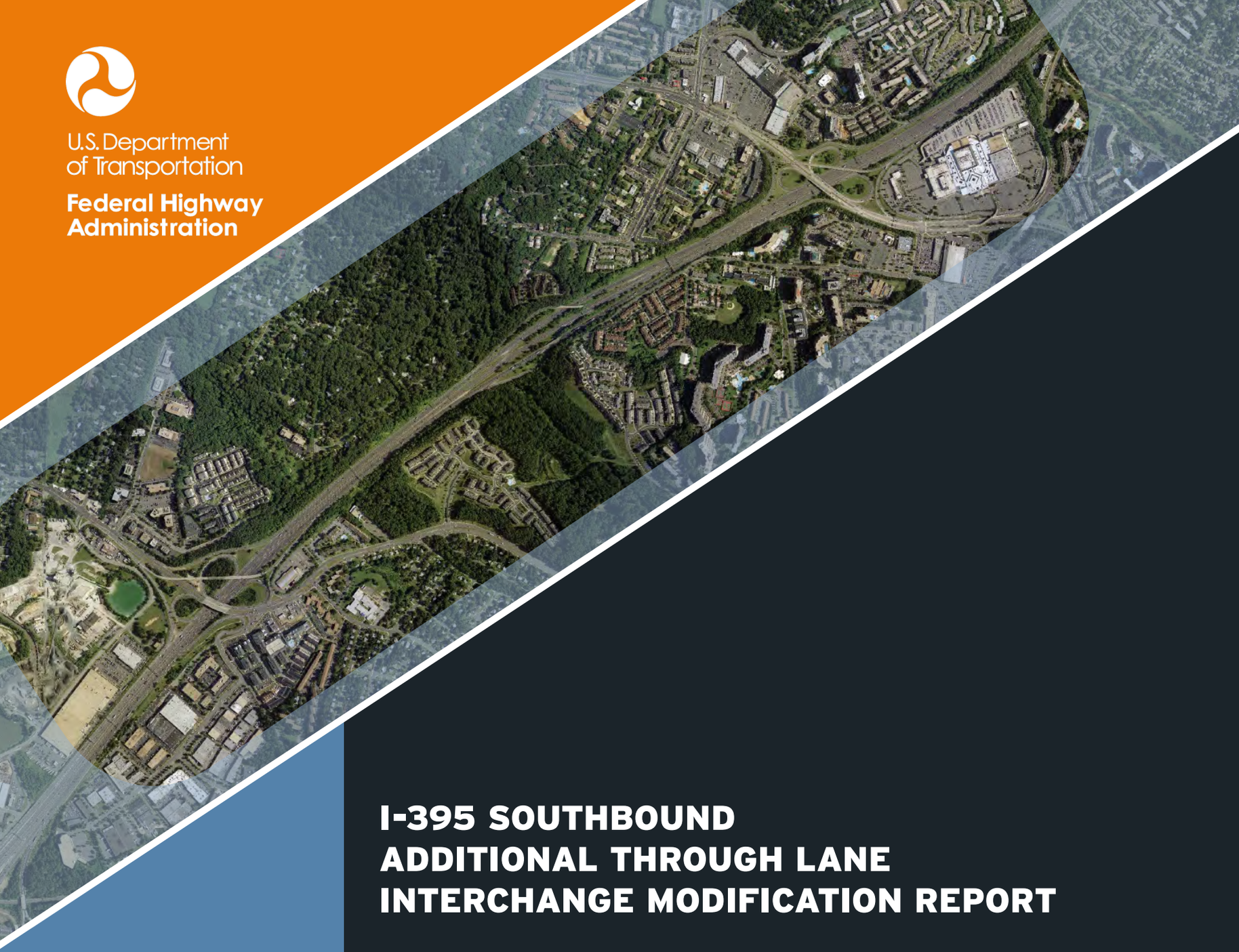
U.S. Department of Transportation

Federal Highway Administration



I-395 SOUTHBOUND ADDITIONAL THROUGH LANE INTERCHANGE MODIFICATION REPORT

MAY 2017

Submitted to: U.S. Department of Transportation, Federal Highway Administration

Submitted by: Virginia Department of Transportation

Prepared by: HNTB Corporation

VDOT

HNTB

Interchange Modification Report

I-395 SOUTHBOUND ADDITIONAL THROUGH LANE

Commonwealth of Virginia

State Project Number: 0395-029-015, P101
Federal Project Number: HSIP-395-4(177)
UPC: 103316

This document has been prepared and submitted pursuant to 23 U.S.C. 111 to obtain FHWA approval to modify existing interchange ramps on a fully-controlled interstate highway.

Submitted May 2017 to:

U.S. Department of Transportation
Federal Highway Administration

Submitted by:

VDOT Virginia Department of Transportation

The request for reconfiguration of the interstate access points is approved for a Finding of Engineering and Operational Acceptability. This approval is conditional upon compliance with applicable federal requirements, specifically with the National Environmental Policy Act (NEPA). Completion of the NEPA process is considered acceptance of the general project location and concepts denoted in the environmental documentation.

Virginia Division Federal Highway Administration	Virginia Department of Transportation
Date of Approval	Date of Approval

U.S. Department of Transportation
Federal Highway Administration

Virginia Division

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May 15, 2017

Interstate 395 Southbound Additional Through Lane Project
Federal Project #: HSIP-395-4(177)
State Project #: 0395-029-015; UPC 103316
Fairfax County and the City of Alexandria

Ms. Susan H. Keen, P.E.
State Location and Design Engineer
Virginia Department of Transportation
1401 East Broad Street
Richmond, VA 23219

Dear Ms. Keen,

We have received the Interchange Modification Report (IMR) for the subject project that was submitted by the Virginia Department of Transportation (VDOT) on May 11, 2017. Our review of the IMR concludes that all our previous comments have been adequately addressed.

The proposed project will construct a fourth lane along the I-395 southbound mainline and remove a loop from both the Duke Street and Edsall Road interchanges. The additional lane will remove an existing bottleneck along I-395 between Duke Street and Edsall Road, and will provide a consistent four lane typical section through the corridor. Removing a loop at each interchange will remove an existing weave condition and improve the safety and operation at the two interchanges.

Based on our review, we find the engineering and operations of the access request acceptable. The NEPA process resulted in the approval of a Categorical Exclusion on March 1, 2017, therefore this IMR is approved. Thank you for collaborating with our office during the IMR process. Please contact Elliott Moore if you have any further questions at (804) 775-3338.

Sincerely,

Jessie Yung, P.E.
Division Administrator

By: Tarsem Lal, P.E., PMP
Senior Major Projects Engineer

cc: Theron I. Knouse, P.E.
Elliott Moore, P.E.
Susan Shaw, P.E.

Interchange Modification Report

I-395 SOUTHBOUND ADDITIONAL THROUGH LANE

Commonwealth of Virginia

State Project Number: 0395-029-015, P101
Federal Project Number: HSIP-395-4(177)
UPC: 103316

This document has been prepared to satisfy the requirements set forth by Federal and State Policy for changes in interstate access. It is consistent with the Virginia Department of Transportation's Location and Design Division Instructional and Informational Memorandum LD-200.7 and in accordance with the most recent update to FHWA's policy on Access to the Interstate System dated August 27, 2009.

Submitted May 2017 to:

U.S. Department of Transportation
Federal Highway Administration

Submitted by:

VDOT Virginia Department of Transportation

NOVA District
Virginia Department of Transportation

Date 5/10/2017

NOVA District Traffic Engineer
Virginia Department of Transportation

Date 5/11/2017

NOVA District Location and Design Engineer
Virginia Department of Transportation

Date 5/10/2017

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EXECUTIVE SUMMARY / FHWA INTERSTATE ACCESS POLICY COMPLIANCE

ES.1 Project Background

Interstate 395 (I-395) is a spur route of Interstate 95 (I-95) that begins at the I-95/I-395/I-495 Springfield Interchange and passes through portions of Fairfax County, the City of Alexandria and Arlington County in Virginia, and extends into the District of Columbia where it ends at the interchange with U.S. Route 50 New York Avenue in northwest Washington D.C. This is a regional interstate route for commuters in the Washington, D.C. metropolitan area, and is one of the most heavily traveled and congested freeways in the region and in the Commonwealth of Virginia.

Currently southbound I-395 operates with three general purpose (GP) travel lanes between the Virginia Route 236 Duke Street interchange and the Virginia Route 648 Edsall Road interchange. The adjacent segments of southbound I-395 operate with four GP through travel lanes. The lane drop at the Duke Street interchange creates a traffic "bottleneck" during the weekday PM peak period. This condition results in heavy congestion and queuing in all of the southbound I-395 travel lanes that extends upstream well beyond the Virginia Route 420 Seminary Road interchange. Travel times on the 5.7-mile segment of southbound I-395 between the Seminary Road interchange and the Springfield Interchange increase from 5.3 minutes in free flow conditions to more than 12.5 minutes during the weekday PM peak hours.

In 2012, the Virginia Department of Transportation (VDOT) completed a feasibility study[1] to evaluate various operational and geometric options to relieve the recurring daily congestion. The study recommended widening southbound I-395 to provide a fourth GP through travel lane between the Duke Street and Edsall Road interchanges. In addition, with improvements at each interchange to eliminate restrictive mainline weave conditions between adjoining tight radius loop ramps by removing one of the loop ramps, and replacing it with an outer connection ramp and at-grade intersection.

The I-395 Southbound Additional Through Lane project refines the 2012 study recommendations, makes select improvements at the Duke Street and Edsall Road interchanges, and advances the initial preferred design concept to preliminary design. This Interchange Modification Report (IMR) documents the technical studies performed to support design, traffic operations and safety of the I-395 Southbound Additional Through Lane project.

ES.2 Summary of Project Purpose and Need

The purpose of the proposed project is to relieve the recurring peak period congestion and to reduce crash potential on southbound I-395 in the vicinity of the Duke Street and Edsall Road interchanges. The proposed improvements will add a fourth through lane between the Duke Street and Edsall Road

[1] *I-395 Southbound between Duke Street & Edsall Road Congestion Relief Feasibility Study: Operational & Geometrical Analysis Technical Memorandum*, VDOT, July 2012.

interchanges, consistent with the number of lanes in the adjacent portions of southbound I-395, and will eliminate short weaving sections between adjoining loop ramps at both interchanges.

Analyses performed as part of this study support the following needs and proposed improvements:

- Alleviate recurring daily congestion resulting from the lane drop on southbound I-395.
- Reduce the potential for crashes on southbound I-395 in the vicinity of the lane drop by maintaining lane continuity.
- Eliminate short weave segments between adjoining loop ramps at the Duke Street and Edsall Road interchanges.

ES.3 Screening of Alternatives

In addition to the No-Build Alternative, VDOT developed and evaluated four draft alternatives based on the preliminary design concept recommended in the 2012 study. The refinement concepts considered replacing select free-flow ramp terminals at arterial cross streets with signalized at-grade intersections; combining ramps; and spot improvements to correct ramp deceleration and acceleration lane lengths. Four alternatives were analyzed for traffic operations, overall environmental impacts, right-of-way impacts, utility impacts, and construction cost. Based on the evaluation and review, VDOT selected the Preferred Alternative for further evaluation and refinement because it best addressed the purpose and need of the project.

ES.4 Proposed Action in the Preferred Alternative

This project proposes to add an additional through lane on southbound I-395 GP from the lane drop at the Duke Street interchange to the Edsall Road interchange, resulting in a continuous four-lane section on this segment. The project also proposes to reconfigure the Duke Street and Edsall Road interchanges to accommodate the additional through lane with minimal impacts to existing highway infrastructure. The Preferred Alternative includes the following improvements:

- From Duke Street to Edsall Road
    - Add an additional through lane on southbound I-395.
- Duke Street interchange
    - Close the southbound I-395 to eastbound Duke Street loop ramp and combine this movement with the existing directional exit ramp from southbound I-395 to westbound Little River Turnpike.
    - Add a signalized intersection at Duke Street/Little River Turnpike for the left turns from southbound I-395 to eastbound Duke Street.
    - Realign the loop ramp from westbound Duke Street to southbound I-395 and increase the acceleration length.
    - Add the provisions for allowing a U-Turn movement on Duke Street, located east of I-395 between I-395 and Walker Road, to accommodate the limited volume of eastbound 236 traffic entering I-395 SB and entering the Express Lanes at Turkeycock Run.

- Turkeycock Run access ramps
  - Combine the ramp from eastbound Little River Turnpike to southbound I-395 with the existing flyover exit ramp from HOV to GP lanes.
- Edsall Road interchange
  - Close the westbound Edsall Road to southbound I-395 loop ramp and combine this movement with an entrance ramp from eastbound Edsall Road.
  - Add a signalized intersection at Edsall Road for the left turns from westbound Edsall Road to southbound I-395.
  - Extend the southbound I-395 auxiliary lane from the Turkeycock Run entrance ramp to the exit ramp to eastbound Edsall Road

ES.5 Summary of Findings

ES.5.1 Traffic Operational Analysis Findings

Traffic operations analysis results for opening year (2020) and design year (2040) conditions show that the Preferred Alternative will eliminate the capacity constraint (north of Duke Street interchange due to lane-drop) and reduce congestion on southbound I-395 during the PM peak period. Microsimulation modeling confirms the benefits of the Preferred Alternative in the form of reduced travel times and flow densities, increased travel speeds and served travel demand, and improved Level of Service (LOS) metrics. The Preferred Alternative will not degrade operations on the northbound GP mainline, the HOV/Express lanes, or the crossing arterials. Analyses also verify that improvements to southbound I-395 are needed before 2020 to reduce severe congestion and improve traffic flow through the design year.

