



# PROJECT PIPELINE

**ST-23-06: CITY OF HARRISONBURG  
PORT REPUBLIC ROAD (ROUTE 253)  
FROM FOREST HILL ROAD  
TO BLUESTONE DRIVE**



# Port Republic Road (Route 253) from Forest Hill Road to Bluestone Drive

Final Report

July 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: [vapipeline.org](http://vapipeline.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 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**.

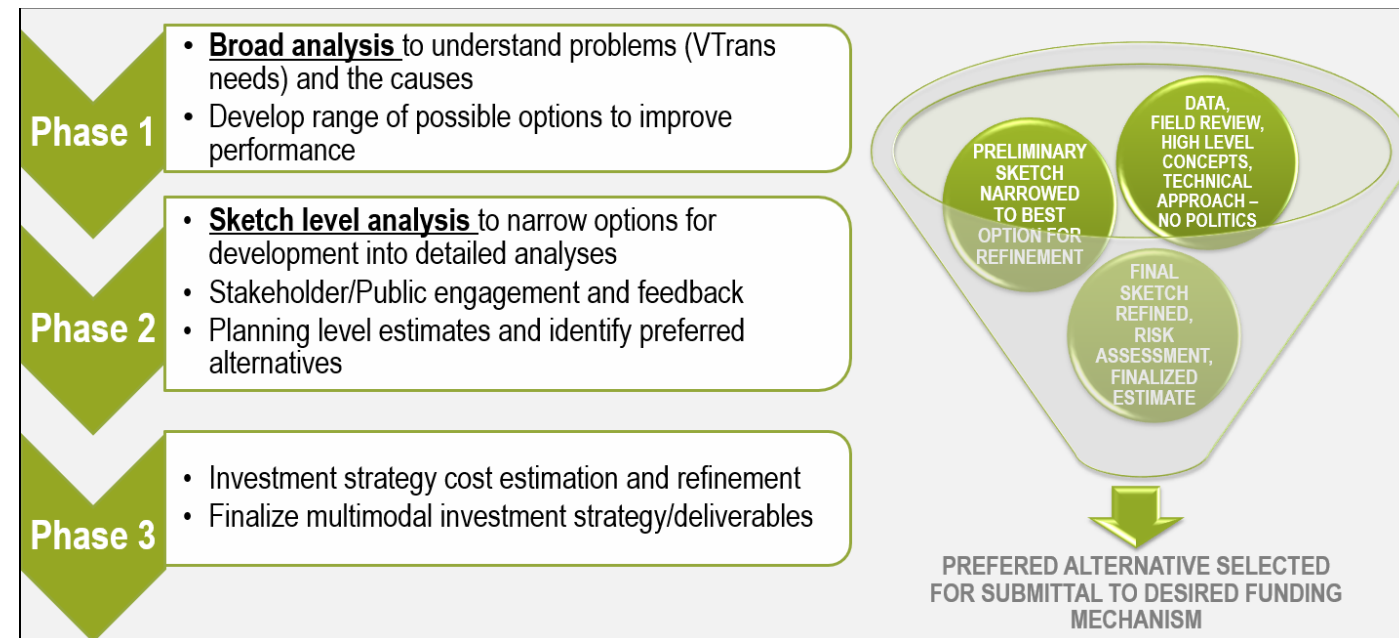


Figure 2: Study Phase Methods and Solutions

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 expected that the same Technical Team will be responsible for all studies within a district for the cycle. 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 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 Port Republic Road (Route 253) study corridor from Forest Hill Road (Route 115) to Bluestone Drive (Route 331) is located in the City of Harrisonburg, Virginia. Port Republic Road is classified as a minor arterial road within the study area. The posted speed limit is 35 miles per hour (MPH). A map detailing the locations of the study intersections is shown below in **Figure 4**.



Figure 4: 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.<sup>1</sup> 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](https://vtrans.org/resources/VTrans_Policy_Guide_v6.pdf). The mid-term needs, as identified in VTrans for the Port Republic Road study corridor, were ‘Very High’ for Bicycle Access,

Pedestrian Access, Safety Improvement, and Transit Access, and ‘High’ for Transportation Demand Management, as presented in **Table 3**.

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                        | Very High  |
| Safety Improvement                       | Very High  |
| Pedestrian Safety Improvement            | None       |
| Reliability                              | None       |
| Rail On-time Performance                 | None       |
| Transit Access                           | Very High  |
| Transit Access for Equity Emphasis Areas | None       |
| Transportation Demand Management         | High       |

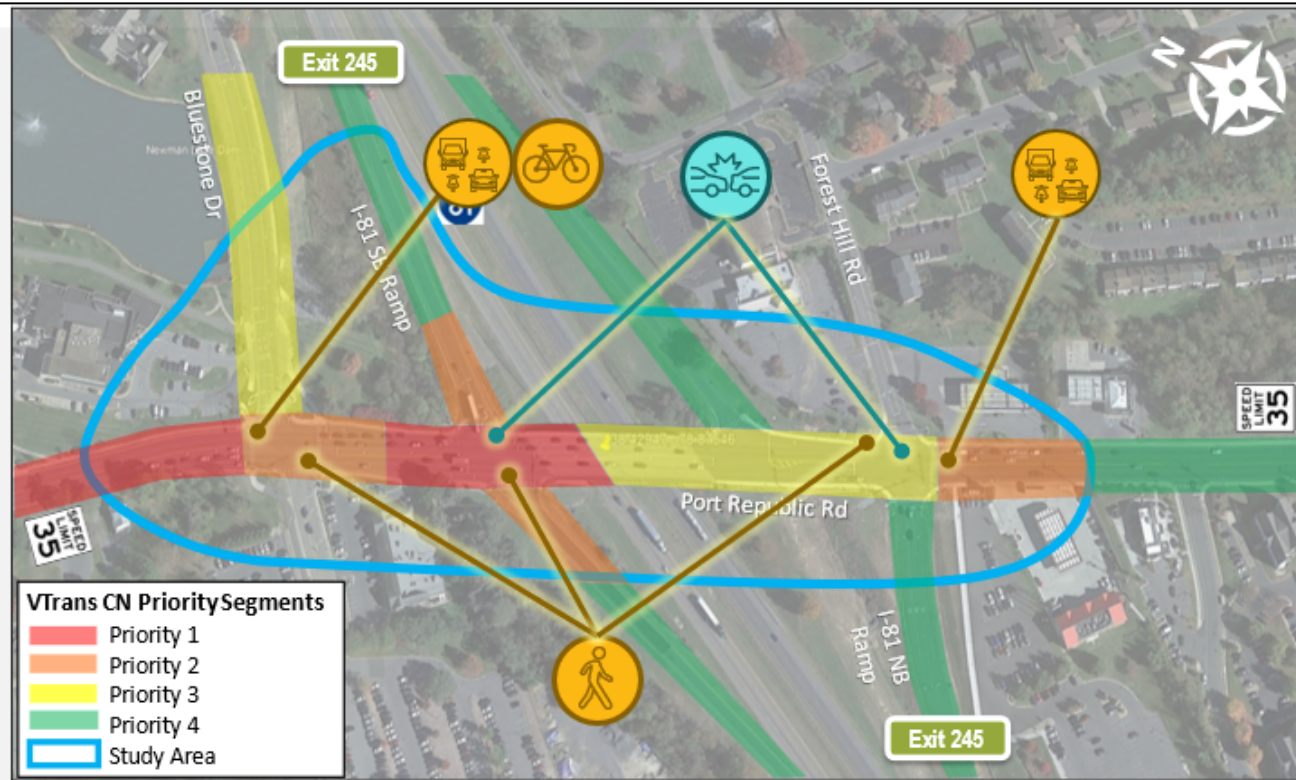
*Note: Congestion does not show up as a VTRANS Need due to the lack of traffic congestion when the nearby James Madison University has summer break. However, per the Study Working Group’s observations, the study area is heavily congested during the remaining 9 months.*

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 the 2019 VTrans priority segments in the study corridor by Construction District Priority, along with an overview of the study corridor’s existing conditions in relation to the VTrans needs.

<sup>1</sup> 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



Note: The I-81 Northbound Off-Ramp was realigned to intersect with Port Republic Road/Forest Hill Road in the year 2020



- At the I-81 SB Off-Ramp intersection, 44 Left Turn Angle crash incidents. A high proportion of Westbound Through (WBT) Red Light Runners (71%). At the Forest Hill Rd intersection, 25 Rear-End (RE) incidents were associated with WBT and 14 RE incidents were associated with EBT after the intersection.
- Two Ped incidents at SB Ramp and two at Bluestone Dr intersections involving left-turning vehicles not yielding to pedestrians. Missing sidewalk from Port Republic Rd to the University Outpost bookstore entrance at Forest Hill Rd.
- Significant bicycle and pedestrian generators with James Madison University and multiple transit routes.
- Current transit service provided by the HDPT Route 6. The closest existing Park & Ride Lot is at Mt Crawford, 5 miles to the south.
- The closest existing Park & Ride lot is at Mt Crawford (5 miles to the south). Funded SMART SCALE Project to expand the lot to 82 spaces.
- Forest Hill Rd intersection operating on LOS D (Average Delay 35-55 sec) in the Year 2023 PM conditions.
- Port Republic Rd eastbound queues extends to US-11 in the afternoon.
- Port Republic Rd westbound queues extends beyond Devon Ln multiple times a day due to the congestion related to James Madison University at class change times.

**Project Purpose, Goals, & Objectives**

Analyze the operational and safety issues identified along Port Republic Road near I-81, focusing on improving congestion and safety, as well as enhancing pedestrian and bicycle access.

Identify cost-effective preferred improvement alternatives that address the deficient conditions and prioritize safety and accessibility.

| Project Fact Sheet         |   |
|----------------------------|---|
| VDOT District              | Staunton  |
| Locality                   | Harrisonburg  |
| # of Study Intersections   | 4   |
| Transit Routes             | - Harrisonburg Transit Route 6<br>- JMU Routes<br>- BRCC North Route (BRITE)  |
| Nearby Transit Connections | Mt. Crawford Park and Ride (~ 5 miles to the south)   |
| Nearby Bikeways            | Bluestone Trail and Butler Street Shared Lane; Port Republic Road Bike Lanes; Shared Use Path along University Boulevard and Driver Drive |
| Functional Classification  | Minor Arterial  |
| Speed Limit                | 35 mph  |

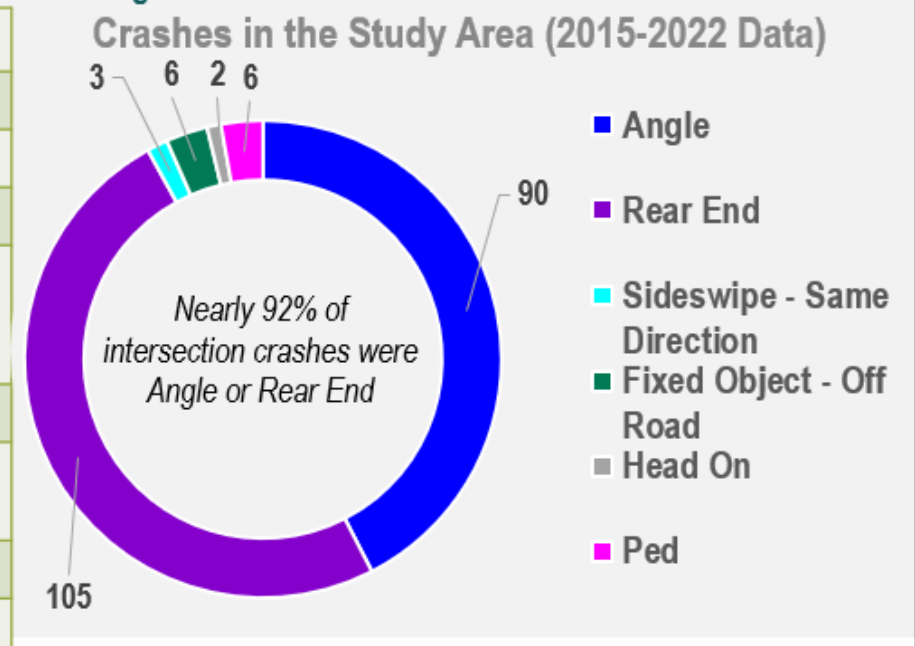


Figure 5: Project Overview

## Previous Study Efforts

### Port Republic Road Safety and Operations Study, 2019

This Harrisonburg Rockingham Metropolitan Planning Organization (HRMPO) corridor study took a detailed look at safety issues and existing and future operational issues on Port Republic Road between US-11 to the west and Devon Lane to the east. Several recommendations from this study have since been funded, including the Bluestone Drive to Crawford Avenue turn lane extension, and the improvements between Bradley Drive and Devon Lane with a new traffic signal and median installation. A recommendation from the study to restrict left turns at select side streets has been implemented east and west of the Project Pipeline study area. Vissim modeling of future traffic conditions identified a critical queueing issue at the I-81 SB off-ramp, with queues extending back to mainline I-81 by the year 2030. This issue was the primary factor behind initiating this Project Pipeline effort, which will include an evaluation of options to extend a second southbound lane on the I-81 SB off-ramp.

### Port Republic Road & Bluestone Drive Bicycle-Pedestrian Bridge Feasibility Study, 2020

A follow-up effort to the 2019 HRMPO corridor study was undertaken in 2020 to evaluate the feasibility of the recommendations for a pedestrian bridge over Port Republic Road at the Bluestone Drive intersection. The Vissim analysis from the corridor study was revised to test and compare a bridge option versus an at-grade option in which the crossings across Port Republic Road would be consolidated to a single crossing on the west/north leg of the Bluestone Drive intersection. The study found that the at-grade option was preferable to the bridge. This resulted in the relocation of the pedestrian crossing from the east side to the west side of the Bluestone Drive intersection.

## Funded / Completed Projects

### Traffic Signal Safety Improvements – Completed in 2021

As part of a city-wide improvement to the traffic signal system for 18 intersections, the city upgraded the intersection of Port Republic Road and I-81 SB Ramps to include:

- Audible pedestrian signals to communicate ‘walk’ and ‘do not walk’ information to pedestrians.
- Upgraded the Port Republic Road westbound left turn from a green ball to a flashing yellow arrow, for which the research has shown a safer operation compared to a green ball. <sup>2</sup>

<sup>2</sup> <https://www.fhwa.dot.gov/publications/research/safety/19035/19035.pdf>

### Port Republic Road: Bluestone Drive to Crawford Avenue – Construction in 2025

This project was funded through the VDOT SMART SCALE program. The project will include:

- Extending the Port Republic Road Eastbound left turn storage lane at the Bluestone Drive intersection from 100’ to 300’.
- Constructing a 5’ wide sidewalk along Port Republic Road on either side connecting Crawford Avenue and Bluestone Drive.
- Constructing a 460-foot median along Port Republic Road from Crawford Avenue to Bluestone Drive.

A design concept sketch developed for the Port Republic Road: Bluestone Drive to Crawford Avenue project is presented in **Figure 6**.

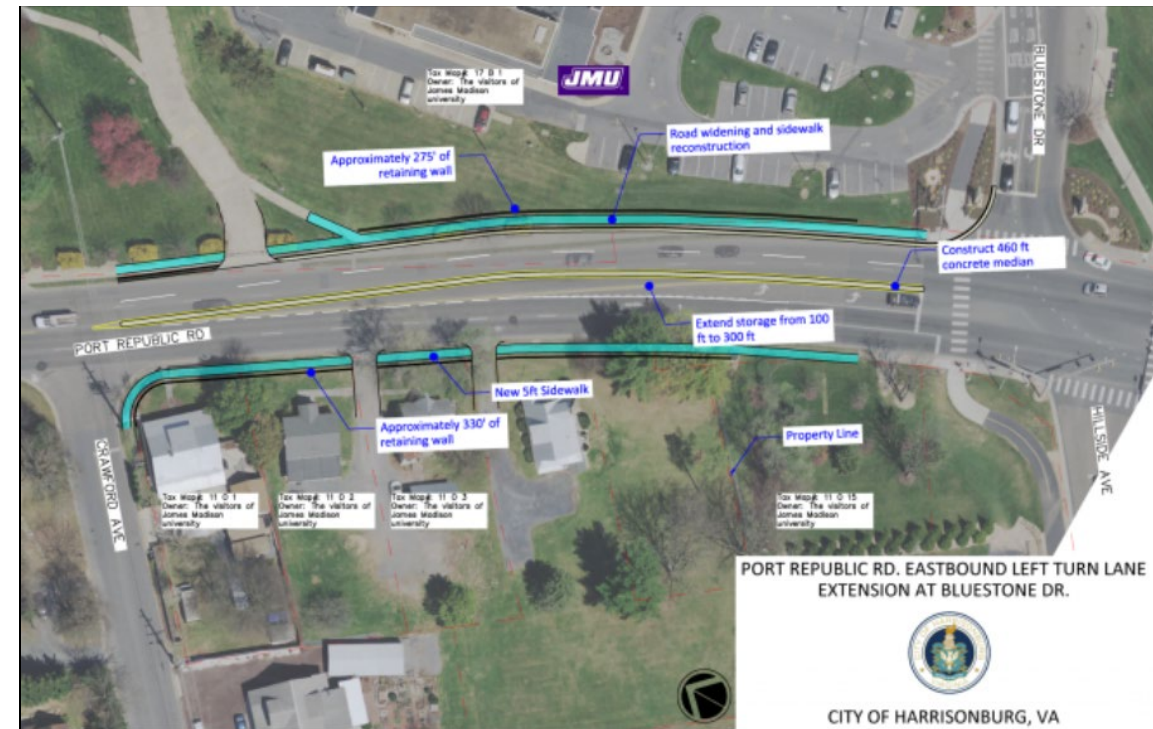


Figure 6: “Conceptual Sketch for the Port Republic Road: Bluestone Drive to Crawford Avenue” Project  
Source: <https://www.harrisonburgva.gov/transportation-projects>

## University Boulevard Realignment – Construction in 2025

This project will realign University Boulevard between the old JMU Convocation Center parking lot and Forest Hill Road at the Oak Hill Drive intersection. The proposed changes are detailed below and illustrated in **Figure 7** and **Figure 8**.

