# Short Pump Area Interchange Access Report

May 19, 2023

PREPARED FOR:

County of Henrico, Virginia

PREPARED BY:

Kimley»Horn

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# FHWA Interstate Access Policy Points

As detailed in FHWA's *Policy on Access to the Interstate System*, dated May 22, 2017, FHWA's decision to approve new or revised access points to the interstate system is dependent on the proposal satisfying two policy points. The following sections outline an overview of the study and responses to the required policy points.

## OVERVIEW

The objective of this study is to identify the needs and to develop and evaluate potential solutions to address those needs of the transportation network in the Short Pump area (in Henrico County just west of Richmond), which includes sections of I-64, I-295, Route 288, and US 250. The purpose for the project is to address and improve upon the identified needs of the transportation network, which include:

- ***Addressing capacity-constrained roadways:*** several ramps and roadway segments within the Short Pump area are over capacity or are projected to be over capacity in the future
- ***Reducing recurring congestion:*** the Short Pump area contains three high-volume freeway networks and a US Route that serves a popular commercial area. This mix leads to recurring congestion on several roadway segments within the study area.
- ***Improving safety at hot spots:*** the Short Pump area contains several intersections and roadway segments that have been identified as high-ranking areas with potential for safety improvement within VDOT Richmond District

The study team screened individual improvement alternatives to address needs identified throughout the study area and developed three Build packages that included the improvements outlined in *Table 1*. The study team prepared an alternatives comparison matrix to evaluate the differences between the three Build packages and the No-Build scenario using the following criteria. Build Package 3 scored the highest and was selected as the preferred alternative.

- Right-of-way (RW) and utility impacts
- Safety impacts
- Operational impacts
- Bicycle and pedestrian accommodation
- Meets Purpose and Need
- Environmental impacts
- Preliminary cost of construction

*Table 1: Summary of Build Package Components*

| Improvement | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|
| Construct a partial cloverleaf interchange (option 3) that removes the on-ramp from eastbound US 250 to westbound I-64. Construct dual westbound right-turn lanes at intersection with westbound I-64 ramps plus contraflow left-turn lanes | ✓ | ✗ | ✓ |
| Construct a new diverging diamond interchange on I-64 at N Gayton Road | ✗ | ✓ | ✓ |
| Construct an auxiliary lane on southbound Route 288 between US 250 and Tuckahoe Creek Parkway | ✓ | ✓ | ✓ |
| Construct an auxiliary lane on northbound Route 288 between Tuckahoe Creek Parkway and US 250. Signalize and add a second lane to serve the right-turn movement on the southbound Route 288 off-ramp to US 250. Add a second lane to serve the right-turn movement on the northbound Route 288 off-ramp to US 250. | ✓ | ✓ | ✓ |
| Convert the westbound US 250 right-turn lane at Tom Leonard Drive to a shared through/right lane and install a thru-cut | ✓ | ✓ | ✓ |
| Restrict vehicles on the westbound off-ramp from I-64 to eastbound US 250 from turning left at Dominion Boulevard | ✓ | ✓ | ✓ |
| Convert the single-lane I-295 on-ramp from westbound I-64 to two lanes. Construct a continuous northbound auxiliary lane from I-64 to Nuckols Road interchange. | ✓ | ✓ | ✓ |
| Reconfigure the eastbound I-64 ramp diverge at I-295 to create one exit only lane and one choice lane | ✓ | ✗ | ✗ |

## POLICY POINT 1

*An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).*

### Response

The study team conducted operational and safety analyses and determined that the preferred alternative addresses the needs of the transportation network, which included addressing capacity-constrained roadways, reducing recurring congestion, and improving safety at hot spots.

The preferred alternative is projected to improve operations at several points in the study area that are over capacity or are projected to be over capacity in the future. The preferred alternative is projected to serve a higher percentage of demand than the No-Build scenario on all roadways as documented in the *Build Package Operational Comparison* section. The improvements are also projected to result in travel times in the study area that are lower or comparable to the No-Build scenario on I-64 and US 250.

Crashes were projected to be added to the network in the vicinity of the new interchange at N Gayton Road since the new interchange adds two new on- and off-ramps to the interstate system and attracts more vehicles to the section of interstate. The goal of the safety analysis was to determine if the projected reduction in crashes at the existing freeway hot spots outweighed the crashes that were projected to be added to the network in the vicinity of the new interchange. The study team determined that the preferred alternative was projected to reduce enough crashes at the existing freeway hotspots to result in an overall safety benefit on the freeway as documented in the *Safety Conclusions* section.

A conceptual signing plan for the preferred alternative is described in the *Conceptual Signing Plan* section and included in *Appendix H*.

## POLICY POINT 2

*The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design.*

### Response

The proposed modifications to access in the preferred alternative include new access at the existing grade-separated crossing of N Gayton Road over I-64, which will provide for all traffic movements and connect to a public road only. Additional modifications in access include interchange reconfiguration improvements at US 250, in which the westbound I-64 on-ramp from eastbound US 250 is proposed to be removed. Access will be maintained for vehicles making this movement via a left turn onto the existing westbound I-64 on-ramp from westbound I-64. The preferred alternative was conceptually designed to meet or exceed current design standards except at the locations noted in the *Potential Design Exceptions* and *Potential Design Waivers* sections.

# Introduction

## BACKGROUND

The interstate, interchanges, and arterial network in the Short Pump area have experienced operational and safety challenges and are expected to have significant growth in the coming years. Henrico County is advancing and implementing several improvements in the Short Pump area, but the improvements are not enough to provide relief to the congestion and safety issues.

### Study Work Group

A study work group (SWG) was formed for the Short Pump Area Interchange Access Report (IAR) project to capture input from local stakeholders through the study process and to shape the development of the preferred alternative. The SWG provided key knowledge of the study area, reviewed study methodologies, provided input on assumptions, and reviewed alternatives developed throughout the study process. The Short Pump IAR SWG included members representing the following organizations:

- Henrico County Department of Transportation
- Goochland County Department of Transportation
- Virginia Department of Transportation (VDOT) – Central Office and Richmond District Office
- Federal Highway Administration (FHWA) – Virginia Division Office
- Kimley-Horn & Associates, Inc. (Henrico County transportation consultant)

## PURPOSE AND NEED

The objective of this study is to identify the needs of the transportation network in the Short Pump area, which includes sections of I-64, I-295, Route 288, and US 250, and to develop and evaluate potential solutions to address those needs. Previous studies and current traffic conditions demonstrate that the highway segments above are experiencing operational and safety challenges and are limited in capacity. The area in the vicinity of Short Pump is expected to have significant growth in the coming years, which will add to the challenges. Henrico County is advancing and implementing a number of multimodal transportation improvements in the Short Pump area, but the improvements are not enough to provide relief to the congestion and safety issues on the interstate.

Key findings from recent studies include the following conclusions:

- The *STARS US 250 (Short Pump) Study* included a high-level analysis of the I-64 /US 250 interchange (Exit 178). Through preliminary alternatives analysis, the study determined that the I-64/US 250 interchange could not be improved enough to accommodate demand on I-64 nor on US 250.
- Another key finding from the *STARS US 250 (Short Pump) Study* was that US 250 could not be improved enough to relieve congestion on the segments between the I-64/US 250 interchange and Pouncey Tract Road, and between N. Gayton Road and Route 288. This congestion is independent of the capacity-constrained congestion on the ramp from the westbound I-64 to westbound US 250.
- A subarea model derived from the Richmond region Travel Demand Model was created by VDOT Transportation Mobility Planning Division (TMPD) with a focus on the Short Pump area. It was calibrated with updated traffic count data and was based on the latest available socioeconomic data in Henrico and Goochland counties. Several potential Build scenarios, which included potential planned improvements in the region, were derived to evaluate the impact(s) each improvement had on Short Pump area traffic independently. Based on the results of the subarea model analysis, an additional interstate connection at N. Gayton Rd was shown to potentially reduce demand at critical, over-capacity interchange ramps, as well as on key sections of major arterials. This reduction in demand would also potentially reduce congestion along sections of I-64, I-295, Route 288 and US 250, and alleviate congestion-related safety issues.

- Another previous study, the *Greater RVA Transit Vision Plan,* determined that increased transportation demand strategies considered for deployment in this area are not expected to address all identified capacity constraints. As such, this study should consider improvements to the existing roadway network and new roadway connections or limited access point connections that may reduce demand on the existing roadway network as potential solutions to address the needs identified in the Short Pump area.

Based on these findings, it was determined that existing and future traffic volumes and travel patterns point to the need to identify long-term solutions to increase capacity and improve safety in the Short Pump area.

The purpose for the project is to address and improve upon the identified needs of the transportation network, which include:

- ***Addressing capacity-constrained roadways:*** several ramps and roadway segments within the Short Pump area are over capacity or are projected to be over capacity in the future
- ***Reducing recurring congestion:*** the Short Pump area contains three high-volume freeway networks and a US Route that serves a popular commercial area. This mix leads to recurring congestion on several roadway segments within the study area.
- ***Improving safety at hot spots:*** the Short Pump area contains several intersections and roadway segments that have been identified as high-ranking areas with potential for safety improvement within VDOT Richmond District

## PROJECT LOCATION

The study area includes the follow corridors, interchange ramps, and intersections as shown in *Figure 1*.

### *Corridors*

- Eastbound and westbound I-64 between the Route 623 interchange and the Gaskins Road interchange
- Northbound and southbound I-295 between the Nuckols Road interchange and the I-64 interchange
- Northbound and southbound Route 288 between the Tuckahoe Creek Parkway interchange and the I-64 interchange

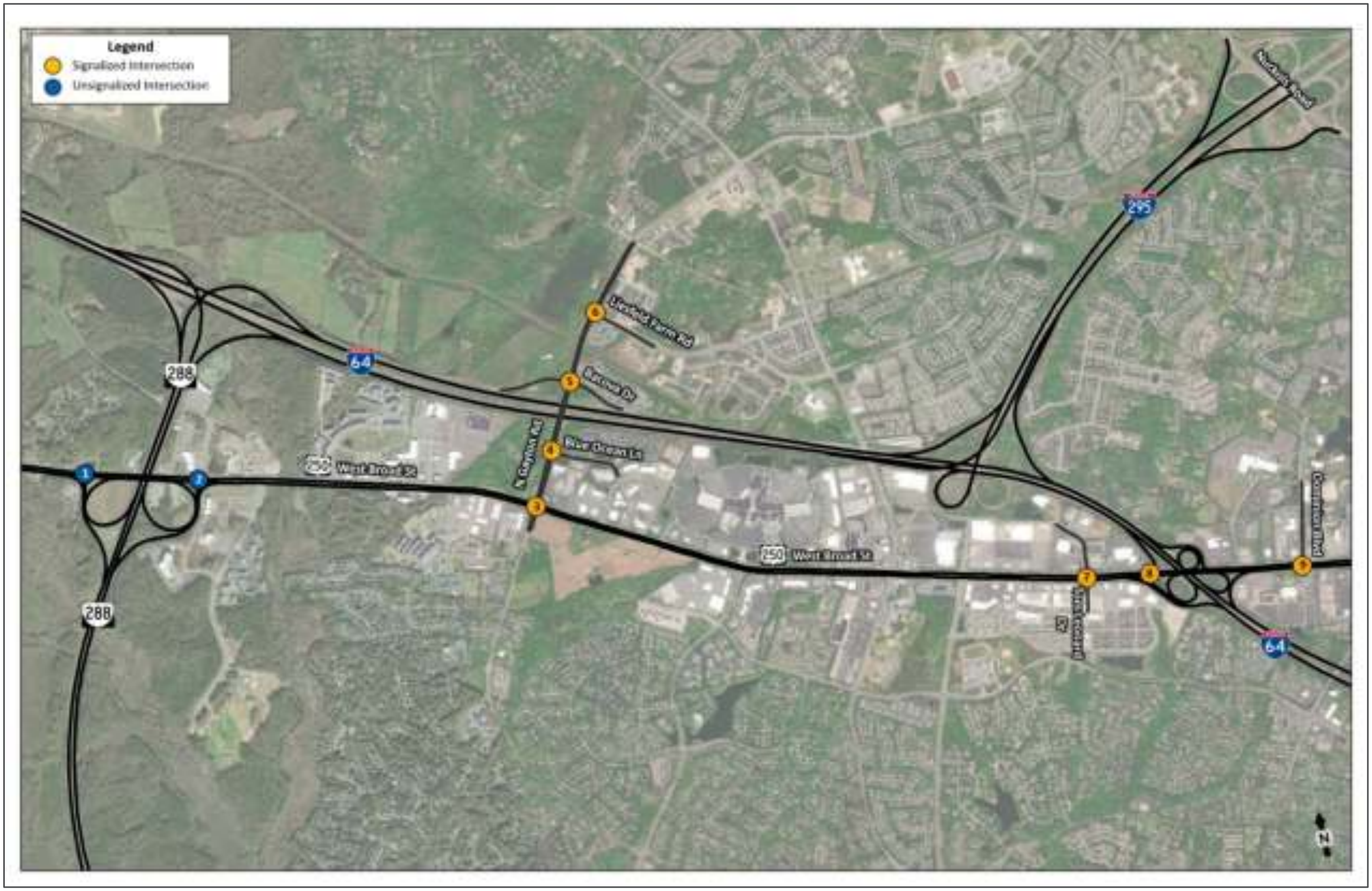
### *Intersections*

- N Gayton Road at Blue Ocean Lane
- N Gayton Road at Bacova Drive
- N Gayton Road at Liesfeld Farm Drive
- US 250 at Tom Leonard Drive
- US 250 at Dominion Boulevard
- US 250 at eastbound I-64 on-ramp
- US 250 at northbound Route 288 ramps
- US 250 at southbound Route 288 ramps

### *Interchange Ramps*

- Eastbound I-64
  - Off-ramp to southbound Route 288
  - On-ramp from northbound Route 288
  - Off-ramp to southbound I-295
  - On-ramp from northbound I-295
  - Off-ramp to westbound US 250
  - Off-ramp to eastbound US 250
  - On-ramp from US 250
  - Off-ramp to eastbound US 250
  - On-ramp from eastbound US 250
- Westbound I-64
  - Off-ramp to eastbound US 250
  - On-ramp from eastbound US 250
  - Off-ramp to westbound US 250
  - On-ramp from westbound US 250
  - Off-ramp to southbound I-295
  - On-ramp from northbound I-295
  - Off-ramp to southbound Route 288
  - On-ramp from northbound Route 288
- Northbound Route 288
  - Off-ramp to US 250
  - On-ramp from US 250
- Southbound Route 288
  - Off-ramp to US 250
  - On-ramp from US 250
- Northbound I-295
  - On-ramp from southbound Nuckols Road
- Southbound I-295
  - Off-ramp to southbound Nuckols Road

*Figure 1: Study Area*



# Methodology

This IAR was developed according to the applicable VDOT and FHWA interchange access criteria stated in IIM-LD-200.11.

A framework document was developed for this IAR that documented the methodologies and assumptions for this study. The original document was signed on March 24, 2021. The document was revised on October 6, 2021, and was re-signed by Henrico County, VDOT, and FHWA. The revised framework document is attached in *Appendix A*.

## RELEVANT STUDIES

The *STARS West Broad Street (US 250) Corridor Study* was prepared in December 2018 for VDOT to provide recommendations to improve operations and safety on the US 250 corridor between Glenside Drive and Dominion Boulevard.

The *STARS US 250 (Short Pump Area) Corridor Study* was prepared in December 2020 to provide recommendations to improve operations and safety on the US 250 corridor between the I-64 interchange and Hockett Road/St. Matthews Lane. As documented in the *Purpose and Need*, this study concluded that further study was needed to address deficiencies on US 250 between the I-64 interchange and Pouncey Tract Road and between the Route 288 interchange and N Gayton Road. It was also determined that the I-64 interchange at US 250 could not be improved enough to accommodate demand on I-64 nor on US 250.

The *I-64 at Parham Road Interchange Modification Report (Parham IMR)* and the *I-64 at Gaskins Road Interchange Modification Report (Gaskins IMR)* were prepared in conjunction with the analysis efforts for the *STARS US 250 (Short Pump Area) Corridor Study*. Traffic modeling and growth rate assumptions are consistent between these two IMRs, the *STARS US 250 (Short Pump Area) Corridor Study*, and this IAR.

## ANALYSIS TOOLS

The traffic operations analysis was conducted in accordance with methodologies from VDOT's *Traffic Operations and Safety Analysis Manual (TOSAM),* Version 2.0. The following traffic analysis tools were selected for the development of this IAR:

- Vissim 11: freeway and intersection analyses
- Synchro Professional, Version 10: screen intersection and interchange improvements; optimize signal timings for use in Vissim

## MEASURES OF EFFECTIVENESS

The following measures of effectiveness (MOE) were selected to evaluate analysis results:

- Vissim freeway analyses
  - Density, measured in vehicles per lane per mile (veh/ln/mi)
  - Speed, measured in miles per hour (mph)
  - Travel time, measured in minutes (min)
  - Vehicle throughput, measured in vehicles (veh)
- Vissim intersection analyses
  - Delay, measured in seconds per vehicle (sec/veh)
  - Maximum queue length, measured in feet (ft)

  - Vehicle throughput, measured in vehicles (veh)
- Synchro screening analyses
  - Control delay, measured in seconds per vehicle (sec/veh)
  - 95th percentile queue length, measured in feet (ft)

### ANALYSIS YEARS

The following analysis years were selected and agreed upon by the SWG to evaluate results:

- Existing conditions: 2019
- Opening year: 2026
- Design Year: 2046

### ALTERNATIVES DEVELOPMENT, SCREENING, AND PREFERRED ALTERNATIVE SELECTION

Potential geometric improvements were developed to address existing and projected operational and safety deficiencies described in the Purpose and Need. Improvements that were considered included concepts from previous studies (including concepts screened out and recommended) and new concepts. Seven SWG meetings were held throughout the alternatives development and screening process to present potential solutions and their potential to address the Purpose and Need. Screening matrices were developed to justify advancing an alternative or removing it from consideration in the final Build packages, and ultimately, to select the preferred Build alternative. The screening matrices considered the following criteria:

- Right-of-way (RW) and utility impacts
- Safety impacts
- Operational impacts
- Bicycle and pedestrian accommodation
- Environmental impacts
- Preliminary cost of construction (high-level construction cost estimates categorized into low, medium, and high ranges)

The detailed alternatives development and screening process is documented in the *Alternatives Considered* chapter.

## Existing Conditions

### EXISTING ROADWAY NETWORK

The roadways within the study area vary from interstates to local facilities as described below:

***Interstate 64:*** I-64 is classified as an interstate and intersects with I-295, Route 288, and US 250 within the study area limits. It is a six-lane, divided roadway with three 12-foot lanes in each direction of travel separated by a variable-width, primarily grass median. There is an auxiliary lane in each direction on I-64 between the Route 288 and I-295 interchanges and between the US 250 and I-295 interchanges. I-64 is generally oriented in an east-west direction and has a posted speed limit of 65 mph through the US 250, I-295, and Route 288 interchanges. The posted speed limit on I-64 west of Route 288 is 70 mph. Based on the 2019 traffic data published by VDOT, the annual average daily traffic (AADT) for both directions of I-64 ranges from 57,000 vehicles per day west of the Route 288 interchange to 89,000 vehicles per day east of the US 250 interchange.

***Interstate 295:*** I-295 is classified as an interstate and intersects with I-64 and Route 695 (Nuckols Road) within the study area limits. It is a six-lane, divided roadway with three 12-foot lanes in each direction of travel separated by a variable-width grass median. Northbound and southbound I-295 are referred to as southwestbound and northeastbound I-295, respectively, for the remainder of this study due to the directionality of I-295 within the study area. The posted speed limit on I-295 is 70 mph. Based on the 2019 VDOT traffic data, the AADT for both directions of I-295 is 67,000 vehicles per day between the I-64 and Nuckols Road interchanges.

***Route 288:*** Route 288 is classified as an other freeway or expressway and intersects with US 250 and I-64 within the study area limits. It is a four-lane, divided roadway with two 12-foot lanes of travel in each direction separated by a variable-width grass median. The posted speed limit on Route 288 in the study area is 65 mph. Based on the 2019 VDOT traffic data, the AADT for both directions of Route 288 ranges from 47,000 vehicles per day north of the US 250 interchange to 54,000 vehicles per day south of the US 250 interchange.

***US 250:*** US 250 (West Broad Street) is classified as an other principal arterial. US 250 is a six-lane, divided facility with three 12-foot travel lanes in each direction separated by a curbed, primarily grass median. US 250 is generally oriented in an east-west direction within the study area with a posted speed limit of 45 mph. Based on the 2019 VDOT traffic data, the AADT for both directions of US 250 varies from 32,000 to 76,000 vehicles per day within the study area limits.

***N Gayton Road:*** N Gayton Road is classified as a major collector road and intersects US 250, Blue Ocean Lane, Bacova Drive, and Liesfeld Farm Drive within the study area. N Gayton Road is a six-lane, divided roadway with three 12-foot travel lanes in each direction of travel and a 16-foot raised concrete median of within the study area. N Gayton Road is generally oriented in a north-south direction with a posted speed limit of 45 mph. Based on the published 2019 VDOT traffic data, the AADT on N Gayton Road is 7,100 vehicles per day.

## INTERCHANGES

The study area for this IAR includes four full interchanges and one partial interchange, which are described in the following paragraphs.

### *I-64 at US 250*

I-64 at US 250 is a partial cloverleaf interchange that consists of three loop ramps and four directional ramps. The interchange is bound by commercial and office buildings in the northwest, northeast, and southeast quadrants. It is bound by commercial buildings and multifamily residential complexes in the southwest quadrant.

### *I-64 at I-295*

The I-64 at I-295 interchange is a three-leg directional interchange that consists of three two-lane directional ramps and one single-lane loop ramp. The interchange is bound by residential neighborhoods in the northwest and northeast quadrants. It is bound by commercial buildings to the south of the interchange.

### *I-64 at Route 288*

The I-64 at Route 288 interchange is a three-leg directional interchange that consists of four directional ramps. All four ramps at this interchange consist of two 12-foot lanes. The interchange is bound by commercial and multifamily residential buildings in the southeast quadrant and undeveloped land in the southwest quadrant and north of the interchange.

### *Route 288 at US 250*

The Route 288 at US 250 is a partial cloverleaf interchange that consists of two loop ramps and four directional ramps. The ramp terminal intersections were converted to signalized intersections in fall 2020. The interchange is bound by commercial and residential developments to the east and some undeveloped land to the west.

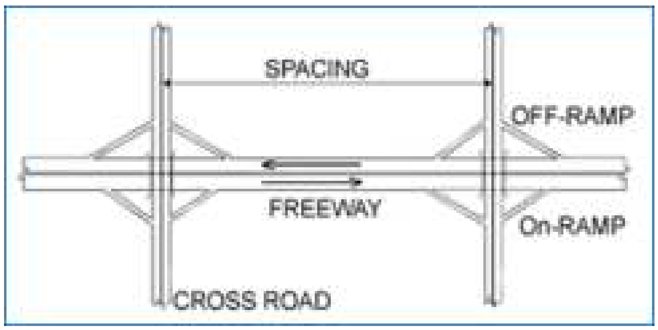
### *I-295 at Nuckols Road*

The I-295 at Nuckols Road interchange is a full cloverleaf interchange that consists of four directional ramps and four loop ramps. The study area for this IAR only includes two directional ramps in the traffic analysis study area: the southwestbound I-295 on-ramp from southbound Nuckols Road and the northeastbound I-295 off-ramp to southbound Nuckols Road.

### Interchange Spacing

According to the American Association of State Highway and Transportation Officials (AASHTO) Green Book, the general guidance for minimum interchange spacing on urban freeways is one mile. The FHWA TechBrief *Safety Assessment of Interchange Spacing on Urban Freeways* (Publication Number FHWA-HRT-07-031), defines interchange spacing as the distance between interchange crossroads as shown in *Figure 2.*

*Figure 2: Interchange Spacing Measurement*




Source: FHWA Techbrief "Safety Assessment of Interchange Spacing on Urban Freeways" (Publication Number: FHWA-HRT-07-031)

Existing interchange spacing between crossroads in the study area is summarized in *Table 2*. Two locations in the study area do not meet AASHTO's one-mile interchange spacing criterion: I-64 between the US 250 and I-295 interchanges, and Route 288 between the I-64 and US 250 interchanges.

*Table 2: Interchange Spacing*

| From | To | Interchange Spacing (miles) |
|---|---|---|
| **I-64** | | |
| Gaskins Rd | US 250 | 1.4 |
| US 250 | I-295 | 0.8 |
| I-295 | Route 288 | 2.8 |
| **Route 288** | | |
| I-64 | US 250 | 0.7 |
| **I-295** | | |
| I-64 | Nuckols Rd | 1.7 |

## LAND USE

The 2010 land use map for Henrico County is provided in *Appendix B*. The map shows that most parcels surrounding US 250 are designated for commercial/retail use. The 2026 land use map from the *Henrico County Vision 2026 Comprehensive Plan* is provided in *Appendix B* and shows additional parcels along the US 250 corridor zoned for commercial and urban mixed use. Much of the area surrounding I-64 in the study area is designated as multi-family or suburban residential on both existing and future maps.

The 2015 zoning use map for Goochland County is provided in *Appendix B*. The map shows most parcels around Route 288 and I-64 in the study area are designated for agriculture or industry. The 2035 land use map from the *Goochland County 2035 Comprehensive Plan* shows many of these parcels rezoned as commercial or prime economic development to accommodate the expected growth in this area of the county in future years. The future lane use map is provided in *Appendix B*.

## ALTERNATIVE TRAVEL MODES

Greater Richmond Transit Company (GRTC) is the primary transit and bus service provider operating in the study area. GRTC provides local service on US 250 with Route 19, which runs along US 250 from east of the study area limits to Bon Secours Parkway. Route 19 runs every 30 minutes in each direction during the AM and PM peak hours. As part of the *Interstate 64/664 Corridor Improvement Plan*, two additional GRTC express bus routes were funded through the Interstate Operations and Enhancement Program and provide access to Short Pump: one route from downtown Richmond and one route from the Willow Lawn area.

## EXISTING TRAFFIC DATA AND OPERATIONAL PERFORMANCE

Traffic operational analyses were conducted to evaluate the overall performance of the study corridors and intersections under existing AM and PM peak hour conditions. To maintain consistency with the previously completed studies adjacent to the study area, the existing analysis year for this study was 2019. The intent of the existing conditions analysis was to provide a general understanding of the baseline traffic conditions as a starting point for developing future improvement strategies. Existing conditions were modeled using Vissim 11. Existing conditions modeling inputs, assumptions, and results are described in detail in the following sections.

### Existing Traffic Volumes, Peak Hour Factors, and Heavy Vehicle Percentages

Turning movement counts (TMCs) and 48-hour video ramp counts were conducted as a part of the *Gaskins IMR, Parham IMR,* and *STARS US 250 Corridor Study*. Additional traffic counts were conducted on April 20, 2021, to supplement the traffic data collected in 2019 for the expanded roadway network used in this study. The additional locations included:

- N Gayton Road at Blue Ocean Lane (TMC)
- N Gayton Road at Bacova Drive (TMC)
- N Gayton Road at Liesfeld Farm Drive (TMC)
- Southwestbound I-295 on-ramp from southbound Nuckols Road (48-hour directional count)
- Northeastbound I-295 off-ramp to southbound Nuckols Road (48-hour directional count)

The raw traffic count data for all study area intersections, ramps and mainline locations can be found in *Appendix B*.

Based on direction provided in the *TOSAM*, the individual AM and PM peak hours for each intersection and ramp within the study were held constant throughout the analysis. The SWG determined in the framework document that the AM and PM peak hours would stay consistent with the previously completed *STARS US 250 Corridor Study*. The peak hours used for analysis were:

- AM Peak: 7:45 – 8:45 AM
- PM Peak: 5:00 – 6:00 PM

Balanced AM and PM peak hour traffic volumes are illustrated in *Figure 3*. AM and PM peak hour factors were calculated for each intersection based on guidance provided in the *TOSAM*. The AM and PM peak hour factors are illustrated in *Figure 4* and *Figure 5*, respectively.

All collected intersection, ramp, and mainline count data included vehicle classification information. The vehicle classification data was used to compute heavy vehicle percentages during the peak hours throughout the study area. Heavy vehicle percentages are shown in *Figure 4* and *Figure 5*.

### Existing Geometries, Lane Designations, and Speed Data

Existing intersection geometries, turn lane storage lengths, and posted speed limits were all confirmed by the study team on a field visit on April 24, 2019. A summary of the existing lane designations and turn lane storage lengths is illustrated in *Figure 6*. INRIX data provided by VDOT was used to obtain free-flow mainline travel speeds in both directions on I-64. During the field review, free-flow speeds observed in the field were comparable to the INRIX data.

*Figure 3: Existing (2019) Peak Hour Traffic Volumes*

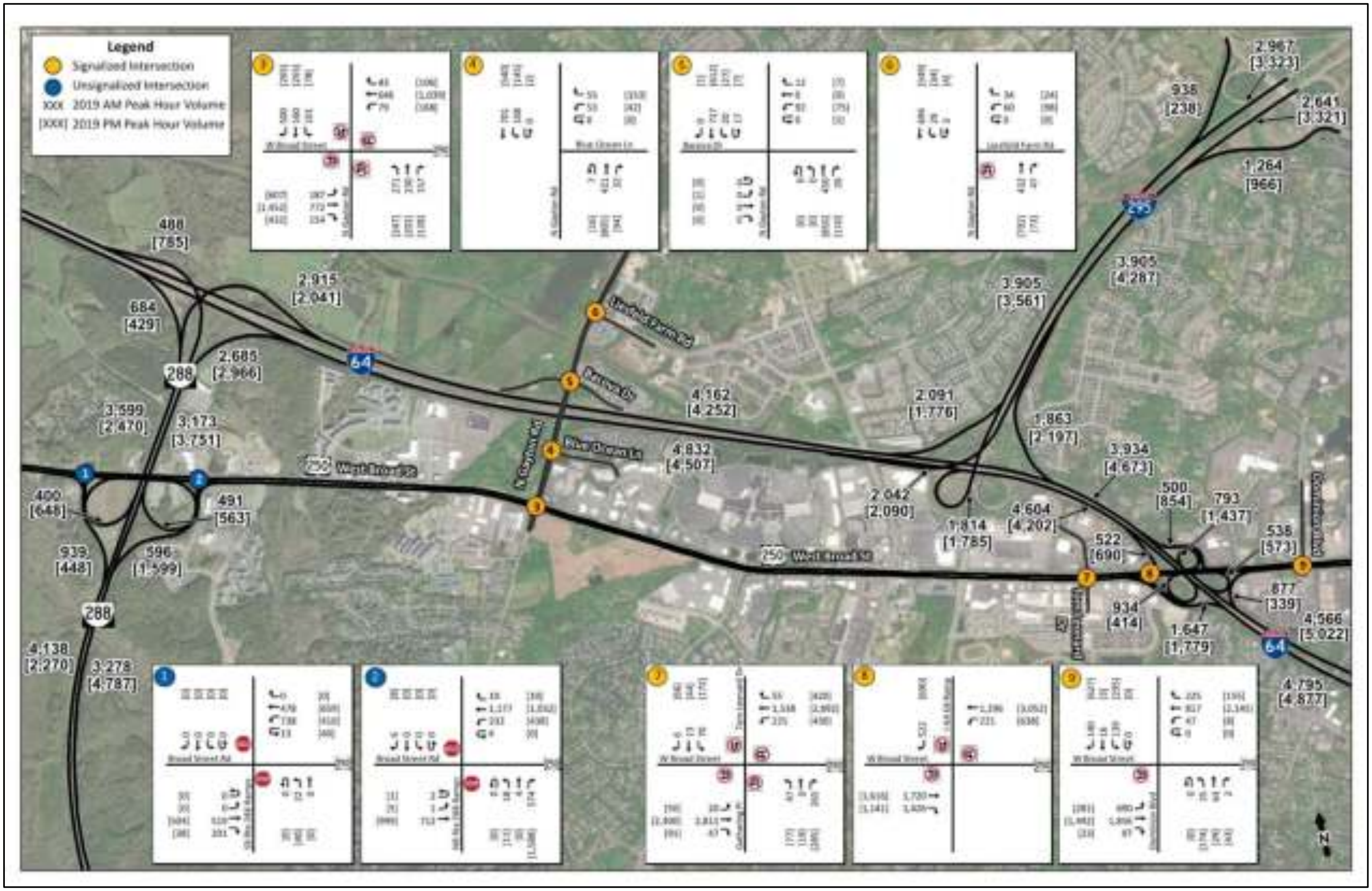


*Figure 4: Existing (2019) AM Peak Hour Factor and Heavy Vehicle Percentages*

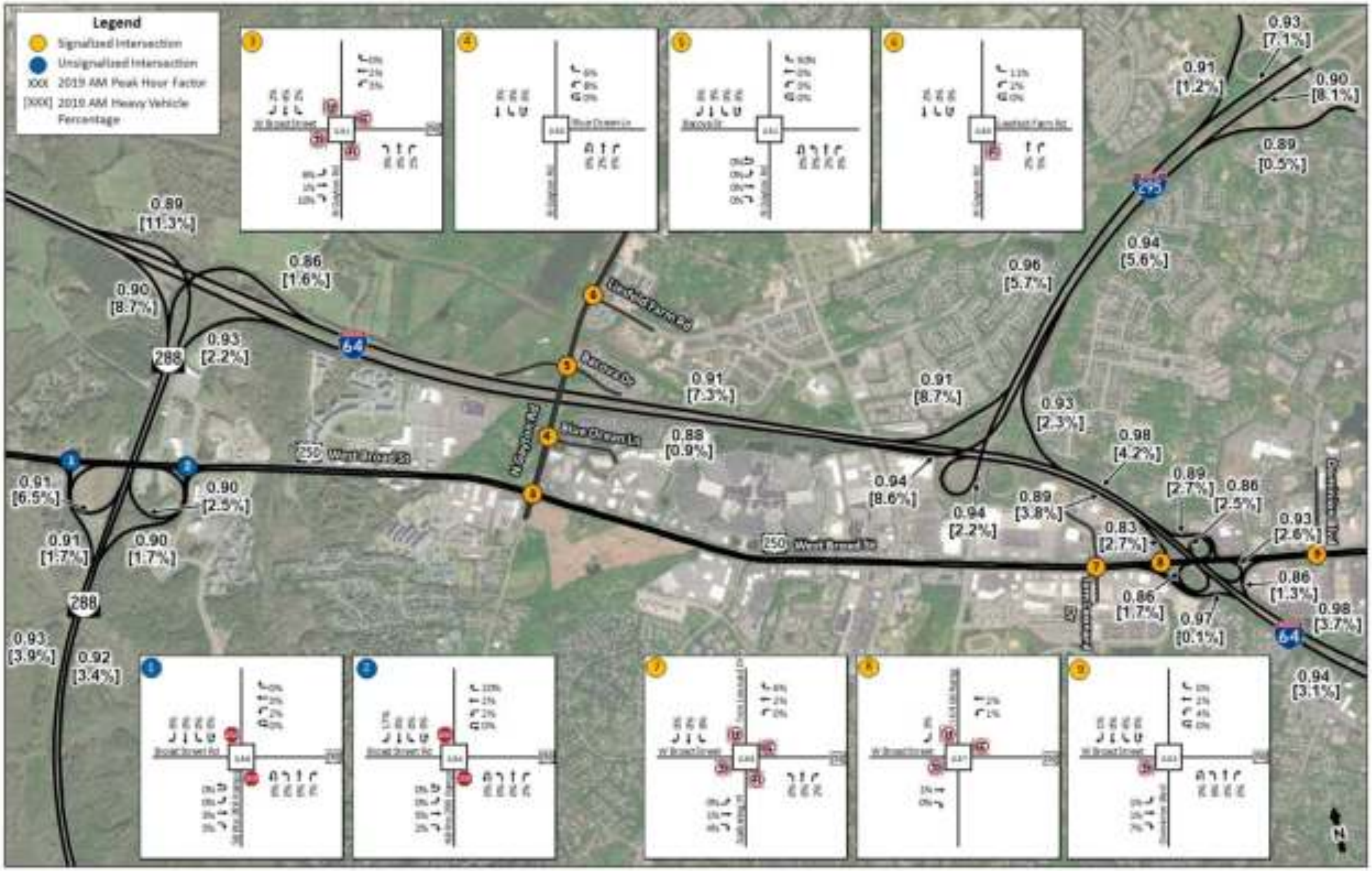


*Figure 5: Existing (2019) PM Peak Hour Factor and Heavy Vehicle Percentages*

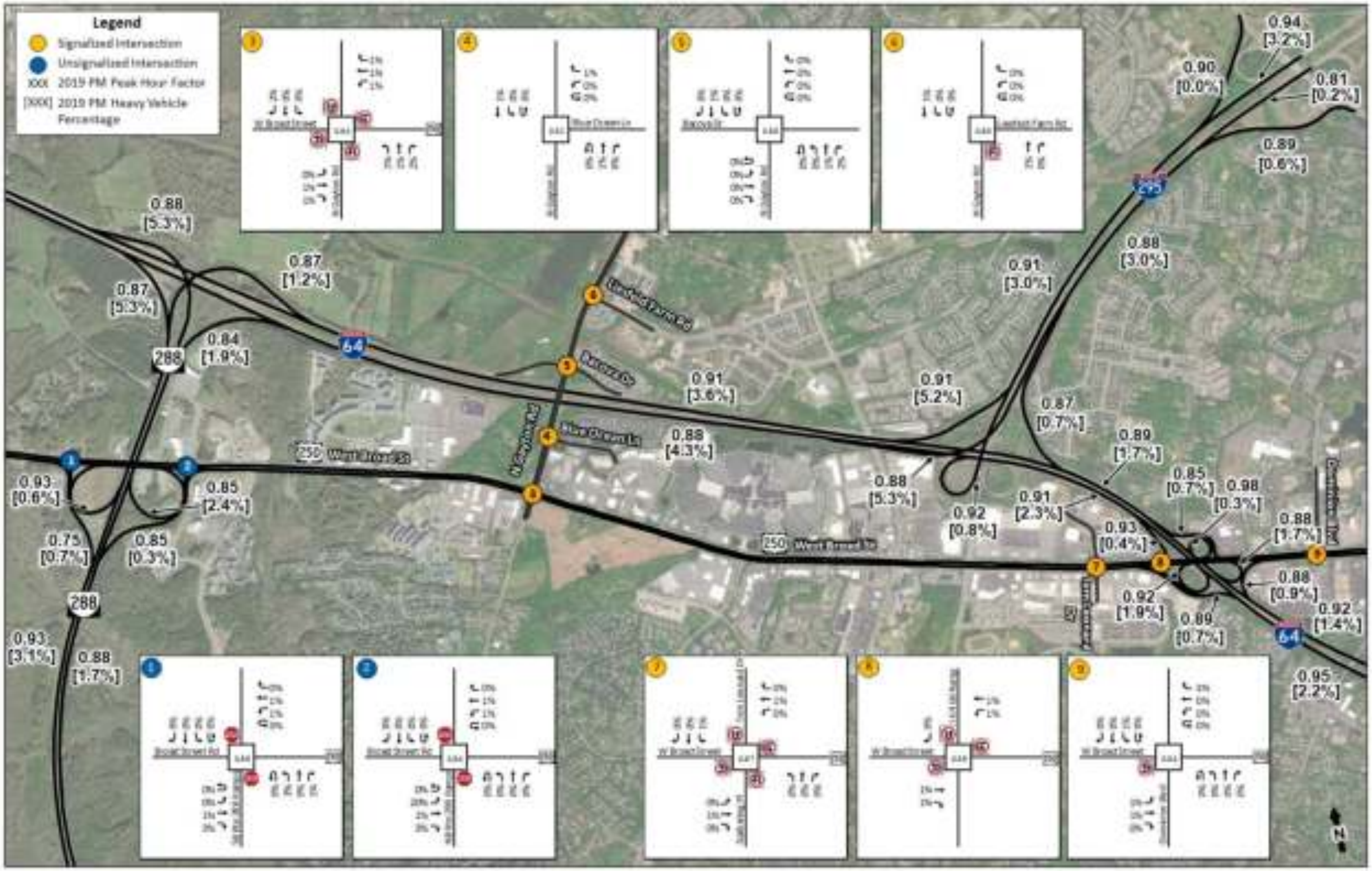
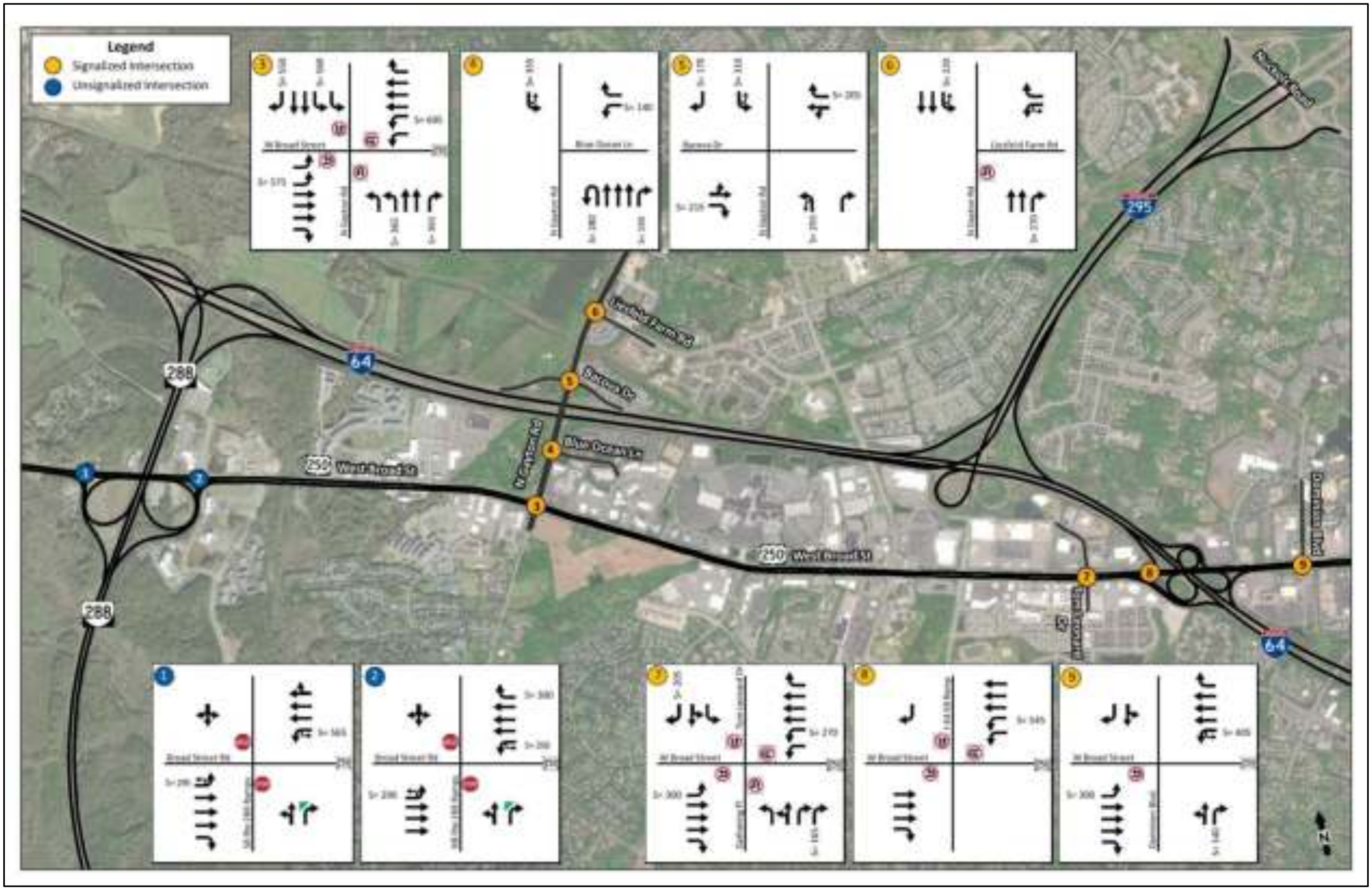


*Figure 6: Existing (2019) Geometrics and Lane Designations*



## Criteria for Evaluating Analysis Results

The criteria for reporting intersection and segment results for the Vissim analyses shown in *Table 3* were agreed upon for the *Gaskins IMR* and *Parham IMR* and were used for this IAR.

*Table 3: Criteria for Vissim Analyses*

| Color Scale | Intersection | Segments | |
|---|---|---|---|
| | Average Delay (sec/veh) | Average Density (veh/ln/mi) | Average Speed (mph) |
| (dark green) | ≤ 10 | ≤ 18 | > 60 |
| (light green) | > 10 - 20 | > 18 – 26 | > 50 – 60 |
| (yellow) | > 20 – 35 | > 26 – 35 | > 35 – 50 |
| (orange) | > 35 – 55 | > 35 – 45 | > 20 – 35 |
| (red) | > 55 | > 45 | > 20 |

## Existing Conditions Modeling Assumptions

The existing AM and PM Vissim models were developed based on a combination of collected data and visual observations from field review. Traffic volumes, travel times, and maximum queue lengths were used as calibration measures for this IAR to satisfy *TOSAM* requirements. A detailed summary of Vissim modeling inputs, assumptions, and calibration results is provided in *Appendix C*.

The VDOT Sample Size Determination Tool, Version 2.0 was used to determine the number of traffic simulation runs required to provide the acceptable 95th percentile confidence level for both the AM and PM models. The appropriate sample size for this study was determined using speed results from test locations throughout the study corridors. Based on the results of the Sample Size Determination Tool, the minimum of 10 traffic simulation runs were performed at a 95th percentile confidence level for the AM peak hour traffic simulation model. The PM peak hour model required 19 runs to be performed at a 95th percentile confidence level. The results from the Sample Size Determination Tool and the speed test locations are provided in *Appendix C*.

## Existing Conditions Freeway Analysis Results

The AM and PM peak hour average freeway segment density (vehicle per lane per mile) and speed (mph) are illustrated in *Figure 7* through *Figure 10*. Graphical representation of the freeway results by lane is included in *Appendix C*.

### *AM Peak Hour*

In the AM peak hour, all eastbound and westbound mainline I-64 segments operate with densities under 26 veh/ln/mi and speeds greater than 50 mph. The southwestbound I-295 off-ramp to eastbound I-64 operates with the worst density at 72 veh/ln/mi due to the demand of 1,814 vehicles in the peak hour on a single-lane loop ramp. The speeds slow to between 35 and 50 mph on southwestbound I-295 approaching I-64 due to the congestion on the single-lane loop ramp. The eastbound I-64 on-ramp from US 250 operates with a density of 58 veh/ln/mi where the ramp merges from two lanes to one lane prior to merging onto the interstate.

### *PM Peak Hour*

In the PM peak hour, most mainline I-64 segments in both directions operate with densities under 26 veh/ln/mi. Westbound I-64 operates with higher densities and slower speeds within and approaching the weaving segment at the US 250 interchange. The link density within this weaving segment reaches 45.1 veh/ln/mi while the speed slows to 29 mph. The increased density and reduced speed are attributed to congestion in the right through lane (63.6 veh/ln/mi; 23.2 mph) and the auxiliary lane (69.6 veh/ln/mi; 19.8 mph) that is caused by the high number of vehicles exiting to westbound US 250 and queuing from the signals on westbound US 250 that back up to the interstate as shown in *Figure 11*. The left two lanes on westbound I-64 within the weaving segment operate at 44 mph or higher with densities less than 32 veh/ln/mi. The maximum queue length on westbound I-64 extends approximately 3,500 feet from the gore for the westbound I-64 off-ramp to westbound US 250 to the Cox Road bridge as shown in *Figure 11*.

The southwestbound I-295 off-ramp to eastbound I-64 operates at a density of 54 veh/ln/mi due to the demand of 1,785 vehicles in the peak hour on a single-lane loop ramp. However, the high density and slower speed does not extend north on southwestbound I-295 like the AM peak hour. Southwestbound I-295 between the Nuckols Road interchange and the off-ramp to westbound I-64 operates at speeds above 60 mph.

Higher densities also occur on the following ramps: eastbound I-64 on-ramp from Northbound Route 288, westbound I-64 off-ramp to northeastbound I-295, westbound I-64 on-ramp from westbound US 250, and eastbound I-64 on-ramp from eastbound US 250.

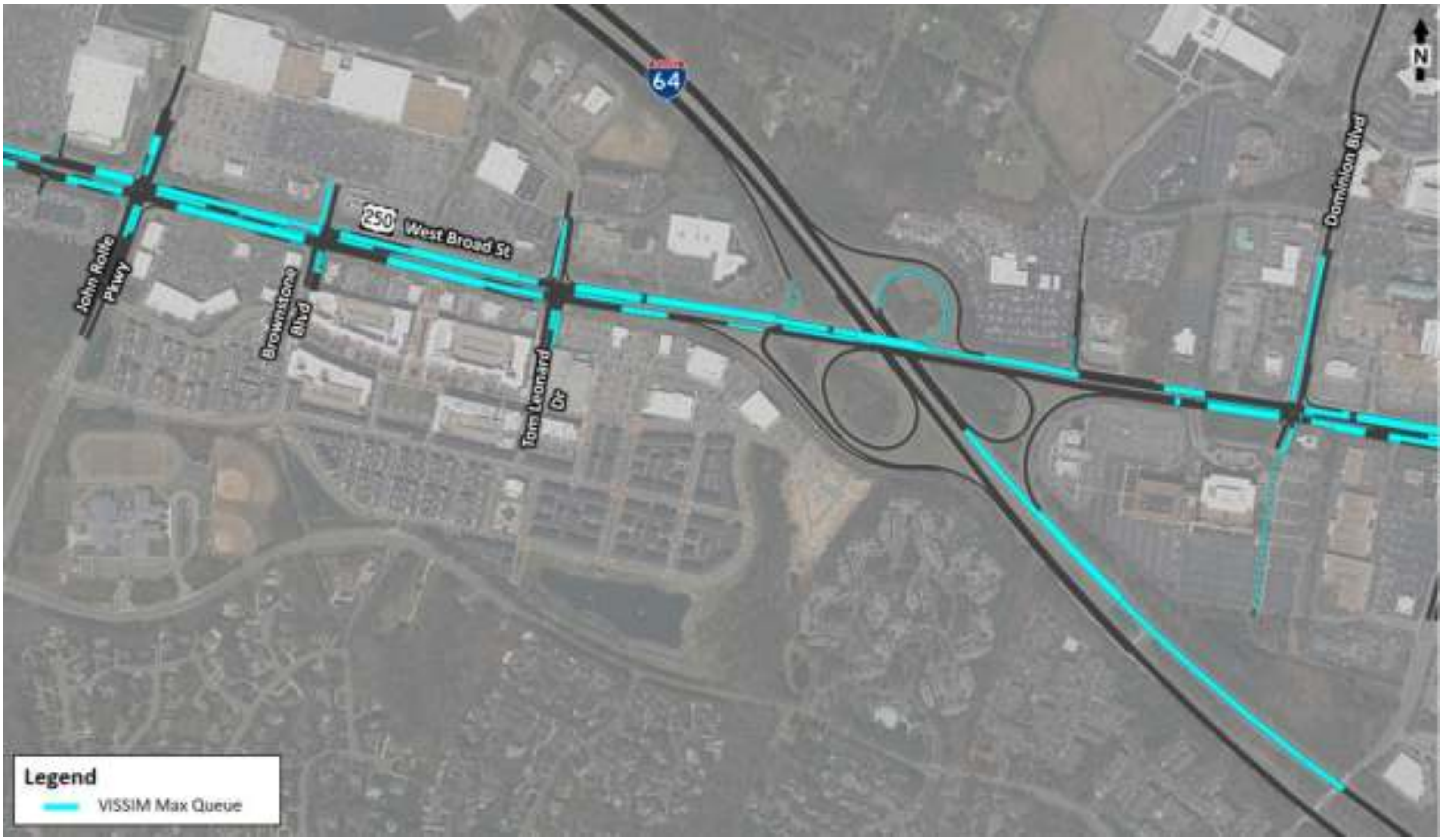
*Figure 7: Existing (2019) AM Peak Hour Average Densities*

*Figure 8: Existing (2019) AM Peak Hour Average Speeds*

*Figure 9: Existing (2019) PM Peak Hour Average Densities*

*Figure 10: Existing (2019) PM Peak Hour Average Speeds*

Figure 11: Existing (2019) PM Peak Hour Maximum Queue Lengths



### Existing Conditions Intersection Analysis Results

Graphical representation of the average intersection delay (seconds per vehicle) by movement and maximum queue (feet) by movement are shown in *Figure 12* through *Figure 15*.

#### *AM Peak Hour*

In the AM peak hour, all intersections operate with overall acceptable delays. The intersection of US 250 and Dominion Boulevard operates with the highest overall intersection delay of 31.4 seconds per vehicle. All left turn movements at the intersection operate with delays of 49.9 seconds per vehicle or greater. The maximum queue length for the eastbound left-turn movement extends 1,000 feet, which is beyond the storage capacity of the left-turn lane and past the terminal of the westbound I-64 off-ramp. This queue contributes to slow speeds on the ramp since there is no restriction to vehicles on this off-ramp accessing the left turn.

All left turn movements at the intersection of US 250 and N Gayton Road operate with delays of 57.7 seconds per vehicle or greater, but the total intersection operates with 29.8 seconds per vehicle. At the intersection of US 250 and Tom Leonard Drive, all left-turn movements operate with delays of 53.4 seconds per vehicle or greater. At the unsignalized intersection of US 250 and the southbound Route 288 on-ramp, the westbound left turn queue extends 1,065 feet and spills back into the through lanes on westbound US 250.

#### *PM Peak Hour*

In the PM peak hour, the intersection of US 250 and Dominion Boulevard operates with the highest overall intersection delay of 38.3 seconds per vehicle. The northbound approach, eastbound left-turn movement, and southbound left-turn movement all operate with delays of 71.2 seconds or greater.

The intersection of US 250 and Tom Leonard Drive operates with an overall intersection delay of 30.4 seconds per vehicle. All left-turn movements at the intersection operate with 59.4 seconds of delay or greater. The westbound queues at the intersection extend back to the upstream intersection at the on-ramps to eastbound I-64 and through the I-64 interchange, impacting the operations of the two I-64 off-ramps as shown in *Figure 11*.

At the intersection of US 250 and N Gayton Road, all left-turn movements operate with delays of 64.6 seconds per vehicle or greater. The eastbound left-turn queue extends 685 feet and spills back into the through lanes on eastbound US 250.