ES.5.2 Safety Analysis Findings

Three-year crash data identifies the lane drop location on southbound I-395 near Duke Street as a high crash location. Two-thirds of the reported crashes at this location were rear-end crashes. The Preferred Alternative is expected to reduce the crash potential at this location because it will eliminate the lane drop and associated merging, maintain the basic number of lanes on southbound I-395, and improve traffic flows during peak hours.

By applying the Crash Modification Factors to the existing (2011-2013) crash frequency on I-395 southbound, a potential reduction of 64 crashes (18%) is expected due to the various geometric and operational changes of the Preferred Alternative. This reduction is projected without including the effect of reducing the ramp density (from 4.5 ramps/mile to 2.8 ramps/mile), eliminating two short weave segments and adding signalized intersections.

ES.6 Responses to FHWA Interstate Access Policy Requirements

This report addresses each of the eight FHWA interstate access policy requirements for the proposed improvements to the southbound I-395 mainline and two interchanges as follows.

ES.6.1 Policy Requirement 1: Need for the Access Point Revision

The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands.

I-395 is a primary commuting corridor serving established residential and employment centers in the Washington, D.C. metropolitan area. Commuter traffic patterns are well established and are not expected to materially change over time. Under existing conditions during the PM peak period, the lane drop at the Duke Street interchange creates a capacity constraint along southbound I-395 resulting in congested and saturated operating conditions north of Duke Street. Demand in this corridor already exceeds capacity, and forecasts for the design year (2040) show that travel demand will continue to increase. Congestion will worsen, traffic operations will continue to degrade, and crash potential will remain elevated along I-395. The local arterials and streets in the corridor also operate at or above capacity during peak periods, and already accommodate diversions from I-395 due to recurring congestion. Accordingly, the proposed project addresses the need for capacity and safety improvements along the I-395 mainline and at the two interchanges within the project limits.

With regard to the requested access point revision, the Duke Street and Edsall Road interchanges are both partial cloverleaf designs with a semi-directional ramp for the eastbound to northbound movements. At each interchange, successive tight-radius entrance and exit ramps induce low operating speeds for weaving operations along the southbound I-395 GP lanes. Weaving operations between interchanges also pose operational problems due to limited distances between interchanges and the number of travel lanes involved. The modifications to both interchanges are required to address undesirable weave conditions and otherwise alleviate congestion, traffic operations and safety concerns.

ES.6.2 Policy Requirement 2: Reasonable Alternatives

The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate without the proposed change(s) in access.

Currently all entrance ramps are metered in the southbound direction during the PM peak period. In addition, a two-lane barrier-separated reversible facility that operates under HOV-3 restriction during the peak periods is located in the median of I-395. Construction of the I-95 Express Lanes project have recently been completed to convert this facility to a three-lane high-occupancy toll (HOT) facility south of the Turkeycock Run access ramps. The I-95 Express Lanes were opened in December 2014. The project development process for the proposed southbound I-395 improvements included consideration of transportation system management (TSM) solutions. However, TSM strategies alone will not meet the needs of this corridor. Additionally, the proposed mainline widening cannot occur without the proposed interchange modifications due to the physical constraints imposed by existing overpass structures.

ES.6.3 Policy Requirement 3: Operational and Collision Analyses

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, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access. The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, shall 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. Requests for a proposed change in access must 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 streets. Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative.

The study area for safety and operational analyses performed as part of this IMR satisfies the FHWA requirements for roadway network analysis.

Microsimulation analysis demonstrates that the Preferred Alternative will remove the capacity constraint along southbound I-395 and will improve traffic operations when compared to the No-Build Alternative. The Preferred Alternative also eliminates the problematic weaving (successive merging and diverging) movements within the project limits by consolidating the entrance and exit ramps along southbound I-395.

Safety analysis demonstrates that the Preferred Alternative will enhance traffic safety along southbound I-395 within the project limits. Specifically, the elimination of the lane drop on southbound I-395, along with the redesign of the entrance and exit ramps at the Duke Street and Edsall Road interchanges, is expected to reduce the potential for crashes on the southbound I-395 mainline movement and on the weaving segments.

Supporting documentation also includes a functional signing plan (**Appendix G**) and assumptions used in developing a signing concept, as provided in **Chapter 6** of this document.

ES.6.4 Policy Requirement 4: Access Connections and Design

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 for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards.

The Preferred Alternative will retain current full directional access to and from I-395 GP lanes at the Duke Street and Edsall Road interchanges. However, the reconfiguration of the entrance ramps at the Duke Street interchange will partially modify the access to the southbound I-95 Express Lanes during the PM peak periods. Currently vehicles merge onto the southbound I-395 GP lanes and weave across three through travel lanes to access the left slip ramp to enter the southbound I-395 HOV lanes at Turkeycock Run. Under the Preferred Alternative, vehicles traveling eastbound on Duke

Street destined for the southbound Express Lanes could cross I-395, execute a U-turn movement along Duke Street and use the entrance ramp from westbound Duke Street to southbound I-395, from which they can access the Express Lanes facility. While the Preferred Alternative will affect approximately 83 Express Lanes users during the PM peak hour (in 2040), it is proposed to reduce congestion and enhance safety for approximately 8,000 motorists on the southbound I-395 mainline during the PM peak hour. Also, HOV travelers have other options for accessing the Express Lanes including the new Seminary Road HOV ramp that is currently under construction.

The Preferred Alternative has been advanced to a preliminary design level and will be further refined during subsequent design stages. The design of the proposed improvements on southbound I-395, and the Duke Street and Edsall Road interchanges meets or exceeds American Association of State Highway and Transportation Officials (AASHTO) design guidelines, where feasible. However, there are several aspects of the proposed improvements that will require a Design Exception or a Design Waiver. These conditions are associated with substandard existing conditions that cannot be corrected within the stated purpose and need of the project. **Chapter 5** presents a summary justification and possible mitigation measures for each Design Exception and Design Waiver.

ES.6.5 Policy Requirement 5: Land Use and Transportation Plans

The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the Congestion Management Process within transportation management areas, as appropriate, and as specified in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.

The proposed improvements to southbound I-395 are consistent with local and regional land use plans, including the latest versions of the comprehensive plans prepared for and adopted by the City of Alexandria and Fairfax County. The improvements are also consistent with the Metropolitan Washington Council of Government's (MWCOG) National Capital Region Constrained Long Range Transportation Plan (CLRP), and are included in the Transportation Improvement Plan (TIP). Funding for the project is identified and programmed in VDOT's current Six-Year Improvement Program (SYIP-2014).

ES.6.6 Policy Requirement 6: Future Interchanges

In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan.

The CLRP for the National Capital Region comprehensively addresses at the transportation needs throughout the region, including the I-395 corridor. The traffic operational and safety analyses completed for this IMR considered all of the programmed projects in the CLRP that affect traffic operations on I-395. These projects include the I-95 Express Lanes, I-395 northbound auxiliary lane, and Seminary Road HOV ramp.

ES.6.7 Policy Requirement 7: Coordination

When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvement. The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point.

The project is not associated with any private development or changes in land use. The proposed improvements and revised access points will not be used to provide access between any new or expanded development and the interstate facility. Rather, they are required to alleviate the recurring congestion and reduce crash potential along southbound I-395.

Improvement concepts were formulated to respond to forecasted travel demand in the area. Traffic volumes were projected using the latest version of the MWCOG's regional travel demand model. VDOT has endorsed that the inputs and outputs of the travel demand model reflect the demand associated with all programmed land use changes within the model's coverage area.

The project is supported by both Fairfax County and the City of Alexandria. Through coordination meetings and personal briefings with elected officials, County and City staff have expressed a willingness to participate in the continuing public involvement program, and work to maintain public support for the project. **Appendix C** includes letters of support for the project from Fairfax County and the City of Alexandria.

ES.6.8 Policy Requirement 8: Environmental Processes

The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of the environmental processing.

In compliance with state and federal laws, VDOT is currently preparing an environmental document to identify potential environmental impacts associated with the project. The environmental document will include a consideration of the No-Action (No-Build) Alternative, as well as the Preferred Alternative identified in this IMR document. In consultation with FHWA, VDOT has determined that a Categorical Exclusion (CE) is appropriate for this project. The CE was approved in March 2017.

CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1 Overview

Interstate 395 (I-395) is a spur route of Interstate 95 (I-95). I-395 begins at the I-95/I-395/I-495 Springfield Interchange in Fairfax County, Virginia and ends at the interchange with U.S. Route 50 (New York Avenue) in northwest Washington, D.C. It passes through portions of Fairfax County, the City of Alexandria, and Arlington County in Virginia, and portions of Washington, D.C. I-395 accommodates regional commuting activity in Washington, D.C. and the metropolitan area of Northern Virginia. It is one of the most heavily traveled and congested freeways in the region and in the Commonwealth of Virginia.

The existing I-395 mainline freeway has four GP lanes in the southbound direction between Shirlington Road and Duke Street (Virginia Route 236) interchanges. The right lane drops just before the on-ramp from westbound Duke Street. From this point south, the southbound I-395 mainline has only three GP lanes until it reaches the Edsall Road (Virginia Route 648) interchange, where southbound I-395 picks up an additional lane, as well as an auxiliary lane, before merging with I-95/I-495 at the Springfield Interchange. The three-lane segment between the Duke Street and Edsall Road interchanges is 2.1 miles long.

The lane drop at the Duke Street interchange creates a traffic bottleneck. With heavy commuter traffic in the PM peak period, this segment of southbound I-395 becomes congested and queues extend upstream beyond the Seminary Road (Virginia Route 420) interchange. The extent of congestion is such that travel times on the 5.7-mile segment of southbound I-395 within the study area[2] more than double from 5.3 minutes in free flow conditions, to 12.5 minutes with stop-and-go traffic in all travel lanes during the PM peak hour.

1.1.2 Previous Studies

In 2012, the Virginia Department of Transportation (VDOT) completed a planning study to examine the operational and geometric feasibility of widening southbound I-395 to accommodate an additional through lane. Six design options were evaluated for improvements to the Duke Street and Edsall Road interchanges along southbound I-395. The study culminated with a technical memorandum[3] dated July 17, 2012, which recommended a design concept for each interchange. The technical memorandum document is provided in **Appendix A** of this report.

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[2] Refer to Chapter 3 for the study area boundaries.

[3] *I-395 Southbound between Duke Street & Edsall Road: Congestion Relief Feasibility Study / Operational & Geometrical Analysis Technical Memorandum*, VDOT, July 17, 2012.

In May 2013, VDOT issued the current project (UPC 103316) to refine the preferred alternatives, advance the project into preliminary design, and perform technical studies. This report documents the technical results to support the refined design to Federal Highway Administration (FHWA) requirement policy.

1.2 Purpose and Need

1.2.1 Purpose

The purpose of this project is to relieve the recurring peak period congestion and to enhance traffic safety on southbound I-395 within the project limits.

1.2.2 Need

The need for improvements within the project limits is based on the following:

- Alleviate recurring daily congestion resulting from the lane drop on southbound I-395.
- Reduce the potential for crashes on southbound I-395 in the vicinity of the lane drop by maintaining lane continuity.
- Eliminate short weave segments between adjoining loop ramps at the Duke Street and Edsall Road interchanges.

Southbound I-395 between Duke Street and Edsall Road is the only remaining three-lane section on a 16-mile stretch of the I-395/I-95 corridor from the Shirlington Road interchange to the Route 123 interchange in Prince William County, Virginia. The mainline lane drop, combined with short weave sections at the Duke Street and Edsall Road interchanges, provide inadequate capacity to meet high traffic demand volumes during PM peak periods, resulting in severe traffic congestion along southbound I-395.

Figure 1–1 on the following page illustrates a four-weekday average speed plot of southbound I-395 during the PM peak period from October 28 to October 31, 2013. The plot illustrates that the lane drop at the Duke Street interchange creates a traffic bottleneck condition that meters traffic on southbound I-395. This results in lower speeds upstream of the lane drop location, and queuing conditions extending beyond the Seminary Road interchange located upstream of the Duke Street interchange.

The mainline lane drop results in a high frequency of rear-end crashes. Between January 1, 2011 and December 31, 2013, the crash rate at this location was 159.1 crashes per hundred-million vehicle miles of travel (HMVMT). This is the highest crash rate in the study area, and two times higher than the Virginia statewide-average crash rate for urban interstate freeways[4]. The predominant crash type was rear-end collision. The lack of mainline lane continuity and the congestion associated with it are considered to be contributing factors for this crash pattern.

[4] *2012 Summary of Crash Data, Interstate, Primary and Secondary System under Jurisdiction of Virginia Department of Transportation*, VDOT, 2012.