- The project will replace the existing University Boulevard with a new 2-lane roadway that will include a 10' shared-use path (SUP) and a 5' sidewalk. The project will upgrade University Boulevard from a 'rural' section to an 'urban collector'.
- The realignment will allow University Boulevard to become the through movement at Oak Hill Drive, thereby transferring the stop control to the side street.
- Construct a 10' SUP along Forest Hill Road and University Boulevard from Port Republic Road to Carrier Drive.
- Construct a 5' sidewalk from Oak Hill Drive to Old Convocation Center Parking

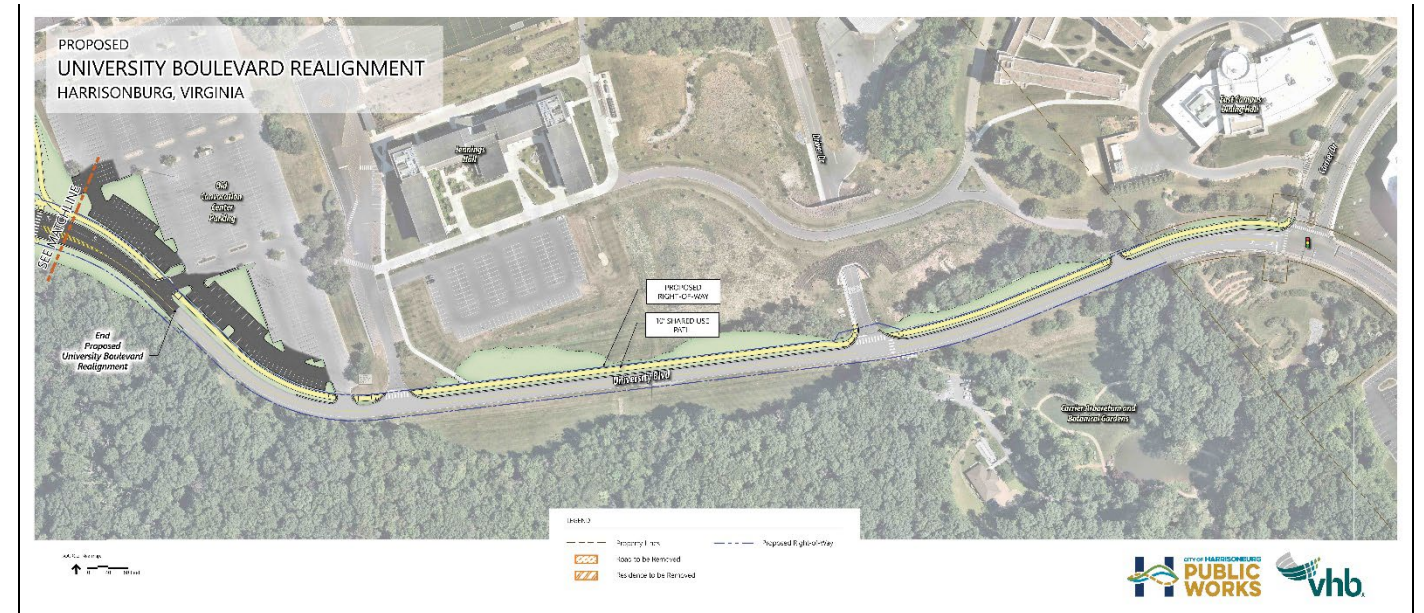


Figure 8: University Boulevard Realignment (2)  
Source: <https://www.harrisonburgva.gov/university-blvd-realignment>

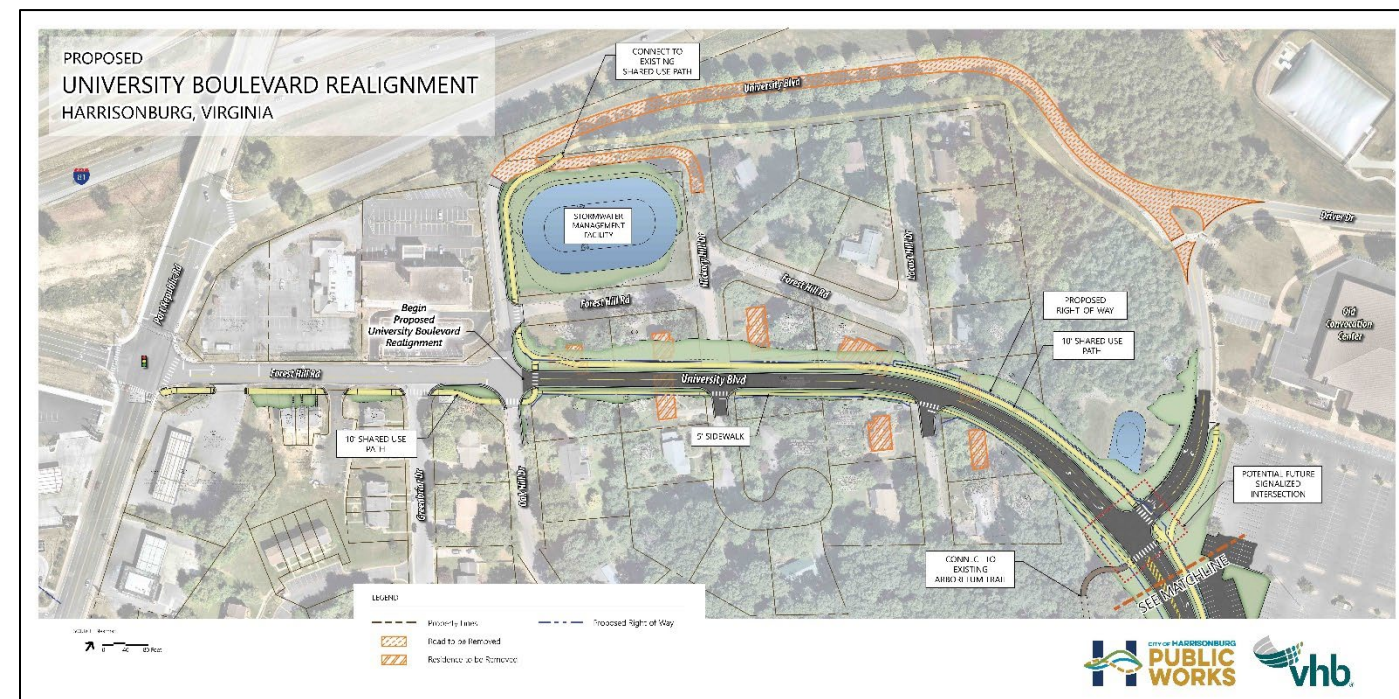


Figure 7: University Boulevard Realignment (1)  
Source: <https://www.harrisonburgva.gov/university-blvd-realignment>

## Port Republic Road Corridor Improvements – Construction in 2028

This project was selected through the VDOT SMART SCALE funding program and will include:

- Installation of a traffic signal and high-visibility pedestrian crosswalk at the intersection of Port Republic Road and Bradley Drive.
- Providing a three-foot wide concrete median along the corridor between Devon Lane and Bradley Drive.
- Constructing a left turn lane on Port Republic Road westbound to Bradley Drive.
- Constructing a pork chop island at Hunters Road to convert the existing full access to right-in/right-out-only access.
- Constructing a bike lane and sidewalk along Port Republic Road westbound between Devon Lane and approximately 300 feet west of Bradley Drive.
- Constructing a retaining wall along Port Republic Road westbound from Bradley Drive to 280 feet west of Bradley Drive.

A design concept sketch developed for the "Port Republic Road: Devon Lane to Hunters Road" project is presented in **Figure 9**.

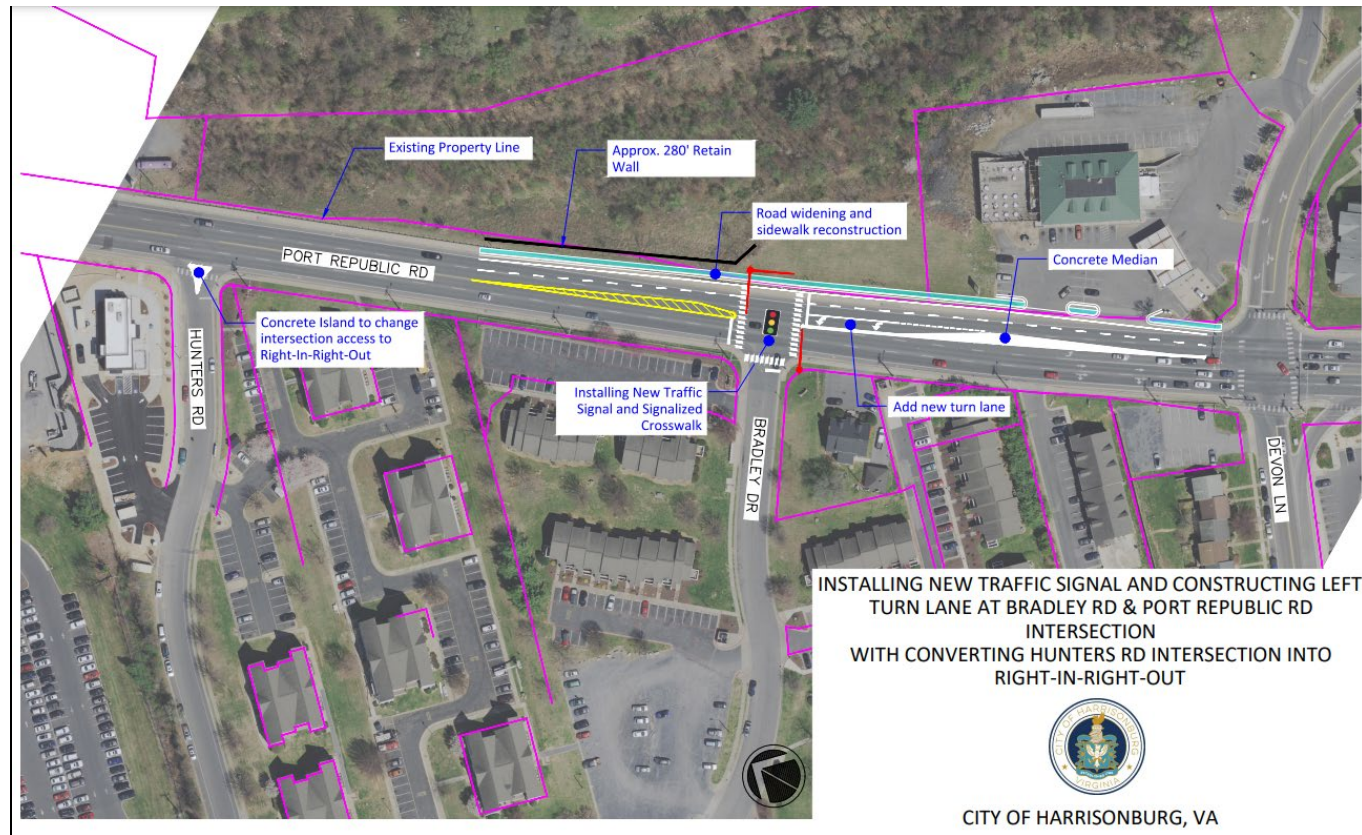


Figure 9: Conceptual Sketch for Port Republic Road Corridor Improvements from Devon Lane to Hunters Road  
 Source: <https://smartportal.virginiahb2.org> (ID: 7099)

## 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, presented in **Figure 10** through **Figure 14**, indicate that:

- 95% of the residents within a 0.5-mile radius of the study area are between 18-64 years old. This exceeds the City of Harrisonburg and the State of Virginia’s averages (75% and 63%, respectively) and is assumed to be directly influenced by the university student population. Approximately 1% of the area residents are seniors (+65 years old). This number is significantly lower than the City’s 9% and the State’s 15% as shown in **Figure 10**.
- The percentage of households with household income greater than \$75,000 is 28%. This is significantly lower than the state average of 51% and is assumed to be directly influenced by the university student population. More than 25% of the households make less than \$15,000/month, whereas only 15% (City) and 8% (State) households make less than \$15,000/month. As shown in **Figure 11**.
- Approximately 70% of the STEAP analysis households own 2+ vehicles as shown in **Figure 12**.
- Of the non-English speakers (age 5+), 1% speak English “not well” and 1% do not speak English at all as shown in **Figure 13**.
- The percentage of vulnerable populations or households in the study area is significantly lower than the City and State averages across the categories of “Veterans”, “People with Disability”, “Households with No Computers”, and “Households with No Internet Connection” as shown in **Figure 14**. Again, these statistics are likely influenced by the university student population.