*Figure 12: Existing (2019) AM Peak Hour Intersection Delay*

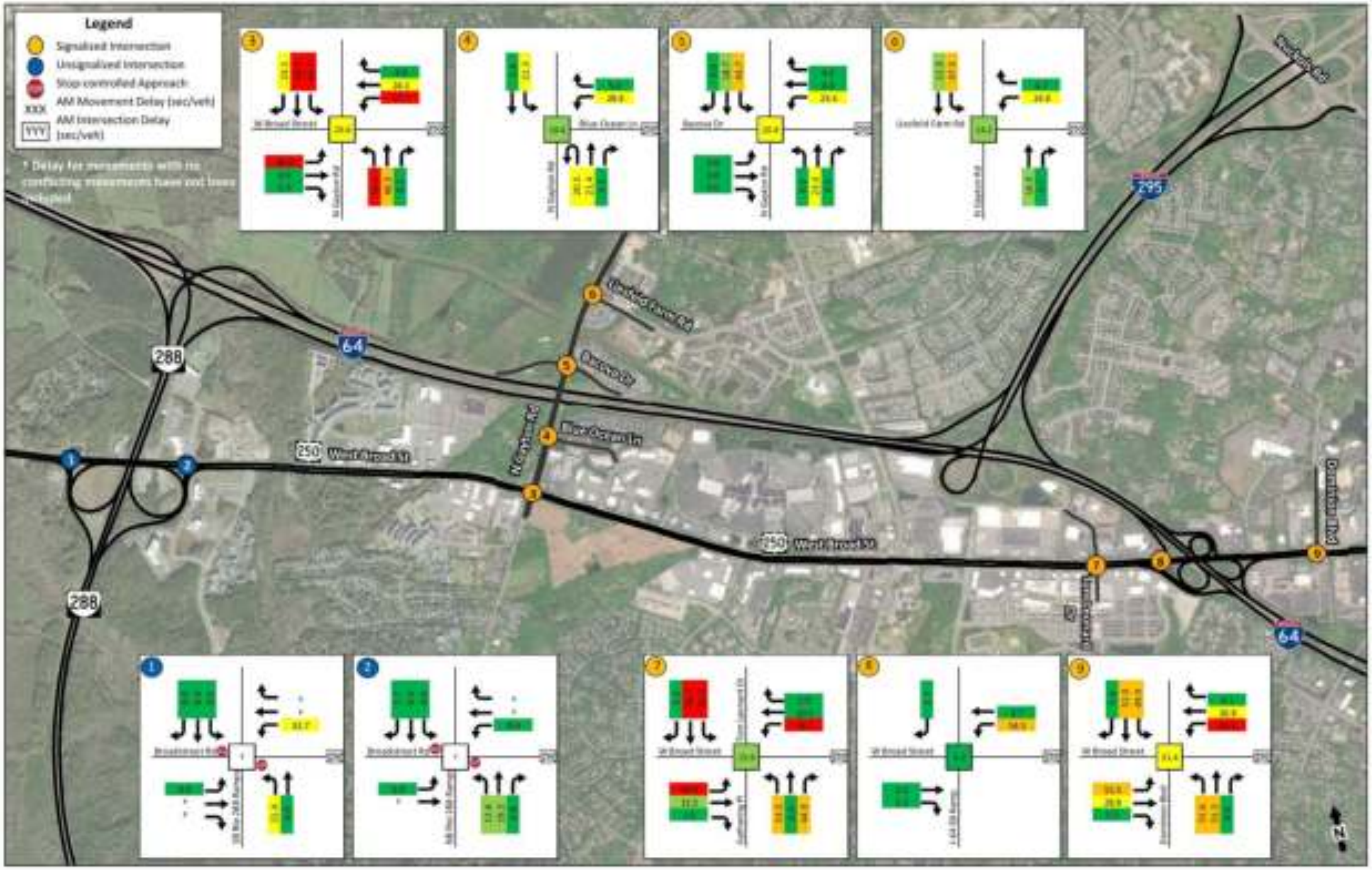


*Figure 13: Existing (2019) AM Peak Hour Maximum Queue Length*

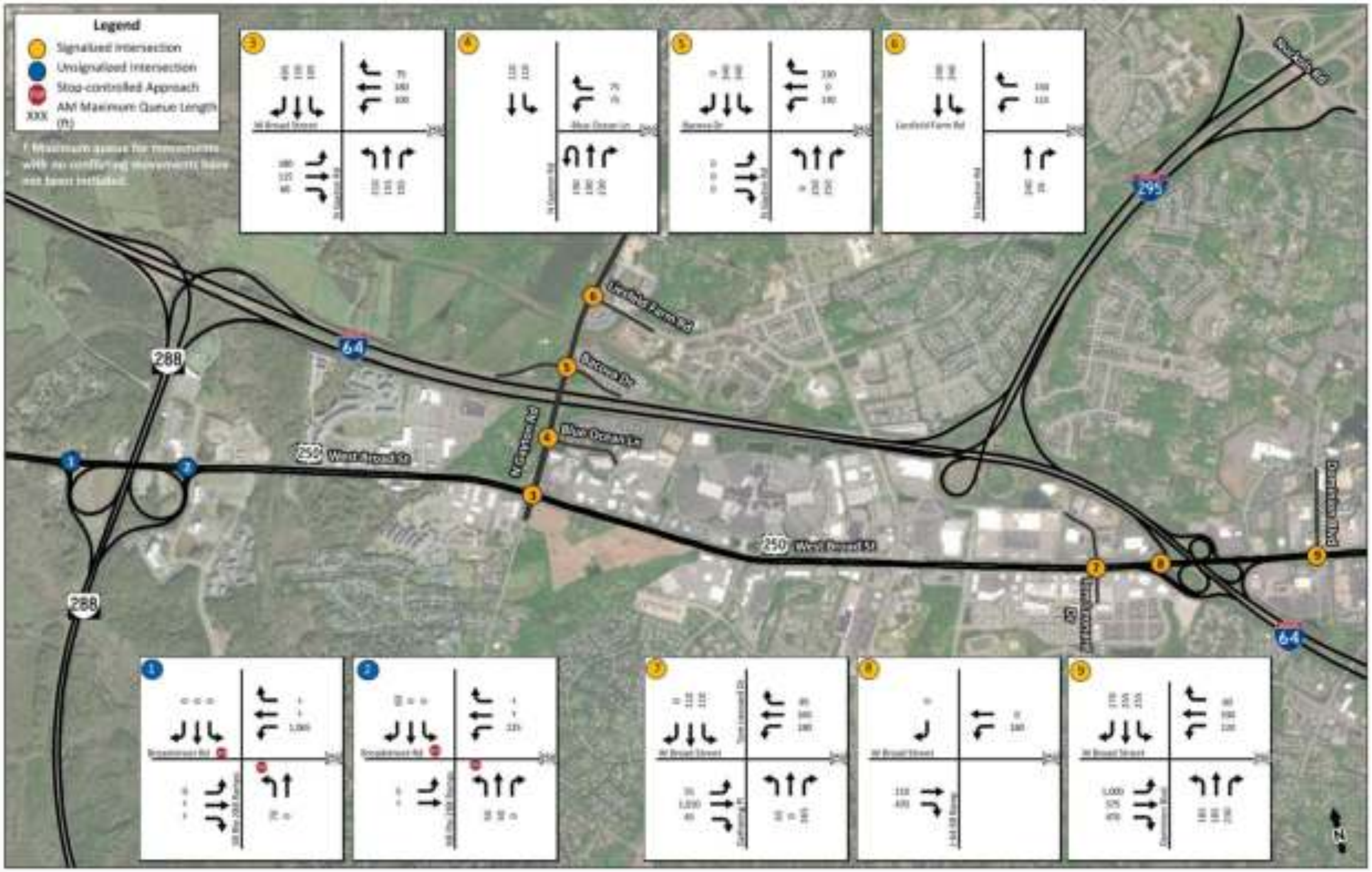


*Figure 14: Existing (2019) PM Peak Hour Intersection Delay*

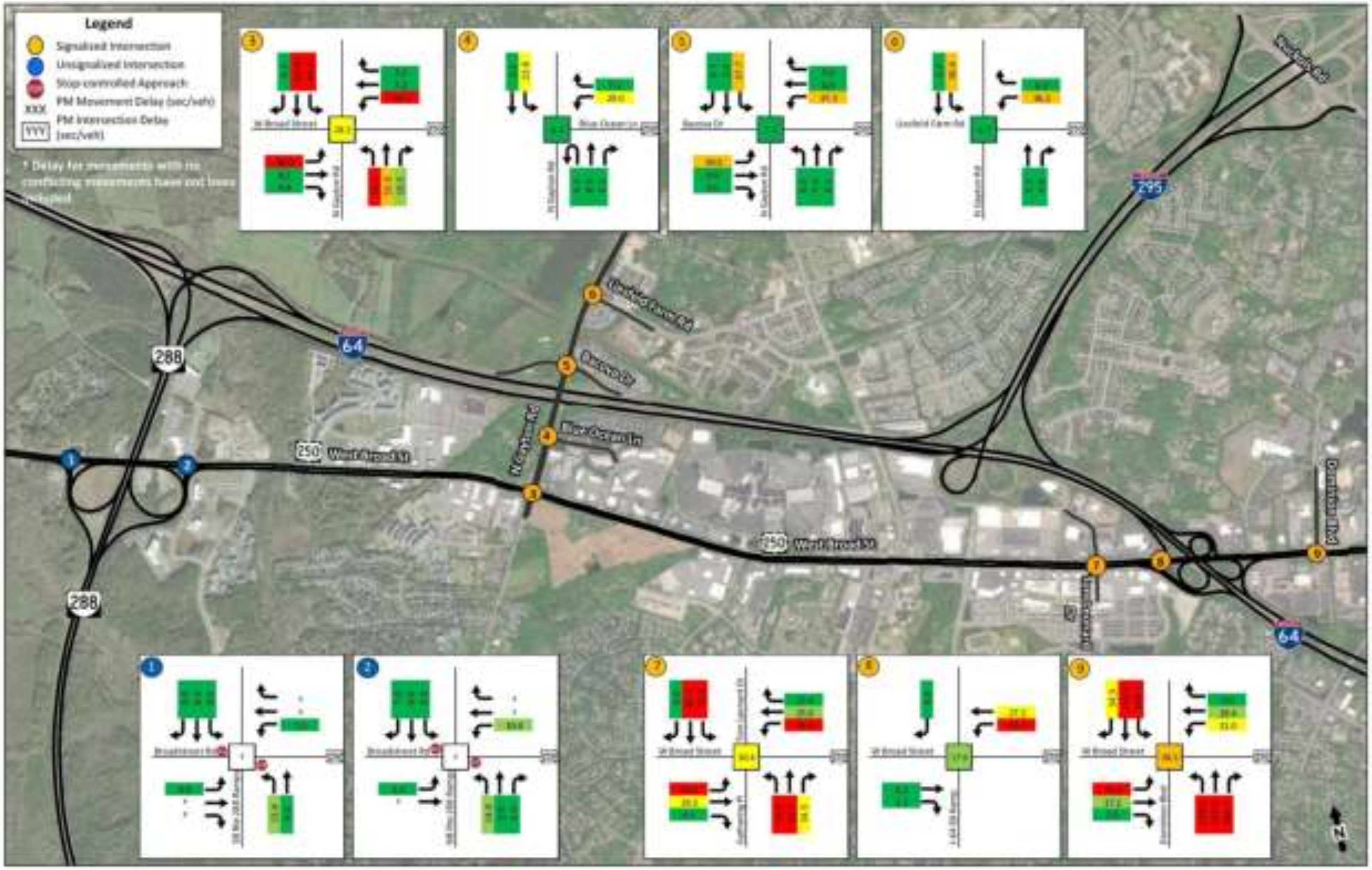
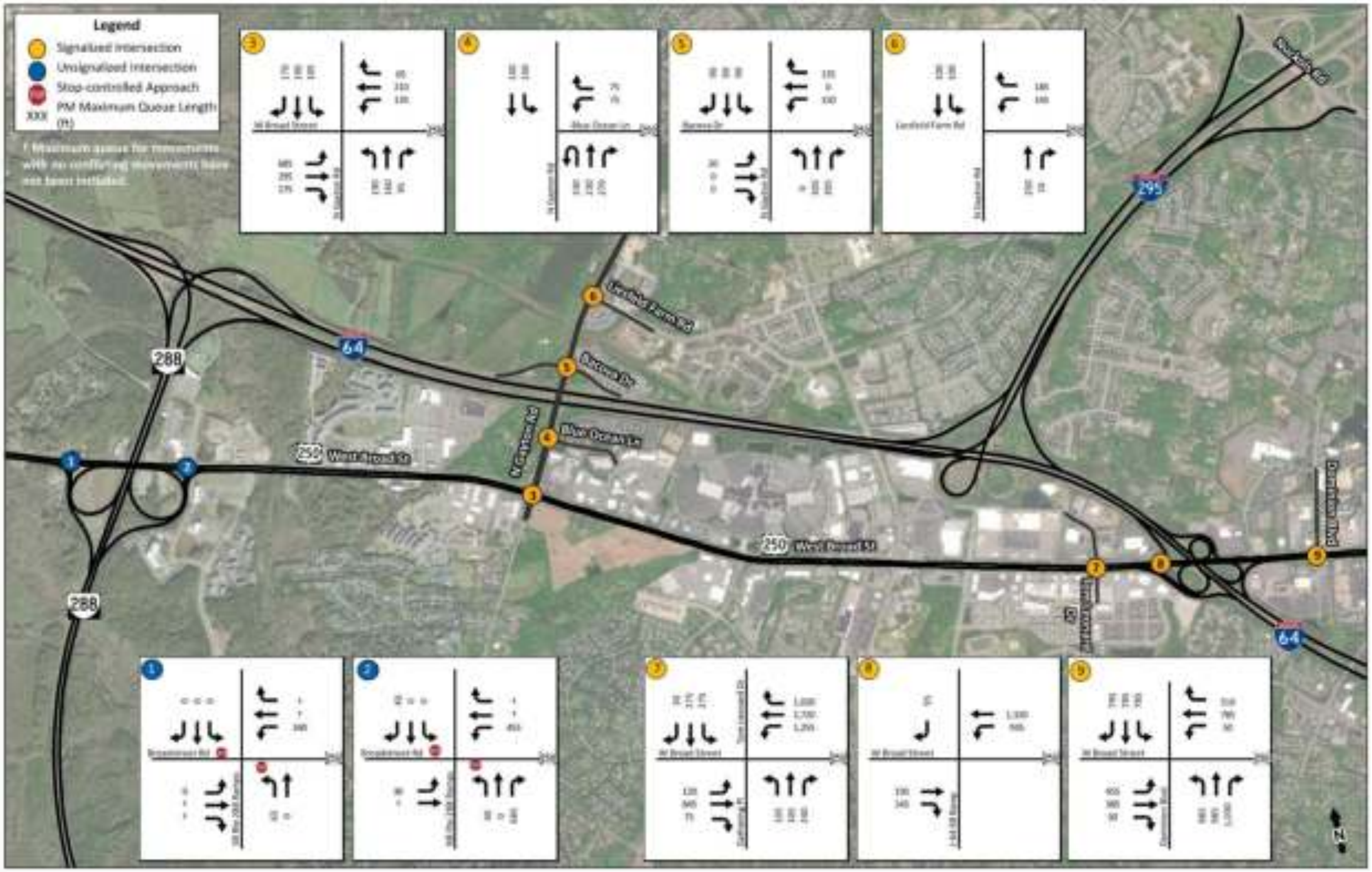


*Figure 15: Existing (2019) PM Peak Hour Maximum Queue Length*



## EXISTING SAFETY DATA AND IDENTIFICATION OF PROBLEM AREAS

A crash analysis was conducted to review and document crash patterns and trends within the study area roadway network. To remain consistent with the analysis year for the existing conditions Vissim analyses, the five years of crash data between January 1, 2015, and December 31, 2019, were obtained from the VDOT Traffic Engineering Division (TED) Roadway Network System (RNS) database. The crash analysis was completed at the nine study area intersections and along the following freeway segments:

- Eastbound and westbound I-64 from east of the US 250 interchange to the Ashland Road interchange
- Northbound and southbound Route 288 from the Tuckahoe Creek Parkway interchange to the I-64 interchange
- Northeastbound and southwestbound I-295 from the I-64 interchange to the Nuckols Road interchange

The existing crash analysis did not include any interchange ramps within the study area.

VDOT Traffic Engineering Division (TED) performed a network screening analysis based on *Highway Safety Manual* (*HSM*) methodology to rank intersection and roadway segments throughout the state based on each site's potential for safety improvement (PSI). PSI is an indication of how much the long-term crash frequency could be reduced at a particular site and is based on Virginia-specific safety performance functions (SPFs). TED releases the ranks for the top 100 VDOT-maintained intersections and the top 100 miles of VDOT-maintained roadway segments within each district.

*Table 4* summarizes the segments within the study area or on US 250 within the modeling area that were in the top 100 miles of segments in Richmond District based on 2016-2020 crash data. Segments are ranked based on the cumulative mileage of segments (e.g., two segments can be ranked in the top mile if the highest-ranking segment is shorter than one mile). None of the study area intersections were ranked in the top 100 within Richmond District. However, the following intersections on US 250 are within the modeling area and rank in the top 100 intersections within Richmond District.

- US 250 at Brownstone Boulevard (1)
- US 250 at Pouncey Tract Road (9)
- US 250 at Cox Road (83)
- US 250 at Lauderdale Road (98)

*Table 4: Study Area PSI Segments*

| Location | Length (mi) | 2016-2020 PSI Rank* |
|---|---|---|
| Westbound I-64 between the off-ramp to eastbound US 250 and the on-ramp from westbound US 250 | 0.34 | 7 |
| Eastbound I-64 at the acceleration lane for the on-ramp from US 250 | 0.172 | 53 |
| Northbound Route 288 between the off-ramp to US 250 and the on-ramp from US 250 | 0.22 | 100 |
| US 250 between Mills Road and the northbound Route 288 ramps | 0.57 | 43 |
| US 250 between Wilkes Ridge Parkway and Robert Atack Way | 0.43 | 16 |
| US 250 between Robert Atack Way and Cabela Drive | 0.16 | 75 |
| US 250 between Cabela Drive and N Gayton Road | 0.37 | 26 |
| US 250 between N Gayton Road and Towne Center West Boulevard | 0.23 | 56 |
| US 250 between Towne Center West Boulevard and private driveway | 0.14 | 78 |
| US 250 between private driveway and Lauderdale Drive | 0.35 | 46 |
| US 250 between Westgate Parkway and Spring Oak Drive | 0.15 | 30 |
| US 250 between Spring Oak Drive and Pouncey Tract Road | 0.24 | 8 |
| US 250 between Pouncey Tract Road and John Rolfe Parkway | 0.24 | 1 |
| US 250 between John Rolfe Parkway and Brownstone Boulevard | 0.18 | 2 |
| US 250 between Brownstone Boulevard and Tom Leonard Drive | 0.21 | 2 |
| US 250 between Tom Leonard Drive and the eastbound US 250 ramp to eastbound I-64 | 0.21 | 3 |
| US 250 between the eastbound US 250 ramp to eastbound I-64 and the eastbound US 250 ramp to westbound I-64 | 0.29 | 3 |
| US 250 between the eastbound US 250 ramp to westbound I-64 and Dominion Boulevard | 0.25 | 7 |
| US 250 between Dominion Boulevard and Cox Road | 0.21 | 14 |

*Mile rank for VDOT-maintained roads within Richmond District

### Existing Mainline Freeway Crash Summary

Over the five-year crash period, there were 579 crashes on the freeways in the study area. Of the reported crashes on the freeways, there were 2 fatal injury crashes, 162 injury crashes, and 415 crashes involving property damage only. *Table 5* through *Table 9* provide summaries of the crashes on freeways in the study area by year, severity, crash type, time of day, and weather condition. Crash severity is coded using the KABCO scale, which is defined using the following classifications:

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

Crashes were fairly evenly distributed across the five-year period, except for a decrease in crashes in 2017. Generally, crashes on westbound I-64 were higher in 2015 and 2016, while crashes on southwestbound I-295 and southbound Route 288 were higher in 2017 through 2019. Rear end crashes constitute 48 percent of all freeway crashes within the study area, but only 23 percent of all crashes on eastbound I-64. The lower percentage of rear end crashes on eastbound I-64 is likely because there is no significant bottleneck on eastbound I-64 within the study area. Conversely, the percentage of rear end crashes on westbound I-64 (59 percent), southwestbound I-95 (56 percent), and northbound Route 288 (69 percent) all exceed 50 percent rear end crashes.

*Table 5: Freeway Crash Summary by Year (2015 - 2019)*

| Route | Number of Crashes | | | | | |
|---|---|---|---|---|---|---|
| | 2015 | 2016 | 2017 | 2018 | 2019 | Total |
| Eastbound I-64 | 31 | 39 | 25 | 25 | 42 | 162 |
| Westbound I-64 | 65 | 58 | 41 | 49 | 36 | 249 |
| Southwestbound I-295 | 7 | 7 | 10 | 15 | 15 | 54 |
| Northeastbound I-295 | 9 | 2 | 2 | 9 | 4 | 26 |
| Northbound Route 288 | 5 | 10 | 9 | 7 | 14 | 45 |
| Southbound Route 288 | 3 | 4 | 12 | 13 | 11 | 43 |
| **Total** | **120** | **120** | **99** | **118** | **122** | **579** |

*Table 6: Freeway Crash Summary by Severity (2015 - 2019)*

| Route | Number of Crashes | | | | | |
|---|---|---|---|---|---|---|
| | K | A | B | C | PDO | Total |
| Eastbound I-64 | 1 | 11 | 31 | 0 | 119 | 162 |
| Westbound I-64 | 1 | 10 | 54 | 12 | 172 | 249 |
| Southwestbound I-295 | 0 | 2 | 10 | 1 | 41 | 54 |
| Northeastbound I-295 | 0 | 3 | 5 | 2 | 16 | 26 |
| Northbound Route 288 | 0 | 2 | 7 | 1 | 35 | 45 |
| Southbound Route 288 | 0 | 1 | 8 | 2 | 32 | 43 |
| **Total** | **2** | **29** | **115** | **18** | **415** | **579** |

*Table 7: Freeway Crash Summary by Crash Type (2015 - 2019)*

| Route | Number of Crashes | | | | | | |
|---|---|---|---|---|---|---|---|
| | Rear End | Angle | Sideswipe | Fixed Object | Deer | Other | Total |
| Eastbound I-64 | 37 | 14 | 17 | 70 | 4 | 20 | 162 |
| Westbound I-64 | 147 | 16 | 24 | 51 | 3 | 8 | 249 |
| Southwestbound I-295 | 30 | 2 | 9 | 10 | 2 | 1 | 54 |
| Northeastbound I-295 | 13 | 0 | 2 | 7 | 1 | 3 | 26 |
| Northbound Route 288 | 31 | 3 | 2 | 7 | 2 | 0 | 45 |
| Southbound Route 288 | 19 | 1 | 2 | 15 | 6 | 0 | 43 |
| **Total** | **277** | **36** | **56** | **160** | **18** | **32** | **579** |

*Table 8: Freeway Crash Summary by Time of Day (2015 - 2019)*

| Route | Number of Crashes | | | |
|---|---|---|---|---|
| | AM Peak Period (6-10 AM) | PM Peak Period (3-7 PM) | Off Peak | Total |
| Eastbound I-64 | 47 | 35 | 80 | 162 |
| Westbound I-64 | 40 | 104 | 105 | 249 |
| Southwestbound I-295 | 16 | 23 | 15 | 54 |
| Northeastbound I-295 | 12 | 7 | 7 | 26 |
| Northbound Route 288 | 12 | 26 | 7 | 45 |
| Southbound Route 288 | 17 | 10 | 16 | 43 |
| **Total** | **144** | **205** | **230** | **579** |

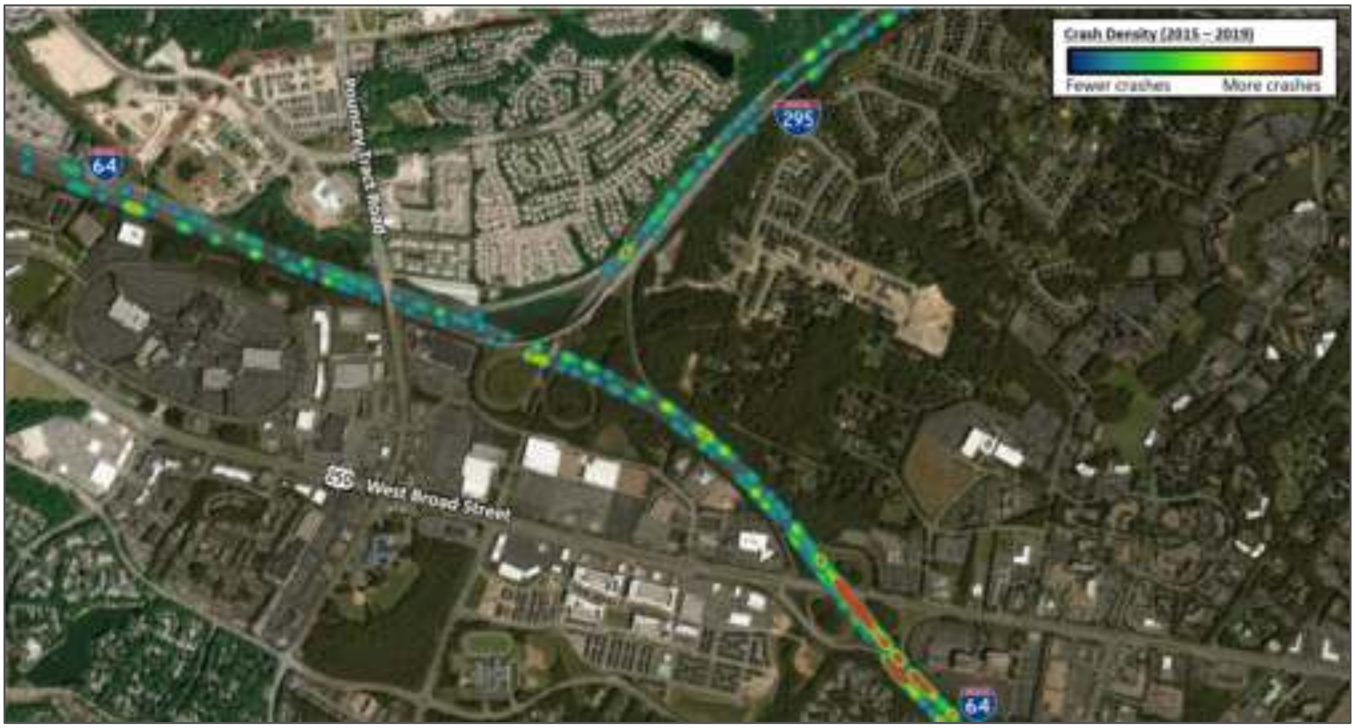
Table 9: Freeway Crash Summary by Weather Condition (2015 - 2019)

| Route | Number of Crashes | | | | | | |
|---|---|---|---|---|---|---|---|
| | Clear/Cloudy | Fog | Mist | Rain | Snow | Sleet/Hail | Total |
| Eastbound I-64 | 104 | 3 | 2 | 47 | 3 | 3 | 162 |
| Westbound I-64 | 185 | 0 | 2 | 52 | 9 | 1 | 249 |
| Southwestbound I-295 | 43 | 0 | 0 | 9 | 2 | 0 | 54 |
| Northeastbound I-295 | 19 | 0 | 0 | 5 | 1 | 1 | 26 |
| Northbound Route 288 | 39 | 1 | 1 | 4 | 0 | 0 | 45 |
| Southbound Route 288 | 29 | 0 | 1 | 13 | 0 | 0 | 43 |
| **Total** | **419** | **4** | **6** | **130** | **15** | **5** | **579** |

*Figure 16* and *Figure 17* show the density of total crashes along the corridors for 2015-2019. The following paragraphs document crash trends for the hot spots identified in the density maps, which correlate with the PSI segments identified in *Table 4* that were based 2016-2020 data.

Figure 16: Freeway Crash Density Summary (2015 – 2019) (1)

Figure 17: Freeway Crash Density Summary (2015 – 2019) (2)




### *Westbound I-64 Within and Approaching the US 250 Interchange*

Westbound I-64 within the US 250 interchange was identified as the highest freeway crash density location within the study area. This segment ranks in the top 7 miles of VDOT-maintained roadways in Richmond District for PSI as shown in *Table 4*. Crashes in this location are mostly congestion-related and are attributed to the queuing on the interstate during the PM peak period. The existing maximum queue length in 2019 extends approximately 3,500 feet from the gore for the westbound I-64 off-ramp to westbound US 250 to the Cox Road bridge. This queue is caused by congestion on westbound US 250 that backs up to the interstate and friction associated with vehicles weaving and changing lanes in advance of the freeway weaving segment.

Figure 18: Westbound I-64 at US 250 Interchange Crash Type Summary (2015 – 2019)


Between 2015 and 2019, 155 crashes occurred on westbound I-64 over the limits of the PM maximum queue. The crashes were much more predominant in the afternoon as 57 percent of crashes occurred between 3:00 and 7:00 PM and 26 percent occurred during the PM peak hour between 5:00 and 6:00 PM. Both percentages are higher than the average for urban interstates throughout the state for the same years: 42 percent from 3:00 to 7:00 PM and 9 percent from 5:00 to 6:00 PM. The crashes were also predominantly rear ends as 84 percent of all crashes, 92 percent of crashes from 3:00 to 7:00 PM and 100 percent of crashes from 5:00 to 6:00 PM were rear ends. *Figure 18* illustrates the number of rear end crashes for this section of westbound I-64. The high percentage of rear end crashes point to the safety hot spot being attributable to the bottleneck in this area.

### *Eastbound I-64 On-Ramp from US 250*

Eastbound I-64 at the on-ramp from US 250 ranks in the top 53 miles of VDOT-maintained roadways in Richmond District for PSI as shown in *Table 4*. Crashes in this area predominantly occur in wet or icy conditions and most involve a roadway departure. Of the 31 crashes between 2015 and 2019 shown in *Figure 19*, 77 percent occurred in wet or icy conditions and 74 percent involved a roadway departure.

### *Northbound Route 288 within US 250 Interchange*

Northbound Route 288 within the US 250 interchange ranks in the top 100 miles of VDOT-maintained roadways in Richmond District for PSI as shown in *Table 4*. Crashes in this location are mostly congestion-related and attributed to slower speeds on Route 288 during the PM peak period as vehicles preposition in the right lane in advance of the exit to eastbound I-64. Between 2015 and 2019, 23 crashes occurred over the 1,500 feet between the off-ramp to US 250 and the on-ramp from US 250 as shown in *Figure 20*. Rear end crashes constituted 74 percent of crashes in this area. Rear end crashes between 5:00 and 6:00 PM constituted 39 percent of crashes in this area.

*Figure 19: Eastbound I-64 at US 250 Interchange Roadway Condition Crash Summary (2015 – 2019)*


*Figure 20: Route 288 at US 250 Interchange Crash Type Summary (2015 – 2019)*

### Existing Intersection Crash Summary

Over the five-year crash period, 626 crashes occurred within the influence areas of the nine study area intersections. The influence area for each intersection generally extended to the back of tapers for turn lanes on each approach. The study team reviewed crash descriptions for those crashes outside the original influence area and extended the influence area as necessary to include additional intersection-related crashes (e.g., to capture a pattern of rear end crashes that extended beyond the back of taper).

Approximately seventy percent of all intersection crashes that occurred at the study area intersections resulted in property damage only. One fatal crash occurred at an intersection in the study area during the analysis period, at the intersection of US 250 and the southbound Route 288 ramps. This fatal crash was an angle crash that occurred in 2019. A traffic signal was installed at this intersection and the intersection of US 250 and the northbound Route 288 ramps in 2020. *Table 10* summarizes 2015-2019 crashes by severity at each study area intersection. The signalized intersections on US 250 at Tom Leonard Drive, Dominion Boulevard, and the eastbound I-64 on-ramp had the most crashes in the five-year analysis period.

*Table 10: Intersection Crash Summary by Severity (2015 - 2019)*

| Intersection | Number of Crashes by Severity | | | | | |
|---|---|---|---|---|---|---|
| | K | A | B | C | PDO | Total |
| US 250 at Dominion Boulevard | 0 | 4 | 27 | 4 | 58 | 93 |
| US 250 at Eastbound I-64 On-Ramp | 0 | 2 | 22 | 4 | 62 | 90 |
| US 250 at Tom Leonard Drive | 0 | 0 | 48 | 10 | 211 | 269 |
| US 250 at N Gayton Road | 0 | 1 | 11 | 1 | 35 | 48 |
| N Gayton Road at Blue Ocean Road | 0 | 0 | 0 | 0 | 9 | 9 |
| N Gayton Road at Bacova Drive | 0 | 0 | 5 | 0 | 6 | 11 |
| N Gayton Road at Liesfeld Farm Road* | 0 | 0 | 0 | 0 | 2 | 2 |
| US 250 at Northbound Route 288 Ramps | 0 | 4 | 8 | 8 | 18 | 38 |
| US 250 at Southbound Route 288 Ramps | 1 | 6 | 7 | 18 | 16 | 48 |
| **Total** | **1** | **17** | **128** | **45** | **417** | **608** |

**The intersection of N Gayton Road and Liesfeld Farm Road was constructed as an unsignalized intersection in 2016. It was converted to a signalized intersection in 2017.*

The predominant crash type at study area intersections was rear ends, which accounted for 57 percent of all crashes at intersections. Rear end crashes constituted 77 percent of all crashes at the intersection of US 250 and Tom Leonard Drive and over 40 percent of the rear end crashes occurred between 3:00 and 7:00 PM. The pattern of rear end crashes during the PM peak period can be attributed to the congestion and queuing at this intersection. Angle crashes were the second most-frequent crash type, accounting for 26 percent of all crashes at intersections. However, 40 percent of all angle crashes occurred at the US 250 intersections with the northbound or southbound Route 288 ramps. Both intersections were signalized in 2020, which should mitigate the number of angle crashes in future years. One crash involving a pedestrian occurred in the study area during the five-year analysis period at the intersection of US 250 and Dominion Boulevard. A summary of the crash types at each intersection can be found in *Appendix D*.

# Alternatives Considered

## NO-BUILD ALTERNATIVE

Traffic operational and safety analyses were conducted to evaluate the overall performance of the study area using forecasted traffic volumes in the opening and design years. The development of future traffic volumes used in the No-Build analyses can be found in the *Forecasted Traffic Volumes and Operations* section of the report.

### Background Improvements

Funded transportation projects within the study area were included in the No-Build models provided that the improvements were projected to open before the analysis year. All known funded transportation projects in the study area were projected to open by 2026, so all improvements were included in both the 2026 and 2046 No-Build analyses. *Table 11* summarizes the location, improvement, and expected opening year of the funded transportation projects that were included in the No-Build models. A few of the improvements are outside of the study area for this IAR but are within the limits of the Vissim models and were included as background improvements.

*Table 11: Funded Transportation Projects within the Study Area*

| Location | Improvements | Opening Year |
|---|---|---|
| Northbound Route 288 Ramps at US 250 | ▪ Convert to signalized intersection<br>▪ Construct dual westbound left-turn lanes<br>▪ Relocate eastbound right turn to main intersection | 2020 |
| Southbound Route 288 Ramps at US 250 | ▪ Convert to signalized intersection<br>▪ Construct dual westbound left-turn lanes | 2020 |
| Dominion Boulevard at US 250 | ▪ Construct dual southbound right-turn lanes | 2020 |
| Dominion Boulevard at US 250 | ▪ Construct dual eastbound left-turn lanes | 2025 |
| I-64 at Parham Road Interchange | ▪ Convert intersection with westbound ramp to signalized intersection<br>▪ Construct dual left-turn lanes on eastbound off-ramp | 2026 |
| Cabela Drive at US 250 | ▪ Construct northbound leg of intersection and upgrade traffic signal | 2021 |
| Gaskins Road at Three Chopt Road | ▪ Construct dual left-turn lanes on all approaches<br>▪ Widen Three Chopt Road to provide one additional through lane in each direction | 2024 |
| Ashland Road at US 250 | ▪ Realign Hockett Road to create fourth leg of intersection | 2026 |

Additional uncommitted projects outside of the study area, but within the modeling area, were included in the No-Build models to prevent bottlenecks outside of the study area from severely limiting the projected demand from entering the study area. These projects do not fully address all bottlenecks outside of the study area but allow for a higher percentage of the demand to enter the study area, which allows for a better comparison of No-Build and Build alternatives for this IAR. The additional projects are documented in *Table 12*.

*Table 12: Transportation Projects within the Modeling Area*

| Location | Improvements |
|---|---|
| Glenside Drive at Westbound I-64 Ramp | ■ Convert ramp terminal to signalized intersection |
| Westbound I-64 Between Staples Mill Road and Glenside Drive | ■ Construct continuous auxiliary lane on westbound I-64 between interchanges |
| Westbound I-64 Between Glenside Drive and Parham Road | ■ Construct continuous auxiliary lane on westbound I-64 between interchanges |
| I-64 between Parham Road and Gaskins Road | ■ Construct continuous auxiliary lanes in both direction on I-64 between interchanges |

## ALTERNATIVES DEVELOPMENT AND SCREENING

Potential geometric improvements were developed to address existing and projected operational and safety deficiencies identified in the existing and No-Build conditions analysis. Improvements that were considered included concepts from previous studies (including concepts screened out and recommended) and new concepts. The following SWG meetings were held throughout the concept screening and alternatives development process:

- June 17, 2021 – presented results for the existing conditions analysis and discussed travel demand model results for the subarea model scenarios
- August 2, 2021 – presented concepts from previous studies and initial new concepts that did not include a new access point; discussed screening-level results for those concepts considered in previous studies; advanced concepts to screening-level analysis in Vissim
- October 14, 2021 – presented screening-level Vissim results and preliminary sketches for concepts that did not include a new access point; introduced preliminary results for a concept that included a new interchange at N Gayton Road; advanced one package of alternatives to Build analysis
- December 15, 2021 – presented screening-level Vissim results for mainline concepts for the new interchange at N Gayton Road and screening-level Synchro results for interchange concepts
- February 10, 2022 – presented preliminary safety analysis results and signing options for mainline concepts for the new interchange at N Gayton Road
- April 22, 2022 – presented updated safety analysis and screening-level Vissim results for mainline concepts for the new interchange at N Gayton Road; advanced one package of alternatives to Build analysis
- June 24, 2022 – presented Vissim and safety analysis results, preliminary concept sketches, and cost estimates for the Build alternative packages

A screening-level analysis was performed in Vissim for the 2046 peak hours for all concepts that were not screened out at the August 2021 meeting based on findings from previous studies. Additionally, screening matrices were compiled to summarize the concepts based on the following criteria:

- Right-of-way (RW) and utility impacts
- Safety impacts
- Operational impacts
- Bicycle and pedestrian accommodation
- Environmental impacts

- Preliminary cost of construction (high-level construction cost estimates categorized into low, medium, and high ranges)

The screening matrices used to establish the three Build alternative packages are provided in *Appendix F*. The following sections document the concepts considered, the level of analysis completed, and the justification for either advancing the alternative or removing it from consideration.

### Transportation Management Options

The *RVA Transit Vision Plan* determined that increased transportation demand management strategies considered for deployment in the area are not expected to address all capacity constraints identified in previous studies.

### Subarea Model Scenarios

As part of the *STARS US 250 Corridor Study*, VDOT TMPD created a subarea model from the Richmond/Tri-Cities regional travel demand model and calibrated it with updated traffic count and socioeconomic data in Henrico and Goochland counties. VDOT TMPD evaluated several Build scenarios for potential roadway widenings or new roadway connections in the region using the subarea model to determine the potential benefits to roadways within the study area.

The scenarios described in *Table 13* do not include any geometric improvements that specifically target the capacity, congestion, and safety issues identified as part of the existing and No-Build analyses. As such, any potential benefit to the issues identified within the study area would be attributed to a change in demand on the study area roadways resulting from a change in traffic patterns from a specific improvement. Results showing the projected change in demand throughout the Short Pump area for each Build scenario are provided in *Appendix F*. The new interchange on I-64 at N Gayton Road had the potential to significantly reduce demand on key study area roadways (e.g., the westbound I-64 off-ramp to westbound US 250) and was advanced to a more detailed analysis and design. The SWG reached a consensus that the changes in demand on study area roadways in other scenarios did not rise to the level that a notable benefit would be shown in a detailed Vissim analysis. Therefore, these scenarios were screened out and were not advanced to a more detailed analysis and design.

Several of the scenarios have standalone project benefits and are supported by Henrico or Goochland County. This study does not draw any conclusions regarding the localized benefits and potential funding for the scenarios that do not have the potential to address the issues identified in the existing and No-Build analyses.

*Table 13: Subarea Model Scenarios*

| Improvement Description | Findings | Recommendation |
|---|---|---|
| Construct a new interchange on I-64 at N Gayton Road | Projected to reduce demand on the following study area roadways that are over capacity or have congestion-related issues: westbound I-64 off-ramp to westbound US 250, eastbound I-64 on-ramp from US 250, eastbound I-64 on-ramp from I-295, US 250 between Lauderdale Drive and I-64. | Advanced to a more detailed screening-level operations analysis in Vissim |

| Improvement Description | Findings | Recommendation |
|---|---|---|
| Widen Pouncey Tract Road from two to four lanes between Twin Hickory Lake Drive and Nuckols Road | Projected to provide arterial operational benefits to N Gayton Road by reducing demand in AM and PM peak hours; however, demand on Pouncey Tract Road increases. No notable benefits to critical locations in the study area beyond the margin of error. | Recommended as standalone project outside of the IAR. Included in DRAFT ConnectRVA 2045 CLRP and supported by Henrico County. Projected to provide some arterial benefits but doesn't address purpose and need. Will likely happen as future development occurs. |
| Extend Three Chopt Road in Henrico County to N Gayton Road | Projected to provide arterial operational benefits to US 250 between N Gayton Road and Lauderdale Drive by shifting traffic to Three Chopt Road. No notable benefits to critical locations in the study area beyond the margin of error. | Recommended as standalone project outside of the IAR. Supported by Henrico County. Anticipated to be constructed as part of future development. Projected to provide some arterial benefits but doesn't address purpose and need. |
| Connect Three Chopt Road in Goochland via an underpass to US 250 | Primarily projected to benefit eastbound US 250 in the AM peak hour between Ashland Road and Route 288 interchange. No notable benefits to critical locations in the study area beyond the margin of error. | Recommended as standalone project outside of the IAR pending demonstration of higher need as development occurs. Included in DRAFT ConnectRVA 2045 CLRP and supported by Goochland County. Doesn't address purpose and need. |
| Connect Wilkes Ridge Parkway and Tuckahoe Creek Parkway | Projected to improve traffic operations on southbound Route 288 in the AM peak hour and northbound Route 288 in the PM peak hour. No notable benefits to other critical locations in study area. | Recommended as standalone project outside of the IAR. Supported by Goochland County. Anticipated to be constructed as part of future development. |
| Extend Bacova Drive to connect N Gayton Road and Ashland Road | No notable benefits to critical locations in the study area beyond the margin of error. | Considered recommending pending demonstration of higher need as development occurs; however, doesn't address purpose and need. |
| Construct a new interchange on Route 288 between US 250 and Tuckahoe Creek Parkway and connect Wilkes Ridge Parkway and Hockett Road | Projected to improve traffic operations on southbound Route 288 in the AM peak hour and both directions of Route 288 in the PM peak hour. No other notable benefits to critical locations in study area. Further study needed to understand impacts of new interchange. | Separate study underway by others. Requires separate IAR for new access on 288. |
| Provide partial access from I-295 to John Rolfe Parkway at the interchange with I-64 | Projected to reduce demand on the following study area roadways that are over capacity or have congestion-related issues: eastbound and westbound I-64 on-ramps from I-295. | Not recommended to provide access to US 250 from a system-to-system interchange. Additionally, Henrico County vacated John Rolfe Parkway north of US 250 in 1997 so new partial access violates FHWA policy for connection to public roads only. |

| Improvement Description | Findings | Recommendation |
|---|---|---|
| Provide full access to/from I-295 and John Rolfe Parkway at the interchange with I-64 | Projected to reduce demand on the following study area roadways that are over capacity or have congestion-related issues: eastbound and westbound I-64 on-ramps from I-295, eastbound and westbound I-64 off-ramps to I-295, westbound I-64 between US 250 and I-295. | Not recommended to provide access to US 250 from a system-to-system interchange. Additionally, Henrico County vacated John Rolfe Parkway north of US 250 in 1997. |

### Route 288

*Table 14* outlines the concepts that were considered to address the capacity, congestion, and safety issues identified on Route 288 and at Route 288 interchanges. No concepts were analyzed to address the capacity issues on northbound Route 288 between the on-ramp from US 250 and the off-ramps to I-64.

*Table 14: Concepts on Route 288*

| Improvement Description | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Construct auxiliary lane on southbound Route 288 between US 250 and Tuckahoe Creek Parkway | Vissim | Improvement is projected to decrease congestion and improve speeds on southbound Route 288. This improvement is projected to prevent the queue from affecting upstream operations on westbound I-64. | Advanced to both Build alternatives at October 2021 meeting |
| Construct auxiliary lane on northbound Route 288 between Tuckahoe Creek Parkway and US 250. Signalize and add a second lane to serve the right-turn movement on the southbound Route 288 off-ramp to US 250. Add a second lane to serve the right-turn movement on the northbound Route 288 off-ramp to US 250. [From *STARS US 250 Corridor Study*] | Vissim | Improvement is projected to increase speeds and decrease queuing on northbound Route 288 and increase throughput on northbound Route 288 and eastbound US 250 | Advanced to both Build alternatives at October 2021 meeting |

### I-64 at US 250 Interchange

*Table 15* outlines the concepts that were considered to address the capacity, congestion, and safety issues identified on I-64 at the interchange with US 250. Additional improvements that spanned the I-64 interchanges with US 250 and I-295 are outlined in the *I-64 at US 250 and I-295 Interchanges* section.

*Table 15: Concepts at the I-64 at US 250 Interchange*

| Improvement Description | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Construct a partial cloverleaf interchange that removes the westbound I-64 off-ramp to westbound US 250 [From *STARS US 250 Corridor Study*] | Synchro | Preliminary Synchro analysis from *STARS US 250 Corridor Study* showed that three left-turn lanes were required to serve the new movement on the westbound I-64 off-ramp but queuing and delay concerns persisted on the off-ramp. Modifications to the off-ramp would significantly impact the parcel in the southeast quadrant of the interchange. | Screened out at August 2021 meeting |
| Construct a diverging diamond interchange (DDI) [From *STARS US 250 Corridor Study*] | Synchro | Preliminary Synchro analysis from *STARS US 250 Corridor Study* showed that three left-turn lanes were required to serve the new movement on the westbound I-64 off-ramp but queuing and delay concerns persisted on the off-ramp. | Screened out at August 2021 meeting |
| Construct a single point urban interchange (SPUI) [From *STARS US 250 Corridor Study*] | Synchro | Preliminary Synchro analysis from *STARS US 250 Corridor Study* showed that three left-turn lanes were required to serve the new movement on the westbound I-64 off-ramp but queuing and delay concerns persisted on the off-ramp. | Screened out at August 2021 meeting |
| Construct a flyover ramp from westbound I-64 to westbound US 250 [From *STARS US 250 Corridor Study*] | N/A | Flyover ramp would require modifications to inter-parcel connections on north side of US 250 and may require relocation of the US 250 intersection with Tom Leonard Drive. | Screened out at August 2021 meeting |
| Construct a partial cloverleaf interchange (option 1) that removes the westbound I-64 on-ramp from eastbound US 250. Construct three westbound through lanes at intersection with westbound I-64 ramps. [Revised from *STARS US 250 Corridor Study*] | Vissim | The partial cloverleaf interchange is projected to reduce congestion and congestion-related crashes on westbound I-64 approaching the US 250 interchange. The projected queues on westbound US 250 approaching the new signal were longer than the other partial cloverleaf concepts. | Screened out at October 2021 meeting |
| Construct a partial cloverleaf interchange (option 2) that removes the westbound I-64 on-ramp from eastbound US 250. | Vissim | The partial cloverleaf interchange is projected to reduce congestion and congestion-related crashes on westbound I-64 approaching the US | Screened out at October 2021 meeting |

| Improvement Description | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Construct dual westbound right-turn lanes at intersection with westbound I-64 ramps. [Revised from *STARS US 250 Corridor Study*] | | 250 interchange. The projected queues on westbound US 250 approaching the new signal were shorter than the first partial cloverleaf option. | |
| Construct a partial cloverleaf interchange (option 3) that removes the westbound I-64 on-ramp from eastbound US 250. Construct dual westbound right-turn lanes at intersection with westbound I-64 ramps plus contraflow left-turn lanes. [Revised from *STARS US 250 Corridor Study*] | Vissim | The partial cloverleaf interchange is projected to reduce congestion and congestion-related crashes on westbound I-64 approaching the US 250 interchange. The contraflow left-turn lanes provide additional storage for left-turning vehicles on US 250 and queues were projected to be contained within the contraflow left-turn lanes. This concept was preferred over the other partial cloverleaf concepts. | Advanced to one Build alternative at October 2021 meeting |
| Convert westbound US 250 right-turn lane to a shared through/right lane and install thru-cut at Tom Leonard Drive [From *STARS US 250 Corridor Study*] | Vissim | Improvements are projected to reduce queuing on westbound US 250 approaching Tom Leonard Drive by increasing the capacity of the through movement and reducing the number of signal phases. These improvements are projected to prevent the queue from impacting the interchange ramps at the interchange with I-64. | Advanced to both Build alternatives at October 2021 meeting |
| Restrict vehicles on westbound I-64 off-ramp to eastbound US 250 from turning left at Dominion Boulevard | Vissim | Improvement is projected to reduce queuing on eastbound US 250 between the I-64 interchange and Dominion Boulevard and has the potential to reduce the number of angle and sideswipe crashes | Advanced to both Build alternatives at October 2021 meeting |

### I-64 at I-295 Interchange

*Table 16* outlines the concepts that were considered to address the capacity, congestion, and safety issues identified on I-64 at the interchange with US 250. Additional improvements that spanned the I-64 interchanges with US 250 and I-295 are outlined in the *I-64 at US 250 and I-295 Interchanges* section. At the October 2021 SWG meeting, the study team presented two options for Build alternative packages: one set of Build alternative packages that sought to address capacity, congestion, and safety issues on I-64 and Route 288 and a second set of Build alternative packages that sought to address capacity, congestion, and safety issues on I-64, I-295, and Route 288. The SWG decided that the Build alternative packages should focus on addressing issues on I-64 and Route 288, but that further improvements should be considered for I-295 in the future. As such, any improvements (e.g., converting the on-ramp from I-295 to eastbound I-64 to two lanes) where the main focus was to address issues on solely on I-295, including capacity, congestion, and safety, were screened out. Some improvements to I-295 (e.g., auxiliary lane between I-64 and Nuckols Road) were advanced to a Build alternative package since the primary benefits of the improvement were to I-64.

Table 16: Concepts at the I-64 at I-295 Interchange

| Improvement Description | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Convert I-295 on-ramp from westbound I-64 to two lanes. Construct continuous auxiliary lane to Nuckols Road interchange. | Vissim | Improvement is projected to reduce queuing on westbound I-64 approaching the I-295 interchange and to provide additional capacity on I-295. Improvements at the US 250 interchange should be packaged with this improvement to best mitigate queuing on westbound I-64. | Advanced to both Build alternatives at October 2021 meeting |
| Convert eastbound I-64 on-ramp from I-295 to a two-lane loop ramp | Vissim | Improvement is projected to increase throughput on southwestbound I-295 but creates a new bottleneck on eastbound I-64 at the US 250 interchange and should not be recommended without an improvement that helps release the new bottleneck | Screened out at October 2021 meeting |
| Convert eastbound I-64 on-ramp from I-295 to a two-lane directional ramp | Vissim | Improvement is projected to increase throughput on southwestbound I-295 but creates a new bottleneck on eastbound I-64 at the US 250 interchange and should not be recommended without an improvement that helps release the new bottleneck | Screened out at October 2021 meeting |
| Reconfigure eastbound I-64 diverge to I-295 to create one exit only lane and one choice lane | Vissim | Improvement is projected to help address imbalanced lane utilization that causes slow speeds after the merge from northbound Route 288 to eastbound I-64 | Advanced to one Build alternative at October 2021 meeting |

### I-64 at US 250 and I-295 Interchanges

*Table 17* outlines the concepts that were considered to address the capacity, congestion, and safety issues identified on I-64 at the interchanges with US 250 and I-295. At the October 2021 SWG meeting, the study team presented two options for Build alternative packages: one set of Build alternative packages that sought to address capacity, congestion, and safety issues on I-64 and Route 288 and a second set of Build alternative packages that sought to address capacity, congestion, and safety issues on I-64, I-295, and Route 288. The SWG decided that the Build alternative packages should focus on addressing issues on I-64 and Route 288, but that further improvements should be considered for I-295 in the future. As such, any improvements (e.g., converting the eastbound I-64 on-ramp from I-295 to two lanes) where the main focus was to address capacity, congestion, and safety issues on I-295 were screened out.

*Table 17: Concepts at the I-64 Interchanges with US 250 and I-295*

| Improvement Description | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Construct a partial C-D road on westbound I-64 between US 250 and I-295 | Vissim | Improvement is projected to decrease queuing and congestion on westbound I-64 at the US 250 interchange, which improves speeds and throughput at and approaching the interchange in the PM peak hour. The improvement improves safety on westbound I-64 by removing two weaves. The improvement has similar benefits to the partial cloverleaf at US 250 but does not address operational issues on eastbound US 250 or eastbound I-64 in the AM peak hour. | Screened out at October 2021 meeting |
| Convert eastbound I-64 on-ramp from I-295 to a two-lane directional ramp and construct a full access C-D road on eastbound I-64 between I-295 and US 250 (option 1) | Vissim | Improvement is projected to increase throughput and reduce congestion on southwestbound I-295 but does not address operational issues on eastbound US 250 and eastbound I-64 at the interchange. The increased throughput is projected to result in additional queuing on US 250 that backs up to and degrades operations on the C-D road. | Screened out at October 2021 meeting |
| Convert eastbound I-64 on-ramp from I-295 to a two-lane directional ramp and construct a partial access C-D road on eastbound I-64 between I-295 and US 250 (option 2) | Vissim | Improvement is projected to increase throughput and reduce congestion on southwestbound I-295 but does not address operational issues on eastbound US 250 and eastbound I-64 at the interchange. The increased throughput is projected to result in additional queuing on US 250 that backs up to and degrades operations on eastbound I-64. | Screened out at October 2021 meeting |

### I-64 at N Gayton Road

A new interchange at N Gayton Road was included in the constrained project list in *ConnectRVA 2045*, which was developed by the Richmond Regional Transportation Planning Organization and supported by PlanRVA. This plan was adopted in 2021. The SWG agreed to advance the scenario that included a new interchange on I-64 at N Gayton Road to further screening-level operations analysis in Vissim and preliminary safety analysis as documented in the *Subarea Model Scenarios* section. The goal of the screening-level analysis was to determine how well the changing traffic patterns attributed to the new interchange improved operations and safety on other study area roadways with capacity, congestion, and safety issues.

New traffic volumes for the N Gayton Road interchange concept were developed for the study area by applying the projected percent change in traffic volumes from the subarea travel demand model to the forecasted No-Build traffic volumes as described in the **Build Traffic Volumes** section.

A preliminary Vissim model was created to test the N Gayton Road interchange concept using the new traffic volumes. The preliminary interchange configuration assumed a diamond interchange with additional improvements on mainline I-64 as needed to accommodate the new interchange traffic. The screening-level analysis results showed that the new interchange at N Gayton Road was projected to address several of the congestion and safety issues identified in throughout the study area, particularly the congestion on westbound I-64 approaching the US 250 interchange. The SWG determined at the October 2021 meeting to advance the new interchange at N Gayton Road, along with several of the improvement concepts previously discussed, to one of the Build alternative packages provided that additional screening is performed to refine the alternative. The following sections document the approach, findings, and recommendations for further analysis that identified the appropriate interchange configuration and any necessary improvements on N Gayton Road or mainline I-64 to accommodate the new interchange:

### *Mainline Improvement Screening*

Various concepts were considered on mainline I-64 between Route 288 and I-295 to accommodate the proposed interchange at N Gayton Road. The preliminary Vissim model used to screen the mainline improvement concepts assumed a traditional diamond interchange at N Gayton Road and included the following improvements that were advanced to both Build alternative packages at the October 2021 meeting.

- Construct a new diverging diamond interchange on I-64 at N Gayton Road
- Construct an auxiliary lane on southbound Route 288 between US 250 and Tuckahoe Creek Parkway
- Construct an auxiliary lane on northbound Route 288 between Tuckahoe Creek Parkway and US 250. Signalize and add a second lane to serve the right-turn movement on the northbound Route 288 off-ramp to US 250.
- Convert the westbound US 250 right-turn lane to a shared through/right lane and install thru-cut at Tom Leonard Drive
- Restrict vehicles on the off-ramp from westbound I-64 to eastbound US 250 from turning left at the downstream intersection with Dominion Boulevard
- Convert the single-lane on-ramp from westbound I-64 to I-295 to two lanes. Construct a continuous northbound auxiliary lane between I-64 and Nuckols Road interchange.

The following mainline improvement concepts were developed and screened in Vissim. The screening-level analysis used to identify the preferred mainline alternative assumed a traditional diamond interchange at N Gayton Road with sufficient capacity at the ramp terminals to prevent any queues from impacting freeway operations. Interchange configuration screening is documented in the *Interchange Configuration Screening* section and the preferred interchange configuration was incorporated into Vissim for the Build alternative packages.

- Auxiliary lanes: construct auxiliary lanes in both directions on I-64 between the new interchange at N Gayton Road and the interchanges with Route 288 and I-295. Construct choice lanes for the eastbound I-64 off-ramp to I-295 and the westbound I-64 off-ramps to N Gayton Road and Route 288. The proposed lane configuration diagram is shown in *Figure 21*. Conceptual line diagrams are included in *Appendix F*.
- Braided ramps: construct auxiliary lanes on eastbound I-64 between Route 288 and N Gayton Road and on westbound I-64 between I-295 and N Gayton Road. Construct braided ramps on eastbound I-64 between N Gayton Road and I-295 so that the off-ramp to I-295 diverges from I-64 prior to and crosses the on-ramp from N Gayton Road. Construct braided ramps on westbound I-64 between N Gayton Road and Route 288 so that the off-ramp to Route 288 diverges from I-64 prior to and cross the on-ramp from N Gayton Road. The proposed lane

configuration diagrams are shown in *Figure 22* and *Figure 23*. Conceptual line diagrams are included in *Appendix F*.

- Collector-distributor (C-D) roads: construct a C-D road on eastbound I-64 that starts prior to the on-ramp from Route 288, ends with the off-ramp to I-295, and has slip ramps to and from I-64 throughout. Construct a C-D road on westbound I-64 that starts prior to the on-ramp from I-295, ends with the off-ramp to Route 288, and has slip ramps to and from I-64 throughout. The proposed lane configuration diagrams are shown in *Figure 24* and *Figure 25*. Conceptual line diagrams are included in *Appendix F*.

*Figure 21: Proposed Lane Configuration for Auxiliary Lane Concept*

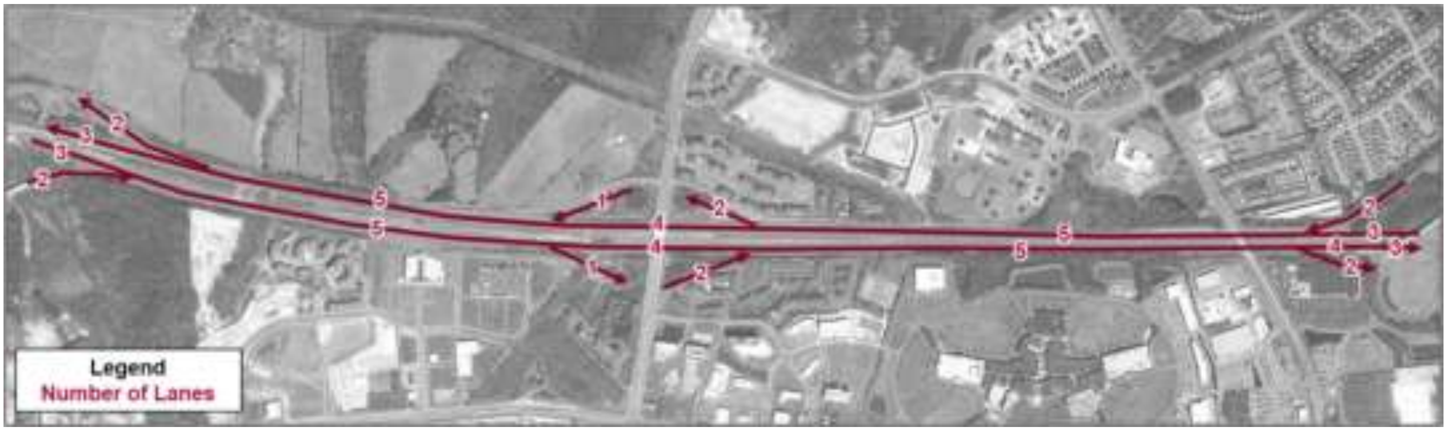



*Figure 22: Proposed Lane Configuration for Braided Ramp Concept (1/2)*

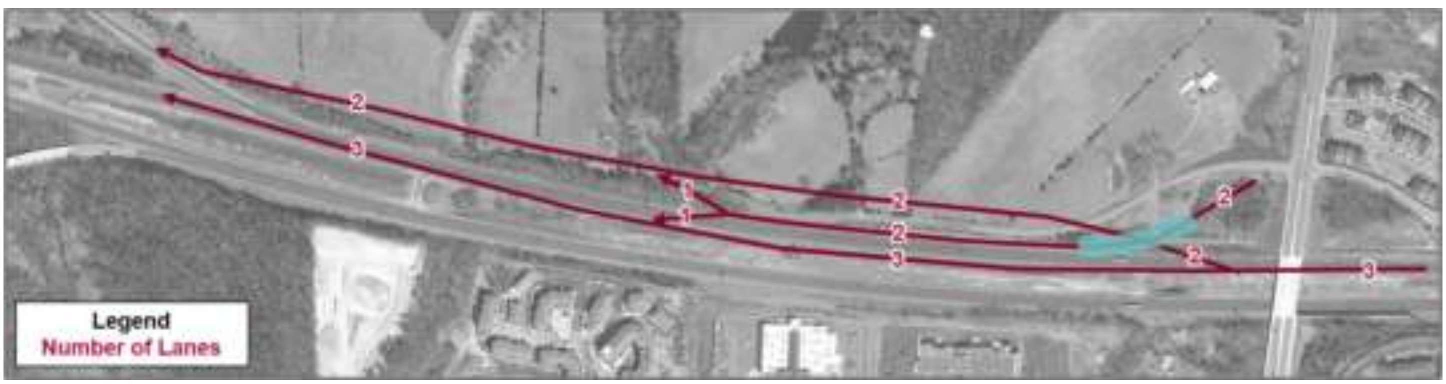


*Figure 23: Proposed Lane Configuration for Braided Ramp Concept (2/2)*

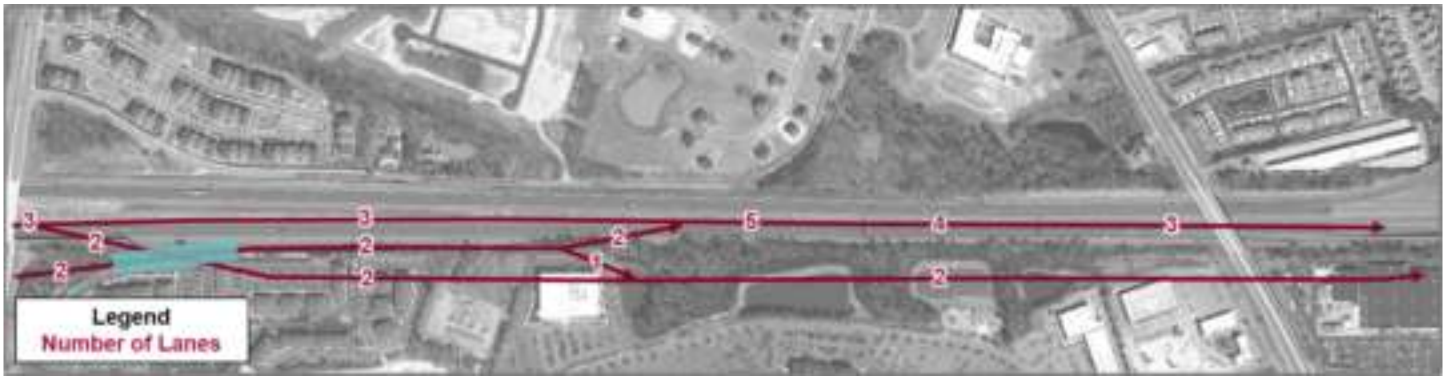



*Figure 24: Proposed Lane Configuration for C-D Road Concept (1/2)*

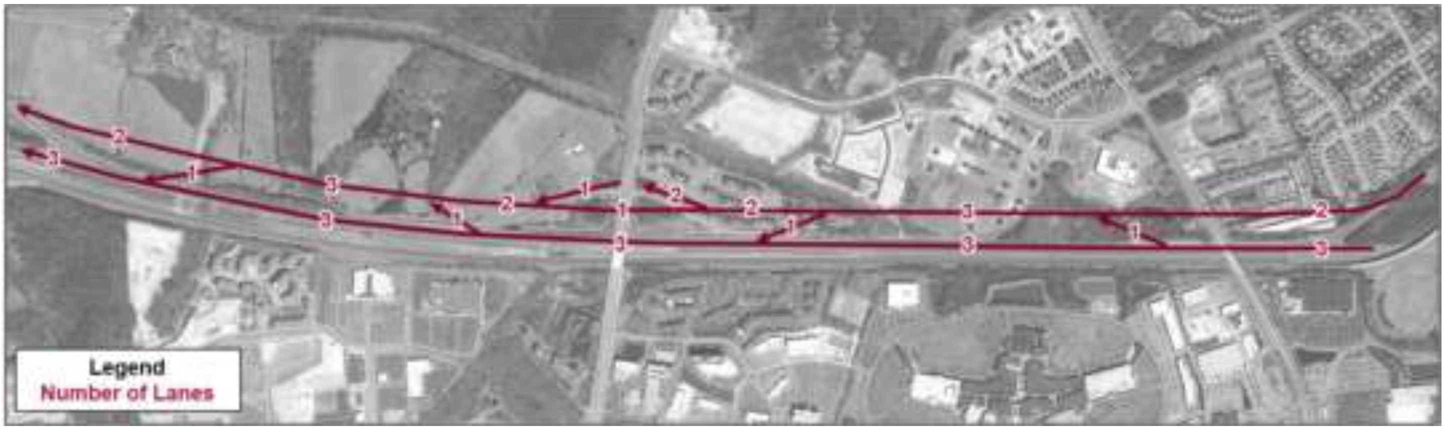
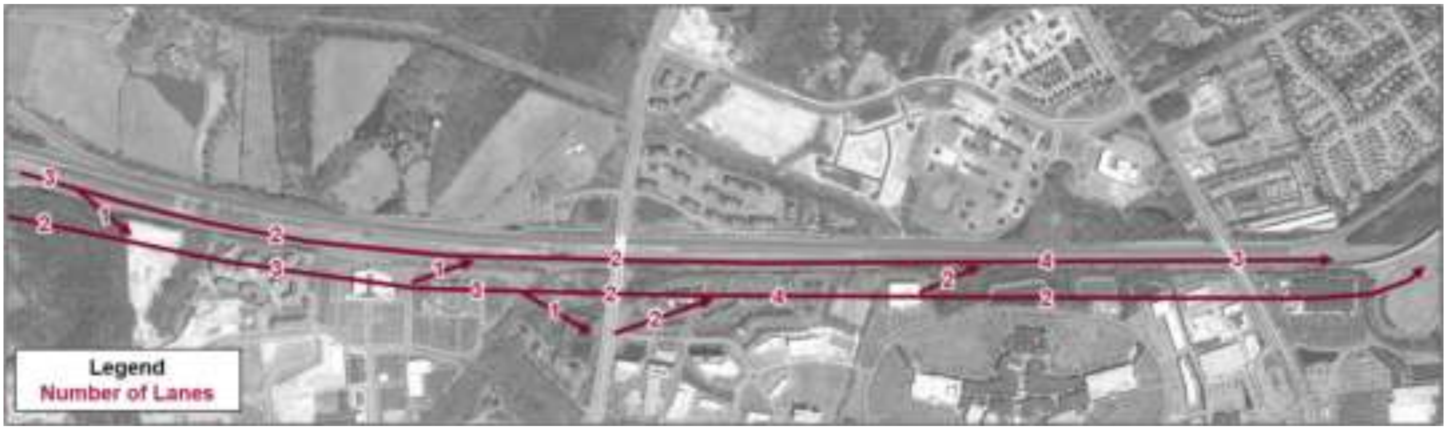



*Figure 25: Proposed Lane Configuration for C-D Road Concept (2/2)*




Larger C-D road concepts were discussed with the SWG but were screened out without more detailed analysis or design due to geometric concerns. These concepts included a C-D road that spanned from west of the Route 288 interchange through the US 250 interchange and a C-D road similar to the concept shown in *Figure 24* and *Figure 25* without the slip ramps to and from I-64 throughout the C-D road. *Figure 26* and *Figure 27* document the projected AM and PM peak hour traffic volumes on mainline I-64 and the C-D roads for the concept without the slip ramps to and from I-64. *Figure 26* and *Figure 27* also display the proposed lane configurations for mainline I-64 and the C-D roads that were developed to maintain lane balance while accommodating the projected peak hour traffic volumes. This C-D road concept was projected to carry up to five times more vehicles on the C-D road than on mainline I-64 and would require five lanes for the eastbound C-D road segment between N Gayton Road and I-295. Building this C-D road concept with the proposed lane configurations was projected to have the following right-of-way and cost impacts.

