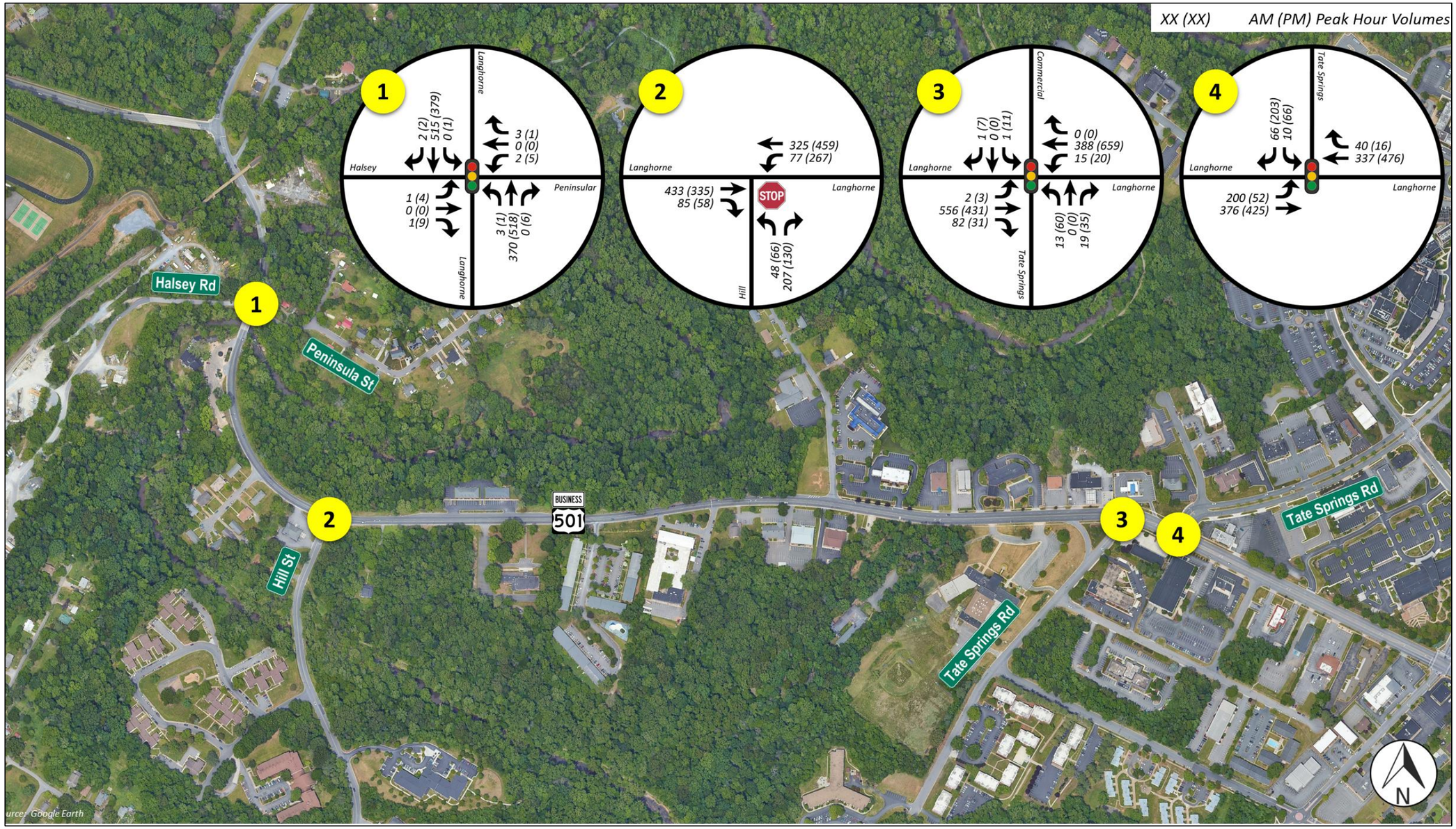
- Control Delay (measured in seconds per vehicle – sec/veh)
- Level of service (LOS)
- 95th Percentile Queue Length for Synchro and SIDRA (measured in feet – ft)
- Volume-to-Capacity (v/c) Ratio

Traffic Operations Analysis Results

Overall, the study area intersections along the Langhorne Road corridor are currently operating under capacity. Operations along the corridor are summarized below. The Synchro analysis results are provided in Appendix C.

- The existing analysis indicates that all of the signalized study area intersections are currently operating at an overall level of service of LOS B or better in both peak hours, while the stop-controlled Hill Street approach is currently operating at LOS C or better in both peak hours.
- In the AM peak hour, there are 207 vehicles turning right from Hill Street onto Langhorne Road and in the PM peak hour, the reciprocal movement is 267 vehicles.
- At the eastern Langhorne Road and Tate Springs Road intersection, there are 200 vehicles turning left-from Langhorne Road onto Tate Springs Road in the AM peak hour. In the PM peak hour, there are 203 vehicles in the reciprocal movement.

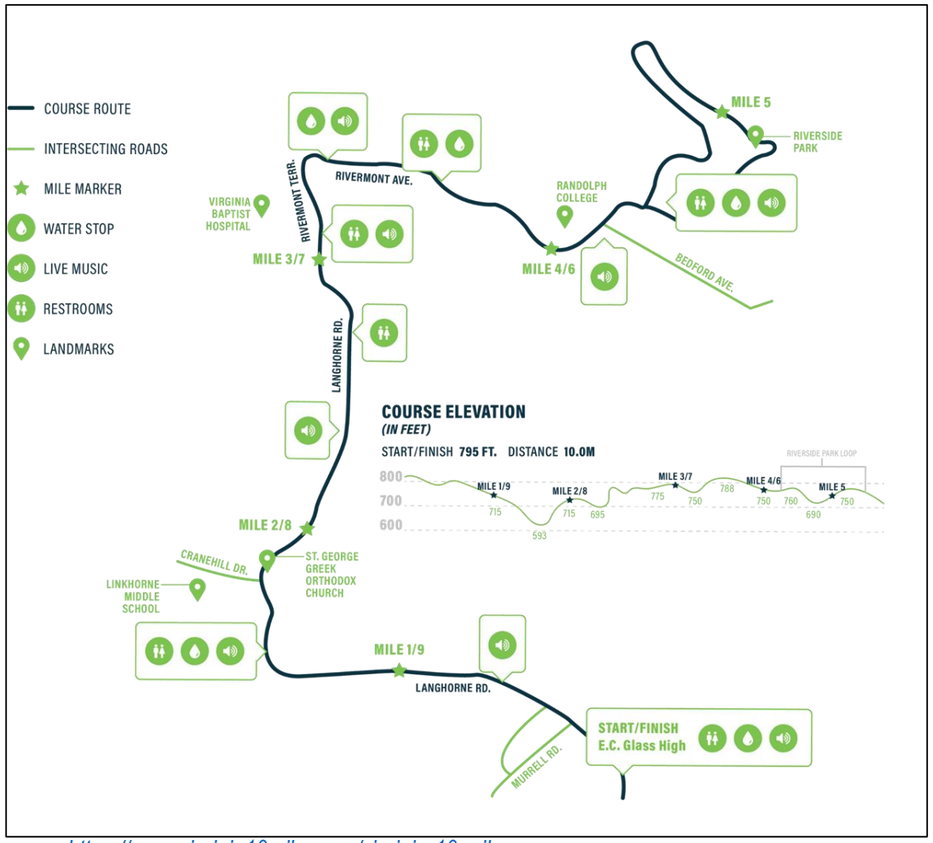
Figure 12. Existing AM & PM Peak Hour Volumes



Pedestrian and Bicycle Access

Sidewalks are present along the south side of the Langhorne Road corridor, between Halsey Road and Tate Springs Road, and along the north side, between Clifton Street and Tate Springs Road. Additionally, this section of Old Langhorne Road is part of the Virginia 10 Miler, a race started by the Lynchburg Road Runners Club in 1974. The 2024 course map is shown in Figure 13. Figure 14 shows one of the mile markers painted on Langhorne Road, west of Clifton Street, in front of the Seven Hill Rehabilitation Nursing facility.

Figure 13: Virginia 10 Miler Course Map



https://www.virginia10miler.com/virginia-10-miler

Figure 14: Virginia 10 Miler Mile Marker 1/9 along Langhorne Road

Image Source – Google Earth

Safety and Reliability

For the analysis of existing safety conditions, the VDOT Crash Analysis PowerBI Tool was utilized to determine the crash history at the study intersections and along Langhorne Road. Crash data was collected and analyzed for an eight-year period spanning from January 2015 to December 2022. The study team reviewed the FR-300 reports provided by VDOT to determine specific trends and "hot spot" areas for consideration in developing alternative improvement concepts. For the purposes of this analysis, "injury crashes" is defined as the sum of type A (severe injury), B (visible injury), and C (non-visible injury) crashes. Raw crash data is provided in Appendix C.

Safety Analysis Results

The crash severity within the study area is summarized by year and type in Table 4 and Table 5, respectively. The lighting conditions, adverse weather conditions, and the other related factors including, alcohol, speeding, and guardrail are summarized in Table 6 and crash locations and crash types for each of the study intersections are shown in Figure 15.

Figure 16 shows the travel time data along each direction of the corridor.

Table 4. Study Area Crash Severity by Year

Crash Year and Severity	K. Fatal Injury	A. Severe Injury	B. Visible Injury	C. Nonvisible Injury	PDO. Property Damage Only	Total
2015	0	0	2	0	4	**6**
2016	0	0	2	0	8	**10**
2017	0	0	1	5	7	**13**
2018	0	0	4	9	3	**16**
2019	0	0	1	3	6	**10**
2020	0	0	0	0	2	**2**
2021	0	1	3	3	0	**7**
2022	0	1	1	0	6	**8**
Total	**0**	**2**	**14**	**20**	**36**	**72**

Table 5. Study Area Crash Severity by Type

Crash Type and Severity	K. Fatal Injury	A. Severe Injury	B. Visible Injury	C. Nonvisible Injury	PDO. Property Damage Only	Total
Rear End	0	1	2	6	13	**22**
Angle	0	0	4	9	9	**22**
Head On	0	0	0	0	1	**1**
Sideswipe – Same Direction	0	0	0	3	8	**11**
Fixed Object in Road	0	0	0	0	1	**1**
Non-Collision	0	0	1	1	0	**2**
Fixed Object – Off Road	0	1	4	0	2	**7**
Deer	0	0	0	0	1	**1**
Other Animal	0	0	0	0	0	**0**
Ped	0	0	0	0	0	**0**
Other	0	0	3	1	1	**5**
Total	**0**	**2**	**14**	**20**	**36**	**72**

A total of 72 crashes were reported within the Langhorne Road corridor study area during the eight-year study period.

Key takeaways from the crash data are as follows:

1. Three of the four lowest reported crash years have occurred during the past three years with the lowest (2) in 2020, third lowest (7) in 2020 and fourth lowest (8) in 2022. Six crashes were reported in 2015.
2. The approximate average number of reported crashes per year is 9.
3. Angle crashes (31%) and rear end crashes (31%) were the highest reported crashes along the corridor.
4. A total of 36 reported crashes were associated with injuries, accounting for approximately 50% of the reported crashes along the corridor. There were no fatalities reported.
5. A total of 16 crashes (22%) occurred during the night.
6. There was one crash (1%) due to speeding.
7. Guardrail was not involved in any crashes.
8. There were 16 crashes (22%) that occurred during adverse weather conditions. This includes one crash for which weather conditions were classified as “other”.

The detailed collision diagrams are shown in Appendix C.

Table 6. Study Area Crash Type and Lighting, Adverse Weather, Alcohol, Speeding, and Guardrail Conditions

Crash Type and Other Related Factors	Lighting Conditions		Weather Conditions[1]						Alcohol Related		Speeding Related		Guardrail Related	
	Daylight	Darkness	No Adverse Conditions	Fog	Mist	Rain	Snow	Sleet/Hail	Yes	No	Yes	No	Yes	No
Rear End	18	4	15	0	1	6	0	0	2	20	1	21	0	22
Angle	18	4	18	0	0	4	0	0	0	22	0	22	0	22
Head On	1	0	1	0	0	0	0	0	0	1	0	1	0	1
Sideswipe – Same Direction	9	2	10	0	0	1	0	0	0	11	0	11	0	11
Fixed Object in Road	0	1	1	0	0	0	0	0	1	0	0	1	0	1
Non-Collision	1	1	1	0	0	1	0	0	0	2	0	2	0	2
Fixed Object – Off Road	5	2	7	0	0	0	0	0	1	6	0	7	0	7
Deer	1	0	0	0	1	0	0	0	0	1	0	1	0	1
Other Animal	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ped	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	3	2	3	0	0	1	0	0	0	5	0	5	0	5
Total	**56**	**16**	**56**	**0**	**2**	**13**	**0**	**0**	**4**	**68**	**1**	**72**	**0**	**72**

[1]The weather conditions for Crash 210415083 was classified as “other” and is not accounted for in the table.