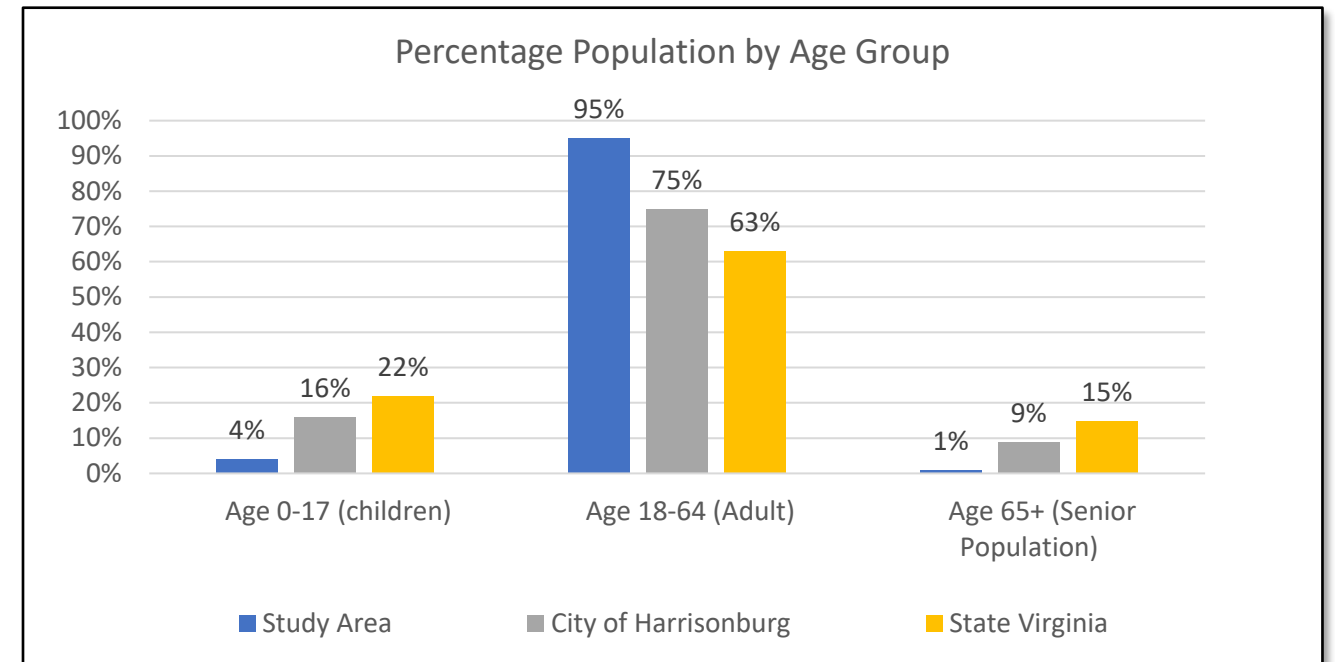


Figure 10: STEAP Tool Analysis Population by Age Group

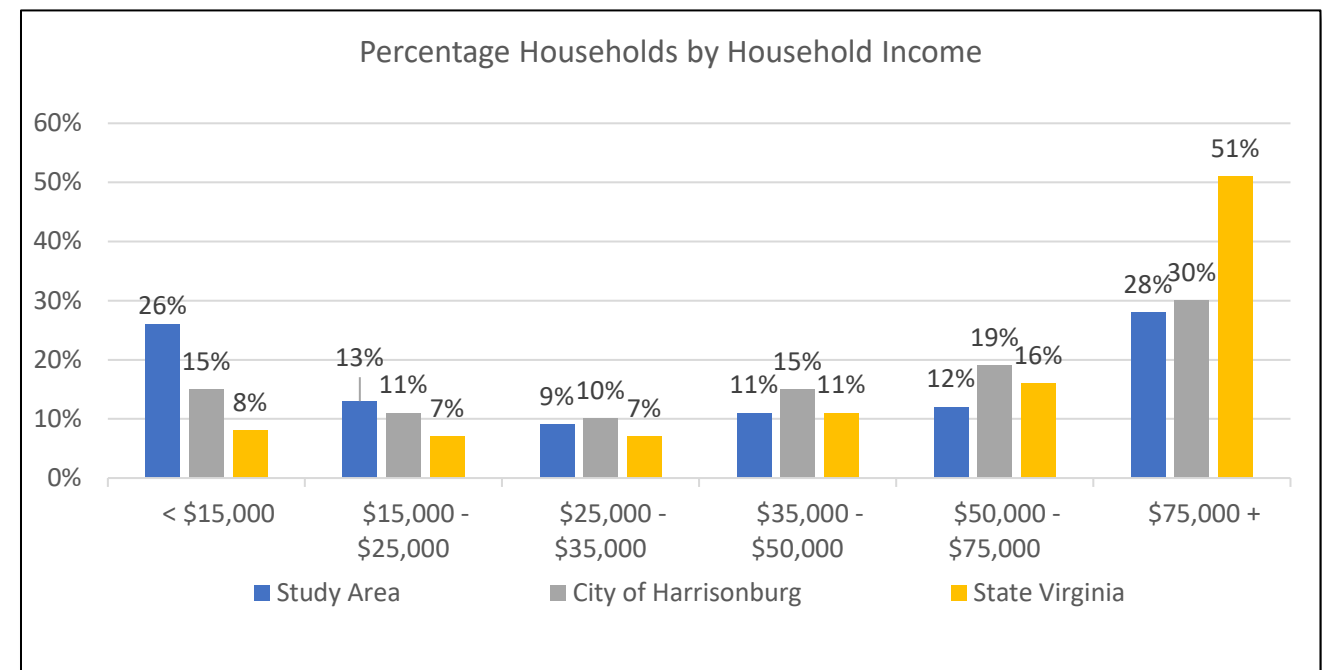


Figure 11: STEAP Tool Analysis Household Income

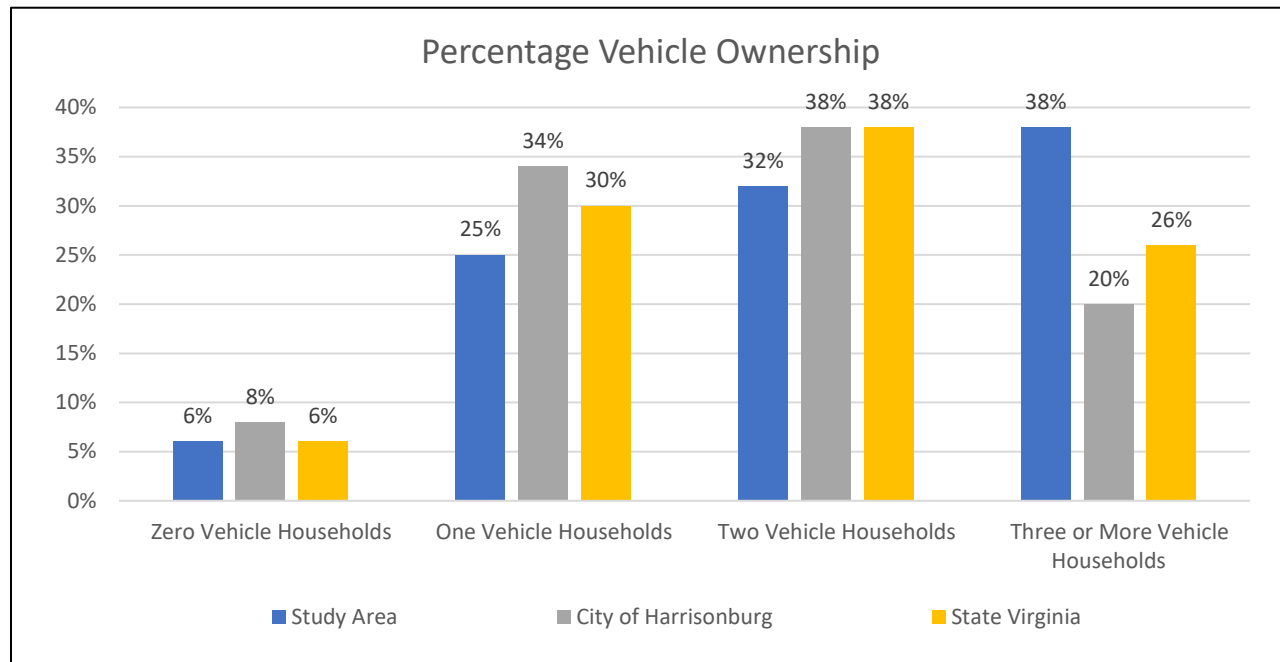


Figure 12: STEAP Tool Analysis Vehicle Ownership

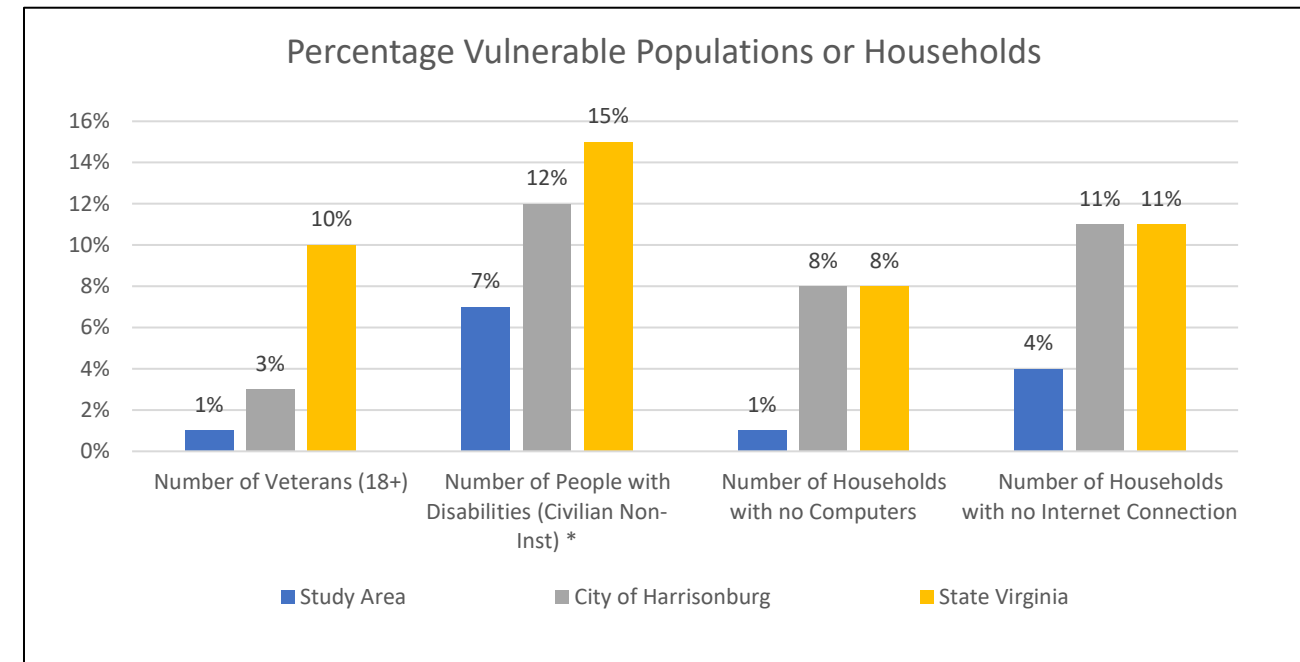


Figure 14: STEAP Tool Analysis of Vulnerable Populations

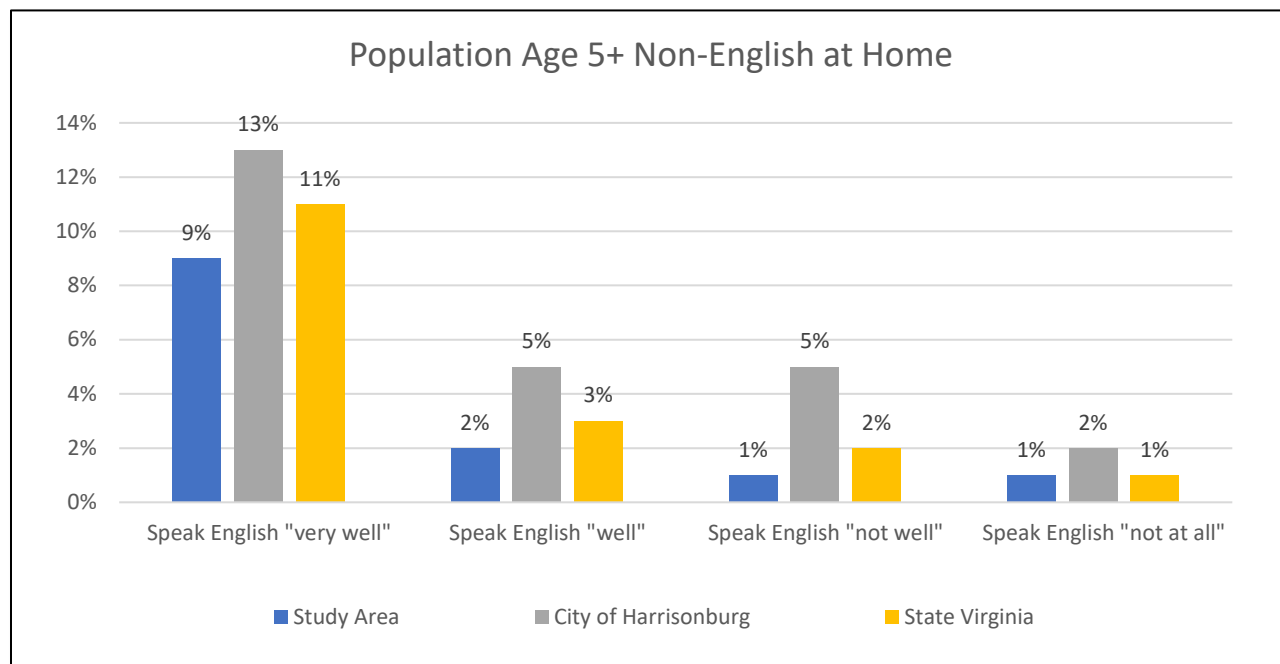


Figure 13: STEAP Tool Analysis Non-English at Home

## Traffic Operations and Accessibility:

The traffic operational analysis was performed using Synchro 11 software for all study intersections along the Port Republic 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.

## Existing Conditions

Turning movement counts were collected as per the Data Collection Map provided in Figure 15 on Tuesday, October 24, 2023, a typical weekday when schools were in session. The peak hours were identified as 8:30 to 9:30 AM for the AM peak hour and 4:45 to 5:45 PM for the PM peak hour.

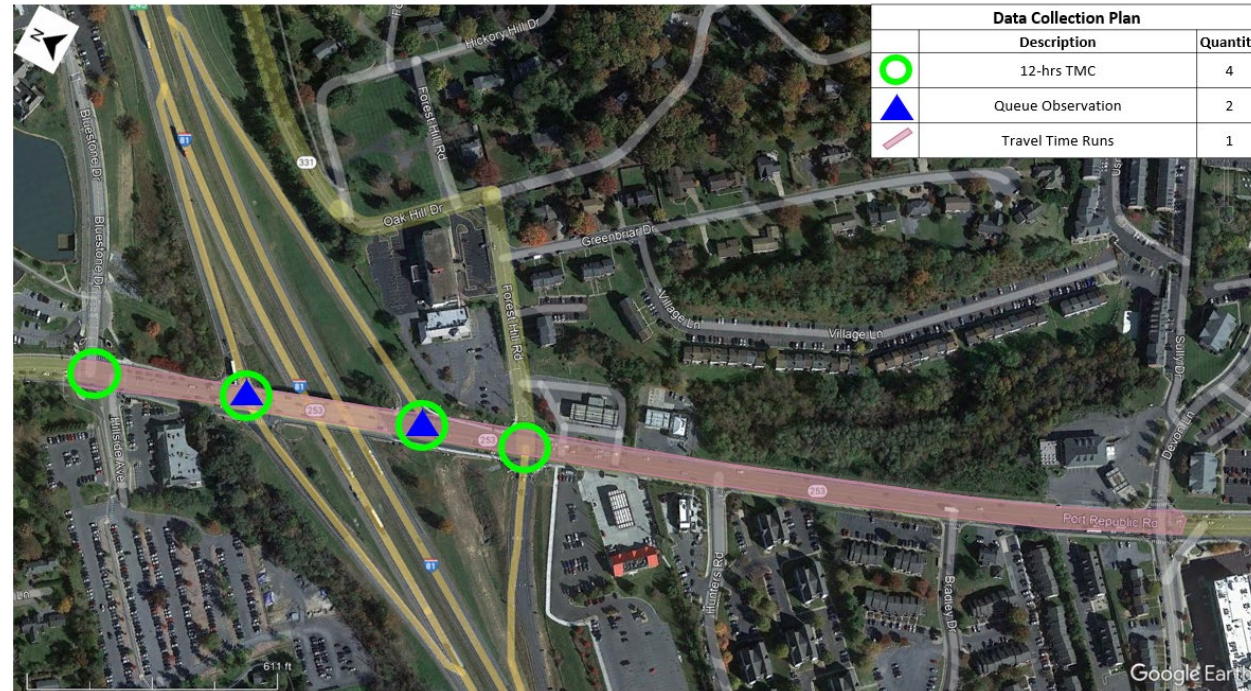


Figure 15. Data Collection Map

In both peak hours, there is a high pedestrian demand of 178 in the AM peak and 139 in the PM peak hour to cross Port Republic Road at Bluestone Drive / Hillside Avenue. To the north of this intersection is the James Madison University Campus. To the south, there is a student parking lot with approximately 400 parking spaces, a Starbucks, and a UPS Store. This Crosswalk also provides connectivity to Bluestone Trail, a one-mile Shared-Use Path (SUP) between Stony Spring Road (Route 280) and Port Republic Road.

The study corridor experiences queuing in a specific direction based on the time of day. In the AM peak hour, queuing is prevalent in the Port Republic Road westbound direction. The queues emanating from the Bluestone Drive intersection go all the way up to Devon Lane. The observed queue length for Westbound Port Republic Road at I-81 NB off-ramp is 1480 ft. The observed maximum queue length at I-81 NB off-ramp is 600 feet. The traffic queuing is exacerbated by the high pedestrian demand and pedestrian call observed at the Bluestone Drive intersection as shown in Figure 16.



Figure 16. Aerial Image showing areas of significant queuing in the AM Peak Hour

In the PM peak hour, the Bluestone Drive approach at Port Republic Road & Bluestone Drive intersection experiences significant queuing of 1300 ft. The volume demand for southbound left turn is 269 vehicles and the total approach demand is 403 vehicles in the PM peak hour. It is to be noted that the through volume demand from both minor street approaches at this intersection is negligibly low with less than 15 vehicles. The PM peak hour queuing of 1300 feet from Bluestone Drive southbound approach at this intersection is illustrated in the following Figure 17. Like the Bluestone Drive southbound approach, Forest Hill Road southbound approach also experiences excessive queuing of max length 440 feet during the PM peak hour. The volume demand on Forest Hill Road approach during the PM peak hour is 486 vehicles (283 right turn and 203 left turn). The Bluestone Drive and Forest Hill Road provide immediate connectivity from James Madison University to Port Republic Road and from there to I-81. The next nearest available entry point to I-81 is Exit 247 interchange at I-81/East Market Street (Route 33) which is approximately two miles to the north.

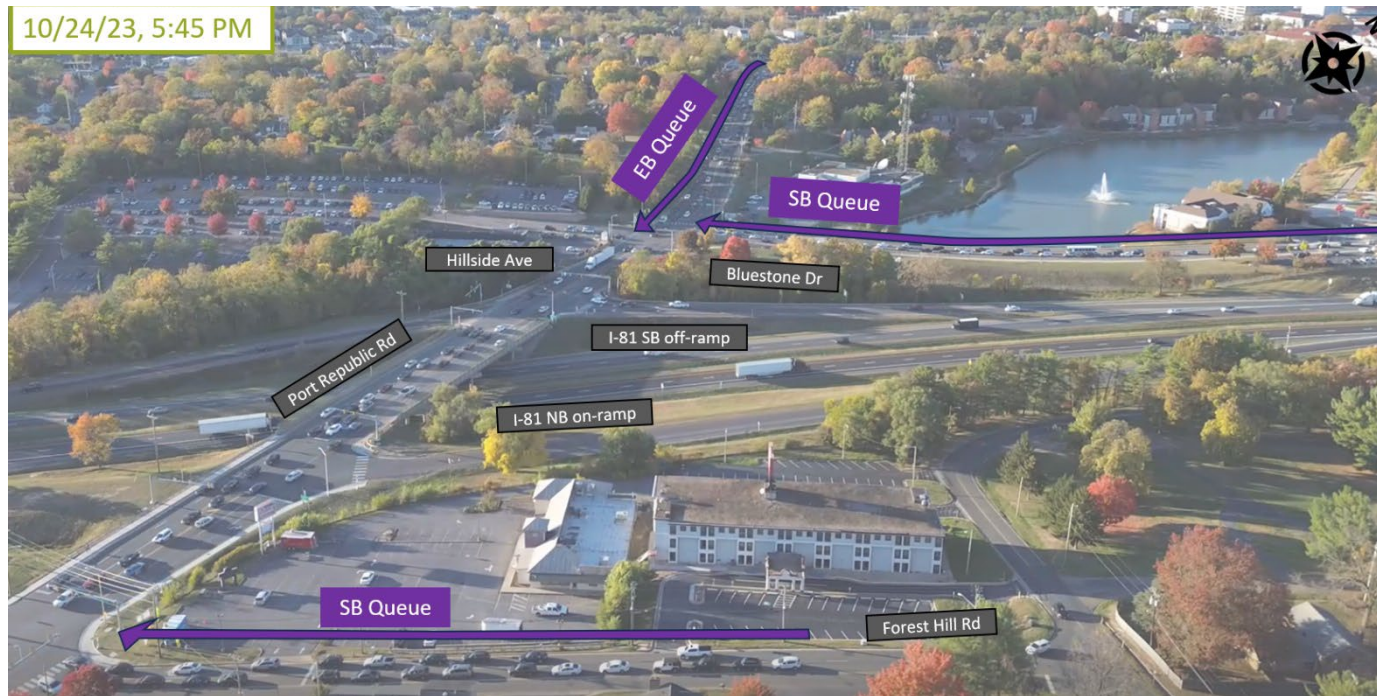


Figure 17. Aerial Image showing areas of significant queueing in the PM Peak Hour

There is a high demand for I-81 bound vehicles at the two turn lanes on the Port Republic Road bridge in the PM peak hour. During this time, 229 vehicles turned left from the eastbound approach of Port Republic Road onto I-81 northbound, and 198 vehicles turned left from the westbound approach of Port Republic Road onto I-81 southbound. The turn lanes have a storage length of approximately 130 feet. The high-volume demand during the PM peak resulted in queue spillbacks on Port Republic Road as shown in **Figure 18**.

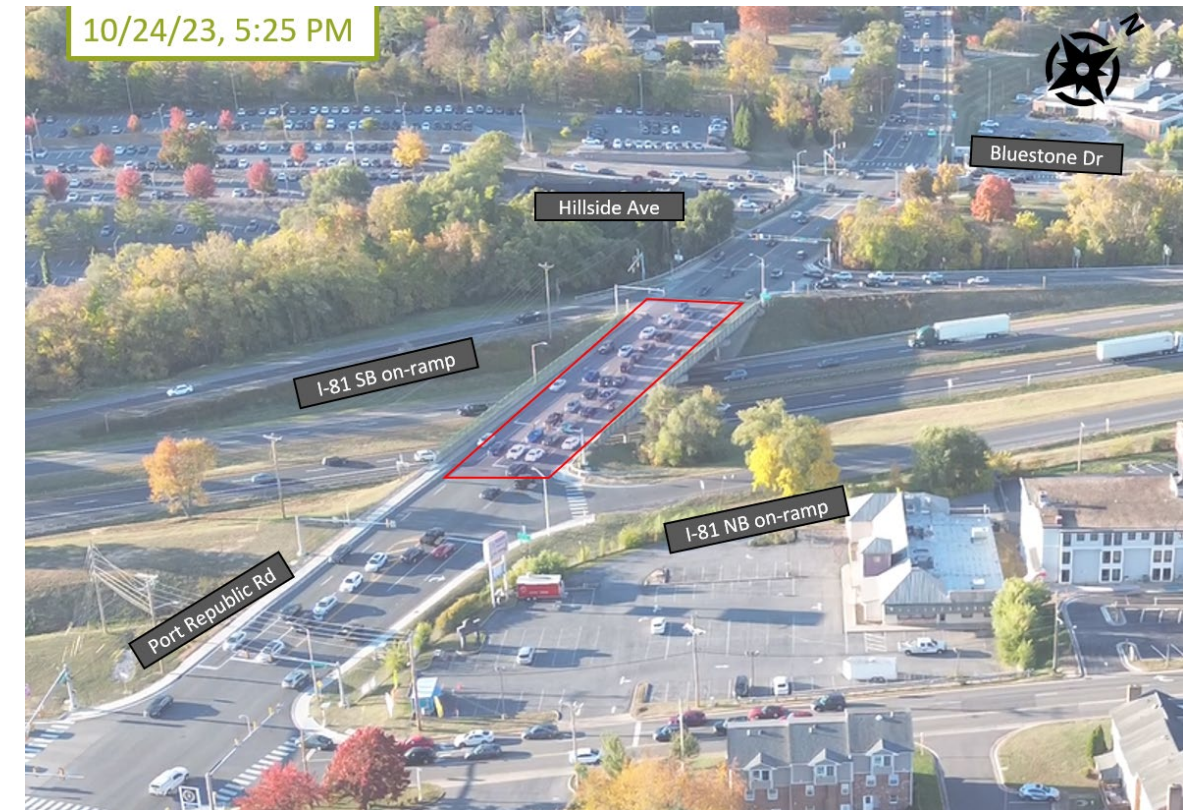


Figure 18. Aerial Image showing I-81 bound queue spillback on Port Republic Road Bridge

The intersection peak hour volumes and the max queue lengths observed at the study intersections are shown in **Figure 19**. The raw turning movement counts, and max queue lengths observed in five min intervals are provided in **Appendix A**.



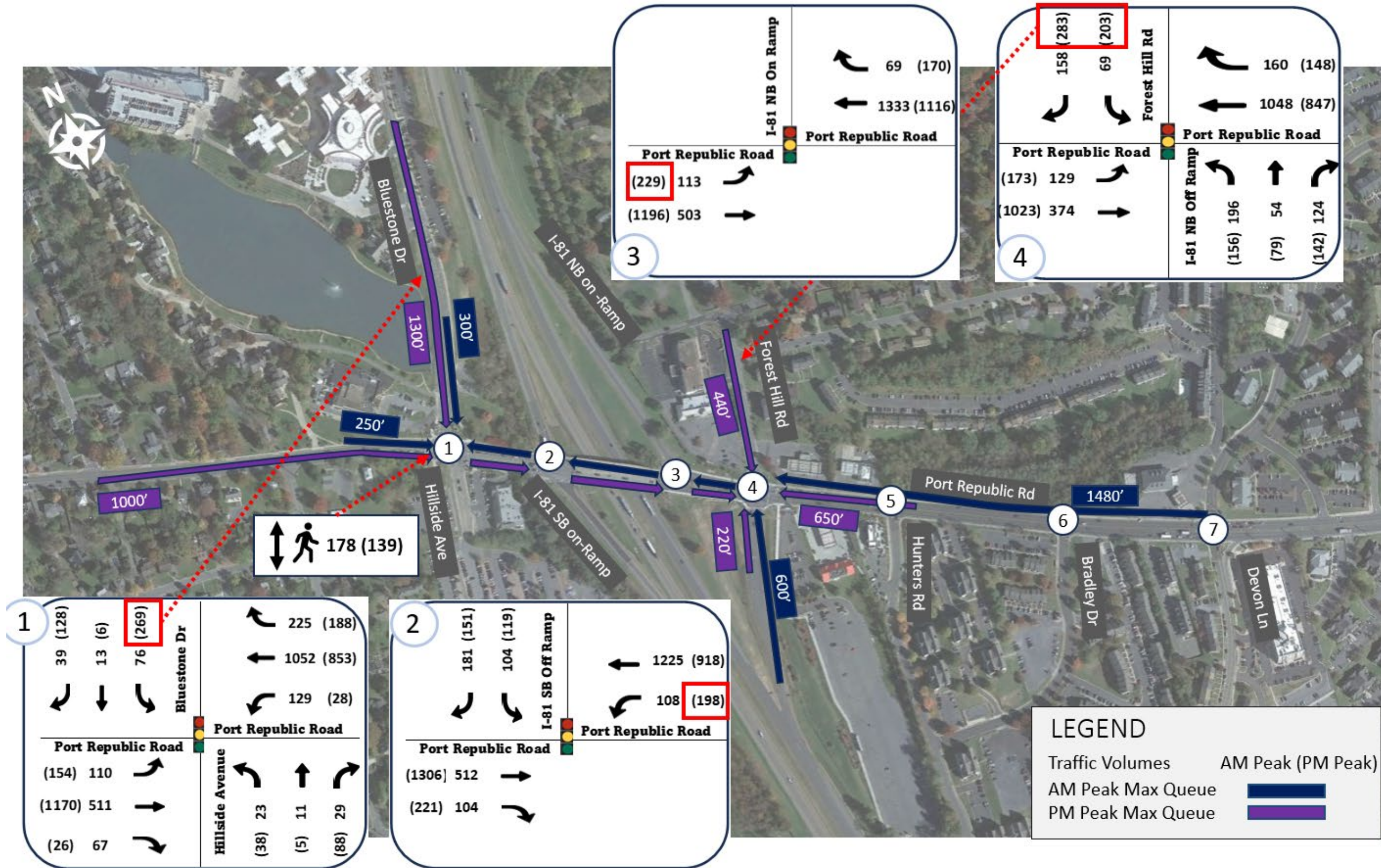


Figure 19. Turning Movement Counts and Observed Max Queue Length

## Intersection Analysis Methodology

Traffic operations analysis was performed at the four study intersections on Port Republic Road during the weekday AM and PM peak hours using Synchro 11, a macroscopic traffic analysis software. Synchro's capacity analysis for signalized and unsignalized intersections is based on the methodology presented in the Highway Capacity Manual (HCM).

To quantify operational conditions on existing and proposed highways, the concept of Level of Service (LOS) is defined in the HCM as “a quantitative stratification of a performance measure or measures that represent the quality of service, measured on an A – F scale, with LOS A representing the best operating conditions from the traveler’s perspective and LOS F the worst.” For interrupted flow facilities, including both unsignalized and signalized intersections, the base scale for LOS is divided into six levels as shown in **Table 4**. The LOS criteria are based on the delay experienced by drivers. Control delay is the delay caused by an intersection control device and is divided into two (2) components: the sum of the time that the vehicle spends in queue plus the delay caused by acceleration and deceleration. LOS criteria for the two (2) basic types of intersection control are different because drivers expect higher delays at signalized intersections.

Table 4. Level of Service Criteria for Intersections (Adapted from HCM)

| Level of Service | Control Delay per Vehicle (sec/veh) |                          |
|------------------|-------------------------------------|--------------------------|
|                  | Unsignalized Intersections          | Signalized Intersections |
| A                | 0-10                                | ≤ 10                     |
| B                | > 10-15                             | > 10-20                  |
| C                | > 15-25                             | > 20-35                  |
| D                | > 25-35                             | > 35-55                  |
| E                | > 35-50                             | > 55-80                  |
| F                | > 50                                | > 80                     |

In addition, another performance measure that results from the capacity analysis is the volume-to-capacity (v/c) ratio. This ratio compares the traffic demand at the evaluated facility (v) versus the capacity of the system (c). A ratio of v/c > 1 shows that the capacity of the system is not enough to handle the expected traffic demand.