- The Pouncey Tract Road bridge over I-64 would need to be rebuilt
- Larger footprint of C-D road would potentially require total property takes of residential properties and possibly require some takes along adjacent commercial properties
- Additional measures such as retaining walls would be necessary to avoid impacts to stormwater management basins north of the Short Pump mall

A larger C-D road that spanned from west of the Route 288 interchange through the US 250 interchange would have similar impacts plus the following additional impacts:

- The eastbound I-64 ramps to and from I-295 would need to be rebuilt and the westbound I-64 ramps to and from I-295 would need to be realigned
- All ramps at the I-64 at Route 288 interchange would need to be rebuilt or realigned
- All ramps at the I-64 at US 250 interchange would need to be rebuilt or realigned
- The C-D road would require additional bridges over Little Tuckahoe Creek to carry the C-D roads west of the Route 288 interchange
- The larger footprint of C-D road would require additional total property takes of residential and commercial businesses

Since the C-D road concept shown in *Figure 24* and *Figure 25* better distributed traffic volumes between mainline I-64 and the C-D road and was projected to have fewer right-of-way and environmental impacts at a cheaper cost, the two larger C-D road concepts were screened out.

*Figure 26: Peak Hour Traffic Volumes and Proposed Lane Configuration for Larger C-D Road Concept (1/2)*

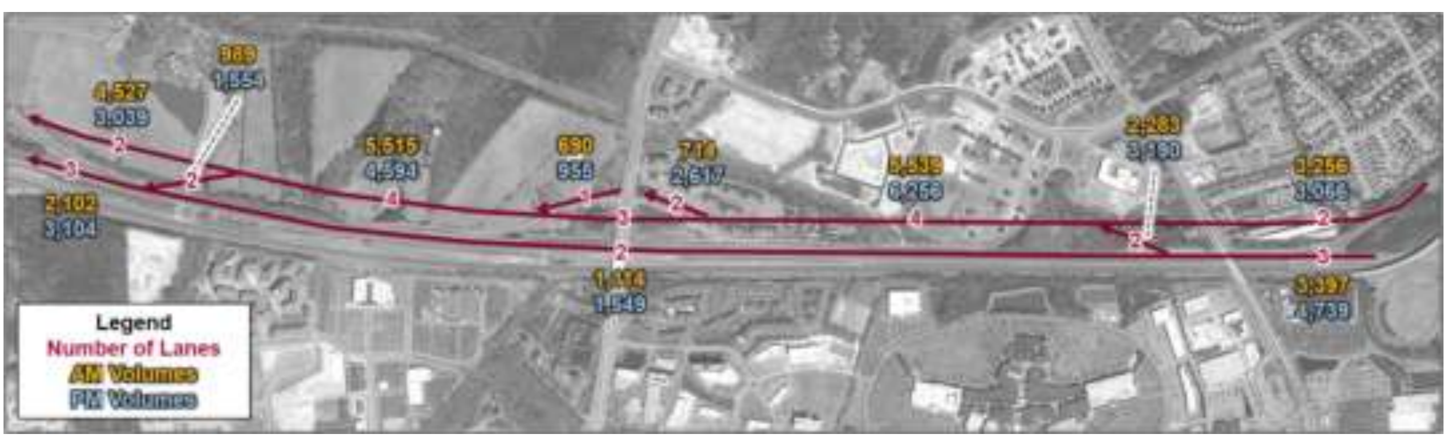
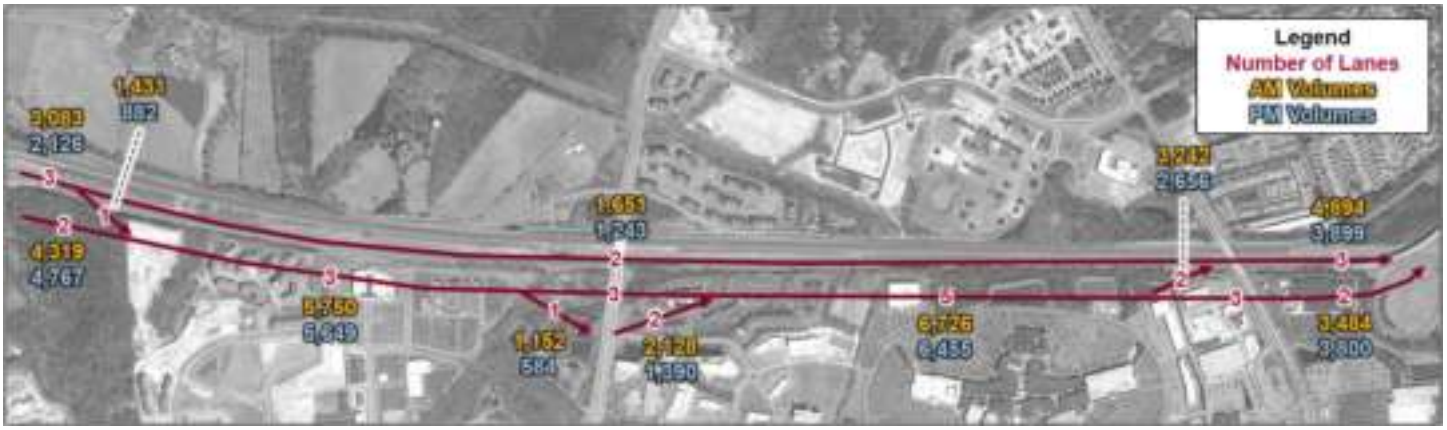


*Figure 27: Peak Hour Traffic Volumes and Proposed Lane Configuration for Larger C-D Road Concept (2/2)*




## Operational Screening Results

Screening-level operational results were reviewed for the section of I-64 between Route 288 and I-295 to compare the three mainline improvement concepts using speed, density, travel time index, travel time, and throughput. Operations outside this section of I-64 were not projected to be significantly different due to the changes in geometry and access within this section.

There was little differentiation in throughput, shown as the percent of demand served in *Table 18*, between the three mainline improvement concepts in the AM and PM peak hour. Similarly, I-64 was projected to operate at or near the speed limit during both peak hours. The C-D road was projected to operate below the 45-mph speed limit in both peak hours, with a minimum projected speed of 37 mph for the eastbound C-D road between Route 288 and N Gayton Road in the AM peak hour. The screening-level operational results figures are included in *Appendix F*.

*Table 18: Percent of Demand Served Comparison*

| Mainline Improvement Concept | Eastbound I-64 | | Westbound I-64 | |
|---|---|---|---|---|
| | Between Route 288 and N Gayton Road | Between N Gayton Road and I-295 | Between I-295 and N Gayton Road | Between N Gayton Road and Route 288 |
| AM Percent of Demand Served | | | | |
| Auxiliary Lanes | 100 | 98 | 86 | 87 |
| Braided Ramps | 99 | 96 | 86 | 87 |
| C-D Roads* | 96 | 98 | 86 | 87 |
| PM Percent of Demand Served | | | | |
| Auxiliary Lanes | 91 | 89 | 91 | 91 |
| Braided Ramps | 91 | 90 | 91 | 90 |
| C-D Roads* | 90 | 94 | 90 | 90 |

*Percent of demand served considers the demand on mainline I-64 and the C-D road

As shown in *Table 18*, demand was not fully served on I-64 near the N Gayton interchange in the Vissim screening analyses. This was attributed to bottlenecks on I-295 and Route 288 that are not fully addressed with the improvements that were advanced to the Build alternative package in the October 2021 meeting. A sensitivity test was performed to evaluate how the three mainline improvement concepts would operate if future projects were to recommend improvements that addressed these bottlenecks so that a higher percentage of the demand on I-64 between Route 288 and I-295 would be served. The sensitivity testing resulted in a 30-mph decrease in speed on westbound I-64 approaching the off-ramp to Route 288 in the AM peak hour in the braided ramp scenario. This decrease in speed can be attributed to the additional vehicles prepositioning in the right lanes in advance of the braided ramp as other vehicles preposition to exit to N Gayton Road. While this behavior occurs without the release of the bottleneck from I-295, the level of demand served is not projected to be high enough to impact operations. The sensitivity testing also resulted in a 5-mph decrease in speed on the westbound C-D road between I-295 and N Gayton Road in the AM peak hour and the eastbound C-D road between Route 288 and N Gayton Road in the PM peak hour. No decreases in speed were projected in the auxiliary lane concept with the release of the bottlenecks, which indicates that the auxiliary lane concept is less susceptible to break down if all demand in the study area could be served.

### Safety Screening Results

The new interchange at N Gayton Road is projected to increase traffic volume on I-64 between Route 288 and I-295 due to vehicles entering or exiting I-64 at the new interchange instead of an existing interchange. The additional traffic volume on this section of I-64 increases the risk of crashes; however, the new interchange has the potential to reduce crashes at other interchanges where traffic volumes are projected to decrease since many vehicles are projected to be rerouted to the new interchange. To determine if the potential increase in crashes between Route 288 and I-295 outweighed the potential decrease in crashes elsewhere in the study area, the auxiliary lane concept was evaluated using the Enhanced Interchange Safety Analysis Tool (ISATe) and other predictive methods. This analysis was originally conducted assuming a traditional diamond for the new interchange with two two-lane ramps on the eastern side of the interchange and two one-lane ramps on the western side of the interchange. The study team concluded that concluded that the auxiliary lane concept was projected to have either fewer or a comparable number of crashes on mainline I-64 than the No-Build scenario. The preliminary analysis was refined after the screening stage; the refined analysis is detailed in the *Safety Analysis* section.

The study team also conducted a preliminary analysis of the braided ramp alternative in the westbound direction to determine if the projected increase in crashes on westbound I-64 outweighed the projected increase in crashes on the braided ramp facility. This analysis was also conducted assuming a traditional diamond for the new interchange. The study team concluded that the projected increase in crashes on the proposed braided ramp facility outweighed the projected decrease in crashes on westbound I-64. The study team could not conduct a similar test for the proposed C-D road alternative since crash prediction methodologies are only available for one- and two-lane ramps; the proposed C-D road, which is considered a ramp in ISATe, contains more than two lanes for almost all segments.

The three mainline improvement concepts were qualitatively compared by considering the number of conflict points on I-64. *Table 19* documents the number of diverging, merging, and weaving conflict points associated with each concept. A weaving conflict point was defined as a location where two vehicles must make lane changes in opposite directions to complete their desired origin-destination movements. The analysis assumed that vehicles are prepositioned on ramps to make the fewest number of lane changes to complete their desired origin-destination movement and that vehicles will choose the least severe conflict (e.g., will choose to merge instead of weave). While the auxiliary lane concept contained the most diverging and merging conflict points, it did not have any weaving conflicts since the concept included choice lanes at the eastbound I-64 off-ramp to I-295 and the westbound I-64 off-ramps to N Gayton Road and Route 288.

Table 19: Conflict Point Summary for Mainline Improvement Concepts

| Improvement Concept | Weaving Speed | Eastbound | | | Westbound | | |
|---|---|---|---|---|---|---|---|
| | | Diverges | Merges | Weaves | Diverges | Merges | Weaves |
| Auxiliary Lanes | 65 mph | 6 | 6 | 0 | 5 | 5 | 0 |
| Braided Ramps | 65 mph | 2 | 3 | 1 | 2 | 2 | 1 |
| C-D Roads | 45 mph | 2 | 3 | 3 | 3 | 3 | 2 |

### Mainline Improvement Selection

A matrix was prepared to compare each of the three mainline improvement concepts using all criteria listed in the *Alternatives Development and Screening* section, except for bicycle and pedestrian accommodation, which had no bearing on the mainline improvement concepts. Each criterion was assigned an equal weight in the scoring process for preliminary screening. The concepts were then ranked relative to each other based on total score. *Table 20* documents the high-level findings and recommendations for the three mainline improvement concepts. The complete matrix that summarizes the score by criteria, criteria weight, and cumulative scores and ranks is provided in *Appendix F*. The auxiliary lane concept scored the highest and was advanced to a Build alternative package at the April 2022 meeting.

Table 20: Mainline Improvement Concepts for New Interchange at N Gayton Road

| Mainline Improvement Concept | Analysis Tool | Findings | Recommendation |
|---|---|---|---|
| Auxiliary Lanes | Vissim | This concept was preferred because it had fewer right-of-way, utility, and environmental impacts than the other two concepts and it was less susceptible to break down if demand were to be fully served in the study area. | Advanced to one Build alternative at April 2022 meeting |
| Braided Ramps | Vissim | This concept had more right-of-way, utility, and environmental impacts than the auxiliary lane concept. I-64 was projected to operate at or near the speed limit, but westbound I-64 was susceptible to break down if the demand were to be fully served in the study area. | Screened out at April 2022 meeting |
| C-D Roads | Vissim | This concept had the most significant right-of-way, utility, and environmental impacts. I-64 was projected to operate at or near the speed limit, but the C-D road was projected to operate below the speed limit and was susceptible to break down if the demand were to be fully served in the study area. Crashes were projected to be reduced on mainline I-64 but weaving conflict points were introduced on the C-D roads, which carried more volume than mainline I-64 in several sections. | Screened out at April 2022 meeting |

## *Interchange Configuration Screening*

Initial interchange configuration screening was performed at the potential N Gayton Road interchange as proposed in Build Package 2 using the VDOT Junction Screening Tool (VJuST). VJuST is a planning-level tool that helps transportation engineers and planners screen innovative intersection and interchange configurations based on operations, safety, and pedestrian accommodation, and that helps identify potential configurations that could effectively satisfy the purpose and need and thus advance to more detailed analysis and design. The VJuST results for the N Gayton Road interchange are provided in *Appendix F*. The following interchange configurations were screened out based on the VJuST results, since these configurations were not projected to accommodate the projected traffic volumes at an acceptable volume-to-capacity (V/C) ratio.

- Single Roundabout
- Contraflow Left Turn
- Michigan Urban Diamond

Although the projected V/C ratio for the double roundabout configuration was higher than those of the contraflow left turn and Michigan urban diamond interchange configurations, it advanced to further screening analysis in SIDRA Intersection since it could likely be constructed using the existing bridge over I-64 without requiring new structures. The following interchange configurations were analyzed in Synchro 10 for signalized intersection concepts and SIDRA Intersection 9 for roundabout concepts. Delay (seconds per vehicle) and level of service (LOS) were used to compare projected operations for the interchange configurations. Weighted conflict points from VJuST were used to compare the safety impacts of each interchange configuration.

- Traditional Diamond
- Displaced Left Turn
- Diverging Diamond Interchange (DDI)
- Single Point Urban Interchange (SPUI)
- Double Roundabout
- Partial Cloverleaf

A matrix was prepared to compare each of the six interchange configuration concepts using the criteria listed in the *Alternatives Development and Screening* section. Each criterion was assigned an equal weight in the scoring process for preliminary screening. The SWG discussed multiple variations of category weights based on different priorities at the April 2022 meeting and agreed to increase the weights for three categories: safety, operations, and pedestrian/bike accommodations. The concepts were then ranked relative to each other based on total score. A summary of the score by criteria, criteria weight, and cumulative scores and ranks is provided in *Appendix F*. With the revised category weighting, the DDI scored the highest.

An additional matrix, provided in *Appendix F*, was prepared to document any potential challenges with constructability of an interchange configuration alternative with any mainline I-64 alternative. The DDI was not projected to have any major constructability issues with the preferred mainline alternative of continuous auxiliary lanes and was advanced to a Build alternative package.

## BUILD PACKAGES

*Table 21* shows a summary of the improvements from the screening process that were advanced to each Build alternative package, based on input and consensus from the SWG during the alternative development process. The reconfiguration of the eastbound I-64 ramp diverge at I-295 was not included in Build Packages 2 or 3 since both packages include an auxiliary lane between the N Gayton Road and I-295 interchanges. Neither package has a lane configuration that contributes to upstream imbalances in lane distribution and this improvement was deemed unnecessary.

*Table 21: Summary of Build Package Components*

| Improvement | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|
| Construct a partial cloverleaf interchange (option 3) that removes the on-ramp from eastbound US 250 to westbound I-64. Construct dual westbound right-turn lanes at intersection with westbound I-64 ramps plus contraflow left-turn lanes | ✓ | ✗ | ✓ |
| Construct a new diverging diamond interchange on I-64 at N Gayton Road | ✗ | ✓ | ✓ |
| Construct an auxiliary lane on southbound Route 288 between US 250 and Tuckahoe Creek Parkway | ✓ | ✓ | ✓ |
| Construct an auxiliary lane on northbound Route 288 between Tuckahoe Creek Parkway and US 250. Signalize and add a second lane to serve the right-turn movement on the southbound Route 288 off-ramp to US 250. Add a second lane to serve the right-turn movement on the northbound Route 288 off-ramp to US 250. | ✓ | ✓ | ✓ |
| Convert the westbound US 250 right-turn lane at Tom Leonard Drive to a shared through/right lane and install a thru-cut | ✓ | ✓ | ✓ |
| Restrict vehicles on the westbound off-ramp from I-64 to eastbound US 250 from turning left at Dominion Boulevard | ✓ | ✓ | ✓ |
| Convert the single-lane I-295 on-ramp from westbound I-64 to two lanes. Construct a continuous northbound auxiliary lane from I-64 to Nuckols Road interchange. | ✓ | ✓ | ✓ |
| Reconfigure the eastbound I-64 ramp diverge at I-295 to create one exit only lane and one choice lane | ✓ | ✗ | ✗ |

## Description and Configuration of Interchange Access

### BUILD PACKAGE 1

As shown in *Table 21*, Build Package 1 includes seven different improvements throughout the study area roadway network. *Figure 28* through *Figure 38* show conceptual roadway sketches of the geometric changes that are part of these seven improvements in Build Package 1.

### BUILD PACKAGE 2

As shown in *Table 21*, Build Package 2 includes six different improvements throughout the study area roadway network. Five improvements are the same as those included in Build Package 1 and are shown in *Figure 30* through *Figure 37.*

Additionally, Build Package 2 includes the proposed new interchange at N Gayton Road and additional mainline improvements on I-64, shown in *Figure 39* through *Figure 43*. In addition to the construction of the diverging diamond ramp terminals on N Gayton Road, modifications and improvements at existing intersections were proposed. The proposed changes at the existing signalized intersection of Blue Ocean Lane at N Gayton Road include converting the intersection to right-in only to allow space for the DDI signalized crossover intersection. Additionally, the proposed design involves the removal of the signalized intersection of N Gayton Road and Bacova Drive and realignment/reconfiguration of Bacova Drive, with the roadway terminating at Marshall Run Circle east of N Gayton Road. Residents of the Marshall Springs townhomes would have access maintained on N Gayton Road at Marshall Run Circle, which current operates as right-in/right-out access, as well as access from Marshall Run Circle to Liesfeld Farm Drive via Bacova Drive. To the west of N Gayton Road, Bacova Drive would be reconstructed either as a fourth leg of the intersection with Liesfeld Farm Drive, or as a right-in/right-out access road south of Liesfeld Farm Drive, in coordination with a proposed site development plan for the area in the northwest quadrant of the proposed interchange.

New traffic volumes for the N Gayton Road interchange concept were developed for the study area by applying the projected percent change in traffic volumes from the subarea travel demand model to the forecasted No-Build traffic volumes as described in the *Build Traffic Volumes* section. This section also documents how vehicles were rerouted based on the proposed changes in access on N Gayton Road.

## BUILD PACKAGE 3

As shown in *Table 21*, Build Package 3 includes the partial cloverleaf interchange at US 250 from Build Package 1, the proposed new interchange at N Gayton Road from Build Package 2, and five additional improvements throughout the study area roadway network. *Figure 28* through *Figure 37* and *Figure 39* through *Figure 43* show conceptual roadway sketches of the geometric changes that are part of these seven improvements in Build Package 3.

A sensitivity test was performed using Build Package 3 to evaluate how the proposed DDI would operate if future projects were to be implemented that addressed the remaining bottlenecks on I-295 and Route 288 and provided additional benefit to US 250. While no improvements were identified during the alternatives development and screening process that addressed these issues without negatively impacting I-64, the SWG determined it was important to understand the potential impacts if future projects were identified and implemented. This sensitivity test showed that the original ramp configuration proposed for the eastbound I-64 off-ramp at the DDI could result in queues that back up to the freeway once the bottleneck on northbound Route 288 was released. To account for this, the study team revised the design of the DDI to add a second right-turn lane on this ramp. This change was also made in Build Package 2 and is reflected in *Figure 41*.

*Figure 28: US 250 at I-64 Partial Cloverleaf Improvement (1)*

*Figure 29: US 250 at I-64 Partial Cloverleaf Improvement (2)*

*Figure 30: Route 288 Continuous Auxiliary Lanes to Tuckahoe Creek Parkway*

*Figure 31: Route 288 at US 250 Ramp and Ramp Terminal Improvements (1)*

*Figure 32: Route 288 at US 250 Ramp and Ramp Terminal Improvements (2)*

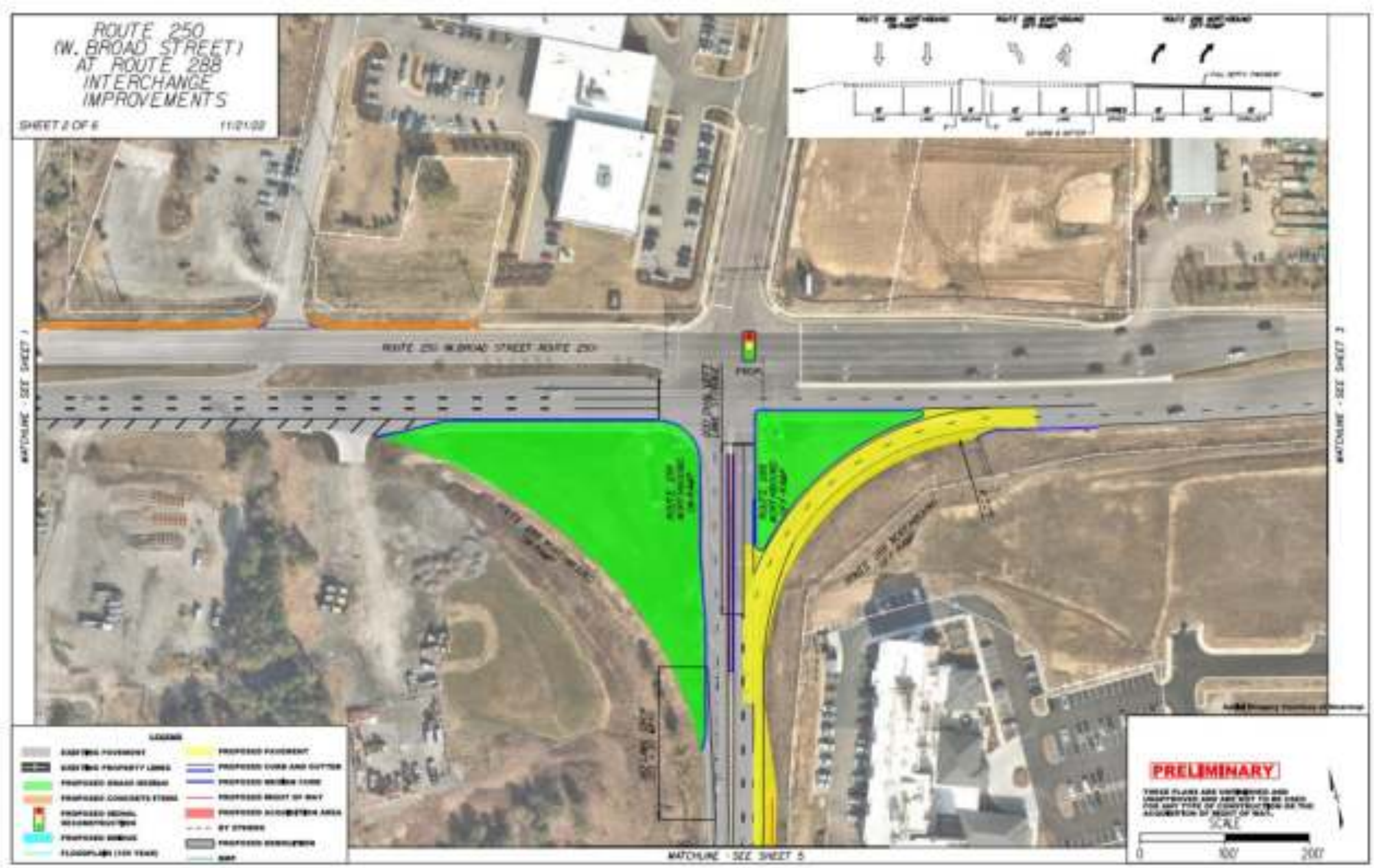


*Figure 33: Route 288 at US 250 Ramp and Ramp Terminal Improvements (3)*

*Figure 34: Route 288 at US 250 Ramp and Ramp Terminal Improvements (4)*

*Figure 35: Route 288 at US 250 Ramp and Ramp Terminal Improvements (5)*

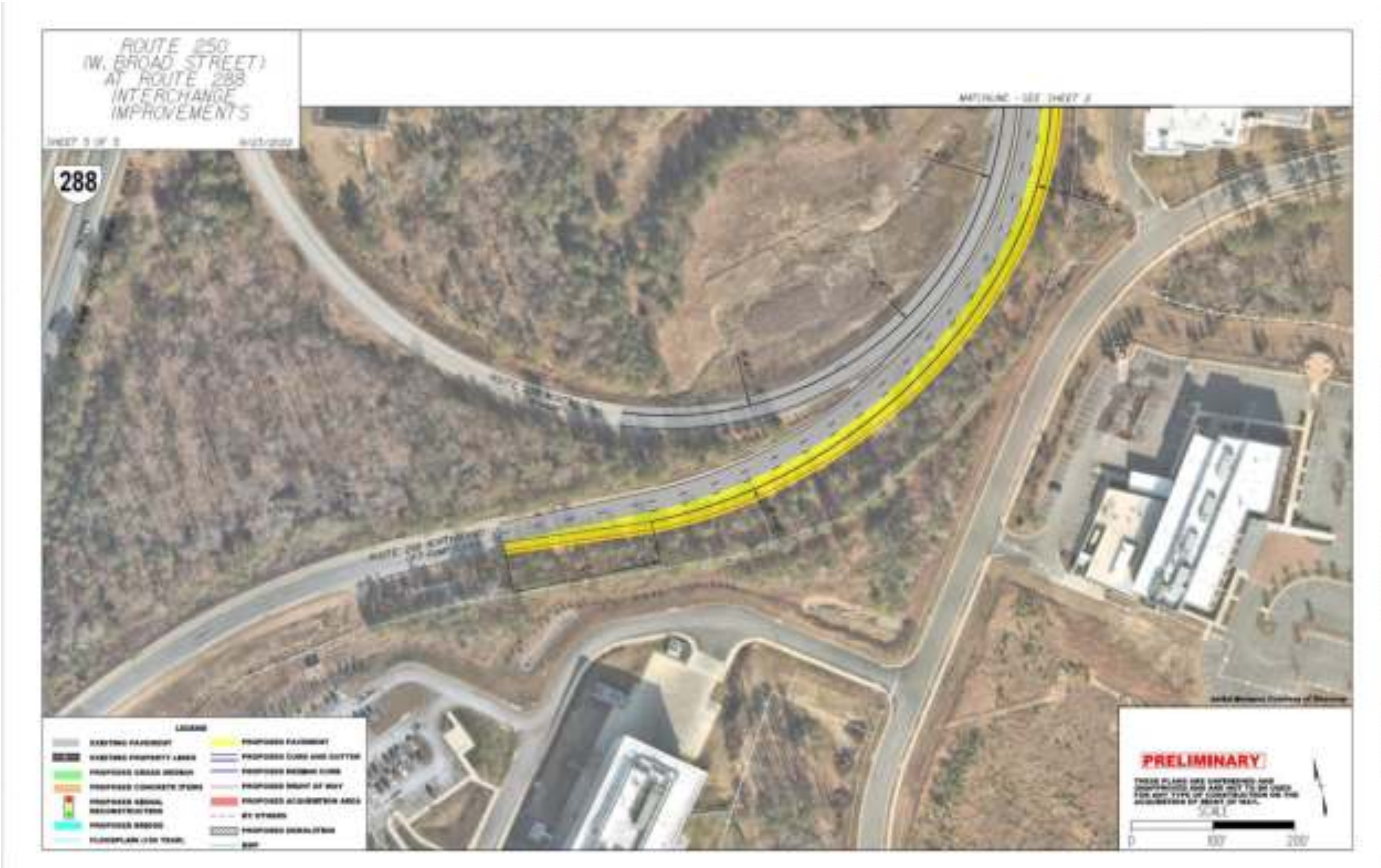


*Figure 36: US 250 at Tom Leonard Drive Intersection Improvements*

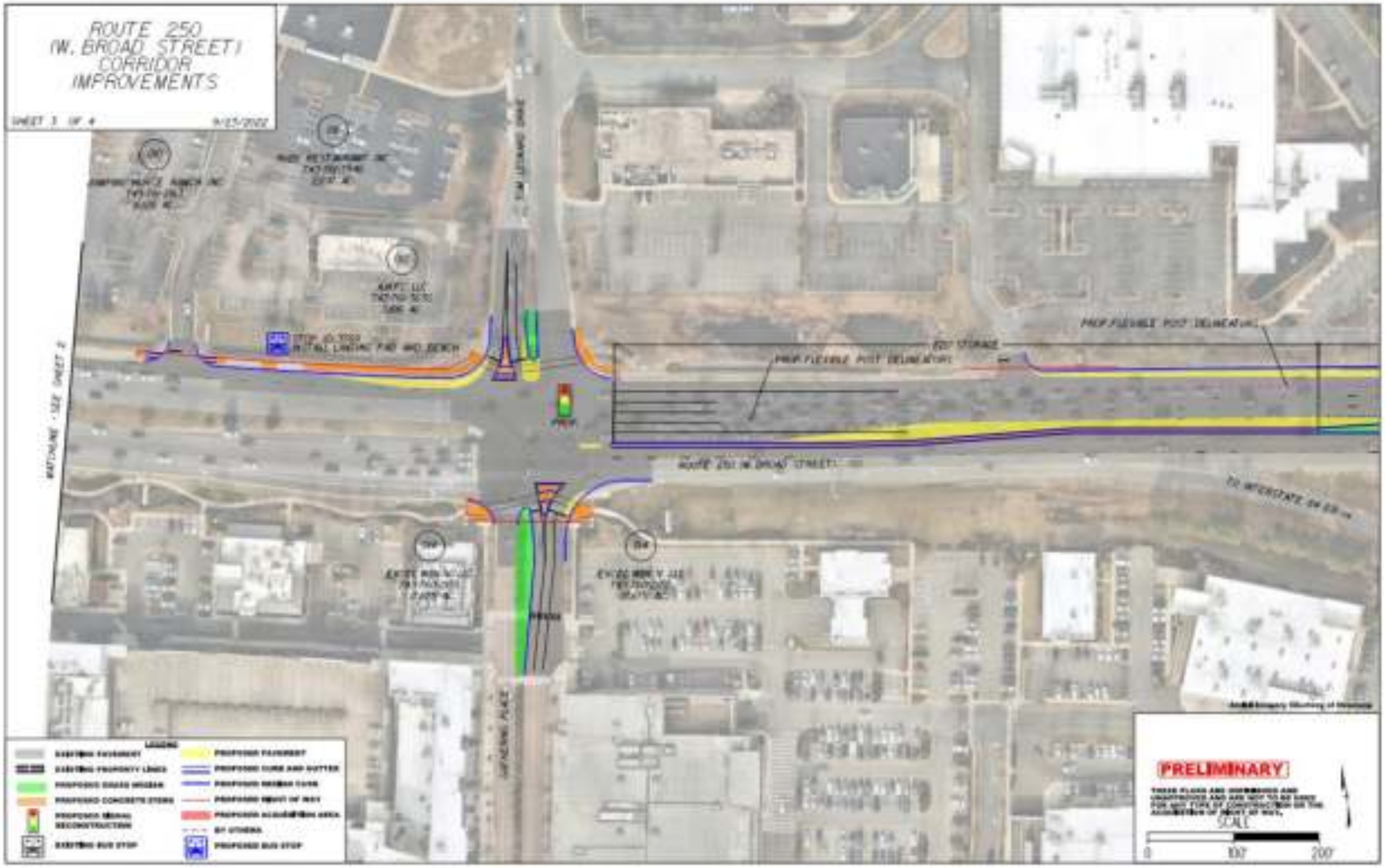


*Figure 37: I-295 Continuous Auxiliary Lane from I-64 to Nuckols Road*

*Figure 38: I-64 to I-295 Diverge Reconfiguration*

Figure 39: I-64 at N Gayton Road Interchange and Continuous Auxiliary Lanes (1)

*Figure 40: I-64 at N Gayton Road Interchange and Continuous Auxiliary Lanes (2)*

*Figure 41: I-64 at N Gayton Road Interchange and Continuous Auxiliary Lanes (3)*

*Figure 42: I-64 at N Gayton Road Interchange and Continuous Auxiliary Lanes (4)*

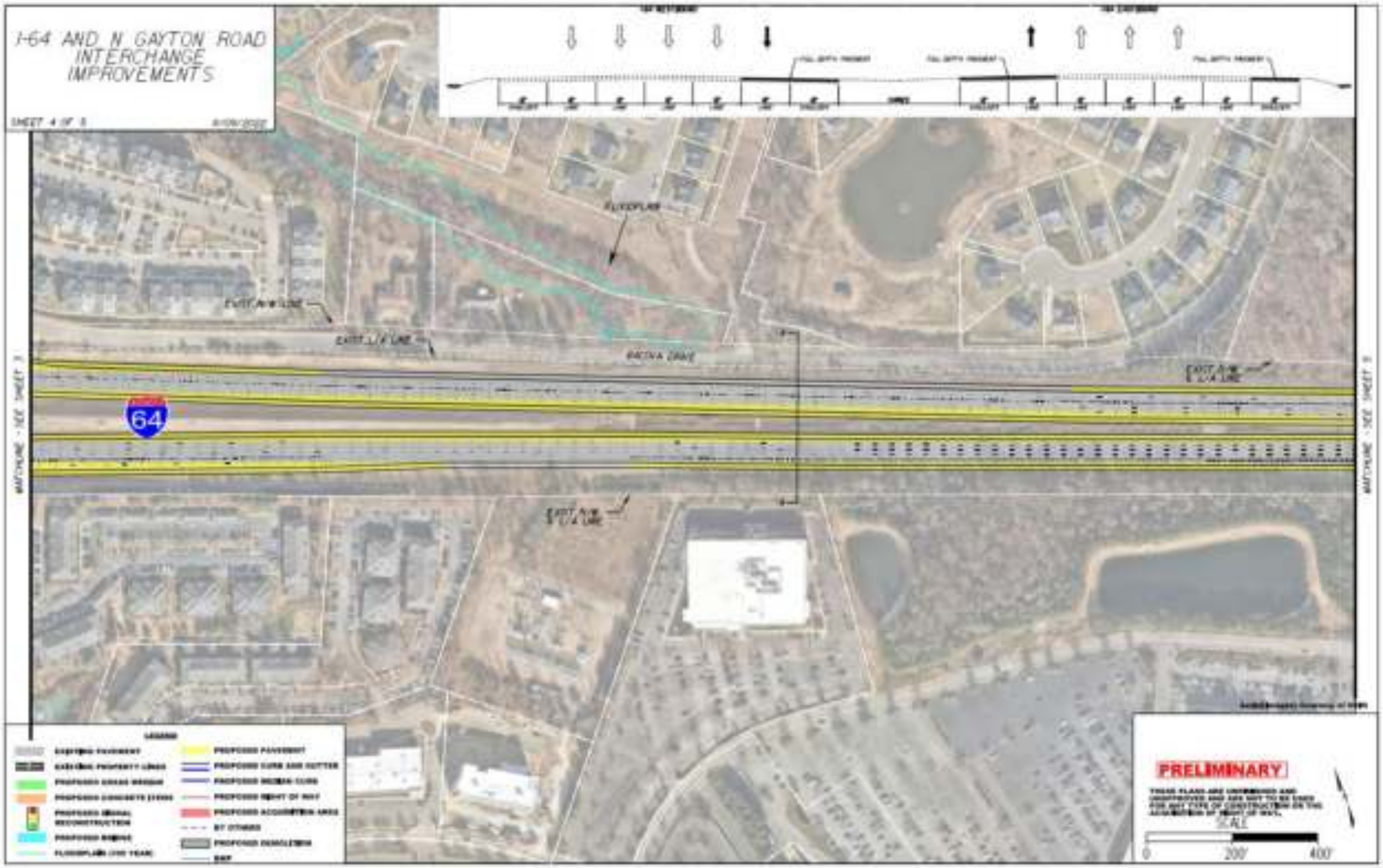


*Figure 43: I-64 at N Gayton Road Interchange and Continuous Auxiliary Lanes (5)*

## Roadway Geometry

Conceptual design plans were developed for the improvements included in the three Build packages. Conceptual design plans were developed in accordance with the following applicable guidelines:

- Policy on Geometric Design of Highways and Streets (AASHTO 2018)
- A Policy on Design Standards – Interstate System (AASHTO 2016)
- VDOT Road Design Manual (Issued January 2005, Revised July 2017)
- VDOT Road and Bridge Standards (VDOT 2016, latest revisions)
- Manual on Uniform Traffic Control Devices (MUTCD 2009)
- 2011 Virginia Supplement to the MUTCD

Design criteria and guidance from these documents were applied to roadways within the project limits based on functional classification and roadway design speeds. The proposed design assumes a WB-67 as the design vehicle to determine the design impacts of the turning radius. *Table 22* summarizes the AASHTO design criteria for each roadway within the project limits. *Table 23* summarizes the VDOT design criteria for each roadway within the project limits.

*Table 22: AASHTO Design Criteria*

| Criteria | I-64 | Route 288 | I-295 | N Gayton Road | US 250 | Interchange Ramps | Interchange Loop Ramps | References or Remarks |
|---|---|---|---|---|---|---|---|---|
| Functional Classification | Interstate | Interstate | Interstate | Urban Major Collector | Urban Principal Arterial | Interchange Ramp | Interchange Ramp | |
| Terrain | Rolling | Rolling | Rolling | Rolling | Rolling | Rolling | Rolling | -- |
| Design Speed | 70 mph | 70 mph | 75 mph | 45 mph | 50 mph | 35 mph | 20 mph | AASHTO Green Book (2018), Section 2.3.6 (page 2-21), Table 10-1 (page 10-105), Section 10.9.6.2.4 (page 10-106) |
| Posted Speed | 65 mph | 65 mph | 70 mph | 45 mph | 45 mph | -- | -- | -- |
| Number of Lanes | 3 each direction | 2 each direction | 2 each direction | 3 each direction | 3 each direction | 1 | 1 | -- |
| Minimum Width, Travel Lane | 12' | 12' | 12' | 11' | 11' | 14' | 14'-16' | AASHTO Green Book (2018), Sections 6.3.2.1 (page 6-16), Sections 7.3.3.2 (page 7-39), 8.2.4 (page 8-3), Table 3-27 (page 3-109) |
| Minimum Width, Vehicle/Bike Shared Lane | -- | -- | -- | 14' | 14' | -- | -- | AASHTO Guide for the Development of Bicycle Facilities, Section 4.3.1 |
| Paved Shoulder Widths | LT: 10' RT: 10' | LT: 10' RT: 10' | LT: 10' RT: 10' | | | LT: 2' RT: 8' | LT: 2' RT: 8' | AASHTO Green Book (2018), Table 6-5 (page 6-6) Table 7-3 (page 7-7), Sections 8.2.4 (page 8-3), 10.9.6 (page 10-102), |
| Total Shoulder Widths | LT: 10' RT: 10' | LT: 10' RT: 10' | LT: 10' RT: 10' | | | LT: 4' RT: 10' | LT: 4' RT: 10' | AASHTO Green Book (2018), Table 6-5 (page 6-6) Table 7-3 (page 7-7), Sections 8.2.4 (page 8-3), 10.9.6 (page 10-102), |
| Normal Cross Slope | 2% | 2% | 2% | 2% | 2% | 2% | 2% | AASHTO Green Book (2018), Table 4-1 (page 4-7), Section 6.3.1.6 (page 6-15), Section 7.3.2.8 (page 7-38), 10.9.6.2.14 (page 10-111) |
| Minimum Radius | 1810' | 1810' | 1810' | 711' | 926' | 314' | 76' | AASHTO Green Book (2018), Table 3-7 (page 3-34) |
| Maximum Superelevation | 8% | 8% | 8% | 4% | 4% | 8% | 8% | AASHTO Green Book (2018), Section 3.3.3.2 (page 3-31) |
| Minimum Stopping Sight Distance on Level Roadways | 730' | 730' | 820' | 360' | 425' | 250' | 115' | AASHTO Green Book (2018),Table 3-1 (page 3-4) |
| Maximum Grade | 4% | 4% | 4% | 9% | 7% | 4 to 6% | 6 to 8% | AASHTO Green Book (2018), Section 6.3.1.5 (page 6-14), Table 7-4a (page 7-38), Table 8-1 (page 8-5), Table 10-2 (page 10-110) |

| Criteria | I-64 | Route 288 | I-295 | N Gayton Road | US 250 | Interchange Ramps | Interchange Loop Ramps | References or Remarks |
|---|---|---|---|---|---|---|---|---|
| Functional Classification | Interstate | Interstate | Interstate | Urban Major Collector | Urban Principal Arterial | Interchange Ramp | Interchange Ramp | |
| Minimum Crest K Value (based on SSD) | 247 | 247 | 312 | 61 | 84 | 29 | 7 | AASHTO Green Book (2018),Table 3-35 (page 3-170) |
| Minimum Sag K Value | 181 | 181 | 206 | 79 | 96 | 49 | 17 | AASHTO Green Book (2018),Table 3-37 (page 3-176) |
| Minimum Median Width | 22' | 22' | 22' | 4' | 4' | -- | -- | AASHTO Green Book (2018), Section 6.3.2.4 (page 6-17), Section 7.3.3.5 (page 7-41), Sections 8.4.2 (page 8-13) |
| Clear Zone | 38' | 38' | 38' | 24' | 14' | 16' | 16' | AASHTO Roadside Design Guide, Table 3-1 (page 3-3) |
| Minimum Vertical Clearance | 16' | 16' | 16' | 14' | 14' | 16' | 16' | AASHTO Green Book (2018), Section 6.3.3.2 (page 6-20), Section 7.3.5.2 (page 7-51), Sections 8.2.9 (page 8-5) |
| Sidewalk Width | -- | -- | -- | 5' | 5' | -- | -- | AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, Section 3.2.3 |
| Sidewalk Buffer Width* | -- | -- | -- | 2' to 4' | 2' to 4' | -- | -- | AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, Section 3.2.4 |
| Access Management Spacing/Limits of Limited Access | -- | -- | -- | -- | -- | -- | -- | TRB Access Management Manual Table 9-14 (page 160) |
| Ramp Terminal Spacing | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' EN-EX (WEAVING) SYSTEM TO SERVICE INTERCHANGE = 2000' | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' EN-EX (WEAVING) SYSTEM TO SERVICE INTERCHANGE = 2000' | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' EN-EX (WEAVING) SYSTEM TO SERVICE INTERCHANGE = 2000' | -- | -- | -- | -- | AASHTO Green Book (2018), Figure 10-70 (page 10-127)<br>*Assumed full freeway & service interchange |

*Table 23: VDOT Design Criteria*

| Criteria | I-64 | Route 288 | I-295 | N Gayton Road | US 250 | Interchange Ramps | Interchange Loop Ramps | References or Remarks |
|---|---|---|---|---|---|---|---|---|
| Functional Classification | Interstate | Interstate | Interstate | Urban Major Collector | Urban Principal Arterial | Interchange Ramp | Interchange Ramp | |
| VDOT Standard | GS-INT | GS-INT | GS-INT | GS-7 | GS-7 | GS-R | GS-R | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Terrain | Rolling | Rolling | Rolling | Rolling | Rolling | Rolling | Rolling | -- |
| Design Speed | 70 mph | 70 mph | 75 mph | 45 mph | 45 mph | 35 mph | 20 mph | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Posted Speed | 65 mph | 65 mph | 70 mph | 45 mph | 45 mph | -- | -- | -- |
| Number of Lanes | 3 each direction | 2 each direction | 2 each direction | 3 each direction | 3 each direction | 1 | 1 | -- |
| Minimum Width, Travel Lane | 12' | 12' | 12' | 11' | 11' | 16' | 18' | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Minimum Width, Vehicle/Bike Shared Lane | -- | -- | -- | 17' | 17' | -- | -- | VDOT Road Design Manual, Appendix A(1), Page A(1)-15 |
| Paved Shoulder Widths | LT: 10' RT: 10' | LT: 10' RT: 10' | LT: 10' RT: 10' | LT: 4' RT: 8' | LT: 4' RT: 8' | LT: 4' RT: 8' | LT: 4' RT: 8' | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Total Shoulder Widths | LT: 12' RT: 12' | LT: 12' RT: 12' | LT: 12' RT: 12' | LT: 6' RT: 10' | LT: 6' RT: 10' | LT: 6' RT: 10' | LT: 6' RT: 10' | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Normal Cross Slope | 2% | 2% | 2% | 2% | 2% | 2% | 2% | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Minimum Radius | 1821' | 1821' | 1821' | 713' | 713' | 316' | 77' | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Maximum Superelevation | 8% | 8% | 8% | 4% | 4% | 8% | 8% | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Minimum Stopping Sight Distance on Level Roadways | 730' | 730' | 730' | 360' | 360' | 250' | 125' | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22 |
| Maximum Grade | 4% | 4% | 4% | 8% | 8% | 4 to 6% | 6 to 8% | VDOT Road Design Manual, Appendix A, Pages A-12, A-18, A-19 and A-22; AASHTO Green Book (2018), Section 6.3.1.5 (page 6-14), Table 7-4a (page 7-38), Table 8-1 (page 8-5), Table 10-2 (page 10-110) |

| Criteria | I-64 | Route 288 | I-295 | N Gayton Road | US 250 | Interchange Ramps | Interchange Loop Ramps | References or Remarks |
|---|---|---|---|---|---|---|---|---|
| Functional Classification | Interstate | Interstate | Interstate | Urban Major Collector | Urban Principal Arterial | Interchange Ramp | Interchange Ramp | |
| Minimum Crest K Value (based on SSD) | 247 | 247 | 247 | 61 | 61 | 29 | 7 | AASHTO Green Book (2018),Table 3-35 (page 3-170) |
| Minimum Sag K Value | 181 | 181 | 181 | 79 | 79 | 49 | 17 | AASHTO Green Book (2018),Table 3-37 (page 3-176) |
| Minimum Median Width | 40' | 40' | 40' | 4' | 4' | -- | -- | VDOT Road Design Manual, Section 2E-3, Pages 2E-9, 2E-10 |
| Clear Zone | 38' | 38' | 38' | 24' | 24' | 16' | 16' | VDOT Road Design Manual, Appendix A, Table A-2-1, Pg. A-29 |
| Minimum Vertical Clearance | 16.5' | 16.5' | 16.5' | 14.5'* | 14.5'* | 14.5'* | 14.5'* | VDOT Manual of the Structure and Bridge Division - Volume V - Part 2 Design Aids - Chapter 6 |
| Sidewalk Width | -- | -- | -- | 5' | 5' | -- | -- | VDOT Road Design Manual, Appendix A(1), Page A(1)-71 |
| Sidewalk Buffer Width | -- | -- | -- | 4' | 4' | -- | -- | VDOT Road Design Manual, Appendix A(1), Page A(1)-69 |
| Access Management Spacing/Limits of Limited Access | -- | -- | -- | X = 750'; Y = 1320'; M = 990' | X = 750'; Y = 1320'; M = 990' | -- | -- | VDOT Road Design Manual, Appendix F, Page F-30, Table 2-3, Figure 2-9<br>X = Distance to first entrance on the right from end of off-ramp terminal; right in/right out only<br>Y = Distance to first four-legged intersection measured from the end of the off-ramp terminal<br>M = Distance to first directional median crossover from off-ramp terminal |
| Ramp Terminal Spacing | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' | EX-EX; EN-EN = 1000' EX-EN = 500' TURNING ROAD = 800' EN-EX = 1600' | -- | -- | -- | -- | AASHTO Green Book (2018), Figure 10-70 (page 10-127)<br>*Assumed full freeway & service interchange |

## DESCRIPTION OF PROPOSED IMPROVEMENTS

### Partial Cloverleaf Interchange at I-64 and US 250

A conceptual roadway sketch of the improvement is provided in *Figure 28* and *Figure 29*. This improvement consists of the following components:

- Construct an auxiliary lane on westbound I-64 between the US 250 and I-295 interchanges
- Reconstruct US 250 between Tom Leonard Drive and Dominion Boulevard by constructing contraflow left turns to the eastbound and westbound I-64 on ramps
- Construct a traffic signal for the eastbound US 250 left turns onto the westbound I-64 on-ramp.
- Construct sidewalk along eastbound US 250 from West Broad Village to connect to the existing sidewalk east of the interchange
- Eliminate the existing loop ramp from eastbound US 250 to westbound I-64
- Widen the westbound I-64 on-ramp from US 250 to two lanes
- Reconstruct I-64, including new bridges over US 250, to accommodate the widening of US 250
- Reconfigure the eastbound I-64 to eastbound US 250 loop ramp

### Route 288 Southbound Auxiliary Lane

A conceptual roadway sketch of the improvement is provided in *Figure 30*. This improvement consists of the following components:

- Construct an auxiliary lane on southbound Route 288 between the US 250 and Tuckahoe Creek Parkway interchanges

### Route 288 Northbound Auxiliary Lane and US 250 Improvements

A conceptual roadway sketch of the improvement is provided in *Figure 30* through *Figure 35*. This improvement consists of the following components:

- Construct an auxiliary lane on northbound Route 288 between the US 250 and I-295 interchanges
- Construct dual northbound right-turn lanes at the US 250 intersection with the southbound Route 288 ramps
- Widen the northbound Route 288 off-ramp to two lanes
- Restripe the eastbound approach at Wilkes Ridges Parkway from a right-turn only lane to a shared through/right lane and construct side street intersection improvements
- Extend the fourth eastbound through lane east of Bon Secours Parkway intersection

### US 250 Thru-Cut at Tom Leonard Drive

A conceptual roadway sketch of the improvement is provided in *Figure 36*. This improvement consists of the following components:

- Install barrier to restrict vehicles weaving from the eastbound I-64 off-ramp to turn left into Gathering Place
- Convert the westbound US 250 right turn lane into a shared through/right lane at Tom Leonard Drive
- Construct a thru-cut intersection at Tom Leonard Drive

### Northeastbound I-295 Auxiliary Lane

A conceptual roadway sketch of the improvement is provided in *Figure 37*. This improvement consists of the following components:

- Construct an auxiliary lane on northeastbound I-295 between the I-64 and Nuckols Road interchanges

### I-64 Eastbound Off Ramp Lane Reconfiguration

A conceptual roadway sketch of the improvement is provided in *Figure 38*. This improvement consists of the following components:

- Restripe the eastbound I-64 ramp diverge at I-295 to create one exit only lane and one choice lane

### Diverging Diamond Interchange at I-64 and N Gayton Road

A conceptual roadway sketch of the improvement is provided in *Figure 39* through *Figure 43*. This improvement consists of the following components:

- Construct a diverging diamond interchange at I-64 and N Gayton Road
- Construct an auxiliary lane on westbound I-64 between the I-295 interchange and the proposed N Gayton Road interchange
- Construct an auxiliary lane on westbound I-64 between the proposed N Gayton Road interchange and the I-288 interchange
- Construct an auxiliary lane on eastbound I-64 between the I-288 interchange and the proposed N Gayton Road interchange
- Construct an auxiliary lane on eastbound I-64 between the proposed N Gayton Road interchange and the I-295 interchange
- Reconstruct N Gayton Road to accommodate the diverging diamond interchange
- Construct a shared-use path along southbound N Gayton Road from US 250 to the existing shared-use path
- Construct traffic signals at the proposed intersections of N Gayton Road and the I-64 ramps
- Eliminate Bacova Drive from Marshall Run Circle to approximately 1,500 linear feet west of N Gayton Road
- Construct triple southbound left-turn lanes at the intersection of N Gayton Road and US 250
- Reconstruct Blue Ocean Lane to right-in only from N Gayton Road to Calm Harbor Drive

## GEOMETRIC CRITERIA

The improvements were developed to follow the design criteria listed in *Table 22* and *Table 23*. For all improvements, the horizontal and vertical alignment, design speeds, sight distance, and access requirements have been reviewed to confirm that the AASHTO and VDOT standards are met for the respective roadway classifications. There are no known sight distance issues. The preferred alternative access change meets AASHTO route continuity and lane balance standards. The design speeds of the ramps proposed to be modified are at least 50 percent of the mainline design speed and the acceleration and deceleration lengths for ramps meet AASHTO and VDOT standards considering truck traffic.

### Existing Conditions and Proposed Conditions

The existing conditions and proposed conditions have been reviewed to highlight the geometric improvements for all roadway improvements. Typical sections for the proposed improvements are shown on *Figure 28* through *Figure 43* where appropriate.

- **Partial Cloverleaf Interchange at I-64 and US 250**
  - **Existing**
    - The existing interchange consists of a partial cloverleaf interchange that consists of two loop ramps and four directional ramps. US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a closed median and a combination of curb and gutter and two-foot outside shoulder. US 250 passes underneath I-64 via a tangent section with a consistent vertical alignment. I-64 consists of a six-lane interstate with 12-foot travel lanes and 12-foot left and right shoulders for eastbound and westbound. I-64 passes over US 250 via a tangent section with a consistent vertical alignment. The I-64 on and off-ramps consist of 16-foot travel lanes with 2-foot left shoulders and 6-foot right shoulders for the single

lane ramps and 12-foot travel lanes with 10-foot left shoulders and 2-foot right shoulders for the dual lane directional ramps.

- **Proposed**
  - The proposed interchange consists of a partial cloverleaf interchange that consists of three loop ramps and four directional ramps. US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a closed median and a combination of curb and gutter and two-foot outside shoulder. I-64 consists of a six-lane interstate with 12-foot travel lanes and 12-foot left and right shoulders for eastbound and westbound. The I-64 on and off-ramps consist of 16-foot travel lanes with 2-foot left shoulders and 6-foot right shoulders for the single lane ramps and 12-foot travel lanes with 4-foot left shoulders and 8-foot right shoulders for the dual lane directional ramps.
- **Route 288 Southbound Auxiliary Lane**
  - **Existing**
    - The existing condition of Southbound Route 288 consists of two 12-foot travel lanes with a 12-foot right shoulder and a 10-foot left shoulder.
  - **Proposed**
    - The proposed condition of Southbound Route 288 consists of two-12 foot travel lanes and a proposed 12-foot auxiliary lane with 12-foot right shoulder and a 10-foot left shoulder.
- **Route 288 Northbound Auxiliary Lane and US 250 Interchange**
  - **Existing**
    - The existing condition of Northbound Route 288 off-ramp consists of two 11-foot travel lanes with a 10-foot right shoulder and a 4-foot left shoulder. US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a closed median and combination of curb and gutter.
  - **Proposed**
    - The proposed condition of Northbound Route 288 off-ramp consists of three 11-foot travel lanes with a 10-foot right shoulder and a 4-foot left shoulder. US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a closed median and curb and gutter.
- **US 250 Thru-Cut at Tom Leonard Drive**
  - **Existing**
    - The existing condition of US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a 24-foot grass median and curb and gutter.
  - **Proposed**
    - The proposed condition of US 250 (W Broad Street) consists of a six-lane divided arterial with 11-foot travel lanes and a 4-foot concrete median and curb and gutter.
- **Northeastbound I-295 Auxiliary Lane**
  - **Existing**
    - The existing condition of Northbound I-295 consists of three 12-foot travel lanes with a 12-foot right shoulder and a 12-foot left shoulder.
  - **Proposed**
    - The proposed condition of Northbound I-295 consists of three-12 foot travel lanes and a proposed 12-foot auxiliary lane with 12-foot right shoulder and a 10-foot left shoulder.
- **Diverging Diamond Interchange at I-64 and N Gayton Road**
  - **Existing**
    - The existing interchange of N Gayton Road consists of a six-lane divided arterial with 12-foot travel lanes and a closed median and curb and gutter. I-64 consists of a six-lane interstate with 12-foot travel lanes and 12-foot left and right shoulders for eastbound and westbound. I-64 currently passes underneath

N Gayton Road via a tangent section with a consistent vertical alignment. N Gayton Road currently passes over I-64 via a tangent section with a crest vertical alignment.

- **Proposed**
  - The proposed interchange consists of a diverging diamond interchange. N Gayton Road consists of a six-lane divided arterial with 12-foot travel lanes and a closed median and curb and gutter. I-64 consists of a six-lane interstate with 12-foot travel lanes and 12-foot left and right shoulders for eastbound and westbound. The I-64 on and off-ramps consist of 16-foot travel lanes with 4-foot left shoulders and 8-foot right shoulders.

### Potential Design Exceptions

Based on a review of the conceptual design for all improvements and the constraints of the corridor, it is anticipated that the following design exceptions may be required for the design of the project:

- Left shoulder width along I-64
  - A potential design exception would be required for the inside widening of eastbound I-64 at the Pouncey Tract Road overpass. The proposed widening will utilize a portion of the existing 12-foot inside shoulder for the travel lane thus reducing the proposed left shoulder to approximately 6 feet adjacent to the bridge pier protection system for Pouncey Tract Road overpass. The potential design exception would only be required in this localized area and this design decision would avoid impacts to the Pouncey Tract Road overpass.

### Potential Design Waivers

Based on a review of the preferred alternative limits and constraints of the corridor, it is anticipated that the following design waivers may be required for the design of the project:

- Right shoulder widths along I-64, I-295, and Route 288
  - The conceptual design of the proposed improvements includes widening to the outside for the auxiliary lanes along I-64, I-295, and Route 288. In an effort to avoid impacting multiple structures – the existing Route 288 bridge over Tuckahoe Creek, the existing N Gayton Road bridge over I-64, and the existing Pouncey Tract Road bridge over I-64 – the proposed shoulder width may be reduced to 8 feet. The VDOT standard right shoulder width required is 10 feet. The existing 10-foot-wide right shoulder is adjacent to a through lane, but the reduced shoulder for the proposed improvements would be adjacent to an auxiliary lane. Approval of this design waiver would concentrate the improvement footprints and minimize the need to impact the existing right-of-way and limited access line with proposed slope limits and/or stormwater management basins.
- Use of existing drainage culvert under I-64, I-295, and Route 288 (hydraulic adequacy in existing and proposed condition has not yet been analyzed)
  - The conceptual design of the proposed improvements, specifically the I-64, I-295, and Route 288 auxiliary lanes, will impact and may require the extension of multiple culverts along I-64, I-295, and Route 288 that do not see a significant increase in drainage due to the project. These drainage appurtenances may or may not be adequate in the existing condition and require extension. If that is the case, a design waiver will be required to not upgrade the unaffected capacity deficiency and extend the pipe or culvert.

*Table 24* summarizes the potential design waivers associated with the proposed improvements.