In addition, the Duke Street and Edsall Road interchanges are both partial cloverleaf designs with a semi-directional ramp for the eastbound to northbound movements. At each interchange,

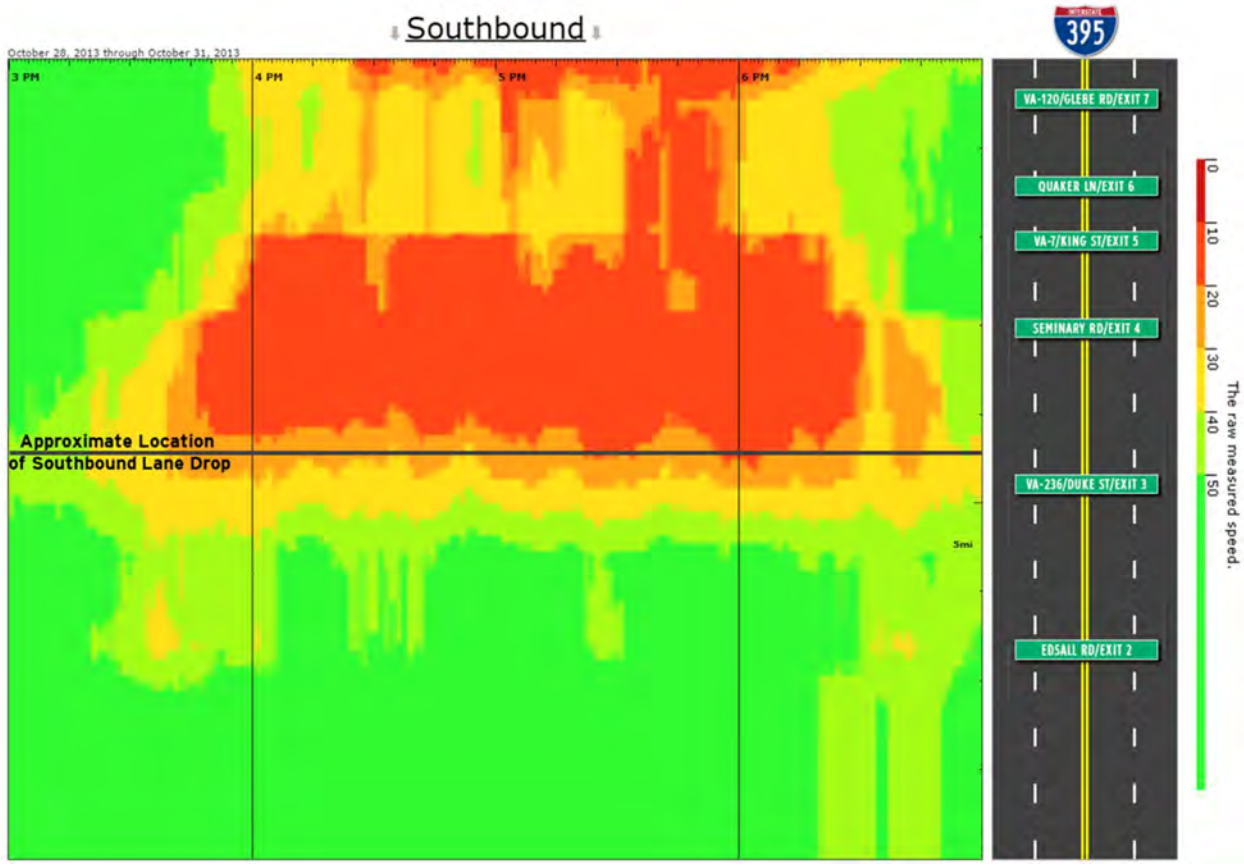

Figure 1–1: INRIX Speed Plot of SB I-395, PM Peak Period[5]

successive tight-radius entrance and exit loop ramps induce low operating speeds for weaving (merge/diverge) operations along the southbound I-395 GP lanes. Weaving maneuvers between interchanges also pose operational and safety concerns due to the short distance between interchanges and the number of travel lanes involved.

The travel demand growth in future years will further exacerbate the congestion and safety concerns on southbound I-395. Therefore, improvements are needed to remove the capacity constraint by constructing an additional through lane and improve short weave sections with modifications to both interchanges. The proposed project will serve forecasted levels of demand, alleviate traffic congestion during peak hours, and subsequently enhance safety along southbound I-395.

[5] Average for four weekdays; Data source: Regional Integrated Transportation Information System (RITIS), University of Maryland CATT Lab. http://www.ritis.org

1.3 Project Location and Study Area

1.3.1 Project Location

The project limits of the I-395 additional through lane are from 0.3 miles north of the Route 236 Duke Street interchange to 0.16 miles south of the Route 648 Edsall Road interchange, and include the ingress/egress ramps from the I-395 HOV lanes at Turkeycock Run. The yellow line in **Figure 1–2** highlights the 2.2-mile segment of the project limits.

1.3.2 Study Area Boundaries

FHWA guidelines[6] for conducting IMR studies indicate the need to include an area of influence beyond the proposed improvements based on traffic operations and safety concerns. Therefore, the study area for operational and safety analysis is centered on the 2.24-mile segment of the project limits and extends to the first adjacent interchange on either side, as well as adjacent intersections on the crossing arterials.

As illustrated in **Figure 1–2**, the study area is a 5.7-mile segment of the I-395 corridor from north of the Seminary Road interchange to south of the Springfield Interchange, and includes the following roadways, ramps and intersections in the area of influence:

- I-395 freeway mainline segments from just north of the Seminary Road interchange to the Springfield Interchange
    - Southbound and northbound GP lanes
    - Reversible HOV lanes
- Interchanges and ramps
    - Seminary Road interchange and all five ramps
    - Duke Street interchange and all eight ramps
    - Edsall Road interchange and all eight ramps
    - I-395 HOV ingress/egress ramps at Turkeycock Run (three in existing conditions and four in future No-Build and Build conditions)
    - I-395/I-95/I-495 Springfield Interchange and the nine ramps that serve traffic entering or exiting I-395
- Arterials and intersections
    - Seminary Road with the following intersections:
        1. Mark Center Drive
        2. Southbound I-395 off-ramp
        3. Southbound I-395 on-ramp
        4. Northbound I-395 off-ramp
        5. Northbound I-395 on-ramp
        6. Seminary Road HOV ramp
        7. Kenmore Avenue

[6] *Interstate System Access Informational Guide*, pp.15-17, FHWA, August, 2010.

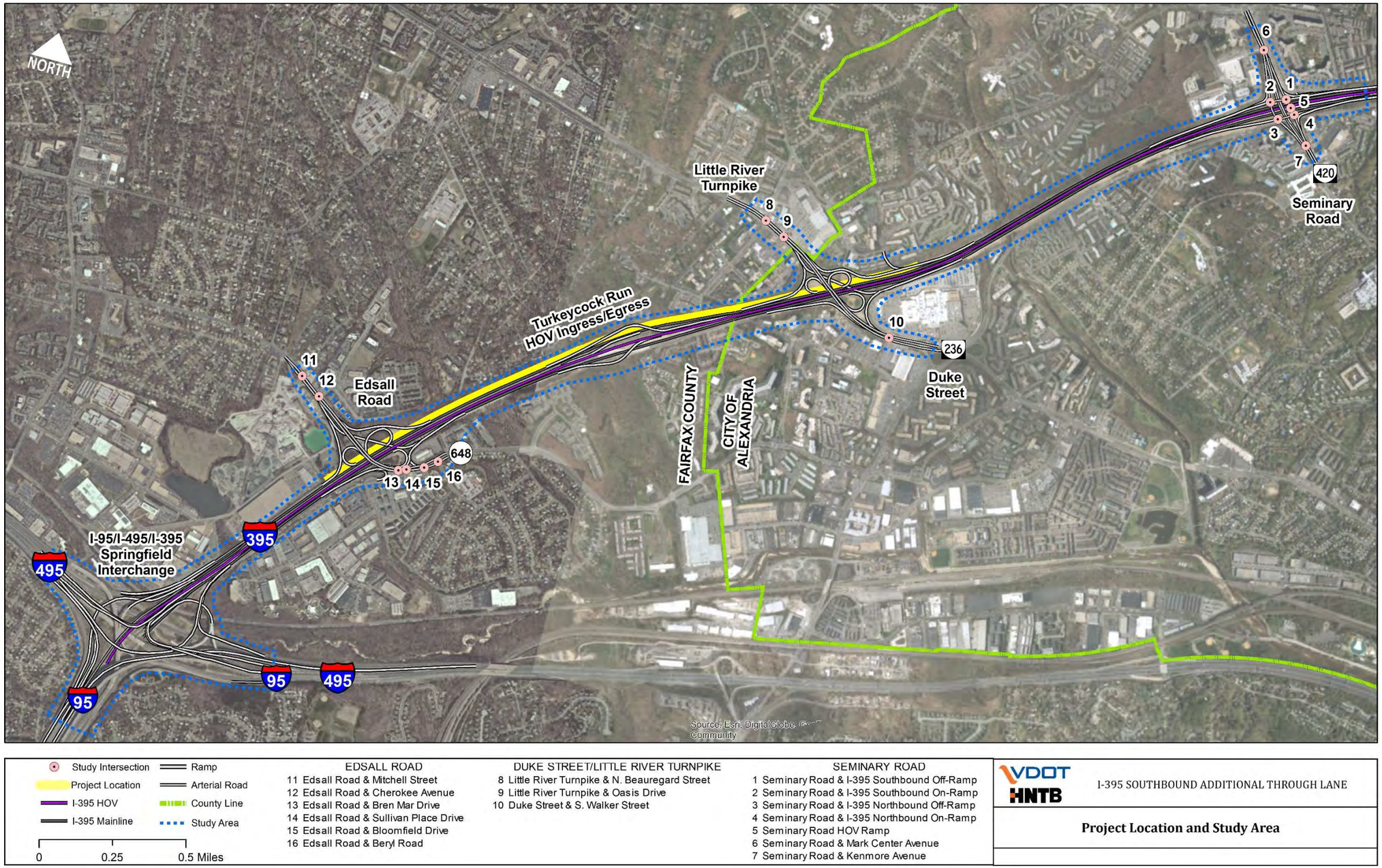

Figure 1–2: Project Location and Study Area for Operations and Safety Analysis

- Duke Street/Little River Turnpike with the following intersections:
    8. Beauregard Street
    9. Oasis Drive and Frontage Road access driveway
- South Walker Street and adjacent ramps to/from Landmark Mall and Edsall Road with the following intersections:
    11. Mitchell Street/Industrial Drive
    12. Cherokee Avenue
    13. Bren Mar Drive
    14. Sullivan Place Drive
    15. Bloomfield Drive
    16. Beryl Road

The study area also includes the northbound Express Lanes egress ramp at Turkeycock Run and the HOV/transit ramp (connections to/from the south) at Seminary Road in the No-Build Conditions.

The IMR Framework Document in **Appendix B** provides additional information on the criteria used to establish the study area limits.

1.4 Relationship to Other Highway Improvement Plans/Projects

The proposed project is adjacent to or overlaps with a number of other improvement projects. These projects are listed and described in detail below:

- I-95 Express Lanes
- I-395/Seminary Road HOV reversible ramp
- Northbound I-395 auxiliary lane from Duke Street to Seminary Road
- Duke Street/Little River Turnpike Widening

1.4.1 I-95 Express Lanes

The I-95 Express Lanes project (UPC 70849) is a public-private partnership to construct and operate HOT lanes on a 29-mile portion of the existing reversible HOV-3 facility on I-95 and I-395. A third reversible lane was added from Prince William Parkway on I-95 to the project's northern terminus at the Turkeycock Run area, where a new flyover exit ramp has been built for northbound traffic from the Express Lanes to GP lanes. This flyover ramp ties in to the northbound I-395 GP lanes just south of the Duke Street interchange. The I-95 Express Lanes were opened in December 2014.

1.4.2 I-395/Seminary Road HOV Reversible Ramp

This project (UPC 96261) includes construction of a reversible HOV/transit ramp on I-395 at Seminary Road on the third level of the rotary interchange. The ramp provides improved access for HOV and transit users working at locations along Seminary Road, including the Mark Center. The Mark Center is a large office complex located near the Seminary Road and I-395 Interchange. It accommodates up to 6,400 employees, and is occupied predominantly by Department of Defense staff and contractors.

As part of the short-term improvements to the Seminary Road interchange, the Seminary Road to southbound I-395 on-ramp was recently improved to reduce congestion and enhance traffic flow at the ramp and at the merging point onto the mainline.

1.4.3 Northbound I-395 Auxiliary Lane from Duke Street to Seminary Road

VDOT constructed a new auxiliary lane on northbound I-395 connecting the northbound on-ramp at Duke Street to the northbound off-ramp at Seminary Road (UPC 102437). This 0.8-mile auxiliary lane improves traffic flow entering and exiting northbound I-395, and provides enhanced access to the Mark Center at Seminary Road. The auxiliary lane was open to traffic in February 2015.

1.4.4 Duke Street/Little River Turnpike Widening

This project will widen Duke Street/Little River Turnpike from a four-lane divided roadway to a six-lane divided roadway from Pickett Road to I-395. The estimated completion date of this project in the 2013 CLRP is 2025.