Traffic data, such as current traffic volumes, intersection geometry, and control type, among others, were input into Synchro 11 to start the operational evaluation. Inputs and analysis methodologies were consistent with VDOT’s Traffic Operations and Safety Analysis Manual (TOSAM), version 2.0. Measures of effectiveness (MOEs) for the study intersections included the following Synchro output based on the HCM methodology: LOS, control delay (sec/veh), 95<sup>th</sup> percentile queue length (ft), and v/c ratio. The basic parameters and evaluation criteria presented in this section are essential in the traffic operational analysis process for existing and future facilities being planned.

## Traffic Operations Analysis

To identify operational and accessibility needs along the study corridor, operations analysis was performed for the existing year 2023 using HCM signalized intersection analysis methodology through Synchro 11. The Synchro analysis was completed for both AM and PM peak hours. The analysis results are provided in **Figure 20**. Existing Conditions Synchro Results. The detailed synchro reports for the existing conditions are included in **Appendix B**.

The following approaches experienced delays greater than 55 sec/veh (LOS E) in existing conditions during both AM and PM peak hours.

- Port Republic Road & Bluestone Drive intersection – This intersection operates at an overall LOS D, with delays greater than 35 sec/veh during both peak hours.
  - Bluestone Drive southbound approach – The current lane configuration at this approach is a shared thru-left-right turn lane of storage length 600 feet and a dedicated left-turn lane. This approach experiences a delay of 50.6 sec/veh in the AM peak and **105.2 sec/ veh** in the PM peak hour. The significant delay experienced at this intersection in the PM peak is due to a combination of high left turn volume (269) demand at the approach, high left turn volume (229) demand onto I-81 NB on-ramp from Port Republic Road, resulting in queue spillback on Port Republic Road eastbound direction.
  - Hillside Avenue northbound approach – This approach gets the least green time (less than 20%) out of the total signal cycle length during both peak hours, due to its low vehicle demand. The vehicular demand at this approach is less than 4% of the total intersection volume. With a shared thru-left lane and a right turn lane, this approach currently operates in a split phase and is served after the green signal phase for the Bluestone Drive approach times out.
- Port Republic Road & I-81 SB ramps intersection
  - I-81 SB off-ramp approach – The lane configuration at this approach is a dedicated right-turn lane with a short storage length of 100 feet and a dedicated left-turn lane. This approach experiences a delay of 60.4 sec/veh in the AM peak and 61.3 sec/ veh in the PM peak hour.
- Port Republic Road & Forest Hill Road/I-81 NB off-ramp intersection – This intersection operates at an overall LOS D, with delays greater than 50 sec/veh during both peak hours.
  - Forest Hill Road southbound approach – This approach provides connectivity from the James Madison University campus on the eastern side of I-81 that includes the University Recreation Center, residence halls, Engineering/Geosciences facility, etc to Port Republic Road. There is a high-volume demand in the PM peak hour with 283 right turns and 203 left turns. Like Bluestone Drive, this approach experiences significant delays in the PM peak hour of **80.6 sec/veh** (LOS F). The current lane configuration at this approach is a dedicated left turn lane and right turn lane of storage length approximately 530 ft.

- Port Republic Road westbound approach – The current lane configuration at this approach is a shared thru-right turn and a thru lane. In both peak hours, this approach experiences delay greater than 50 sec/veh
- I-81 NB off-ramp approach – This approach experiences delays greater than 75 sec/veh in both peak hours. The current lane configuration at this approach is left, thru, and right turn lanes of storage length approximately 275 ft. The northbound left turn experiences queueing greater than 300 ft in both peak hours. The left turn volume demand in the AM peak hours is close to 200 vehicles.

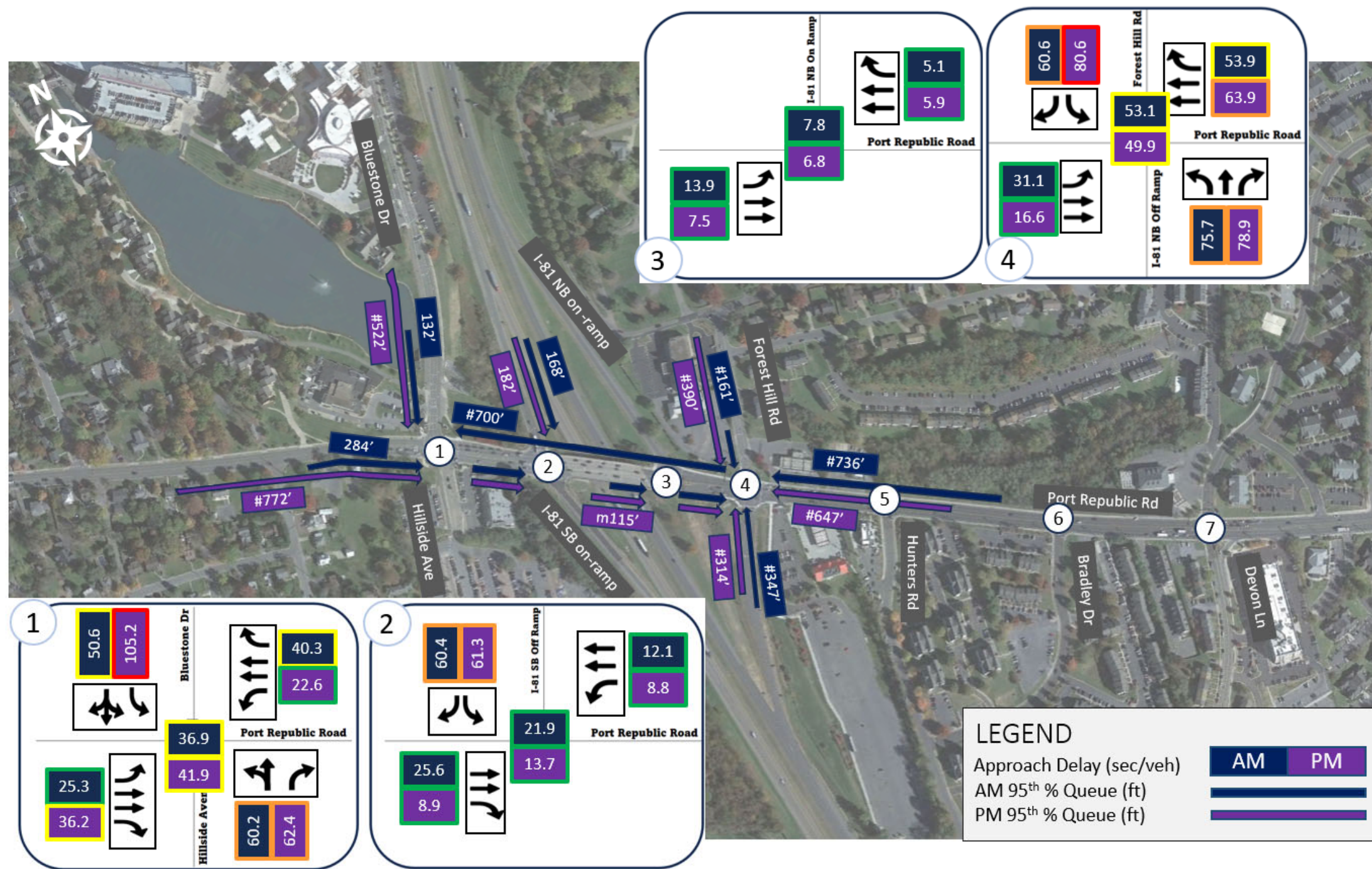


Figure 20. Existing Conditions Synchro Results

## 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 the study corridor on Port Republic Road. Crash data was collected and analyzed for eight years 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.

## Safety Analysis Results

The crash severity within the study area is summarized by year and type in **Table 5** and **Table 6**, respectively. A summary of the safety needs and diagnosis is illustrated in **Figure 21**. The detailed collision diagrams are provided in **Appendix C**.

Table 5: 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                | 3                 | 2                    | 25                        | 30         |
| 2016                    | 0               | 0                | 6                 | 1                    | 28                        | 35         |
| 2017                    | 0               | 1                | 5                 | 2                    | 26                        | 34         |
| 2018                    | 0               | 0                | 3                 | 0                    | 16                        | 19         |
| 2019                    | 0               | 0                | 2                 | 2                    | 16                        | 20         |
| 2020                    | 0               | 0                | 1                 | 0                    | 23                        | 24         |
| 2021                    | 0               | 0                | 5                 | 3                    | 17                        | 25         |
| 2022                    | 1               | 1                | 1                 | 2                    | 21                        | 26         |
| <b>Total</b>            | <b>1</b>        | <b>2</b>         | <b>26</b>         | <b>12</b>            | <b>172</b>                | <b>213</b> |

Table 6: Study Area Crash Severity by Type

| Collision Type and Crash Severity | K. Fatal Injury | A. Severe Injury | B. Visible Injury | C. Nonvisible Injury | PDO. Property Damage Only | Total      |
|-----------------------------------|-----------------|------------------|-------------------|----------------------|---------------------------|------------|
| Rear-End                          | 1               | 0                | 11                | 6                    | 87                        | 105        |
| Angle                             | 0               | 1                | 10                | 5                    | 74                        | 90         |
| Head On                           | 0               | 0                | 0                 | 0                    | 2                         | 2          |
| Sideswipe - Same Direction        | 0               | 0                | 0                 | 0                    | 3                         | 3          |
| Fixed Object - Off Road           | 0               | 0                | 0                 | 0                    | 6                         | 6          |
| Ped                               | 0               | 1                | 4                 | 1                    | 0                         | 6          |
| Backed Into                       | 0               | 0                | 1                 | 0                    | 0                         | 1          |
| Sideswipe - Opposite Direction    | 0               | 0                | 0                 | 0                    | 0                         | 0          |
| Other                             | 0               | 0                | 0                 | 0                    | 0                         | 0          |
| <b>Total</b>                      | <b>1</b>        | <b>2</b>         | <b>26</b>         | <b>12</b>            | <b>172</b>                | <b>213</b> |

A total of 213 crashes were reported within the Port Republic Road study area during the seven-year study period. Key takeaways from the crash data are as follows:

1. Year-over-year crash occurrence varies with the highest number of crashes (35) occurring in 2016, followed by 34 crashes in 2017 as shown in **Table 5**.
2. The approximate average number of reported crash incidents per year is 27.
3. The majority of reported crash incidents within the corridor are rear-end and angle crashes. Combined, these constitute approximately 92% of the total crashes.
4. A total of 41 crash incidents were associated with injuries, which account for approximately 19% of the total reported crashes within the corridor.
5. One (1) fatal crash was reported in the study area. The crash occurred in April 2022 when a vehicle rear-ended a vehicle that was stopped in the I-81 SB off-ramp queue. The crash occurred during the daytime and no adverse weather conditions were reported.
6. A significant concentration of crashes was reported at the Port Republic Road intersections with I-81 SB Ramps and Forest Hill Road / I-81 NB off-ramp.
  - a. The majority of crashes at the Port Republic Road intersection with I-81 SB off-ramp were angle crashes (54 out of 77 crashes). Red light running attributed to the Port Republic Road westbound through movement was a significant factor in most of these angle crashes.
  - b. Rear-end was the predominant crash type at the Port Republic Road intersection with Forest Hill Road / I-81 NB off-ramp (48 out of 79 crashes).

- i. Twenty-five (25) of the reported crashes occurred on Port Republic Road Westbound upstream of Forest Hill Road; the lack of a dedicated right turn lane could be attributed as a contributing factor to most of these crashes.
  - ii. Fourteen (14) of the crash incidents were reported for the Port Republic Road Eastbound downstream of I-81 NB off-ramp; vehicles slowing down to turn to the adjacent gas station of Royal was the contributing factor.
7. Six (6) pedestrian crashes were reported in the study area. All these crashes are intersection-related and resulted in injuries (1 severe, 4 visible, and 1 non-visible),

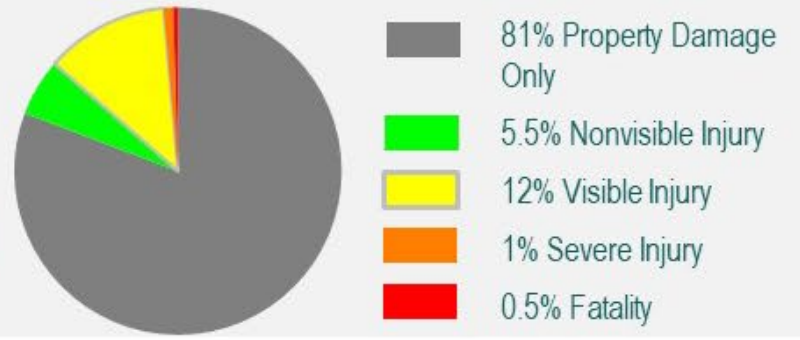
## Scoping-level Safety Improvement Concepts

A set of scoping-level countermeasures for the reported crashes at the Port Republic Road intersections with I-81 ramps are described below and presented in **Figure 22**:

- Port Republic Road at I-81 southbound off-ramp: To mitigate the angle crashes attributed to red light running, the following countermeasures are recommended for consideration.
  1. Add a 3-inch Yellow Retroreflective Sheeting to signal back plates to improve the visibility of the signals at the intersection of the I-81 SB off-ramp.
- Port Republic Road at I -81 northbound on-ramp – To provide a safer ped crossing at the northbound on-ramp, it is proposed to convert this crosswalk into a “two-stage crossing” by introducing a refuge island (not shown in **Figure 22**).
- Port Republic Road at I-81 northbound off-ramp / Forest Hill Road:
  1. Installing a dedicated right-turn lane on Port Republic Road Westbound would likely reduce the frequency of westbound rear-end crashes at this location.
  2. Installing concrete median or flexible delineator posts in the vicinity of the Forest Hill Road/I-81 NB off-ramp intersection would reduce the chance of rear-end and angle crashes related to adjacent, closely spaced commercial entrances. This concept is consistent with the HRMPO 2019 Port Republic Road study, which recommended median segments be installed within the functional area of certain intersections, including Forest Hill Road.



| Safety / Reliability Needs    |           |
|-------------------------------|-----------|
| NEED                          | PRIORITY  |
| Reliability (RN)              | No Need   |
| Safety Improvement            | Very High |
| Pedestrian Safety Improvement | No Need   |



### Safety Summary

- Total of 213 crashes from 2015 to 2022.
- Average number of annual crashes: ~ 27 crashes/year
- Angle and rear-end crashes: ~ 92% of total crashes
- About 19% of crashes resulted in injuries.
- 54 of the 77 crashes at the Port Republic Road intersection with I-81 southbound off-ramp were angle crashes, with red light running being a significant contributing factor.
- Rear end was the predominant crash type at Port Republic Road intersection with Forest Hill Road
  - 25 crashes occurred on Port Republic Road westbound upstream of Forest Hill Road; the lack of a dedicated right turn lane was a contributing factor to most of these crashes.
  - 14 crashes were reported for the Port Republic Road Eastbound downstream of I-81 Northbound off-ramp; vehicles slowing down to turn to the gas stations were a contributing factor

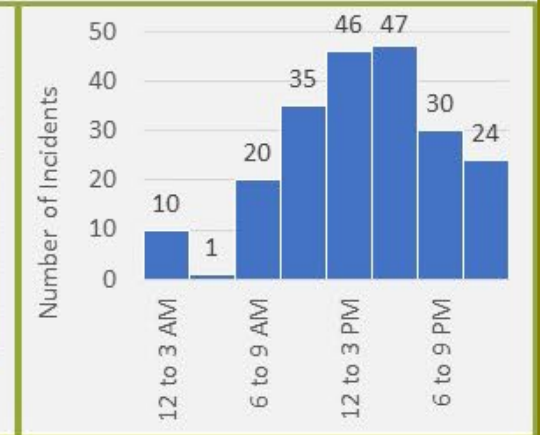
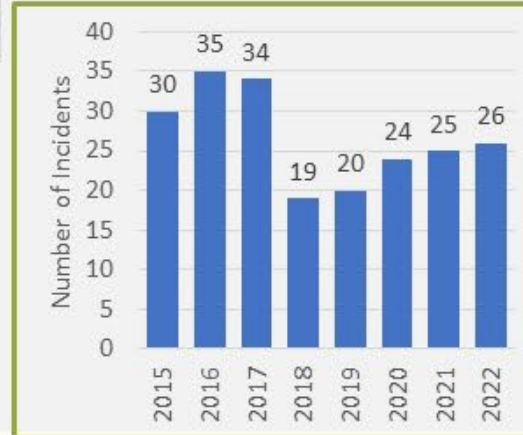
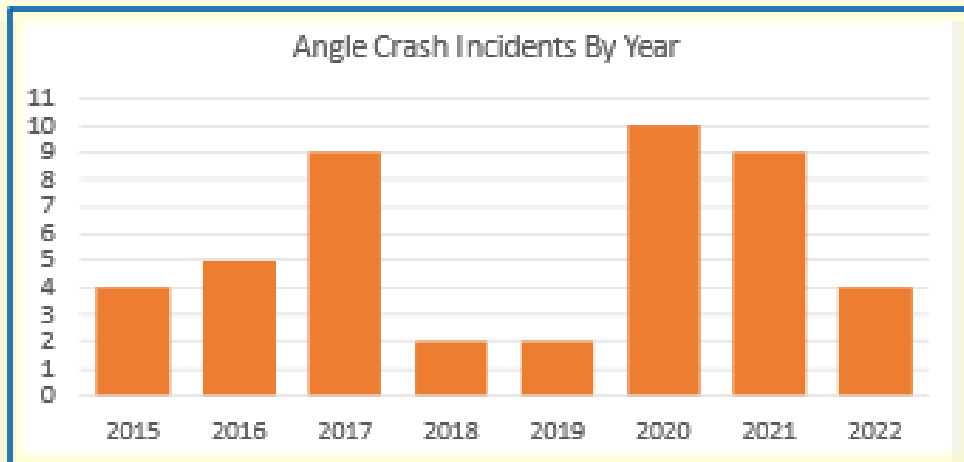


Figure 21: Safety Needs and Diagnosis



Figure 22: Scoping-level Safety Improvement Concepts

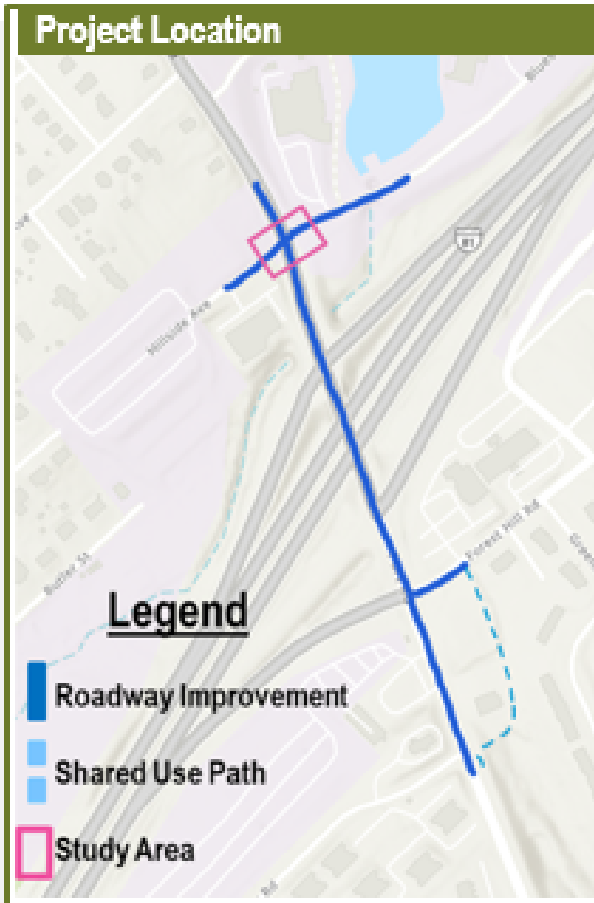




### Safety Results

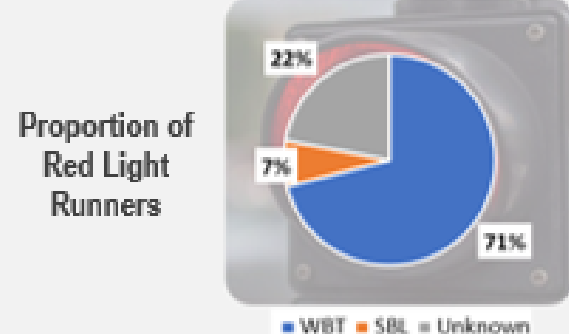
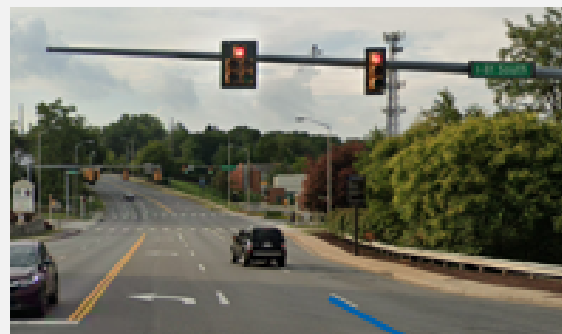
The lack of clarity due to the number of signals on Port Republic Road may confuse drivers traveling westbound on Port Republic Road. They may misinterpret the signal at the I-81 SB off-ramp for the signal at Bluestone Drive.