*Table 24: Potential Design Waivers*

| To Be Obtained By | DE or DW | Item | Location | Design Feature | Proposed Design | Min AASHTO (for DE) and VDOT (For DW) Standards Required | Remarks | Required for Standard to be Fully Met |
|---|---|---|---|---|---|---|---|---|
| VDOT | DW | Reduced Right Shoulder Width for Auxiliary Lane | I-64 | Shoulder Width | 8' Shoulder | 10' Paved Shoulder | This design waiver would be for the localized reduction in shoulder width due to avoiding impacts to the Pouncey Tract Road and N Gayton Road overpasses | Full rebuild of the Pouncey Tract Road and N Gayton Road overpasses |
| VDOT | DW | Reduced Right Shoulder Width for Auxiliary Lane | I-295 | Shoulder Width | 8' Shoulder | 10' Paved Shoulder | This design waiver would be for the localized reduction in shoulder width to avoid the extension of an existing culvert | Multi-cell box culvert extension and additional floodplain impacts |
| VDOT | DW | Reduced Right Shoulder Width for Auxiliary Lane | Route 288 | Shoulder Width | 8' Shoulder | 10' Paved Shoulder | This design waiver would be for the localized reduction in shoulder width due to avoiding widening of the Tuckahoe Creek bridge | Widening of the Route 288 bridge over Tuckahoe Creek |
| VDOT | DW | Reduced Left Shoulder Width Along I-64 | I-64 | Shoulder Width | Varies (0-4') | 4' Paved Shoulder | This design waiver would be for the localized reduction in shoulder width due to avoiding impacts to the Pouncey Tract Road and N Gayton Road overpasses | Full rebuild of the Pouncey Tract Road and N Gayton Road overpasses |
| VDOT | DW | Hydraulic Capacity of Existing Culvert | I-64 | Hydraulic Capacity | Culvert Extension | Meeting Minimum Freeboard | This design waiver would be a culvert extension that would not upgrade the unaffected capacity of the existing culvert | Full rebuild of multiple culverts across the I-64 corridor |

| To Be Obtained By | DE or DW | Item | Location | Design Feature | Proposed Design | Min AASHTO (for DE) and VDOT (For DW) Standards Required | Remarks | Required for Standard to be Fully Met |
|---|---|---|---|---|---|---|---|---|
| VDOT | DW | Hydraulic Capacity of Existing Culvert | I-295 | Hydraulic Capacity | Culvert Extension | Meeting Minimum Freeboard | This design waiver would be a culvert extension that would not upgrade the unaffected capacity of the existing culvert | Full rebuild of one culvert along the I-295 corridor |
| VDOT | DW | Hydraulic Capacity of Existing Culvert | Route 288 | Hydraulic Capacity | Culvert Extension | Meeting Minimum Freeboard | This design waiver would be a culvert extension that would not upgrade the unaffected capacity of the existing culvert | Full rebuild of multiple culverts across the Route 288 corridor |

## Access Management

Key distances between access points along N Gayton Road and US 250 were identified during the geometric review of the proposed improvements based on standards in the Transportation Research Board's (TRB) *Access Management Manual*. The following locations were identified as areas where recommended TRB *Access Management Manual* dimensions could not be accommodated with the least impactful proposed improvements*:*

- **Partial Cloverleaf Interchange at I-64 and US 250**
  - Minimum spacing standards from the end of ramp terminal to partial access/full access intersections along US 250
  - Minimum spacing between traffic signals along US 250 at the proposed signal at the westbound I-64 ramps and the eastbound I-64 ramps
- **Route 288 Northbound Auxiliary Lane and US 250 Improvements**
  - Minimum commercial entrance spacing standards along US 250 between the southbound Route 288 ramps and Robert Atack Way
- **US 250 Thru-Cut at Tom Leonard Drive**
  - Minimum commercial entrance spacing standards along US 250 between Brownstone Boulevard and the eastbound I-64 ramps
- **Diverging Diamond Interchange at I-64 and N Gayton Road**
  - Minimum spacing standards from the end of ramp terminal to partial access/full access intersections along N Gayton Road
  - Minimum commercial entrance spacing standards along N Gayton Road between US 250 and Liesfeld Farm Drive
  - Minimum spacing between traffic signals along N Gayton Road at the proposed intersections with the westbound and eastbound I-64 ramps

### Proposed Right-of-Way Acquisition Line

Proposed right-of-way, easements, and an adjustment to the existing limited access line is anticipated for the proposed improvements on I-64, Route 288, US 250, and N Gayton Road. The following locations were identified for each improvement:

- **Partial Cloverleaf Interchange at I-64 and US 250**
  - Proposed right-of-way impacts are anticipated for properties within the vicinity of the proposed sidewalk along eastbound US 250. Temporary construction and private utility easements are also anticipated near the proposed sidewalk.
- **Route 288 Northbound Auxiliary Lane and US 250 Improvements**
  - Proposed right-of-way impacts are anticipated for properties within the vicinity of the northbound Route 288 off-ramp widening and the proposed sidewalk along eastbound and westbound US 250. Temporary construction and private utility easements are also anticipated near the proposed sidewalk improvements.
- **US 250 Thru Cut at Tom Leonard Drive**
  - Proposed right-of-way impacts are anticipated for properties within the vicinity of the shared through-right lane and proposed sidewalk along westbound US 250. Temporary construction and private utility easements are also anticipated near the proposed sidewalk.

- **Diverging Diamond Interchange at I-64 and N Gayton Road**
  - Proposed right-of-way and limited access changes are anticipated for properties within the vicinity of the proposed ramps from I-64 to N Gayton Road. Temporary construction and private utility easements are also anticipated near these ramps. Utility, right-of-way, and limited access line impacts are anticipated for the auxiliary lane improvements between Route 288 and I-295. The preferred alternative will include the pavement needed for the auxiliary lanes and potential sound walls.

### Conceptual Signing Plan

The study team developed a conceptual signing plan for the preferred alternative (see the *Selection of Preferred Alternative* section), which is included in *Appendix H*. The conceptual signing plan is in accordance with the guidance provided in the *MUTCD*. Due to interchange spacing, the advanced guide signs for the new interchange at N Gayton Road were only placed ½ mile and 1 mile in advance of the exits. Similarly, the advanced guide signs for the westbound I-64 off-ramp to Route 288 and the eastbound I-64 off-ramp to I-295 were only placed ½ mile and 1 mile in advance of the exits.

Interchange sequence signing should be evaluated for potential inclusion in the signing plan during the design phase. Interchange sequence signs can be used to supplement advance guide signs in urban areas with closely spaced interchanges.

### Pedestrian and Bicycle Facilities

Proposed pedestrian and bicycle accommodations are provided throughout the proposed improvements. The partial cloverleaf interchange at the I-64 interchange with US 250 will include pedestrian improvements along eastbound US 250 to tie to existing pedestrian features along US 250. The northbound Route 288 auxiliary lane and improvements on US 250 will include pedestrian improvements along eastbound and westbound US 250 to tie to existing pedestrian features along US 250. The US 250 thru-cut at Tom Leonard Drive will include pedestrian improvements along westbound US 250 to tie to existing pedestrian features. The new diverging diamond interchange on I-64 at N Gayton Road will include a shared-use path along southbound N Gayton Road and sidewalk improvements within the corridor to tie to existing bicycle and pedestrian features along N Gayton Road.

## Forecasted Traffic Volumes and Operations

As part of the *STARS US 250 Corridor Study*, VDOT TMPD created a subarea model from the Richmond/Tri-Cities regional travel demand model, calibrated it with updated traffic count and socioeconomic data in Henrico and Goochland counties, and developed linear growth rates. The SWG for the *STARS US 250 Corridor Study* agreed to apply the linear growth rates developed from the subarea travel demand model except where recent VDOT-approved growth rates existed (e.g., US 250 east of I-64, Route 288 south of US 250). For this IAR, the SWG reached consensus to apply the following growth rates from the *STARS US 250 Corridor Study*:

- I-64
  - 1.50 percent linear growth rate west of Route 288
  - 2.00 percent linear growth rate between Route 288 and I-295
  - 1.75 percent linear growth rate between I-295 and US 250
  - 1.06 percent linear growth rate east of US 250
- I-295
  - 1.67 percent linear growth rate

- Route 288
  - 2.25 percent linear growth rate between I-64 and US 250
  - 2.50 percent linear growth rate south of US 250
- US 250
  - 2.50 percent linear growth rate between Hockett Road and Route 288
  - 2.25 percent linear growth rate between Route 288 and N Gayton Road
  - 1.25 percent linear growth rate between N Gayton Road and Lauderdale Drive
  - 0.75 percent linear growth rate between Lauderdale Drive and I-64
  - 0.70 percent linear growth rate east of I-64
- N Gayton Road
  - 2.25 percent linear growth rate

Linear traffic growth rates were applied to the 2019 existing traffic volumes to generate projected 2026 and 2046 traffic volumes for the No-Build option. Ramp growth was balanced between the arterial and freeway growth rates, which resulted in a blended growth rate for each ramp. The projected 2026 and 2046 AM and PM peak hour traffic volumes for the No-Build option are summarized in *Figure 44* and *Figure 45.*

## NO-BUILD

### No-Build Peak Hour Factors and Heavy Vehicle Percentages

Heavy vehicle traffic was anticipated to grow at a similar rate to passenger vehicles. Therefore, heavy vehicle percentages were assumed to remain unchanged when compared to existing conditions for all study area roadways in the No-Build option.

Peak hour factors were updated in the No-Build Synchro networks based on the guidance provided in the *TOSAM* for the optimization of future conditions traffic signals. Peak hour factors were not used for the No-Build Vissim analyses because 15-minute traffic volumes were coded for the vehicle inputs.

### No-Build Modeling Assumptions

The background improvements discussed in the *Alternatives Considered* chapter were coded into the calibrated existing AM and PM Vissim models to develop the 2026 and 2046 No-Build models. The background improvements were coded separately into each peak period model to maintain the existing calibration adjustments. A detailed summary of the No-Build Vissim modeling inputs is provided in *Appendix E*.

The VDOT Sample Size Determination Tool, Version 2.0 was used to determine the number of traffic simulation runs required to provide the acceptable 95th percentile confidence level for the 2026 and 2046 No-Build models. Ten simulation runs were conducted for all models using different random seeds and the average of these runs was reported. The VDOT Sample Size Determination Tool summary sheets are provided in *Appendix E*.

*Figure 44: No-Build (2026) Peak Hour Traffic Volumes*

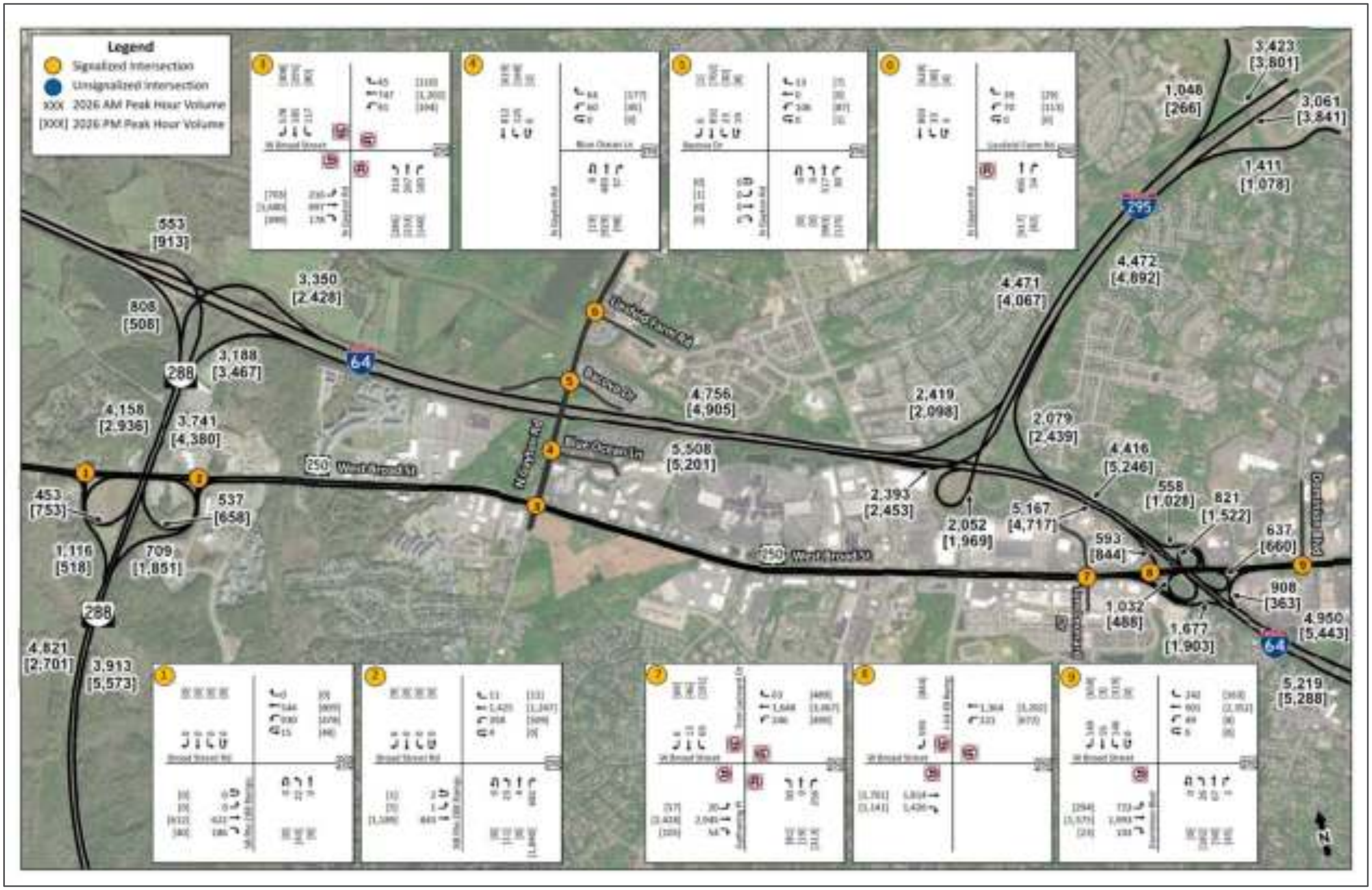
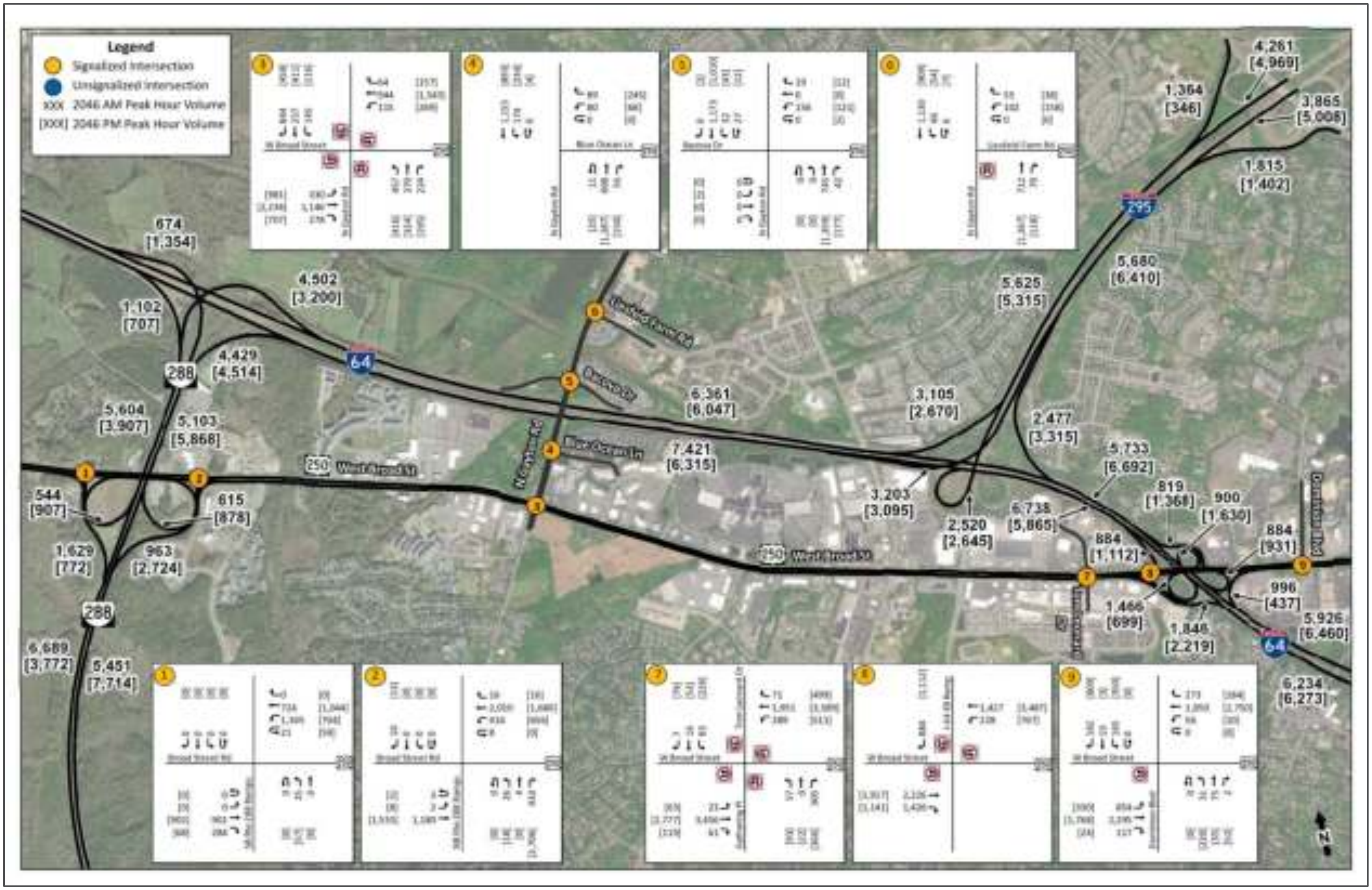


*Figure 45: No-Build (2046) Peak Hour Traffic Volumes*



## No-Build Conditions Freeway Analysis Results

The AM and PM peak hour average freeway segment density and speed for the 2026 and 2046 No-Build conditions are illustrated in *Figure 46* through *Figure 48* and *Figure 50* through *Figure 53*. Graphical representation of the freeway results by lane is included in *Appendix E*.

### *AM Peak Hour*

In the 2026 AM peak hour, the southwestbound I-295 off-ramp to eastbound I-64 was projected to operate with severely congested densities and slow speeds. The congestion at this location is caused by the limited capacity of the single-lane loop ramp as the demand increased to 2,052 vehicles in the AM peak hour. The congestion was projected to extend along southwestbound I-295 back towards the Nuckols Road interchange. Speeds on southwestbound I-295 range between 20 and 35 mph in this area.

Density was also projected to increase slightly from 2019 at the eastbound I-64 on-ramp from northbound Route 288 and at the southbound Route 288 on-ramp from US 250. At the eastbound I-64 on-ramp from northbound Route 288, vehicles were projected to preposition in the rightmost through lane on eastbound I-64 in advance of the exit to I-295, which resulted in densities above 35 veh/ln/mi on the ramp. Densities above 35 veh/ln/mi were also projected at the southbound Route 288 on-ramp from US 250 and further downstream on Route 288 as Route 288 was projected to serve 4,821 vehicles in three lanes.

By 2046, most of the freeway network within the study area was projected to operate with densities greater than 45 veh/ln/mi. Eastbound I-64 was projected to operate with densities above 100 veh/ln/mi and speeds below 20 mph at the on-ramp from northbound Route 288. The congestion in this area was attributed to vehicles that prepositioned in the rightmost through lane on eastbound I-64 in advance of the exit to I-295. The slow speeds were projected to extend upstream where speeds were projected below 20 mph for all of northbound Route 288 within the study area.

Two bottlenecks on southbound Route 288 contribute to high densities and slow speeds on Route 288 between the US 250 and I-64 interchanges and on westbound I-64: the merge from three to two lanes within the US 250 interchange and the on-ramp from US 250. Westbound I-64 between the I-295 and Route 288 interchanges was projected to operate with speeds below 20 mph.

Speeds and densities were also projected to worsen on southwestbound I-295 as the demand on the single-lane loop ramp to eastbound I-64 was projected to increase to 2,520 vehicles in the AM peak hour. This congestion was projected to affect upstream operations on southwestbound I-295 where speeds were projected to fall below 20 mph.

Speeds were also projected to fall below 25 mph on eastbound I-64 between the on-ramp from southwestbound I-295 and the off-ramp to eastbound US 250. These slow speeds were largely attributed to queuing on eastbound US 250 between the interchange and Dominion Boulevard that backed up to eastbound I-64 as shown in *Figure 49*.

### *PM Peak Hour*

In the 2026 PM peak hour, densities greater than 45 veh/ln/mi were projected on westbound I-64 within the US 250 interchange. The high density in this area was attributed to the high number of vehicles exiting to westbound US 250 on a single-lane loop ramp and queuing on westbound US 250 that backs up to the interstate.

The southwestbound I-295 off-ramp to eastbound I-64 was projected to be over capacity as the demand on the single-lane loop ramp was projected to be 1,969 vehicles in the PM peak hour. This excess demand resulted in projected densities greater than 45 veh/ln/mi.

The northeastbound I-295 on-ramp from westbound I-64 was projected to operate with speeds between 20 and 35 mph where the ramp merges from two lanes to one lane prior to merging onto I-295. The slow speeds on the ramp were projected to impact upstream operations on westbound I-64, where speeds were projected to fall below 60 mph between the US 250 and I-295 interchanges.

In 2046, four defined freeway bottlenecks were projected within the study area:

- Westbound I-64 was projected to experience densities over 100 veh/ln/mi and speeds below 10 mph within the weave at the US 250 interchange that was attributed to the high number of vehicles exiting to westbound US 250 on a single-lane loop ramp and queuing on westbound US 250 that backs up to the interstate. The maximum queue length on westbound I-64 was projected to extend approximately 5 miles back to the interchange with US 250 and Glenside Drive as shown in *Figure 54*. The 5-mile projected queue was not solely attributable to the weave at the US 250 interchange. It is worsened by the congestion and cumulative queuing impacts as it extends past the interchanges to the east. This bottleneck was projected to prevent some vehicles from reaching I-295 or the section of I-64 between I-295 and Route 288.
- The northeastbound I-295 on-ramp from westbound I-64 was projected to operate with speeds below 10 mph prior to the merge from two lanes to one lane. The slow speeds on the ramp were projected to impact upstream operations on westbound I-64, where speeds were projected to fall below 20 mph between the US 250 and I-295 interchanges.
- Queues from the northbound Route 288 off-ramp to US 250 were projected to extend the length of the ramp and back to mainline Route 288, causing severe congestion and slow speeds. The heavy northbound right-turn movement at the ramp terminal and the close proximity of the intersection with Wilkes Ridge Parkway contribute to the ramp queuing. Densities on northbound Route 288 were projected to exceed 100 veh/ln/mi upstream of the interchange and the congestion resulted in a bottleneck that prevents some vehicles from reaching I-64.
- The southwestbound I-295 off-ramp to eastbound I-64 was projected to be over capacity as the demand on the single-lane loop ramp was projected to be 2,645 vehicles in the PM peak hour. The congestion from the loop ramp was projected to extend upstream on southeastbound I-295 with densities above 100 veh/ln/mi and speeds below 20 mph. The bottleneck caused by the off-ramp to eastbound I-64 not only limited the number of vehicles that reached eastbound I-64 (56 percent), but also the number of vehicles that reached westbound I-64 (66 percent).

The segment of I-64 between Route 288 and I-295 was projected to operate with densities below 25 veh/ln/mi and speeds above 55 mph during the PM peak hour. However, these speeds and densities were achievable because the bottlenecks elsewhere in the study area prevented many vehicles from reaching this segment of I-64. Eastbound and westbound I-64 in this area were only projected to serve 74 and 78 percent of the PM peak hour demand.

*Figure 46: No-Build (2026) AM Peak Hour Average Density*

*Figure : No-Build (2026) AM Peak Hour Average Speed*

Figure 47: No-Build (2046) AM Peak Hour Average Density

*Figure 48: No-Build (2046) AM Peak Hour Average Speed*

*Figure 49: No-Build (2046) AM Peak Hour Maximum Queue Length (Depictive)*

*Figure 50: No-Build (2026) PM Peak Hour Average Density*

*Figure 51: No-Build (2026) PM Peak Hour Average Speed*

*Figure 52: No-Build (2046) PM Peak Hour Average Density*

*Figure 53: No-Build (2046) PM Peak Hour Average Speed*

*Figure 54: No-Build (2046) PM Peak Hour Maximum Queue Length (Depictive)*

## No-Build Conditions Intersection Analysis Results

Graphical representation of the average intersection delay (seconds per vehicle) by movement and maximum queue length (feet) are shown in *Figure 55* through *Figure 62*. Maximum queue lengths reported with an asterisk in the figures indicate a queue length that backs up to the freeway and includes the queue length on the freeway.

### *AM Peak Hour*

In the 2026 AM peak hour, the intersection of US 250 and N Gayton Road was projected to operate with the most overall intersection delay at 32.1 seconds per vehicle. All left-turn movements at the intersection were projected to operate with delays of 56.9 seconds per vehicle or greater. The southbound right-turn maximum queue at the intersection is projected to extend beyond the end of the 575-foot storage bay.

The longest maximum vehicle queue was projected to occur on eastbound US 250 at the intersection with Tom Leonard Drive (1,060 feet). This queue extends back to the upstream signal at Brownstone Boulevard. All left-turn movements at the intersection were projected to operate with 54.3 seconds per vehicle or greater of delay.

The intersection of US 250 and the southbound Route 288 ramps was projected to operate with an overall intersection delay of 25.9 seconds per vehicle. The westbound left turn at the intersection was projected to operate with 59.6 seconds per vehicle of delay. The maximum queue for the westbound left-turn movement onto southbound Route 288 was projected to extend 975 feet, which is longer than the available storage for the dual left-turn lanes.

The intersection of US 250 and Dominion Boulevard was projected to experience less delay and shorter queues than the existing AM peak hour analysis. This improvement was attributed to the two background improvements that are projected to be constructed before 2026 as shown in *Table 11*.

All other study area intersections were projected to operate with overall intersection delays of 27.1 seconds per vehicle or better.

By 2046, all left-turn movements at the intersection of US 250 and N Gayton Road were projected to operate with delays of 56 seconds per vehicle or greater. The southbound right-turn maximum queue was projected to extend 1,130 feet, impacting the operations of the other movements on the southbound approach and the upstream signalized intersection at Blue Ocean Lane. The intersection of N Gayton Road and Blue Ocean Lane was projected to operate with the highest overall intersection delay of any study area intersection (83.6 seconds per vehicle) due to the queuing downstream.

The intersection of US 250 and Dominion Boulevard was projected to operate with an overall intersection delay of 51.4 seconds per vehicle. All left-turn movements were projected to operate with 61.5 seconds per vehicle of delay or greater. The eastbound left-turn and through movement queues were project to extend over 1,000 feet on US 250 and impact the operations of the ramps at the interchange. A visual depiction of the queues that extend from this intersection back to the interstate is shown in *Figure 49*.

### *PM Peak Hour*

In the 2026 PM peak hour, the intersection of US 250 and N Gayton Road was projected to operate with the most overall intersection delay at 45.7 seconds per vehicle. All left-turn movements were projected to operate with delays greater than 67 seconds per vehicle, with the eastbound left-turn projected to exceed 200 seconds per vehicle. Queues were projected to extend beyond the 500-foot turn bay and impact the operations of eastbound US 250.

The northbound right-turn movement at the intersection of US 250 and the northbound Route 288 off-ramps was projected to operate with a delay of 76.9 seconds of delay per vehicle. The queue was projected to extend the length of the off-ramp and impact the operations on northbound Route 288.

All left-turn movements at the intersection of US 250 and Tom Leonard Drive were projected to operate with more than 60.5 seconds of delay per vehicle. The westbound queues at the intersection are projected to extend back several miles onto westbound I-64

The intersection of US 250 and Dominion Boulevard was projected to experience less delay and shorter queues than the existing PM peak hour analysis. This improvement was attributed to the two background improvements that are projected to be constructed before 2026 as shown in *Table 11*.

By 2046, the intersection of US 250 and the northbound Route 288 ramps was projected to operate with the most overall intersection delay at 153.5 seconds per vehicle. Conditions on the northbound Route 288 off-ramp and specifically the northbound right-turn movement were expected to significantly worsen, with excessive delays of 440.3 seconds per vehicle. The queue from the right-turn movement was projected to extend the length of the off-ramp and cause a bottleneck on northbound Route 288 that prevented some vehicles from continuing to other destinations on I-64 or US 250.

The intersection of US 250 and N Gayton Road was projected to operate with an overall intersection delay of 65.9 seconds per vehicle. The delays and maximum queue lengths for the eastbound approach at the intersection were projected to decrease between 2026 and 2046. This decrease was attributed to the bottleneck on northbound Route 288 that prevented vehicles from reaching this intersection, which improved operations. All movements on the northbound and southbound approaches at the N Gayton Road intersection were projected to operate with significant delays of 72.2 seconds or greater.

Heavy queuing and high delays were projected to continue westbound at the US 250 intersections with Tom Leonard Drive and the I-64 eastbound ramps. These queues were projected to extend back onto both the eastbound and westbound I-64 off-ramps to westbound US 250 and contribute to slow speeds and congestion on I-64 in both directions. A visual depiction of the queues that extend from this intersection back to the interstate is shown in *Figure 54*.

Figure 55: No-Build (2026) AM Peak Hour Intersection Delay

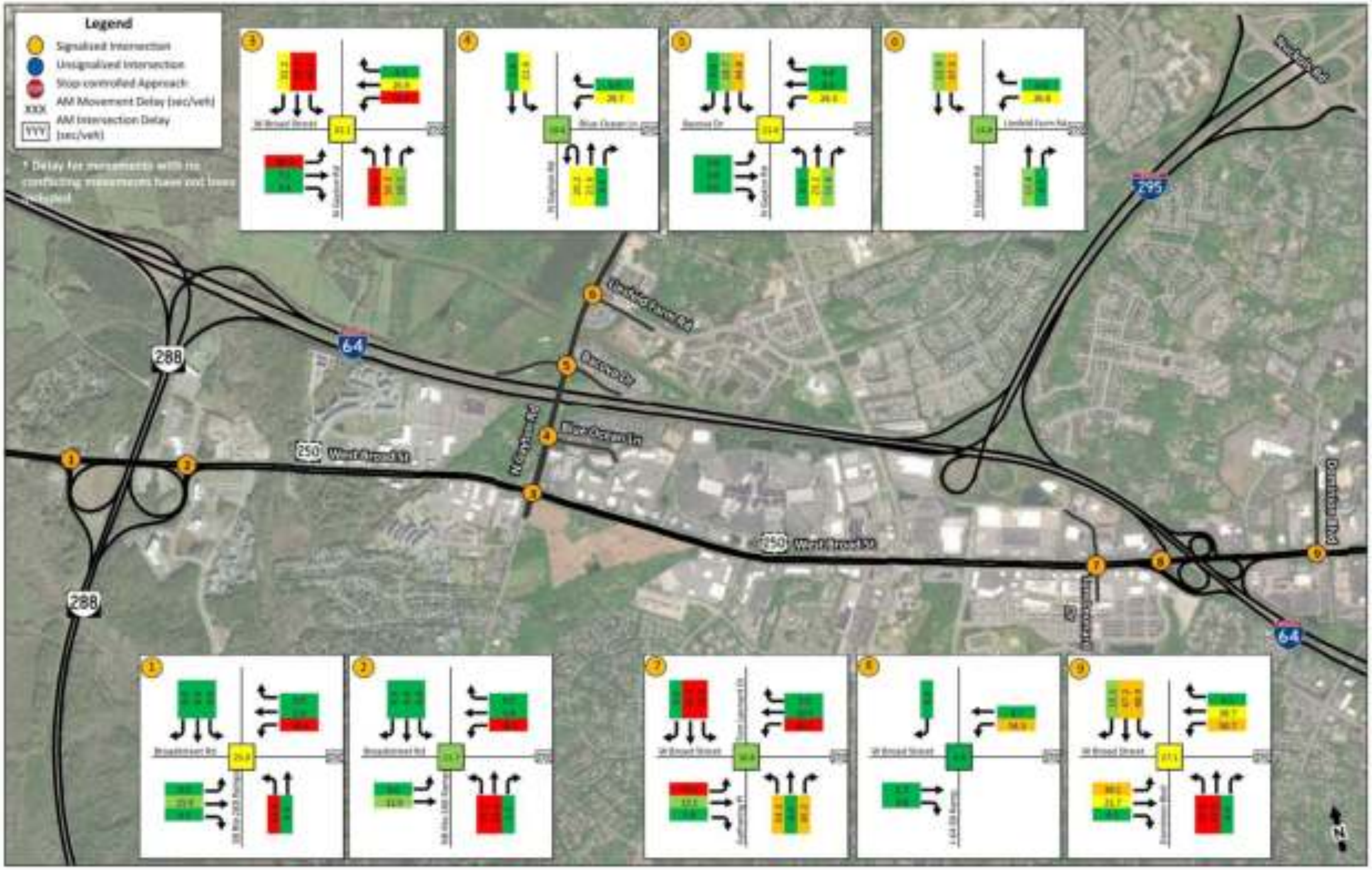


*Figure 56: No-Build (2026) AM Peak Hour Maximum Queue Length*

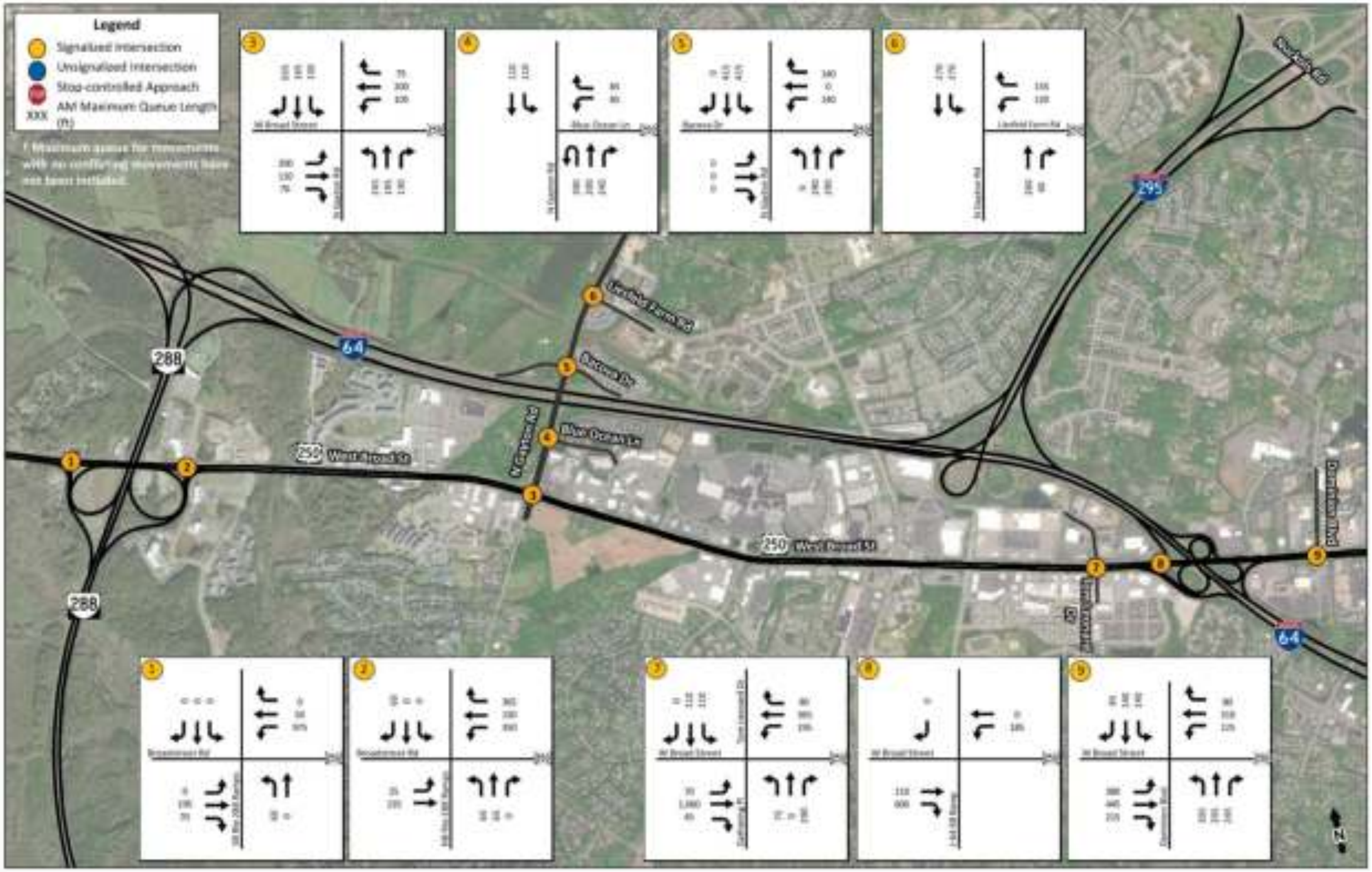


*Figure 57: No-Build (2046) AM Peak Hour Intersection Delay*

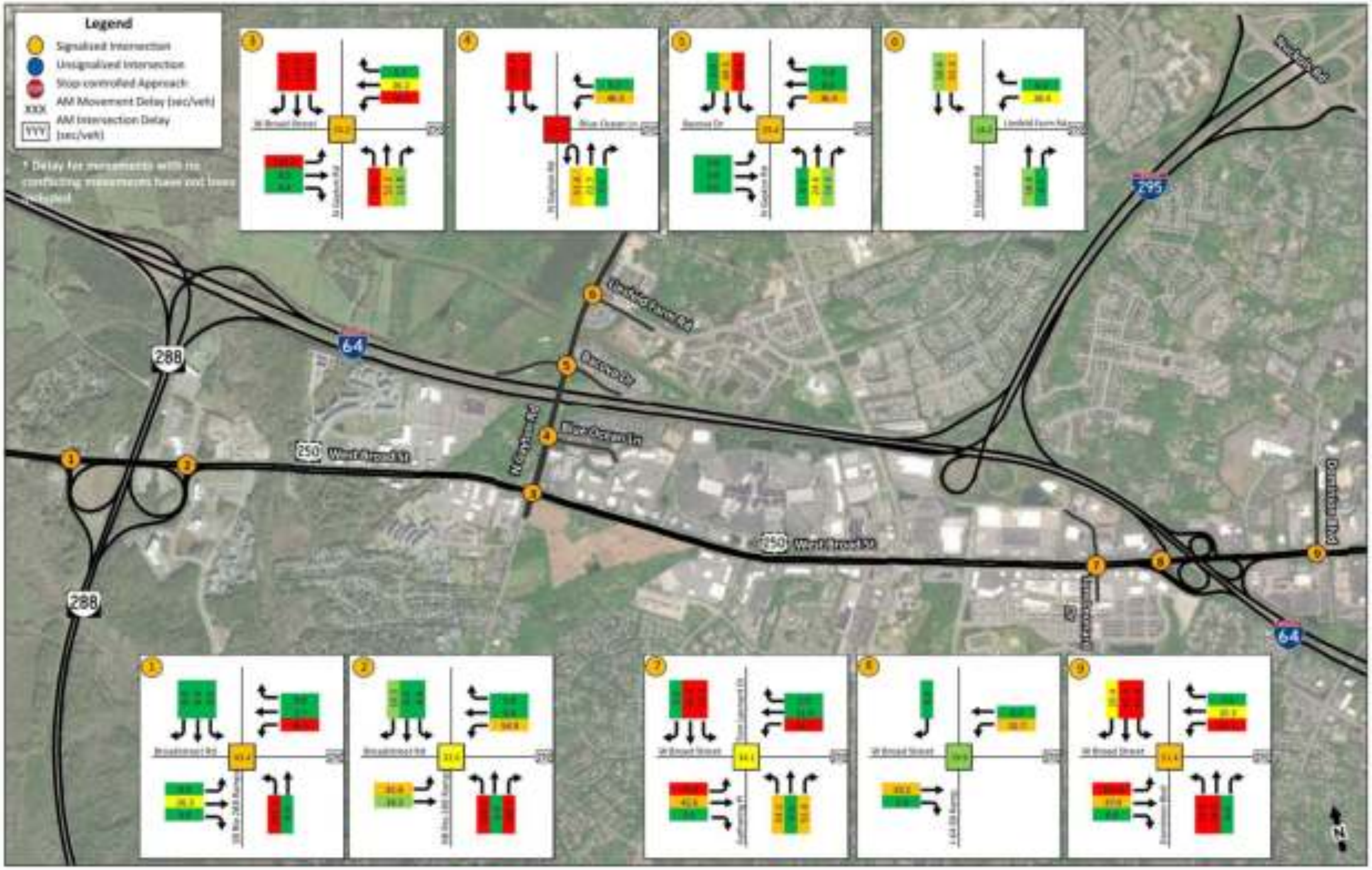


*Figure 58: No-Build (2046) AM Peak Hour Maximum Queue Length*

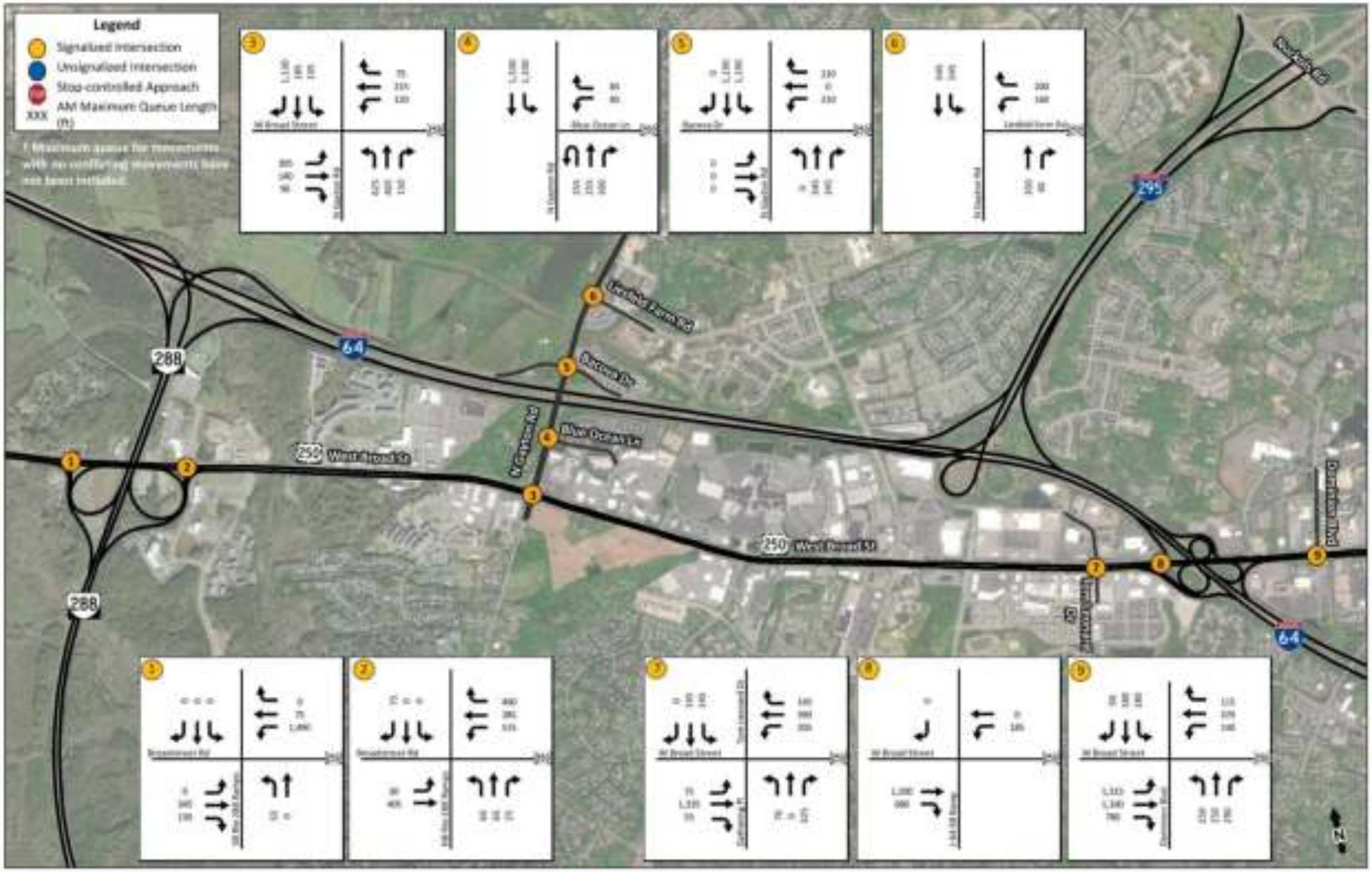


*Figure 59: No-Build (2026) PM Peak Hour Intersection Delay*

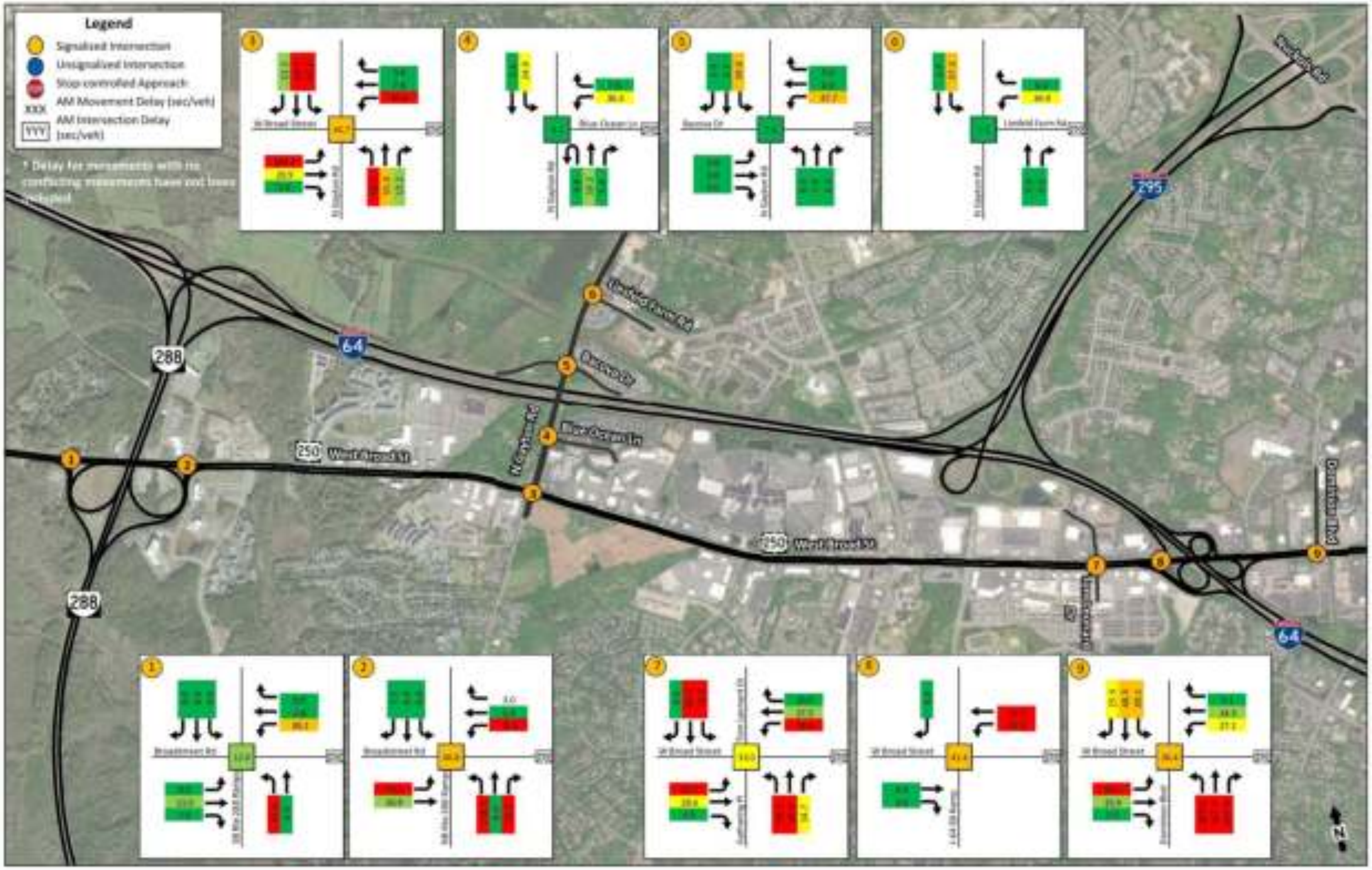


*Figure 60: No-Build (2026) PM Peak Hour Maximum Queue Length*

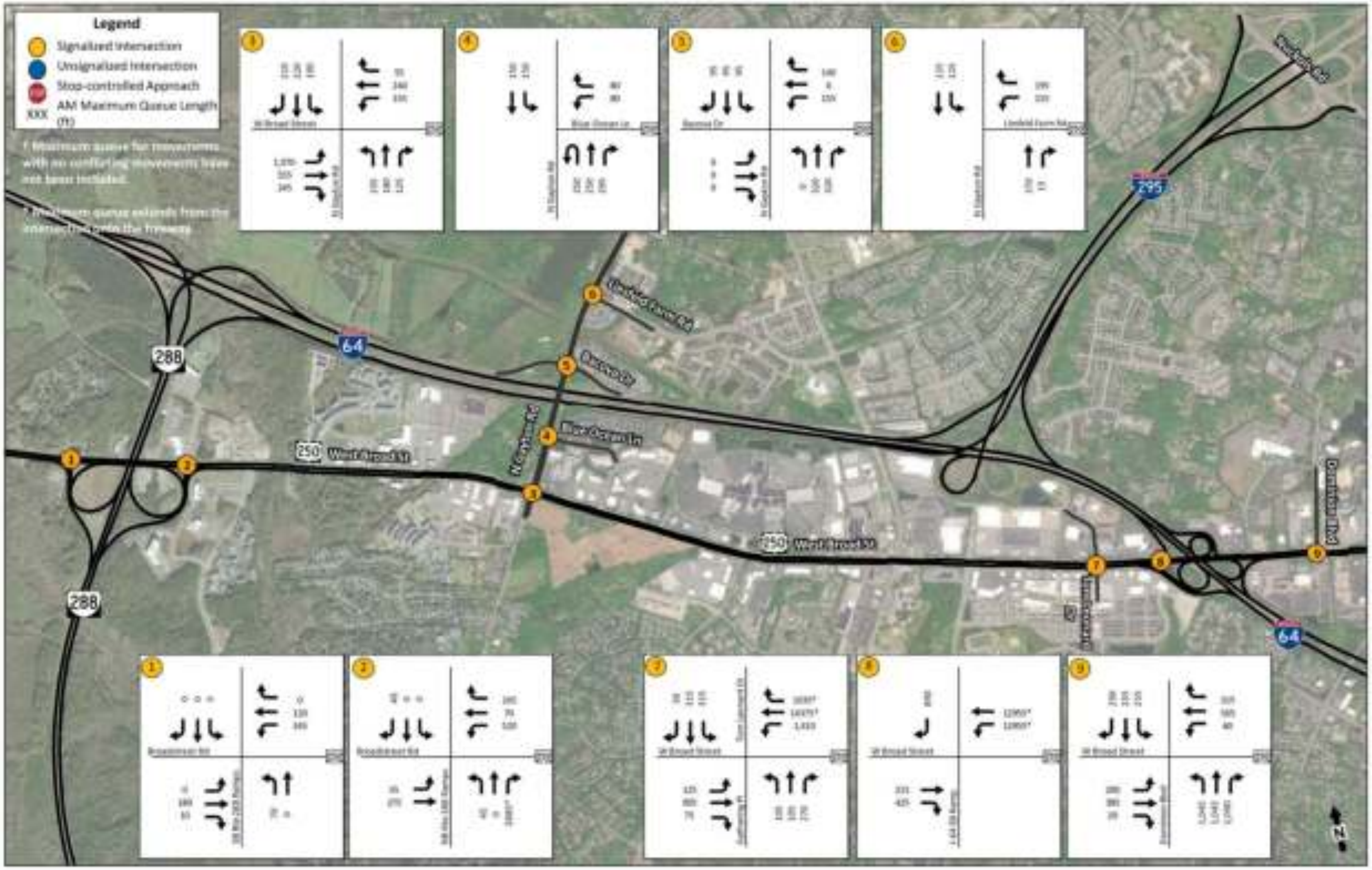


*Figure 61: No-Build (2046) PM Peak Hour Intersection Delay*

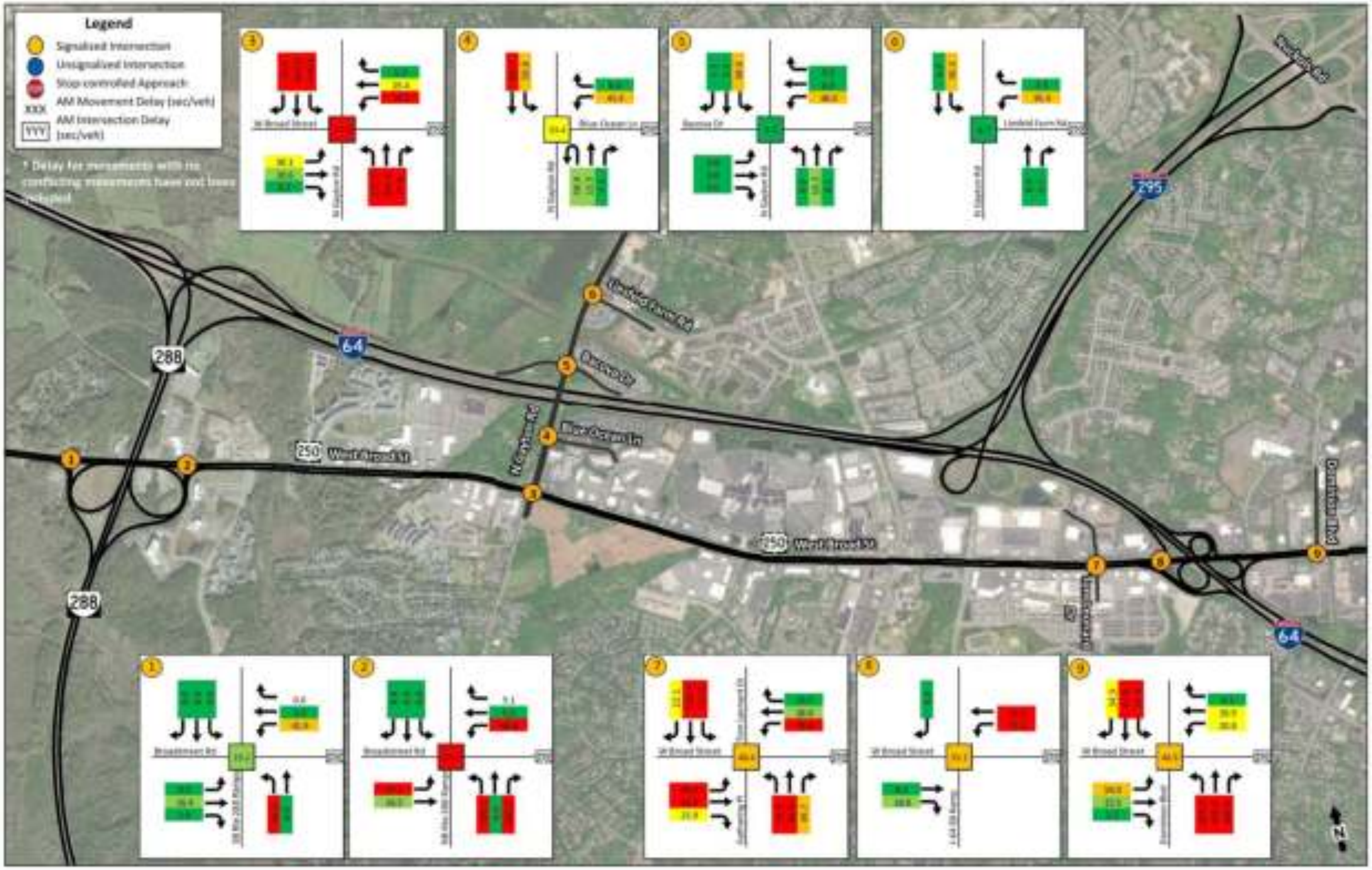
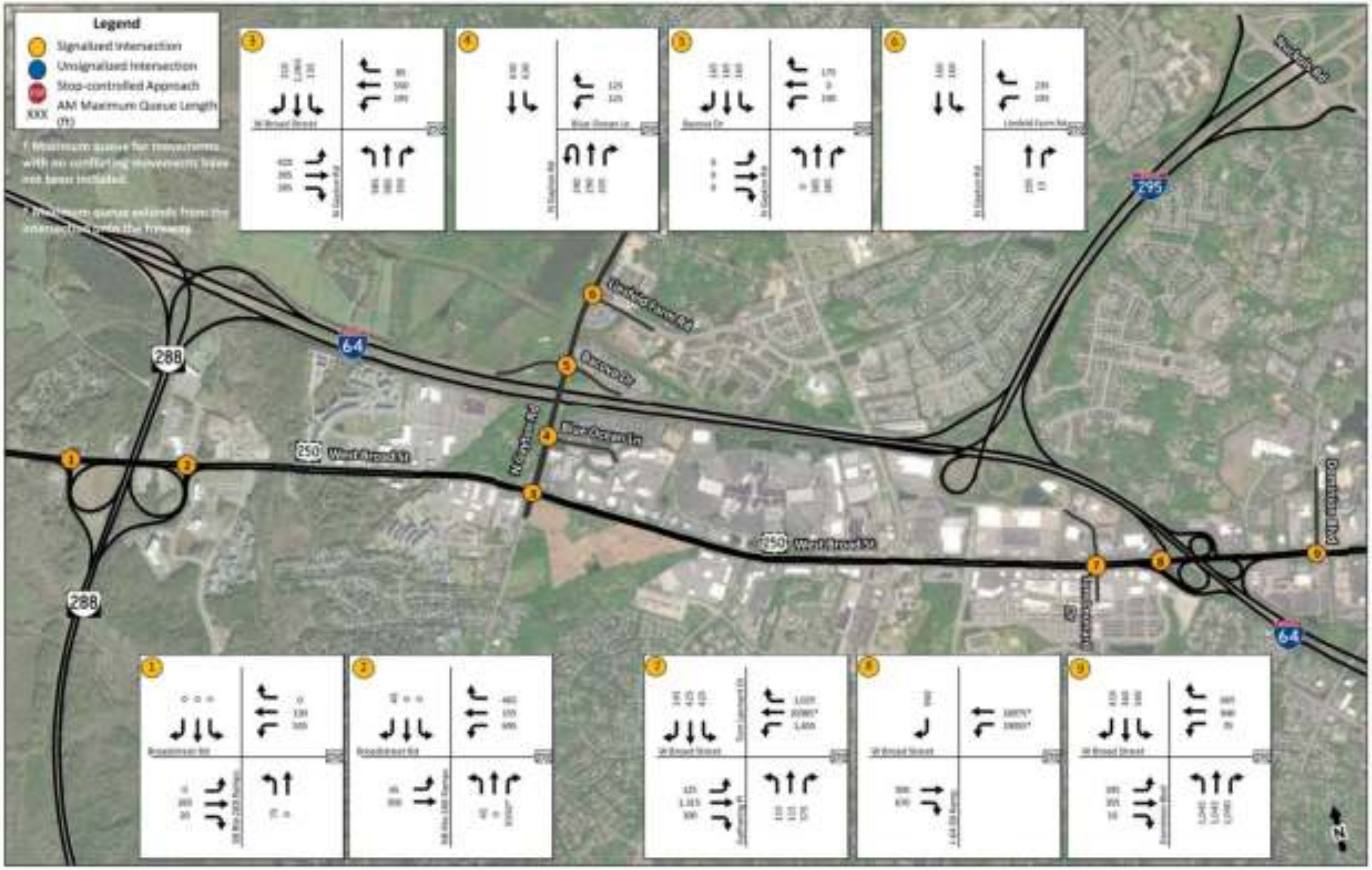


*Figure 62: No-Build (2046) PM Peak Hour Maximum Queue Length*



## BUILD

### Build Traffic Volumes

The No-Build traffic volumes shown in *Figure 44* and *Figure 45* were used for the Build Package 1, except for at the I-64 interchange with US 250 where the volumes on the eastbound US 250 ramp to westbound I-64 were converted to left-turn movements.

New traffic volumes for the two Build alternative packages that contain the new interchange at N Gayton Road (Build Packages 2 and 3) were developed for the study area by applying the projected percent change in traffic volumes on all freeways, ramps, and US 250 segments from the subarea travel demand model to the forecasted No-Build traffic volumes and balancing the resulting traffic volumes. The projected percent (2040 peak period) and value (2040 peak hour) changes from the subarea travel demand model are illustrated in *Figure 63* and *Figure 64*, while the resulting changes in 2046 peak hour traffic volumes from the No-Build scenario to the Build scenario for Build Packages 2 and 3 on freeways, ramps, and some segments of US 250 are illustrated in *Figure 65* and *Figure 66*.

A select link analysis was conducted to determine the approximate origins and destinations of the vehicles using the proposed interchange ramps to access I-64. This analysis was used to derive the turning movements onto and off of the proposed ramps as well as the changes to the turning movements at the intersection of US 250 and N Gayton Road.

Turning movement counts were modified as follows at several intersections within the modeling area to balance traffic volumes and reflect the projected percent changes in traffic volumes on US 250 in the subarea travel demand model.