Figure 15: Langhorne Road Crash Locations and Types

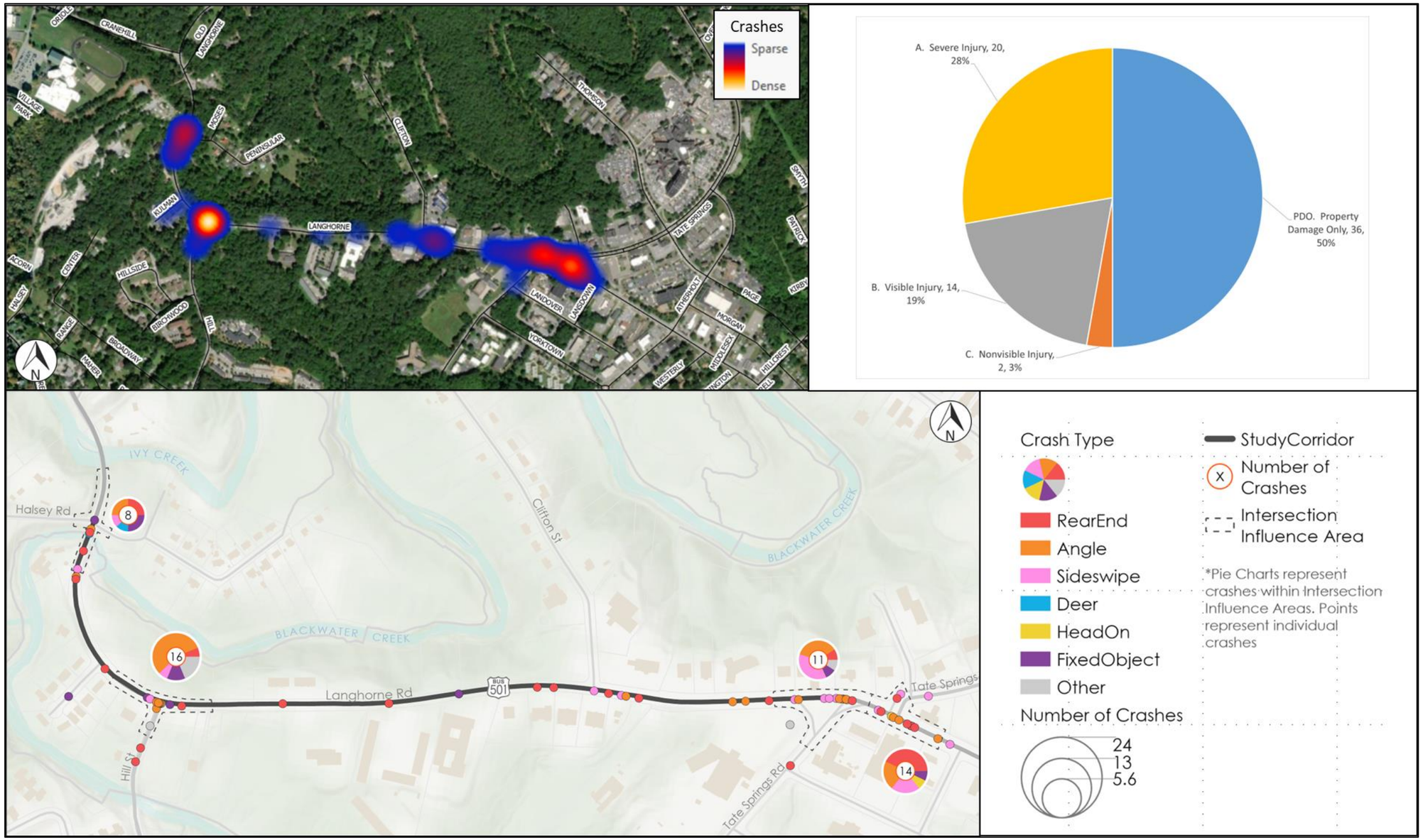


Figure 16: INRIX Travel Time Index and Average Speed

Rail, Transit, and TDM

As previously mentioned, VTrans identified Transit Access as a medium need and Transportation Demand Management as a very high need. Rail On-Time Performance was not identified as a need by VTrans.

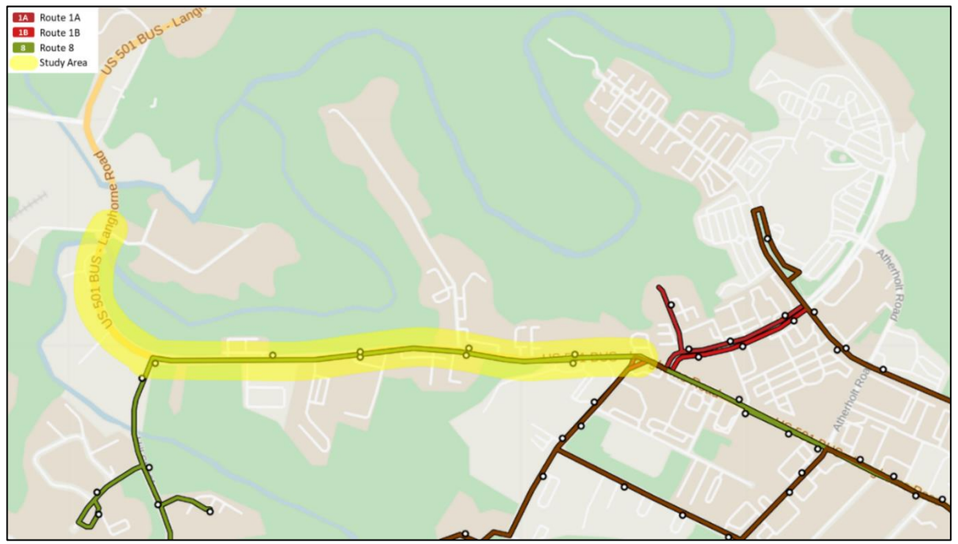
The corridor is currently served by the Greater Lynchburg Transit Company (GLTC) – Route 8. There are several stops along the corridor; however, the field visit noted that there were some concerns with access to the existing bus stop locations and accommodations at the bus stop locations.

- There are eight (8) bus stops located within the study area.
- Only one (1) location included a bench; none included a shelter.
- Six (6) of the locations were connected to sidewalks.

Figure 17 shows the GLTC transit route (Route 8) and stops along the Langhorne Road corridor from GLTC's Realtime Tracking website, while Figure 18 shows the same information from Virginia's Statewide Transit Data.

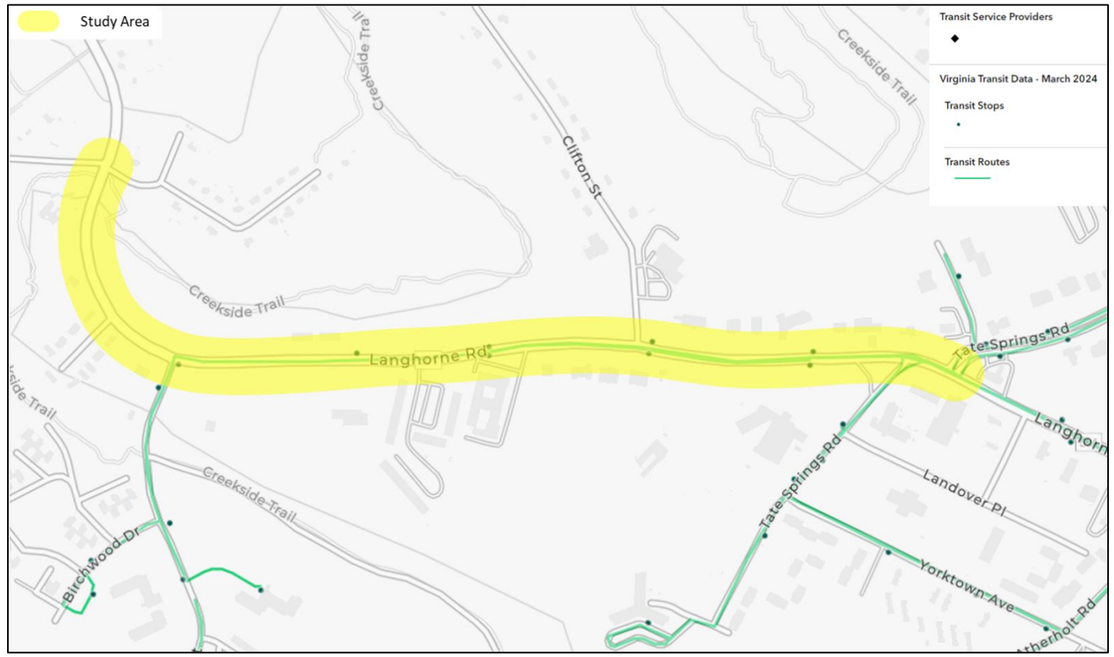
Figure 19 shows the rail infrastructure in the vicinity of the Langhorne Road corridor, from the DRPT Rail Database (Virginia Rail Infrastructure Database).

Figure 17: Greater Lynchburg Transit Company Route 8



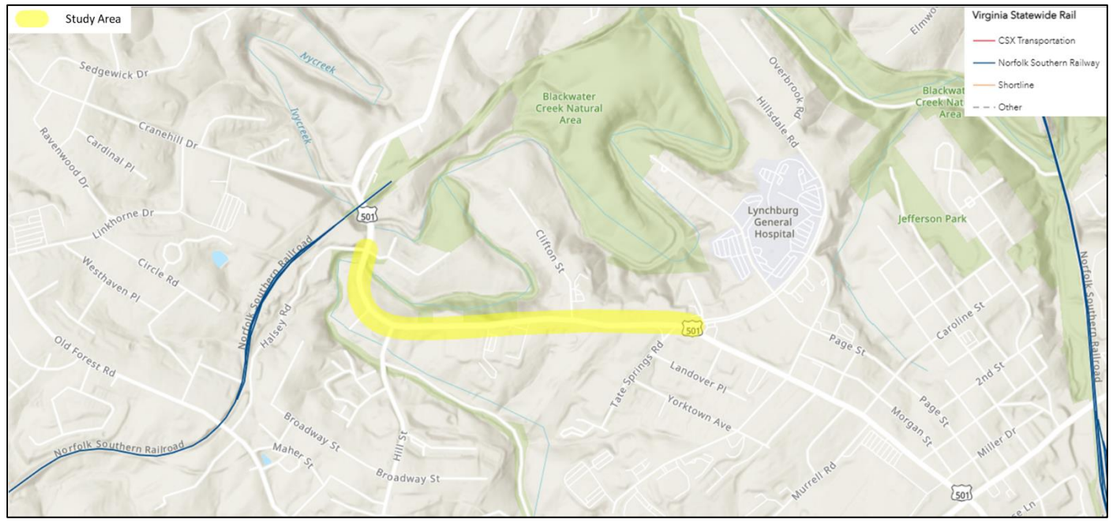
https://gltc.cadavl.com/SWIV/GLTC

Figure 18: Statewide Transit Data



https://gis-drpt.opendata.arcgis.com/apps/d9702b3076f1494a8eb8db5ae2ee66bb/explore

Figure 19: DRPT Rail Database (Virginia Rail Infrastructure Database)



https://gis-drpt.opendata.arcgis.com/apps/DRPT::virginia-rail-infrastructure-application/explore

Phase 1 Corridor/Existing Conditions Public Outreach & Involvement

Initial Public Outreach was conducted to inform the public of the study efforts and goals and solicit feedback on what the public's priorities and perceptions of the corridor are to include in the evaluation of potential alternatives. The survey was conducted through Publicinput.com and there were 105 participants.

As shown in Figure 20, the survey responses indicate that vehicular safety was the greatest need along the corridor, followed by pedestrian safety, pedestrian access, bicycle access, transit access and transportation demand management.