The installation of Optically Programmable signal heads aims to reduce red-light running on Port Republic Road.



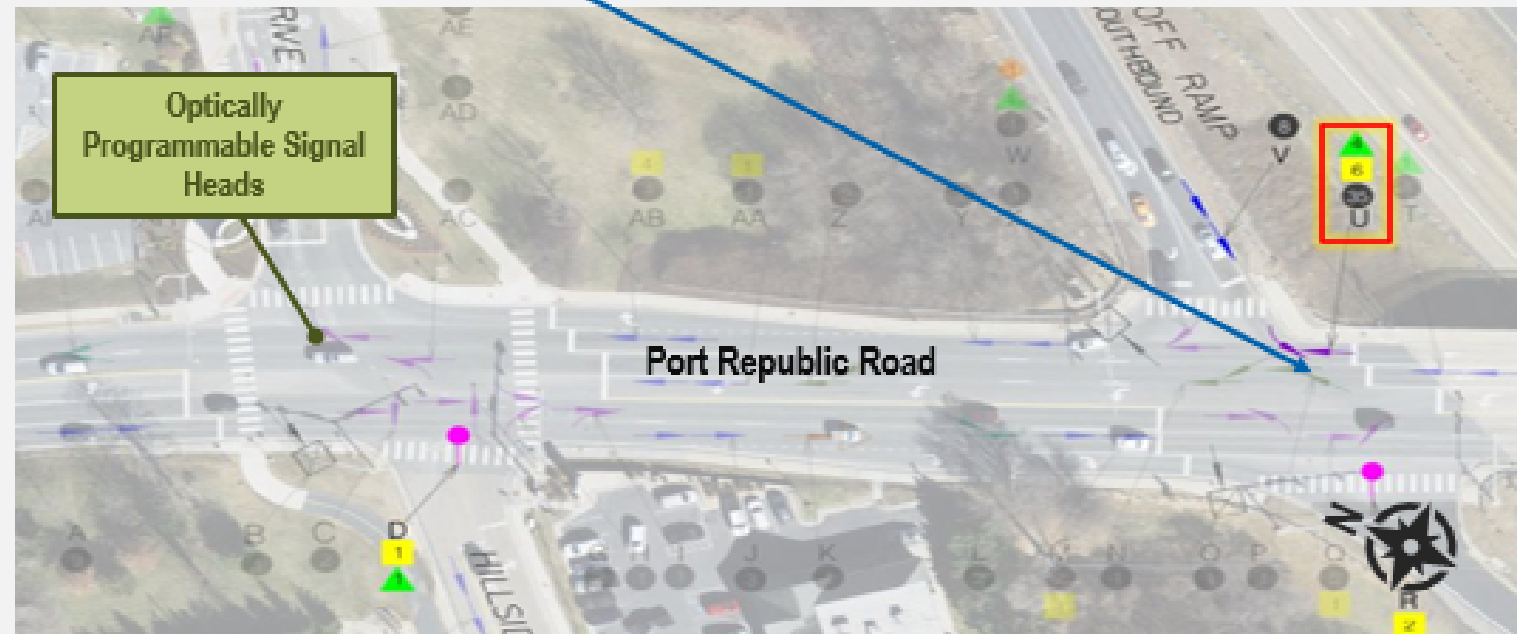
**Countermeasure for Rear-End Crashes at Port Republic Road and Bluestone Drive**

1. Replace signal heads at the westbound approach at the Bluestone Drive intersection with Optically Programmable signal heads.



### Example of Countermeasure #1

| Existing | Proposed |
|----------|----------|
|          |          |



### Preliminary Cost Estimate

Cost estimates were developed based on information available at the time of study and should be reassessed prior to submitting funding applications.

The cost estimate includes the installation of the signal head and related contingencies.

| Phase                      | Cost Estimate (2020 Dollars) |
|----------------------------|------------------------------|
| Preliminary Engineering    | \$0                          |
| ROW and Utility Relocation | \$0                          |
| Construction               | \$20,000                     |
| <b>Total Cost</b>          | <b>\$20,000</b>              |

Figure 23: Port Republic Road & Bluestone Drive Preferred Alternative Summary

## Pedestrian and Bicycle Safety and Accessibility:

### Pedestrian and Bicycle Access Needs

The VTrans Mid-Term needs in the study area include:

- Very High Pedestrian Access needs
- Very High Bicycle Access needs

These needs were identified through the statewide data-driven needs analysis process in VTrans. More information about how the VTrans process identified these needs is available at [www.vtrans.org](http://www.vtrans.org).

- The VTrans needs analysis identified Pedestrian Access needs in areas within walking distance of VTrans Activity Centers. VTrans Activity Centers are “areas of regional importance that have a high density of economic and social activity” and are associated with the VTrans Regional Travel Market.
- The VTrans needs analysis identified Bicycle Access needs in areas within biking distance of VTrans Activity Centers.

The study team examined and validated the pedestrian and bicycle access needs in the study area using crash data, local area plans, StreetLight data, and on-site observations.

### Pedestrian and Bicycle Access Needs Overview

- The study area segment of Port Republic Road has a high level of pedestrian activity due to its proximity to James Madison University (JMU). Pedestrians frequently walk along and across Port Republic Road to access transit stops, scooter parking, commercial destinations, and JMU facilities. The corridor serves two transit routes with bus stops on both sides of the road just east of the Forest Hill Road intersection. There is an unused bus pull-off on Bluestone Drive.
- Between 2015 and 2022, there were 6 crashes involving pedestrians (4 visible injury, 2 non-visible injury).
- There are continuous sidewalks along both sides of Port Republic Road within the study area – though there is at least one trip hazard on the north end of the bridge that would prevent people with disabilities from using the sidewalk and could pose a safety hazard for other users.
- Pedestrian signals with countdown heads, pushbuttons, and audible features exist at all crossing locations (no APS is present at the southbound I-81 ramp intersection). The pushbutton signing and actuation are inconsistent. Existing curb ramps predominantly feature detectable warning surfaces, but a handful need upgrades (the southwest corner of Hillside Avenue and the northwest corner at the southbound I-81 on-ramp).

- There is an existing bike lane east of the study area along Port Republic Road and a shared-use path along Bluestone Drive and Hillside Avenue connecting bicycle networks within the study area. This network is shown in **Figure 24: Existing Bicycle Network**

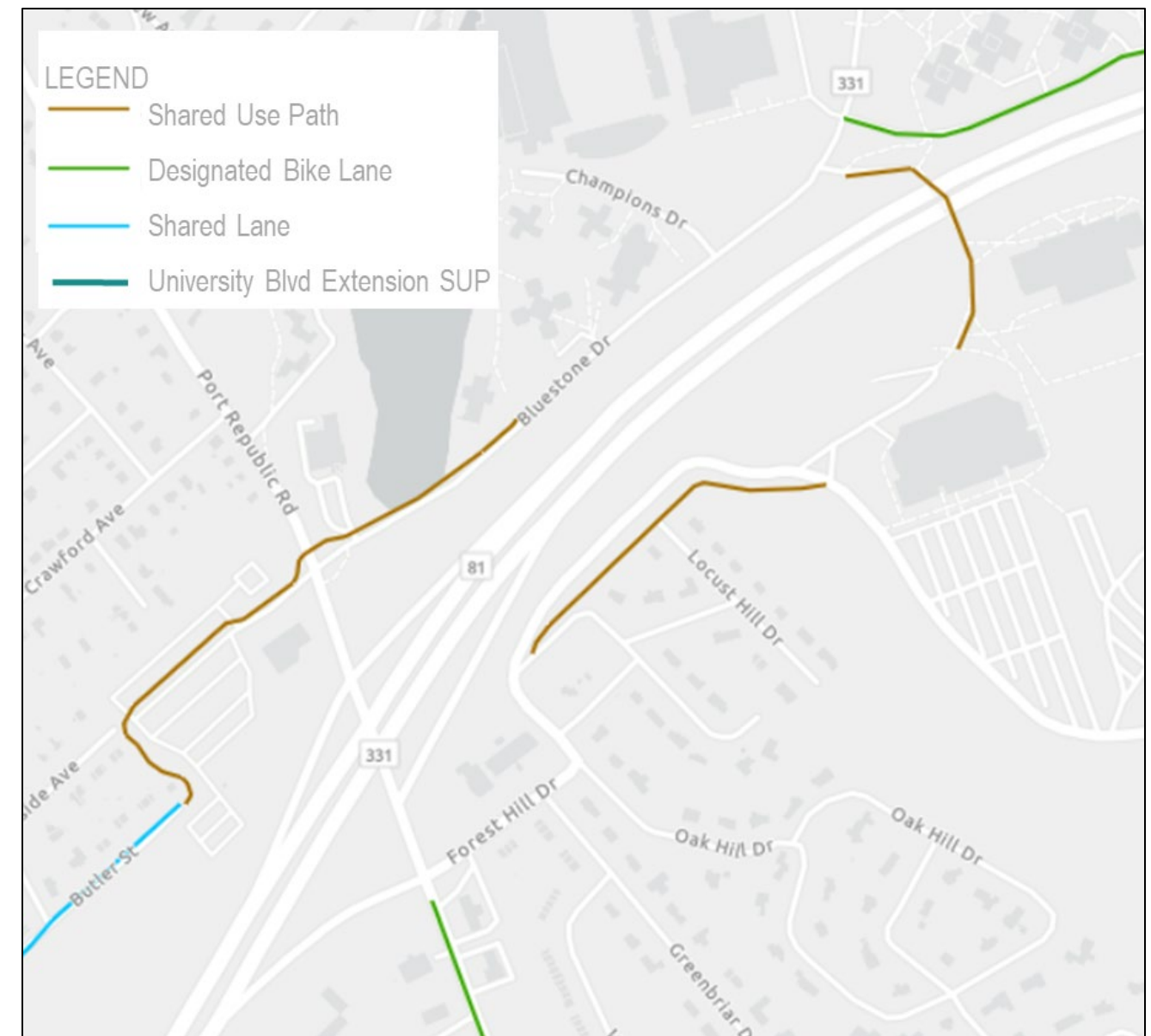


Figure 24: Existing Bicycle Network

## Bicycle and Pedestrian Demand

The study team assessed the existing demand for biking, walking, and transit facilities using StreetLight Data, an on-demand mobility analytics platform that uses anonymized location-based data to determine travel patterns. **Figure 25** illustrates potential non-vehicular trips based on the distance from/to the highlighted zones, going through the study area. There is demand for approximately 420 potential walking trips of less than 1 mile that could start and end within the areas highlighted. Similarly, there is the potential for approximately 8,000 bicycle trips less than 5 miles in length if appropriate facilities were present. There appears to be the greatest demand in the TAZs north of the study area.

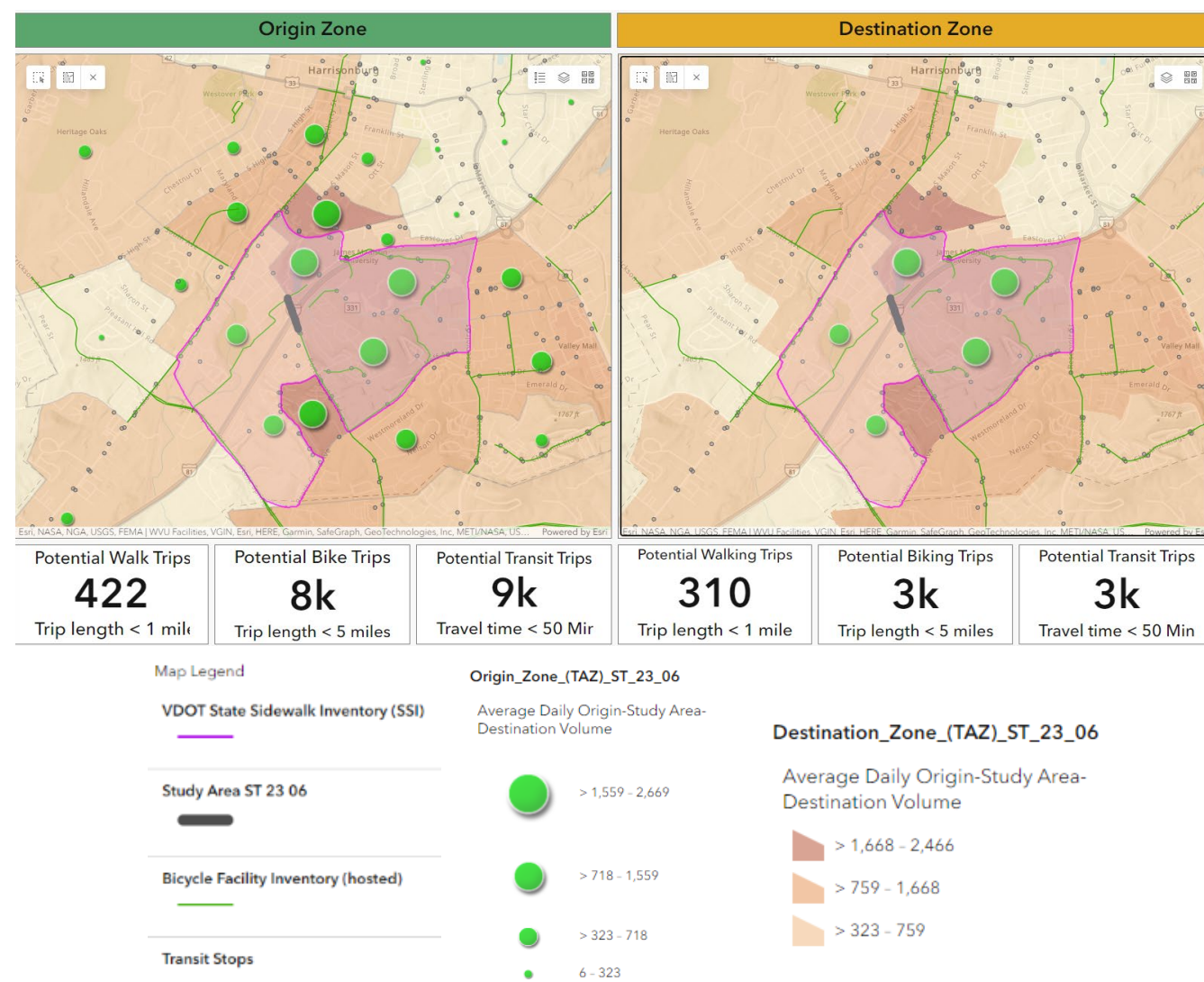


Figure 25: OIPI Travel Demand for Potential Multimodal Trips

## Bicycle and Pedestrian Crash Analysis

The study team analyzed bicycle and pedestrian crashes within the eight-year period from January 1, 2015, to December 31, 2022. A summary of bicycle and pedestrian safety and accessibility needs as well as pedestrian improvements are provided in **Figure 27**.

Six pedestrian crashes occurred in the study area within the analysis time period, as shown in **Figure 26**. Five of the six crashes occurred between September – November, which is consistent with national trends for pedestrian crashes and could be indicative of increased numbers of pedestrians associated with “back to school” and/or risks associated with decreased daylight.

Two crashes took place at the intersection of Bluestone Drive/Hillside Avenue. One of the crashes involved a pedestrian crossing Hillside Avenue against a “flashing don’t walk” indication while a turning vehicle had a left turn arrow. The other also involved a left-turning vehicle and a pedestrian crossing within a marked crosswalk, but the details of the crash were not specified in the FR300 report.

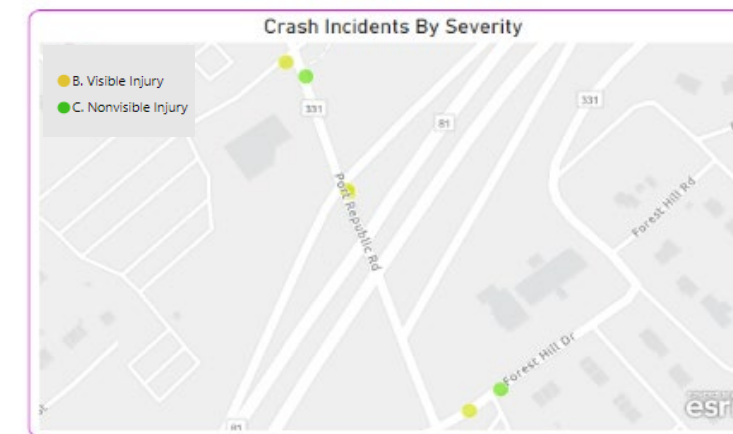


Figure 26: Pedestrian Crashes

Two additional crashes occurred at the southbound on-ramp crosswalk. One involved a pedestrian crossing with the right of way. The driver failed to yield to the pedestrian. The other involved a motorized skateboard that did not yield the right of way to the left-turning driver. Both occurred in daylight under normal weather conditions.

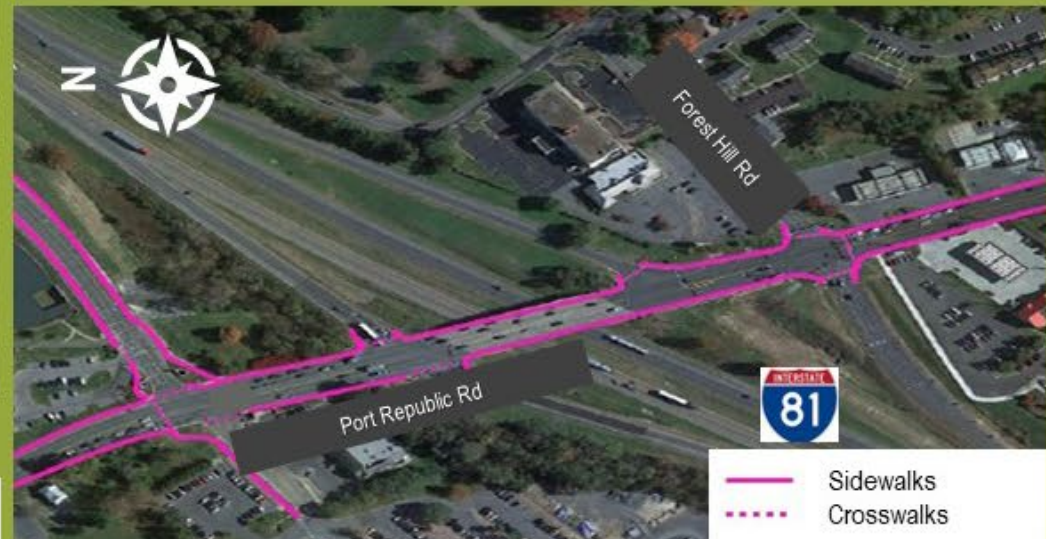
At Forest Hill Road, there were two crashes involving pedestrians crossing the road outside of the crosswalk. In both cases, the pedestrians (a jogger and someone on an electric scooter) entered the roadway while the vehicles were in motion. Both crashes occurred in the evening – after 6:00 PM and 9:00 PM respectively. At this location, there is no sidewalk along Forest Hill Road to provide a connection to the marked crosswalk.

Two reported crashes involving bicycles occurred within the study area. Both involved right-turning vehicles onto Royal gas station hitting cyclists traveling westbound on Port Republic Road near the intersection of Forest Hill Road.



### Bicycle and Pedestrian Safety & Accessibility Summary

- VTrans identifies this corridor as very high need for Bicycle and Pedestrian Access
  - Significant bicycle and pedestrian generators with James Madison University and multiple transit routes
  - Extensive pedestrian network: sidewalks, curb ramps, high visibility crosswalks, and pedestrian signals
  - No bike lane along Port Republic Road within the study area
  - Scooter use and parking observed throughout the area
  - A total of six pedestrian and three bicycle crashes in the study area



### Pedestrian Improvements

- I-81 SB On Ramp: Leading Pedestrian Interval and/or shorten pedestrian crossing
- I-81 SB Off Ramp: Restrict Right-Turn On Red (RTOR) if operationally feasible.
- Forest Hill Road: Extend the sidewalk from Port Republic Rd to the University Outpost Bookstore entrance and evaluate the lighting.
- Harrisonburg Bike-Ped Plan calls for bike lanes on Port Republic Road between Forest Hill Road and Bluestone Drive (Project #BS-17).
- HRMPO Bike-Ped Plan calls for shared-use path.
- Bridge widening is needed to provide a direct bicycle connection on Port Republic Road.