1.5 Support and Commitment from VDOT and Local Jurisdictions

The I-395 Southbound Additional Through Lane project is listed as UPC 103316 in VDOT's current Six-Year Improvement Program. It was added to the MWCOG 2013 CLRP for the National Capital Region with an expected completion date of 2018.

The proposed improvements to southbound I-395 are consistent with local and regional land use plans, including the latest versions of the comprehensive plans prepared for and adopted by the City of Alexandria and Fairfax County. VDOT has coordinated with both Fairfax County and the City of Alexandria through a series of meetings. A summary of meetings is presented in **Table 1–1**.

Table 1–1: Summary of Stakeholder and Public Engagement

Meeting	Attendees	Location	Date
Stakeholder Coordination Meeting	VDOT, Fairfax County, City of Alexandria	VDOT NOVA District Office, Fairfax County	November 13, 2014
Stakeholder Coordination Meeting	VDOT, Fairfax County	Office of Supervisor Gross, Fairfax County	December 19, 2014
Citizen's Information Meeting	VDOT, Fairfax County, local citizens	Holmes Middle School, Alexandria, Virginia	February 10, 2015
Public Hearing	VDOT, Fairfax County, City of Alexandria, local citizens	Bren Mar Park Elementary School, Alexandria, Virginia	April 14, 2016
Public Hearing	VDOT, Fairfax County, City of Alexandria, local citizens	Francis C. Hammond Middle School, Alexandria, Virginia	October 27, 2016

County and City staff that attended these meetings expressed a willingness to participate in VDOT's continuing public involvement program for the project, work to maintain public support for the project, and help VDOT address constituent questions and concerns. VDOT's project is being designed to be compatible with County and City infrastructure projects in the vicinity of I-395, and in doing so will continue to positively address local interests in the project. Moving forward, VDOT will continue to work collaboratively with Fairfax County and the City of Alexandria to advance the I-395 Southbound Additional Through Lane project. **Appendix C** includes letters of support for the project from Fairfax County and the City of Alexandria.

CHAPTER 2: METHODOLOGY

The overall methodology for this IMR was developed following the guidance set forth in the documents below:

- *Interstate System Access Informational Guide*, FHWA, August 2010
- *New or Revised Interstate Access Points*, FHWA Virginia Division, September 2010
- *Interstate, NHS Non-Interstate And Non-NHS (IJR / IMR Guidance)*, IIM-LD-200.7, VDOT, June 2013

VDOT Traffic Operations Analysis Tool Guidebook, Version 1.1, August 2013[7] The IMR Framework Document in **Appendix B** outlines the understanding between the FHWA and VDOT in the development of the IMR in terms of the study area, methodology, assumptions and screening criteria.

This chapter describes the technical methodologies for traffic forecasting, operational and safety analysis procedures.

2.1 Traffic Forecasting Assumptions and Methodology

Traffic forecasts were developed using MWCOG's regional travel demand model Version 2.3.52 and the regional cooperative land use forecast Round 8.2. Model output was post-processed based on NCHRP 255[8] procedures as summarized below:

1. Extract the AM peak period, PM peak period, and daily volumes from travel demand models for links within the study area.
2. Develop an annual non-compounding growth rate for each link from the existing (2013) conditions for the future year (2020 and 2040) conditions.
3. Using the above growth rates, forecast future link volumes from existing (2013) balanced link volumes.
4. Develop future intersection turning movement volumes from future link volumes by applying the FRATAR process.
5. Balance the volumes throughout the study area as described below:
    a. Balance the I-395 mainline first, from one end to the other, holding ramp volumes constant.

[7]VISSIM MOEs are shown using LOS in this IMR per this guidebook. Note that VDOT's TOSAM published in 2015 does not use LOS to show VISSIM MOEs.

[8] *National Cooperative Highway Research Program (NCHRP) Report 255: Highway Traffic Data for Urbanized Area Project Planning and Design*, Transportation Research Board, February 1992.

b. Balance the arterials and volumes ensuring that they do not decrease when balancing along the arterial.

Appendix D contains a detailed description of the process, assumptions and methodology adopted in developing volumes.

2.2 Traffic Operational Analysis Methodology

2.2.1 Analysis Tools

The I-395 GP mainline is one of the most congested freeway segments in the Northern Virginia region. Within the study area, there are multiple closely spaced interchanges and ramps where frequent merge, diverge and weaving maneuvers occur. Traffic flows during weekday peak hours are constantly affected by bottlenecks in the peak direction. This is especially true on southbound I-395 between the Duke Street interchange and the Seminary Road interchange where high traffic demand during the PM peak hours is metered by the lane drop, resulting in severe congestion and extensive queues. Traffic operations during peak hours in this corridor are typically "oversaturated" conditions.

Based on discussions with FHWA and VDOT, and in recognition of the limitations of deterministic analytical models such as Highway Capacity Software and Synchro, microsimulation analysis was determined to the appropriate evaluation tool for traffic operations and performance of the interchange improvement alternatives in this study. Specifically, VISSIM Version 6 software was selected as the primary tool to provide a microscopic level of traffic operation analysis with an integrated consideration of upstream and downstream impacts.

Synchro Version 8 software was used to develop optimized traffic signal timing for all future scenarios.

2.2.2 Modeling Approach and Assumptions

VDOT Traffic Operations Analysis Tool Guidebook[9] and FHWA's Traffic Analysis Toolbox[10] were followed in the use of the VISSIM microsimulation software, including model calibration methodology, seeding time, determination of the number of simulation runs, simulation resolution, vehicle parameters, car-following models, lane-changing parameters, vehicle fleet, and Measure of Effectiveness (MOE) output reporting. The modeling approach and assumptions are consistent with the FHWA approved IMR Framework Document, as provided in **Appendix B**.

Table 2–1 on the following page summarizes the VISSIM model parameters and assumptions.

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[9] *Traffic Operations Analysis Tool Guidebook, Version 1.1*, VDOT, August 2013.
[10] *Traffic Analysis Toolbox Volume III: Guidelines for Applying Traffic Microsimulation Modeling Software,* FHWA, June 2004.

2.2.3 Model Calibration

The existing conditions VISSIM models for AM and PM peak hours were calibrated and validated to ensure the simulation output replicates actual conditions in the field. Following guidance from VDOT and FHWA, a customized three-step strategy was applied. In order of priority, the three steps are:

Table 2–1: VISSIM Model Parameters and Assumptions

Parameter	Existing 2013	2020 & 2040 No-Build	2020 & 2040 Build
VISSIM Version	Version 6 – Build 12		
Simulation Resolution	10 time steps/second		
Seeding Time	2700 seconds (0 – 2700 seconds)		
Recording Time	3600 seconds (2700 – 6300 seconds)		
Number of Simulation Runs	7 for AM model and 6 for PM model		
Random Seeds	Starting seed 100, with an increment of 10		
Vehicle Types	Car, heavy vehicle and bus		
Vehicle Compositions	From existing traffic counts	From travel demand forecasts	From travel demand forecasts
Arterial Car-Following Model	Wiedemann 74		
Freeway Car-Following Model	Wiedemann 99		
Driver Behavior	Default or Adjust for Calibration	If No-Build improvement changes segment, use engineering judgment to roll back calibration adjustment; otherwise same as existing	If proposed design changes segment, use engineering judgment to roll back calibration adjustment; otherwise same as No-Build
Signal Controller Type	Based on timing sheet data	Same as existing; New/Modified intersections will assume actuated-coordinated	
Signal Controller Frequency	10		
Signal Timings/Offsets	Existing signal timing data to be obtained from VDOT and/or the City (Synchro files or signal timing data)	Optimized from Synchro	
Ramp Meters	Based on existing data or field observation	Same as existing; Metering rate set by VDOT	
Grade	Code grades for links with >1.5% grade	From future No-Build improvements; otherwise same as existing	From proposed plans; otherwise same as No-Build
Desired Speed	For Arterials based on posted speeds (+/- 3 mph) and for Freeways based on posted speeds (+10/-3 mph)	From future No-Build improvement plans; otherwise same as existing	From proposed Build plans; otherwise same as No-Build[11]
Intersection Turning Speed	Use Reduced Speed Areas for Right (11-13 mph) and Left (13-17 mph) turns. For Non-Standard	For future No-Build improvements use AASHTO Exhibit 3-16; otherwise same as existing	For future No-Build improvements use AASHTO Exhibit 3-16; otherwise same as No-Build

[11] Shoulder reduction on I-395 SB at Duke Street and Edsall Road interchanges due to bridge pier protection resulted in a negligible speed reduction (≤ 0.2 mph)

Parameter	Existing 2013	2020 & 2040 No-Build	2020 & 2040 Build
	radius use AASHTO Exhibit 3-16		
Ramp Curve Speed	Use Reduced Speed Areas as per as-built plans; otherwise use AASHTO Exhibit 3-16	For all future improvements use AASHTO Exhibit 3-16; otherwise same as existing	
Vehicle Input	Exact Volume		
Lane Change Distance	Freeways based on exit sign location and Arterials default 656 ft. Adjust for calibration.	If No-Build improvement significantly changes segment, use engineering judgment to roll back calibration adjustment; otherwise same as existing	If proposed design significantly changes segment, use engineering judgment to roll back calibration adjustment; otherwise same as No-Build

- *Capacity Calibration*
  VISSIM model parameters were adjusted to meet the calibration criteria of the throughput volumes. These include car-following and lane-changing parameters, and lane change distances for different facilities.
- *System Performance Calibration*
  Travel time and speed profiles from VISSIM model results were then compared to field measurements. Link free flow speed and capacity related parameters were further refined to better match field conditions.
- *Visual Review*
  VISSIM simulation animation was reviewed to check queuing and congestion conditions at key bottleneck locations (such as the southbound lane drop at the Duke Street interchange) between the model and the field observations.

The following criteria were used to verify the adequacy of the model calibration:

- Capacity calibration criteria:
  - Throughput volumes served on I-395 freeway segments, interchange ramps and local arterials, including each turning movement at all study intersections
- System performance calibration criteria:
  - Travel time along the I-395 freeway mainline segments
  - Travel speed on the I-395 freeway mainline segments

Details of the calibration process and results are documented in **Appendix E**.

2.2.4 Measures of Effectiveness

After the existing conditions model was calibrated, VISSIM models were created for the future No-Build and Preferred Alternatives in the opening year (2020) and design year (2040). The following MOEs were used to assess the operations of the roadway network in the study area:

- Freeway mainline segments:
  - Average density (passenger-cars per mile per lane[12])
  - Freeway congestion level (based on density)
  - Throughputs or served demand (vehicles per hour)
  - Unserved demand (vehicles per hour)
  - Average travel times (seconds per vehicle)
  - Average travel speed (miles per hour)
- Arterials and intersections:
  - Average movement control delay (seconds per vehicle)
  - Average intersection control delay (seconds per vehicle)
  - Intersection level of service (based on control delay)
  - Average queue length by movement (ft)
  - Maximum queue length by movement (ft)

Operational conditions of different facilities were categorized into four congestion levels by comparing the corresponding MOE values to the LOS thresholds established in the Highway Capacity Manual 2010 (HCM 2010). Namely, these MOEs are density for freeway segments and control delay for intersections. **Table 2–2** presents the MOE thresholds and color scheme for congestion levels.

Table 2–2: MOE Thresholds for Congestion Levels

Congestion Level	Equivalent LOS	Freeway		Intersection	
		Basic Segment	Weave, Merge, and Diverge	Signalized Control	Stop Control
		Density (pc/mi/ln)		Control delay (sec/veh)	
Light Traffic	A-C	<=26	<=28	<=35	<=25
Moderate Traffic	D	>26-35	>28-35	>35-55	>25-35
Heavily Congested Traffic	E	>35-45	>35-45	>55-80	>35-50
Severely Congested Traffic	F	>45	>45	>80	>50

2.3 Safety Analysis Methodology

The safety analysis was performed in accordance with the methods identified in FHWA's *Interstate System Access Informational Guide*. For the No-Build and Build conditions, a qualitative analysis of roadway safety was performed following the guidance of the Highway Safety Manual (HSM). A quantitative analysis of the Build Condition was performed using Crash Modification Factors (CMFs) from the HSM and those developed by VDOT as part of the Smart Scale process.

[12] VISSIM model reports link density in vehicles per mile per lane. Based on the heavy vehicle percentages, they were converted into passenger-cars per mile per lane (pc/mi/ln) using Passenger Car Equivalent values defined in HCM 2010.

CHAPTER 3: EXISTING CONDITIONS

3.1 Demographics

I-395 is one of the primary corridors connecting Washington, D.C. with activity centers in Arlington County, the City of Alexandria, and the Springfield-Lincolnia areas in Fairfax County. At the Springfield Interchange, I-395 connects with the I-495 Capital Beltway and I-95, which further connect with activity centers in the Washington, D.C. metropolitan area.

Local communities directly served by I-395 are listed in **Table 3–1**.

Table 3–1: Communities Directly Served by I-395

Community	Jurisdiction	Population (2010)[1]
Springfield	Fairfax County, VA	30,484
Lincolnia	Fairfax County, VA	22,855
Alexandria	City of Alexandria, VA	139,966
Arlington	Arlington County, VA	207,627

[1] Data source: 2010 U.S. Census data.