Figure 20. VTrans Needs Along Study Corridor

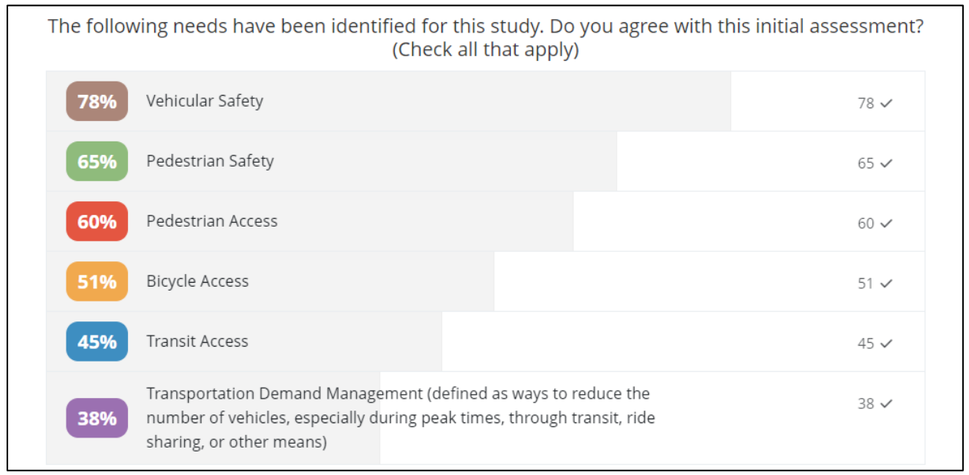
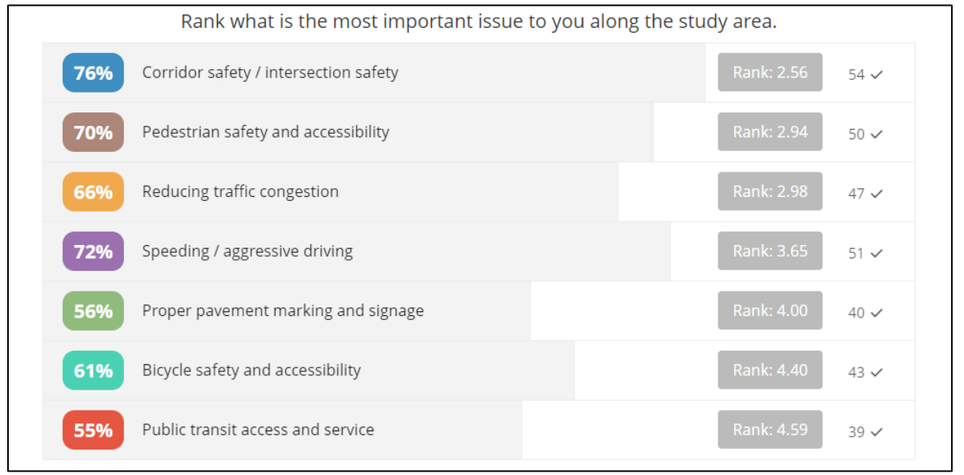


Figure 21 shows the issues along the corridor that the respondents noted need to be addressed.

Figure 22 shows the major issues along the corridor which include corridor and intersection safety, pedestrian safety and accessibility and speeding and aggressive driving. The majority of the respondents use the corridor for shopping/errands, passing through, traveling home, or traveling to work. Additionally, 97% of the respondents travel using personal vehicles. Adding crosswalks/pedestrian signals (61%) and sidewalks (60%) were the two highest multimodal needs identified in the survey.

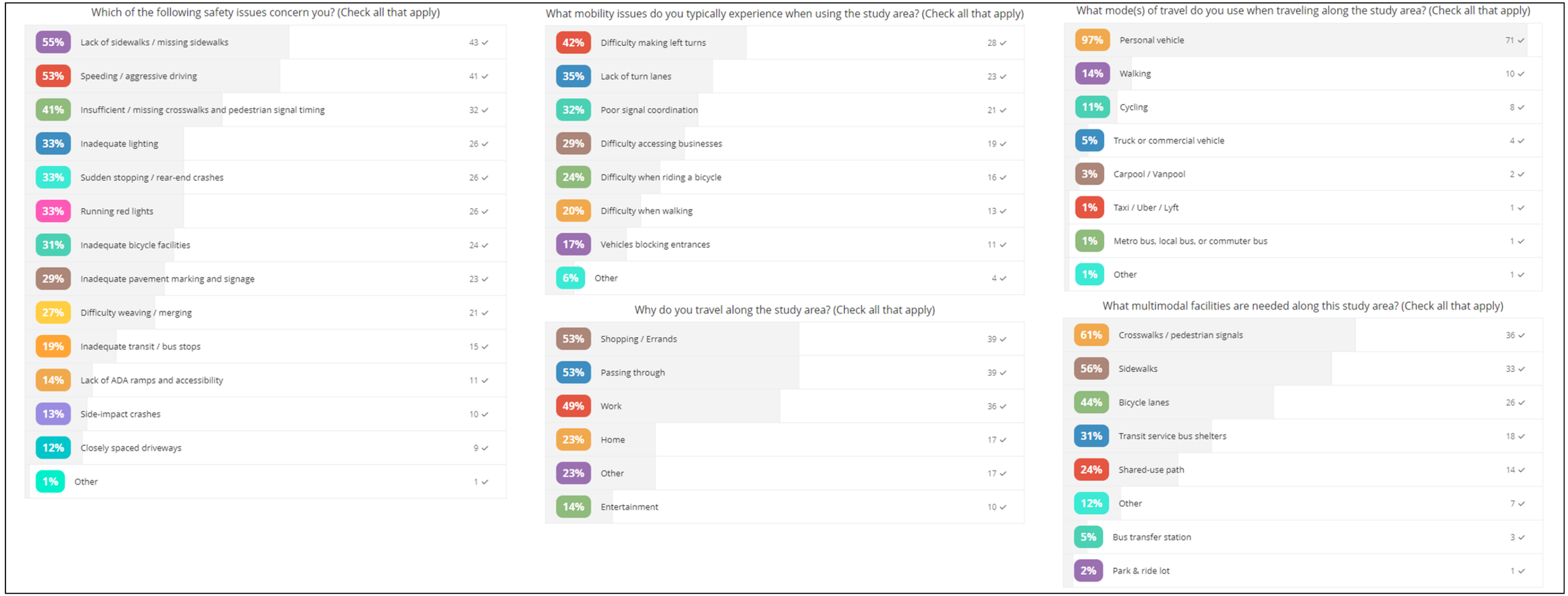
Figure 21. Issues along the Study Corridor



Some notable comments from the survey responses are summarized below:

- *"Dangerous when having to turn from Hill St to Langhorne, any way to make that safer would be appreciated."*
- *"The light at Peninsular needs a warning light for drivers to know if the light is or will be turning red. The current sign constantly blinks."*
- *"Vehicle safety components should focus on speed reduction of vehicles through physical infrastructure like roundabouts and barriers."*
- *"Please narrow lanes, add protected bike lanes, ban right on reds and add dedicated signals for those cycling."*
- *"I have seen to (sic) many cars run red light long after light has changed."*

Figure 22. Public Input Survey Responses



Chapter 2 – Alternative Development and Refinement

Alternative Development and Screening

In order to develop alternative concepts to address the needs identified in Chapter 1, a thorough review of the existing conditions data was conducted. VJuST was used to as a high-level screening tool to identify potential alternative concepts at all study area intersections along the Langhorne Road corridor. These concepts were further screened manually based on a number of factors including operational and safety benefits, costs and right-of-way impacts. The remaining concepts were modeled in Synchro and/or Sidra Intersection.

To enhance bicycle and pedestrian access along Langhorne Road, an on-street bicycle facility and two off-road shared-use path (SUP) concepts were explored – one on the north side of Langhorne Road and one on the south side. These concepts were not modeled in Synchro or Sidra Intersection.

Future Traffic Forecasting

As mentioned in Chapter 1, the future year analysis along the corridor would be done for the year 2045. To estimate these volumes, growth rates were developed along the Langhorne Road corridor and other study area roadways, using the latest Central-Virginia MPO Travel Demand Model, Pathways for Planning and 10-year historic growth. These growth rates were approved by VDOT on December 20, 2023. Table 7 shows the traffic volumes from the Central-Virginia MPO Travel Demand Model, Table 8 shows the historic traffic volumes and Figure 23 shows the growth rates from Pathways for Planning.

The approved growth rates (non-compounded) are as follows:

- Langhorne Road – 1.5%
- Hill Street – 1.5%
- Other Y-lines – 1.5%

The resulting 2045 turning movement volumes for the study area intersections are presented in Figure 24.

Table 7: TDM Total Volumes and Growth Rates within the LY-23-07 Study Area

Route	Location	2016	2045	Annual Growth Rate (%)
Langhorne Drive	N of Hill Street	13,114.71	19,926.93	1.79%
Hill Street	S of Langhorne Drive	4,571.96	7,397.64	2.13%
Langhorne Drive	Hill Street to Tate Springs Road TAZ	10,613.66	17,843.44	2.35%
Tate Springs Road TAZ	S of Langhorne Drive	11,904.86	18,416.80	1.89%
Langhorne Drive	Tate Springs Road TAZ to Tate Springs Road TAZ	17,403.93	25,400.50	1.58%
Tate Springs Road TAZ	N of Langhorne Drive	18,941.09	28,581.32	1.76%
Langhorne Drive	E of Tate Springs Road TAZ	28,524.62	40,219.87	1.41%

Table 8: Historic AADT within the LY-23-07 Study Area

Route	Location	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Langhorne Road	N of Hill Street	12,025	12,070	11,922	12,245	12,264	12,317	12,531	10,909	11,049	12,858	13,433	12,667	10,996
Langhorne Road	E of Hill Street	14,988	15,044	14,860	16,180	16,206	16,275	13,490	13,556	13,853	13,467	14,069	13,267	13,229
Hill Street	S of Langhorne Road	3,713	3,727	3,681	4,011	4,017	4,035	6,731	6,764	6,912	4,835	6,731	6,764	6,912

Covid & Recovery

Route	Location	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Langhorne Road	N of Hill Street	10,790	10,741	9,473	9,607	10,001	10,558	10,621	10,442	10,882	9,997	10,514	9,769
Langhorne Road	E of Hill Street	12,981	12,922	12,698	12,878	13,406	13,584	13,665	13,436	12,141	11,154	11,730	11,923
Hill Street	S of Langhorne Road	4,835	5,051	4,736	5,289	5,190	5,166	5,584	5,663	5,895	5,050	5,311	4,831