### Operations / Access Needs

| NEED                   | PRIORITY  |
|------------------------|-----------|
| Bicycle Access (RN)    | Very High |
| Pedestrian Access (RN) | Very High |

Figure 27: Pedestrian/Bicycle Safety and Accessibility Needs

# Chapter 2:

# Alternative Development and Refinement

## Alternative Development and Screening

A thorough review of the existing conditions operations and safety analysis was performed to develop alternative concepts to address the needs and incorporate the diagnosis identified in Chapter 1. The following study intersections were identified as priority locations for operational and safety improvements.

- Port Republic Road and Bluestone Drive
  - There is a high pedestrian demand of 178 in the AM peak and 139 in the PM peak hour to cross Port Republic Road at Bluestone Drive / Hillside Avenue. This pedestrian demand is generated by students crossing to access the James Madison University campus located north of Port Republic Road from the parking lot located south of Port Republic Road.
  - Bluestone Drive southbound approach – The current lane configuration at this approach is a shared thru-left-right turn lane of storage length 600 feet and a dedicated left-turn lane. This approach experiences a delay of 50.6 sec/veh (LOS D) in the AM peak and 105.2 sec/veh (LOS F) in the PM peak hour. The significant delay experienced at this approach in the PM peak is due to a combination of high left turn volume demand (269 vehicles) onto Port Republic Road, and a high left turn volume (229 vehicles) demand onto I-81 northbound on-ramp from Port Republic Road, resulting in queue spillback on Port Republic Road in the eastbound direction.
- Port Republic Road and I-81 SB off-ramp
  - This intersection experienced a significant number of angle and rear-end crashes. Between 2015 and 2022, 77 out of 213 crashes along the study corridor occurred within or were related to this intersection. It is to be noted that, there is limited sight distance available for I-81 southbound off-ramp vehicles to turn right onto westbound Port Republic Road. Currently, Right Turn on Red (RTOR) is permitted despite the lack of sight distance. Many of the crash incidents can also be attributed to the proximity of signals between Bluestone Drive and the I-81 SB Off-Ramp. This may make it difficult for drivers to distinguish the signal heads, leading to red light running incidents. Of the 44 angle crash incidents that occurred between I-81 southbound left turn and Port Republic Road westbound through, 71% occurred due to red light running.
- Port Republic Road and Forest Hill Road
  - Of all the study intersections, this intersection experienced the highest number of crash incidents with 79 out of 213 crashes along the study corridor occurring within or being related to it. The predominant crash type observed here is rear-end crash incidents (60%) followed by angle crash incidents (32%).
- To the east of this intersection, a significant number of rear-end crash incidents (14) were observed due to Port Republic Road eastbound vehicles slowing down to turn left into the Royal Gas station. Additionally, there were four angle crashes involving vehicles exiting the gas station. Furthermore, two bicycle incidents occurred when a cyclist in the bike lane collided with a Port Republic Road westbound vehicle turning right into the gas station.
- Of all the study intersections, this intersection experienced the highest overall intersection delay of 53.1 sec/vehicle (LOS D) in the AM peak hour and 49.9 sec/vehicle (LOS D) in the PM peak hour.
  - Forest Hill Road Southbound Approach – There is a high-volume demand in the PM peak hour with 283 right turns and 203 left turns. Like Bluestone Drive, this approach experiences significant delays in the PM peak hour of 80.6 sec/veh (LOS F). The current lane configuration at this approach is a dedicated left turn lane and right turn lane of storage length approximately 530 ft.
  - I-81 Northbound Off-Ramp Approach - This approach experiences delays greater than 75 sec/veh (LOS E) in both peak hours. The current lane configuration at this approach is left, through, and right turn lanes of storage length approximately 275 ft. The northbound left turn experiences queueing greater than 300 ft in both peak hours. The left turn volume demand in the AM peak hours is close to 200 vehicles.
  - Port Republic Road Westbound Approach – The current lane configuration at this approach is a shared thru-right turn and a thru lane. In both peak hours, this approach experiences delays greater than 50 sec/veh (LOS D). This approach experienced a significant number of rear-end crashes due to vehicles slowing down to turn right onto Forest Hill Road. 18 out of 25 rear-ends in the westbound approach occurred in the right lane.

## Future Traffic Forecasting

Traffic forecasts for the year 2034 were developed using the Harrisonburg-Rockingham MPO model obtained from VDOT. The 2034 forecast was developed using the ratio adjustment method outlined in National Cooperative Highway Research Program (NCHRP) Report 765. For each intersection, the approach link volumes were adjusted based on the percent change from the base year to the future year. Future turning movements were calculated using an Iterative Proportioning Fitting (IPF) routine, starting with current count data as the seed volume. Adjustments were made to ensure volumes were balanced along Port Republic Road. **Table 7** summarizes the annual growth factor for the links where the daily count data was available.

*Table 7: Growth Factor from 2019 to 2045*

| Intersection   | West | East | North | South | Overall |
|--|------|------|-------|-------|---------|
| Port Republic Road & Bluestone Drive                   | 1.05 | 1.16 | 1.99  | 1.15  | 1.18    |
| Port Republic Road & I-81 SB Off-Ramp                  | 1.17 | 1.16 | 1.19  | 1.18  | 1.17    |
| Port Republic Road & I-81 NB On-Ramp                   | 1.17 | 1.16 | 1.18  |       | 1.15    |
| Port Republic Road & Forest Hill Road/I-81 NB Off-Ramp | 1.17 | 1.30 | 1.73  | 1.18  | 1.29    |

These linear growth rates were applied to the 2024 volumes to project the future 2034 volumes. The future forecast volumes at the study intersections are provided in **Figure 28** below. The complete traffic forecast technical memorandum is attached in **Appendix D**.



Figure 28: 2034 Future Volume Forecasts



## VJuST Analysis

As part of future alternative screening, VJuST analysis was completed for the intersections of Port Republic Road with Bluestone Drive and Forest Hill Road. The VJuST aids transportation engineers and planners in determining which innovative intersection or interchange might be appropriate at a specific location<sup>3</sup>. It uses traffic volume as input and generates alternatives along with their maximum volume-to-capacity (v/c) ratio.

The volume-to-capacity (v/c) ratio, also known as the degree of saturation, is a measure of how well an intersection can handle vehicular demand. A v/c ratio less than 0.85 generally indicates that adequate capacity is available, and vehicles are not expected to experience significant queues and delays. As the v/c ratio approaches 1.0, traffic flow may become unstable, and delay and queuing conditions may occur. Once the demand exceeds the capacity (a v/c ratio greater than 1.0), traffic flow is unstable and excessive delay and queuing are expected. **Table 8** provides a description of capacity based on the v/c ratio:

Table 8: Capacity Description Based On V/C Ratio

| V/C Ratio | Description of Capacity |
|-----------|-------------------------|
| <0.85     | Under Capacity          |
| 0.85-0.95 | Near Capacity           |
| 0.95-1.0  | At Capacity             |
| >1.0      | Over Capacity           |

Source: Highway Capacity Manual 2010

The Port Republic Road bridge/interchange was excluded from the VJuST Analysis since the bridge is a relatively new structure, built in 1989. Consequently, the two ramp intersections/interchange were not considered for alternative screening. It should be noted that VJuST analysis does not consider the influence of adjacent intersections on traffic patterns. Therefore, it was conducted for screening purposes only with detailed analyses performed using HCM signalized intersection analysis methodology through Synchro 11. **Table 9** shows the maximum v/c ratios from the VJuST analysis using existing volumes at the two intersections, identifying the PM Peak hour as the more critical period.

Table 9. VJuST Analysis Results for Existing Conditions

| Intersection                          | Maximum V/C Ratio |
|---------------------------------------|-------------------|
| Port Republic Road & Bluestone Drive  | 0.65              |
| Port Republic Road & Forest Hill Road | 0.72              |

<sup>3</sup> <https://www.vdot.virginia.gov/about/our-system/highways/innovative-intersections/virginia-icap/T>

Future alternatives were selected based on their feasibility at the study intersection and review of the VJuST design. Some alternative design options were deemed unfeasible for the roadway type at the subject intersection; therefore, only the most feasible options were considered during the VJuST analysis. **Table 10** list the alternatives considered and compare their maximum v/c ratio. **Appendix E** provides the VJuST worksheets for the existing conditions and future year AM and PM peak hours for both intersections.

Table 10: Alternative Screening at the Study Intersections

| Intersection                          | Future Alternative       | Description of Alternative  | Maximum V/C Ratio |
|---------------------------------------|--------------------------|---|-------------------|
| Port Republic Road & Bluestone Drive  | No Build                 | Existing lane config. maintained  | 0.91              |
|                                       | Thru Cut                 | Through movements from Bluestone Dr/ Hillside Avenue prohibited           | 0.69              |
| Port Republic Road & Forest Hill Road | No-Build                 | Existing lane config. maintained  | 0.93              |
|                                       | WBR & SBL Turn Lanes Add | Addition of Port Republic Rd WBR turn lane & Forest Hill Rd SBL turn lane | 0.68              |

At the Port Republic Road and Bluestone Drive intersection, the study team reviewed the potential to install a Thru-Cut. In this innovative intersection design, side street through movements are prohibited. This intersection has low side street through volumes from Bluestone Drive and Forest Hill Road. Currently, the side street operates as a split phase. The Bluestone Drive approach has a shared thru-left-right turn lane with a storage length of 600 feet and a dedicated left-turn lane. The Forest Hill Road approach has a shared thru-left lane and a right turn lane, which is served after the green signal phase for the Bluestone Drive approach times out.

As shown in **Table 10**, this intersection is expected to be near capacity in 2034 with a v/c ratio of 0.93. Converting the intersection to a thru-cut would reduce the maximum v/c ratio to 0.68. However, to convert this intersection into a thru-cut, it would require a dedicated right-turn lane from the Bluestone Drive approach, a dedicated pedestrian phase for pedestrians crossing Port Republic Road, and concurrent left-turn operation from the side streets. There are limitations in the geometric landscape due to the limited right of way and existing infrastructure, such as the nearby Newman Lake Dam. Therefore, the proposed geometric improvements have been deemed unfeasible within the scope of this study and should be investigated further in the future.

At the Port Republic Road and Forest Hill Road intersection, the study team reviewed the potential to install a dedicated right turn lane from the Port Republic Road westbound approach and an additional left turn lane from the Forest Hill Road southbound approach. The turn lanes would reduce the maximum v/c ratio from 0.93 to 0.69. This alternative will be analyzed in detail using HCM signalized intersection analysis methodology through Synchro 11.

## Alternative Analysis

Based on the VJuST analysis conducted for alternative options at the Bluestone Drive and Forest Hill Road intersections, the alternatives in **Table 10** were selected for detailed operations analysis. The design feasibility of this alternative was evaluated, and concept sketches were developed (provided in Figure 29 and Figure 30). The Forest Hill Road intersection concept sketch includes pedestrian/bicycle connectivity improvements.

## Operations Analysis

At the Port Republic Road and I-81 southbound off-ramp intersection, the following two alternatives were selected for future year analysis:

- No-Build – The existing lane configuration is maintained and Right Turn On Red (RTOR) is prohibited on the I-81 southbound off-ramp approach.
- Build – Right turns on red remains prohibited on the southbound approach and the right turn lane is extended to a 500-foot storage length.

In the No-Build 2034 future conditions, the 95<sup>th</sup> percentile queue length on the southbound right turn lane during both peak hours approaches 300 feet. By extending the right turn lane storage length from 100 feet to 500 feet, the queue length will be contained within the turn lane, effectively preventing spillback onto the left turn lane. A concept sketch illustrating the build alternative is provided in **Figure 29**. Detailed Synchro analysis results for both the No-Build and Build 2034 future conditions can be found in **Appendix F**.

At the Port Republic Road and Forest Hill Road intersection, the following two alternatives were selected for future year analysis:

- No-Build – The existing lane configuration and traffic control are maintained.
- Build – Install a dedicated right-turn lane at the Port Republic Road westbound approach and an additional left-turn lane at the Forest Hill Road southbound approach.

A comparison of the selected MOEs at the intersection approaches for the more critical PM peak hour is provided in the following **Table 11**. Detailed Synchro analysis results for the No Build and Build 2034 future conditions are provided in **Appendix F**. With the addition of the right and left turn lanes, the overall intersection delays are expected to reduce from 101.1 sec/veh (LOS F) to 42.3 sec/veh (LOS D) in the PM peak hour. The concept sketch for the build alternative is provided in **Figure 30**.

Table 11. Alternative Analysis Comparison at Port Republic Road & Forest Hill Road (PM Peak Hour)

| Approach                     | No Build                |  |               | Build                   |  |               |
|------------------------------|-------------------------|--|---------------|-------------------------|--|---------------|
|                              | Control Delay (sec/veh) | Max 95 <sup>th</sup> % Queue Length (ft) | Max v/c ratio | Control Delay (sec/veh) | Max 95 <sup>th</sup> % Queue Length (ft) | Max v/c ratio |
| Port Republic Road Eastbound | 52.3                    | #471                                     | 1.18          | 29.1                    | #322                                     | 0.91          |
| Port Republic Road Westbound | 132.2                   | #1135                                    | 1.19          | 33.2                    | 517                                      | 0.91          |
| I-81 Northbound Off-Ramp     | 83.3                    | 252                                      | 0.66          | 74.8                    | 241                                      | 0.61          |
| Forest Hill Road Southbound  | 146.3                   | #921                                     | 1.26          | 70.0                    | 331                                      | 0.82          |
| <b>Overall</b>               | <b>101.1</b>            | -  | <b>1.26</b>   | <b>42.3</b>             | -  | <b>0.84</b>   |

# - 95<sup>th</sup> percentile volume exceeds capacity, queues may be longer

## Safety Analysis

To address the crash hotspots identified along the study corridor, the following safety improvements are recommended:

1. Elimination of right turns on red for the I-81 southbound off-ramp approach and extension of the right turn lane,
2. I-81 northbound on-ramp crosswalk modification,
3. Installation of a dedicated right turn lane on the Port Republic Road westbound approach and an additional left turn lane at the Forest Hill Road southbound approach,
4. Access management improvements (median flex posts) to the east of the Forest Hill Road intersection,
5. Installation of a shared-use path to connect Port Republic Road and Forest Hill Road and extension of the sidewalk on Forest Hill Road's west side.

At the Port Republic Road and I-81 southbound off-ramp intersection, eliminating right turns on red at the I-81 southbound off-ramp approach was proposed to address the three (3) angle crashes that occurred between vehicles turning right on the southbound approach and westbound through vehicles due to limited sight distance. These crashes included one (1) severe and one (1) minor injury crash. Restricting right turns on red will also help enhance pedestrian safety for those crossing the off-ramp on Port Republic Road. Extending the right turn lane on the southbound approach will provide additional storage space for the right-turning traffic.

At the Port Republic Road and I-81 northbound on-ramp intersection, the proposed ramp crosswalk modification includes a pedestrian island to provide a shorter and safer pedestrian crossing.

At the Port Republic Road and Forest Hill Road intersection, a dedicated right turn lane was proposed on the Port Republic Road westbound approach to increase capacity and address 18 rear-end crashes. Providing a dedicated right-turn lane would allow right-turning vehicles to decelerate safely while making the turn. The additional left turn lane on the southbound approach can increase capacity and reduce queue length. Adding flexible delineation posts on the median on the eastern side of the intersection would limit access to and from the Royal Gas station, addressing crashes caused by eastbound vehicles slowing down to turn left into the gas station or vehicles turning left from the gas station onto Port Republic Road.

A shared-use path is recommended to connect Port Republic Road to Forest Hill Road to provide improved bicycle/pedestrian connectivity and address vehicle-bicycle crashes (three resulting in minor injury) that occurred on the sidewalk on the northern side of Port Republic Road. Extension of the

sidewalk is also recommended along Forest Hill Road to provide pedestrian connectivity to the University Outpost Port bookstore, as shown in the concept drawing in **Figure 30**.

The study team also considered installing optically programmable signal heads at the Bluestone Drive intersection to address angle crashes caused by westbound vehicles on Port Republic Road running the red light at the I-81 southbound ramp intersection. The red-light running identified in FR-300 crash reports may stem from drivers confusing the Bluestone Drive signal with the I-81 southbound ramp signal, given their proximity of only 360 feet apart. Optically Programmable signal heads can reduce signal visibility for drivers not immediately approaching the intersection. Installing these signal heads would help mitigate the 44 angle crashes that occurred at the I-81 southbound ramp intersection involving southbound left-turning vehicles and westbound through vehicles (shown in **Figure 23**). Further detailed study is recommended for installing these heads at Bluestone Drive.

Safety improvements at the I-81 southbound ramp, I-81 northbound on-ramp, and Forest Hill Road intersections were analyzed using Crash Modification Factors (CMFs). A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a countermeasure. The CMFs for the proposed improvements at these intersections are provided in **Table 12**. **Table 13** provides the predicted changes in average crash incidents per year are provided in, and the crash cost savings per year for injury crashes only, based on Virginia KABCO comprehensive crash unit costs (2020)<sup>4</sup>. The full collision diagrams and detail sheets are provided in **Appendix C**. The targeted crashes affected by the proposed improvements are identified in the collision diagrams provided in **Appendix G**.

No injury crashes related to the Forest Hill Road additional left turn lane and I-81 southbound ramp right turn lane extension were found, so no crash cost savings are provided for these improvements. There are also no relevant crashes for the I-81 northbound ramp pedestrian crossing improvement. While no CMF was found for installing optically programmable signal heads at Bluestone Drive, this countermeasure is still expected to reduce red-light running incidents at the I-81 southbound off-ramp intersection.

<sup>4</sup> [https://www.vdot.virginia.gov/media/vdotvirginiagov/doing-business/technical-guidance-and-support/traffic-operations/vhsip/VDOT-Crash-Costs-Memo\\_acc050222.pdf](https://www.vdot.virginia.gov/media/vdotvirginiagov/doing-business/technical-guidance-and-support/traffic-operations/vhsip/VDOT-Crash-Costs-Memo_acc050222.pdf)

Table 12: CMFs for Proposed Improvements

| Location                            | Proposed Improvement              | Applicable Crash Type | CMF  |      |      |      | Source                   |
|-------------------------------------|-----------------------------------|-----------------------|------|------|------|------|--------------------------|
|                                     |                                   |                       | K    | A    | BC   | O    |                          |
| Port Republic Rd & I-81 SB Off-Ramp | Extend SB Right-Turn Lane         | All                   | 0.85 | 0.85 | 0.85 | 1.00 | FHWA Desktop Ref Page 26 |
|                                     | Prohibit SB Right Turn on Red     | All                   | 0.98 | 0.98 | 0.98 | 0.98 | VDOT SPL CMF ID: 5194    |
| Port Republic Rd & I-81 NB On-Ramp  | Two-Stage Ped Crossing            | All                   | 0.75 | 0.75 | 0.75 | 0.75 | PED CMF Toolbox Page 5   |
| Port Republic Rd & Forest Hill Rd   | Install RT Lane on WB Approach    | All                   | 0.96 | 0.96 | 0.96 | 0.96 | HSM Table 12-26          |
|                                     | Install Flexible Delineator Posts | All                   | 0.89 | 0.89 | 0.89 | 0.89 | FHWA Desktop Ref Page 80 |
|                                     | Install LT Lane on SB Approach    | All                   | 0.90 | 0.90 | 0.90 | 0.90 | HSM Table 12-24          |
|                                     | Add Shared Use Path               | VB*                   | 1.00 | 0.41 | 0.41 | 1.00 | VDOT SPL ID: 4102, 9250  |

\*Vehicle-Bicycle

Table 13: Comprehensive Crash Costs

| Location                            | Scenario                          | Average # of Crash Incidents per Year, By Severity |                          | Crash Cost per Year | Crash Cost Savings per Year |
|-------------------------------------|-----------------------------------|--|--------------------------|---------------------|-----------------------------|
|                                     |                                   | All  | K, A, B, C (Injury Only) |                     |                             |
| Port Republic Rd & I-81 SB Off-Ramp | Existing Conditions               | 0.4  | 0.3                      | \$ 131,113          | -                           |
|                                     | Prohibit SB Right Turn on Red     | 0.4  | 0.2                      | \$ 128,510          | \$ 2,623                    |
|                                     | <b>Intersection Total</b>         | -  |                          |                     | <b>\$ 2,623</b>             |
| Port Republic Road & Forest Hill Rd | Existing Conditions               | 3.1  | 0.6                      | \$ 119,359          | -                           |
|                                     | Install RT Lane on WB Approach    | 3.0  | 0.6                      | \$ 114,584          | \$ 4,774                    |
|                                     | Existing Conditions               | 2.8  | 0.4                      | \$ 181,703          | -                           |
|                                     | Install Flexible Delineator Posts | 2.4  | 0.4                      | \$ 161,716          | \$ 19,987                   |
|                                     | Existing Conditions               | 0.4  | 0.4                      | \$ 97,057           | -                           |
|                                     | Add Shared-Use Path               | 0.2  | 0.2                      | \$ 39,793           | \$57,264                    |
|                                     | <b>Intersection Total</b>         | -  |                          |                     | <b>\$ 82,025</b>            |