- Reroute a percentage of side street turning movements in one or both peak hours at the following intersections for vehicles accessing I-64 at the new interchange instead of the Route 288 interchange:
  - N Gayton Road (northbound left turns to through movements)
  - Haydenpark Lane (northbound left turns to right turns)
  - Cabela Drive (southbound right turns to left turns)
  - Bon Secours Parkway (southbound right turns to left turns)
  - Wilkes Ridge Parkway (northbound left turns to right turns)
- Reroute a percentage of side street turning movements in one or both peak hours at the following intersections for vehicles accessing I-64 at the new interchange instead of the US 250 interchange:
  - N Gayton Road (northbound right turns to through movements)
  - Towne Center West Boulevard (southbound left turns to right turns)
  - Short Pump Town Center West (southbound left turns to right turns)
  - Lauderdale Drive (northbound right turns to left turns and southbound left turns to right turns)
  - Spring Oak Drive/Hagen Drive (northbound right turns to left turns and southbound left turns to right turns)
  - Pump Road/Pouncey Tract Road (northbound right turns to left turns and southbound left turns to right turns)
    - A percentage of northbound right turns were rerouted to northbound left turns at Lauderdale Drive
    - A percentage of southbound left-turn vehicles at Pouncey Tract Road were removed and assumed to be rerouted to the new interchange via southbound N Gayton Road
    - A percentage of westbound right-turn vehicles at Pouncey Tract Road were removed and assumed to be rerouted to northbound N Gayton Road via I-64
  - John Rolfe Parkway (northbound right turns to left turns at Lauderdale Drive)

Additionally, turning movement volumes were modified at the intersections on N Gayton Road as follows to account for the proposed changes in access described in the *Build Package 2* section.

- Reroute westbound left turns at Bacova Drive to right turns out of Marshal Run Circle and U-turns at Liesfeld Farm Drive
- Reroute southbound left turns and U-turns at Bacova Drive to left turns and U-turns at Liesfeld Farm Drive
- Reroute westbound left turns at Blue Ocean Lane to the intersection of US 250 and Towne Center West Boulevard
- Reroute westbound right turns at Blue Ocean Lane to right turns at the intersection of N Gayton Road and Dominion Chevy Access Road
- Reroute southbound left turns at Blue Ocean Lane to eastbound left turns at the intersection of US 250 and Towne Center West Boulevard

The projected 2026 and 2046 AM and PM peak hour traffic volumes for Build Packages 2 and 3 are summarized in *Figure 67* and *Figure 68*.

*Figure 63: AM Traffic Volume Rerouting (2040) in Subarea Model for N Gayton Interchange Scenario*

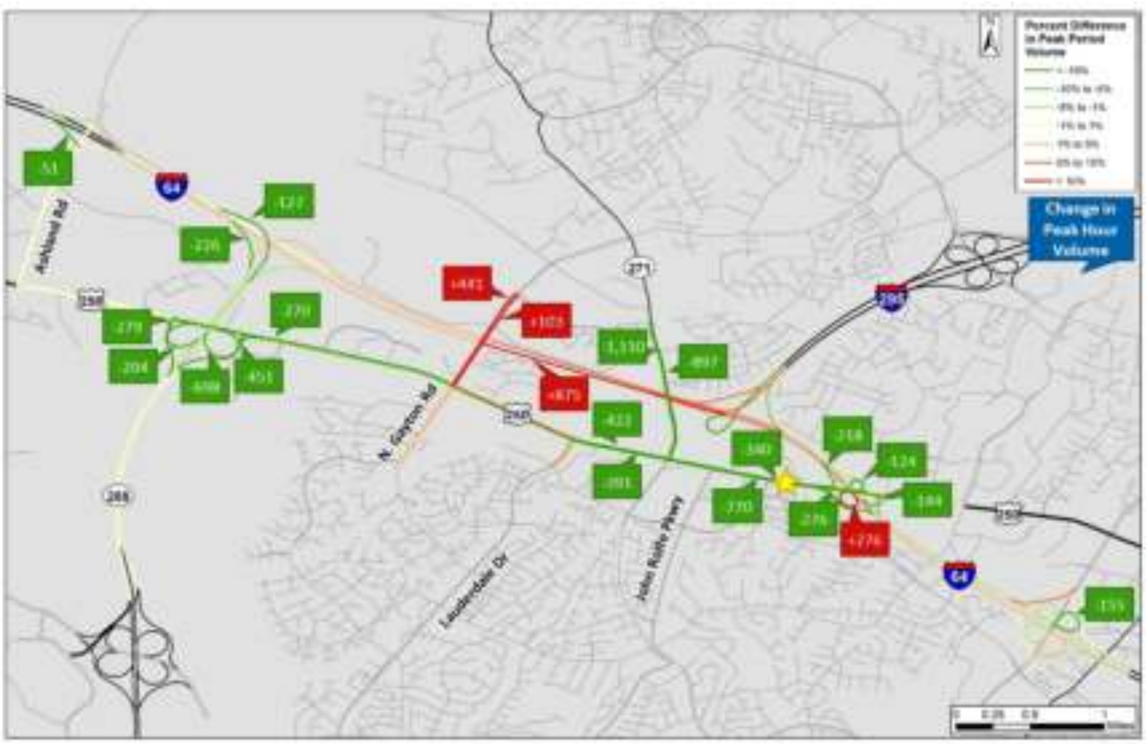


*Figure 64: PM Traffic Volume Rerouting (2040) in Subarea Model for N Gayton Interchange Scenario*


*Figure 65: Changes in 2046 AM Peak Hour Traffic Volumes from No-Build for Build Packages 2 and 3*

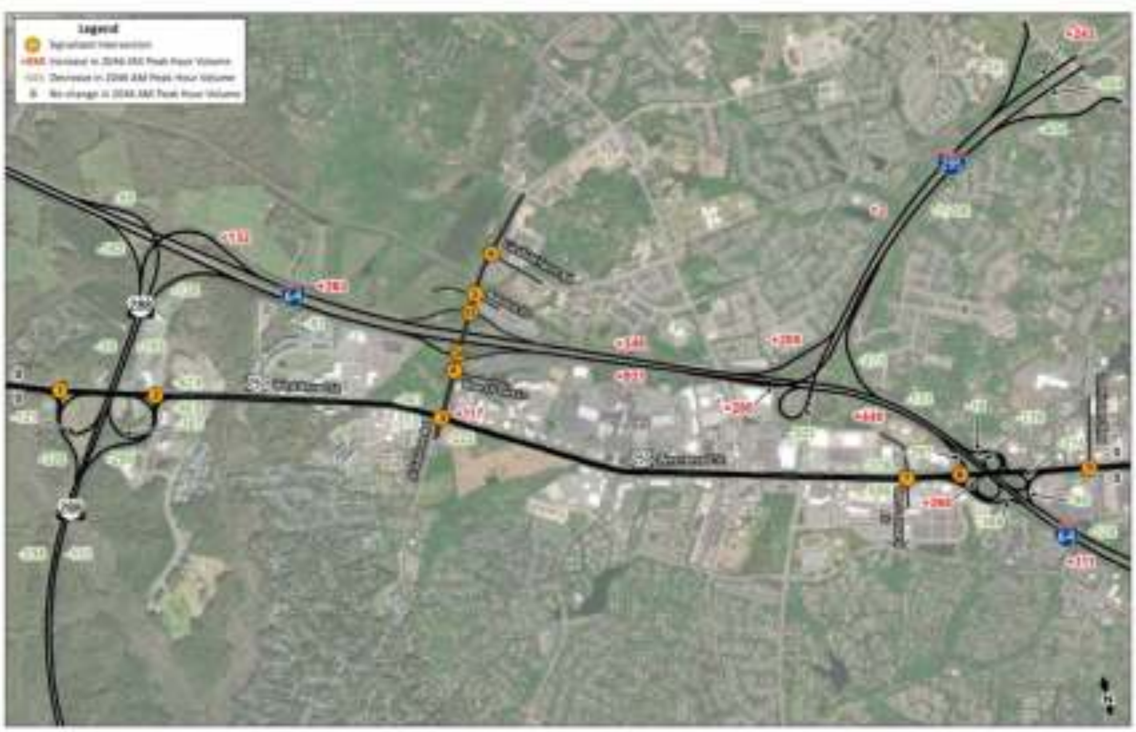


*Figure 66: Changes in 2046 PM Peak Hour Traffic Volumes from No-Build for Build Packages 2 and 3*

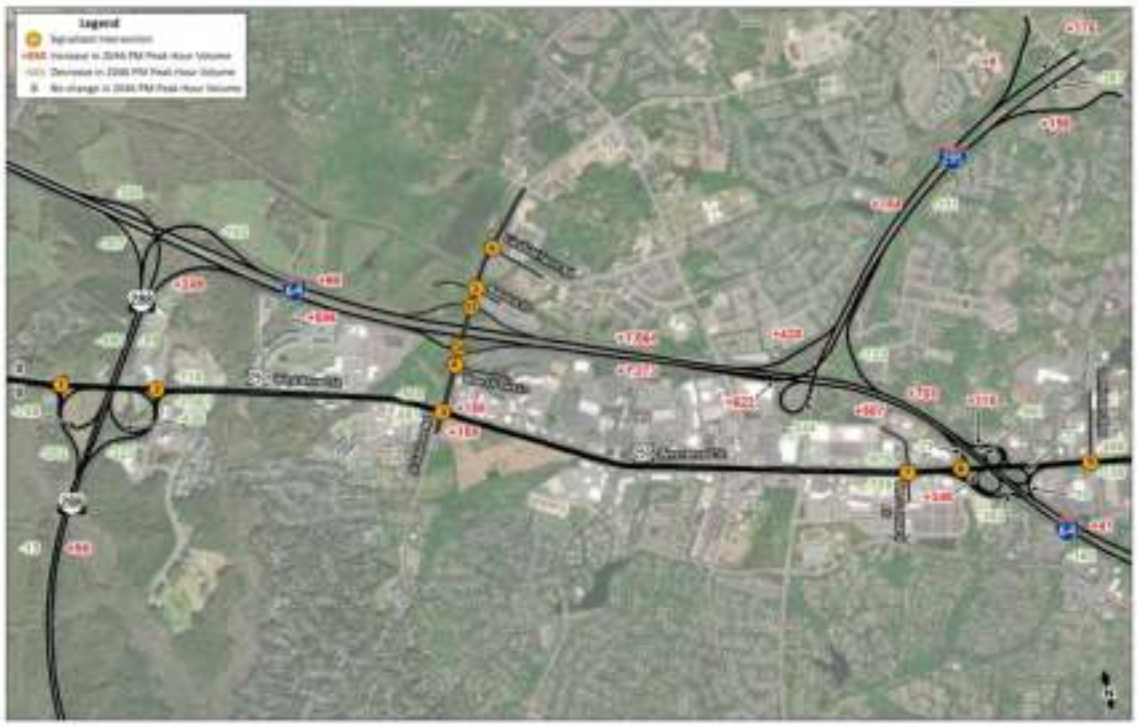


*Figure 67: Build (2026) Peak Hour Traffic Volumes for Build Packages 2 and 3*

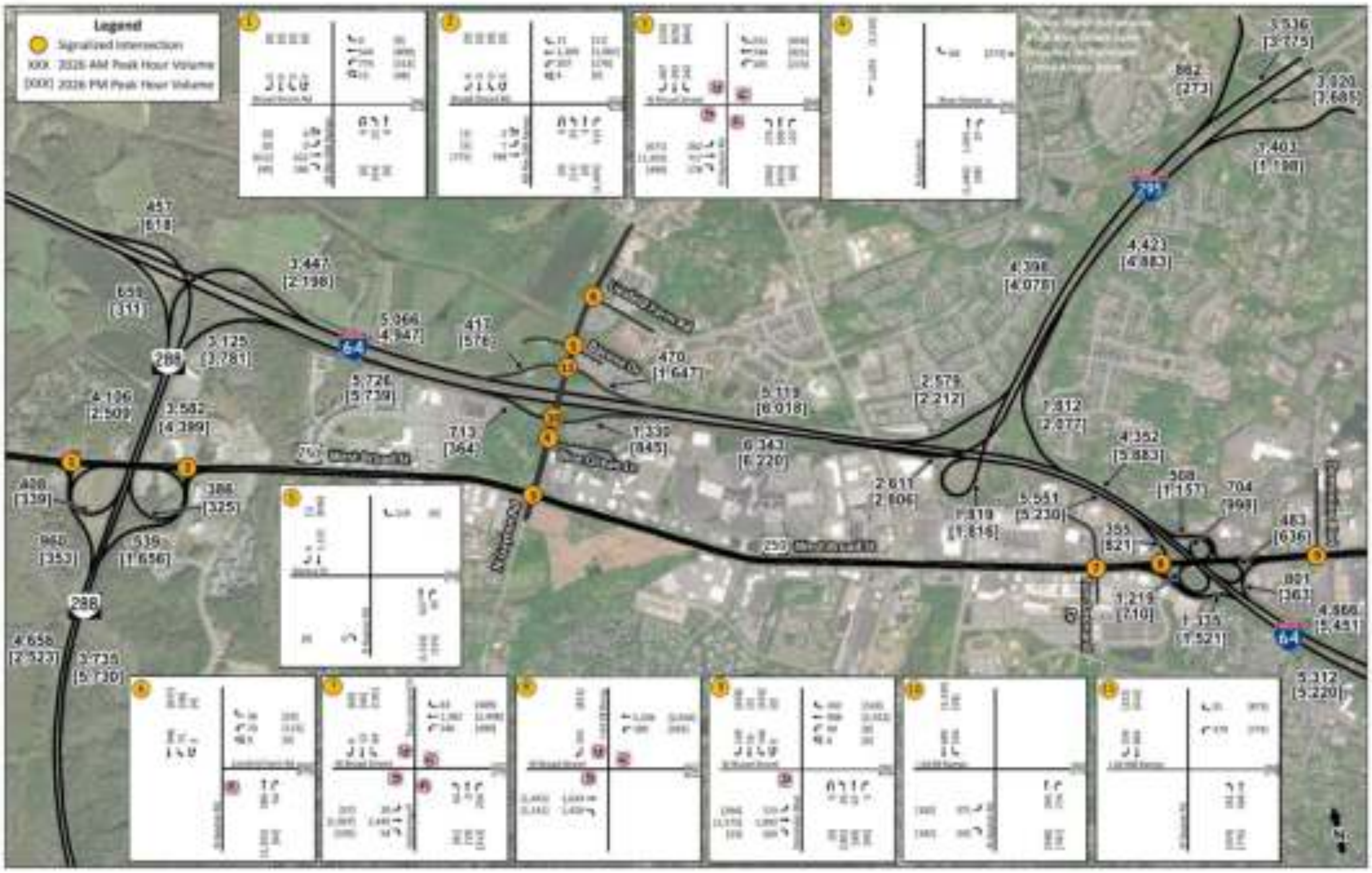
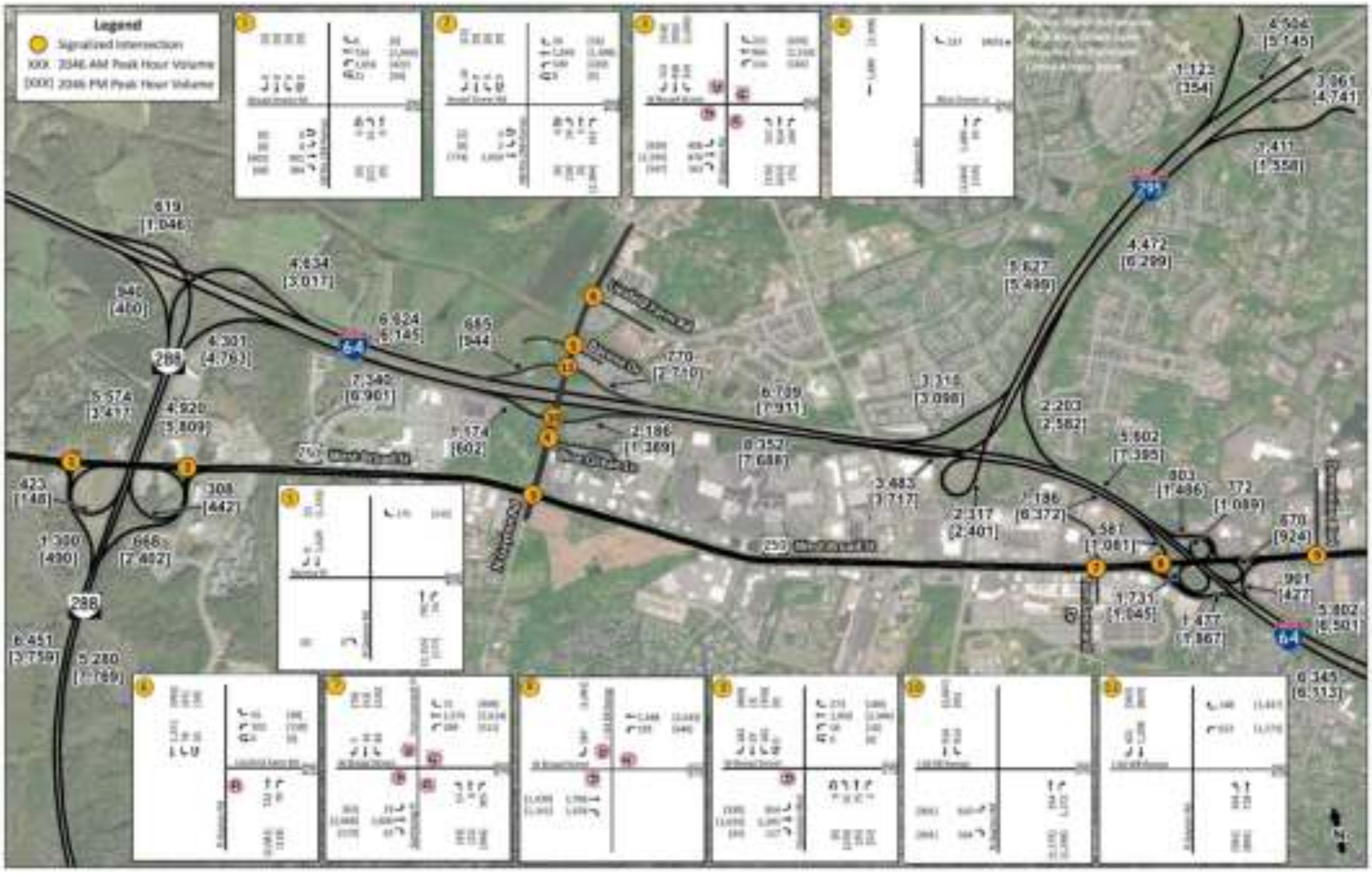


*Figure 68: Build (2046) Peak Hour Traffic Volumes for Build Packages 2 and 3*




## Build Package 1

Heavy vehicle, traffic volume, peak hour factor, and traffic signal timing assumptions remained consistent with the No-Build analyses. A detailed summary of the Build Package 1 inputs is provided in *Appendix G.*

The VDOT Sample Size Determination Tool, Version 2.0 was used to determine the number of traffic simulation runs required to provide the acceptable 95th percentile confidence level for the 2026 and 2046 Build Package 1 models. Ten simulation runs were conducted for the Build Package 1 2026 AM and PM peak hour and 2046 AM peak hour models using different random seeds and the average of these runs was reported. The VDOT Sample Size Determination Tool showed 11 runs were required for the Build Package 1 2046 PM peak hour model. The VDOT Sample Size Determination Tool summary sheets are provided in *Appendix G.*

### *Build Package 1 Freeway Analysis Results*

The AM and PM peak hour average freeway segment density and speed for the 2026 and 2046 Build Package 1 conditions are illustrated in *Figure 69* through *Figure 76*. Graphical representation of the freeway results by lane is included in *Appendix G*.

### AM Peak Hour

In the 2026 AM peak hour, all segments of I-64 in both directions in the study area are projected to operate with speeds of 59 mph or greater. The restriping improvement at the eastbound I-64 off-ramp to I-295 that creates one exit only lane and one choice lane is projected to improve speeds on eastbound I-64 between I-295 and Route 288 by allowing vehicles to better pre-position to take the eastbound I-64 off-ramp to northeastbound I-295. The restriping improvement results in more balanced vehicle lane distribution in the Vissim model since exiting vehicles pre-position in the two rightmost lanes on I-64 instead of one lane in the No-Build scenario. Densities are projected to improve to 21 veh/ln/mi or better along the segment of eastbound I-64.

In 2046, all segments of I-64 in both directions in the study area are projected to operate at 54 mph or greater. The restriping improvement on eastbound I-64 is similarly projected to relieve much of the congestion on eastbound I-64 approaching the I-295 interchange that was identified in the No-Build conditions analysis. Although the rightmost lane on eastbound I-64 is still projected to operate with increased densities between 37 and 42 veh/ln/mi due to vehicles pre-positioning to take the ramp to northeastbound I-295, the increased densities are not projected to impact vehicle speeds along this segment.

The partial cloverleaf ramp reconfiguration and the turning restriction from the westbound I-64 off-ramp to eastbound US 250 to Dominion Boulevard are projected to improve the operations on eastbound I-64 approaching the US 250 interchange to speeds of 54 mph or greater and densities of 30 veh/ln/mi or less. The partial cloverleaf reconfiguration removes the arterial weave on eastbound US 250 and the turning restriction reduces the congestion caused by vehicles weaving from the westbound I-64 off-ramp to eastbound US 250 to make a left-turn onto Dominion Boulevard. Both improvements together are projected to reduce queuing and congestion on US 250 and prevent the queuing from eastbound US 250 from backing up to eastbound I-64. *Figure 77* shows the reduction in queuing on eastbound US 250 and the ramps at the I-64 interchange. Intersection queues are still projected to extend on eastbound US 250 to the westbound I-64 off-ramp to eastbound US 250 and impact westbound I-64 operations; however, this queuing is projected to be comparable to the No-Build scenario.

The southbound Route 288 auxiliary lane between the US 250 and Tuckahoe Creek Parkway interchanges is projected to provide relief to the congestion on southbound Route 288 that was identified in the No-Build conditions analysis. The additional capacity from the auxiliary lane allows southbound Route 288 to serve the projected 6,000 vehicles per hour south of the US 250 interchange while still operating at speeds of 52 mph or greater.

The southwestbound I-295 bottleneck identified in the No-Build conditions analysis is still present in Build Package 1 since the study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section. However, the southwestbound I-295 loop ramp to eastbound I-64 is projected to operate with slightly improved speeds between 25 and 35 mph due to the improved conditions on eastbound I-64, but the congestion on southwestbound I-295 approaching the I-64 ramps is still projected to prevent all the demand on I-295 from being served. Speeds on southwestbound I-295 were projected to remain below 20 mph upstream of the interchange.

### PM Peak Hour

In the 2026 PM peak hour, all segments of I-64 in both directions in the study area are projected to operate with speeds of 52 mph or greater. The partial cloverleaf reconfiguration at the I-64 at US 250 interchange is projected to improve the speeds on westbound I-64 within the interchange from 20 mph in the No-Build conditions analysis to 53 mph.

The improvements at the intersection of US 250 and the northbound Route 288 ramps are projected to improve speeds on the off-ramp and prevent queuing from impacting the operations of northbound Route 288. These improvements are projected to decrease the congestion and densities on northbound Route 288 approaching the interchange to 25 veh/ln/mi or less. The intersection improvements and improvements on US 250 between Route 288 and Bon Secours Parkway are projected to allow the ramp terminal intersection to serve 97 percent of the demand at the intersection.

In 2046, all segments of I-64 in both directions within the study area are projected to operate with speeds of 52 mph or greater. Three of the four bottlenecks identified in the No-Build conditions analysis were addressed with improvements included in Build Package 1. The bottleneck on southwestbound I-295 is still present in Build Package 1 since the study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section. Queuing on the over-capacity loop ramp from southwestbound I-295 to eastbound I-64 is projected to back up onto mainline I-295 causing speeds of 20 mph or less and densities over 80 veh/ln/mi.

The improvements to the intersection of US 250 and the northbound Route 288 ramps are projected to relieve congestion on the off-ramp and prevent queuing from impacting northbound Route 288. The additional auxiliary lane on northbound Route 288 from Tuckahoe Creek Parkway to the US 250 interchange increases capacity and allows northbound Route 288 to serve 95 percent of the demand into the study area network. However, northbound Route 288 is still projected to operate with slow speeds between 18 and 44 mph. The proposed improvements are projected to release the ramp bottleneck, but the additional traffic reaching the interchange is projected to slow at the section of northbound Route 288 between the ramps at the US 250 interchange. This two-lane section is over capacity with a projected demand of 5,000 vehicles in the PM peak hour.

Three different improvements are projected to contribute to the improved operations on westbound I-64 at the US 250 interchange: the partial cloverleaf configuration, the northeastbound I-295 ramp improvements, and the Tom Leonard Drive intersection improvements. The Tom Leonard Drive intersection improvements are projected to reduce congestion on westbound I-64 and prevent queues from backing up to the westbound I-64 off-ramp to westbound US 250. The northeastbound I-295 ramp improvements and the auxiliary lane on northeastbound I-295 to Nuckols Road are projected to reduce the density on the ramp to 29 veh/ln/mi and improve speeds up to 52 mph or greater. These improvements prevent the queuing on the ramp that was identified in the No-Build conditions analysis from backing up to westbound I-64.

The partial cloverleaf reconfiguration removes the weave on the freeway and is projected to improve speeds to 58 mph or greater on westbound I-64 within the interchange. The improvements at the I-64 at US 250 interchange are projected to greatly reduce queuing on westbound I-64. Some queuing is still present on the freeway due to the over-capacity westbound I-64 to westbound US 250 loop ramp that is projected to serve 1,630 vehicles in the peak hour. *Figure 78* shows the residual queuing projected on westbound I-64. The queue on westbound I-64 contributes to slower speeds and congestion upstream on westbound I-64 through adjacent interchanges. The speeds for the upstream interchanges with Gaskins Road and Parham Road are shown in *Figure 79*. Although the improvements in Build Package 1 are projected to improve operations on westbound I-64 at the interchange, speeds as low as 20 mph upstream of the interchange are still present.

*Figure 69: Build Package 1 (2026) AM Peak Hour Average Density*

*Figure 70: Build Package 1 (2026) AM Peak Hour Average Speed*

*Figure 71: Build Package 1 (2046) AM Peak Hour Average Density*

Figure 72: Build Package 1 (2046) AM Peak Hour Average Speed

*Figure 73: Build Package 1 (2026) PM Peak Hour Average Density*

*Figure 74: Build Package 1 (2026) PM Peak Hour Average Speed*

*Figure 75: Build Package 1 (2046) PM Peak Hour Average Density*

Figure 76: Build Package 1 (2046) PM Peak Hour Average Speed

*Figure 77: Build Package 1 (2046) AM Peak Hour Maximum Queue Length (Depictive)*

*Figure 78: Build Package 1 (2046) PM Peak Hour Maximum Queue Length (Depictive)*

*Figure 79: Build Package 1 (2046) PM Peak Hour Average Speeds*

### *Build Package 1 Intersection Analysis Results*

Graphical representation of the average intersection delay (seconds per vehicle) by movement and maximum queue length (feet) are shown in *Figure 80* through *Figure 87*.

#### AM Peak Hour

In 2026, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 31.9 seconds per vehicle. All left-turn movements at the intersection are projected to operate with delays of 62.9 seconds per vehicle or greater. The southbound right-turn movement is projected to operate with the longest maximum queue at 515 feet but is contained in the right-turn storage bay.

All other study area intersections are projected to operate with an overall intersection delay of 24.4 seconds per vehicle or better. The proposed intersection on US 250 at the westbound I-64 ramps is projected to operate with an overall intersection delay of 10.6 seconds per vehicle.

The longest maximum queue in the 2026 AM peak hour is projected to occur at the southbound Route 288 ramp terminal intersection for the westbound left-turn onto southbound Route 288 (935 feet).

By 2046, the intersection of US 250 and N Gayton Road is projected to operate with an overall intersection delay of 49.9 seconds of delay per vehicle. All movements on the southbound approach and all left-turn movements at the intersection are projected to operate with a delay of 56.6 seconds per vehicle or greater. The projected southbound right-turn maximum queue is 1,130 feet which extends out of the 575-feet storage bay, which is comparable to No-Build conditions.

The intersection of US 250 and Dominion Boulevard is projected to operate with an overall intersection delay of 47.4 seconds per vehicle. The southbound, northbound, and westbound left-turn movements at the intersection are projected to operate with 59.2 seconds per vehicle of delay or greater. The eastbound left-turn delay is projected to decrease to 39.5 seconds per vehicle and the eastbound through delay is projected to increase to 64.8 seconds per vehicle in Build conditions due to the improvement that restricts vehicles from the westbound I-64 off-ramp from weaving across US 250 to turn left at Dominion Boulevard. These vehicles are rerouted to travel through the Dominion Boulevard intersection and turn left at the adjacent intersection with Cox Road.

The proposed intersection on US 250 at the westbound I-64 ramps is projected to operate with an overall intersection delay of 13.9 seconds per vehicle. All other study area intersections are projected to operate with overall intersection delays of 30.5 seconds per vehicle or better.

All study area intersections are projected to operate better than or comparable to No-Build conditions. The overall travel time on US 250 between Route 288 and Cox Road is projected to decrease by 2 minutes and 4 seconds in the eastbound direction and increase by 13 seconds in the westbound direction. The section of westbound US 250 between Cox Road and I-64 is projected to experience an increase in travel time from the addition of the new signalized intersection at the westbound I-64 ramps. All other segments of westbound US 250 are projected to experience travel times comparable to No-Build conditions.

#### PM Peak Hour

In the 2026 PM peak hour, the intersection of US 250 and Dominion Boulevard is projected to operate with the most overall intersection delay of 36.6 seconds per vehicle. The maximum queue on the northbound approach is projected to be 1,050 feet. All movements on the northbound approach are projected to operate with over 300 seconds of delay per vehicle, which is similar to the No-Build conditions analysis results.

All other study area intersections are projected to operate with overall intersection delays of 34.0 seconds per vehicle or better and similar to No-Build conditions analysis results. The proposed intersection on US 250 and the westbound I-64 ramps is projected to operate with an overall intersection delay of 12.8 seconds per vehicle.

All left-turn movements at the intersection of US 250 and Tom Leonard Drive are projected to operate with a delay of 70.9 seconds per vehicle or greater. The westbound and eastbound through movements at this intersection are projected to extend 1,025 feet and 900 feet, respectively.

In 2046, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 56.1 seconds per vehicle. All left-turn movements at the intersection are projected to operate with delays of 61.5 seconds per vehicle or greater. The maximum queue in the eastbound left-turn lane is projected to extend 790 feet, which is longer than the 550-foot storage bay. This queue spills back onto eastbound US 250 and is projected to cause additional queuing and congestion on US 250.

The intersection of US 250 and Dominion Boulevard is projected to operate with an overall intersection delay of 44.2 seconds per vehicle. The northbound approach is projected to operate with severe delays between 356.1 and 424.0 seconds per vehicle, which is similar to the No-Build conditions analysis results.

All other study area intersections are projected to operate with overall intersection delays of 48.2 seconds per vehicle or better. The proposed intersection of US 250 and the westbound I-64 ramps is projected to operate with an overall intersection delay of 16.2 seconds per vehicle. The eastbound left-turn movement is projected to operate with a delay of 60.2 seconds per vehicle and a maximum queue of 1,135 feet. Due to the contraflow left-turn interchange configuration proposed at the US 250 interchange, the maximum eastbound left-turn queue is projected to bel contained to its storage bay without impacting eastbound US 250 operations.

The intersection of US 250 and the northbound Route 288 ramps is projected to operate with an overall intersection delay of 50.5 seconds per vehicle. The northbound right-turn movement is projected to operate with a delay of 83.1 seconds per vehicle despite the improvements at the ramp terminal. This delay results from the congested operations on eastbound US 250 that impact this intersection. The proposed improvements are projected to release the bottleneck on northbound Route 288 so that 95 percent of the demand is served. Releasing this bottleneck allows additional vehicles to reach eastbound US 250, causing increased queuing and congestion that contributes to a 2 minute and 4 second increase in travel time from No-Build conditions between Route 288 and N Gayton Road. While the partial cloverleaf interchange improvement at US 250, which is the major improvement unique to Build Package 1, does not contribute to the increased travel time on eastbound US 250 in this area, it is not projected to mitigate the increase. The signalized intersections along this segment of US 250 are projected to process an average of 94 percent of the overall intersection demand, which is an increase from the average of 82 percent served in No-Build conditions. The overall travel time on US 250 between Route 288 and Cox Road is projected to increase by 5 minutes and 18 seconds in the eastbound direction over the No-Build conditions.

In the westbound direction, travel time on US 250 between Cox Road and Route 288 is projected to increase by 32 seconds over the No-Build conditions. This projected increase in travel time can be attributed to the new signalized intersection at the westbound I-64 ramps and to increased congestion between N Gayton Road and the southbound Route 288 ramps. The increased congestion on this segment can be attributed to the additional throughput on eastbound US 250, which affects the signal operations at all intersections.

*Figure 80: Build Package 1 (2026) AM Peak Hour Intersection Delay*

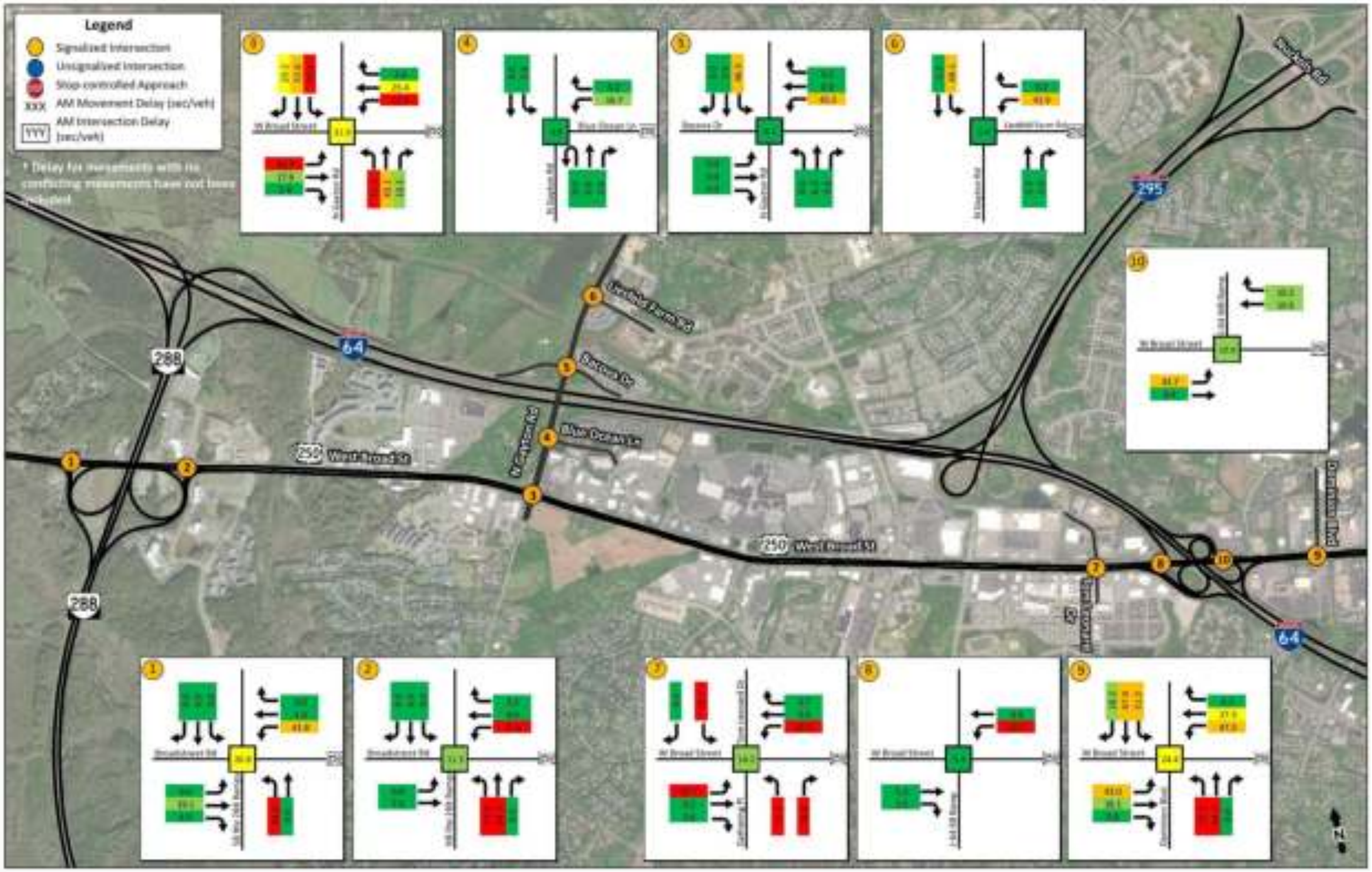


*Figure 81: Build Package 1 (2026) AM Peak Hour Maximum Queue Length*

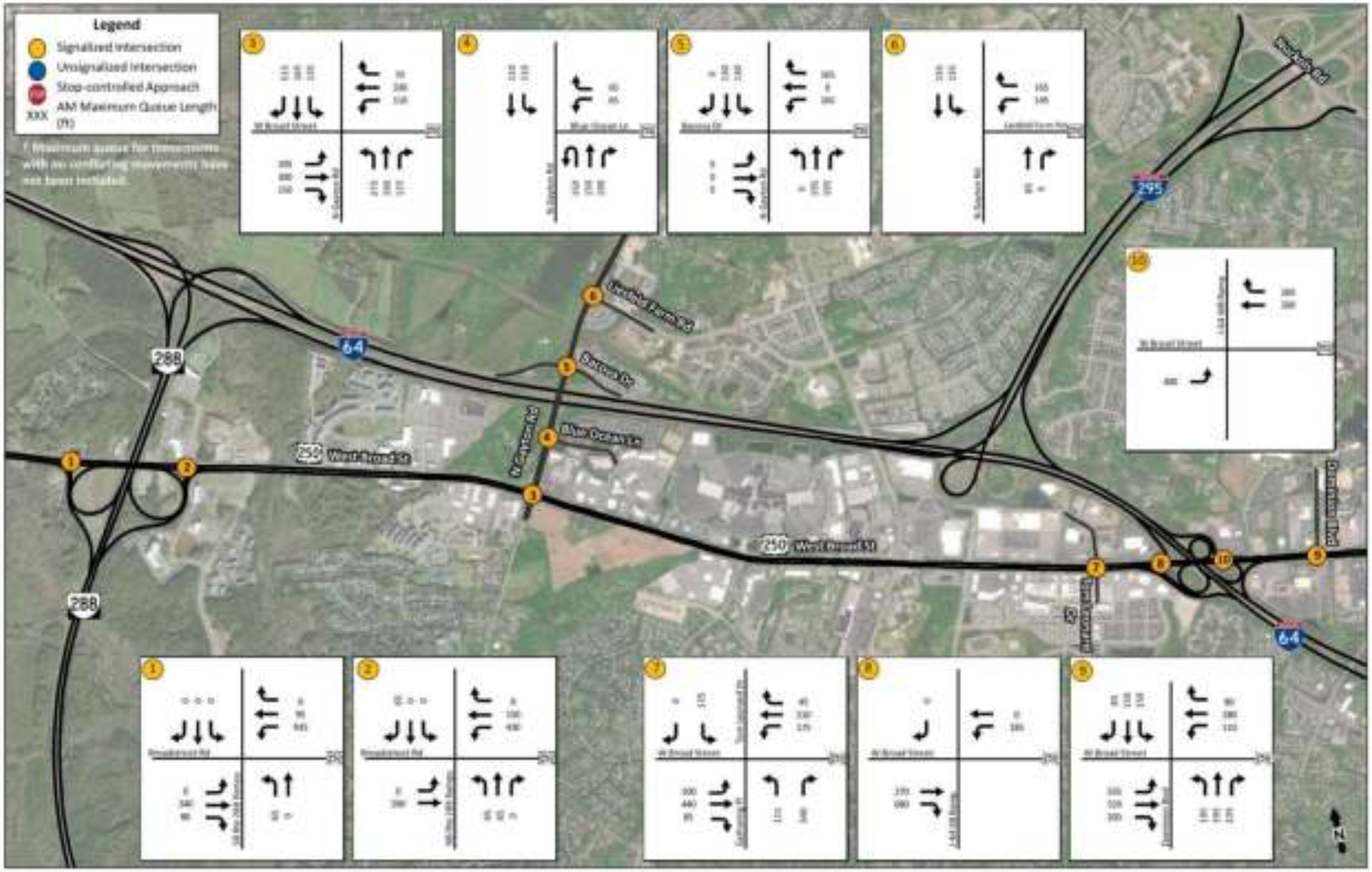


*Figure 82: Build Package 1 (2046) AM Peak Hour Intersection Delay*

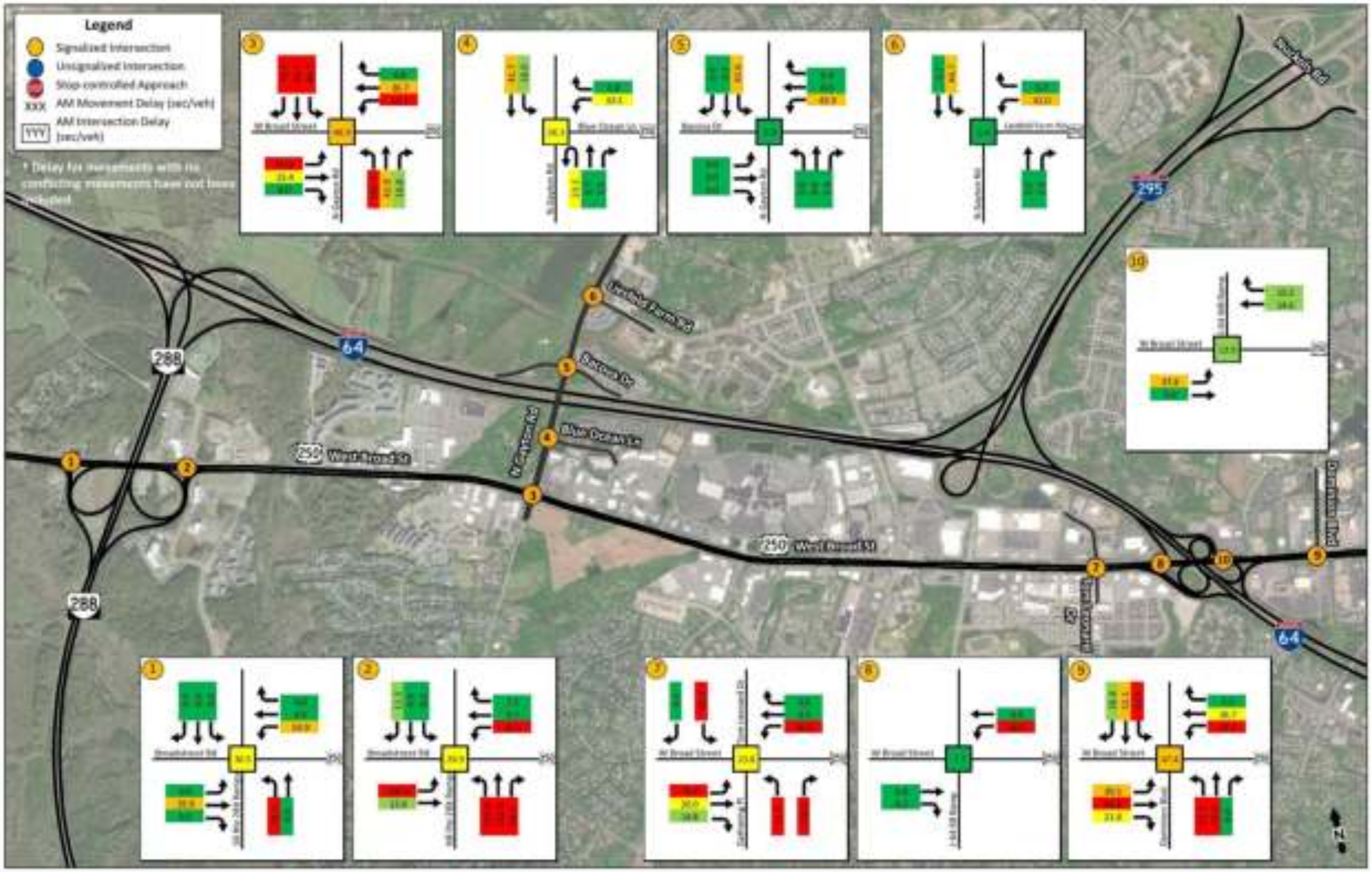


*Figure 83: Build Package 1 (2046) AM Peak Hour Maximum Queue Length*

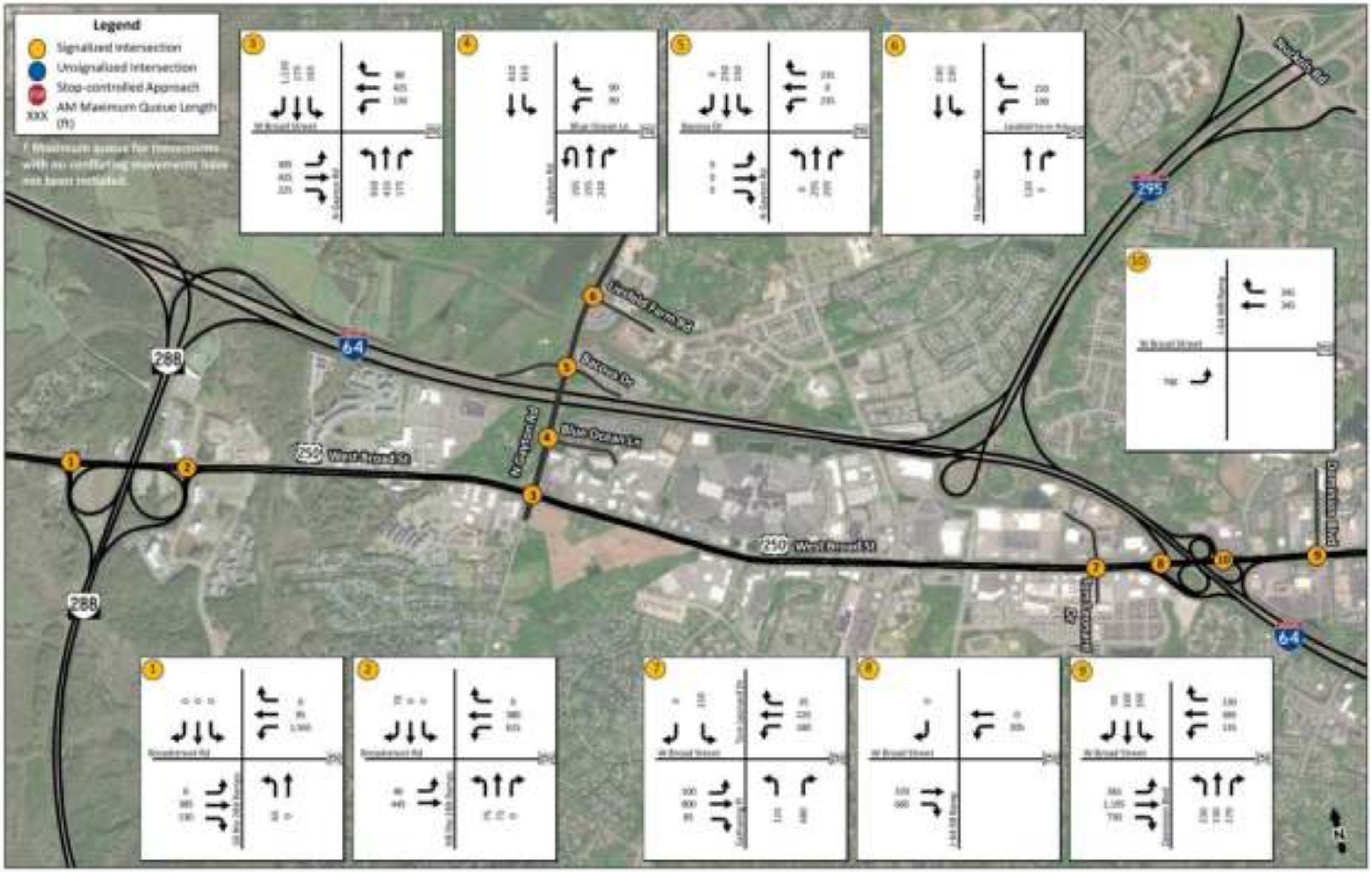


*Figure 84: Build Package 1 (2026) PM Peak Hour Intersection Delay*

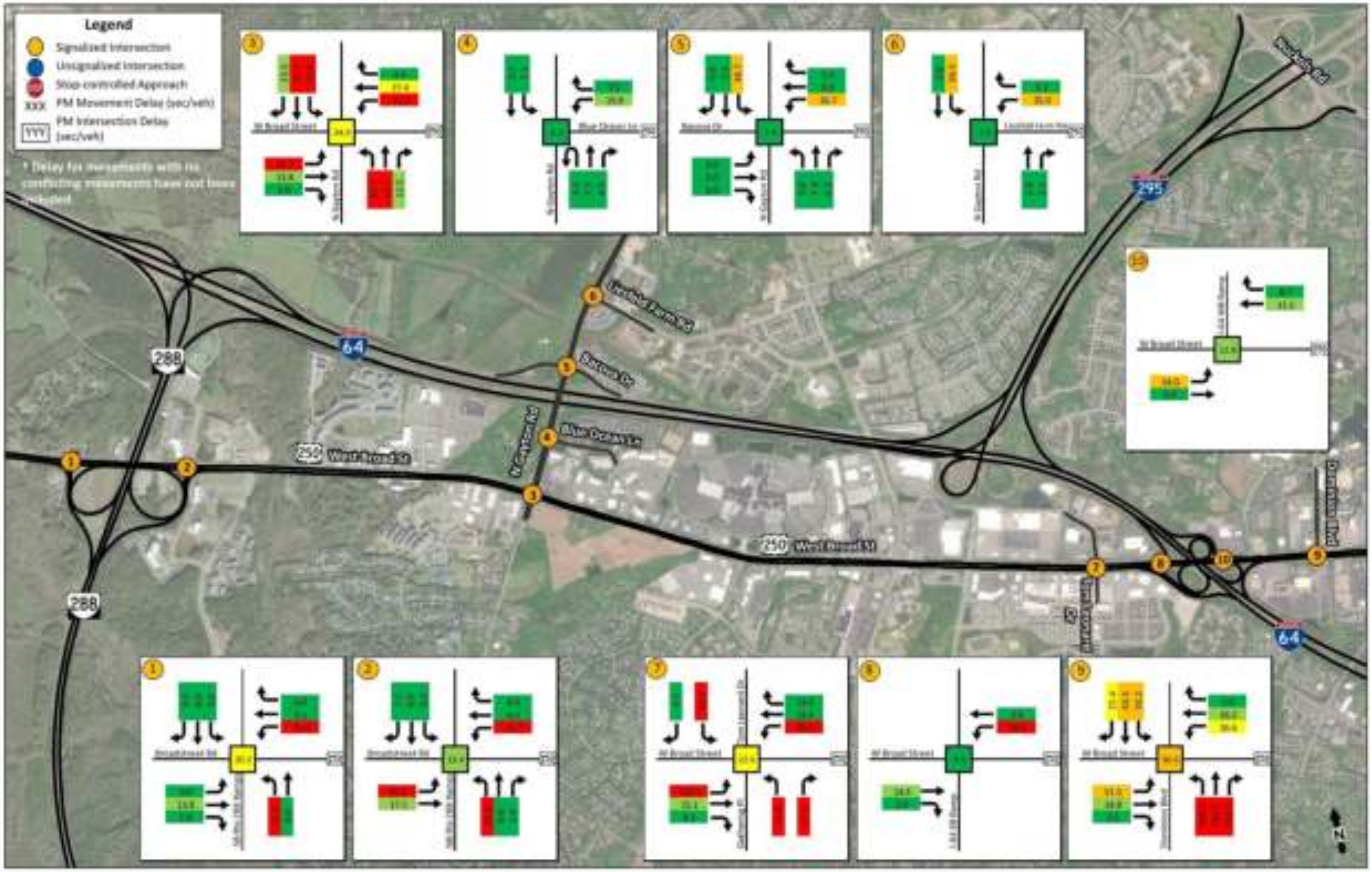


*Figure 85: Build Package 1 (2026) PM Peak Hour Maximum Queue Length*

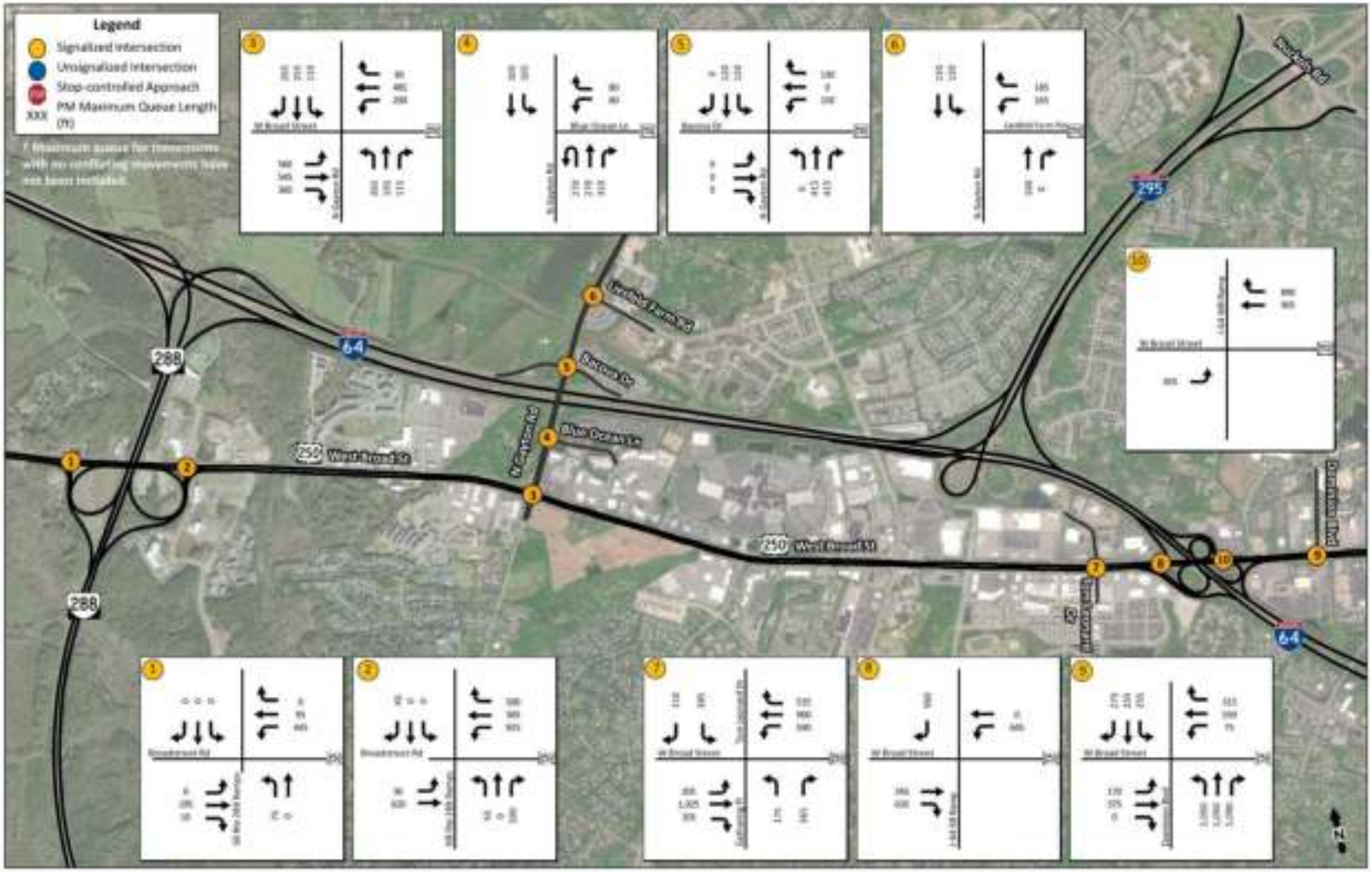


*Figure 86: Build Package 1 (2046) PM Peak Hour Intersection Delay*

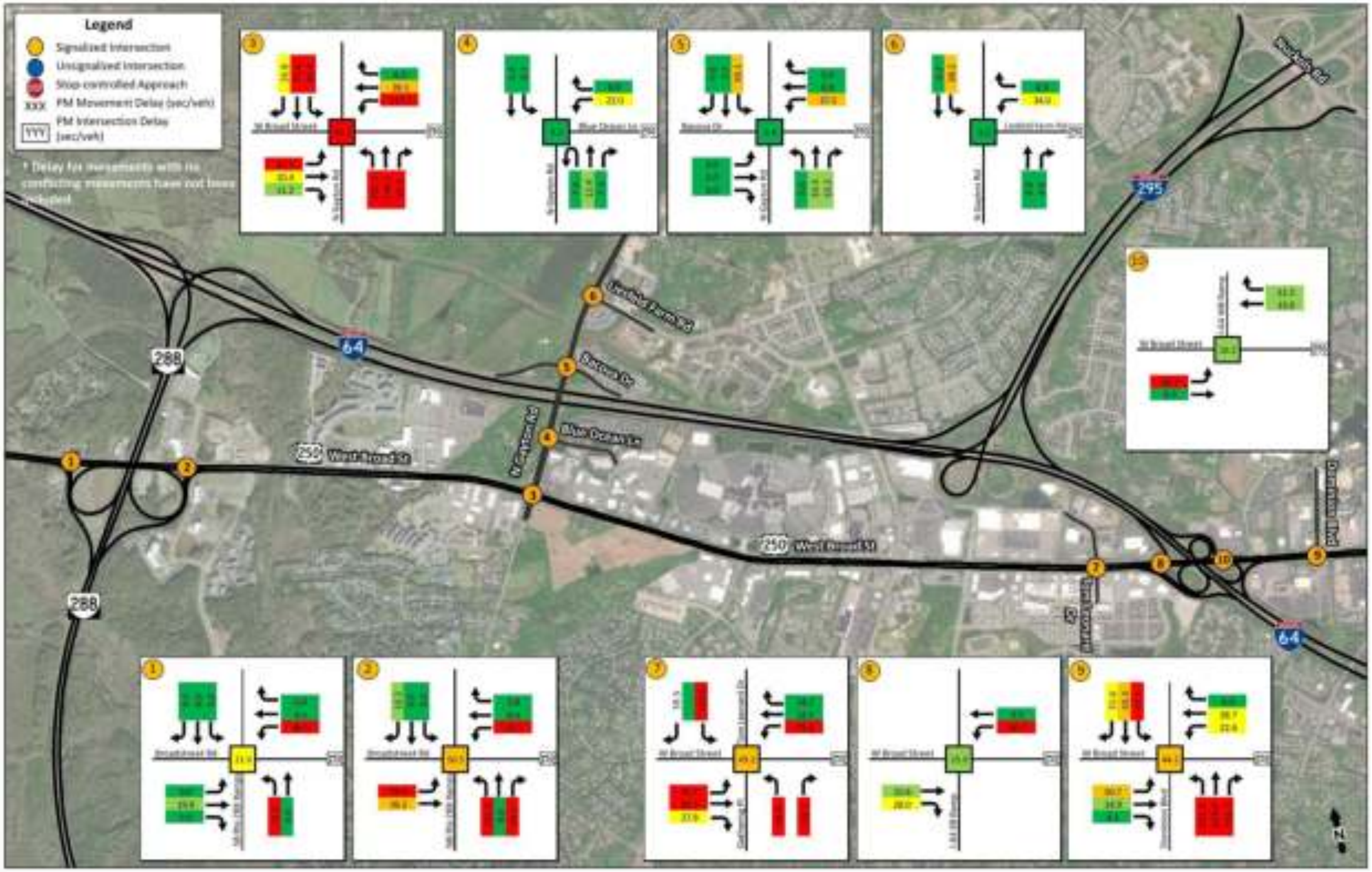
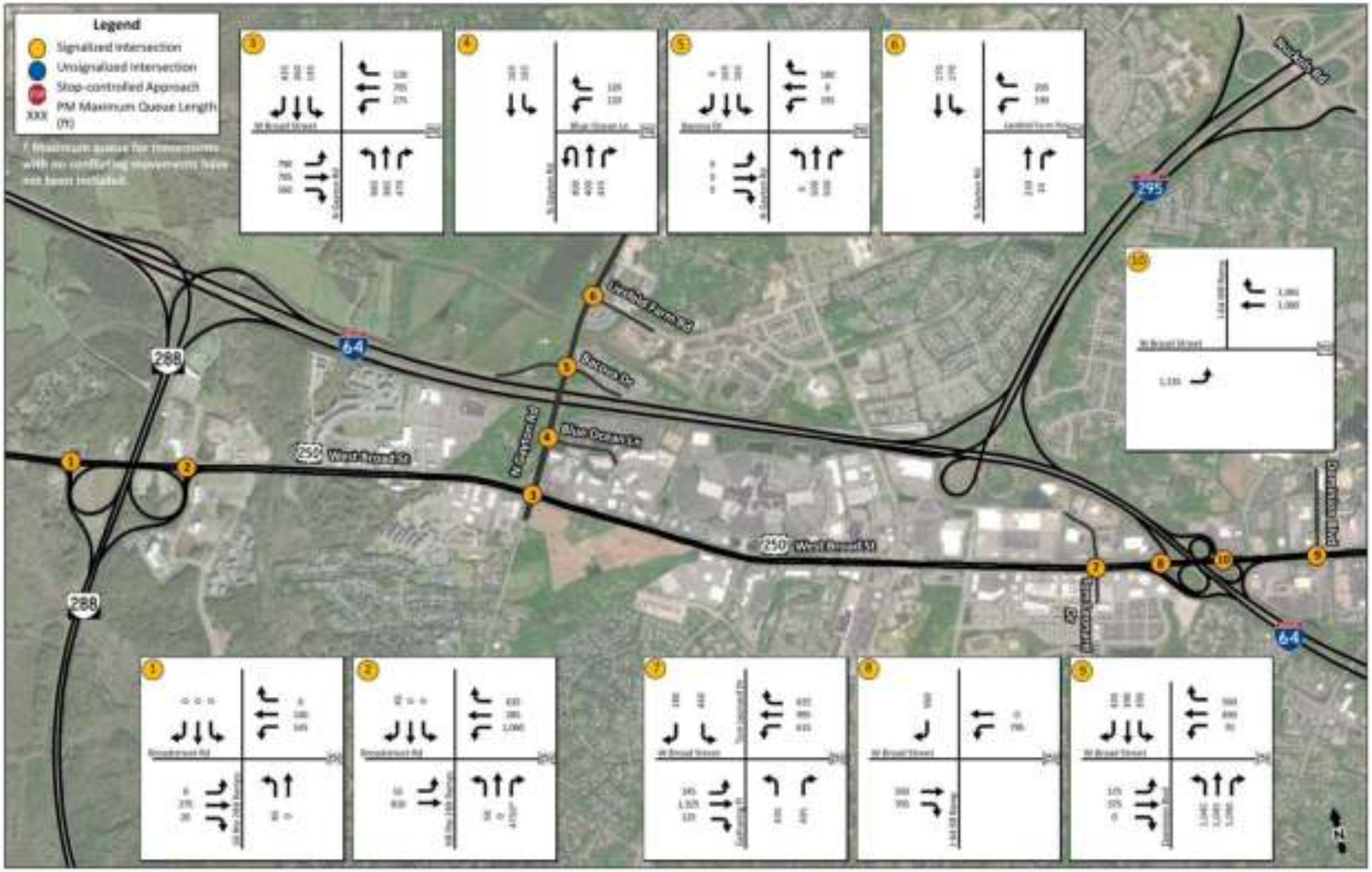


*Figure 87: Build Package 1 (2046) PM Peak Hour Maximum Queue Length*



## Build Package 2

Heavy vehicle, peak hour factor, and traffic signal timing assumptions remained consistent with the No-Build analyses. The input traffic volumes used for Build Package 2 are described and provided in the *Build Traffic Volumes* section of the report. A detailed summary of the Build Package 2 inputs is provided in *Appendix G*.