Figure 23: Pathways for Planning Growth Rates within the LY-23-07 Study Area

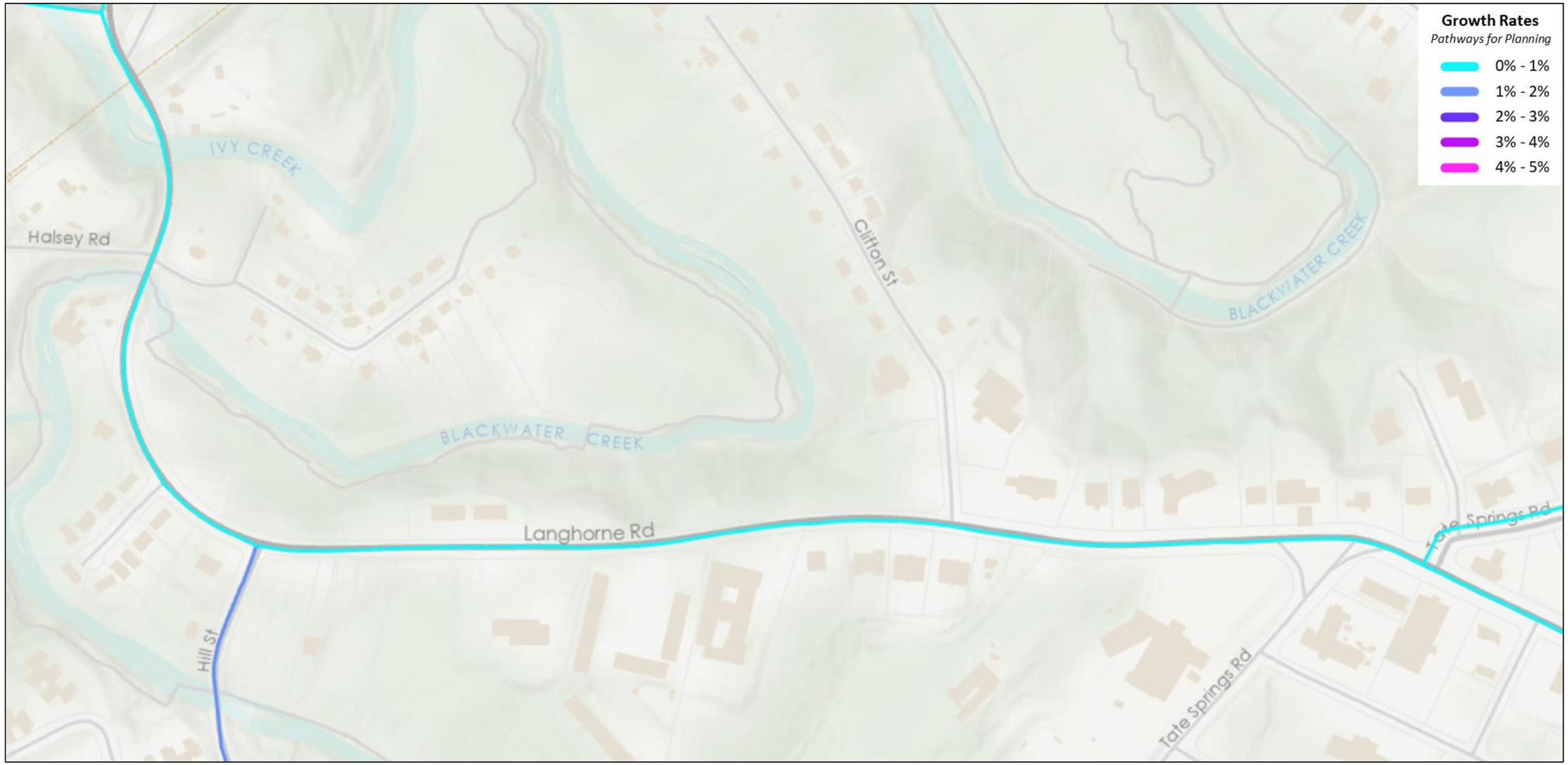
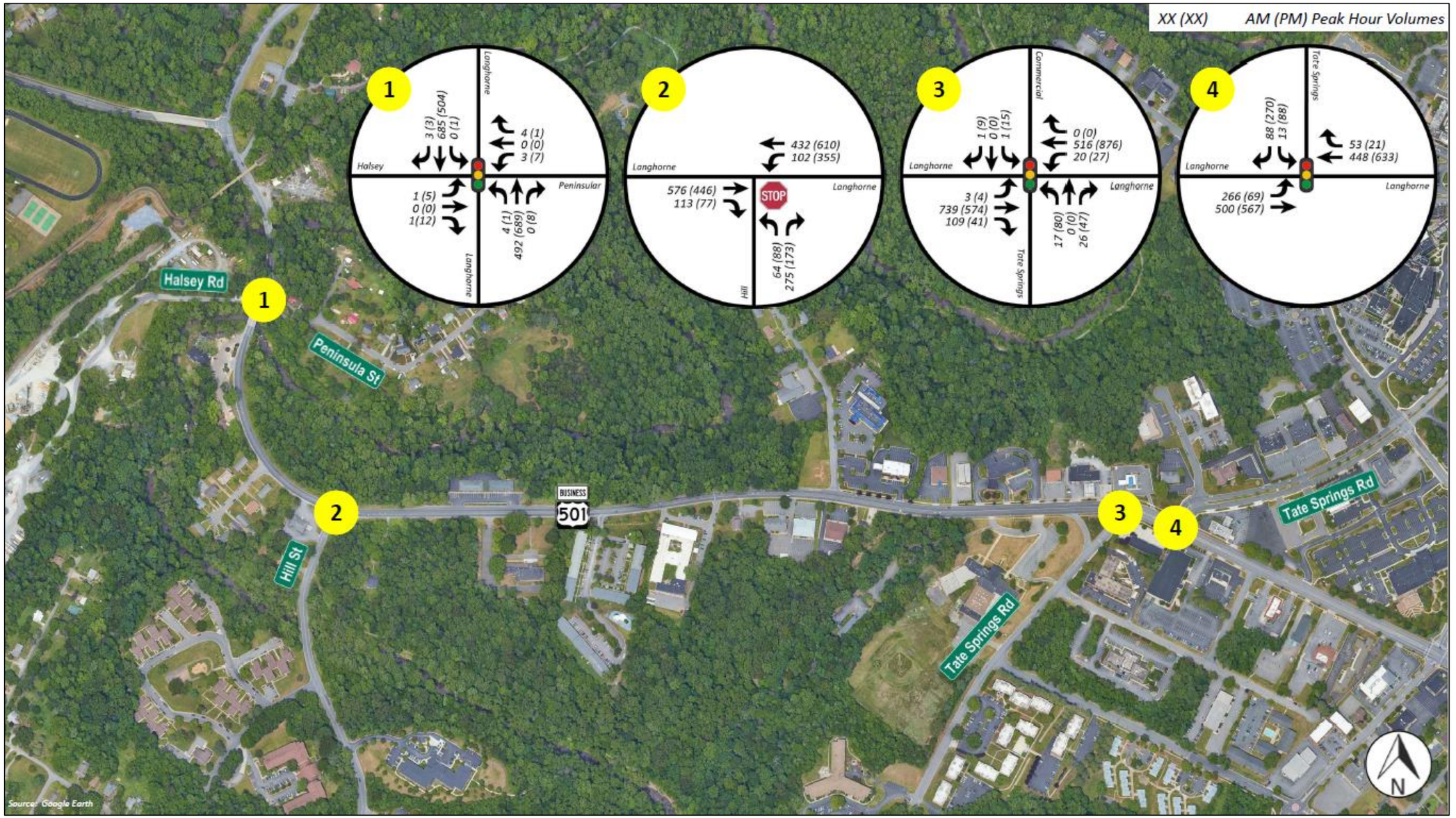


Figure 24. Future AM & PM Peak Hour Turning Movement Volumes



VJuST Analysis

VJuST was used to as a high-level screening tool to identify potential alternative concepts at all study area intersections along the Langhorne Road corridor. These concepts were further screened manually based on a number of factors including operational and safety benefits, costs and right-of-way impacts. The remaining concepts were modeled in Synchro and/or Sidra Intersection. Figure 25, Figure 26, Figure 27 and Figure 28 show the results of the VJuST analysis for each intersection.

For the initial VJuST screening, the 2023 Existing PM peak hour volumes were used; however, a subsequent screening was developed using the forecasted 2045 No-Build PM peak hour volumes.

As shown in Table 3 in Chapter 1, the VTrans needs did not show a congestion issue along the corridor. This was supported by the 2023 Existing and 2045 No-Build PM peak hour VJuST analysis and the 2023 and 2045 No-Build AM and PM peak hour Synchro analysis. In general, a conventional intersection provided some of the best operations at each location; however, it has the highest number of conflict points, which may lead to more crashes.

As previously mentioned, an on-street bicycle facility and two off-road shared-use path (SUP) concepts – one on the north side of Langhorne Road and one on the south side, were explored to enhance bicycle and pedestrian access along Langhorne Road. These concepts were not included in the VJuST analysis.

A preliminary iCap analysis was developed for each preliminary concept however, the Langhorne Road Corridor is not on the Arterial Preservation Network (APN) and as discussed later in this report, none of the preferred alternatives were carried forward for SMART SCALE applications. The results of the preliminary iCap analysis are included in Appendix E.

Figure 25: 2045 No-Build PM Peak Hour VJuST Results for Halsey Road

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Planning Level Cost Category	Notes
Conventional	-	0.45		48	$	Includes EBR turn lane
Thru-Cut	-	0.01		28	$$	
50 Mini Roundabout	-	0.70		8	$	
75 Mini Roundabout	-	0.69		8	$	
Roundabout	-	0.51		8	$$	

Figure 26: 2045 No-Build PM Peak Hour VJuST Results for Hill Street

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Planning Level Cost Category	Notes
Conventional	-	0.58		12	$	Includes EBR turn lane
Continuous Green-T	-	0.58	-	12*	$$	
Roundabout	-	0.51		8	$$	
Two-Way Stop Control	-	1.51		48	$	Existing Condition

Figure 27: 2045 No-Build PM Peak Hour VJuST Results for Tate Springs Road (West)

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Planning Level Cost Category	Notes
Conventional	-	0.33		48	$	
Roundabout	-	0.36		8	$$	

Figure 28: 2045 No-Build PM Peak Hour VJuST Results for Tate Springs Road (East)

Intersection Results

Type	Dir	Maximum V/C	Accommodation Compared to Conventional	Weighted Total Conflict Points	Planning Level Cost Category	Notes
Conventional	-	0.41		48	$	
Roundabout	-	0.44		8	$$	

Synchro/Sidra Intersection Analysis

The following alternative concepts were analyzed for the 2023 Existing and 2045 No-Build AM and PM peak hours using Synchro 11 and/or Sidra Intersection 8:

- Halsey Road
  - None – proposed crosswalks and signage will not impact operations
- Hill Street
  - Installation of a single-lane roundabout
  - Installation of a hybrid roundabout and construction of an exclusive westbound left-turn
  - Installation of a traffic signal and construction of an eastbound right-turn
- Tate Springs Road
  - Installation of a peanut roundabout

Note that the 2023 Existing analysis was initially analyzed in Synchro for screening purposes; however, only the 2045 No-Build analysis is included below as it was used as a basis to compare the alternative concepts listed previously.

The 2045 No-Build AM and PM peak hour Synchro analysis shows that all signalized intersections and stop-controlled movements are currently operating at LOS D or better in both peak hours, with the exception of the signalized Hill Street intersection, which is anticipated to operate at LOS E in the 2045 No-Build PM peak hour. All of the study area intersections are identified by VTrans as having safety needs (District Safety Improvement). Therefore, while operations do not show the need for improvements at the study area intersections, to address the identified VTrans needs and crash history along the corridor, the following improvements were carried forward and presented to the stakeholders.

Hill Street

Hill Street is currently a stop-controlled intersection along a 3-lane undivided roadway with no access restriction. There is a heavy northbound right-turn movement in the future 2045 AM peak hour (275 vehicles) and westbound left-turn movement in the future 2045 PM peak hour (355 vehicles). As shown in Table 9, the Hill Street intersection is anticipated to operate at LOS C in the 2045 No-Build AM peak hour and LOS E in the PM peak hour.

Several options were explored at this location, including constructing an exclusive eastbound right-turn lane, installing a traffic signal, and constructing a roundabout – a single-lane roundabout, or a hybrid roundabout with an exclusive westbound left-turn lane. Ultimately, it was determined that the eastbound right-turn lane with a new traffic signal would provide a significant benefit.

Table 9 also shows that each of the concepts modeled are expected to provide better operations compared to the current intersection configuration and traffic control, with safer operations; however, queues along the mainline would increase if the intersection were to be signalized since the mainline movement would no longer be free flowing. Additionally, westbound queues in the single-lane round concept scenario are extensive due to the heavy westbound left-turn movement.

For constructability, the roundabouts would require significant earth work and may impact right-of-way. The traffic signal and eastbound right-turn lane would likely impact right-of-way too, although to a lesser extent than the roundabout concepts, and the eastbound right-turn lane may require a retaining wall.

Table 9: Hill Street LOS & Delay Summary

Alternative Option	LOS - Delay (sec/veh)	
	2045 AM	2045 PM
No-Build[1]	C - 22.0	E - 38.3
Build (Single-Lane Roundabout)	A - 7.2 (0.718)	B - 13.9 (0.979)
Build (Hybrid Roundabout with Westbound Left-Turn[2]**)**	A - 7.3 (0.779)	A - 8.1 (0.758)
Build (Signal with Eastbound Right-Turn[2]**)**	B - 13.7	B - 16.3

[1] *LOS and Delay reported for the worst side street approach*

[2] *LOS and Delay reported for overall intersection; volume-to-capacity (V/C) reported for the worst approach*

Tate Springs Road

As shown in Table 10 and Table 11 neither Tate Springs Road intersection is anticipated to experience any significant congestion in the 2045 No-Build AM or PM peak hour. These intersections are currently closely-spaced signalized intersections, with the eastern Tate Springs Road intersection having a heavy eastbound left-turn movement in the future 2045 AM peak hour (266 vehicles) and the southbound right-turn movement in the future 2045 PM peak hour (270 vehicles). To enhance safety at these locations, while maintaining acceptable operations at these locations, a peanut roundabout concept was explored and modeled. This would result in access changes to some of the nearby driveways.