## Preferred Alternative Summary

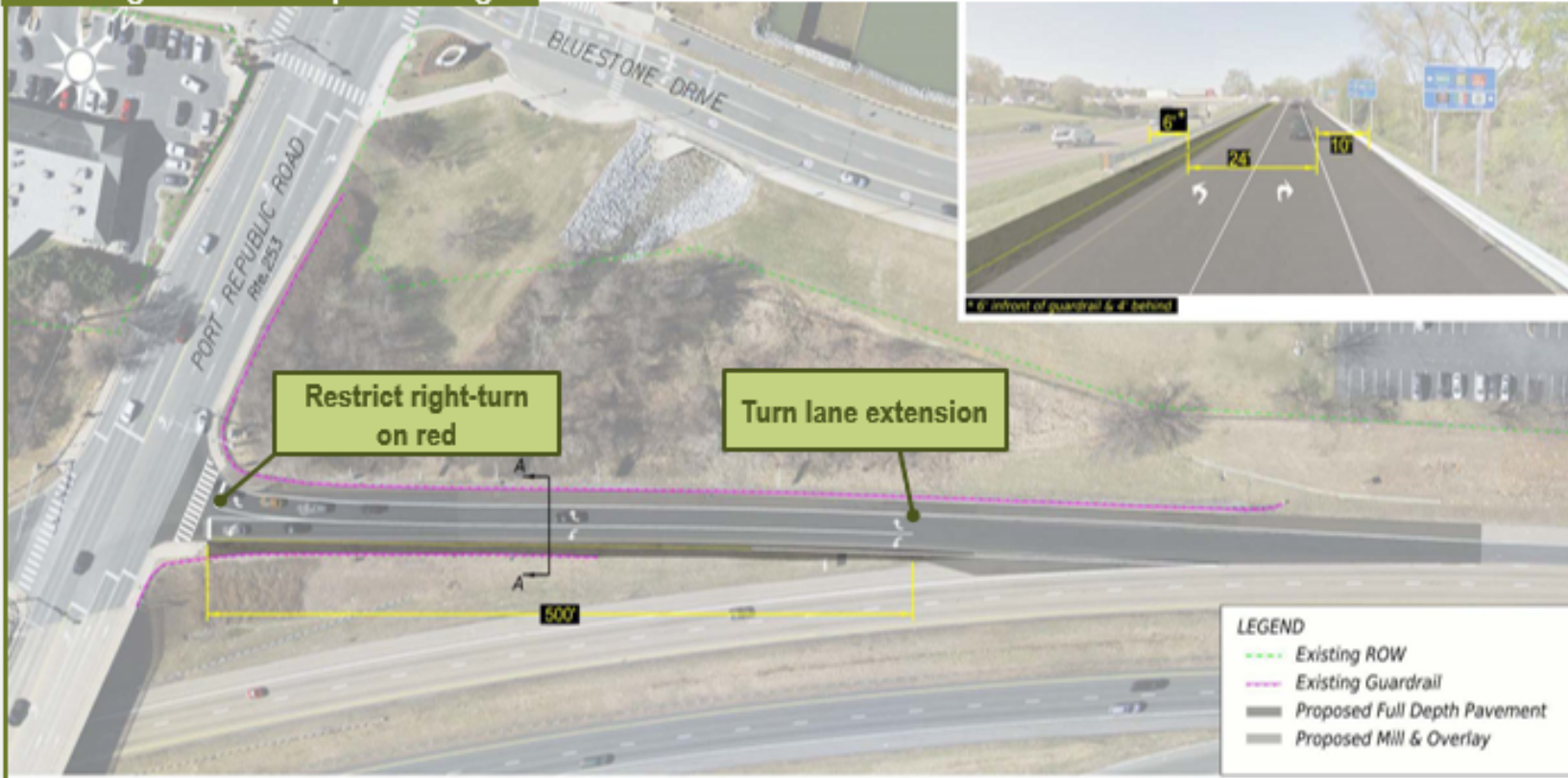
A summary detailing the proposed improvements along the corridor is shown in **Table 14**. An overview of the Preferred Alternative and a summary of the expected operational and safety benefits for the study area are presented in **Figure 29** and **Figure 30**.

Table 14: List of Preferred Alternative Improvements

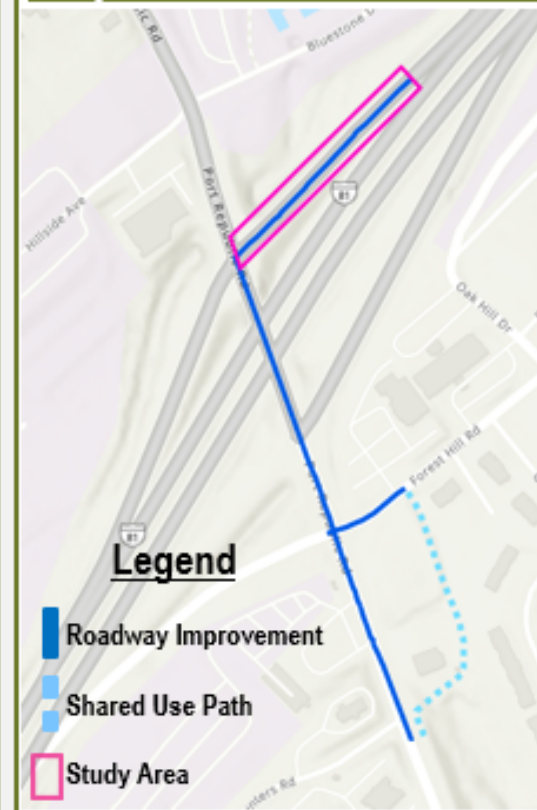
| Location                                | Description  | Improvement Categories   |
|---|--|--|
| Port Republic Road & I-81 SB Off-Ramp * | <ol style="list-style-type: none"> <li>1. Extension of the southbound right-turn lane to 500 feet along the I-81 SB off-ramp</li> <li>2. Restriction of right turns on red from the southbound right-turn lane along the I-81 SB off-ramp to Port Republic Road</li> </ol>   | <ul style="list-style-type: none"> <li>• Safety Improvement</li> <li>• Congestion Mitigation</li> </ul>  |
| Port Republic Road & Forest Hill Road   | <ol style="list-style-type: none"> <li>1. A westbound right turn lane on Port Republic Road to separate turning vehicles from the through lane</li> <li>2. An additional southbound left turn lane on Forest Hill Road</li> <li>3. Concrete/flexible delineation post median for access management to the east of the study intersection</li> <li>4. Shared-use path connecting Port Republic Road and Forest Hill Road</li> </ol> | <ul style="list-style-type: none"> <li>• Safety Improvement</li> <li>• Bicycle Access</li> <li>• Pedestrian Access</li> <li>• Congestion Mitigation</li> </ul> |
| Port Republic Road & I-81 NB On-Ramp    | <ol style="list-style-type: none"> <li>1. Install median refuge for north leg pedestrian crossing</li> </ol>   | <ul style="list-style-type: none"> <li>• Safety Improvement</li> <li>• Pedestrian Access</li> </ul>  |

\* \*These improvements will be performed as a maintenance-level project, to be coordinated with the paving schedule

### Planning-Level Conceptual Design



### Project Location



### Safety Results

Each improvement and countermeasure is expected to reduce the number of crashes and improve operations at the study intersection:

- Prohibit right turn on red for the southbound movement to reduce angle crash incidents turning right onto Port Republic Road
- Extend the right turn lane on the southbound off-ramp – reduce rear-end crash incidents for vehicles waiting to turn right onto Port Republic Road

These safety improvements are expected to target the rear-end crashes (8) on the southbound ramp and angle crashes (3) at the intersection, including one severe injury and one minor injury crash.

### Improvements Description

The improvements proposed at this location include:

- Extension of the southbound right-turn lane to 500 feet along the I-81 southbound off-ramp
- Restriction of right turns on red from the southbound right-turn lane

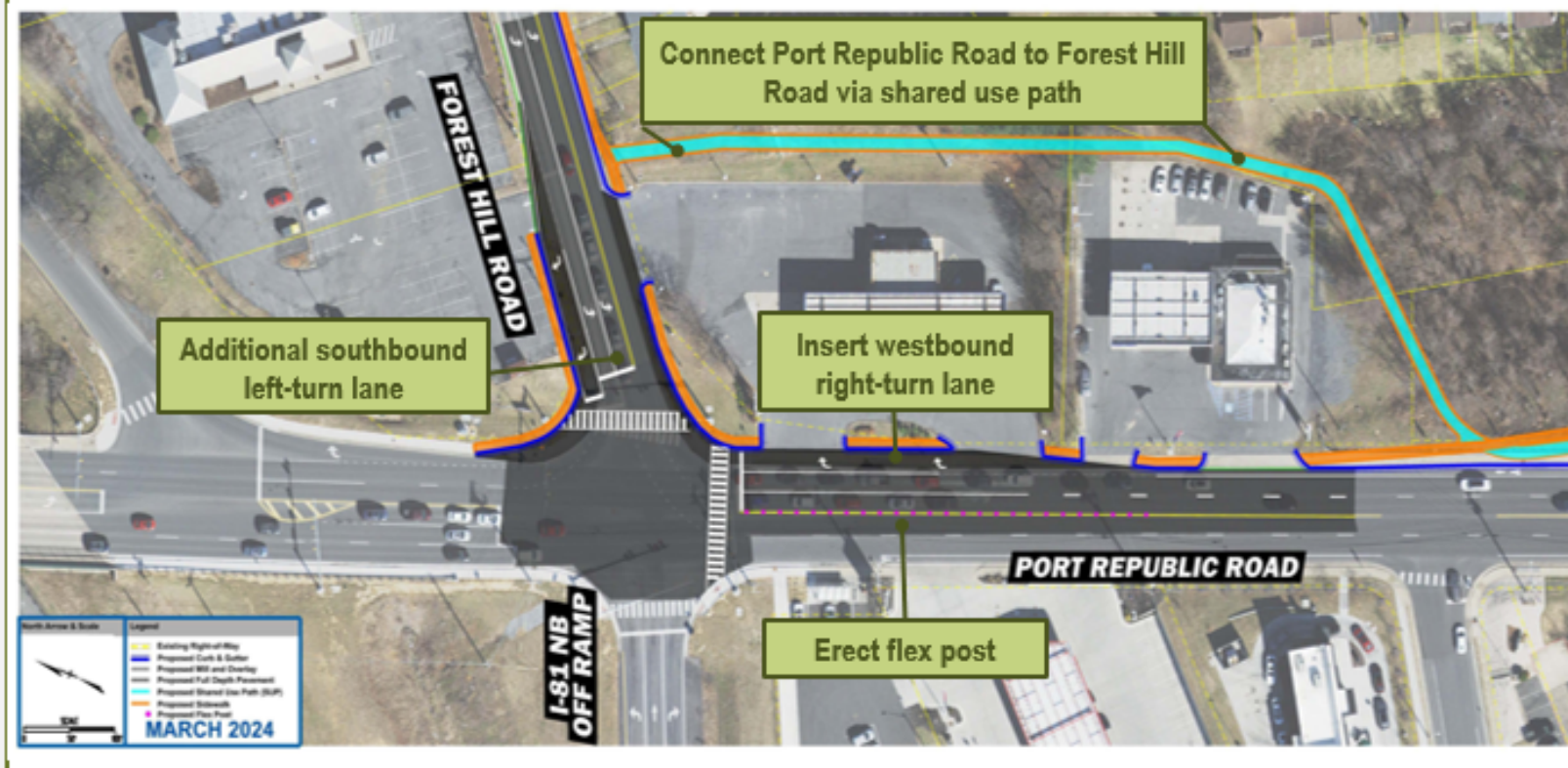
The southbound right turn lane experiences queues that spill into the left turn lane. The right turn lane extension is expected to prevent queue spillback and improve operations. A right turn on red restriction is proposed for the southbound off-ramp to reduce conflicts due to poor visibility of oncoming traffic on Port Republic Road and to enhance pedestrian safety for those crossing the off-ramp on Port Republic Road.

### Traffic Operations Results

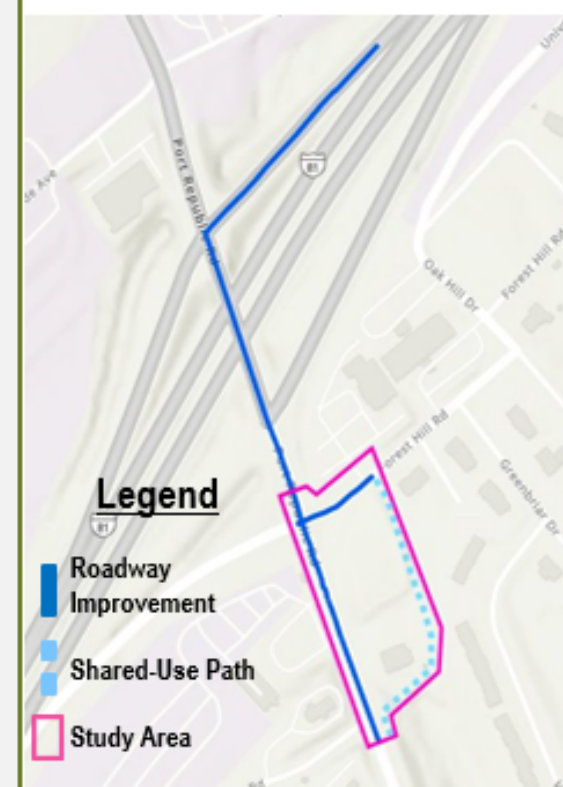
| I-81 Southbound Off-Ramp Intersection Delay |         |         |
|---|---------|---------|
|   | AM Peak | PM Peak |
| No-Build (2034)                             | 17.2 s  | 18.2 s  |
| Build (2034)                                | 15.1 s  | 17.0 s  |

Figure 29: Port Republic Road & I-81 SB Off-Ramp Preferred Alternative Summary

### Planning-Level Conceptual Design



### Project Location



### Safety Results

Each improvement and countermeasure is expected to reduce the number of crashes and improve operations at the study intersection:

- Install additional Forest Hill Road Southbound left turn lane – reduce rear-end crash incidents on Forest Hill Road
- Install Port Republic Road westbound right turn lane – reduce rear-end crash incidents on Port Republic Road
- Prohibit left turns from Port Republic Road to nearby gas stations with flex post– reduce angle crash incidents on Port Republic Road, as multiple lanes of traffic will not be crossed at once
- Add shared-use path – reduce pedestrian conflict points along Port Republic Road and Forest Hill Road

These safety improvements are expected to target the rear-end crashes (45), angle crashes (5), head-on crashes (2), and bicycle crashes (3) that occurred at the intersection.

### Improvements Description

The improvements proposed at this location include:

- A westbound right-turn lane on Port Republic Road to separate turning vehicles from the through lane
- An additional southbound left-turn lane on Forest Hill Road
- Flex post to prevent left turns to and from Port Republic Road to the adjacent gas stations
- A shared use path connecting Port Republic Road to Forest Hill Road

These improvements are expected to reduce crashes and improve operations and non-motorized access and safety. The additional southbound left-turn lane on Forest Hill Road is expected to prevent future delays caused by increasing left-turn volumes by approximately 50%.

### Traffic Operations Results

| Forest Hill Road at Port Republic Road Average Delay |         |         |         |         |
|--|---------|---------|---------|---------|
|  | AM Peak |         | PM Peak |         |
|  | WB      | SB      | WB      | SB      |
| No-Build (2034)                                      | 96.5 s  | 103.9 s | 132.2 s | 146.3 s |
| Build (2034)   | 36.7 s  | 84.8 s  | 33.2 s  | 70.0 s  |

### Preliminary Cost Estimate

Cost estimates were developed based on information available at the time of study and should be reassessed prior to submitting funding applications.

| Phase                      | Cost Estimate (2020 Dollars) |
|----------------------------|------------------------------|
| Preliminary Engineering    | \$1,203,000.00               |
| ROW and Utility Relocation | \$2,404,500.00               |
| Construction               | \$6,015,246.64               |
| <b>Total Cost</b>          | <b>\$9,622,746.64</b>        |

Figure 30. Port Republic Road & Forest Hill Road Preferred Alternative Summary



## Chapter 3:

# Public and Stakeholder Outreach and Feedback



## Public Involvement:

Following the development and analysis of the alternatives, a public involvement survey was developed to determine the public's response to the recommended improvements and what they perceived as the relevant issues within the study area. This survey was available online for 14 days spanning from April 16, 2024, to April 30, 2024.

### Survey Design

Public involvement for this study took place in the form of an online survey developed in *Public Input*, which is an online engagement platform that is designed to educate the public while gathering informed output. The goals of this public outreach effort were to present relevant issues, educate the public on the recommended improvement concepts outlined in Chapter 2, and to receive the public's feedback on the proposed improvements.

Overall, the survey was divided into five sections, which include the following:

1. Welcome/introduction with overview of the project and study area
2. Traveler survey
3. General treatment rating
4. Recommended improvements in the study area / additional comments
5. Wrap up with demographic questions

The first section provides an overview of the study area and the project initiative. In the second section, participants were asked about their trip patterns and to provide feedback about the accessibility and safety along the corridor. In the third section, participants were asked to provide feedback whether they agree or disagree with the potential treatments. Next, in the fourth section, a summary of the recommended improvements and benefits along Port Republic Road was provided, as shown in **Table 14**. For these recommended improvement concepts, participants were asked to rate them based on their opinion from one to five, one being very unfavorable, three being neutral, and five being strongly in favor. They were also provided with an option to input comments or concerns. At the end of the survey, the participants were asked a few demographic questions such as "How do you normally travel in this area?" and "What other modes of travel would you prefer?" A total of 12,901 people responded to the survey.

### Survey Questions and Results

Next, participants were presented with the Preferred Alternative design concepts for the study corridor to rate improvements in each section on a scale from one to five stars. The design concepts that were originally provided to the participants are shown in **Figure 31** and **Figure 33**. **Figure 32** and **Figure 34** show the public response to the proposed improvements. Overall, the participants showed a favorable response to the proposed concepts for each section. A summary of public comments on the Preferred Alternative improvements is shown in **Table 15**.