According to the 2010 U.S. Census, the population density within the I-395 corridor between the Seminary Road interchange and the Springfield Interchange ranges from 15,000 to 25,000 persons per square mile.

3.2 Land Use

The I-395 corridor between Seminary Road and the Springfield Interchange has a mix of residential, commercial, and industrial land uses. Areas adjacent to the highway are predominantly residential, with commercial land uses generally located around arterial routes running parallel and perpendicular to I-395. Industrial land use is located closer to the Springfield Interchange. Activity centers along the corridor include Beauregard and Landmark/ Van Dorn, which are located adjacent to the Duke Street interchange.

Chapter 10 presents more detailed information on the existing and future land uses.

3.3 Roadway Geometry

The existing layout of roadway geometry within the project limits is presented in **Figure 3–1**.

3.3.1 Interstate 395, Henry G. Shirley Memorial Highway

I-395 is a 13.39-mile-long spur route of I-95 that begins at the Springfield Interchange with I-495/I-95 in Springfield, Virginia, and ends at the interchange with U.S. Route 50 New York Avenue in northwest Washington, D.C. The project limits for the I-395 Southbound Additional Through Lane extend 2.2 miles along southbound I-395, from 0.16 miles south of the Edsall Road interchange

Figure 3–1: Existing Roadway Configuration

to 0.3 miles north of the Duke Street interchange. The study area for traffic operations and safety extends to the first adjacent interchange on either side of the project limits and includes a 5.7-mile segment of I-395.

3.3.1.1 I-395 GP Lanes

I-395 is an Urban Principal Arterial Freeway with a posted speed limit of 55 miles per hour (mph). The majority of the southbound facility has four through travel lanes measuring 11 to 12 ft wide, excluding the auxiliary lanes serving entrance and exit ramps. The southbound roadway segment between the Duke Street interchange and the Edsall Road interchange has only three through travel lanes. This condition represents a capacity constraint along I-395, resulting in recurring daily congestion during PM peak travel periods. Southbound I-395 provides a right shoulder varying between 9.0 to 11.5 ft wide and a left shoulder varying between 2.1 to 6.0 ft wide.

The existing southbound roadway provides substandard cross slope and/or superelevation rates at several locations. The left two travel lanes have a typical cross slope of 1% throughout the project limits. North of the Duke Street interchange, the superelevation of the left most (inside) travel lane has a reverse slope of 1.0%-1.5%.

Existing interchanges that provide access to the I-395 GP lanes within the study area include the following:

- Springfield Interchange, I-495 and I-95
- VA Route 648 Edsall Road
- Turkeycock Run access ramps between I-395 HOV and HOT lanes
- VA Route 236 Duke Street/Little River Turnpike
- VA Route 420 Seminary Road

3.3.1.2 I-395 HOV Lanes

I-395 contains a barrier-separated, reversible, two-lane HOV facility situated between the northbound and southbound GP lanes. The posted speed limit is 65 mph. During peak periods, the HOV facility operates in the direction of peak traffic and is restricted to HOV-3. On weekdays, the HOV-3 restriction is in effect northbound (inbound to Washington, D.C.) from 6 AM to 9 AM and southbound (outbound from Washington D.C.) from 3:30 PM to 6 PM.

Within the study area, existing ingress and egress points for the HOV lanes include the following:

- Northbound ingress
    - Turkeycock Run underpass ramp, south of Duke Street
    - Seminary Road
    - I-495 inner loop and outer loop
- Northbound egress (none)
- Southbound ingress
    - Turkeycock Run slip ramp, south of Duke Street
- Southbound egress
    - Turkeycock Run flyover ramp, south of Duke Street

- Seminary Road
- I-495 inner loop and outer loop

3.3.2 Virginia State Route 236 Duke Street/Little River Turnpike

Virginia State Route 236 Duke Street/Little River Turnpike is an Urban Principal Arterial that runs in the east-west direction connecting the independent cities of Fairfax and Alexandria via Annandale in Fairfax County. West of I-395, Route 236 is known as Little River Turnpike in Fairfax County. East of I-395, Route 236 is known as Duke Street, which runs through the City of Alexandria and terminates in Old Town Alexandria. Within the study area, Little River Turnpike is posted at 40 mph and Duke Street is posted at 35 mph. Route 236 is identified on the current FHWA website[13] as a MAP-21 Principal Arterial on the National Highway System (NHS). Each directional roadway provides two 12 ft travel lanes, a 1 ft offset to median curbing, and a paved right shoulder measuring 8.0 to 9.0 ft. The current layout of the Duke Street interchange is a partial cloverleaf with an eastbound-to-northbound semi-direct connection.

3.3.3 Virginia State Route 648 Edsall Road

Virginia State Route 648 Edsall Road is an Urban Minor Arterial that runs in the east-west direction between Backlick Road in Fairfax County and South Pickett Street in the City of Alexandria. Within the study area, Edsall Road is a four-lane divided highway with a posted speed limit of 35 mph. Each directional roadway provides two 12 ft travel lanes, a 1 ft offset to median curbing, and a paved right shoulder measuring 7.9 to 8.7 ft. The current layout of the Edsall Road interchange is a partial cloverleaf with an eastbound-to-northbound semi-direct connection.

3.4 Alternative Travel Modes

A variety of bus transit services operate along the I-395 corridor during the AM and PM peak periods. The reversible HOV facility has a high level of bus transit service. Within the study area, transit routes serve the Mark Center, Landmark Mall and Landmark Plaza. **Table 3-2** lists the various bus routes that operate in the project area. Besides transit, multiple private rideshare programs, carpool and vanpool services operate on the HOV lanes in the study area. The I-395/Seminary Road HOV Reversible Ramp project is expected to improve transit serving the Mark Center. The I-95 Express Lanes project is also expected to improve transit in the I-95/I-395 corridor south of the Springfield Interchange.

[13] *National Highway System Map*, FHWA, http://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/virginia/washington_dc.pdf, Accessed on November 5, 2014.

Table 3–2: Transit Service in the Project Area

Agency	Route Number(s)	Route Name	Major Stop(s)	Schedule
Alexandria Transit Company DASH	AT 1	Seminary Plaza to Van Dorn/ Eisenhower Avenue Metro	Mark Center, Landmark Mall	Weekday AM and PM
	AT 2	Lincolnia to Braddock Metro	Mark Center	Weekday AM and PM
	AT 5	Braddock Metro to Van Dorn/ Eisenhower Avenue Metro	Landmark Mall	Weekday AM and PM
Fairfax County Connector	306	GMU – Pentagon Line	Oasis Drive	Weekday AM and PM
	321	Springfield Clockwise		Weekday AM and PM
	322	Springfield Counterclockwise		Weekday AM and PM
Washington Metropolitan Area Transit Authority (WMATA)	7H, X	Lincolnia – Park Center – Pentagon Line	Landmark Plaza	Weekday AM and PM
	7M	Mark Center-Pentagon Line	Mark Center	Weekday AM and PM
	8W, Z	Foxchase – Seminary Valley Line	Mark Center	Weekday AM and PM
	17A, B, M	Kings Park Line	Landmark Plaza	Weekday AM and PM
	18E, F	Springfield Line		Weekday AM and PM
	21A, D	Landmark – Pentagon Line	Van Dorn Street	Weekday AM and PM
	25B	Landmark – Ballston Line	Mark Center, Landmark Mall	Weekday PM
	28A, X	Leesburg Pike Line	Mark Center	Weekday AM and PM
	29C, E, G, H	Annandale Line	Landmark Plaza	Weekday AM and PM
	29K, N	Alexandria – Fairfax Line	Landmark Mall	Weekday AM and PM

3.5 Environmental Conditions and Constraints

In consultation with FHWA, VDOT has determined that a Categorical Exclusion (CE) is the appropriate level of environmental documentation for this project to satisfy the requirements of the National Environmental Policy Act (NEPA). The project is currently undergoing environmental evaluation. The Draft CE is currently being prepared and is expected to be submitted to FHWA in mid-2016.

3.6 Existing Operational and Safety Conditions

Existing traffic volumes, traffic operational analysis and safety conditions are presented in **Chapter, 7**, **Chapter 8** and **Chapter 9**, respectively.

CHAPTER 4: ALTERNATIVES CONSIDERED

The proposed improvements to southbound I-395 and interchange modifications at Duke Street and Edsall Road interchanges represent the refined design concept following an iterative process of concept development and refinement. This chapter provides an overview of alternatives development, screening and evaluation process.

4.1 Previous Studies

In 2012, VDOT completed a study to evaluate improvements to southbound I 395 along with the Edsall Road and Duke Street interchanges. This study considered six concepts and identified a preferred concept that included modifications to the southbound I-395 GP mainline and both interchanges. The study technical memorandum[14] document is included as part of this IMR in **Appendix A**.

4.2 No-Build Alternative

The No-Build Alternative contains no improvements resulting from the project action. It provides a baseline comparison for various draft build alternatives. **Figure 4–1** illustrates the conceptual layout of the No-Build Alternative. The No-Build Alternative retains the existing configuration of roadways within the study limits, but reflects geometric and operational changes associated with other projects included in MWCOG's 2013 CLRP. These projects are described below.

4.2.1 I-395/Seminary Road HOV Ramp Improvements

This project added a reversible HOV/transit ramp to provide direct access between Seminary Road and I-395 south of the interchange. The ramp was open to traffic in January 2016..

4.2.2 Northbound I-395 Auxiliary Lane from Duke Street to Seminary Road

VDOT constructed a new 0.8-mile auxiliary lane on northbound I-395 connecting the northbound on-ramp at Duke Street to the northbound off-ramp at Seminary Road. The auxiliary lane was open to traffic in February 2015.

4.2.3 I-95 Express Lanes

This project added a third lane to the existing reversible I-95 HOV facility and create 29 miles of reversible HOT facility (Express Lanes) between Edsall Road in Fairfax County and Garrisonville.

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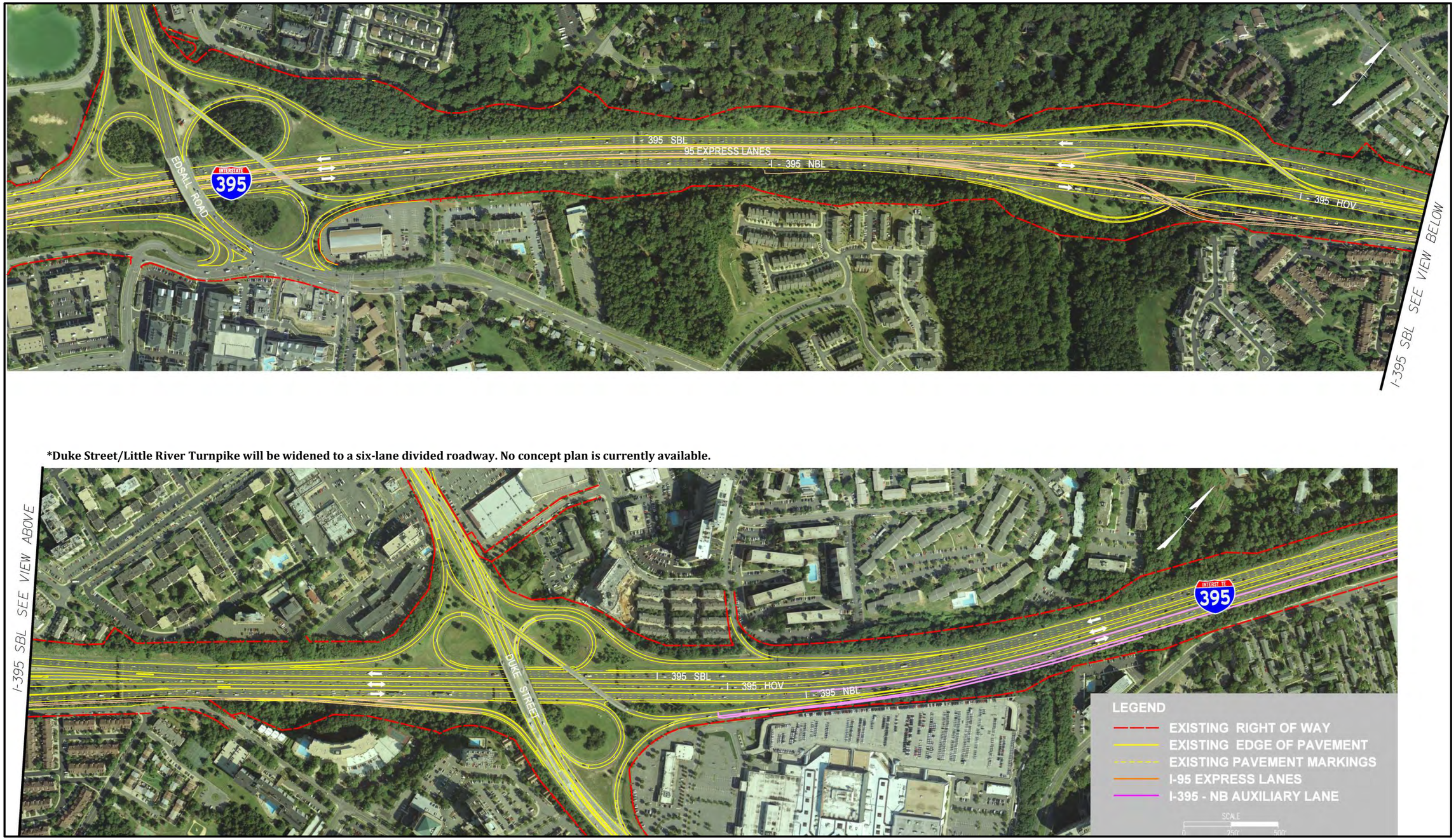
[14] *I-395 Southbound between Duke Street & Edsall Road Congestion Relief Feasibility Study: Operational & Geometrical Analysis Technical Memorandum*, VDOT, July 17, 2012.