Table 10: Tate Springs Road (West) LOS & Delay Summary

Alternative Option	LOS - Delay (sec/veh)	
	2045 AM	2045 PM
No-Build	A - 7.2	B - 10.5
Build (Peanut Roundabout[1])	A - 3.9 (0.716)	A - 4.7 (0.928)

[1] LOS and Delay reported for overall intersection; volume-to-capacity (V/C) reported for the worst approach

Table 11: Tate Springs Road (East) LOS & Delay Summary

Alternative Option	LOS - Delay (sec/veh)	
	2045 AM	2045 PM
No-Build	A - 8.1	B - 12.6
Build (Peanut Roundabout[1])	A - 5.6 (0.677)	A - 7.6 (0.715)

[1] LOS and Delay reported for overall intersection; volume-to-capacity (V/C) reported for the worst approach

Langhorne Road

As previously mentioned, an on-street bicycle facility and two off-road shared-use path (SUP) concepts – one on the north side of Langhorne Road and one on the south side, were explored to enhance bicycle and pedestrian access along Langhorne Road. These concepts were not modeled in Synchro or Sidra Intersection.

Other improvements were considered during Phase 1, including road diet concepts; however, at the direction of the stakeholders during a meeting held on September 5, 2023, these concepts were not carried forward to Phase 2.

Clifton Road Pedestrian Crossing

A pedestrian crossing was proposed just west of the Clifton Road intersection; however, at the direction of the stakeholders during a meeting held on September 5, 2023, this pedestrian crossing was not carried forward to Phase 2.

Figure 29: Hill Street Single-Lane Roundabout Phase 2 Concept

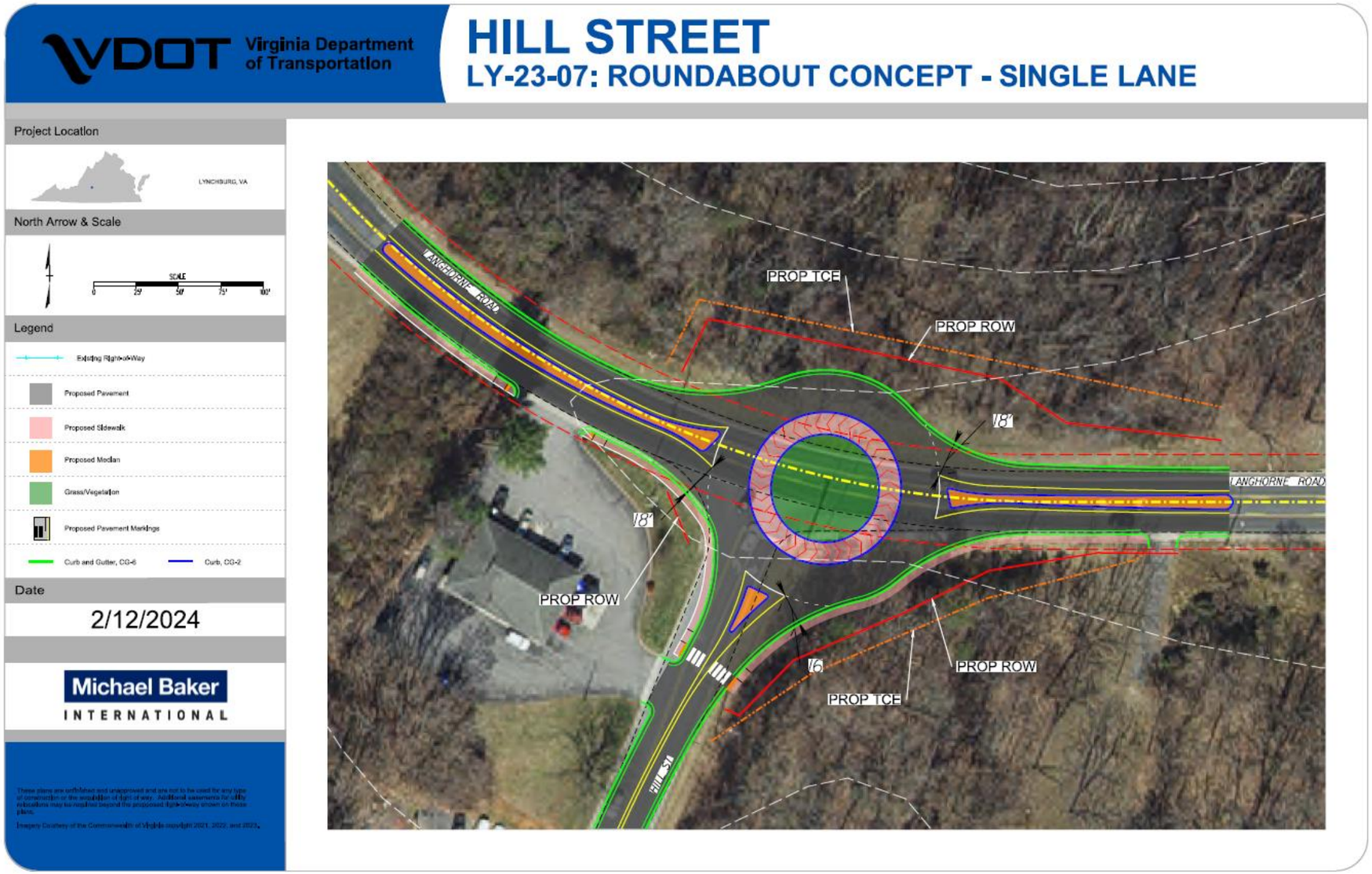


Figure 30: Hill Street Hybrid Roundabout with Westbound Left-Turn Phase 2 Concept

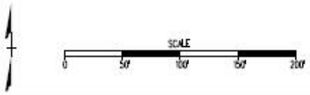
Virginia Department of Transportation

HILL STREET

LY-23-07: ROUNDABOUT CONCEPT - DESIGNATED WB THROUGH LANE

Project Location

North Arrow & Scale



Legend

- Existing Right-of-Way
- Proposed Pavement
- Proposed Sidewalk
- Proposed Median
- Grass/Vegetation
- Proposed Pavement Markings
- Curb and Gutter, CG-6
- Curb, CG-2

Date

2/12/2024

Michael Baker INTERNATIONAL

Figure 31: Hill Street Signal with Eastbound Right-Turn Phase 2 Concept

Figure 32: Tate Springs Road Phase 2 Peanut Roundabout Concept

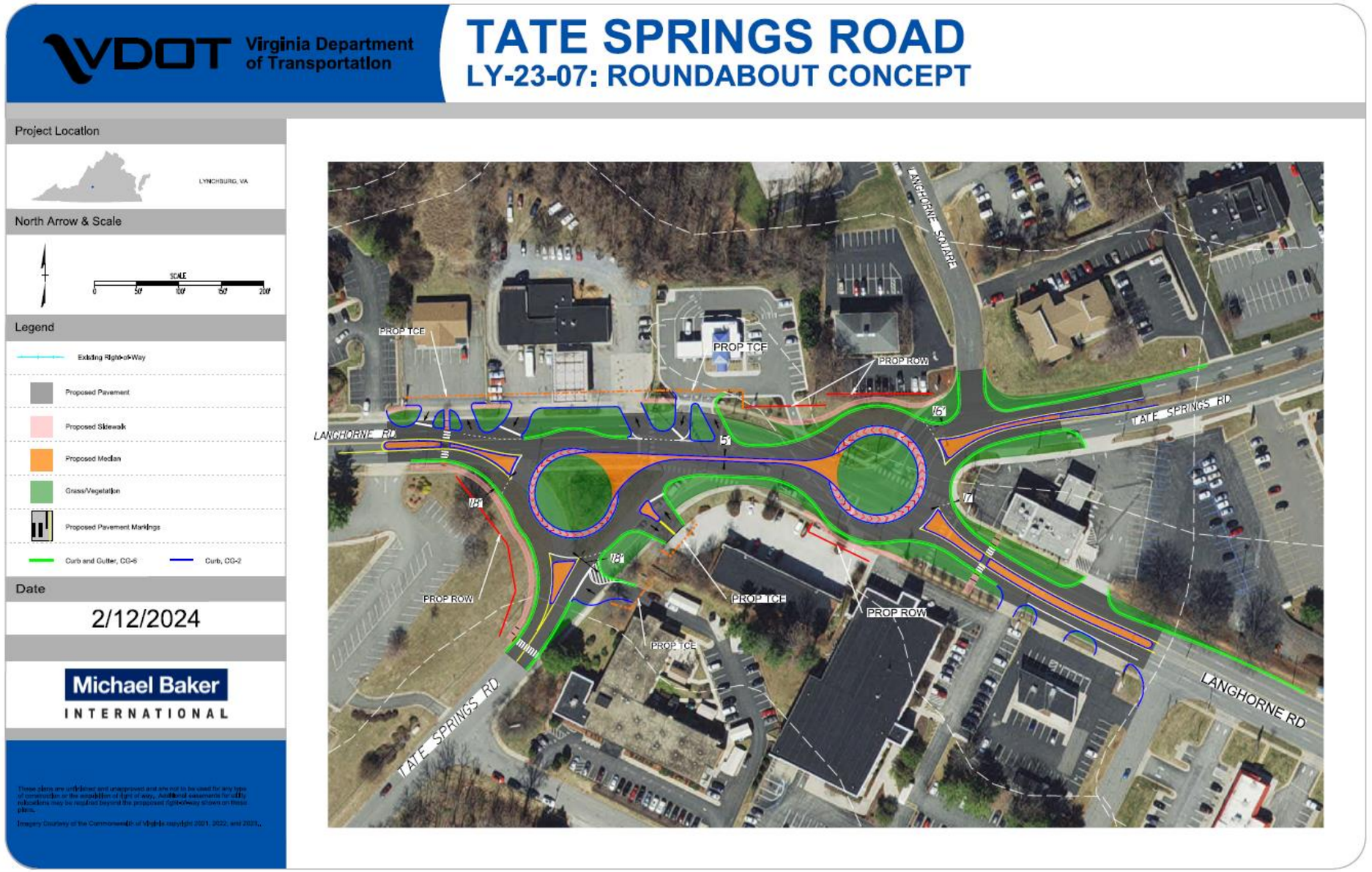
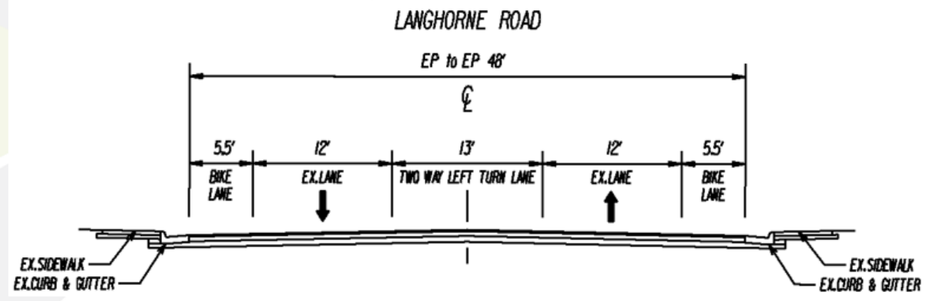


Figure 33: Langhorne Road Phase 2 On-Street Bicycle Facility Concepts

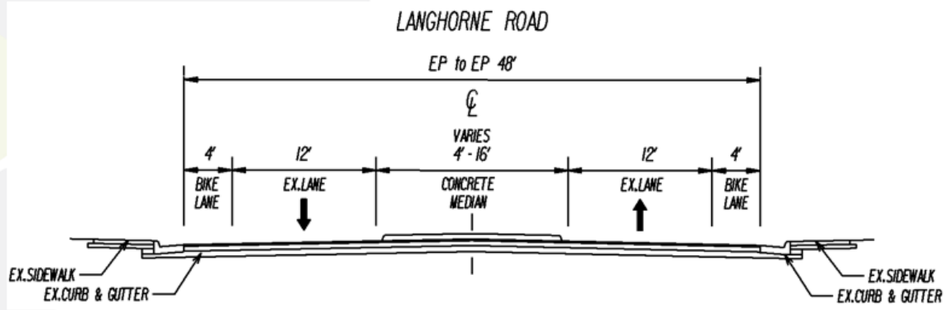
3-Lane Typical Section with Bike Lanes



Pros: Provides 5-½' bike lane along with curb & gutter

Cons: 48-foot right-of-way is not present along the entire corridor

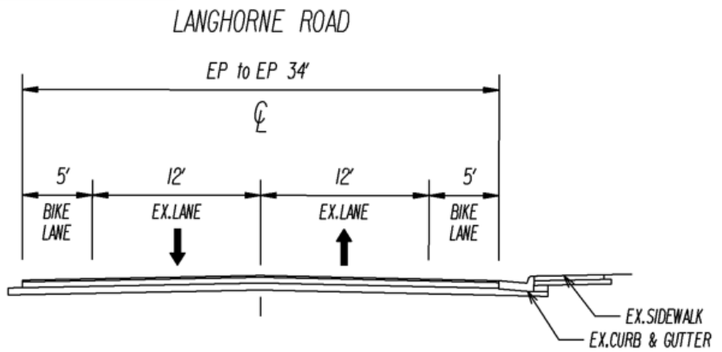
2-Lane Typical Section with Concrete Median & Bike Lanes