The VDOT Sample Size Determination Tool, Version 2.0 was used to determine the number of traffic simulation runs required to provide the acceptable 95th percentile confidence level for the 2026 and 2046 Build Package 2 models. Ten simulation runs were conducted for the Build Package 2 2026 AM and PM peak hour and 2046 PM peak hour models using different random seeds and the average of these runs was reported. The VDOT Sample Size Determination Tool showed 30 runs were required for the Build Package 2 2046 AM peak hour model. The VDOT Sample Size Determination Tool summary sheets are provided in *Appendix G.*

### *Build Package 2 Freeway Analysis Results*

The AM and PM peak hour average freeway segment density and speed for the 2026 and 2046 Build Package 2 conditions are illustrated in *Figure 88* through *Figure 95*. Graphical representation of the freeway results by lane is included in *Appendix G*.

#### AM Peak Hour

In the 2026 AM peak hour, all segments of I-64 in both directions in the study area are projected to operate with speeds of 57 mph or greater. The segment of westbound I-64 between the ramps at the US 250 interchange is projected to experience improved speeds of 56 mph or greater.

In 2046, all segments of I-64 in both directions in the study area are projected to operate with speeds of 53 mph or greater. The segment of westbound I-64 approaching the US 250 interchange is projected to experience improved speeds of 53 mph or greater. The rightmost lane between the westbound I-64 on-ramp from eastbound US 250 and the westbound I-64 off-ramp to westbound US 250 is still projected to operate with speeds of approximately 40 mph due to the vehicles changing lanes in the weaving section. However, due to the change in volume patterns attributed to the new interchange, fewer vehicles are projected to use these two ramps and the speed is projected to increase from No-Build conditions due to fewer weaving movements.

The turning restriction from the westbound I-64 off-ramp to eastbound US 250 to Dominion Boulevard combined with the reduced demand on US 250 is projected to reduce congestion on eastbound US 250 in the vicinity of the I-64 interchange and reduce the queuing on the eastbound I-64 off-ramp to eastbound US 250. *Figure 96* shows the reduced queuing on eastbound US 250 and the ramps at the interchange. Queuing on the eastbound I-64 off-ramp to eastbound US 250 is projected to extend 640 feet from the ramp terminal due to friction caused by vehicles weaving on eastbound US 250, but the queue is not projected to reach the freeway as in the No-Build conditions. Additionally, the queuing on eastbound US 250 is not projected to extend to the westbound I-64 off-ramp to eastbound US 250 since the lower demand on eastbound US 250 combined with the turning restriction that prevents vehicles on this ramp from turning left at Dominion Boulevard are projected to improve operations on US 250. In the case that the volumes on US 250 do not decrease as projected, this queue would be projected to operate similarly to the AM peak hour projections for Build Package 1 and be comparable to the No-Build scenario.

The southbound Route 288 auxiliary lane between the US 250 and Tuckahoe Creek Parkway interchanges is projected to provide relief to the congestion on southbound Route 288 that was identified in the No-Build conditions analysis. The additional capacity from the auxiliary lane allows southbound Route 288 to serve the projected 6,500 vehicles per hour south of the US 250 interchange while operating at speeds of 54 mph or greater.

The southwestbound I-295 bottleneck identified in the No-Build conditions analysis is still present in Build Package 2 since the study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section. However, the southwestbound I-295 loop ramp to eastbound I-64 is projected to operate with slightly improved speeds from the No-Build conditions (between 27 and 35 mph) due to reduced demand on the loop ramp that is attributed to the change in volume patterns attributed to the new interchange. The congestion on southwestbound I-295 approaching the I-64 ramps is still projected to prevent all the demand on I-295 from being served, but the demand served is projected to increase 8 percent from No-Build conditions.

#### PM Peak Hour

In the 2026 PM peak hour, all segments of I-64 in the study area are projected to operate with speeds of 53 mph or greater. The segment of westbound I-64 between I-295 and Route 288 is projected to serve 100 percent of the demand, which is an increase of 4 percent from No-Build conditions, even though the demand has increased by 1,100 vehicles due to changing volume patterns attributed to the new interchange.

The segment of westbound I-64 between the ramps at the US 250 interchange is projected to have a link speed of 43 mph, which is an increase from 20 mph in No-Build conditions. Due to the change in volume patterns attributed to the new interchange, fewer vehicles are projected to use both the westbound I-64 on-ramp from eastbound US 250 and the westbound I-64 off-ramp to westbound US 250 and the speed is projected to increase from No-Build conditions due to fewer weaving movements. The rightmost lane between the ramps is projected to operate with at 36 mph from the friction of weaving vehicles, which is an increase of 3 mph from No-Build conditions.

The improvements at the intersection of US 250 and the northbound Route 288 ramps are projected to improve speeds on the off-ramp and prevent queuing from impacting the operations of northbound Route 288. Additionally, approximately 200 vehicles are rerouted to continue on northbound Route 288 and access US 250 via the N Gayton Road interchange. This reduction in demand on the northbound Route 288 off-ramp to eastbound US 250 is projected to further reduce congestion on the ramp.

By 2046, all segments of I-64 in both directions in the study area are projected to operate with speeds of 53 mph or greater except the section of westbound I-64 between ramps at the US 250 interchange. The projected average link speed on westbound I-64 between the on-ramp from eastbound US 250 and the off-ramp to westbound US 250 is 37 mph. The projected reduction in demand on the ramps at the interchange due to the new access at N Gayton Road improves speeds and significantly reduces queuing on westbound I-64 when compared to the No-Build conditions, but friction from weaving vehicles is still projected to produce a maximum queue of approximately 1,000 feet on westbound I-64. *Figure 97* shows the residual queuing on westbound I-64 at the interchange. This queue is projected to stay contained mostly in the rightmost lane on the freeway. This section of westbound I-64 through the US 250 interchange is projected to serve 94 percent of the demand, which is an increase of 29 percent from No-Build conditions.

The changing traffic patterns on the ramps at the US 250 interchange are projected to increase speeds on westbound I-64 upstream of the interchange as well. The vehicles that are rerouted to continue westbound on I-64 to use the N Gayton Road interchange to access the Short Pump area instead of the US 250 interchange are projected to result in a more balanced lane distribution on westbound I-64 upstream of the US 250 interchange. The more balanced lane distribution is projected to result in increased speeds on westbound I-64 through the Gaskins Road and Parham Road interchanges as shown in *Figure 98.* The travel time on westbound I-64 between the Parham Road and US 250 interchanges is projected to decrease by 9 minutes and 31 seconds in Build Package 2 compared to the No-Build conditions.

Three of the four bottlenecks identified in the *No-Build Conditions Freeway Analysis Results* were addressed with improvements included in Build Package 2. The bottleneck on southwestbound I-295 is still present in Build conditions due to the over-capacity loop ramp from southwestbound I-295 to eastbound I-64, which has a projected demand of 2,400 vehicles in the PM peak hour. The study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section.

The intersection improvements at Tom Leonard Drive are projected to improve operations on westbound US 250 and prevent queuing from impacting the interchange ramps. The eastbound I-64 off-ramp to westbound US 250 is projected to operate with improved speeds of 26 mph resulting from the reduced queuing on westbound US 250.

The improvements to the intersection of US 250 and the northbound Route 288 ramps are projected to relieve congestion on the ramp and prevent queuing from impacting mainline northbound Route 288. Additionally, over 500 vehicles are projected to be rerouted to continue northbound on Route 288 to access the Short Pump area via the N Gayton Road interchange. The proposed improvements are projected to release the ramp bottleneck, but the additional traffic continuing northbound through the interchange is projected to slow on northbound Route 288 between the ramps at the US 250 interchange. This 2-lane section is over capacity with a projected demand of 4,694 vehicles in the PM peak hour and is projected to operate with speeds of 35 mph or less and densities of 63 veh/ln/mi or greater, which is similar to No-Build conditions. Despite the congestion on northbound Route 288, the Build improvements are projected to allow northbound Route 288 to serve an additional 1,200 vehicles in the PM peak hour.

The northeastbound I-295 ramp improvements and the auxiliary lane on northeastbound I-295 to Nuckols Road are projected to reduce the density on the ramp to 23 veh/ln/mi or better and improve speeds up to 53 mph or greater. These improvements prevent the queuing on the ramp that was identified in the No-Build conditions analysis from backing up to westbound I-64.

*Figure 88: Build Package 2 (2026) AM Peak Hour Average Density*

Figure 89: Build Package 2 (2026) AM Peak Hour Average Speed

*Figure 90: Build Package 2 (2046) AM Peak Hour Average Density*

*Figure 91: Build Package 2 (2046) AM Peak Hour Average Speeds*

*Figure 92: Build Package 2 (2026) PM Peak Hour Average Density*

*Figure 93: Build Package 2 (2026) PM Peak Hour Average Speed*

*Figure 94: Build Package 2 (2046) PM Peak Hour Average Density*

*Figure 95: Build Package 2 (2046) PM Peak Hour Average Speed*

Figure 96: Build Package 2 (2046) AM Peak Hour Maximum Queue Length (Depictive)

*Figure 97: Build Package 2 (2046) PM Peak Hour Maximum Queue Length (Depictive)*

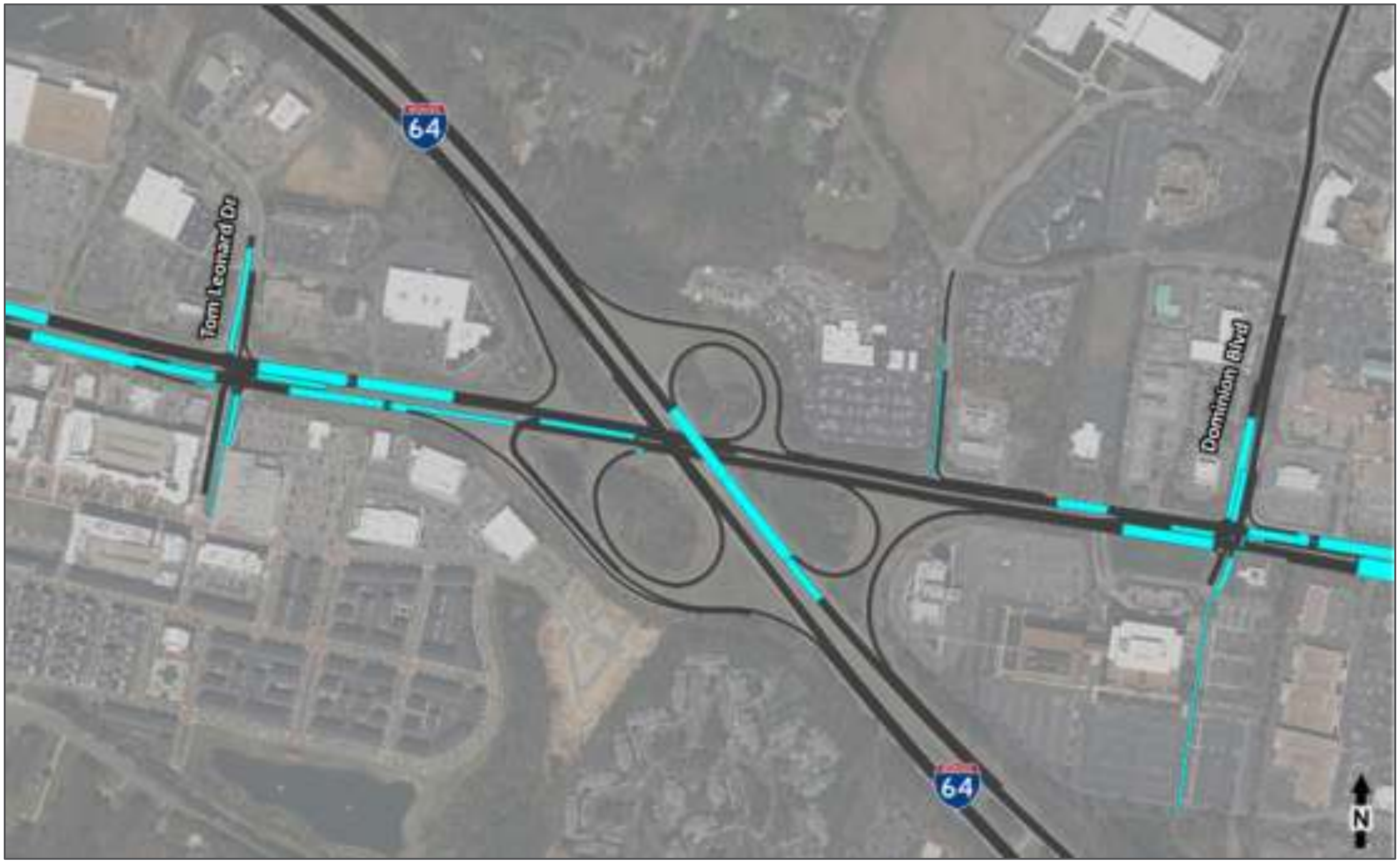
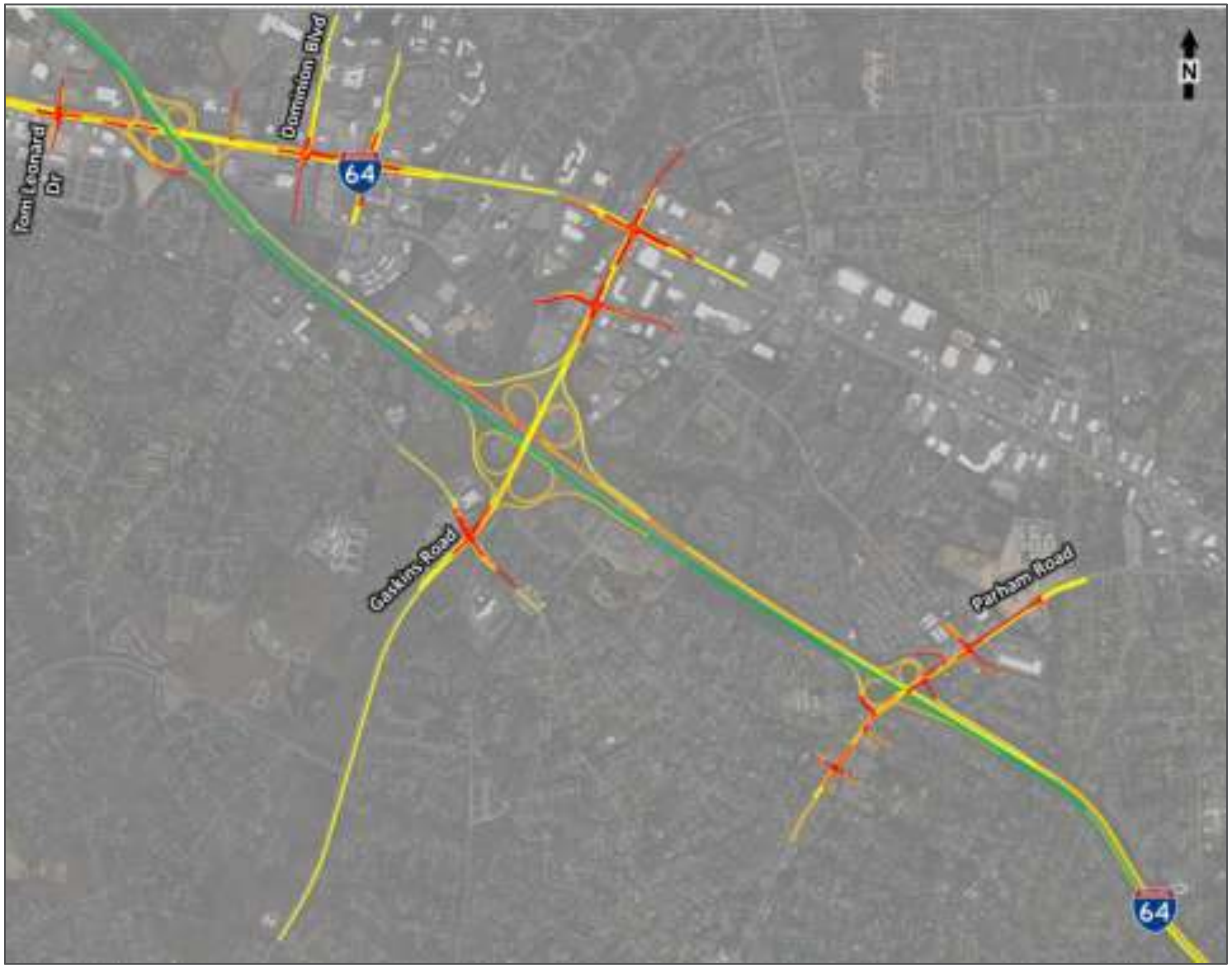


*Figure 98: Build Package 2 (2046) PM Peak Hour Average Speed*



### *Build Package 2 Intersection Analysis Results*

Graphical representation of the average intersection delay (seconds per vehicle) by movement and maximum queue length (feet) are shown in *Figure 99* through *Figure 106*.

#### AM Peak Hour

In the 2026 AM peak hour, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 31.0 seconds per vehicle. All left-turn movements at the intersection are projected to operate with 60.2 seconds per vehicle or greater. All left-turn maximum queue lengths are projected to stay contained to their respective storage bays.

All other study area intersections are projected to operate with an overall intersection delay of 25.2 seconds per vehicle or better. The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 14.4 seconds per vehicle or better.

The longest AM peak hour maximum queue is projected to occur at the westbound left-turn movement at the intersection with the southbound Route 288 ramps, but the 445-foot queue is projected to stay contained in the storage bay.

In the 2046 AM peak hour, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 38.1 seconds per vehicle. The longest AM peak hour maximum queue is projected to occur at the southbound right-turn movement at the intersection of US 250 and N Gayton Road. The projected 825-foot queue extends beyond the right-turn storage bay, which is 305 feet less than No-Build conditions.

All other study area intersections are projected to operate with overall intersection delays of 28.0 seconds per vehicle or better. The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delay of 14.9 seconds per vehicle or better.

All study area intersections are projected to operate at or better than the No-Build conditions analysis results. The overall travel time on US 250 between Route 288 and Cox Road is projected to decrease by 4 minutes and 29 seconds in the eastbound direction and 4 seconds in the westbound direction from No-Build conditions.

#### PM Peak Hour

In the 2026 PM peak hour, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 40.4 seconds per vehicle. The westbound and northbound left-turn movements are projected to operate with delays of 60.8 seconds per vehicle or greater.

The intersection of US 250 and Dominion Boulevard is projected to operate with an overall intersection delay of 37.3 seconds per vehicle. All movements on the northbound approach are projected to operate with delays of 300 seconds of greater. The longest maximum queues in the 2026 PM peak hour are projected on the northbound approach at Dominion Boulevard and extend 1,050 feet.

All other study area intersections are projected to operate with overall intersection delays of 23.9 seconds per vehicle or better. The side street movements at the intersection of Tom Leonard Drive and US 250 are projected to operate with delays of 56.8 seconds per vehicle or greater. The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 14.4 seconds per vehicle or greater.

By 2046, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 63.9 seconds per vehicle. All left-turn movements at the intersection are projected to operate with 58.7 seconds per vehicle of delay or greater. The eastbound left-turn queue is projected to extend 995 feet and spill back out of the 545-foot storage bay.

The intersection of US 250 and Dominion Boulevard is projected to operate with 44.5 seconds per vehicle of overall intersection delay. The northbound approach is projected to operate with delays of 367.8 seconds per vehicle or greater, similar to the results identified in the No-Build conditions analysis.

All other study area intersections are projected to operate with overall intersection delays of 27.2 seconds per vehicle or better. The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 16.8 seconds per vehicle or better. All ramp terminal movements are projected to operate with 31.7 seconds of delay per vehicle or better.

The westbound right-turn vehicles rerouted from Blue Ocean Lane to the Dominion Chevy Access Road are projected to experience 250.3 seconds of delay per vehicle. The westbound right-turn queue is projected to extend 1,265 feet back into the shopping center roadway network. These projections were based on volume rerouting assumptions that increased this right-turn volume from the No-Build scenario to account for vehicles accessing the new interchange from the nearby developments. If this Build package were to be built, these delay and queuing projections may be overstated as drivers may elect to access the new interchange via subsequent right turns onto US 250 and N Gayton Road to avoid long delays. In this case, the delay and queuing would distribute between the westbound right-turn movement at the Dominion Chevy Access Road and the southbound right-turn movements at Henley Drive or Town Center W Boulevard. In the case that long delays and queues persist at the Dominion Chevy Access Road, this intersection should be reviewed for further improvements to mitigate the delay and queuing.

All study area intersections are projected to operate at or better than the No-Build conditions analysis results. The overall travel time on US 250 between Route 288 and Cox Road is projected to decrease by 1 minute and 26 seconds in the eastbound direction and 43 seconds in the westbound direction. As described in the *Build Traffic Volumes* section, the demand on US 250 is projected to decrease with the addition of the new interchange at N Gayton Road. The decreased demand is projected to result in improved intersection operations and improved travel times.

*Figure 99: Build Package 2 (2026) AM Peak Hour Intersection Delay*

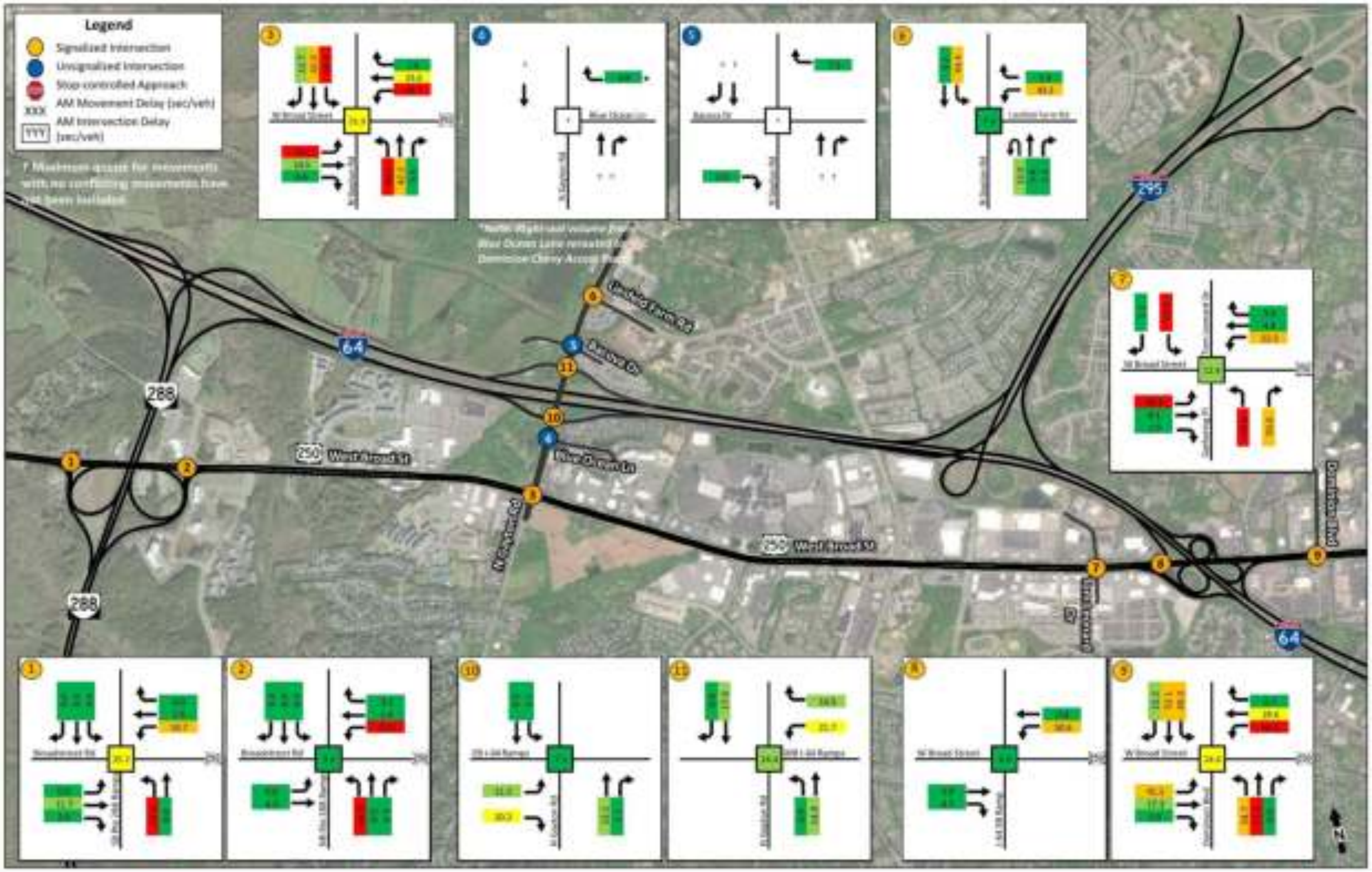


*Figure 100: Build Package 2 (2026) AM Peak Hour Maximum Queue Length*

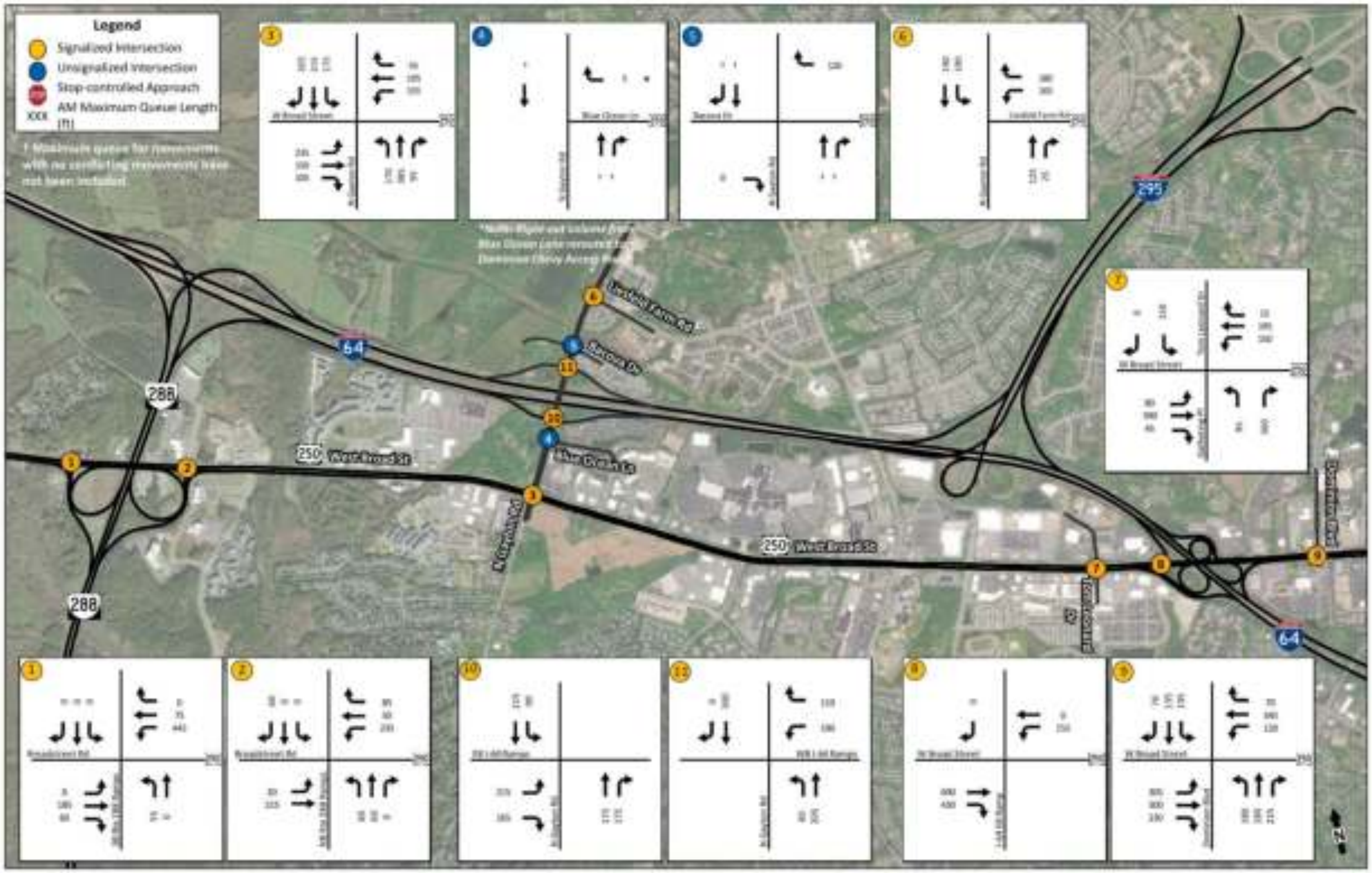


*Figure 101: Build Package 2 (2046) AM Peak Hour Intersection Delay*

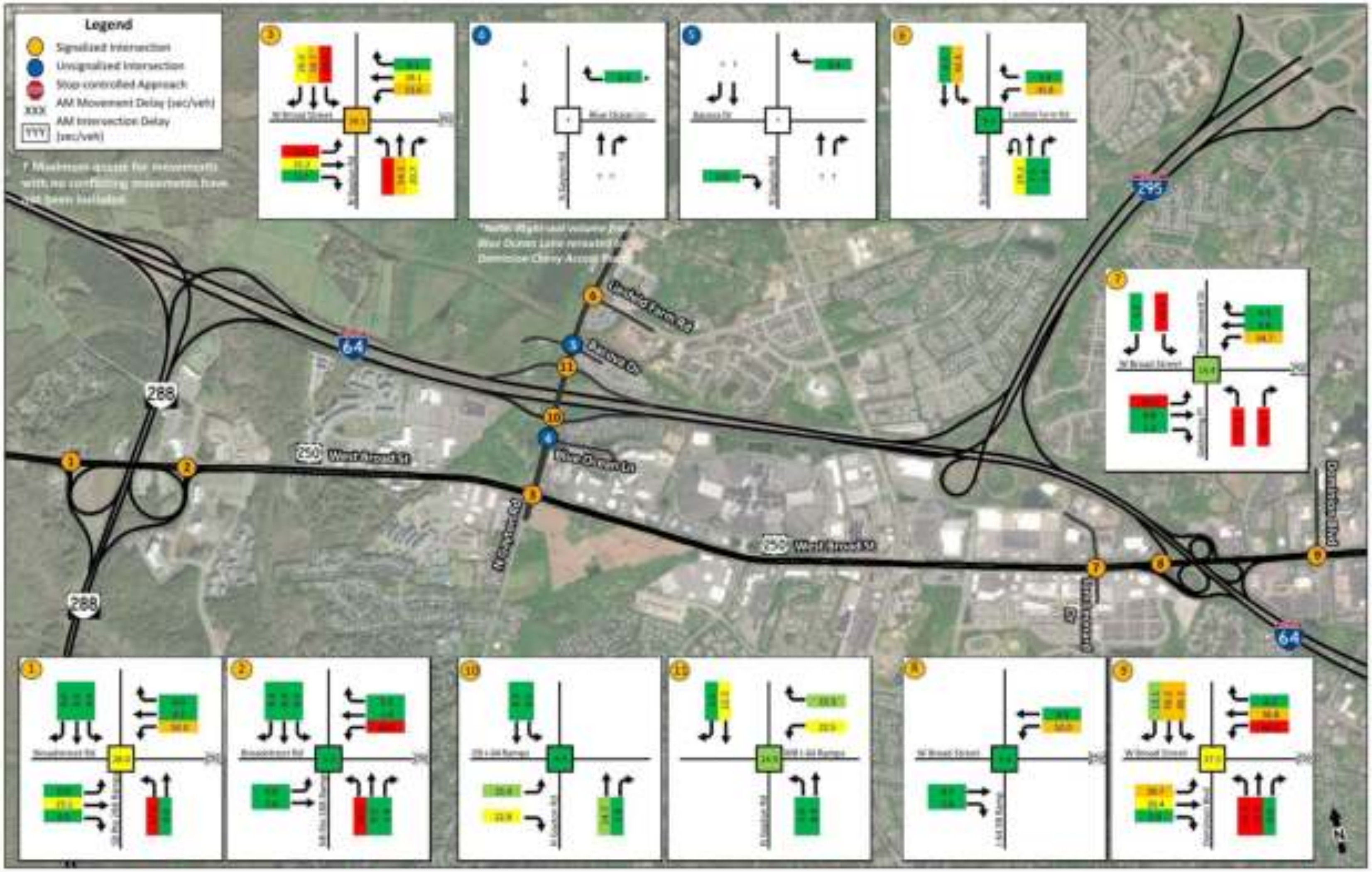


*Figure 102: Build Package 2 (2046) AM Peak Hour Maximum Queue Length*

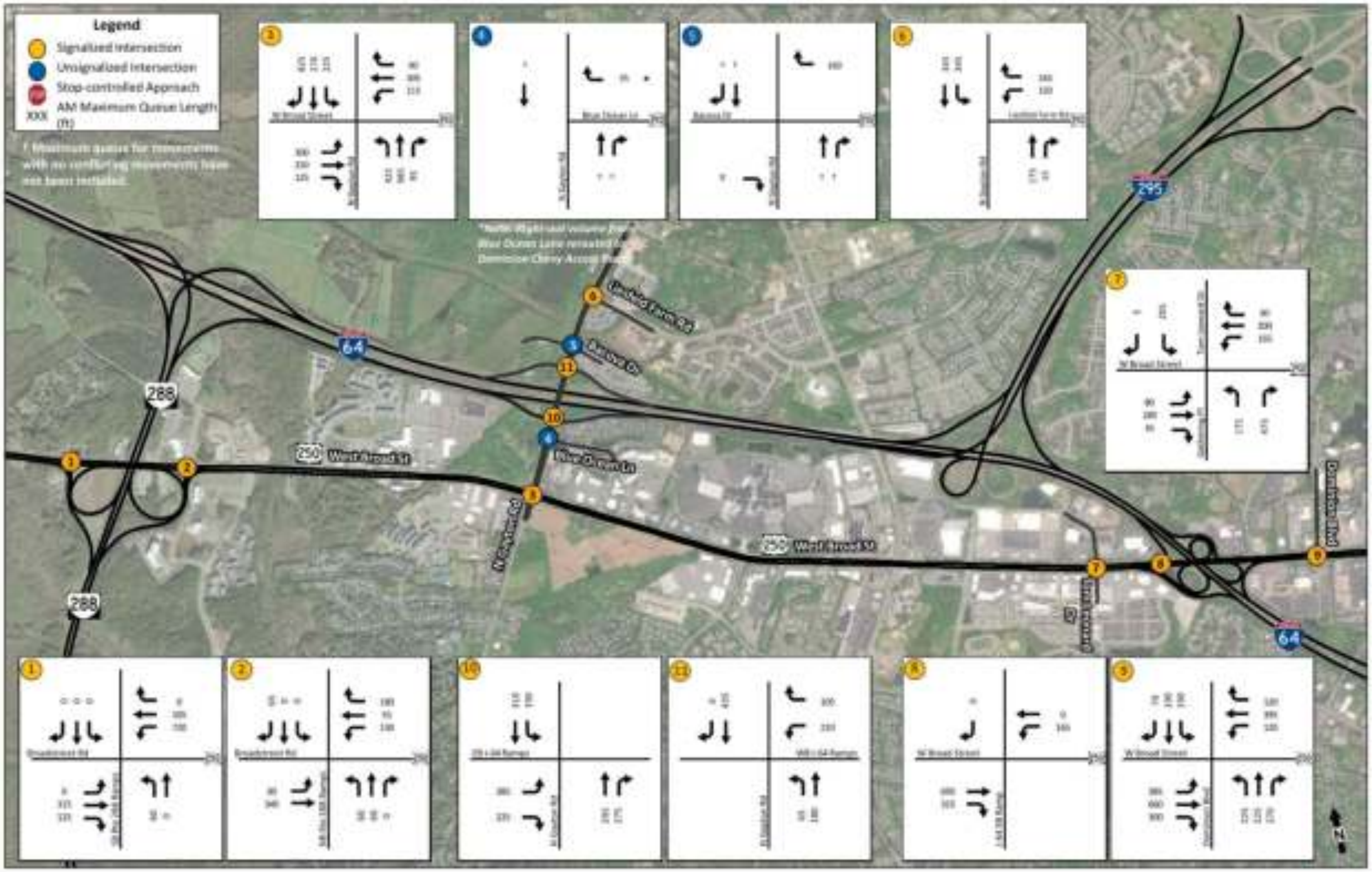


*Figure 103: Build Package 2 (2026) PM Peak Hour Intersection Delay*

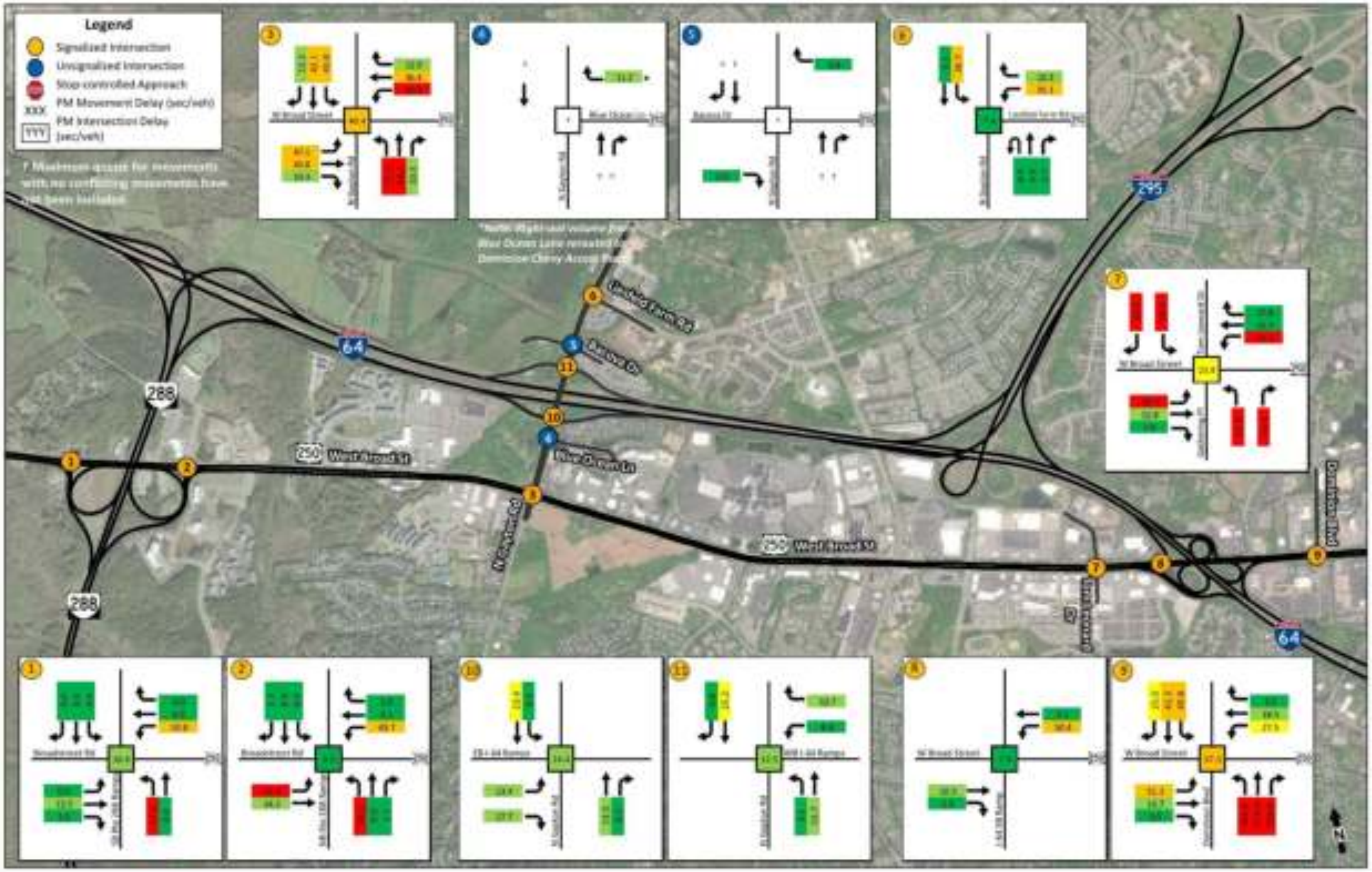


*Figure 104: Build Package 2 (2026) PM Peak Hour Maximum Queue Length*

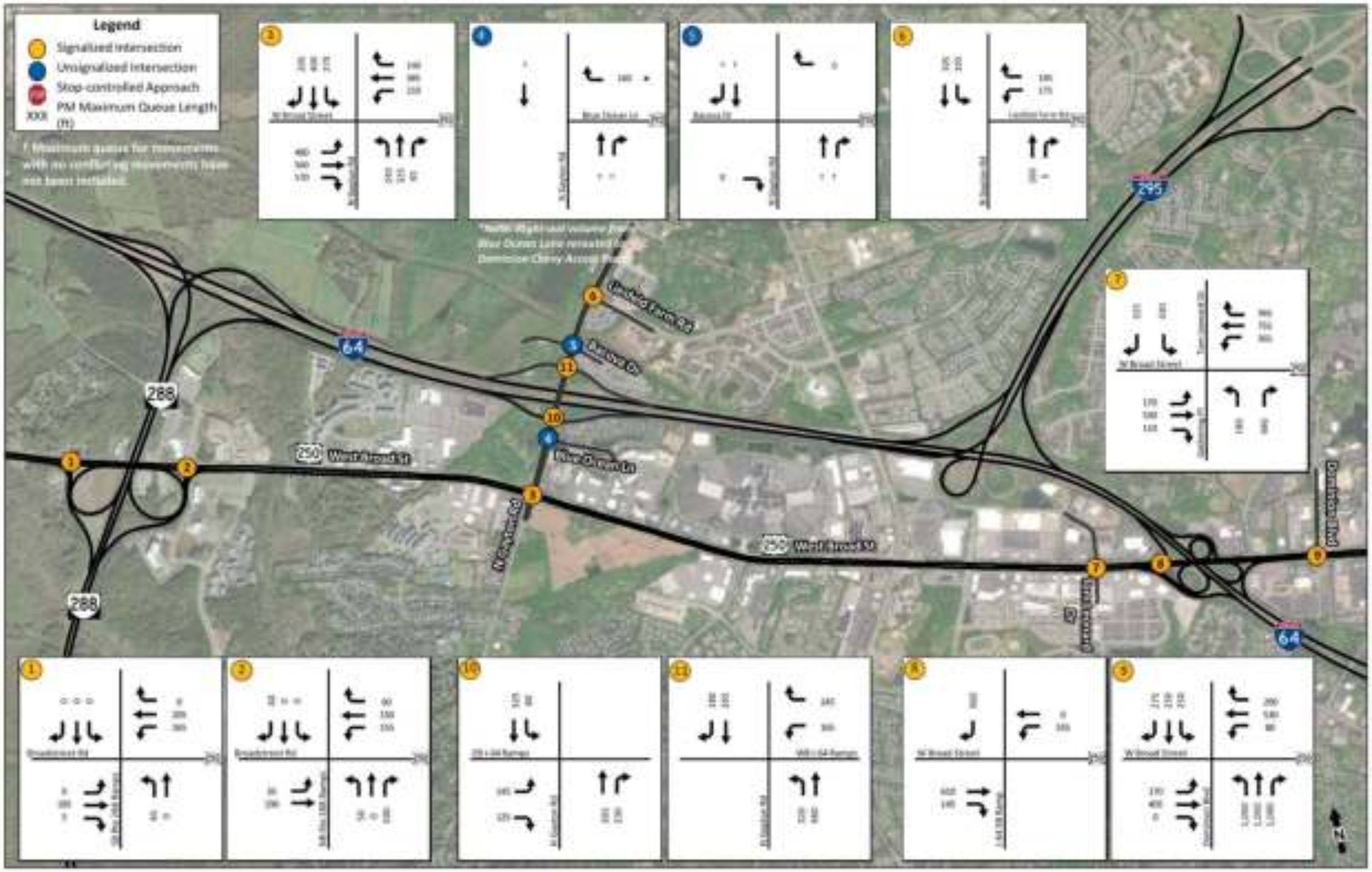


*Figure 105: Build Package 2 (2046) PM Peak Hour Intersection Delay*

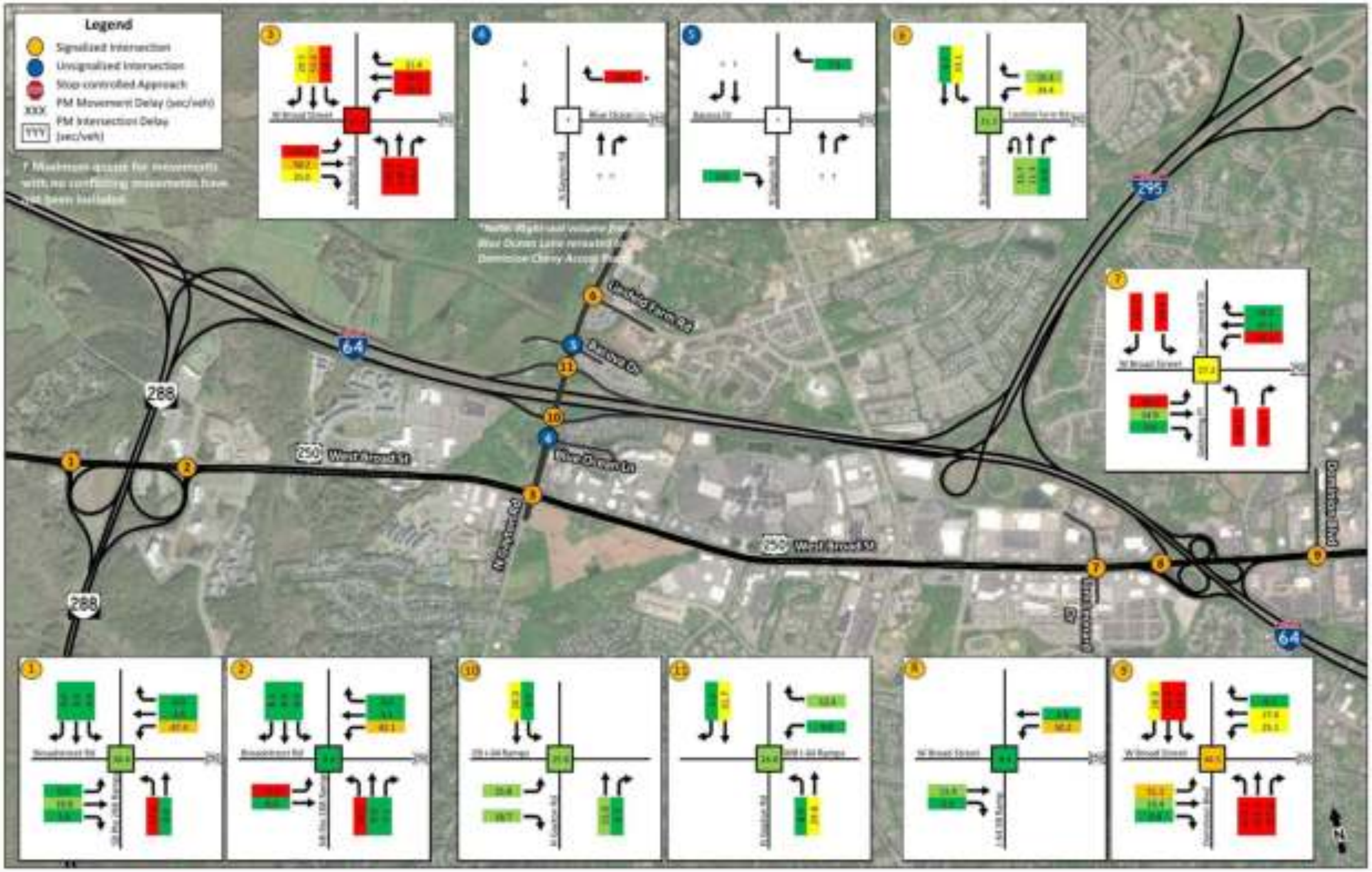
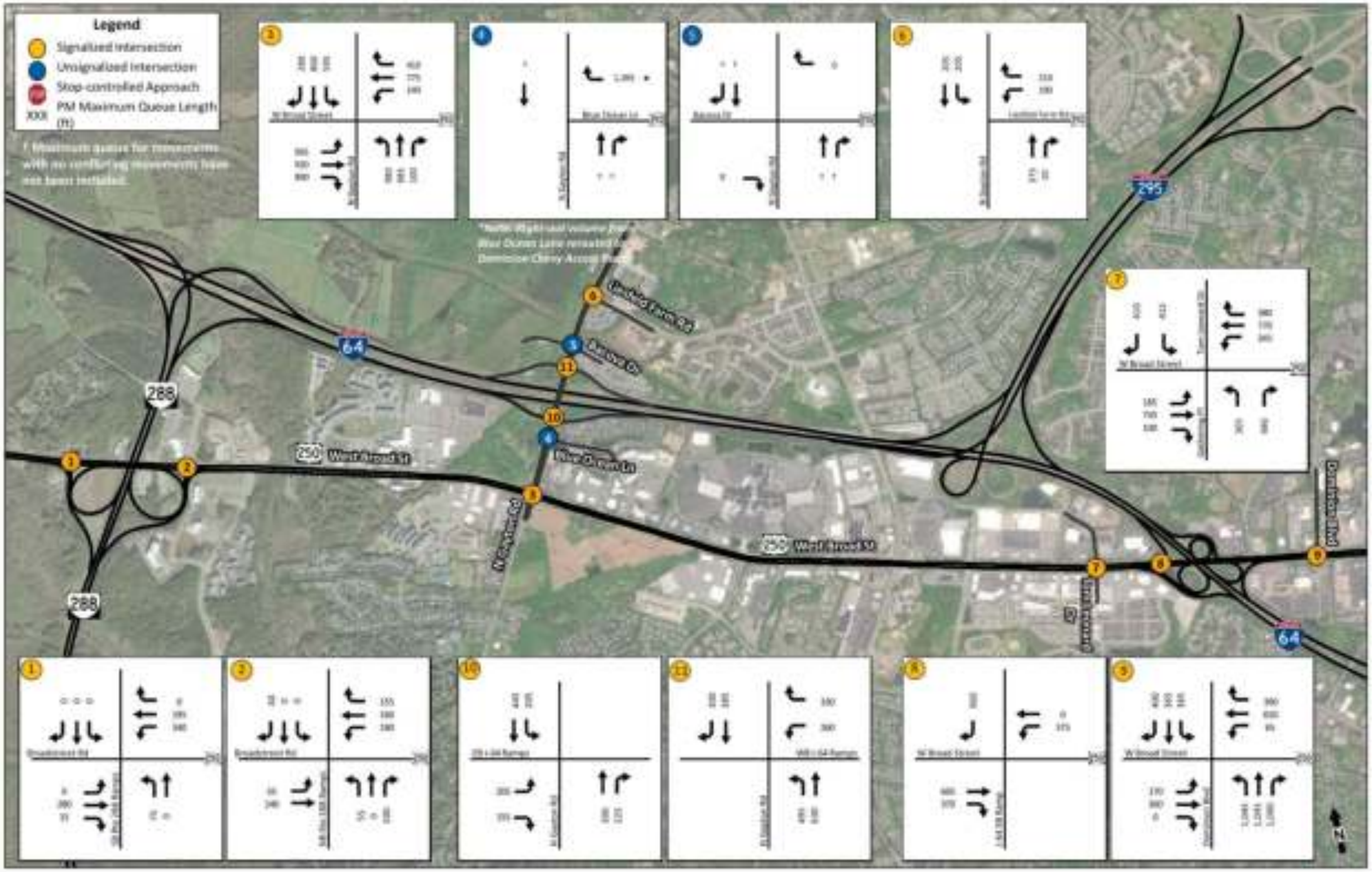


*Figure 106: Build Package 2 (2046) PM Peak Hour Maximum Queue Length*



### Build Package 3

Heavy vehicle, peak hour factor, and traffic signal timing assumptions remained consistent with the No-Build analyses. The input traffic volumes used for Build Package 3 are described and provided in the *Build Traffic Volumes* section of the report. A detailed summary of the Build Package 3 inputs is provided in *Appendix G*.

The VDOT Sample Size Determination Tool, Version 2.0 was used to determine the number of traffic simulation runs required to provide the acceptable 95th percentile confidence level for the 2026 and 2046 Build Package 3 models. Ten simulation runs were conducted for all of the Build Package 3 models using different random seeds and the average of these runs was reported. The VDOT Sample Size Determination Tool summary sheets are provided in *Appendix G.*

#### *Build Package 3 Freeway Analysis Results*

The AM and PM peak hour average freeway segment density and speed for the 2026 and 2046 Build Package 3 conditions are illustrated in *Figure 107* through *Figure 114*. Graphical representation of the freeway results by lane is included in *Appendix G*.

##### AM Peak Hour

In the 2026 AM peak hour, all segments of I-64 in both directions in the study area are projected to operate with speeds of 62 mph or greater.

In 2046, all segments of I-64 in the study area are projected to operate with speeds of 55 mph or greater. The segment of westbound I-64 between ramps at the US 250 interchange is projected to operate with improved speeds of 62 mph or greater. The partial cloverleaf ramp reconfiguration removes the weaving section on westbound I-64 and improves speeds to 62 mph or greater at and approaching the interchange and densities of 31 veh/ln/mi or better.

The turning restriction from the westbound I-64 off-ramp to eastbound US 250 to Dominion Boulevard and the partial cloverleaf ramp reconfiguration are projected to improve operations on eastbound US 250 at the I-64 interchange and prevent any queuing on the arterial from impacting the interchange ramps. *Figure 115* shows the maximum queue results at the interchange ramps. The partial cloverleaf ramp reconfiguration removes the weave on the arterial and removes any friction on eastbound US 250 that was present in the weave in No-Build conditions from impacting the eastbound I-64 off-ramp to eastbound US 250. Additionally, the queuing on eastbound US 250 is not projected to extend to the westbound I-64 off-ramp to eastbound US 250 since the lower demand on eastbound US 250 combined with the turning restriction that prevents vehicles on this ramp from turning left at Dominion Boulevard are projected to improve operations on US 250. In the case that the volumes on US 250 do not decrease as projected, this queue would be projected to operate similarly to the AM peak hour projections for Build Package 1 and be comparable to the No-Build scenario.

The southbound Route 288 auxiliary lane between the US 250 and Tuckahoe Creek Parkway interchanges is projected to provide relief to the congestion on southbound Route 288 that was identified in the No-Build conditions analysis. The additional capacity from the auxiliary lane allows southbound Route 288 to serve the projected 6,500 vehicles per hour south of the US 250 interchange while operating at speeds of 54 mph or greater.

The southwestbound I-295 bottleneck identified in No-Build conditions is still present in Build Package 3 since the study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section. However, the southwestbound I-295 loop ramp to eastbound I-64 is projected to operate with slightly improved speeds from No-Build conditions (between 25 and 42 mph) due to the reduced demand on the loop ramp that is attributed to the change in volume patterns for the new interchange. The congestion on southwestbound I-295 approaching the I-64 ramps is still projected to prevent all the demand on I-295 from being served, but the demand served is projected to increase 8 percent from No-Build conditions.

### PM Peak Hour

In the 2026 PM peak hour, all segments of I-64 in the study area are projected to operate with speeds of 61 mph or greater. The segment of westbound I-64 between I-295 and Route 288 is projected to serve 100 percent of the demand, which is an increase of 4 percent from No-Build conditions, even though the demand increased by 1,110 vehicles due to the changing volume patterns attributed to the new interchange.

The segment of westbound I-64 between the ramps at the US 250 interchange is projected to experience speeds of 59 mph, which is an increase from 20 mph in No-Build conditions. The partial cloverleaf ramp reconfiguration reduces congestion on westbound I-64 by removing the weaving segment on the freeway. Due to the change in volume patterns attributed to the new interchange, fewer vehicles are projected to use the westbound I-64 off-ramp to westbound US 250 and the speed is projected to increase from No-Build conditions.

By 2046, all segments of I-64 in the study area are projected to operate with speeds of 59 mph or greater. The projected average link speed on westbound I-64 approaching the off-ramp to westbound US 250 is 61 mph. The removal of the weave on westbound I-64 from the partial cloverleaf ramp reconfiguration and the projected reduction in demand on the westbound I-64 off-ramp to westbound US 250 are projected to improve speeds and significantly reduce queuing on westbound I-64 when compared to No-Build conditions. Despite the projected reduction in demand, the westbound I-64 off-ramp to westbound US 250 is still projected to serve 1,100 vehicles in the peak hour. The operational results show a projected maximum queue of approximately 100 feet on westbound I-64, which is primarily caused by last minute lane changes to decelerate and exit to westbound US 250 based on simulation observations. *Figure 97* shows the residual queuing on westbound I-64 at the interchange; however, significant improvement within this section of I-64 is expected compared to No-Build conditions given the removal of the weave and the reduced demand to the westbound US 250 off-ramp. This segment of westbound I-64 through the US 250 interchange is projected to serve 96 percent of the demand, which is an increase of 31 percent from No-Build conditions.

The changing traffic patterns on the ramp at the US 250 interchange are projected to increase speeds on westbound I-64 upstream of the interchange as well. The vehicles that are rerouted to continue westbound on I-64 to use the N Gayton Road interchange to access the Short Pump area instead of the US 250 interchange are projected to result in a more balancing lane distribution on westbound I-approaching the US 250 interchange. The more balanced lane distribution is projected to result in increased speeds on westbound I-64 through the upstream Gaskins Road and Parham Road interchanges as show in *Figure 117*. The travel time on westbound I-64 between Parham Road and the US 250 interchange is projected to decrease by 9 minutes and 53 seconds compare to the No-Build conditions.

Three of the four bottlenecks identified in the *No-Build Conditions Freeway Analysis Results* were addressed with improvements included in Build Package 3. The bottleneck on southwestbound I-295 is still present in Build conditions due to the over-capacity loop ramp from southwestbound I-295 to eastbound I-64, which has a projected demand of 2,400 vehicles in the PM peak hour. The study team agreed not to include further improvements on southwestbound I-295 to address the bottleneck as documented in the *I-64 at US 250 and I-295 Interchanges* screening section.

The intersection improvements at Tom Leonard Drive are projected to improve operations on westbound US 250 and prevent queuing from impacting the interchange ramps at I-64. The eastbound I-64 off-ramp to westbound US 250 is projected to operate with improved speeds between 25 and 35 mph resulting from the reduced queuing on westbound US 250.

The northeastbound I-295 ramp improvements and the auxiliary lane on northeastbound I-295 to Nuckols Road are projected to reduce the density on the ramp to 24 veh/ln/mi or better and improve speeds up to 53 mph or greater. These improvements prevent the queuing on the ramp that was identified in No-Build conditions from backing up to westbound I-64.

The improvements to the intersection of US 250 and the northbound Route 288 ramps are projected to relieve congestion on the ramp and prevent queuing from impacting northbound Route 288. Additionally, over 500 vehicles are projected to be rerouted to continue northbound on Route 288 to access the Short Pump area at the N Gayton Road interchange. The proposed improvements are projected to release the ramp bottleneck, but the additional traffic continuing northbound through the interchange is projected to slow on northbound Route 288 between the ramps at the US 250 interchange. The 2-lane section between the ramps at the interchange is over capacity with a projected demand of 4,694 vehicles in the PM peak hour and is projected to operate with speeds of 34 mph or less and densities of 63 veh/ln/mi or greater. Despite the congestion on northbound Route 288, the Build improvements are projected to allow northbound Route 288 to serve an additional 1,200 vehicles in the PM peak hour.