*Duke Street/Little River Turnpike will be widened to a six-lane divided roadway. No concept plan is currently available.

Figure 4–1: Conceptual Layout of No-Build Alternative

Road in Stafford County. Within the study area, a third lane was added to the existing reversible facility south of the Turkeycock Run area. At the northern terminus, a new flyover ramp was constructed south of Duke Street for the northbound Express Lanes traffic exiting to northbound I-395 GP lanes. This project was opened to traffic in December 2014.

4.2.4 Duke Street Pedestrian Improvements

The City of Alexandria is advancing a project to enhance pedestrian mobility along Route 236 Duke Street. Improvements will include additional sidewalk and crosswalks to connect the existing bridge carrying Duke Street over I-395 and existing sidewalk north of the interchange. The project was constructed in 2015[15].

4.2.5 Duke Street/Little River Turnpike Widening

A future project will widen Duke Street/Little River Turnpike from a four-lane divided roadway to a six-lane divided roadway from Pickett Road to I-395. The estimated completion date of this project in the 2013 CLRP is 2025.

4.3 Transportation System Management Options

TSM strategies focus on improving the operational efficiency of transportation systems without major system improvements such as adding lanes or new ramps. Freeway TSM strategies can include signing and pavement striping improvements, traffic surveillance and control equipment, incident management programs, HOV facilities, and ramp metering. Corridor- and system-wide TSM strategies may incorporate improvements to mass transit service, multimodal facilities, and intelligent transportation systems (ITS).

Currently, VDOT operates fixed-time ramp meters on most ramps along I-395 in Northern Virginia. Specifically, during the PM peak period, all traffic flow entering southbound I-395 is metered to reduce congestion on freeway mainline segments. In addition, I-395 contains a reversible, barrier-separated, two-lane HOV facility in the median. During the PM peak period, the HOV facility operates in the southbound direction and is restricted to vehicles containing three or more passengers (HOV-3). Construction of the I-95 Express Lanes project is currently underway to convert this facility to a three-lane HOT facility south of the Turkeycock Run access ramps, and is expected to open in December 2014.

Even though these strategies are helpful to overall traffic operations on I-395, they will not address the capacity constraint and safety issues associated with the lane drop on the southbound mainline. Therefore, TSM options alone will not satisfy the purpose and need of this project.

4.4 Build Alternatives

The development of build alternatives started with refining the preliminary design concept recommended in VDOT's 2012 feasibility study. Reasonable design refinements that satisfied the

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[15] *Duke Street Pedestrian Improvements Website*, City of Alexandria, http://alexandriava.gov/localmotion/info/default.aspx?id=75118, Accessed on November 4, 2014.

project's purpose and need were considered. Through discussions with project stakeholders, VDOT initially identified a preliminary set of three refinements at the Edsall Road interchange and four refinements at the Duke Street interchange for detailed analysis and evaluation.

These seven design refinements were presented to, reviewed by, and discussed with the project stakeholders in various meetings held between January 2014 and August 2014. Each interchange improvement concept was evaluated for compliance with design guidelines, construction costs, right-of-way impacts, and traffic operations. Some refinements were dropped from consideration, some refinements were investigated further in their original form, and other refinements were revised and refined. **Appendix F** contains a technical memorandum detailing the evaluation of these design refinements and conceptual layouts.

Various concept alternatives were derived and analyzed in 2014 based on combinations of different refined design concepts at the Duke Street and Edsall Road interchanges. These initial concept alternatives were eventually screened down to three viable draft alternatives, Alternatives A, B and C. VDOT used the following technical criteria to further evaluate these draft alternatives for engineering, operational, and environmental considerations:

- I-395 freeway improvements
  - Provide an additional through lane on southbound I-395
  - Eliminate short weave segment at Duke Street interchange
  - Eliminate short weave segment at Edsall Road interchange
- Traffic operations and accessibility
  - Overall traffic operational efficiencies
  - Traffic queues at the bottleneck location and upstream segments
  - Traffic operations at weave sections at both interchanges
  - Direct access to Express Lanes from Duke Street interchange
- Compliance with AASHTO and VDOT design criteria
- Construction costs
- Right-of-way impacts
- Overall environmental impacts
- Utility impacts

Through this process, VDOT and FHWA reached a consensus that Alternative B best addressed the purpose and need of the project. In November 2014, VDOT presented Alternative B to Fairfax County and the City of Alexandria and obtained the support of both local jurisdictions. However, in 2016, when VDOT combined this project with the I-395 Express Lanes Northern Extension project, it sought to reduce costs for the improvements to better align the anticipated costs with the available funding. As a result, VDOT, in coordination with all the stakeholders, further refined Alternative B to develop Alternative D referred to as 'Preferred Alternative' in the IMR. Alternatives A – D are described in **Table 4–1. Table 4–2** presents a comparison of these build alternatives.

Figure 4–2 through **Figure 4–4** present the conceptual layout of the Preferred Alternative.

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Table 4–1: Description of Draft Alternatives

	Draft Alternative A	Draft Alternative B	Draft Alternative C	Draft Alternative D (Preferred)
Improvements to I-395 /Duke Street Interchange	• Replace the southbound-to-eastbound loop ramp with a spur off the southbound-to-westbound ramp and new signalized intersection at Little River Turnpike. • Widen the existing southbound off-ramp to provide a two-lane exit ramp. • Merge the westbound-to-southbound ramp and the eastbound-to-southbound ramp together, which then remain barrier-separated from the southbound I-395. • The combined east/westbound to southbound ramp remains barrier-separated until it joins the Turkeycock Run HOV exit ramp, accessing mainline I-395 north of the Edsall Road interchange.	• Replace the southbound-to-eastbound loop ramp with a spur off the southbound-to-westbound ramp and new signalized intersection at Little River Turnpike. • Widen the existing southbound off-ramp to provide a two-lane exit ramp. • Merge the westbound-to-southbound ramp with the southbound I-395 mainline just south of the Duke Street Interchange. • The eastbound to southbound ramp remains barrier-separated from both the I-395 mainline and the westbound to southbound ramp until it joins the Turkeycock Run HOV exit ramp, and accesses mainline I-395 north of the Edsall Road interchange.	• Replace the southbound-to-eastbound loop ramp with a spur off the southbound-to-westbound ramp and new signalized intersection at Little River Turnpike. • Widen the existing southbound off-ramp to provide a two-lane exit ramp. • Merge the westbound-to-southbound ramp with the southbound I-395 mainline just south of the Duke Street Interchange. • The eastbound to southbound ramp remains barrier-separated from both the I-395 mainline and the westbound to southbound ramp until it joins the Turkeycock Run HOV exit ramp, and accesses mainline I-395 north of the Edsall Road interchange.	• Replace the southbound-to-eastbound loop ramp with a spur off the southbound-to-westbound ramp and new signalized intersection on Little River Turnpike. • Merge the westbound-to-southbound loop ramp with the southbound I-395 mainline just north of the Duke Street Interchange. • The eastbound to southbound ramp is barrier-separated from both the I-395 mainline and the westbound to southbound ramp until it joins the Turkeycock Run HOV exit ramp, and joins mainline I-395 north of the Edsall Road interchange.
Improvements to I-395 /Edsall Road Interchange	• Replace the westbound-to-southbound loop ramp and the eastbound-to-southbound ramp with a new combined ramp and a signalized intersection at Edsall Road. • An exclusive right turn lane will provide access to the southbound I-395 entrance ramp from eastbound Edsall Road. An exclusive left turn lane constructed in the median of Edsall Road will provide access to southbound I-395 from westbound Edsall Road. • Combine the two exit ramps for eastbound and southbound Edsall Road into a single two-lane exit ramp.	• Replace the westbound-to-southbound loop ramp and the eastbound-to-southbound ramp with a new combined ramp and a signalized intersection at Edsall Road. • An exclusive right turn lane will provide access to the southbound I-395 entrance ramp from eastbound Edsall Road. An exclusive left turn lane constructed in the median of Edsall Road will provide access to southbound I-395 from westbound Edsall Road. • Combine the two exit ramps for eastbound and southbound Edsall Road into a single two-lane exit ramp.	• Replace the westbound-to-southbound loop ramp with a signalized left turn movement from westbound Edsall Road onto a new ramp oriented to southbound I-395. • The new westbound to southbound entrance ramp will merge into the existing eastbound-to-southbound entrance ramp, which will undergo a minor alignment shift before merging with southbound I-395. • Combine the two exit ramps for eastbound and southbound Edsall Road into a single two-lane exit ramp.	• Replace the westbound-to-southbound loop ramp with a signalized left turn movement from westbound Edsall Road onto the eastbound-to-southbound ramp to I-395. • The new westbound to southbound entrance ramp will merge into the existing eastbound-to-southbound entrance ramp, which will undergo a minor alignment shift before merging with southbound I-395. • The auxiliary lane from the entrance ramp at Turkeycock Run will continue beyond the exit for westbound Edsall Road up to the loop exit for eastbound Edsall Road.

Table 4–2: Evaluation Matrix for Build Alternatives

Criteria		No-Build	Build Alternative A	Build Alternative B	Build Alternative C	Build Alternative D [PREFERRED]
Freeway Improvements	Provide an additional through lane on southbound I-395	■ No	● Yes	● Yes	● Yes	● Yes
	Eliminate short weave segment at Duke Street interchange	■ No	● Yes	● Yes	● Yes	● Yes
	Eliminate short weave segment at Edsall Road interchange	■ No	● Yes	● Yes	● Yes	● Yes
Traffic Operations & Accessibility	Overall traffic operational efficiency	■	●	●	●	●
	Traffic queues at the bottleneck location and upstream segments	■	●	●	●	●
	Traffic operations at weave sections at both interchange	■	●	●	●	●
	Direct access to Express Lanes from Duke Street interchange	● Full	○ None	◉ Partial	◉ Partial	◉ Partial
Compliance with Design Criteria		▢	○	○	○	○
Construction Costs[1]		●	◉ $53.3M	◉ $53.3M	○ $56.0M	◉ $50.0M
Right-of-Way Impacts		●	◉ 0.4 Acres	◉ 0.4 Acres	◉ 0.5 Acres	◉ 0.4 Acres
Limited Access Line Impacts		●	◉ 2 locations	◉ 3 locations	◉ 3 locations	◉ 2 locations
Environmental Impacts		◉	0.4 Acres	0.4 Acres	0.5 Acres	0.4 Acres
Utility Impacts		◉	◉	◉	◉	◉
Supporting Purpose and Needs		■	◉	●	◉	●

[1] Includes a 35% contingency. Does not include utility relocations and adjustments, right-of-way costs, or environmental mitigation measures (if needed), preliminary engineering costs, or construction engineering/inspection costs.