Pros: Provides 4' bike lane along with curb & gutter

Cons: 48-foot right-of-way is not present along the entire corridor

2-Lane Typical Section with Bike Lanes



Pros: Provides 5' bike lanes

Cons: Operations may be a challenge | Left-turn lane needed at Hill St

Figure 34: Langhorne Road Phase 2 Off-Road Shared-Use Path (North Alignment) Concept

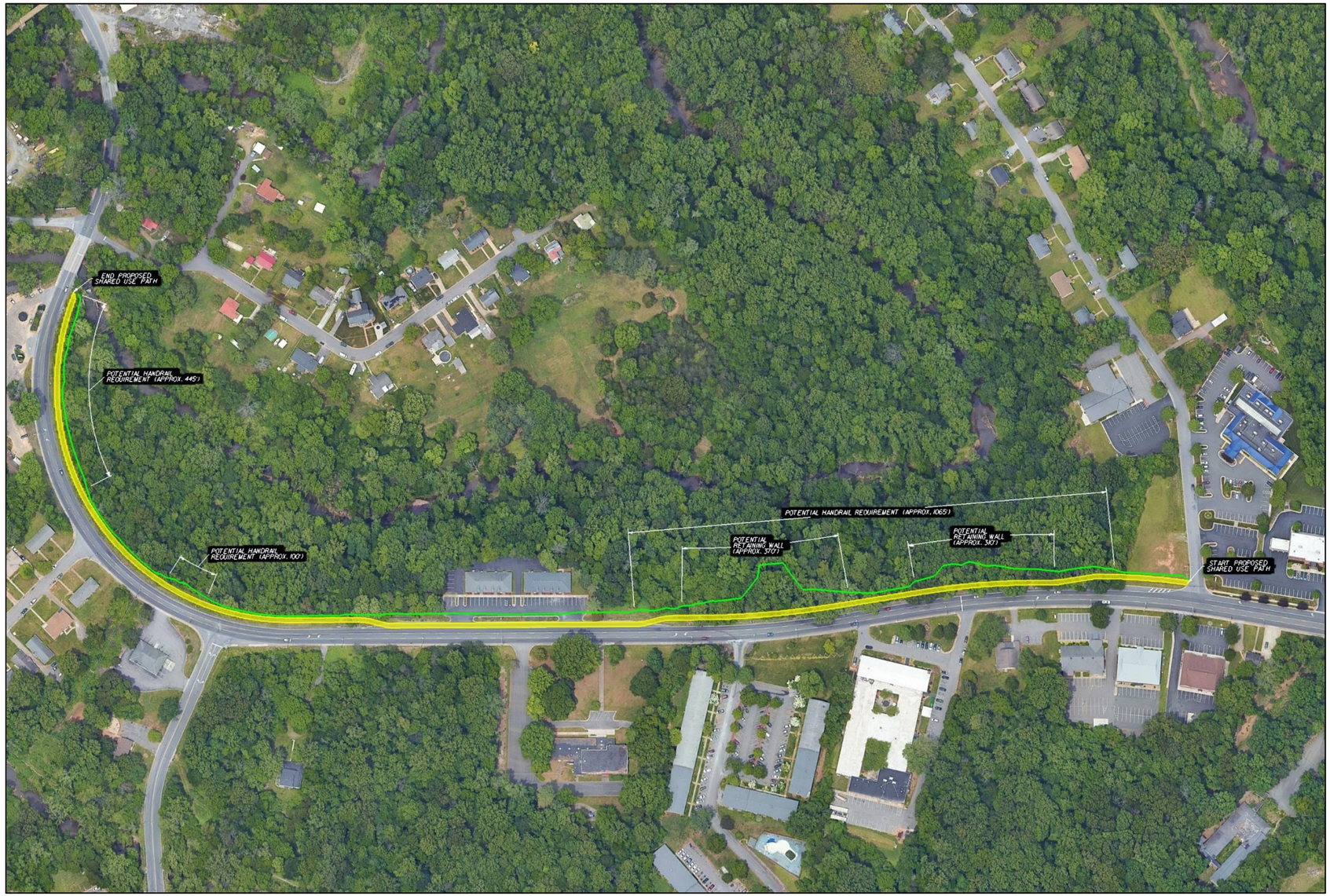


Figure 35: Langhorne Road Phase 2 Off-Road Shared-Use Path (South Alignment) Concept

Preferred Alternatives

Preferred alternatives were developed for the Langhorne Road corridor and at each intersection based on the VJuST screening, the Synchro and/or Sidra Intersection analysis and input from the stakeholders during a stakeholders working group meeting held on February 12, 2024.

After the conclusion of the Phase 2 Survey (discussed in the next section), the City indicated that the following concepts should be carried forward to Phase 3 as preferred alternatives:

- Construct an off-road Shared-Use Path (North Alignment)
- Install a traffic signal and construct an exclusive eastbound right-turn lane at the Hill Street intersection

Expected Crash Reduction

The SMART SCALE Planning Level Crash Modification Factors (CMFs) for Round 5 were reviewed for each of the preferred alternatives along the Langhorne Road corridor to determine what changes may be expected in crash frequency. Note that some locations list the CMF value as "Function." At these locations, the expected crash reduction was used based on the functions included in the Virginia State Preferred CMF List documentation.

Table 12 summarizes the preferred alternatives CMF's. Additionally, vehicle, pedestrian and bicyclist CMFs were available for the off-road shared-use path being carried forward.

Table 12: CMF Summary

Intersection	CMF
Hill Street Eastbound Right-Turn[1]	0.96
Hill Street Traffic Signal	0.65
Langhorne Road Off-Road SUP	0.55 (Vehicles)
Langhorne Road Off-Road SUP	0.12 (Pedestrians)
Langhorne Road Off-Road SUP	0.41 (Bicyclists)

[1] *Calculated using function.*

Chapter 3 – Public and Stakeholder Outreach and Feedback

Public Involvement

Two surveys were developed as part of this Pipeline corridor study using the PublicInput.com platform. The initial survey focused on soliciting public feedback regarding their use of the corridor and identifying issues and needs along the corridor. It was available for public feedback from September 7, 2023 – September 21, 2023. The results of the initial public outreach are summarized in Chapter 1 of this report.

As part of Phase 2, a stakeholder meeting was held on February 12, 2024 to discuss the alternative concepts at the study area intersections and segments along the Langhorne Road corridor that were developed during Phase 1 and Phase 2. Based on input from the stakeholders, six preferred alternative concepts were carried forward to Phase 3. A second survey was prepared soliciting public feedback on these preferred alternatives. This survey was open from March 18, 2024 to April 1, 2024. These improvements include:

- Construct an off-road Shared-Use Path (North Alignment)
- Install and upgrade pedestrian accommodations at Halsey Road, Hill Street and Tate Springs Road
- Enhance signage at Halsey Road
- Install a traffic signal and construct an exclusive eastbound right-turn lane

Survey Questions and Results

Phase 1

There were 105 participants and 2,376 responses to the Phase 1 survey. Of the VTrans needs identified along the corridor, public responses indicated that vehicular safety was the greatest need and the vast majority of people using the corridor use their personal vehicle. Additionally, they indicated that reducing traffic congestion, corridor and intersection safety and addressing speeding and aggressive drivers are the most important issues within the study area. The results of the Phase 1 survey are discussed in more detail in Chapter 1.

Phase 2

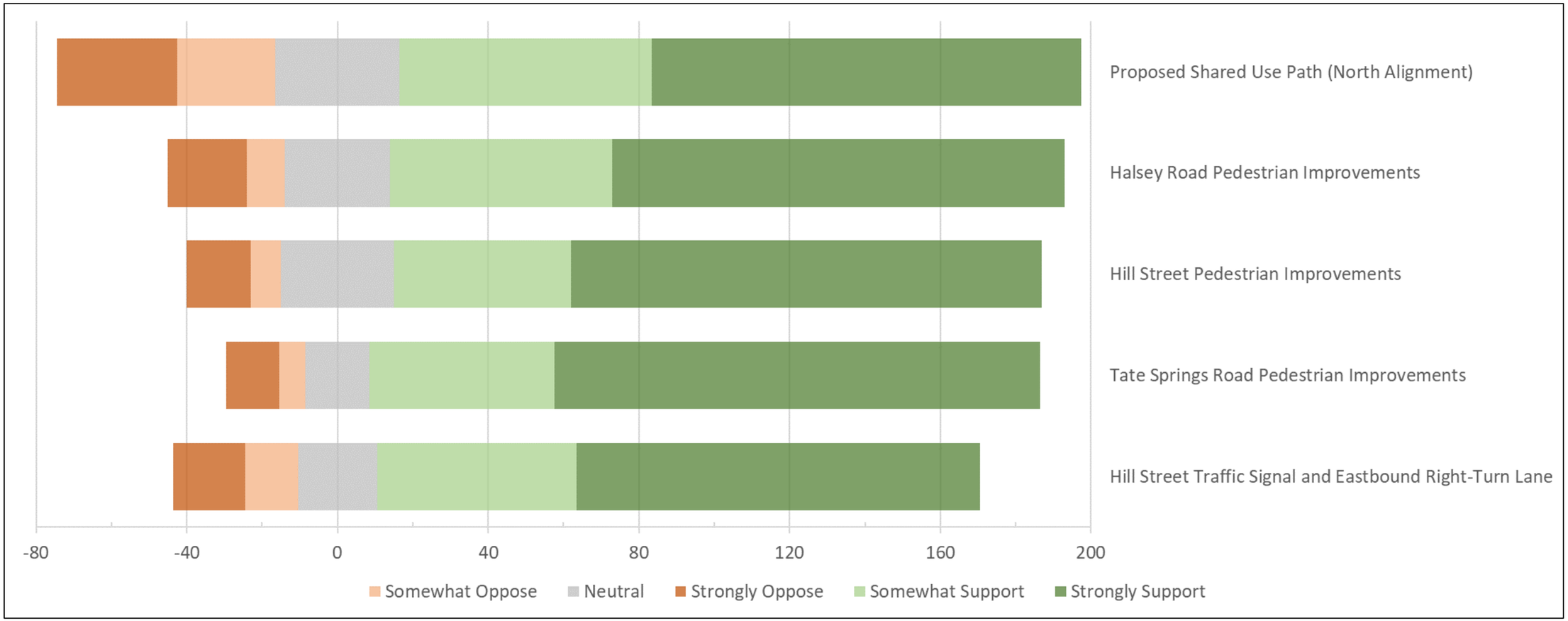
There were 276 participants and 2,507 responses to the Phase 2 survey. Each preferred concept was presented visually with feedback solicited via a 5-point Likert scale, as follows:

- Strongly Oppose
- Somewhat Oppose
- Neutral
- Somewhat Support
- Strongly Support

The concepts presented in the survey were well received by the public with the majority of respondents indicating that they strongly supported each concept, with at least 42% of respondents (with ranges up to 60%) indicating strong support for each concept. Overall, support for each concept ("somewhat support" and "strongly support") ranged from 67% to 82% for each concept and opposition ("somewhat oppose" and "strongly oppose") ranged from 10% to 21% for each concept.

The results of the survey are shown in Figure 36.

Figure 36: Phase 2 Survey Results



Chapter 4 – Preferred Alternative Design Refinement and Investment Strategy

Intent of Phase 3

As part of Phase 3, the preferred alternatives carried over from Phase 2 were further refined and detailed cost estimates were developed in order to aid with project funding and validation. The design refinement process included in Phase 3 intends to provide highly-detailed designs and cost estimates, while also identifying and mitigating risks associated with the designs.

As noted previously, the following projects were identified as preferred alternatives by the stakeholders during a meeting held February 12, 2024:

- Construct an off-road Shared-Use Path (North Alignment)
- Install a traffic signal and construct an exclusive eastbound right-turn lane at the intersection of Langhorne Road and Hill Street intersection

While these projects were identified as preferred alternatives during the meeting, City staff later indicated that these projects would not be submitted for SMART SCALE funding during this cycle; however, based on discussions with VDOT this document is being prepared as though the preferred alternatives are being carried through to the funding stage and will be a shelf-ready document in the future.