*Figure 107: Build Package 3 (2026) AM Peak Hour Average Density*

Figure 108: Build Package 3 (2026) AM Peak Hour Average Speed

*Figure 109: Build Package 3 (2046) AM Peak Hour Average Density*

*Figure 110: Build Package 3 (2046) AM Peak Hour Average Speed*

*Figure 111: Build Package 3 (2026) PM Peak Hour Average Density*

*Figure 112: Build Package 3 (2026) PM Peak Hour Average Speed*

Figure 113: Build Package 3 (2046) PM Peak Hour Average Density

*Figure 114: Build Package 3 (2046) PM Peak Hour Average Speed*

*Figure 115: Build Package 3 (2046) AM Peak Hour Maximum Queue Length (Depictive)*

*Figure 116: Build Package 3 (2046) PM Peak Hour Maximum Queue Length (Depictive)*

*Figure 117: Build Package 3 (2046) PM Peak Hour Average Speed*

### *Build Package 3 Intersection Analysis Results*

Graphical representation of the average intersection delay (seconds per vehicle) by movement and maximum queue length (feet) are shown in *Figure 118* through *Figure 125*.

#### AM Peak Hour

In the 2026 AM peak hour, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 31.1 seconds per vehicle. All left-turn movements at the intersection are projected to operate with delays of 60.1 seconds per vehicle or greater. The southbound right-turn queue is projected to be the longest maximum queue at the intersection, extending 400 feet.

The intersection of US 250 and Dominion Boulevard is projected to operate with an overall intersection delay of 24.6 seconds per vehicle and the intersection of US 250 at the southbound Route 288 ramps is projected to operate with an overall intersection delay of 25.5 seconds per vehicle. All other study area intersections are projected to operate with overall intersection delays of 14.4 seconds per vehicle or better.

The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 14.4 seconds per vehicle or better. The intersection of US 250 at the westbound I-64 ramps is projected to operate with an overall intersection delay of 8.0 seconds per vehicle.

By 2046, the intersection of US 250 and the northbound Route 288 ramps is projected to operate with the most overall intersection delay of 42.3 seconds per vehicle. The intersection of US 250 and N Gayton Road is projected to operate with an overall intersection delay of 36.7 seconds per vehicle. The southbound right-turn queue is projected to be the longest maximum queue at the intersection, extending 670 feet.

All other study area intersections are projected to operate with overall intersection delays of 27.4 seconds or better. The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 15.3 seconds per vehicle or better. The intersection of US 250 and the westbound I-64 ramps is projected to operate with an overall intersection delay of 9.9 seconds per vehicle.

All study area intersections are projected to operate at or better than the No-Build conditions analysis results. The overall travel time on US 250 between Route 288 and Cox Road is projected to decrease by 5 minutes and 3 seconds in the eastbound direction. The overall travel time on US 250 between Route 288 and Cox Road is projected to increase by 20 seconds in the westbound direction due to the addition of the signalized intersection at the westbound I-64 ramp terminal. All other segments of westbound US 250 are projected to experience travel times comparable to No-Build conditions

#### PM Peak Hour

In the 2026 PM peak hour, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 40.4 seconds per vehicle. The intersection of US 250 and Dominion Boulevard is projected to operate with 37.3 seconds of delay per vehicle. All other study area intersections are projected to operate with overall intersection delays of 23.6 seconds per vehicle or better.

The longest maximum queue in the 2026 PM peak hour is projected on the northbound approach at the intersection of US 250 and Dominion Boulevard.

The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 15.2 seconds per vehicle of better. All movements at the ramp terminal intersections are projected to operate with

25.4 seconds of delay per vehicle or better. The intersection of US 250 and the westbound I-64 ramps is projected to operate with an overall intersection delay of 13.4 seconds per vehicle.

By 2046, the intersection of US 250 and N Gayton Road is projected to operate with the most overall intersection delay of 63.6 seconds per vehicle. The longest maximum queue at the intersection is the eastbound left-turn queue, which is projected to extend 975 feet. This queue is projected to be longer than in the No-Build conditions due to the release of the bottleneck on northbound Route 288, which resulted in an increased percentage of demand served on eastbound US 250.

The intersection of US 250 and Dominion Boulevard is projected to operate with an overall intersection delay of 44.0 seconds per vehicle. All other study area intersections are projected to operate with overall intersection delays of 27.1 seconds per vehicle or better.

The intersections of N Gayton Road and the I-64 ramps are projected to operate with overall intersection delays of 17.0 seconds per vehicle or better. All movements at the ramp terminal intersections are projected to operate with 32.2 seconds per vehicle of delay or better. The intersection of US 250 and the westbound I-64 ramps is projected to operate with an overall intersection delay of 18.9 seconds per vehicle. The eastbound left-turn movement is projected to operate with 48.8 seconds per vehicle of delay and a maximum queue length of 970 feet. Due to the contraflow left-turn interchange configuration, the eastbound left-turn queue is contained to the contraflow storage and does not impact operations on mainline eastbound US 250.

The westbound right turning vehicles out of Blue Ocean Road that were rerouted to the westbound right turn at the Dominion Chevy Access Road are projected to operate with 267.2 seconds of delay per vehicle, resulting in a maximum queue length of 1,305 feet. These projections were based on volume rerouting assumptions that increased this right-turn volume from the No-Build scenario to account for vehicles accessing the new interchange from the nearby developments. These delay and queuing projections may be overstated as drivers may elect to access the new interchange via subsequent right turns onto US 250 and N Gayton Road to avoid long delays. In this case, the delay and queuing would distribute between the westbound right-turn movement at the Dominion Chevy Access Road and the southbound right-turn movements at Henley Drive or Town Center W Boulevard. In the case that long delays and queues persist at the Dominion Chevy Access Road, this intersection should be reviewed for further improvements to mitigate the delay and queuing.

All signalized study area intersections are projected to operate at or better than the No-Build conditions analysis results. The overall travel time on US 250 between Route 288 and Cox Road is projected to decrease by 1 minute and 33 seconds in the eastbound direction and 22 seconds in the westbound direction. The section of westbound US 250 between Cox Road and I-64 is projected to experience an increase in travel time due to the addition of the new signalized intersection at the westbound I-64 ramps. The section of westbound US 250 between Lauderdale Road and N Gayton Road is projected to experience an increase in travel time of 48 seconds from No-Build conditions due to the additional demand traveling to access the new interchange. All other segments of US 250 are projected to experience a reduction in travel times, resulting in an overall travel time improvement for the length of the corridor.

*Figure 118: Build Package 3 (2026) AM Peak Hour Intersection Delay*

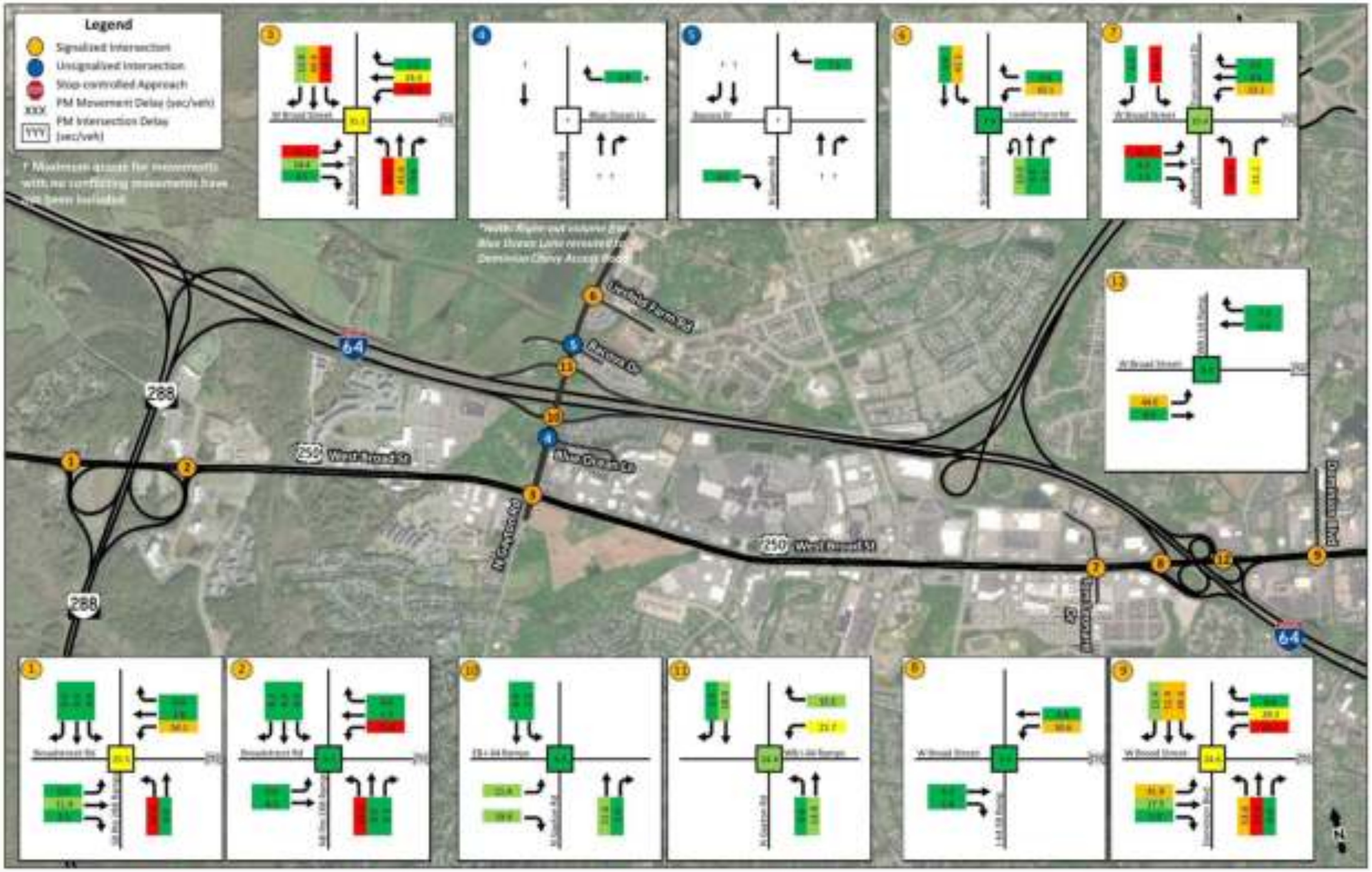


*Figure 119: Build Package 3 (2026) AM Peak Hour Maximum Queue Length*

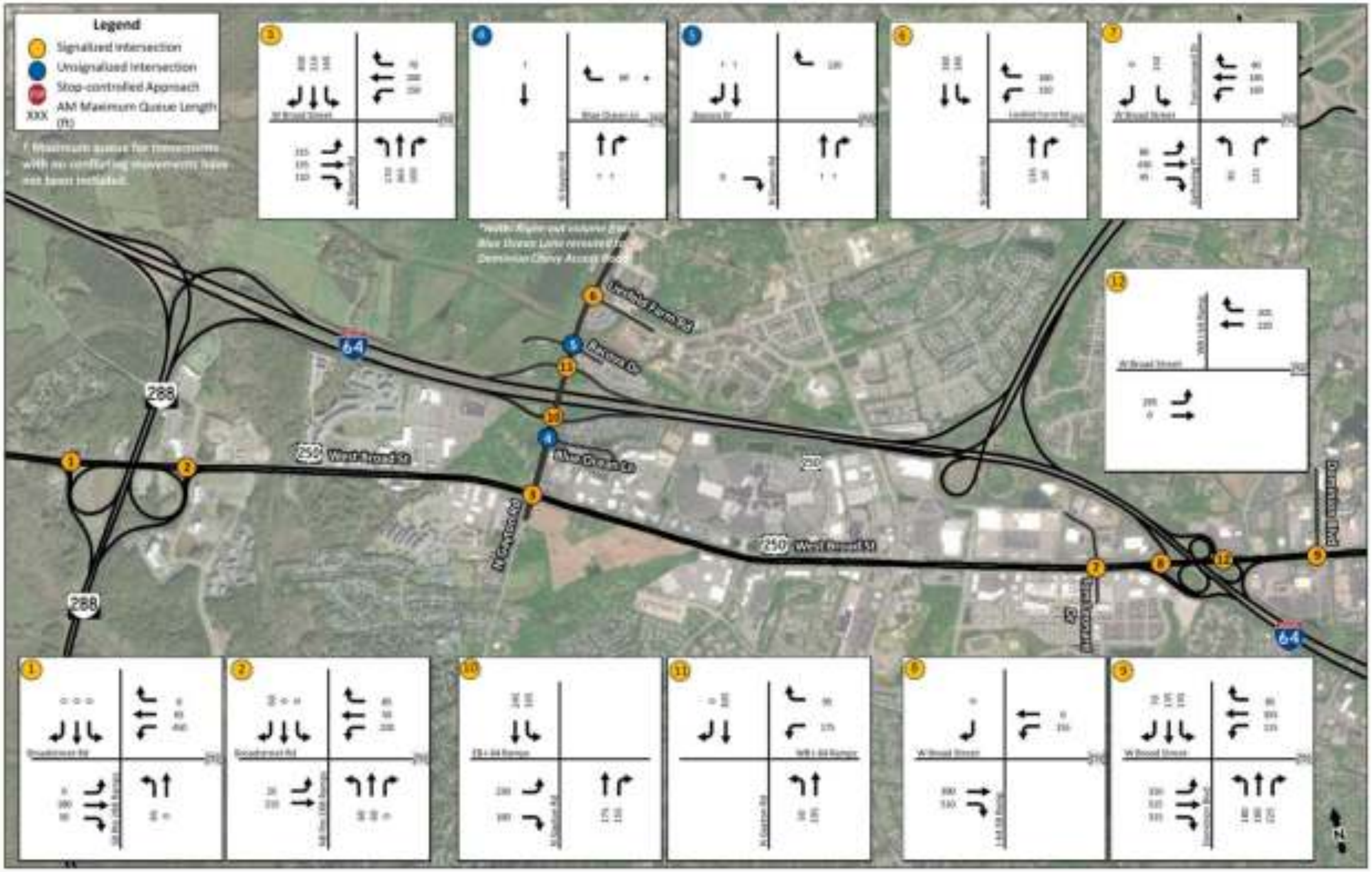


*Figure 120: Build Package 3 (2046) AM Peak Hour Intersection Delay*

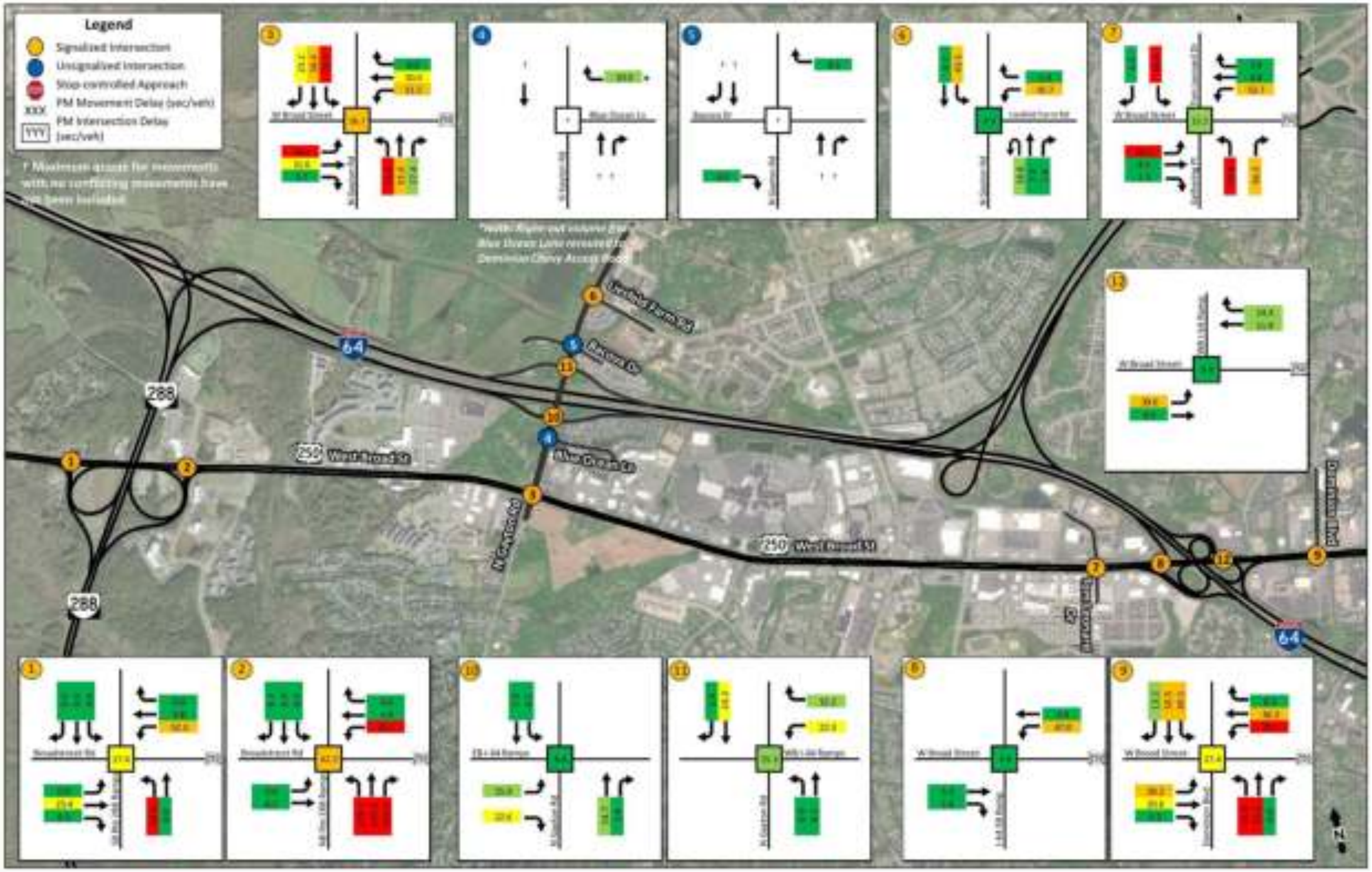


*Figure 121: Build Package 3 (2046) AM Peak Hour Maximum Queue Length*

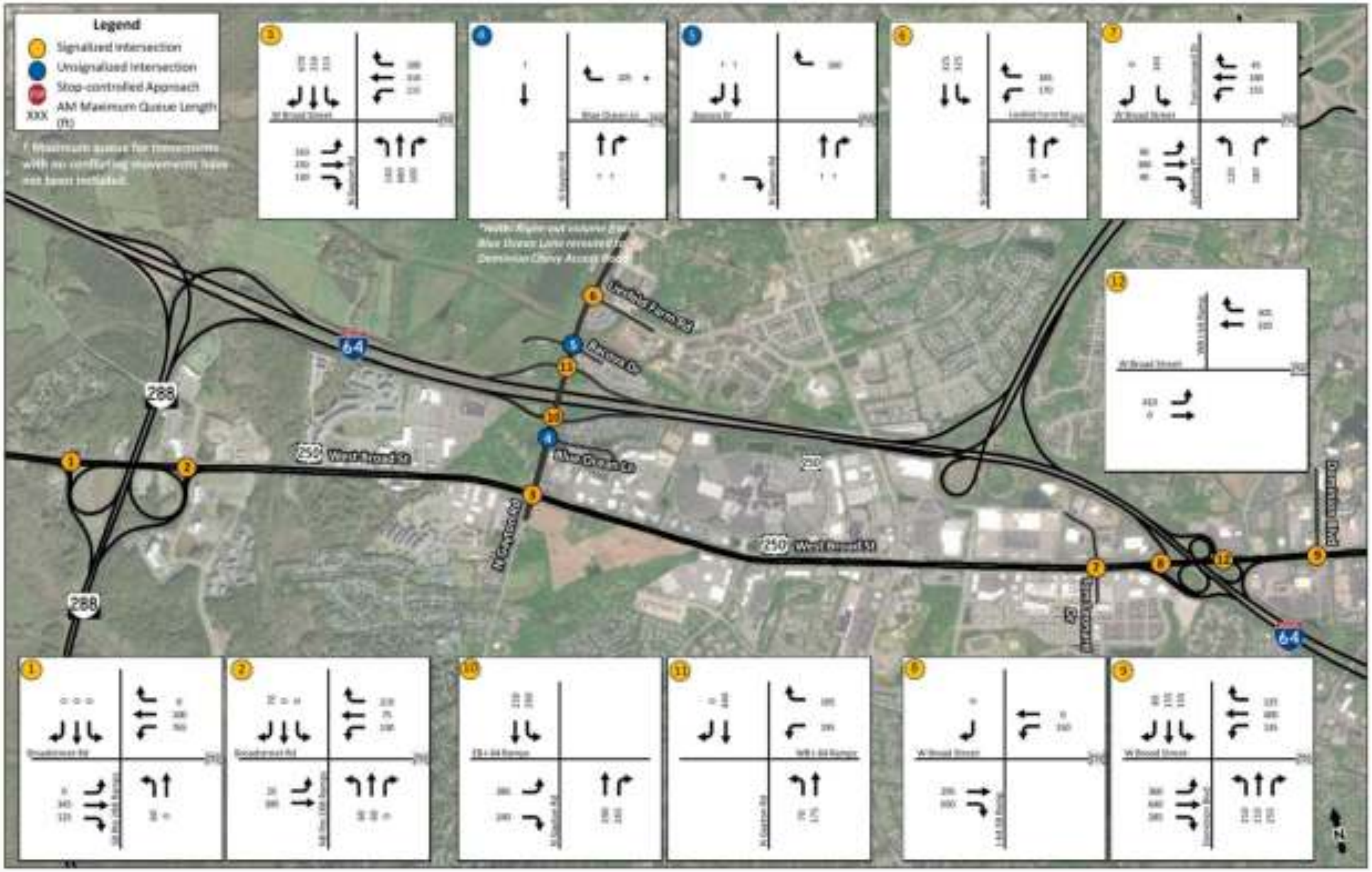


*Figure 122: Build Package 3 (2026) PM Peak Hour Intersection Delay*

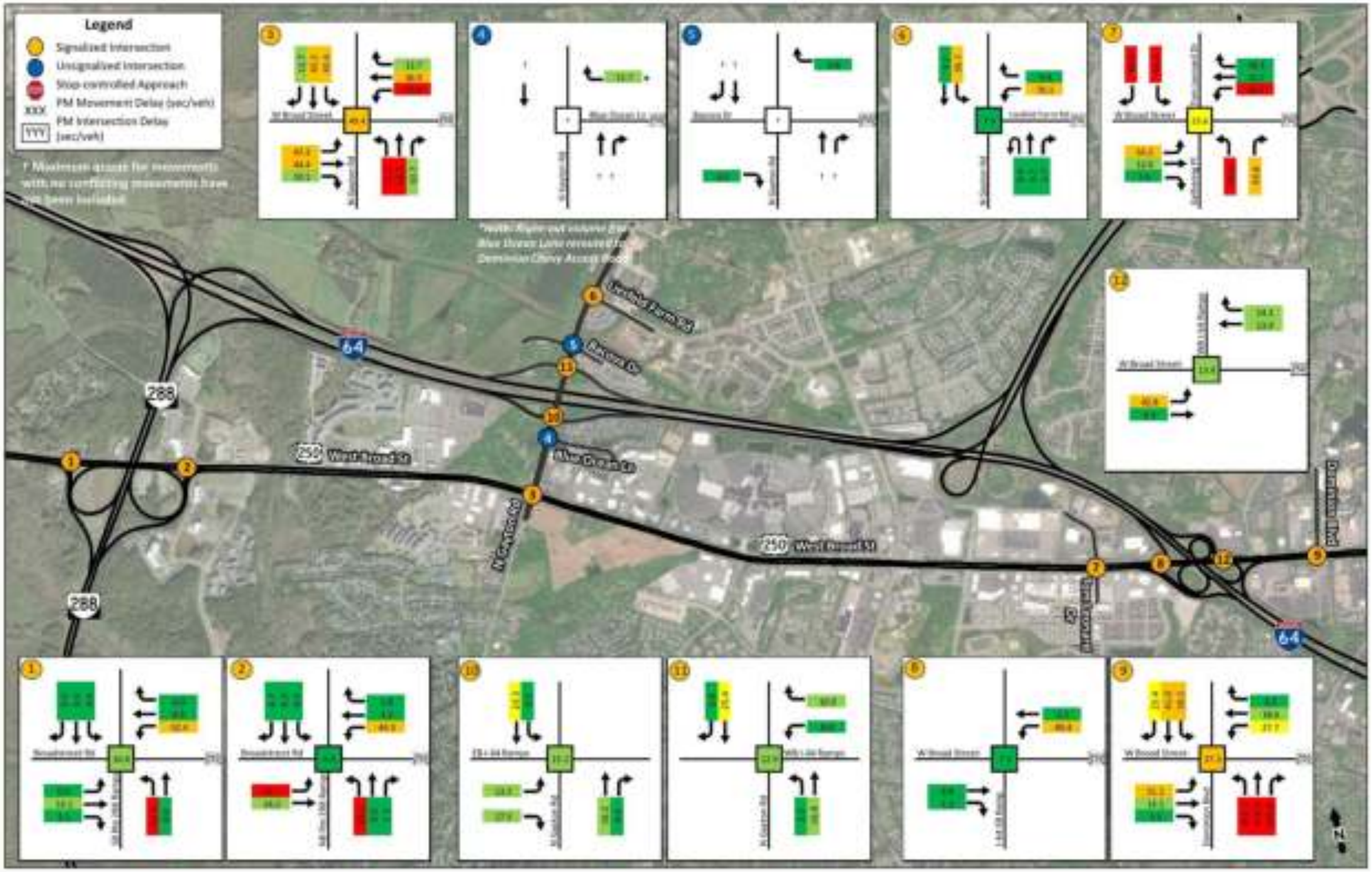


*Figure 123: Build Package 3 (2026) PM Peak Hour Maximum Queue Length*

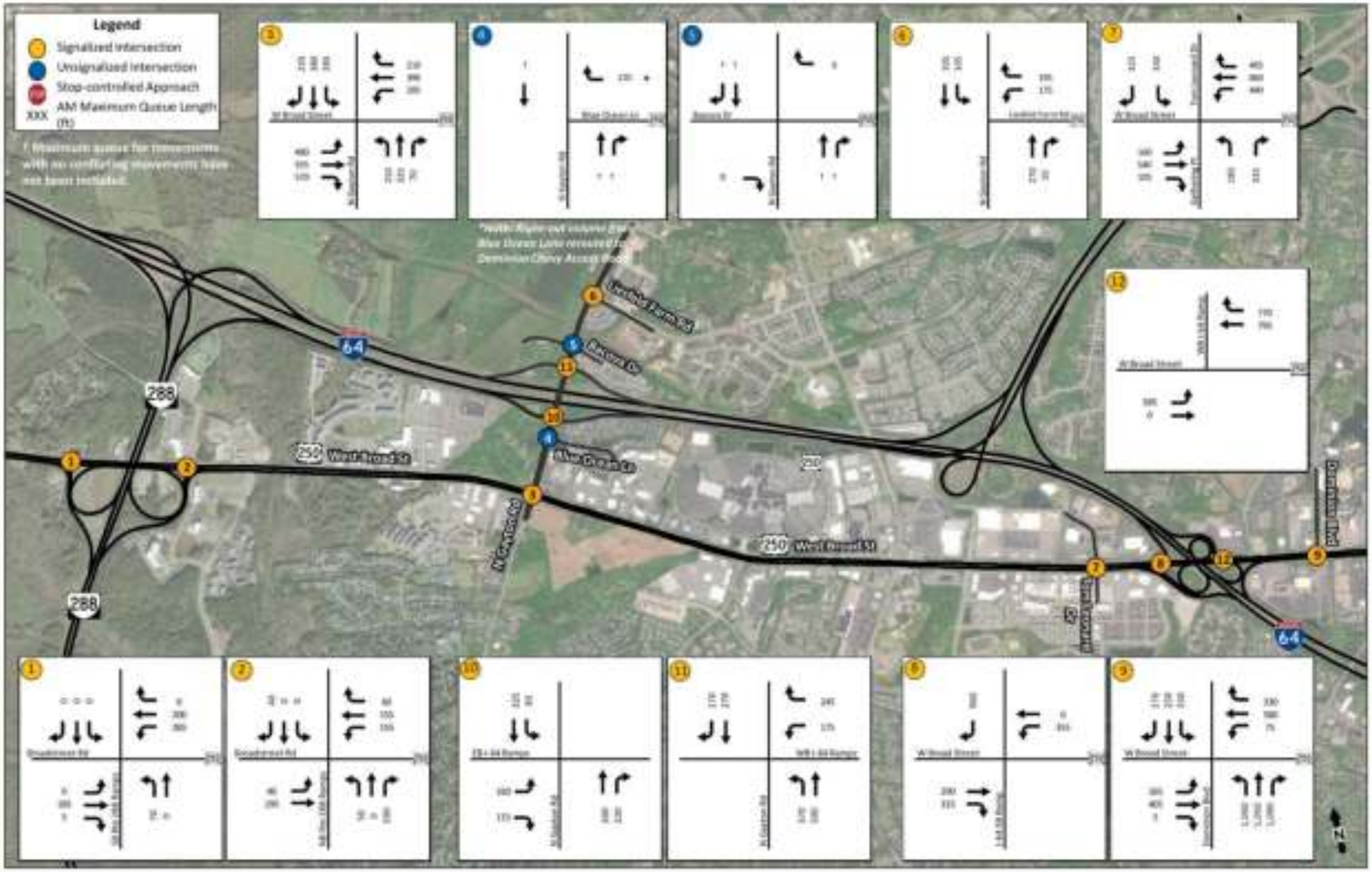
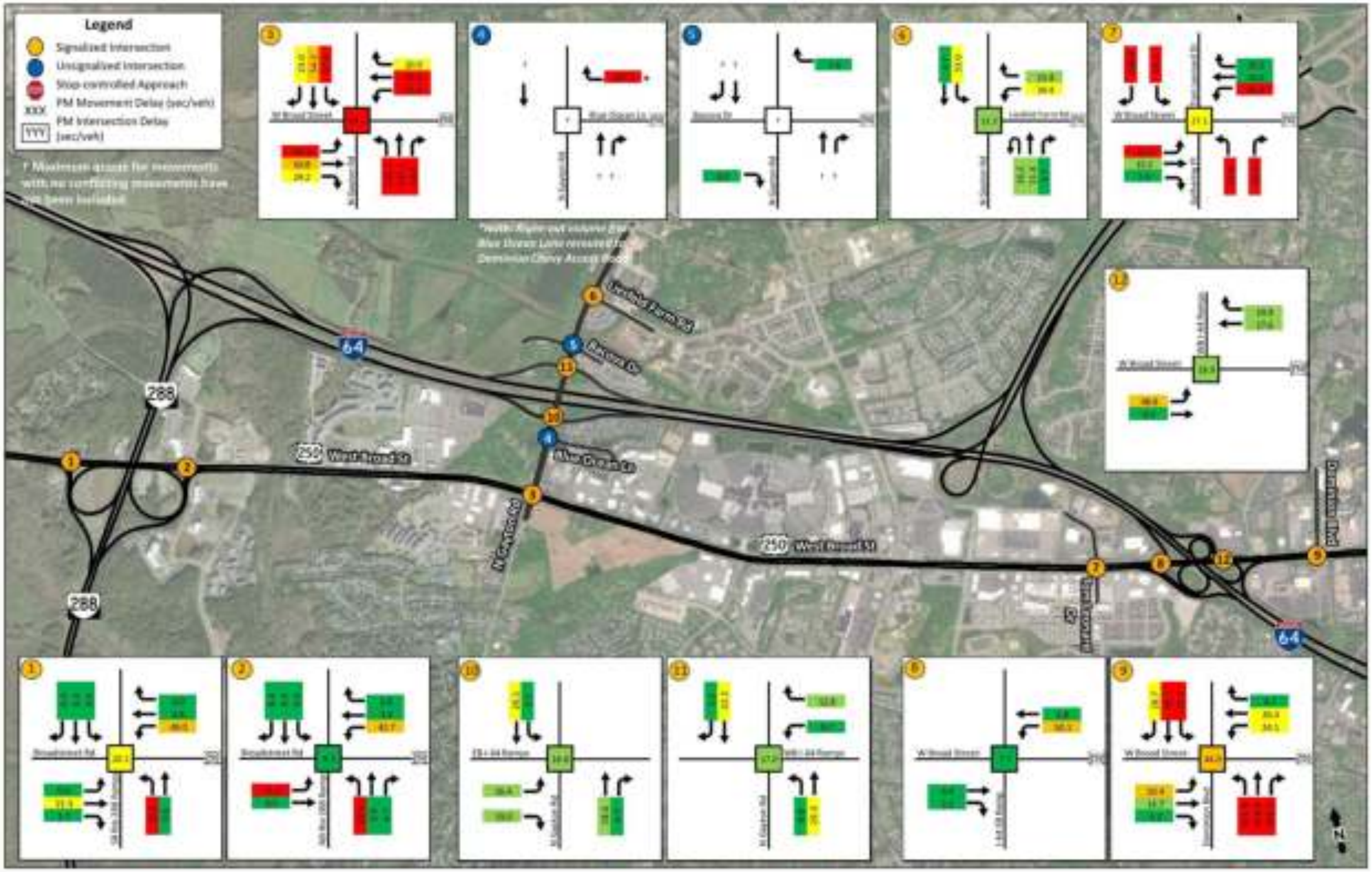


*Figure 124: Build Package 3 (2046) PM Peak Hour Intersection Delay*



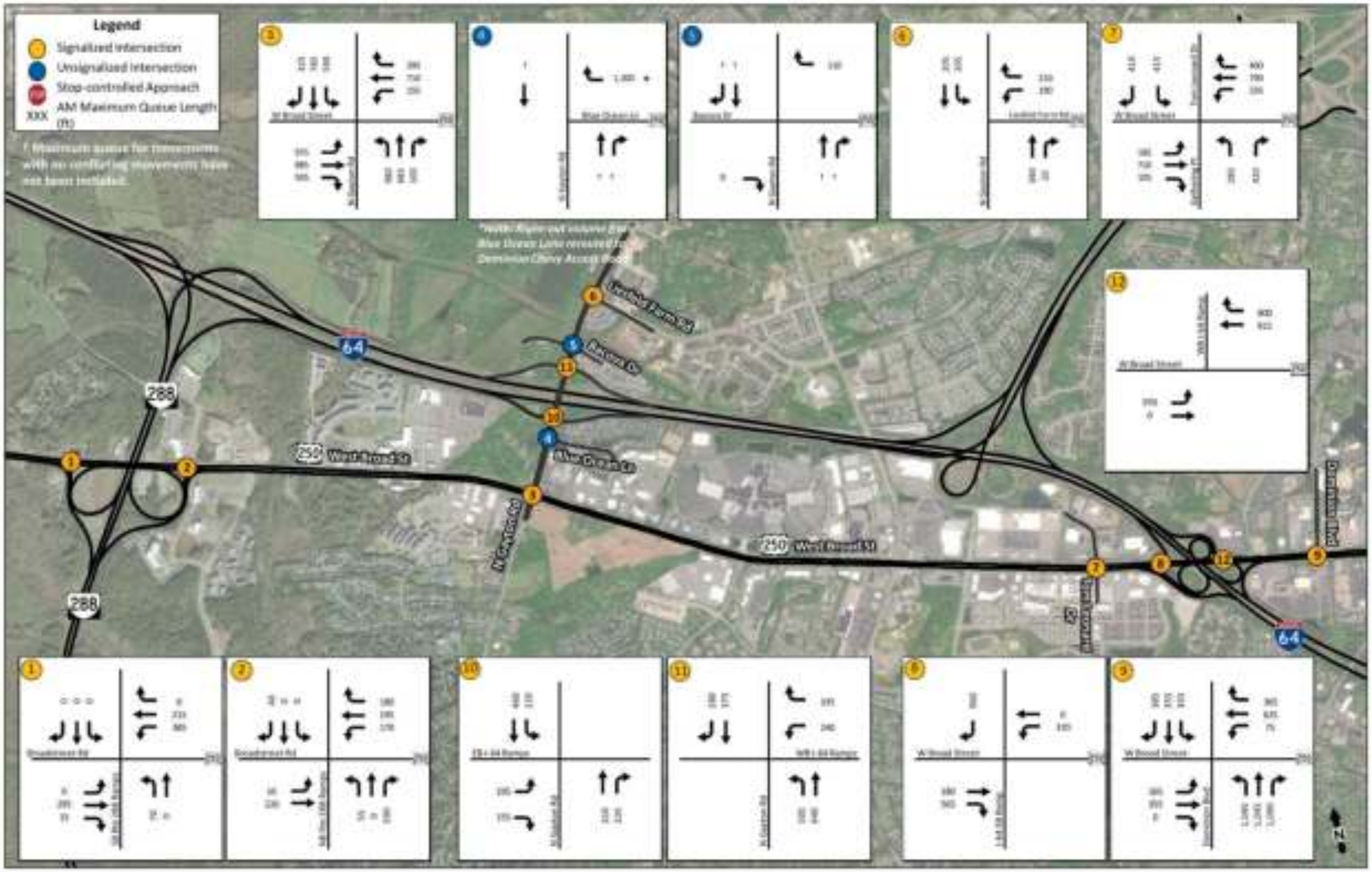



*Figure 125: Build Package 3 (2046) PM Peak Hour Maximum Queue Length*

### Build Package Operational Comparison

All three Build packages are projected to significantly improve operations throughout the study area roadway network and provide relief to multiple bottlenecks that were identified in No-Build conditions. The following sections compare the projected results for the three Build packages for the 2046 peak hours.

#### *AM Peak Hour*

In the 2046 PM peak hour, all three Build packages are projected to significantly improve speeds on eastbound I-64 approaching the off-ramp to westbound US 250. Build Packages 1 and 3 are projected to experience the biggest improvements in speed since both remove the weave on US 250, which is projected to prevent queuing from backing up to the freeway. Speeds are projected to improve from 37 mph in the No-Build conditions to 54 and 52 mph, respectively. Build Package 2 is projected to improve speeds to 49 mph.

The increase in speeds is projected to result in upstream increases in throughput. All three Build packages are projected to process 8 percent more demand on southwestbound I-295 prior to the ramps to I-64.

Between I-295 and Route 288, all three Build packages are projected to operate with speeds greater than 60 mph and densities less than 30 veh/ln/mi in both directions except for all three Build Packages at the eastbound I-64 on-ramp from Route 288, which are projected to operate at 57 or 58 mph, and Build Packages 2 and 3 at the eastbound I-64 off-ramp from N Gayton Road, which are projected to operate at 53 mph. The remaining segments on eastbound I-64 between Route 288 and I-295 are projected to operate at speeds greater than 60 mph.

Travel times on I-64 and US 250 in both directions in the AM peak hour are shown *Table 25* and *Table 26.*

In the 2046 AM peak hour, all Build packages are projected to experience an improvement in travel time on the section of westbound I-64 between I-295 and Route 288 resulting from the southbound Roue 288 auxiliary lane improvement. Build Packages 2 and 3 are projected to experience a further reduced travel time on westbound I-64 between the Glenside Drive and US 250 interchanges resulting from the more balanced lane distribution at the US 250 interchange attributed to the changing traffic patterns for the N Gayton Road interchange. Build Package 3 is projected to experience the lowest travel time on westbound I-64 at 8 minutes and 41 seconds, which is 9 seconds less than Build Package 2 and 44 seconds less than Build Package 1.

All Build packages are projected to experience an improvement in travel time on eastbound I-64 between the Route 288 and US 250 interchanges that can be attributed to multiple improvements at the US 250 interchange. In Build Packages 1 and 3, the partial cloverleaf ramp reconfiguration removes the arterial weave, which is projected to relieve congestion on eastbound US 250 and prevent queuing from reaching the eastbound I-64 off-ramp to eastbound US 250. In Build Package 2, the turning restriction at Dominion Boulevard eliminates weaving movements on eastbound US 250 and is projected to prevent intersection queuing from backing up to eastbound I-64, though it is projected to extend 640 feet onto the eastbound I-64 off-ramp to eastbound US 250. Build Package 3 is projected to experience the lowest travel time on eastbound I-64 at 8 minutes and 35 seconds, which is 10 seconds less than Build Package 2 and 19 seconds less than Build Package 1.

Westbound US 250 is projected to operate similarly in all Build packages. Build Packages 1 and 3 are projected to experience a slight increase in travel time from No-Build due to the addition of the signalized intersection with the westbound I-64 ramps for the partial cloverleaf ramp reconfiguration. Eastbound US 250 is projected to experience improved travel times in all three Build packages.

*Table 25: I-64 AM Peak Hour (2046) Travel Time Comparison (minutes:seconds)*

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Eastbound I-64 | | | | |
| Between Route 288 and I-295 | 4:09 | 2:33 | 2:40 | 2:37 |
| Between I-295 and US 250 | 2:19 | 0:56 | 0:56 | 0:50 |
| Between US 250 and Gaskins Road | 1:08 | 1:25 | 1:17 | 1:08 |
| Between Gaskins Road and Parham Road | 1:17 | 1:22 | 1:17 | 1:17 |
| Between Parham Road and US 250 | 2:33 | 2:39 | 2:36 | 2:44 |
| **Total** | **11:26** | **8:54** | **8:45** | **8:35** |
| Westbound I-64 | | | | |
| Between US 250 and Parham Road | 2:34 | 2:55 | 2:43 | 2:41 |
| Between Parham Road and Gaskins Road | 1:21 | 1:49 | 1:37 | 1:32 |
| Between Gaskins Road and US 250 | 1:15 | 1:22 | 1:11 | 1:10 |
| Between US 250 and I-295 | 1:00 | 0:47 | 0:48 | 0:47 |
| Between I-295 and Route 288 | 11:15 | 2:32 | 2:31 | 2:31 |
| **Total** | **17:26** | **9:24** | **8:50** | **8:41** |

*Table 26: US 250 AM Peak Hour (2046) Travel Time Comparison (minutes:seconds)*

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Eastbound US 250 | | | | |
| Between Southbound Route 288 Ramps and N Gayton Road | 3:19 | 3:19 | 2:55 | 2:56 |
| Between N Gayton Road and Lauderdale Road | 1:20 | 1:32 | 1:27 | 1:26 |
| Between Lauderdale Road and John Rolfe Parkway | 2:26 | 1:41 | 1:50 | 1:38 |
| Between John Rolfe Parkway and I-64 | 3:53 | 1:54 | 1:44 | 1:30 |
| Between I-64 and Cox Road | 3:14 | 3:40 | 1:46 | 1:38 |
| **Total** | **14:11** | **12:07** | **9:42** | **9:08** |
| Westbound US 250 | | | | |
| Between Cox Road and I-64 | 1:21 | 1:36 | 1:26 | 1:40 |
| Between I-64 and John Rolfe Parkway | 1:27 | 1:19 | 1:25 | 1:26 |
| Between John Rolfe Parkway and Lauderdale Drive | 1:49 | 1:51 | 1:47 | 1:45 |
| Between Lauderdale Drive and N Gayton Road | 1:31 | 1:45 | 1:45 | 1:45 |
| Between N Gayton Road and Southbound Route 288 Ramps | 3:13 | 3:02 | 3:02 | 3:05 |
| **Total** | **9:21** | **9:34** | **9:25** | **9:41** |

*Table 27* shows the percent demand served on various locations throughout the study area network for all three Build packages. All three Build packages are projected to increase demand on southwestbound I-295 but still only serve 75 percent of the demand since the study team agreed not to include further improvements on southwestbound I-295 as documented in the *I-64 at US 250 and I-295 Interchanges* screening section. This remaining bottleneck contributes to the lower percent served values that are projected on westbound I-64 between I-295 and Route 288. Build Packages 2 and 3

are projected to serve 2 percent less demand on northbound Route 288 than Build Package 1, but all Build packages are projected to serve an increase from No-Build.

*Table 27: AM Peak Hour (2046) Freeway Demand (Percent Served)*

| Location | No-Build | Build Package 1 | Build Package 2 | Buil0d Package 3 |
|---|---|---|---|---|
| Westbound I-64 approaching the US 250 interchange | 98 | 94 | 98 | 98 |
| Westbound I-64 between I-295 and Route 288 | 81 | 88 | 87 | 86 |
| Eastbound I-64 between Route 288 and I-295 | 93 | 99 | 98 | 98 |
| Northbound Route 288 approaching I-64 | 88 | 98 | 96 | 96 |
| Southwestbound I-295 approaching I-64 | 66 | 75 | 75 | 75 |

### PM Peak Hour

In the 2046 PM peak hour, all three Build packages are projected to significantly improve speeds on westbound I-64 in the existing weaving segment at the US 250 interchange, which was projected to operate at 10 mph in the No-Build conditions. Build Package 2 is projected to increase speeds to 37 mph. Since Build Packages 1 and 3 both remove the freeway weave, speeds are projected to further increase to 58 and 61 mph, respectively.

The increase in speeds is also projected to result in increases in throughput downstream on westbound I-64. All three Build packages are projected to process a higher percentage of demand on westbound I-64 between the US 250 and I-295 interchanges. Build Package 1 is projected to increase the percentage of demand served from 63 percent in the No-Build conditions to 93 percent. Build Packages 2 and 3 are projected to have higher demand in this segment due to the change in travel patterns attributed to the new interchange yet are still projected to serve a higher percentage of demand at 94 and 96 percent, respectively.

Between I-295 and Route 288, all three Build packages are projected to operate with speeds greater than 60 mph and densities less than 24 veh/ln/mi in both directions except for Build Package 1 before the westbound off-ramp to Route 288, which is projected to slow to 48 mph due to some friction in advance of the diverge, and Build Packages 2 and 3 immediately after the eastbound on-ramp from Route 288, which are projected to operate at 58 mph. The remaining segments on eastbound I-64 between Route 288 and I-295 are projected to operate at speeds greater than 60 mph.

Travel times on I-64 and US 250 in both directions in the PM peak hour are shown in *Table 28* and *Table 29*.

In the 2046 PM peak hour, all three Build packages are projected to operate with significantly improved travel times on westbound I-64 throughout the study area. In Build Packages 1 and 3, the partial cloverleaf ramp reconfiguration removes the weave on westbound I-64, which is projected to reduce the queue on the freeway and improve speeds at the interchange. Build Packages 2 and 3 are projected to experience improved speeds and decreased travel time due to the changing traffic patterns at the US 250 interchange that are attributed to the new N Gayton Road interchange. Build Packages 2 and 3 are projected to experience further reductions in travel times on westbound I-64 upstream of the US 250 interchange due to the more balanced vehicle lane distribution resulting from the new interchange.

Eastbound I-64 from Route 288 to Glenside Drive is projected to experience an increase in travel time in all three Build packages on the segment between Parham Road and Glenside Drive. All three Build packages are projected to increase throughput on eastbound I-64 through the study area to 92 percent of the demand or greater, which causes downstream congestion at the eastbound I-64 on-ramp from the eastbound I-64 C-D road that serves the US 250 and Glenside Drive interchanges. Eastbound I-64 in the vicinity of the Glenside Drive interchange was identified as an area in need of improvement in the I-64/I-664 Corridor Improvement Plan On all other segments of I-64 through the study area, all three Build packages are projected to operate with travel times comparable to No-Build conditions.

Build Packages 2 and 3 are projected to experience improved travel times on westbound US 250 from Cox Road to Route 288 compared to No-Build conditions. Build Package 1 is projected to experience a 32 second increase in travel time on westbound US 250 compared to No-Build conditions. Build Packages 1 and 3 are projected to experience an increase in travel time from No-Build on westbound US 250 between Cox Road and the I-64 interchange due to the addition of the signalized intersection at the westbound I-64 ramps. Build Package 1 is projected to experience additional increase in travel time on westbound US 250 between N Gayton Road and Wilkes Ridge Parkway due to the increased traffic eastbound on US 250 from the northbound Route 288 improvements. The additional traffic results in increased delay in the westbound direction because of the competing signal operations trying to serve both directions of US 250. These changes lead to an overall increase in travel time on westbound US 250 from No-Build conditions in Build Package 1. Build Packages 2 and 3 are projected to experience an increase in travel time from No-Build on westbound I-64 between Lauderdale Road and N Gayton Road due to the additional demand traveling to access the new interchange, but the travel time reductions on all other sections of westbound US 250 lead to an overall decrease in travel time.

Build Packages 2 and 3 are projected to experience improved travel times on eastbound US 250 from Route 288 to Cox Road compared to No-Build conditions. The section of eastbound US 250 between John Rolfe Parkway and I-64 is projected to experience the most travel time improvement of 1 minute and 24 seconds in Build Package 2 and 1 minute and 31 seconds in Build Package 3. The Tom Leonard Drive intersection improvements and the reduction in demand on the eastbound I-64 on-ramp from eastbound US 250 are projected to reduce queuing on eastbound US 250 at the interchange and improve travel times. Build Package 1 is projected to experience the largest increase in travel times on eastbound US 250 in the section between Route 288 and N Gayton Road due to the increased volumes traveling eastbound. The northbound Route 288 ramp intersection improvements combined with the auxiliary lane allow northbound Route 288 to serve 95 percent of the demand. Releasing this bottleneck allows additional vehicles to reach the arterial, causing increased queuing and congestion on eastbound US 250. While the partial cloverleaf interchange improvement at US 250, which is the major improvement unique to Build Package 1, does not contribute to the increased travel time on eastbound US 250 in this area, it is not projected to mitigate the increase. This increase is not as significant in Build Packages 2 and 3 since the demand decreases on the northbound Route 288 off-ramp to eastbound US 250.

*Table 28: I-64 PM Peak Hour (2046) Travel Time Comparison (minutes:seconds)*

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Eastbound I-64 | | | | |
| Between Route 288 and I-295 | 2:31 | 2:32 | 2:33 | 2:32 |
| Between I-295 and US 250 | 0:49 | 0:48 | 0:48 | 0:49 |
| Between US 250 and Gaskins Road | 1:08 | 1:08 | 1:08 | 1:08 |
| Between Gaskins Road and Parham Road | 1:16 | 1:16 | 1:16 | 1:16 |
| Between Parham Road and US 250 | 2:43 | 3:25 | 4:53 | 4:58 |
| **Total** | **8:27** | **9:18** | **10:38** | **10:43** |

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Westbound I-64 | | | | |
| Between US 250 and Parham Road | 13:10 | 5:51 | 4:28 | 4:29 |
| Between Parham Road and Gaskins Road | 9:22 | 4:08 | 3:20 | 3:23 |
| Between Gaskins Road and US 250 | 6:18 | 2:51 | 2:21 | 2:24 |
| Between US 250 and I-295 | 1:08 | 0:48 | 0:51 | 0:48 |
| Between I-295 and Route 288 | 2:32 | 2:32 | 2:32 | 2:32 |
| **Total** | **32:30** | **15:59** | **13:32** | **13:36** |

*Table 29: US 250 PM Peak Hour (2046) Travel Time Comparison (minutes:seconds)*

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Eastbound US 250 | | | | |
| Between Southbound Route 288 Ramps and N Gayton Road | 4:05 | 6:32 | 3:44 | 3:45 |
| Between N Gayton Road and Lauderdale Road | 1:33 | 1:58 | 1:50 | 1:47 |
| Between Lauderdale Road and John Rolfe Parkway | 2:11 | 4:03 | 2:26 | 2:28 |
| Between John Rolfe Parkway and I-64 | 3:20 | 3:49 | 1:33 | 1:30 |
| Between I-64 and Cox Road | 1:37 | 1:42 | 1:47 | 1:43 |
| **Total** | **12:46** | **18:04** | **11:20** | **11:13** |
| Westbound US 250 | | | | |
| Between Cox Road and I-64 | 1:52 | 1:58 | 1:33 | 1:53 |
| Between I-64 and John Rolfe Parkway | 3:07 | 1:55 | 1:36 | 1:37 |
| Between John Rolfe Parkway and Lauderdale Drive | 1:37 | 1:48 | 1:42 | 1:41 |
| Between Lauderdale Drive and N Gayton Road | 1:33 | 1:44 | 2:21 | 2:21 |
| Between N Gayton Road and Southbound Route 288 Ramps | 2:51 | 4:03 | 3:05 | 3:06 |
| **Total** | **11:00** | **11:28** | **10:17** | **10:38** |

*Table 30* shows the percent demand served at various locations throughout the study area roadway network for all three Build packages. All three Build packages are projected to experience a significant increase in percent demand served on westbound I-64 approaching the US 250 interchange. Build Packages 2 and 3 are projected to serve additional demand over Build Package 1 due to the more balanced lane distribution upstream of the US 250 interchange that improves speeds and reduces congestion on westbound I-64. Build Packages 2 and 3 are also projected to serve the most demand on southwestbound I-295 since the changing traffic patterns that are attributed to the new N Gayton Road interchange are projected to reduce traffic volume on the over-capacity loop ramp. This change is projected to result in increases to the percent demand served on westbound I-64 between the I-295 and Route 288 interchanges as well. Build Package 1 is projected to serve the most percent demand on northbound Route 288 which then increases the percent demand served on eastbound I-64 between the Route 288 and I-295 interchanges.

*Table 30: PM Peak Hour (2046) Freeway Demand (Percent Served)*

| Location | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
|---|---|---|---|---|
| Westbound I-64 approaching the US 250 interchange | 65 | 91 | 94 | 94 |
| Westbound I-64 between I-295 and Route 288 | 78 | 88 | 90 | 92 |
| Eastbound I-64 between Route 288 and I-295 | 74 | 97 | 92 | 92 |
| Northbound Route 288 approaching I-64 | 65 | 95 | 88 | 89 |
| Southwestbound I-295 approaching I-64 | 80 | 79 | 84 | 84 |

*Figure 126* through *Figure 129* show the 2046 maximum queue lengths in the PM peak hour for the eastern intersections on US 250 for the No-Build scenario and all three Build packages. Build Package 1 is projected to have slight reductions in queue on westbound US 250 when compared to the No-Build conditions. Build Packages 2 and 3 are projected to have a greater reduction in queuing for both directions of US 250 due to the reduced traffic volumes. *Figure 130* through *Figure 133* show the 2046 maximum queue lengths in the PM peak hour for the western intersections on US 250. Build Package 1 is projected to experience increased queuing on eastbound US 250 due to the release of the northbound Route 288 bottleneck. Build Packages 2 and 3 are projected to experience less queueing on eastbound US 250 when compared to the No-Build conditions except at the intersection of US 250 and N Gayton Road.

*Figure 126: No-Build (2046) PM Maximum Queue Length (Depictive) – Eastern Intersections on US 250*


*Figure 127: Build Package 1 (2046) PM Maximum Queue Length (Depictive) – Eastern Intersections on US 250*


*Figure 128: Build Package 2 (2046) PM Maximum Queue Length (Depictive) – Eastern Intersections on US 250*


*Figure 129: Build Package 3 (2046) PM Maximum Queue Length (Depictive) – Eastern Intersections on US 250*

Figure 130: No-Build (2046) PM Maximum Queue Length (Depictive) – Western Intersections on US 250


Figure 131: Build Package 1 (2046) PM Maximum Queue Length (Depictive) – Western Intersections on US 250


Figure 132: Build Package 2 (2046) PM Maximum Queue Length (Depictive) – Western Intersections on US 250


Figure 133: Build Package 3 (2046) PM Maximum Queue Length (Depictive) – Western Intersections on US 250

## Safety Analysis

The Enhanced Interchange Safety Analysis Tool (ISATe) was used to analyze the 2046 No-Build scenario and all three 2046 Build packages to determine if the Build packages were projected to results in a safety benefit.

### EXISTING CONDITIONS ISATE ANALYSIS

Prior to conducting the analysis for 2046, the study team analyzed the study area in the existing year to determine how accurately ISATe predicts crashes in the study area between 2015 and 2019. The existing conditions analysis helps to understand if the base crash prediction can be used in future years to project the potential change in crashes associated with recommended improvements. This analysis was performed only for freeway segments within the study area.

The predicted crashes from ISATe were used as the primary analysis output, which is the base crash prediction based on geometry and volume inputs. The expected number of crashes, which also considers crash history inputs, were not used for the Build packages since the proposed improvements differ enough from the existing geometry that the crash history should not be used to influence the future year crash prediction.

- ***Predicted crashes:*** the base crash prediction from ISATe that is based on geometry and volume inputs
- ***Expected crashes:*** the crash prediction from ISATe that is based on geometry, volume, and crash history inputs. This value falls in between the base crash prediction and the annual crash history. Expected crashes were not calculated for the Build packages since the proposed improvements differ enough from the existing geometry that the crash history should not be used to influence the future year crash prediction.

The predicted crashes were within 12 percent of the annual crash history on I-64 west of the westbound I-64 off-ramp to westbound US 250, within 20 percent on Route 288, and within 21 percent on I-295 as shown in *Table 31*. Additionally, the predicted crashes were all within 10 percent of the expected crashes. These results indicate that ISATe is reasonably accurate when predicting crashes for these areas and that predicted crashes can be used for future year analyses to understand the potential change in crashes associated with recommended improvements.

However, the predicted crashes were 78 percent lower than the annual crash history on I-64 east of the westbound I-64 off-ramp to westbound US 250. This indicates that ISATe cannot accurately predict the magnitude of crashes on westbound I-64 approaching the US 250 interchange, which is likely because the crashes are largely attributed to queuing on I-64 that is caused by congestion on westbound US 250 that backs up to the interstate and friction associated with vehicles weaving on westbound I-64 as documented in the *Existing Mainline Freeway Crash Summary* section. ISATe freeway predictions do not account for operating speed, freeway queuing, or congestion on arterials that impact freeway operations. These results indicate that predicted crashes from ISATe are likely not reliable enough to be used for future year analyses in this area to understand the potential change in crashes associated with recommended improvements.

*Table 31: Existing Conditions ISATe Analysis Results*

| Freeway | 2015-2019 Annual Crash History | Predicted Crashes | Expected Crashes | Percent Difference from Crash History | Percent Difference from Expected Crashes |
|---|---|---|---|---|---|
| I-64 west of the westbound I-64 off-ramp to westbound US 250 | 49.20 | 55.00 | 50.83 | 12% | 8% |
| I-64 east of the westbound I-64 off-ramp to westbound US 250 | 37.80 | 25.84 | 8.22 | -78% | -68% |
| Route 288 | 19.20 | 15.43 | 16.50 | -20% | -6% |
| I-295 | 11.00 | 13.27 | 12.16 | 21% | 9% |

## BUILD PACKAGE FREEWAY ANALYSIS

ISATe crash predictions for all freeways for the No-Build scenario and all three Build packages are shown in *Table 32*. The two Build packages that contain a new interchange at N Gayton Road are projected to increase crashes on I-64 between the Route 288 and I-295 interchanges since there are four new ramps and the AADT in this segment is projected to increase for vehicles accessing the proposed interchange. *Table 33* summarizes the projected crash rates for the No-Build scenario and all three Build packages. While Build Packages 2 and 3 are projected to increase crashes by 6 percent across all freeways, the crash rate is only projected to increase by 1 percent.

*Table 32: Build Package ISATe Freeway Analysis Crash Predictions (2046)*

| Freeway | Crash Prediction | | | |
|---|---|---|---|---|
| | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
| I-64 west of the westbound I-64 off-ramp to westbound US 250 | 111 | 109 | 125 | 125 |
| I-64 east of the westbound I-64 off-ramp to westbound US 250 | 16 | 14 | 16 | 15 |
| Route 288 | 47 | 43 | 43 | 43 |
| I-295 | 28 | 30 | 31 | 31 |
| **Total** | **201** | **196** | **214** | **213** |

*Table 33: Build Package ISATe Freeway Analysis Crash Rate Predictions (2046)*

| Freeway | Crash Rate Prediction (crashes per 100M VMT) | | | |
|---|---|---|---|---|
| | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
| I-64 west of the westbound I-64 off-ramp to westbound US 250 | 61.6 | 60.8 | 64.4 | 64.3 |
| I-64 east of the westbound I-64 off-ramp to westbound US 250 | 73.1 | 69.0 | 74.0 | 70.2 |
| Route 288 | 77.9 | 71.1 | 71.2 | 71.2 |
| I-295 | 69.2 | 73.6 | 73.9 | 73.9 |
| **Total** | **66.7** | **65.2** | **67.6** | **67.3** |

ISATe crash predictions for all ramps for the No-Build scenario and all three Build packages are shown in *Table 34*. Build Package 1 is projected to have a reduction in crashes at the I-64 interchange with US 250 since one loop ramp is removed. Build Packages 2 and 3 are projected to reduce crashes at most existing interchanges because fewer vehicles are projected to use several existing ramps since they are redirected to ramps at the new interchange. However, Build Packages 2 and 3 are projected to add ramp crashes due to the addition of four ramps at the proposed interchange.

*Table 34: Build Package ISATe Ramp Analysis Crash Predictions (2046)*

| Interchange | Crash Prediction | | | |
|---|---|---|---|---|
| | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
| I-64 at Ashland Road | 2 | 2 | 2 | 2 |
| I-64 at Route 288 | 27 | 27 | 26 | 26 |
| I-64 at I-295 | 29 | 29 | 31 | 31 |
| I-64 at US 250 | 29 | 27 | 27 | 25 |
| Route 288 at US 250 | 9 | 9 | 7 | 7 |
| I-295 at Nuckols Road | 3 | 3 | 3 | 3 |
| I-64 at N Gayton Road | N/A | N/A | 12 | 12 |
| **Total** | **98** | **97** | **107** | **105** |

*Note: Individual crash predictions may not sum to total value due to rounding*

ISATe crash predictions for ramp terminals for the No-Build scenario and all three Build packages are shown in *Table 35*. The ISATe ramp terminal crash module only includes certain configurations, so the ramp terminal analysis only included the following ramp terminals:

- Northbound Route 288 at US 250
- Southbound Route 288 at US 250
- Eastbound I-64 at Ashland Road
- Westbound I-64 at Ashland Road
- Eastbound I-64 at US 250
- Westbound I-64 at US 250 (for Build Packages 1 and 3)
- Eastbound I-64 at N Gayton Road (for Build Packages 2 and 3)
- Westbound I-64 at N Gayton Road (for Build Packages 2 and 3)

Since ISATe does not have crash prediction methodologies for ramp terminals that cover DDIs, the crash predictions for the ramp terminals at N Gayton Road summarized in *Table 35* were developed using the methodologies for a traditional signalized ramp terminal and were multiplied by a crash modification factor (CMF) from the VDOT State Preferred CMF List for converting a signalized ramp terminal to a DDI (0.59 for fatal and injury crashes and 0.67 for property damage only crashes).