Legend:

Comparative Ratings				
Excellent	Favorable	Fair	Unfavorable	Poor
●	◉	○	▢	■

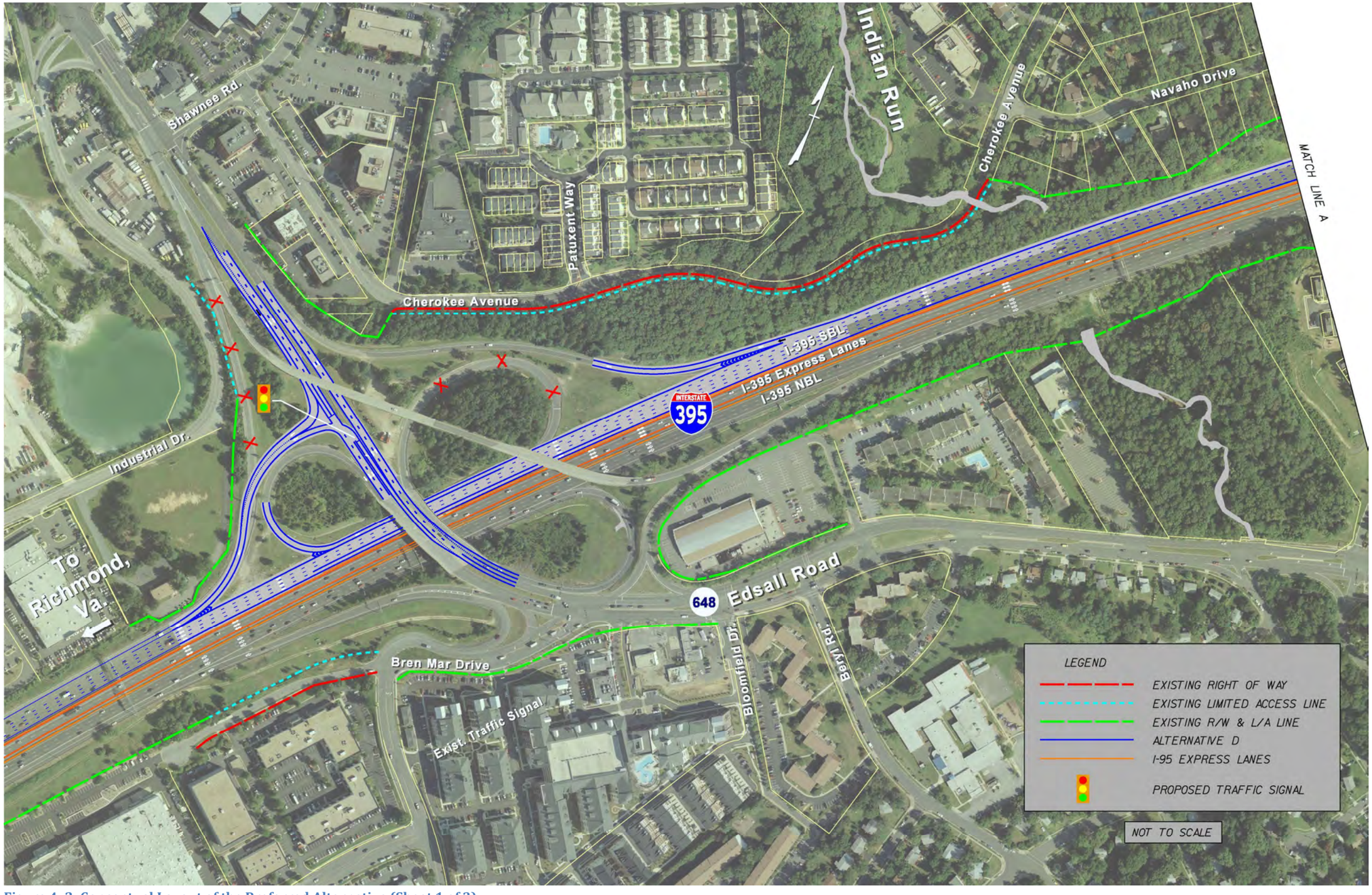

Figure 4–2: Conceptual Layout of the Preferred Alternative (Sheet 1 of 3)

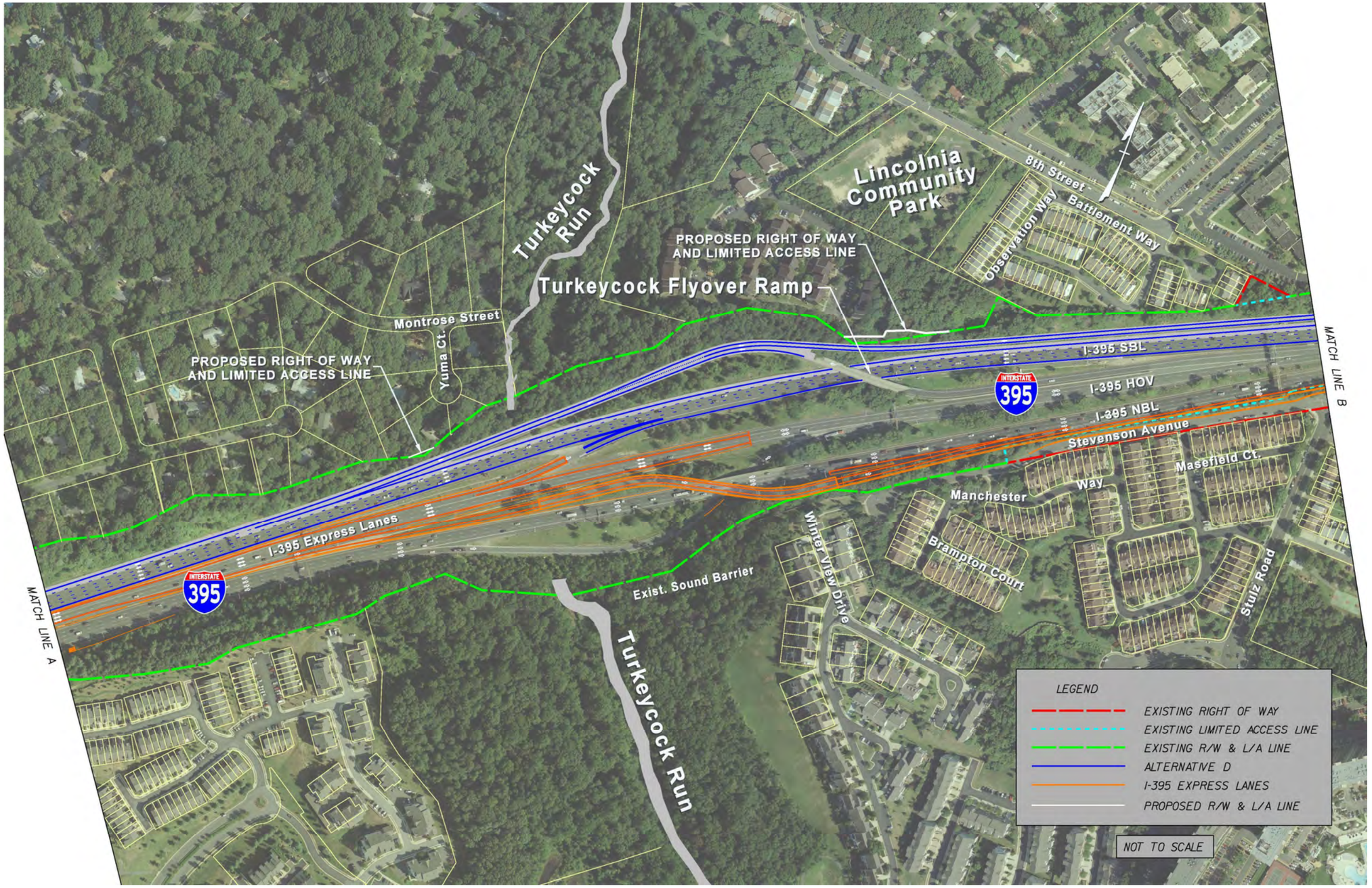

Figure 4–3: Conceptual Layout of the Preferred Alternative (Sheet 2 of 3)

Figure 4–4: Conceptual Layout of the Preferred Alternative (Sheet 3 of 3)

4.5 Access to Southbound I-95 Express Lanes from Eastbound Duke Street

The Preferred Alternative will retain current full directional access to and from I-395 GP lanes at the Duke Street and Edsall Road interchanges. However, the reconfiguration of the entrance ramps at the Duke Street interchange will partially modify the access to the southbound I-95 Express Lanes during the PM peak periods due to operational and safety concerns. Currently vehicles from eastbound Duke Street merge onto the southbound I-395 GP lanes and weave across three through travel lanes within about 2,430 ft to access the left slip ramp to enter the southbound I-395 Express Lanes at Turkeycock Run. Currently[16], 45 vehicles complete this maneuver during the PM peak hour.

The additional southbound through lane will result in higher throughput volumes during the PM peak hour. The eastbound Duke Street on-ramp traffic destined to the I-95 Express Lanes ramp will not only compete with higher mainline through volumes, but will also have to weave across one additional through lane. This will result in degraded traffic operations and safety conditions on this weave segment.

Under the Preferred Alternative, vehicles traveling eastbound on Duke Street destined for the southbound Express Lanes could execute a U-turn movement along Duke Street, utilize the westbound on-ramp to I-395, and weave across I-395 to access the left-side entrance to Express Lanes. The proposed location for this U-turn on Duke Street is between the directional ramp to I-395 GP northbound and the loop ramp from I-395 GP northbound as shown in **Figure 7–4.** It is anticipated that approximately 80% of existing Express Lane users at Duke Street will utilize the U-turn, while the rest will use the GP lanes. The expected PM Peak hour U-turn volumes[17] are 57 and 83 vehicles respectively in 2020 and 2040.

While the Preferred Alternative will shift approximately 20 percent (15 vehicles/hour and 21 vehicles/hour in 2020 and 2040 respectively) of Express Lanes users to GP lanes during the PM peak hour, it is proposed to reduce congestion and enhance safety for approximately 8,000 motorists on the southbound I-395 mainline during the PM peak hour.

Appendix F includes additional discussion on the options considered relative to access to southbound I-95 Express Lanes from eastbound Duke Street.

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[16] Based on 2016 Origin-Destination counts performed by VDOT.

[17]

Year	EB Duke Street to I-395 Express Lanes (vehicles per hour)	Potential U-turn volume [3] (vehicles per hour)
2016	45[1]	N/A
2020	72[2]	**57**
2040	104[2]	**83**

[1] VDOT Counts from October 2016
[2] Based on growth rates established in Chapter 6
[3] Using TransUrban's OD estimate, 33% of the traffic destined to Springfield area from Little River Turnpike is assumed to use I-395 GP lanes instead of the proposed U-turn

CHAPTER 5: ROADWAY GEOMETRY

5.1 Design Criteria

The design layouts were developed using criteria and guidance set forth in the following documents:

- *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011
- *A Policy on Design Standards – Interstate System*, *5th Edition*, AASHTO, 2005
- *Highway Safety Manual*, AASHTO, 2010
- *Road Design Manual, Volume 1*, VDOT, 2005, (Revised January 2017)
- *Structure and Bridge Manual, Volume V, Parts 2 and 3*, VDOT, 2011
- *Road and Bridge Standards*, VDOT, 2016
- *Applicable Instructional and Informational Memoranda*, VDOT, Location and Design Division
- *Guardrail Installation Training Manual*, VDOT, March 2012 (Revised February 2015)

Design criteria and guidance in these documents were applied to roadways within the project limits based on the functional classification and design speed of each roadway. **Table 5–1** summarizes select design criteria for each roadway within the project limits. Where these values cannot be achieved, Design Exceptions or Waivers will be pursued.

Table 5–1: Roadway Inventory and Major Design Criteria

Design Criteria	I-395	Route 648 Edsall Road	Route 236 Duke Street	Interchange Ramps
Functional Classification	Urban Principal Arterial - Freeway	Urban Minor Arterial	Urban Principal Arterial - Other	Interchange Ramp
VDOT Standard	GS-5	GS-6	GS-5	GS-R
Design Speed (mph)	60	35	35	25 (min.) [1]
Superelevation Standard	TC-5.11R	TC-5.11U	TC-5.11U	TC-5.11R
Vertical Clearance	16.5 ft.	16.5 ft.	16.5 ft.	16.5 ft.
Min. Lane Width	12 ft.	12 ft.	12 ft.	16 or 18 ft. [1]
Min. Left Shoulder Width	4 ft. [2]	1 ft. [3]	1 ft. [3]	2 ft. [4]
Min. Right Shoulder Width	10 ft. [2]	2 ft. [3]	2 ft. [3]	2 ft. [4]
Min. Profile Grade	0.5%	0.5%	0.5%	0.5%

[1] Width of a single ramp is dependent on design speed. Per VDOT GS-R standards, multilane ramps shall accommodate widths given in Table 3-29 in AASHTO's "A Policy on Geometric Design of Highways and Streets", 2011 Edition. Existing and proposed WB Duke Street to SB I-395 on ramp Design Speed is 20mph.
[2] No additional offset required at guardrail or barrier.
[3] Value represents offset to vertical curbing left, or width of gutter pan right.
[4] Ramp width must accommodate passing a stalled vehicle, pursuant to Table 3-29 of the AASHTO "Green Book".

5.2 Design Constraints

The physical attributes of the project area present specific constraints to the design of interchange improvements. The following narrative provides a brief, generalized summary of the constraints posed by various features within the project limits.

5.2.1 Right-of-Way

The existing right-of-way width along I-395 typically varies between 300 ft. to 430 ft. I-395 was originally constructed in the early 1960's, and numerous improvement projects have been undertaken since then. The resulting shape and configuration of the existing right-of-way varies within the study area.

While the existing right-of-way is sufficient to accommodate proposed improvements throughout most of the project limits, VDOT anticipates the need to acquire additional right-of-way for this project. The total land area to be acquired is less than one half acre. Impacted areas are identified in the layouts of the Preferred Alternative. The proposed right-of-way impacts, as shown in **Figure 4–3** and **Figure 4–4**, are subject to change as final design activities generate more refined information regarding roadway edge conditions, drainage requirements, embankment grading, and retaining wall limits. Future design activities will seek to reduce or eliminate right-of-way impacts in the interest of reducing overall project costs and impacts to the project schedule.

5.2.2 Existing Highway Infrastructure

In the context of current and projected funding limitations, VDOT wishes to avoid undertaking improvements that are not necessary to fulfill the project's purpose and need. Consequently, the proposed improvements avoid changes to or replacement of many of the existing highway features, including the following:

- Existing bridge carrying Edsall Road over I-395
- Existing bridge carrying the eastbound-to-northbound entrance ramp at the Edsall Road interchange over I-395
- Existing bridge at Turkeycock Run carrying the southbound HOV exit ramp over southbound I-395
- Existing bridge carrying Duke Street over I-395
- Existing bridge carrying the eastbound-to-northbound entrance ramp at the Duke Street interchange over I-395
- Specialized ITS equipment such as generator and propane tank installations
- Recently installed signs, sign support structures, concrete barrier, communications equipment, and other features associated with concessionaire-operated Express Lanes along I-395.