Preferred Alternative Refinement

No modifications were made to the *Synchro* or *Sidra* models developed during Phase 1 and Phase 2.

Designs for each of the preferred alternatives were refined, and the final concepts were developed with the following design details and assumptions. These designs conform to VDOT's most-recent *Road Design Guide (published January 1, 2005; revised July 11, 2024)* and the *2009 Manual on Uniform Traffic Control Devices (MUTCD).*

Off-Road Shared-Use Path (North Alignment)

The initial concept for the off-road Shared-Use Path presented to the stakeholders during the February 12, 2024 meeting showed the off-road Shared-Use Path extending from Peninsular Street to Clifton Street; however, stakeholders indicated a desire to extend the Shared-Use-Path farther east and terminate at Tate Springs Road. Therefore, the off-road, Shared-Use-Path design was extended toward Tate Springs Road intersection while maintaining its geometry of 10 feet wide with an 8-foot minimum setback on the north side of Langhorne Road. The length of proposed Shared-Use-Path now extends from Peninsular Street to the existing sidewalk network at the gas station near the Tate Springs Road intersection. The Shared-Use-Path alignment was designed to minimize utility impacts and is located behind existing utilities poles although relocation of some utilities and commercial signage will be required for its extension east of Clifton Street. Additionally, significant earthwork and/or retaining walls will be needed and handrail may be required for sections between Peninsular Street and Clifton Street.

Hill Street Traffic Signal and Eastbound Right-Turn Lane

Installing a traffic signal and constructing an eastbound right-turn lane is the preferred alternative at the Langhorne Road and Hill Street intersection. The traffic signal was assumed to be a 3-phase traffic signal with a protected westbound left-turn lane from Langhorne Road to Hill Street. In conjunction with the construction of the eastbound right-turn lane, two parcels are anticipated to be impacted, and a retaining wall was also recommended in the southwest quadrant of the intersection to minimize right-of-way impacts to the existing parking lot.

The final concept designs are shown in Figure 37 through Figure 41.

Risk Assessment

Several risks were identified for each of the preferred alternatives, including the following:

Off-Road Shared-Use Path (North Alignment)

- Retaining walls and handrails may be necessary to reduce grading and/or right-of-way impacts for the Shared-Use-Path from Peninsular Street to Clifton Street.
- Existing utility poles along Langhorne Road impose design constraints throughout corridor.
- Hydraulic risks include the potential need for additional earthwork/infrastructure if purchase of nutrient credits is unavailable (i.e. local nutrient credits are expended by time of design).
- Right-of-way coordination with impacted properties will be required in order to maintain access to numerous commercial entrances for utility relocations and at all times throughout construction.

Hill Street Traffic Signal and Eastbound Right-Turn Lane

- Existing utilities will be impacted by proposed construction and require relocation of 3 utility poles with impacts to the overhead lines of 2 additional utility poles.
- Unimpacted, existing utility lines in the project area will present an additional hazard and difficulty for the contractor throughout construction.
- A retaining wall may be required to reduce impacts to the Lincare facility parking lot and property requiring additional right-of-way coordination.

Cost Estimate

Cost estimates for each of the preferred alternatives were developed using VDOT's *Cost Estimate Workbook (CEWB, published February 1, 2023)* and other resources as needed. Table 13 summarizes the cost estimates developed for each of the preferred alternatives in Phase 3, with a detailed breakdown of each preferred alternative's cost estimate included in Appendix F.

Table 13. SMART SCALE-Level Cost Estimates for the Preferred Alternatives

Preferred Alternative	Preliminary Engineering	Right-of-Way and Utilities	Construction	Contingency	Total Cost
Off-Road Shared-Use Path (North Alignment)	$670,100	$485,000	$4,956,240	$2,691,150	$8,802,490
Hill Street Traffic Signal and Eastbound Right-Turn Lane	$255,300	$675,000	$1,446,900	$1,068,025	$3,445,225

Investment Strategy

While this study was developed following the guidance included in the *Project Pipeline Program Guide 2023 – 2024 (dated January 2023) and the SMART SCALE Technical Guide (dated February 2024)*, as noted previously, the preferred alternatives included in Phase 3 are not being submitted as part of the SMART SCALE applications during this round; however, there are potential funding sources that can aid with the final development and construction of each of the preferred alternatives including VDOT's Revenue Sharing Program, the United States Department of Transportation's (USDOT) Congestion Mitigation and Air Quality (CMAQ) Improvement Program and the Virginia Highway Safety Improvement Program (VHSIP). Table 14 shows which funding sources the preferred alternatives may be applicable for.

Table 14. Project Funding Sources

Funding Source	Project Types Funded	Preferred Alternative Applicable
VDOT Revenue Sharing[1]	Appropriate for local construction projects, reconstruction projects, improvement projects and maintenance projects on VDOT- or locally-maintained roadways.	Off-Road Shared-Use Path (North Alignment) Hill Street Traffic Signal and Eastbound Right-Turn Lane
USDOT CMAQ[2]	Appropriate for projects that reduce congestion and/or improve air quality by reducing emissions. Many types of projects are eligible under the CMAQ program including: • Electric vehicles and charging stations • Diesel engine replacements and retrofits • Transit improvements • Bicycle and pedestrian facilities • Shared micromobility projects including shared scooter systems	Off-Road Shared-Use Path (North Alignment)
Virginia HSIP[3]	Appropriate for projects that have the greatest potential to reduce fatalities and injuries along roadways. To be eligible, projects must generally conform to the following: • Be consistent w/ a State's SHSP • Correct or improve a hazardous road location or feature, or address a highway safety problem • Be identified on the basis of crash experience, crash potential, crash rate, or other data-support means • Be listed under 23.U.S.C 148(a)(4)(B) or (a)(11); and • Comply with other title 23 requirements	Hill Street Traffic Signal and Eastbound Right-Turn Lane

[1] https://www.vdot.virginia.gov/doing-business/for-localities/local-assistance/revenue-sharing/ & https://law.lis.virginia.gov/vacode/title33.2/chapter3/section33.2-357/
[2] https://www.transportation.gov/sustainability/climate/federal-programs-directory-congestion-mitigation-and-air-quality-cmaq & https://www.fhwa.dot.gov/environment/air_quality/cmaq/index.cfm
[3] https://www.vdot.virginia.gov/doing-business/technical-guidance-and-support/traffic-operations/vhsip/ & https://safety.fhwa.dot.gov/hsip/rulemaking/docs/BIL_HSIP_Eligibility_Guidance.pdf

Figure 37: Final Off-Road Shared Use Path Design (Sheet 1)

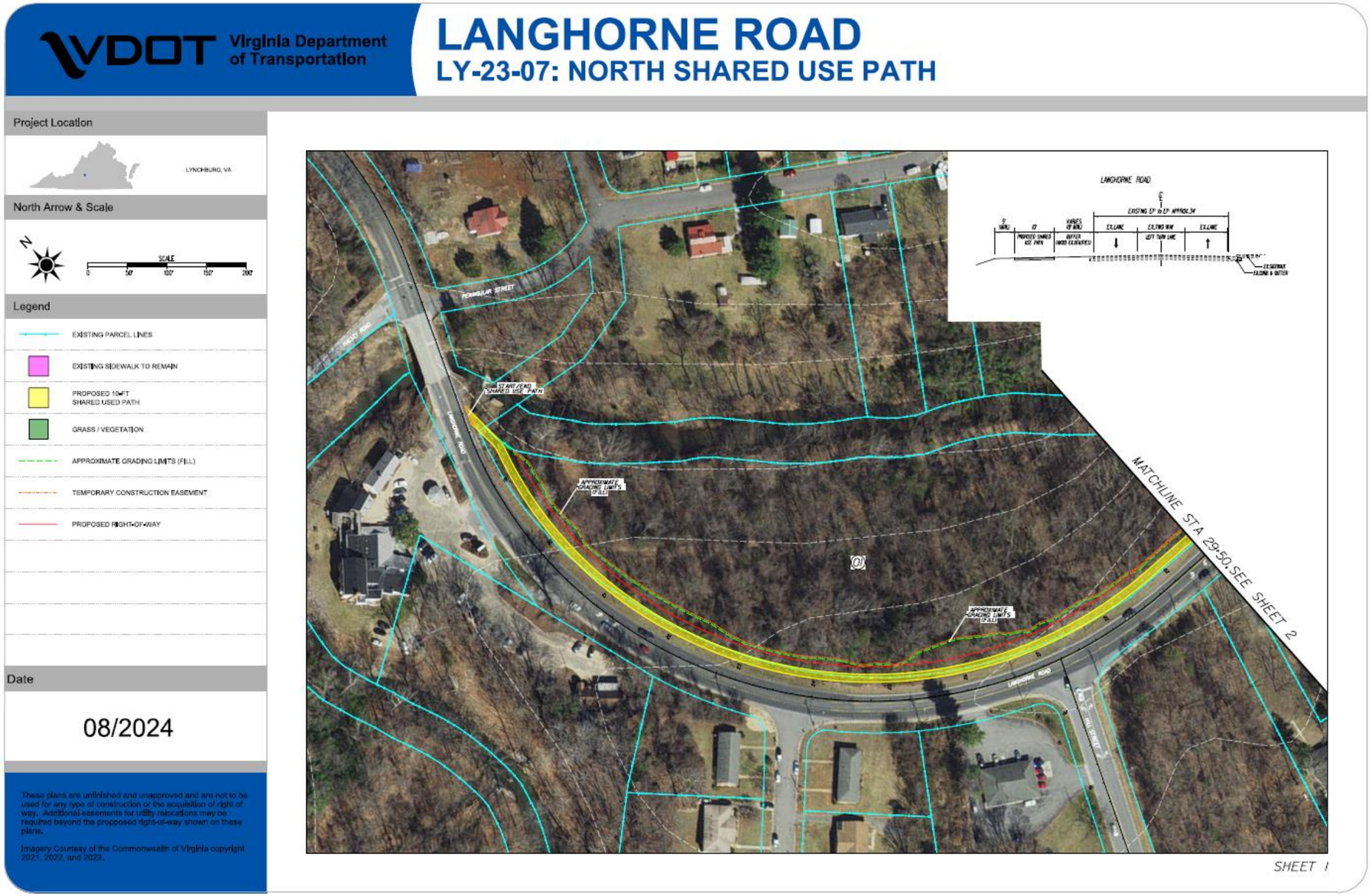


Figure 38: Final Off-Road Shared Use Path Design (Sheet 2)

VDOT Virginia Department of Transportation

LANGHORNE ROAD
LY-23-07: NORTH SHARED USE PATH

Project Location

North Arrow & Scale

N

SCALE
0 50' 100' 150' 200'

Legend

- EXISTING PARCEL LINES
- EXISTING SIDEWALK TO REMAIN
- PROPOSED 10-FT SHARED USED PATH
- GRASS / VEGETATION
- APPROXIMATE GRADING LIMITS (FILL)
- TEMPORARY CONSTRUCTION EASEMENT
- PROPOSED RIGHT-OF-WAY