Table 35: Build Package ISATe Ramp Terminal Analysis Crash Predictions (2046)

| Interchange | Crash Prediction | | | |
|---|---|---|---|---|
| | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
| I-64 at Ashland Road | 13 | 13 | 13 | 13 |
| I-64 at US 250 | 23 | 33 | 17 | 26 |
| Route 288 at US 250 | 21 | 21 | 16 | 16 |
| I-64 at N Gayton Road | N/A | N/A | 30 | 30 |
| **Total** | **57** | **67** | **76** | **85** |

### Limitations of ISATe Analysis

As mentioned in the *Existing Conditions ISATe* Analysis section, ISATe cannot accurately predict the magnitude of congestion-related crashes on westbound I-64 approaching the off-ramp to westbound US 250. *Table 36* summarizes the ISATe crash predictions on westbound I-64 between the off-ramp to eastbound US 250 and the off-ramp to westbound US 250. The crash prediction for 2046 in this area is approximately three times lower than the annual crash history for 2015-2019. The crash prediction methodologies from the *Highway Safety Manual* that are used in ISATe are bidirectional, so the tool does not differentiate what percentage of crashes are associated with each direction of travel.

Similarly, ISATe does not project a crash reduction on westbound I-64 in this area for Build Package 2 as shown in *Table 36*. This increase in crashes for Build Package 2 is contrary to reasonable expectation since the existing crashes in this section are largely rear end crashes that are attributed to congestion on I-64 and Build Package 2 is projected to reduce queuing on I-64 as documented in the *Build Package 2 Freeway Analysis Results* section.

Table 36: ISATe Crash Predictions on I-64 Between the Two Westbound I-64 Off-Ramps to US 250 (2046)

| Interchange | Crash Prediction | | | |
|---|---|---|---|---|
| | No-Build | Build Package 1 | Build Package 2 | Build Package 3 |
| Existing crashes per year (2015-2019) | 25.6 | N/A | N/A | N/A |
| 2046 crash prediction | 8.6 | 7.3 | 9.1 | 8.3 |

### Alternative Analysis Methodologies

The study team considered applying crash modification factors to better understand the potential crash reduction on westbound I-64 approaching the off-ramp to westbound US 250 that can be attributed to the projected improvement in operations on I-64 in all three Build packages. The following three approaches were used to develop a range of potential benefits that were applied to the 2015-2019 crashes on westbound I-64 over the extent of the maximum queue (from the westbound I-64 off-ramp to westbound US 250 back to the Cox Road bridge).

- ***Low-range estimate:*** a custom CMF was calculated based on a ratio comparing the percentage of ramp volume to total volume on westbound I-64 within the existing weaving area at the US 250 interchange between each Build package and the No-Build scenario. This approach is similar to assumptions that may be made for safety scoring in SMART SCALE when reliable CMFs are not available. The resulting CMFs are summarized in *Table 37*.

*Table 37: Low-range CMF Estimates for Westbound I-64 at US 250 Interchange*

| Build Package | CMF | Projected Annual Crash Reduction (2015-2019) |
|---|---|---|
| 1 | 0.72 | 8.7 |
| 2 | 0.83 | 5.3 |
| 3 | 0.55 | 14.0 |

- ***High-range estimate:*** since the Build packages are projected to improve operations in the PM peak period and significantly reduce the queue on the freeway as documented in the *Build* analysis results section, this custom CMF assumes a reduction in rear end crashes that were mainly attributed to congestion and queuing on the freeway. The CMF was assumed to mitigate those rear end crashes that occurred during the PM peak period (3:00 – 7:00 PM) over the extent of the maximum queue (from the westbound I-64 off-ramp to westbound US 250 back to the Cox Road bridge) where the crash description specifically mentioned traffic, congestion, or stopped or slowing vehicles. Seventy-three rear end crashes fit these criteria, which equates to a reduction of 48 percent of all crashes and 58 percent of rear end crashes. Although the other rear end crashes may have been attributed to congestion on the freeway, the study team did not assume that all rear end crashes would be mitigated by the improvements since rear end crashes can still occur at interchanges without recurring congestion issues.

  This CMF results in a reduction of 14.6 rear end crashes per year on westbound I-64 based on 2015-2019 crash history. The Build packages that include the partial cloverleaf at the US 250 interchange are also projected to mitigate angle and sideswipe crashes over the same extent since the improvement removes the weave on the freeway. This results in a further reduction in 2 crashes per year based on 2015-2019 crash history.

The low- and high-range estimates were calculated based on the 2015-2019 crash history and were factored to project the potential crash reduction for each Build package in 2046. *Table 38* summarizes the ISATe crash prediction for 2019 and 2046. The annual crash prediction was projected to at least double across all three freeways by 2046. As such, the study team assumed that the potential reduction in crashes on westbound I-64 associated with the low-, medium-, and high-range estimates would double by 2046. This estimate was deemed to be conservative since the maximum freeway queue on westbound I-64 was projected to increase approximately tenfold between 2019 (*Figure 11*) and 2046 (*Figure 54*), which would likely increase the number of rear end crashes by more than two times. *Table 39* summarizes the resulting projections for crash reductions on westbound I-64 between the Cox Road Bridge and the off-ramp to westbound US 250 for all three Build packages.

*Table 38: ISATe Crash Predictions per Year*

| Year | Crash Prediction | | |
|---|---|---|---|
| | I-64 | I-295 | Route 288 |
| 2019 | 63.2 | 13.3 | 15.4 |
| 2046 | 126.3 | 28.1 | 46.9 |
| **Percent Increase** | **100%** | **111%** | **205%** |

*Table 39: Projected Crash Reduction on Westbound I-64 between the Cox Road Bridge and the Off-Ramp to Westbound US 250*

| Build Package | Cause of Crash Reduction | Projected Crash Reduction (2046) on Westbound I-64 | |
|---|---|---|---|
| | | Low Range | High Range |
| 1 | Improved operations; removal of weave | 17.7 | 33.2 |
| 2 | Improved operations | 10.6 | 29.2 |
| 3 | Improved operations; removal of weave | 28.0 | 33.2 |

## BUILD PACKAGE ARTERIAL ANALYSIS

The two Build packages that include a new interchange at N Gayton Road are projected to decrease crashes on US 250 since volumes on US 250 are projected to decrease on US 250 as described in the *Build Traffic Volumes* section. Crash prediction methodologies are not available for six-lane urban and suburban arterials in the Highway Safety Manual spreadsheet tools developed and maintained by AASHTO. The study team developed a low- and high-range projection for the reduction in annual crashes on US 250 between the intersection with the northbound Route 288 ramps and the intersection with the eastbound I-64 ramps. The low- and high-range projections were based on a test performed for a six-lane arterial in the Interactive Highway Safety Design Model (IHSDM) to compare the same roadway with different volume inputs. This test showed that a 1 percent decrease in traffic volume was projected to reduce segment- and driveway-related crashes by 1 percent and projected to reduce intersection-related crashes by 0.25 percent.

- ***Low-range estimate:*** a custom CMF was calculated based on a four-to-one relationship between a percent change in traffic volume and the resulting percent change in crashes
- ***High-range estimate:*** a custom CMF was calculated based on a one-to-one relationship between a percent change in traffic volume and the resulting percent change in crashes. This approach is similar to assumptions made for safety scoring in SMART SCALE when reliable CMFs are not available as documented in the *SMART SCALE Technical Guide*.

*Table 40* summarizes the potential reduction in crashes on US 250 between the northbound Route 288 ramps and the eastbound I-64 ramps. Crashes were grown from 2015-2019 to a 2046 projection by comparing the projected 2019 and 2046 AADTs and increasing crashes by 0.25 percent for every one percent increase in AADT. The volume reductions on US 250 are projected to reduce by 22 to 86 crashes per year.

*Table 40: Projected Crash Reduction on US 250*

| Segment | Projected Reduction in AADT | 2015-2019 Annual Crashes | Projected 2046 Crashes | Projected Annual Crash Reduction | |
|---|---|---|---|---|---|
| | | | | Low Range | High Range |
| US 250 between Route 288 and N Gayton Road | 29% | 33.4 | 38.6 | 2.8 | 11.2 |
| US 250 between N Gayton Road and Lauderdale Drive | 13% | 21.4 | 24.5 | 0.8 | 3.2 |
| US 250 between Lauderdale Drive and Pouncey Tract Road | 23% | 34.0 | 37.0 | 2.1 | 8.5 |
| US 250 between Pouncey Tract Road and I-64 | 31% | 192.8 | 204.4 | 15.8 | 63.4 |
| **Total** | | **281.6** | **304.5** | **21.6** | **86.2** |

## SAFETY CONCLUSIONS

All three Build packages are projected to significantly reduce crashes at the highest freeway crash density hot spot in the study area – westbound I-64 approaching the US 250 interchange – since the existing crash pattern is largely attributed to the existing bottleneck and all three Build packages are projected to significantly improve operations. As shown in *Table 39*, Build Packages 1 and 3 have the greatest potential for crash reductions at this location using the high-range estimate since both eliminate the weave on westbound I-64. Build Package 3 has the greatest potential for crash reductions at this location using the low-range estimate since it removes the weave and reduces the traffic volume exiting the freeway at the remaining ramp.

For the Build packages that contain a new interchange at N Gayton Road, the goal of the safety analysis was to determine if the projected reduction in crashes at the existing freeway hot spots outweighs the crashes that are projected to be added to the network in the vicinity of the new interchange. As shown in *Table 32*, Build Packages 2 and 3 are projected to increase crashes on I-64 in both directions by 14 crashes in 2046. As shown in *Table 39*, the low-range projection is not projected to offset that increase for Build Package 2, but the high-range projection for Build Package 2 and all projections for Build Package 3 are projected to offset that increase.

Additionally, the Build packages that contain a new interchange at N Gayton Road are projected to reduce crashes on US 250, which targets several of the highest-ranked intersections and segments in Richmond District for safety needs as documented in the *Existing Safety Data and Identification of Problem Areas* section.

The results of the safety analyses for all three Build packages are summarized in *Table 41*. Based on the low-range estimates of safety benefits, Build Package 1 is projected to have the greatest reduction in crashes throughout the study area. However, since Build Packages 2 and 3 are projected to remove traffic volume from US 250, these Build packages have the greatest potential to reduce crashes throughout the study area, based on the high-range estimates of safety benefits.

While the low-range estimates of safety benefits for Build Package 2 are projected to increase crashes throughout the study area, the study team determined that Build Package 2 was a better alternative than the No-Build scenario because it was projected to decrease crashes at several of the high crash locations on the freeway and arterial and because the high-range estimates of safety benefits were projected to decrease crashes overall. However, since crashes are projected to increase on I-64 between I-295 and Route 288 due to the new access point, the study team recommends that crash mitigation strategies are incorporated into the final design to help minimize the crash increase on this segment if this Build package were to be selected as the preferred alternative. Potential mitigation strategies include interchange lighting, high-friction surface treatment on ramps, and changeable message signs that can be used to warn motorists of an incident or upcoming congestion. Interchange lighting has the potential to reduce 50 percent of nighttime crashes; high-friction surface treatment has the potential to reduce 24 percent of all crashes on ramps; changeable message signs have the potential to reduce the frequency of secondary crashes.

The study team determined that Build Package 3 had the highest potential safety benefit since it is projected to improve freeway operations on westbound I-64, remove the freeway weave at the US 250 interchange, and reduce crashes on US 250. Build Package 3 was projected to reduce crashes overall using the low-range estimates of safety benefits and had the second largest potential to reduce crashes using the high-range estimates. Like in Build Package 2, crashes are projected to increase on I-64 between I-295 and Route 288 due to the new access point, so the study team recommends that crash mitigation strategies are incorporated into the final design to help minimize the crash increase on this segment if this Build package were to be selected as the preferred alternative.

*Table 41: Network Safety Summary for Low- and High-Range Projections for Change in Annual Crash Frequency)*

| Analysis Component | | Projected Change in Annual Crash Frequency for Each Build Package | | | | | |
|---|---|---|---|---|---|---|---|
| | | Build Package 1 | | Build Package 2 | | Build Package 3 | |
| | | Low | High | Low | High | Low | High |
| Freeway Segments | I-64 | -20 | -35 | +3 | -15 | -14 | -19 |
| | I-295 | +2 | | +3 | | +3 | |
| | Route 288 | -4 | | -4 | | -4 | |
| | Total | -22 | -37 | +2 | -16 | -15 | -20 |
| Ramp Segments | Existing | -2 | | -3 | | -5 | |
| | Proposed | N/A | | +12 | | +12 | |
| Ramp Terminals | Existing | No change | | -11 | | -11 | |
| | Proposed | +10 | | +30 | | +39 | |
| US 250 Segments | | No change | | -22 | -86 | -22 | -86 |
| Overall Network Summary | | -14 | -29 | +8 | -74 | -2 | -71 |

# Environmental Considerations

As part of the IAR, a high-level review of environmental considerations was undertaken to better understanding the existing environment, potential impacts of alternatives being considered, and future steps that may need to be taken to comply with state and federal environmental review regulations. The environmental considerations discussed in this section cover the three Build packages under consideration. Prior to reaching a consensus on this combination of design elements and Build packages, multiple other concepts were considered. In order to narrow down the list of concepts being considered, a high-level review of environmental considerations was completed to identify any major issues. This helped guide the team in selecting concepts to carry forward that would meet the purpose and need of the project and were not anticipated to have a high likelihood of substantial impacts to the environment.

## METHODOLOGY

A desktop review using readily available GIS data, online environmental resource maps, and other relevant data were referenced from national, statewide, and county agencies to identify existing environmental resources within the project study areas. Data was gathered to cover resources pertaining to the natural and human environment consistent with the resource categories included in the VDOT Categorical Exclusion checklist (EQ-104). A summary of the resources identified in the study areas is shown in *Figure 134* through *Figure 136*.

Presence of resources was determined using a study area that was defined for each design element within the Build packages. These study areas were defined as a 100-foot buffer of the current proposed concept designs to conservatively capture an inventory of known resources surrounding the current design, which would then be further evaluated for the potential to be impacted by the proposed project. Four study areas were defined as follows to capture the different design elements that are being considered in different combinations to form the three Build packages.

- Diverging Diamond Interchange on I-64 at N Gayton Road
  - Included in Build Packages 2 and 3
  - Shown in yellow in *Figure 135*
- Partial Cloverleaf on I-64 at US 250
  - Included in Build Packages 1 and 3
  - Shown in green in *Figure 136*
- Restriping on eastbound I-64 off-ramp to I-295
  - Included in Build Package 1
  - Shown in purple in *Figure 136*
- Common design elements included in all three Build Packages
  - Southbound Route 288 auxiliary lane
  - Northbound Route 288 auxiliary lane and US 250 improvements
  - Northeastbound I-295 auxiliary lane
  - Improvement at US 250 and Tom Leonard Drive
  - Turning restriction at Dominion Boulevard
  - Shown in orange in *Figure 134* and *Figure 136*

The footprint of the current concept designs was referenced to determine whether resources identified within the study areas would likely be impacted by the project. Engineering judgment considering the proposed improvements and the attributes of the existing resources were used to make a preliminary determination of whether the project would have no impact, a positive impact, or an adverse impact to individual resources.

For the purposes of this study, community services were defined as publicly accessible facilities used to provide services to the public or as gathering spaces for organizations. These may include public education, welfare, emergency services, mail, libraries, social work, food banks, health care, police, fire services, public transportation, and public housing.

*Figure 134: Environmental Features and Proposed Improvement Impact Areas (1)*

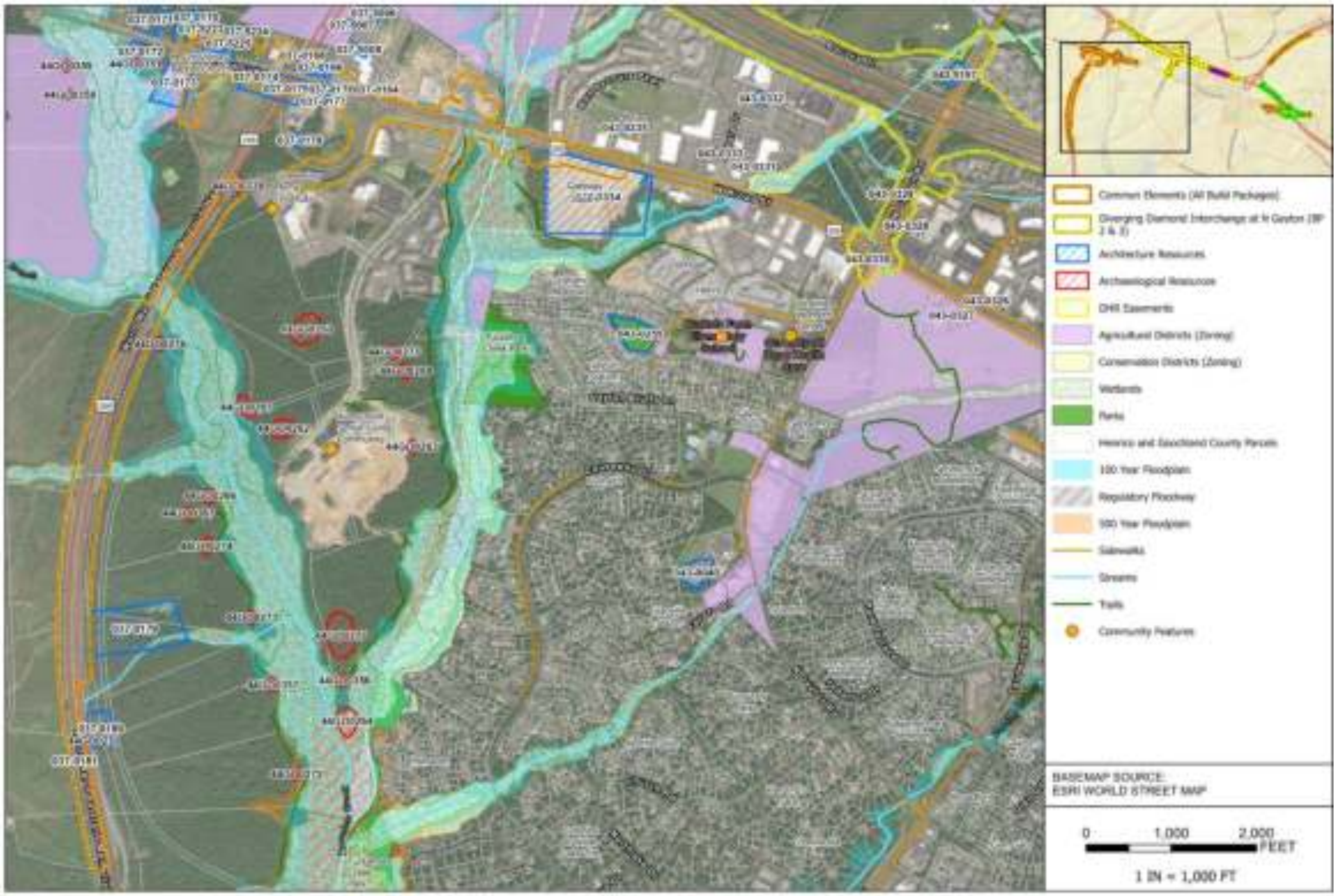


*Figure 135: Environmental Features and Proposed Improvement Impact Areas (2)*

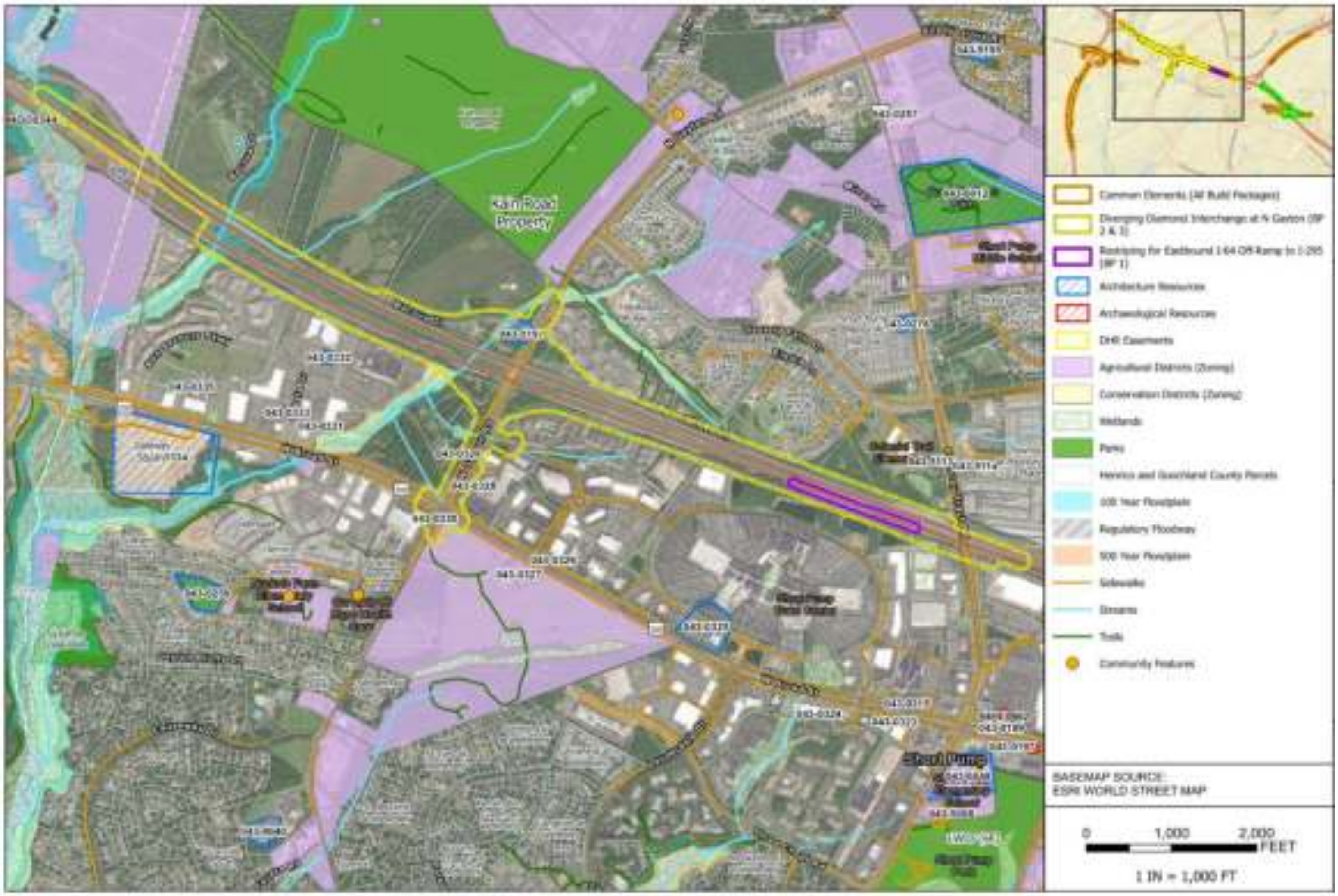
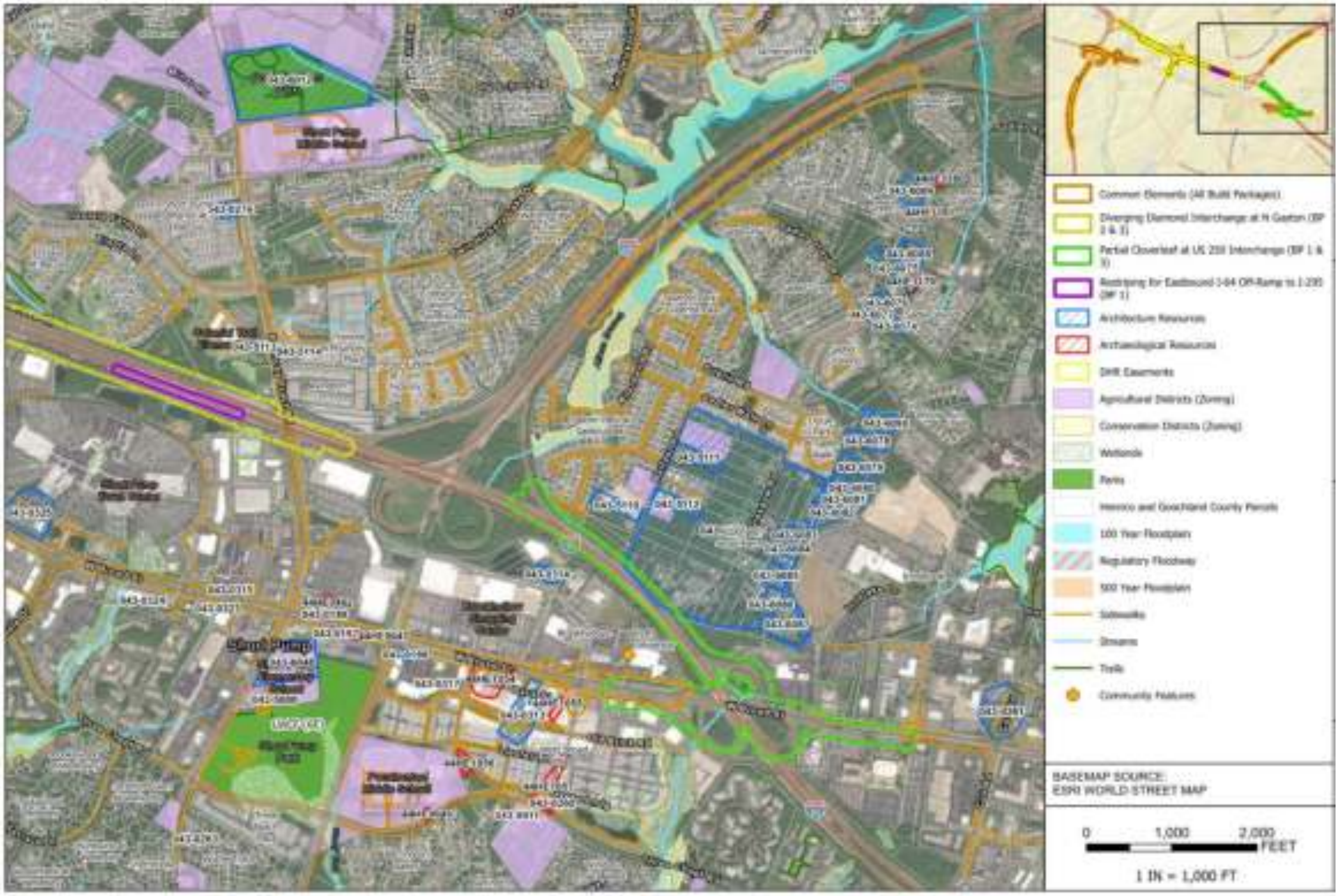


*Figure 136: Environmental Features and Proposed Improvement Impact Areas (3)*



## ENVIRONMENTAL CONSEQUENCES

Using the study areas and impact areas defined in the *Environmental Considerations Methodology* section, existing resources were identified and potential for impacts were determined and are described in detail below.

### No-Build Alternative

The No-Build alternative would result in no construction or ground disturbing activities and therefore would have no impacts to natural or human environment resources. However, the No-Build alternative would not address the purpose and need of the project.

### Common Elements in All Build Packages

#### *Environmental Justice – Minority and Low-Income Populations*

Minority (80th percentile nationally) and low-income (below 50th percentile nationally) populations were identified in the areas within and surrounding the study area. The proposed project is not anticipated to result in major traffic disruptions, more than minor amounts of temporary or permanent right-of-way acquisition, or more than limited displacements, community disruptions, or a disruption to emergency services. Therefore, these elements are not anticipated to result in a disproportionately high and adverse effect on low-income or minority populations.

#### *Community Services*

Three community service sites were identified within the study area: The Sheltering Arms Institute: Physical Rehabilitation Hospital, Mount Victory Baptist Church, and ECPI University. Though some partial right-of-way acquisition may be necessary on these three properties, the level of impact is not anticipated to have an adverse effect on the community's use and operation of the facilities. Access to these locations is anticipated to be maintained during construction.

#### *Bike and Pedestrian Facilities*

Existing sidewalks were identified along US 250 within the study area. The proposed project is anticipated to require temporary closures or detours of segments to accommodate construction of new segments of sidewalk. These impacts are anticipated to be temporary and result in an overall positive benefit to users upon completion of new segments of sidewalks.

#### *Historic Properties and Archaeological Resources – Section 106*

Multiple previously recorded cultural resource sites were identified within the study area, as listed in *Table 42*. However, none of the sites are listed on, or have been determined eligible for, the National Register of Historic Places (NRHP) and are still extant. Therefore, no impacts to Section 106 resources are anticipated. Additional studies and field surveys of potential sites with no prior evaluation may be required during the environmental review process.

#### *Section 4(f)*

No recreational resources subject to Section 4(f) regulations were identified within the study area. There are also no previously documented cultural resource sites that are listed on, or have been determined eligible for, the National Register of Historic Places (NRHP) (and are still extant) located within the study area. There is one site located within the study area that has been documented but not evaluated and may require evaluation during the environmental review process. If this site were to be determined eligible for the NRHP, it would become protected under Section 4(f).

*Table 42: Previously Recorded Cultural Resources within the Common Elements Study Area*

| VDHR ID | Evaluation Status |
|---|---|
| 44GO0338 | No Evaluation |
| 043-0334<br>037-0164<br>037-0177<br>037-0176<br>037-0165<br>037-0166<br>037-0167<br>037-0169<br>037-0175<br>037-0174<br>037-0173<br>037-5225<br>037-5224<br>037-5223<br>037-0170 | VDHR Staff: Not Eligible |
| 037-0179<br>037-0181<br>037-0168 | Recommended Not Eligible |

### Surface Water

Based on Virginia Department of Environmental Quality (VDEQ) data, seven stream crossings were identified within the study area. Based on the extents and scope of the current design concepts, approximately 215 linear feet of stream impacts are possible.

### Floodplains

Three Federal Emergency Management Agency (FEMA) listed floodplain crossings were identified within the study area. Based on the extents and scope of the current design concepts, approximately 0.5 acres of floodplain impacts are possible.

### Wetlands

National Wetlands Inventory (NWI) data hosted by the US Fish and Wildlife Service (USFWS) was reviewed and four separate wetland areas were identified within the study area. Based on the extents and scope of the current design concepts, approximately 0.15 acres of wetland impacts are possible.

### Conservation, Agricultural, and Forestral Districts

An area zoned as a conservation district was identified along the eastern edge of the study area associated with the northeastbound I-295 auxiliary lane improvements. The proposed construction is not anticipated to extend beyond the existing right-of-way though, so no impacts are anticipated.

### Farmland

The majority of the study area is located within the urbanized area associated with Richmond, Virginia as designated by the 2010 US Census Bureau Urbanized Area Map with the exception of portions of the study area located in Goochland County. Suitable farmland soils were identified within these non-urbanized areas using the Natural Resources Conservation Service (NRCS) Web Soil Survey. Since the design concepts are anticipated to have impacts outside of existing right-of-way (areas already converted to transportation use), impacts to farmland soils are possible and a further analysis using the NRCS-CPA-106 form for corridor type projects should be conducted during the environmental review process for the project.

#### *Invasive Species*

Invasive species are anticipated to be present within the study area. However, the nature of the project is not anticipated to result in impacts to native species in such a manner that would result in proliferation of invasive species.

#### *Noise*

Although the improvements included as “common elements” across all of the Build packages are not anticipated to be considered Type I noise projects, they are proposed to be combined with elements (partial cloverleaf or diverging diamond interchanges) that would be considered Type I noise projects as part of the ultimate Build Packages. Therefore, a noise analysis would be required for the entire Build package, including these “common elements”, during the project development phase of the project.

#### *Right-of-Way Relocations*

The proposed improvements along I-295 and Route 288 are not anticipated to require right-of-way acquisition. Improvements along US 250 and at the Route 288 interchange are anticipated to require minimal amounts of right-of-way acquisition and are not anticipated to include any relocations or full takes of property. A total of approximately 3 acres of temporary construction easements across 26 parcels may be required for these elements.

#### *Resources Not Present Within Study Area*

- Recreational Facilities
- Section 6(f)
- Protected Species
- Open Space and Conservation Easements

### Restriping for Eastbound I-64 Off-Ramp to I-295

#### *Environmental Justice – Minority and Low-Income Populations*

Minority (69th percentile nationally) and low-income (below 50th percentile nationally) populations were identified in the areas within and surrounding the study area. The proposed project is not anticipated to result in major traffic disruptions, more than minor amounts of temporary or permanent right-of-way acquisition or more than limited displacements, community disruptions, or a disruption to emergency services. Therefore, this alternative is not anticipated to result in a disproportionately high and adverse effect on low-income or minority populations.

#### *Invasive Species*

Invasive species are anticipated to be present within the study area. However, the nature of the project is not anticipated to result in impacts to native species in such a manner that would result in proliferation of invasive species.

#### *Noise*

Although the restriping described here is not anticipated to be considered a Type I noise project, it is proposed to be combined with the partial cloverleaf (in Build Package 1) that would be considered a Type I noise project. Therefore, a noise analysis would be required for the entire Build Package 1 project during the project development phase.

#### *Resources Not Present Within Study Area*

- Recreational Facilities
- Community Services

- Bike and Pedestrian Facilities
- Historic Properties and Archaeological Resources – Section 106
- Surface Water
- Floodplains
- Wetlands
- Conservation, Agricultural, and Forestral Districts
- Farmland
- Section 4(f)
- Section 6(f)
- Protected Species
- Open Space and Conservation Easements
- Right-of-Way Relocations

### Partial Cloverleaf at US 250 Interchange (Build Packages 1 and 3)

#### *Environmental Justice – Minority and Low-Income Populations*

Minority (80th percentile nationally) and low-income (below 50th percentile nationally) populations were identified in the areas within and surrounding the study area. The proposed project is not anticipated to result in major traffic disruptions, more than minor amounts of temporary or permanent right-of-way acquisition or more than limited displacements, community disruptions, or a disruption to emergency services. Therefore, this improvement is not anticipated to result in a disproportionately high and adverse effect on low-income or minority populations.

#### *Community Services*

One community service site, ECPI University, was identified within the study area. Though some partial right-of-way acquisition may be necessary on this property, the level of impact is not anticipated to have an adverse effect on the community's use and operation of the facilities. Access to this location is anticipated to be maintained during construction.

#### *Bike and Pedestrian Facilities*

Existing sidewalks were identified along US 250 within the study area. The proposed project is anticipated to require temporary closures or detours of segments to accommodate construction of new segments of sidewalk. These impacts are anticipated to be temporary and result in an overall positive benefit to users upon completion of new segments of sidewalks which will connect facilities on the east and west sides of I-64 along the southern side of US 250.

#### *Historic Properties and Archaeological Resources – Section 106*

One previously recorded cultural resource site (043-5109) was identified within the study area but has been determined by VDHR to be not eligible for the NRHP. Therefore, no Section 106 resources have been identified within the study area.

#### *Surface Water*

Based on VDEQ data, a single stream with two crossing points were identified within the study area. Based on the extents and scope of the current design concepts, approximately 480 linear feet of stream impacts are possible.

#### *Wetlands*

NWI data was reviewed, and two wetland areas were identified within the study area. Based on the extents and scope of the current design concepts, approximately 0.2 acres of wetland impacts are possible.

#### *Invasive Species*

Invasive species are anticipated to be present within the study area. However, the nature of the project is not anticipated to result in impacts to native species in such a manner that it would result in proliferation of invasive species.

### *Noise*

The partial cloverleaf being proposed is anticipated to be considered a Type I noise project and would therefore require further analysis during the project development phase of the project. The area surrounding the interchange is mostly commercial with few sensitive noise receptors. Along the east side of I-64, where the additional auxiliary lane to I-295 is proposed, some residential properties within the McDonald's Small Farms and Dalton Park at Sadler Walk neighborhoods which may require noise walls to be studied along this segment of the corridor.

### *Right-of-Way Relocations*

Improvements associated with the US 250 and I-64 interchange are anticipated to require minimal amounts of right-of-way acquisition and are not anticipated to include any relocations or full takes of property. A total of approximately 0.25 acres of permanent right-of-way across three parcels may be required for this project.

### *Resources Not Present Within Study Area*

- Recreational Facilities
- Section 4(f)
- Section 6(f)
- Floodplains
- Conservation, Agricultural, and Forestral Districts
- Farmland
- Protected Species
- Open Space and Conservation Easements

## Diverging Diamond Interchange at N Gayton Road (Build Packages 2 and 3)

### *Environmental Justice – Minority and Low-Income Populations*

Minority (69th percentile nationally) and low-income (below 50th percentile nationally) populations were identified in the areas within and surrounding the study area. The proposed project is not anticipated to result in major traffic disruptions, more than minor amounts of temporary or permanent right-of-way acquisition or more than limited displacements, community disruptions, or a disruption to emergency services. Therefore, this improvement is not anticipated to result in a disproportionately high and adverse effect on low-income or minority populations.

### *Bike and Pedestrian Facilities*

Existing sidewalks were identified along N Gayton Road within the study area. The proposed project is anticipated to require temporary closures or detours of segments to accommodate construction of new segments of sidewalk. These impacts are anticipated to be temporary and result in an overall positive benefit to users upon completion of the project to include new segments of sidewalks and the proposed multi-use trail on the west side of N Gayton Road.

### *Historic Properties and Archaeological Resources – Section 106*

Four previously recorded cultural resource sites were identified within the study area. Three of these sites (043-0328, 043-0329, 043-0330) have been determined by VDHR to be not eligible for the NRHP. The fourth site (043-5197) has been evaluated and recommended to be not eligible for the NRHP but has not yet received confirmation from VDHR. Therefore, no Section 106 resources have been identified within the study area. Confirmation by VDHR of the recommendation for site 043-5197 may be required during the environmental review process.

### *Section 4(f)*

No recreational resources subject to Section 4(f) regulations were identified within the study area. There are also no previously documented cultural resource sites that are listed on, or have been determined eligible for, the National Register of Historic Places (NRHP) (and are still extant) located within the study area. There is one site located within the study area that has been documented but whose eligibility has not been confirmed by VDHR and therefore may require confirmation by VDHR during the environmental review process. If this site were to be determined eligible for the NRHP, it would become protected under Section 4(f).

### *Surface Water*

Based on VDEQ data, six streams with nine crossing points were identified within the study area. Based on the extents and scope of the current design concepts, approximately 1,910 linear feet of stream impacts are possible.

### *Floodplain*

Two Federal Emergency Management Agency (FEMA) listed floodplain crossings were identified within the study area. Based on the extents and scope of the current design concepts, approximately 2.0 acres of floodplain impacts are possible.

### *Wetlands*

NWI data was reviewed, and seven wetland areas were identified within the study area. Based on the extents and scope of the current design concepts, approximately 1.1 acres of wetland impacts are possible.

### *Conservation, Agricultural, and Forestral Districts*

An area zoned as a conservation district, associated with the floodplain crossing, and an area zoned as agricultural were identified in the study area. The proposed project is anticipated to require acquisition of a portion (approximately 0.15 acres) of the designated conservation district to construct the eastbound off-ramp which would be considered a conversion of the zoned conservation district to right-of-way. Though the area is zoned conservation, no conservation easements have currently been identified.

### *Farmland*

The study area is located within a non-urbanized area as designated by the 2010 US Census Bureau Urbanized Area Map for the Richmond, Virginia area. Suitable farmland soils were identified within the study area using the NRCS Web Soil Survey. Since the design concept is anticipated to have impacts outside of existing right-of-way (areas already converted to transportation use) impacts to farmland soils are possible and a further analysis using the NRCS-CPA-106 form for corridor type projects should be conducted during the environmental review process for the project.

### *Invasive Species*

Invasive species are anticipated to be present within the study area. However, the nature of the project is not anticipated to result in impacts to native species in such a manner that would result in proliferation of invasive species.

### *Noise*

The diverging diamond interchange being proposed is anticipated to be considered a Type I noise project and would therefore require further analysis during the project development phase of the project. The area surrounding the interchange is mostly residential properties which are considered sensitive noise receptors. Based on the results of the noise analysis to be conducted at a later date, noise walls may be warranted.

### *Right-of-Way Relocations*

Improvements associated with the Gayton Road interchange are anticipated to require more than minimal amounts of right-of-way acquisition including some relocations or full takes of property. A total of approximately 9 acres of permanent right-of-way across 13 parcels may be required for this project.

### *Resources Not Present Within Study Area*

- Recreational Facilities

- Community Services
- Section 6(f)
- Protected Species
- Open Space and Conservation Easements

## ALTERNATIVES MATRIX

Based on the review of existing conditions and potential for impacts, a matrix of these conclusions was created to compare the impacts to the environment of the three Build packages and the No-Build alternative across all of the environmental resource categories considered, as shown in *Table 43*. A color-coding system was used to summarize the anticipated level of impacts that the specific alternative would have on each environmental resource category. This color-coding system is defined in *Table 44*.

.

*Table 43: Build Package Environmental Impacts Matrix*

| Environmental Resource | No-Build | Build Package 1 | Build Package 2 | Build Package 3 | Source |
|---|---|---|---|---|---|
| Minority/Low Income Populations | | | | | EPA EJ Screen<br>Justice40 |
| Recreational Facilities | | | | | VDCR Natural Heritage Data Explorer<br>Henrico County and Goochland County GIS<br>VDCR Virginia Outdoor Plan Mapper |
| Community Services | | <0.1 acres TCE | <0.1 acres TCE | <0.1 acres TCE | Aerial Imagery<br>Henrico County and Goochland County GIS<br>Google Maps |
| Bike/Pedestrian Facilities | | | | | Henrico County and Goochland County GIS<br>Aerial Imagery<br>Google Maps<br>VDCR Virginia Outdoor Plan Mapper |
| Section 6(f) | | | | | VDCR Virginia Outdoor Plan Mapper |
| Historic Properties* | | | | | VDHR Virginia Cultural Resource Information System |
| Section 4(f)* | | | | | VDCR Natural Heritage Data Explorer<br>Henrico County and Goochland County GIS<br>VDCR Virginia Outdoor Plan Mapper<br>VDHR Virginia Cultural Resource Information System |
| Surface Water | | 695 LF | 2,125 LF | 2,605 LF | VDEQ Virginia Water Quality Standards |
| Protected Species | | | | | VDWR Wildlife Environmental Review Map Service<br>VDWR Fish and Wildlife Information Service<br>VDGIF NLEB Winter Habitat and Roost Tree Application<br>VDGIF MYLU PESU Habitat PESU Habitat Application |
| Floodplains | | 0.5 acres | 2.5 acres | 2.5 acres | FEMA Flood Hazard Areas |
| Wetlands | | 0.35 acres | 1.25 acres | 1.45 acres | USFWS National Wetland Inventory |
| Open Space and Conservations Easements | | | | | VDCR Natural Heritage Data Explorer |
| Conservation, Agricultural, and Forestral Districts | | | 0.15 acres | 0.15 acres | Henrico County and Goochland County GIS<br>Henrico County and Goochland County Zoning Map |
| Farmland | | | | | US Census Bureau Urban Area Maps<br>NRCS Web Soil Survey |
| Invasive Species | | | | | VDCR Natural heritage Invasive Species<br>USADA Forest Service Raster Data |
| Noise | | | | | Aerial Imagery<br>Google Maps |
| Right of Way Relocations | | 3 acres TCE; 0.25 acres ROW | 3 acres TCE; 9 acres ROW | 3 acres TCE; 9.25 acres ROW | Henrico County and Goochland County GIS |

*Assessment based on the currently listed, determined eligible, or recommended eligible for the NRHP properties pending potential further investigations for recommendations not yet confirmed by VDHR or for individual sites not yet evaluated. TCE = Temporary Construction Easement; ROW = Right-of-Way

*Table 44: Environmental Impacts Matrix Legend*

| Legend | Description |
|---|---|
| | **None Present/Non-applicable**<br>This color is used if there are no resources related to the subject category identified within any of the study areas for elements included in the subject Build package. |
| | **Present – No Adverse Impacts Anticipated**<br>This color is used if at least one resource related to the subject category is identified within any of the study areas for elements included in the subject Build package AND impacts to these resources have been preliminary determined to have a low likelihood of impacting in an adverse nature. This may include natural resources present in the study area but not within the footprint of the concept, right-of-way impacts that are limited to partial acquisitions, or impacts to a resource that are positive in nature such as temporary closures of sidewalks to tie to extensions of said facilities. |
| | **Present – Impacts Anticipated**<br>This color is used if at least one resource related to the subject category is identified within any of the study areas for elements included in the subject Build package AND impacts to these resources have been preliminary determined to occur, potentially in an adverse nature. This may include natural resources present in the study area and within the footprint of the concept or right-of-way impacts that include complete takes and relocations. |

## PROJECT ENVIRONMENTAL REVIEW COMPLIANCE

Further analysis of environmental resources and potential impacts will be necessary including consideration of measures to avoid, minimize, and mitigate impacts. Regardless of the potential funding source, the project will have a federal nexus due to the proposed changes to the interchanges on interstate facilities. Therefore, the environmental review process will need to follow the National Environmental Policy Act of 1969 regulations and the implementing regulations of FHWA. Based on the scope of the proposed projects outlined in the three Build packages, it is anticipated that Build Package 1 may qualify as Categorical Exclusion actions under the NEPA Programmatic Agreement between FHWA and VDOT, dated October 2017, and that Build Packages 2 and 3 may require completion of an Environmental Assessment and Finding of No Significant Impact. Further analyses to be conducted during this process should include, but not be limited to a noise analysis, stream and wetland delineations, Section 106 coordination with VDHR, public involvement, and floodplain impact studies.

## RESOURCES

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## Planning Level Cost Estimate

A planning level cost estimate in 2022 dollars was developed for the proposed improvements as summarized in *Table 45*. Construction (CN) costs were estimated based on conceptual major quantity estimates. Unit costs were identified using VDOT's Statewide Bid Tab Query to utilize recent bid tabs for similar projects based on overall size and location. Preliminary engineering (PE) and construction engineering and inspection (CEI) costs were estimated as a percentage of construction costs. A contingency and allowance were documented for the proposed improvements based on a risk analysis that noted identified and unidentified project risks. A detailed cost estimate should be prepared during the design phase of this project.

*Table 45: Planning Level Cost Estimates*

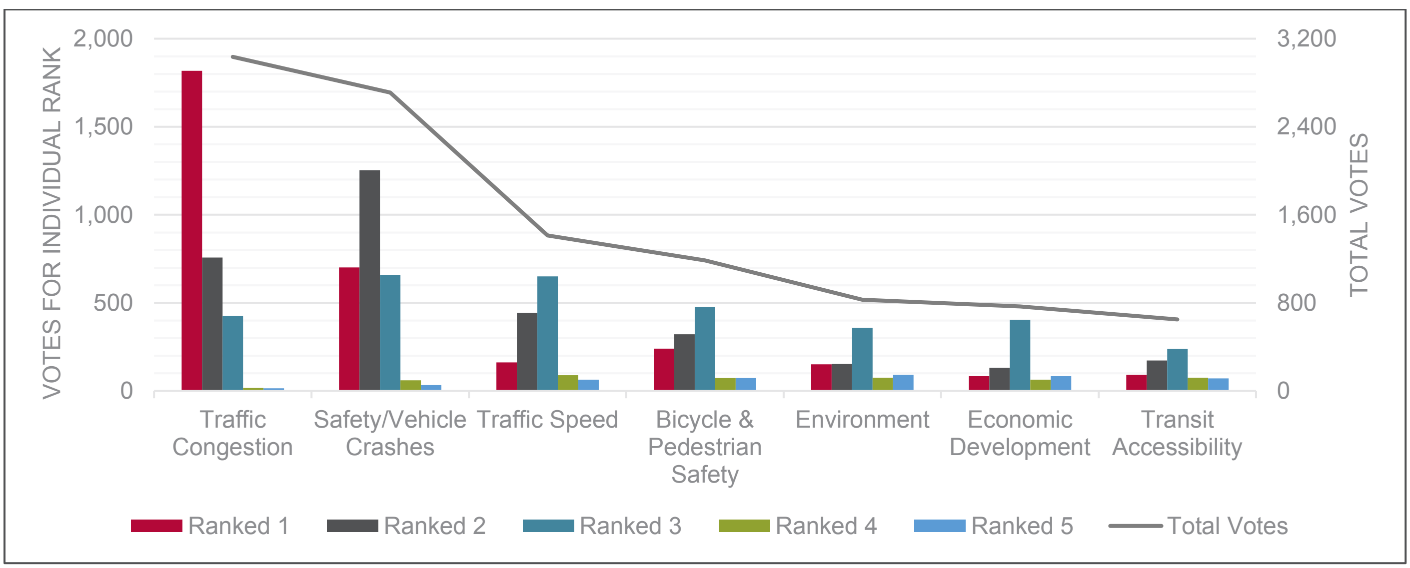
| Build Package | Total Project Cost |
|---|---|
| 1 | $209,000,000 |
| 2 | $177,000,000 |
| 3 | $305,000,000 |

## Selection of Preferred Alternative

### PUBLIC INVOLVEMENT

The study team prepared an online public survey using MetroQuest that was open to the public from December 15, 2022, to January 2, 2023. The public survey prompted responders to rank up to their top 5 priorities in the study area. *Figure 137* illustrates that the public's highest priority within the study area was reducing traffic congestion, which was listed as the number one priority 1,818 times and was ranked in top five priorities 3,035 times. Safety received the second-most votes as the number one priority (702) and was ranked in the top five priorities 2,711 times. Overall, 3,610 people participated in the survey.

*Figure 137: Public Survey Rankings of Priorities within Study Area*

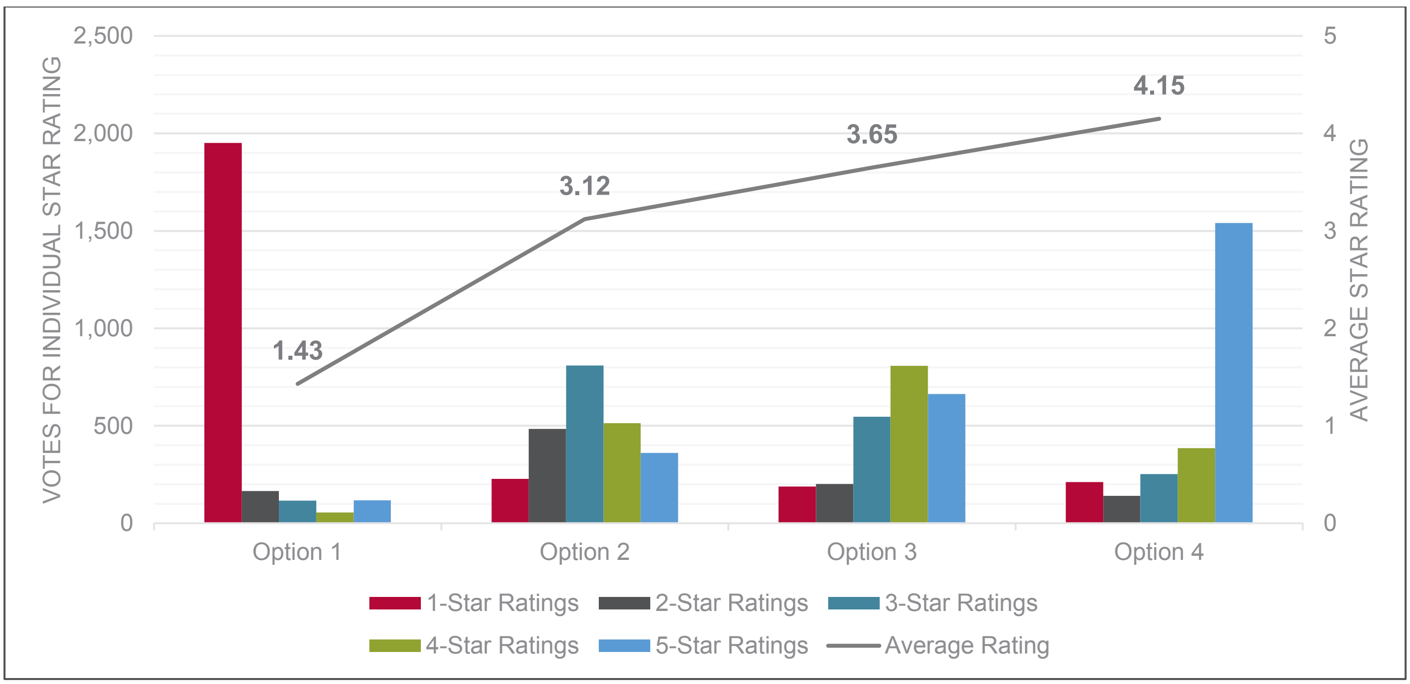



The survey also asked participants to rate four options from one (least desirable) to five (most desirable) stars and allowed the participants to provide open comments on the options. Since the three Build packages had several common improvements, the survey focused on the major interchange improvements that differed across the Build packages as follows:

- Option 1: No-Build
- Option 2: The partial cloverleaf interchange at US 250 in Build Package 1
- Option 3: The diverging diamond interchange at N Gayton Road in Build Package 2
- Option 4: Both interchange improvements in Build Package 3

*Figure 138* summarizes the number of ratings given for each option and the average star rating. The combined interchange improvements in Build Package 3 (Option 4) received the highest average rating. Approximately one half of a rating point separated both the top (Build Package 3) and second (Build Package 2) options and the second and third (Build Package 1) options. Participants submitted more than 300 comments specific to the Build packages and more than 1,100 general comments. All comments from the survey are compiled in *Appendix I*.

*Figure 138: Public Survey Ratings for Build Options*



## MATRIX

The study team prepared an alternatives comparison matrix to evaluate differences between the three Build packages using the following criteria and weights. The bicycle and pedestrian accommodation category was not given a weight and instead was treated as a checkbox item to indicate if bicyclists and pedestrians can be accommodated with all proposed improvements. This same approach applies for the ability to meet the Purpose and Need of the project.

- Right-of-way (RW) and utility impacts (weight = 1)
- Safety impacts (weight = 2)
- Operational impacts (weight = 2)
- Bicycle and pedestrian accommodation (no weight)
- Meets Purpose and Need (no weight)
- Environmental impacts (weight = 1)
- Preliminary cost of construction (weight = 1)

The concepts were then ranked relative to each other based on total score. *Table 46* documents the weighted scores given in each category for the No-Build scenario and three Build packages. The complete matrix that summarizes the score by criteria, criteria weight, and cumulative scores and ranks is provided in *Appendix H*. Build Package 3 scored the highest and was advanced to discussions on phasing as the preferred alternative. Build Package 3 was also the highest-rated option in the online public survey as documented in the *Public Involvement* section.

*Table 46: Build Package Simplified Matrix*

| Alternative | R/W and Utility Impacts | Safety | Operations | Bicycle & Pedestrian | Meets Purpose and Need | Environmental | Cost of Construction | Total | Rank |
|---|---|---|---|---|---|---|---|---|---|
| No-Build | 5 | 2 | 2 | | | 5 | 5 | 19 | 4 |
| 1 | 3 | 8 | 6 | ✓ | ✓ | 3 | 3 | 23 | 2 |
| 2 | 2 | 6 | 8 | ✓ | ✓ | 2 | 4 | 22 | 3 |
| 3 | 2 | 10 | 10 | ✓ | ✓ | 2 | 1 | 25 | 1 |

| Category Score | Description for Safety Improvements and Operational Improvements | Descriptions for R/W and Utility Impacts, Environmental Impacts, and Cost of Construction |
|---|---|---|
| 5 | Positive effect or best alternative | Generally no change from No-Build conditions |
| 4 | Moderate improvement from No-Build conditions | Minimal impact from No-Build conditions |
| 3 | Mild improvement from No-Build conditions | Mild impact from No-Build conditions |
| 2 | Minimal improvement from No-Build conditions | Moderate impact from No-Build conditions |
| 1 | Generally no change from No-Build conditions | Negative effect or worst alternative |

## IMPROVEMENT PHASING

To best address the needs in the study area, all seven improvements included in Build Package 3, which was selected as the preferred alternative, should be constructed by 2046 to meet the safety and operational needs identified for the design year. The study team developed a phasing plan to determine the recommended order of construction for the seven improvements. The goal of the phasing plan was to verify that each proposed phase of improvements is projected to improve operations and safety throughout the network compared to the No-Build scenario, while prioritizing improvements that would more effectively facilitate the maintenance of traffic during construction of subsequent improvements, and for which local or regional funding for design and construction could be expected to be reasonably available. The phasing plan was informed based on the results of the No-Build conditions analyses, the alternatives screening analyses, and the Build conditions analyses for each of the Build packages.

Since the Build conditions analysis did not summarize operational or safety results for individual improvements within a given Build package, the study team did not recommend dividing the project into phases where an individual improvement would be constructed before others that it is paired with in that Build package. This approach was taken so that the conclusions made in the *Build Package Operational Comparison*, *Safety Conclusions*, and *Selection of Preferred Alternative* sections could justify that the phasing of the recommended first Build package is projected to improve operations and safety throughout the network when compared to the No-Build scenario. Since all Build packages were rated higher than the No-Build scenario for both operations and safety, the study team concluded that any Build package could be phased before others to see an overall benefit for the study area network.

While all Build packages are projected to improve operations for the study area network, the study team recommends that all improvements in Build Package 1 are not constructed prior to the new interchange at N Gayton Road to avoid localized degradation on US 250. If the bottleneck on northbound Route 288 is released with the construction of the northbound Route 288 auxiliary lane and the improvements at the Route 288 interchange with US 250, the additional vehicles reaching US 250 are projected to create a new bottleneck on eastbound US 250. The new bottleneck is projected to result in a significant increase in travel time from the No-Build scenario on eastbound US 250 and a slight increase in travel time on westbound US 250 during the PM peak hour as documented in the *Build Package Operational Comparison* section for Build Package 1. Build Packages 2 and 3 were not projected to experience an increase in travel time on US 250 since the new interchange at N Gayton Road was projected to reduce traffic volumes on US 250. While the increase in travel time in Build Package 1 is not attributed to the partial cloverleaf interchange, the study team recommends that the improvements to northbound Route 288 should not be phased before the new interchange at N Gayton Road to prevent any degradation in travel time on US 250.

Additionally, the new interchange at N Gayton Road and other improvements included in Build Package 2, if phased first, are projected to alleviate the negative impacts of construction of the partial cloverleaf at the US 250 interchange on study area traffic. These improvements are projected to more effectively facilitate the maintenance of traffic in the following ways:

- The AM and PM peak hour volumes are projected to decrease from the No-Build scenario on the following ramps that will be modified due to the new access point to the Short Pump area. The reduced demand on the ramps during construction will allow for a safer work zone, shorter construction duration, and improved work zone operations.
  - Westbound I-64 on-ramp from eastbound US 250 (AM peak hour only)
  - Westbound I-64 off-ramp to westbound US 250
  - Westbound I-64 on-ramp from westbound US 250
  - Eastbound I-64 on-ramp from US 250

- The AM and PM peak hour volumes are projected to increase on the eastbound I-64 off-ramp to eastbound US 250. However, all vehicles making this movement will have the option to exit I-64 via the new interchange at N Gayton Road during the construction of the new bridges on I-64. This projected reduction in demand will allow for a safer work zone, shorter construction duration, and improved work zone operations.
  - While the AM and PM peak hour volumes on eastbound US 250 approaching the interchange are projected to increase during the construction of the I-64 bridges, the volumes are projected to decrease from the No-Build scenario once the I-64 bridges are completed. Since the proposed improvements on US 250 are likely to be constructed after the new bridges on I-64 and involve a reduction in travel lanes during construction, this reduced demand on eastbound US 250 approaching the interchange will allow for a safer work zone, shorter construction duration, and improved work zone operations.

Considering that the improvements in Build Package 2 are projected to improve safety and operations within the study area network and that the improvements are projected to facilitate easier maintenance of traffic during construction of subsequent improvements – and that the funding for the anticipated construction costs of Build Package 2 is anticipated to be more readily available by the localities compared with the funding required for the larger costs of Build Package 1 – the study team recommends that all elements in Build Package 2 are constructed in the first phase. The recommended phasing is summarized in *Table 47*. Since some improvements included in Phase 1 were recommended and approved in prior studies, these improvements may be removed from Phase 1 if the improvement is funded separately provided that construction of the individual improvement is completed prior to the construction of the remaining elements in Phase 1. Additionally, coordination of the improvements recommended in this study with any other improvements recommended as part of other studies can be accomplished during the NEPA or preliminary engineering phases.

*Table 47: Recommended Improvement Phasing*

| Phase | Improvements Included |
|---|---|
| 1 | Construct auxiliary lane on southbound Route 288 |
| | Construct a new diverging diamond interchange at N Gayton Road |
| | Construct an auxiliary lane on northbound Route 288. Construct improvements to ramp terminals at US 250 interchange with Route 288. |
| | Construct improvements at intersection of US 250 and Tom Leonard Drive |
| | Implement turning restriction at Dominion Boulevard |
| | Convert the westbound I-64 off-ramp to I-295 to two lanes and construct a continuous auxiliary lane on I-295 between I-64 and Nuckols Road |
| 2 | Construct a partial cloverleaf interchange with contraflow left-turn lanes at I-64 interchange with US 250. |