Figure 31: I-81 SB Off-Ramp Concept Design

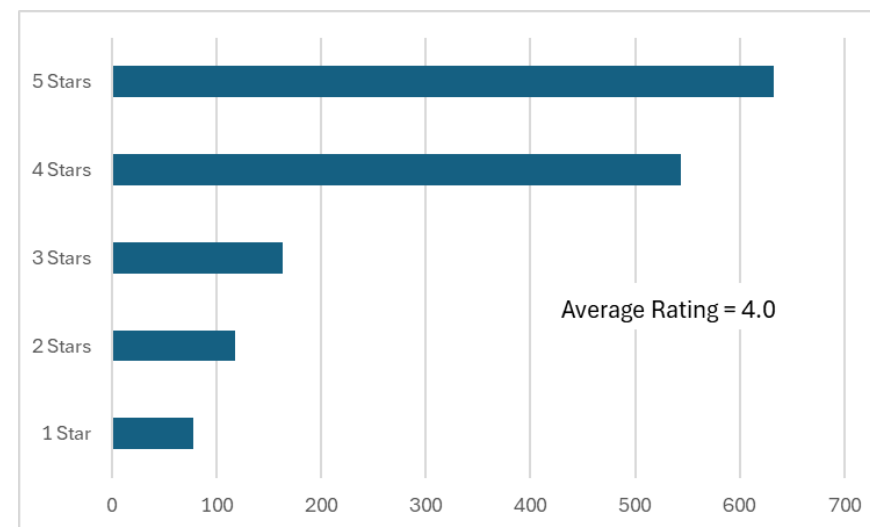


Figure 32: I-81 SB Off-Ramp Concept Design Public Rating

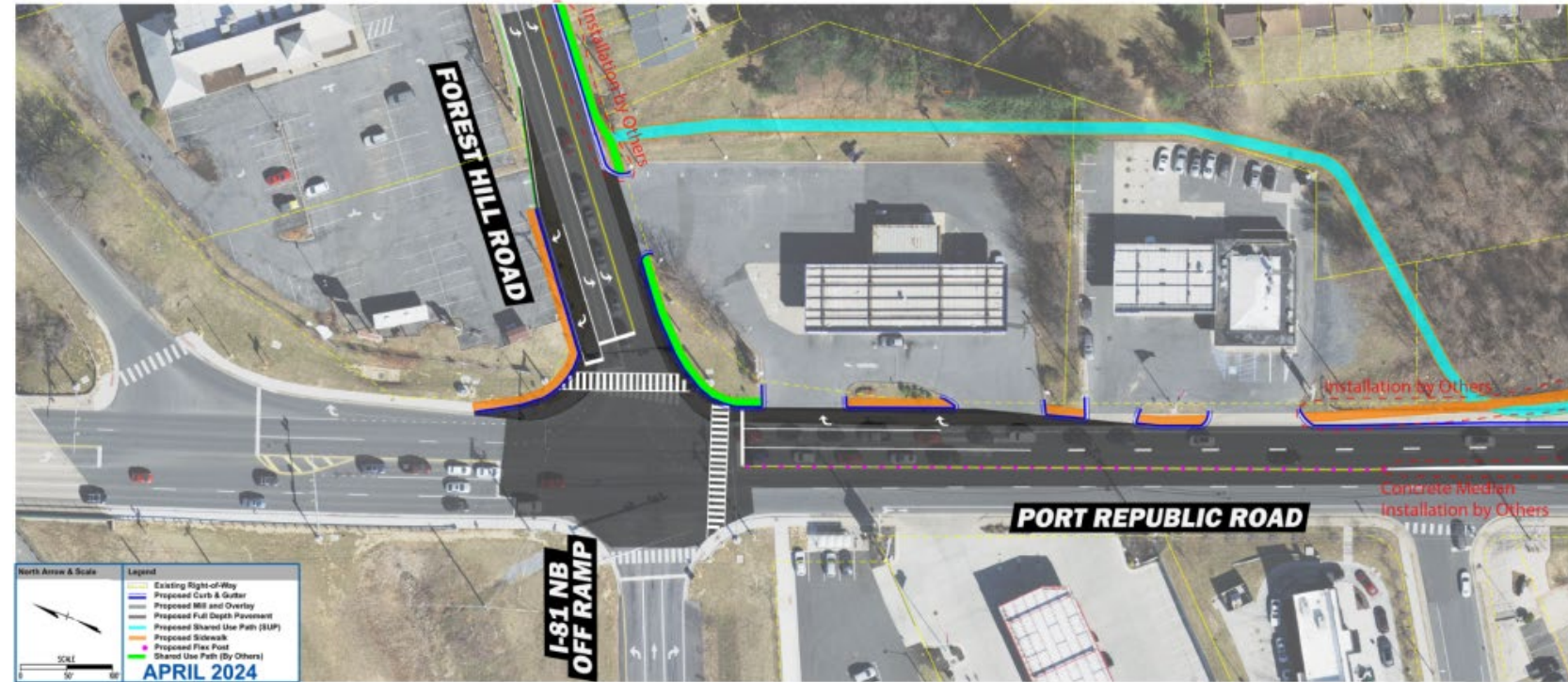


Figure 33: Forest Hill Road Concept Design

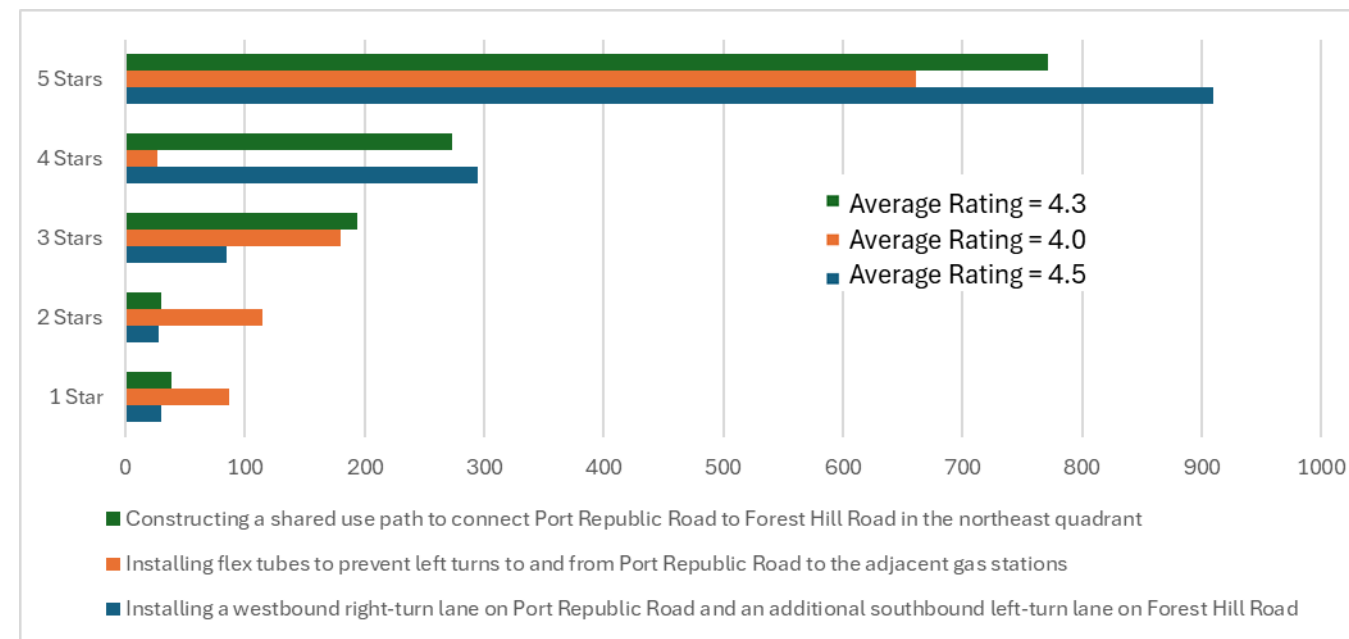


Figure 34: Forest Hill Road Concept Design Public Rating

Table 15. Summary of Public Comments and Study Team Responses

| Public Comments and Study Team Responses |   |  |
|--|---|--|
| Concept Design                           | Areas of Concern                        | Public Comment   |
| I-81 SB Off-Ramp                         | Safety                                  | <ul style="list-style-type: none"> <li>• Many people agreed that the Right Turn On Red (RTOR) restriction would provide safety benefits for pedestrians and cyclists by providing them with a safe space to cross this intersection. Some of the comments also acknowledged the limited intersection sight distance presently available for the right-turning traffic on red and agreed that this countermeasure would provide safety benefits.</li> <li>• However, some expressed concerns that this might increase queuing on the southbound approach and suggested extending the right-turn lane even further to alleviate the issue.</li> <li>• A few comments recommended allowing RTOR during off-peak times, particularly when traffic volumes are lower.</li> </ul>  |
| Forest Hill Road Concept Design          | Access Management                       | <ul style="list-style-type: none"> <li>• There was overwhelmingly positive feedback for the turn lane addition. Of the total respondents, 66% provided a 5-star rating and 22% provided a 4-star rating</li> <li>• Constructing a shared-use path connecting Port Republic Road and Forest Hill Road also received a favorable rating from the survey respondents.</li> <li>• Public feedback on the proposed flex tube installation was slightly less favorable but still a high 4.0 average, compared to the other improvements at the study intersection. Some expressed support for this and cited high traffic volume and safety concerns regarding left turns into the gas station as their reason, whereas others disagreed citing potential issues such as unsafe U-turns and increased congestion from multiple turns at the intersection.</li> </ul> |
| Other Comments                           | Bicycle & Pedestrian Safety Improvement | <ul style="list-style-type: none"> <li>• Public comments emphasize the need for pedestrian and cyclist safety improvements at Port Republic Road and Bluestone Drive, suggesting overpasses or tunnels.</li> <li>• There were multiple suggestions to synchronize traffic lights along Port Republic Road, particularly at the ramps, to improve traffic flow and reduce stops that could lead to congestion and inefficiency</li> </ul>   |



## Chapter 4:

# Preferred Alternative Design Refinement & Investment Strategy

## Intent of Phase 3

Phase 3 of the Pipeline Effort is intended to develop detailed concepts of the Phase 2 Preferred Alternative that will carry through to funding applications and project validation. The goal is to ensure that projects are defined to the maximum extent possible and to identify and mitigate potential risks. Utilizing technical resources of both VDOT and consultant teams, a multidisciplinary design approach is part of the overall effort that provides the needed input and problem-solving to ensure funding applications are thoroughly vetted and taken past a planning level sketch and estimate.

The goal is to develop more detailed, quantity based, deterministic estimates and designs paired with thoughtful risk assessment and mitigation. The team will use practical design and common-sense engineering methods to document the assumptions and approaches that lead to the most efficient and effective project scopes. The effort maintains focus on the purpose and needs identified through Phases 1 and 2 that address the VTRANS priorities.

Technical resources utilize Phase 3 for thorough communication and collaboration with District, Central Office, FHWA, or other key partners and stakeholders that may have decision making authority or input on final designs if projects are selected for funding. An intended outcome is that projects, if funded, will have the documentation and support for innovation and flexibility that may be necessary to achieve success.

The Phase 3 Technical Team developed the analysis, design, deliverables, and documentation that will serve as the basis for future Preliminary Engineering work on the projects. At the conclusion of Phase 3, projects should achieve a solid foundation of understanding from a planning and preliminary engineering focus that will ensure applications are well validated, reasonably scoped, meet the needs originally established in studies, and have a high probability of success.

## Assumptions

The following are key design assumptions that informed the concept development and cost estimate preparation:

- Roadway geometry:
  - The design assumes widening Port Republic Road east of the Forest Hill Intersection to provide 30-ft of pavement in the eastbound direction to accommodate the dual left turn movements from Forest Hill Road. Westbound Port Republic Road will maintain two 11-ft through lanes and add an 11-ft wide right turn lane, a new 2-ft wide raised median will be constructed to separate the traffic and provide manage access to the two service stations along Port Republic Road. Southbound Forest Hill Road will be widened to provide dual left turn lanes, special attention will need to be paid to the existing retaining wall within the Trout Enterprises (parcel 02) parking lot and the right turn taper length may need to be adjusted to avoid impacts to the wall.
  - At the I-81 northbound on-ramp, a new channelized island will be added to improve pedestrian safety crossing the intersection.
- Pedestrian accommodations:
  - A new pedestrian crossing with pedestrian signals will be added at the I-81 northbound on-ramp.
  - At the intersection of Port Republic Road and Forest Hill Road, the existing westbound sidewalk will be reconstructed in accordance with the City of Harrisonburg Design and Construction Standards Manual City and provide 5' sidewalk with 2' buffer.
  - A new 10-ft wide shared use path will be constructed to connect pedestrian improvements constructed with the Port Republic Road / Bradley Drive (UPC 119652) and the University Boulevard Extension (UPC 116863) projects.
- Stormwater management:
  - The project assumes the existing stormwater management facilities will be sufficient to accommodate the improvements or are able to be modified to meet the requirements, with minimal impervious area being added. Nutrient credits may be required to meet stormwater quality standards. Existing inlets will need to be replaced in widening sections and connected to the existing underground storm drain network within the area.
- Traffic:
  - At the I-81 northbound on-ramp intersection new pedestrian signals and pushbuttons will be required and a new traffic signal for westbound traffic entering the interstate.

- At the Port Republic Road and Forest Hill Road new signals will be required at the northwest and northeast quadrants.
- Utility Impacts:
  - The project will impact at least three (3) overhead utility poles along Forest Hill Road, two (2) behind the Royal Mart service station (parcel 03) and one (1) in the vicinity of the relocated transit stop (parcel 04).
- Right of Way:
  - The proposed improvements will involve acquiring right of way and easements on eight (8) parcels (six (6) commercial and two (2) residential). The two service stations (parcels 03 and 04) will be impacted by the access management being achieved by the installation of the proposed median, the existing entrances for these parcels will become right-in, right-out only.
  - Per VDOT Estimate dated 7/17/2024: *“SS Estimate Rnd #6. Prop acq areas calculated from R/W DS provided by PM. Asphalt, Concrete, Trees & Shrubs, Parking lot lights and IP’s. Assumptions: No TTs; No well / septic impacts; All parcels to retain reasonable access; Condemn elev due to recent attorney involvement; Damages elev due to loss of 8 Comm parking spots and 1 spot during const; Fee RW increased to 20k to account for unec remnants; Sign on Parcel 4 to not be disturbed (25% Contingency added to Manual Inflation Rate). [DWL]”*
- Transit:
  - The existing Bus Stop along Port Republic Road approximately 110-ft east of Forest Hill Road is proposed to be relocated to the east as shown on the concept plan. The proposed relocated transit stop will include a concrete pad for ADA access.

## Risk Assessment/Contingency

As part of the risk assessment process, a risk register was developed to identify major/high impact project risk elements. The guidance provided in VDOT’s Cost Estimating Manual (Chapter 5) and IIM PMO-15.0 was followed and identified after assessing collected data, field visits, stakeholder input, and concept development. Risks were organized by broad categories including Maintenance of Traffic (MOT), Roadway Design, Right-of-Way, Utilities, Mobilization/Construction Survey, Hydraulics, Traffic, Structures/Bridge Design, Geotechnical, and Environmental. The major risks identified in this project include:

- MOT plans have not been developed at this stage; the MOT is not anticipated to be complex and the Most Likely Estimate (MLE) is recommended.

- The hydraulic design is based on field observations, GIS data, and as-built plans. The project assumes the existing storm drain system is adequate and only minor adjustments will be required where the proposed widening impacts existing inlets – however if the project cannot connect to the existing 42-inch trunk line along Port Republic Road the trunk line and connections will need to be reconstructed within the limits of the project. It is assumed nutrient credits will be adequate to satisfy any stormwater management requirements.
- The project is located in an urbanized area with the potential for water and sanitary sewer impacts. Generally, it is assumed the impacts will be minor and consist of utility adjustments or relocation of service lines.
- Construction limits and earthwork quantities are based on LIDAR surface data. The major areas requiring earthwork are along the proposed shared use path. Detailed cross sections were not performed for the project.

The project is considered Moderately Complex. However, the level of concept design development is relatively detailed (between Pre-Scoping and PFI level of design), therefore the MLE contingency would be more accurately in the 40% to 45% range. Each individual risk was “scored” based on probability, cost impacts, and time impacts. Scoring was used to assign contingencies per risk line item. These line-item risk contingencies were then aggregated to determine a contingency amount per category to include preliminary engineering, right-of-way and utilities, mobilization/construction survey, MOT, roadway design, hydraulics, traffic, and earthwork/geotechnical.

## Cost Estimate

The project cost estimate was developed using the following methodology:

- Understanding the goals of the project and scope of improvements to be implemented.
- Gathering and reviewing as much information about the project as possible including site visits and stakeholder input.
- Establishing design criteria and developing a detailed design concept.
- Performing quantity takes offs and identifying unit prices based on Bid Express, and historical VDOT cost data (2-year District and Statewide average) to develop “defined costs”.
- Developing “allowance costs” for some elements based on potential impacts and complexity. Allowances add costs for elements based on percentage of the base construction cost.
  - Maintenance of Traffic 5% Allowance.
  - 1.5% for a field office
  - Roadside Development at 2.5%

- \$21,375 for additional pavement overlay to correct pavement cross slopes
- Stormwater Management (SWM) as 6% Allowance (assume Nutrient Credits)
- Erosion and Sediment Control (E&SC) 3% Allowance
- In-Plan Utilities 2% Allowance to cover minor water and sanitary sewer adjustments.
- Traffic Signal items are included as a lump sum item. An allowance of 2% is included each for pavement markings and signing replacement/improvements.
- \$475,000 for potential rock excavation along the shared use path alignment.
- \$30,000 to treat potential unsuitable soils along the shared use path alignment.
- Identifying proposed property impacts, developing a Right of Way Data Sheet, and providing the information to VDOT to develop the right-of-way and utility budget for the project.
- Performing a risk assessment as outlined above and identifying appropriate contingency percentages by category.
- Developing Preliminary Engineering costs by category based on a percentage of the Construction cost.

## Concept Revisions & Final Estimate

Based on VDOT and Stakeholder input from Phase 2 and the site visit performed at the commencement of Phase 3, the concept was advanced, refining key elements of the preferred alternative, as shown in **Figure 35**. As the design progressed, several elements were altered from the concept that resulted from Phase 2 to include:

- Adding a pedestrian island and a traffic signal along westbound Port Republic Road at the I-81 Northbound On-Ramp.

### Cost Estimate Breakdown

The total project cost is estimated to be \$7,752,018 and broken down by Phase/Major area as shown in **Table 16** below. This cost includes contingencies and represents uninflated 2024 dollars.

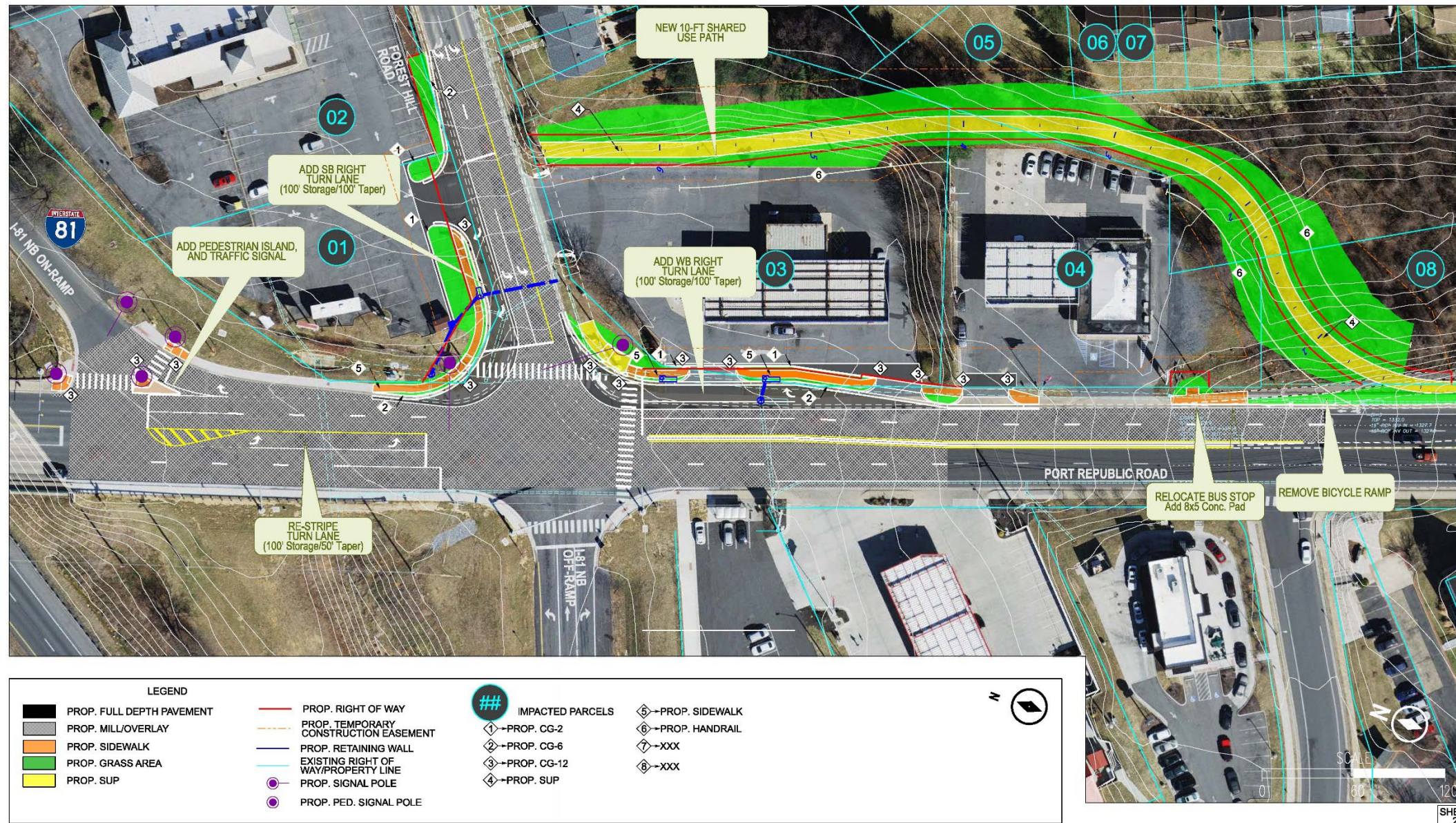
*Table 16: Cost Estimate Breakdown*

| Phase                            | Total              |
|----------------------------------|--------------------|
| Preliminary Engineering Phase    | \$825,500          |
| Right-of-Way and Utilities Phase | \$1,416,344        |
| Construction Phase (without CEI) | \$4,642,430        |
| Construction Phase (with CEI)    | \$5,510,174        |
| <b>Total</b>                     | <b>\$7,752,018</b> |



# PORT REPUBLIC/ FOREST HILL ROAD INTERSECTION IMPROVEMENTS

JULY 2024



**PROJECT ST-23-06 | CITY OF HARRISONBURG**



Figure 35: Port Republic Road / Forest Hill Road Intersection Improvements