Date

08/2024

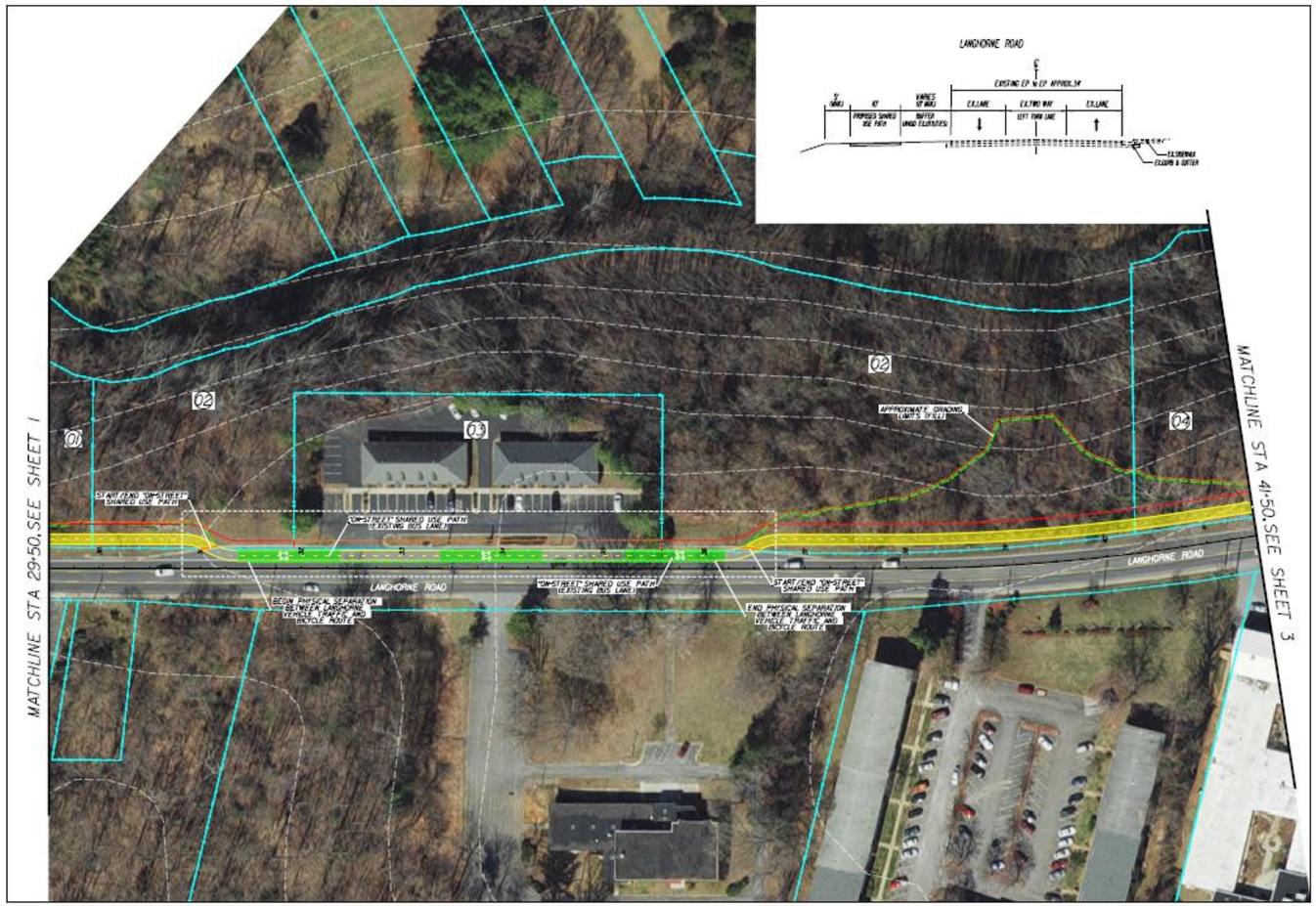


Figure 39: Final Off-Road Shared Use Path Design (Sheet 3)

VDOT Virginia Department of Transportation

LANGHORNE ROAD
LY-23-07: NORTH SHARED USE PATH

Project Location

North Arrow & Scale

N

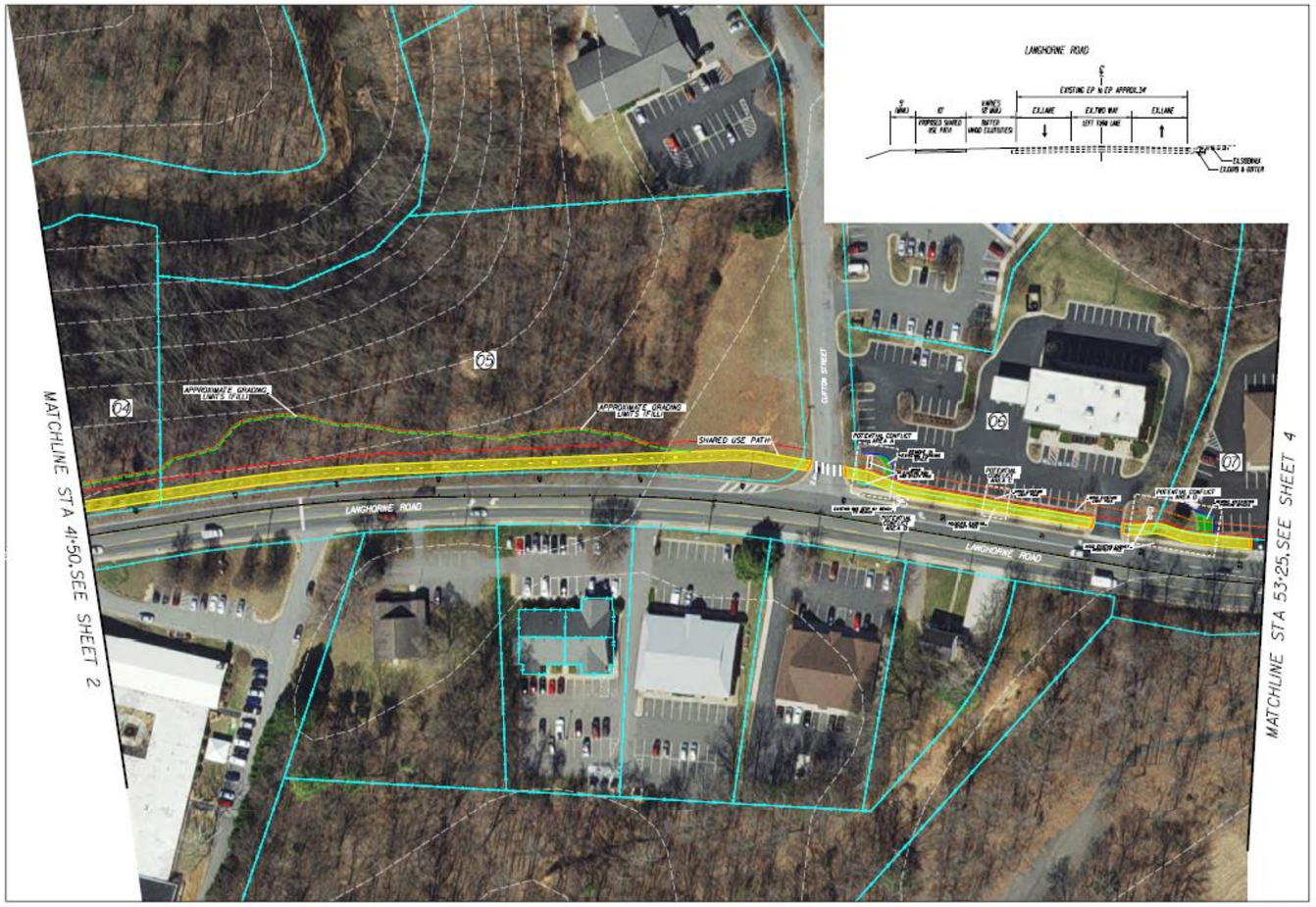
SCALE
0 50' 100' 150' 200'

Legend

- EXISTING PARCEL LINES
- EXISTING SIDEWALK TO REMAIN
- PROPOSED 10-FT SHARED USED PATH
- GRASS / VEGETATION
- APPROXIMATE GRADING LIMITS (FILL)
- TEMPORARY CONSTRUCTION EASEMENT
- PROPOSED RIGHT-OF-WAY

Date

08/2024



SHEET 3

Figure 40: Final Off-Road Shared Use Path Design (Sheet 4)

VDOT Virginia Department of Transportation

LANGHORNE ROAD
LY-23-07: NORTH SHARED USE PATH

Project Location

North Arrow & Scale

Legend

- EXISTING PARCEL LINES
- EXISTING SIDEWALK TO REMAIN
- PROPOSED 10-FT SHARED USED PATH
- GRASS / VEGETATION
- APPROXIMATE GRADING LIMITS (FILL)
- TEMPORARY CONSTRUCTION EASEMENT
- PROPOSED RIGHT-OF-WAY

Date

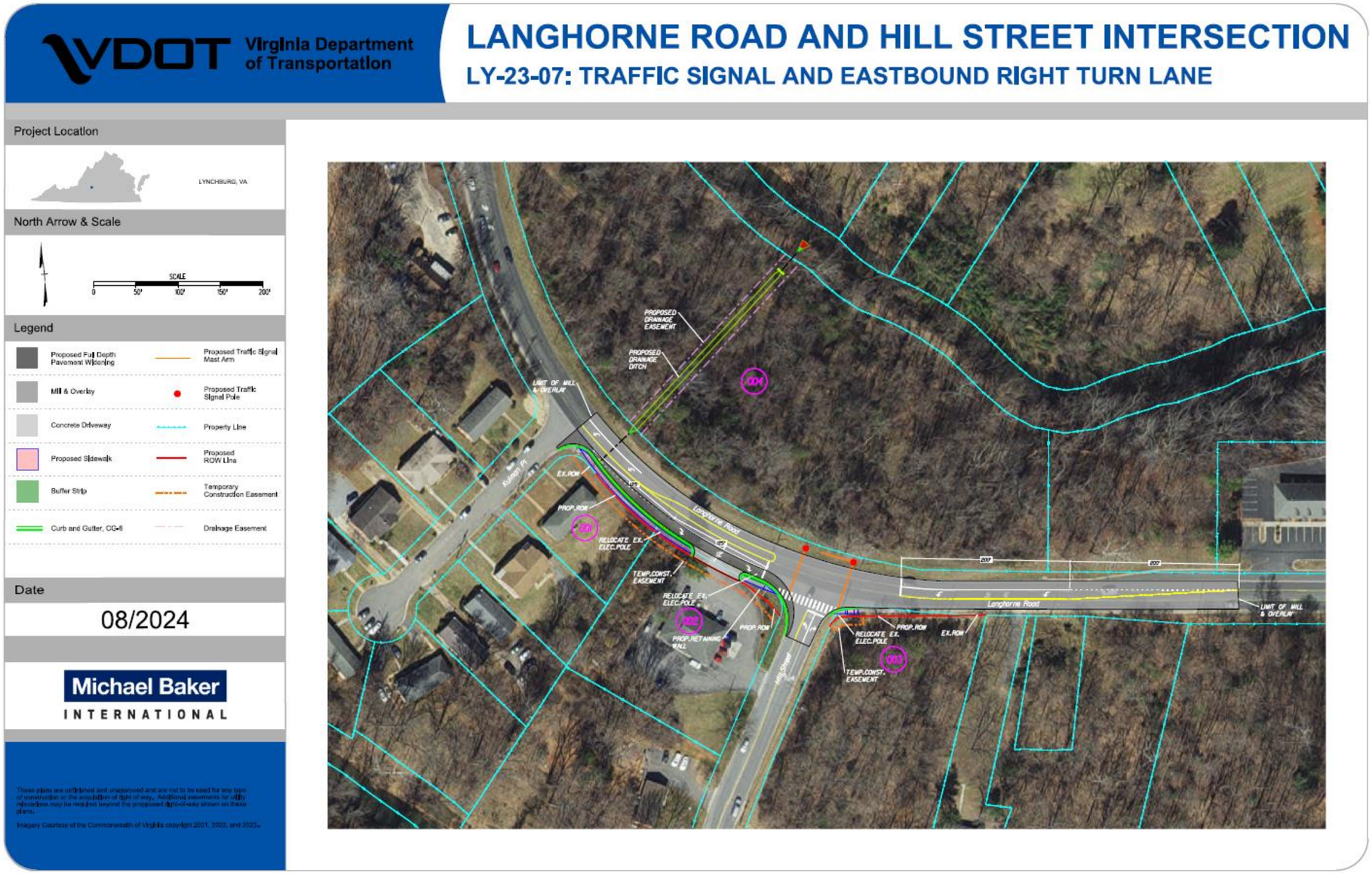
08/2024

These plans are unfinished and unapproved and are not to be used for any type of construction or the acquisition of right of way. Additional easements for utility relocations may be required beyond the proposed right-of-way shown on these plans.

Imagery Courtesy of the Commonwealth of Virginia copyright 2021, 2022, and 2023.

SHEET 4

Figure 41: Final Design for Langhorne Road and Hill Street Intersection



Appendices

Appendix A:

Framework Document

Pre-Scoping Meeting Presentation

Kickoff Meeting Presentation

Previous Studies

Field Visit Notes

Appendix B:

Phase 1 Executive Summary

Appendix C:

Phase 1 Stakeholder Working Group Presentation

Crash Diagrams and HSM Spreadsheets

Traffic Count Data

Existing Conditions Analysis Results

Phase 1 Public Outreach

Appendix D:

Volume Balancing Sheet

Traffic Forecasting

Future No-Build Condition Analysis Results

Traffic Signal Timing Plans

Appendix E:

Phase 2 Shareholder Working Group Meeting Presentation

Phase 2 Public Outreach

iCAP Workbooks

Appendix F:

Preliminary Alternative Future Build Condition Operational Analysis Results

Basis of Design Memos

Preferred Alternative Cost Estimate

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