5.2.3 Design Vehicle

Roadway improvements accommodate a WB-67 interstate semitrailer as the design vehicle. Use of this design vehicle generally requires wide pavement areas at intersections to accommodate turning movements. Information regarding the heavy vehicle percentage of overall traffic volumes under existing conditions is provided in **Chapter 6**.

5.3 Existing and Proposed Limited Access Lines

5.3.1 Existing Limited Access Lines

Current AASHTO guidance[18] at interchanges recommends that limited access (L/A) lines extend the full length of the ramp and extend a minimum of 100 ft. beyond the ramp terminal in an urban condition. Existing L/A lines are shown in **Figure 4–2** through **Figure 4–4** and were evaluated to determine compliance with this guidance. **Table 5–2** presents the summarized findings.

Table 5–2: L/A Line Evaluation for Existing Ramps

Location		L/A line extends along full length of ramp?	L/A line extends 100 ft. beyond ramp terminal?
Along Duke Street	Westbound West of I-395	No[1]	No[1]
	Westbound East of I-395	No[2]	No[2]
	Eastbound West of I-395	Yes	Yes
	Eastbound East of I-395	Yes	Yes
Along Edsall Road	Westbound West of I-395	Yes	Yes
	Westbound East of I-395	Yes	Yes
	Eastbound West of I-395	Yes	Yes
	Eastbound East of I-395	No[3]	No

[1] The exit ramp forms an auxiliary lane for right turns onto Beauregard Street. Access points are provided within areas of limited access at Quantrell Avenue.
[2] Entrance ramp begins as turn lane from the Landmark Mall. L/A line stops 600 ft. short of this point.
[3] The exit ramp forms an auxiliary lane for right turns onto Bren Mar Drive, Sullivan Place, and Bloomfield Drive.

In each of the deficient cases above, the existing driveway located within areas of limited access have been in place and operational for several years. and correcting the deficiencies noted above is beyond the scope of the I-395 Southbound Additional Through Lane project.

5.3.2 Proposed Limited Access Line

The project will modify existing L/A lines at two locations where the Turkeycock HOV Ramp merges with southbound I-395 and where Duke Ramp A starts to meet the Turkeycock Flyover Ramp (See Figure 4-3). These changes will maintain a constant L/A line along I-395 in conjunction with new right-of-way. In all cases, proposed changes to the L/A lines are considered conceptual and are subject to public review and input. Public involvement activities will allow for public review of the proposed improvements as part of the final design of the project.

[18] A Policy on Design Standards – Interstate System, 5th Edition, AASHTO, 2005

5.4 Geometric Configuration

The geometric layout of the Preferred Alternative is illustrated in **Figure 4–2** through **Figure 4–4**. Under the Preferred Alternative, both the Edsall Road and Duke Street interchanges will be partially reconfigured to eliminate the short weaving sections between the existing cloverleaf loop ramps and to accommodate the additional mainline southbound through lane.

5.4.1 Interchange Ramps

5.4.1.1 I-395/Edsall Road Interchange

As shown in **Figure 5–1**, the Preferred Alternative replaces both the existing westbound-to-southbound loop ramp and the eastbound-to-southbound ramp with a new ramp (Ramp A) and signalized intersection at Edsall Road. Access to the southbound I-395 entrance ramp from eastbound Edsall Road will be provided by an exclusive right turn lane. Access to southbound I-395 from westbound Edsall Road will be provided from an exclusive left turn lane constructed in the Edsall Road median. The turn lane will provide a storage length of 770 ft.

Figure 5–1: Proposed I-395/Route 648 Edsall Road Interchange

Under existing conditions, the interchange provides two separate southbound exit ramps oriented to eastbound and westbound Edsall Road. The Preferred Alternative will provide a 4th I-395 southbound lane and a separate 1,300 foot long deceleration lane for the eastbound Edsall Road exit

ramp. For the westbound Edsall Road exit ramp a taper departure is proposed from the exit only lane prior to the eastbound Edsall Road exit.

5.4.1.2 I-395/ Duke Street Interchange

As shown in **Figure 5–2,** the westbound Duke Street to southbound I-395 loop ramp (Ramp E) is modified to merge with the southbound I-395 mainline south of Duke Street. A 1,250 foot acceleration lane is provided for merging traffic. There will be four mainline through lanes. The eastbound-to-southbound entrance ramp (Ramp A) remains barrier-separated from the I-395 mainline to Turkeycock Run HOV exit ramp, and merges with southbound I-395 north of the Edsall Road. interchange.

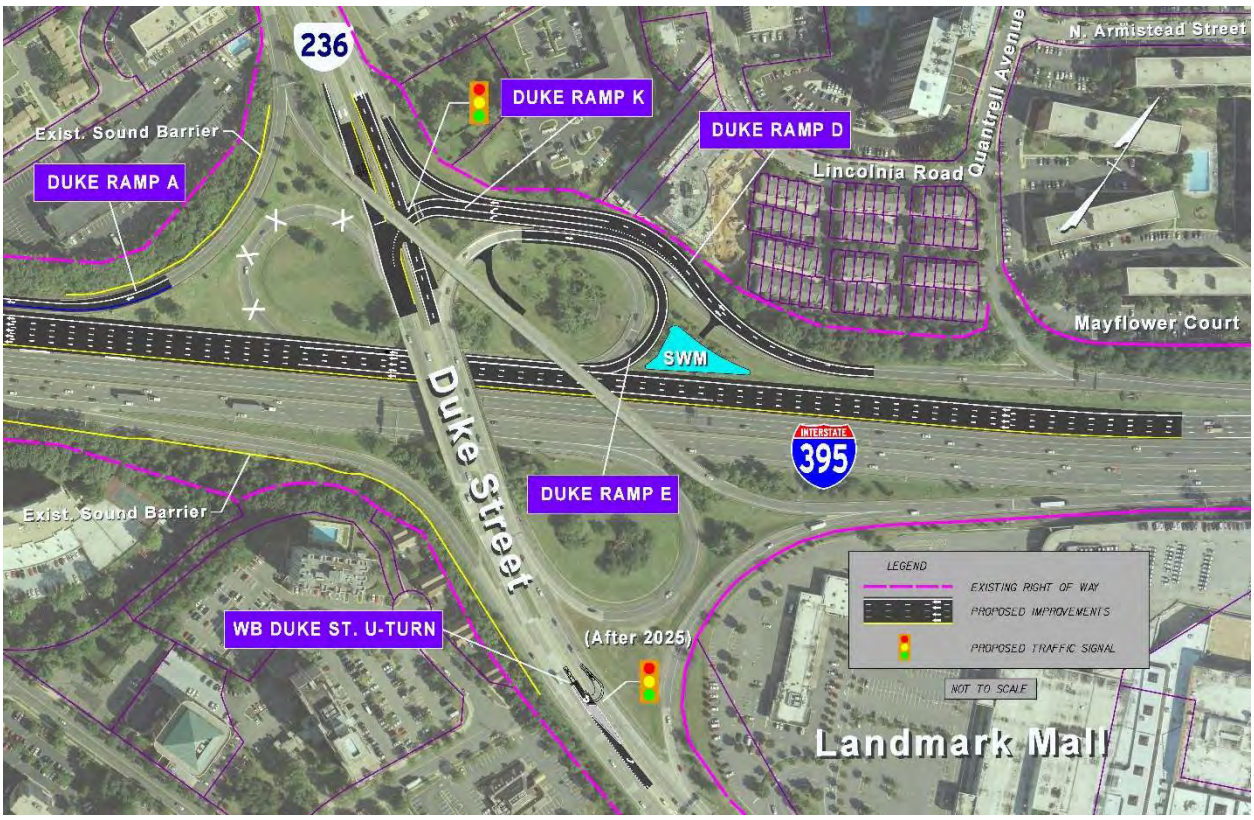

Figure 5–2: Proposed I-395/Route 236 Duke Street Interchange

The Preferred Alternative replaces the existing I-395 southbound to Duke Street eastbound loop ramp with a new signalized intersection at Little River Turnpike from a new spur (Ramp K) off the I-395 southbound-to-westbound exit ramp (Ramp D). The existing southbound-to-westbound exit ramp now proposes a widened ramp with a dual left turn lane for eastbound Edsall Road and a reconfigured one lane ramp for westbound Edsall Road.

5.4.2 Intersection Sight Lines

Proposed intersections at both the Route 648 and Route 236 interchanges will provide sight lines that comply with 2011 AASHTO Green Book and 2005 VDOT's Road Design Manual.

5.5 Design Exceptions

Multiple typical section distributions of Southbound I-395 at the Duke and Edsall Road interchanges were analyzed for safety considerations in coordination with VDOT and FHWA. **Table 5–3** shows these options and the finalized proposed sections. The Design Exceptions discussed in this subchapter as well as the Design Waivers in the following subchapter are based on these finalized typical sections.

Table 5–3: Lane and Shoulder Width Layout Alternatives

Edsall Road Options	Lane and Shoulder Widths in Feet (LTshldr+Ln+Ln+Ln+Ln+DecelLn+RTshldr)	Conclusion
1	2+12+12+12+12+12+4	
2	3+11+12+12+12+12+4	Final
3	4+12+11.5+11.5+11.5+11.5+4	
4	4+12+12+12+11+11+4	
Duke Street Options	**Lane and Shoulder Widths in Feet LTshldr+Ln+Ln+Ln+Ln+Buffer+AccelLn+RTshldr)**	**Conclusion**
1	4+12+12+12+12+12+4	
2	4+11.5+11.5+11.5+12+2+11.5+4	
3	4+11+12+12+12+2+11+4	Final
4	4+11+11+12+12+2+12+4	

The FHWA document *Mitigation Strategies for Design Exceptions* (FHWA, July 2007) states that:

> *Thirteen criteria, commonly referred to as the 13 controlling criteria, have been identified by FHWA as having substantial importance to the operational and safety performance of any highway such that special attention should be paid to them in design decisions. FHWA requires a formal written design exception if design criteria on the NHS are not met for any of these 13 criteria.*

The Preferred Alternative proposes several conditions that do not meet minimum guidelines established within the AASTHO Green Book and fall within the 13 controlling criteria. They are summarized in **Table 5–4**.

The need for design exceptions generally stems from substandard existing conditions that cannot be corrected within the stated purpose and need of the project. Each exception has been evaluated to determine the feasibility of correction and the possible mitigation strategies for the substandard condition.

Table 5–4: Design Exceptions in the Preferred Alternative

DE No.	Design Exception	Design Guidance	Required Value	Value Provided
DE-01	Left Shoulder Width, SB I-395(Turkeycock)	VDOT RDM Std. GS-5, Freeways	14.0 ft	2.4-4 ft
DE-02	Right Shoulder Width, SB I-395 (Turkeycock)	VDOT RDM Std. GS-5, Freeways	14.0 ft	2-10 ft
DE-12	Mainline SB I-395 In-Fill Pier Protection (Turkeycock)	AASHTO LRFD 3.6.5.1	BPPS	In-Fill Pier Protection
DE-13	Mainline SB I-395 In-Fill Pier Protection (Edsall and Duke)	AASHTO LRFD 3.6.5.1	BPPS	In-Fill Pier Protection
DE-14	Left Shoulder and left-most lane Width, SB I-395	VDOT RDM Std. GS-5, Freeways AASHTO Green Book, p. 8-3	4.0 ft. 12 ft.	3 ft. 11 ft.

5.5.1 Left Lane and Shoulder Width, Southbound I-395

Within the project limits, the existing left shoulder along I-395 ranges in width from 4.0 to 7.5 ft. AASHTO guidance specifies a 4 ft. minimum shoulder width. As the proposed improvements widen southbound I-395 to the outside, this allows the existing left shoulder to remain except for locations in the vicinity of the Edsall Road and Duke Street. Due to the limited distance between the existing bridge piers (66 ft. between Edsall Road bridge piers), the shoulder widths under the existing bridges will be reduced. To accommodate this restricted width and provide four thru lanes a minimum 3 foot left shoulder is provided under the Edsall Road and Edsall Road flyover bridges. One 11 ft. through lane will be provided to maximize the shoulder width and lane configuration under the Edsall Road and Duke Street overpasses.

Providing a full 4 foot wide left shoulder along southbound I-395 under the Edsall Road bridges is not feasible without impacting the existing bridge piers. Alternatively, the full left shoulder could be provided by widening the travelway to the outside and shifting the GP travel lanes to the right. This design solution is also considered cost-prohibitive because it would negatively impact adjacent developed properties and would require more extensive ramp reconstruction and replacement of all bridges over I-395 within the project limits.

5.5.2 In-Fill Pier Protection, Southbound I-395

Volume V, Part 2 of VDOT's Manual of the Structure and Bridge Division requires bridge piers located within 30 feet of the edge of travel lanes and not designed for collision forces to be protected with an approved pier protection barrier. Volume V, Part 3 of the referenced manual provides details BPPS-1 to BPPS-3 as the only pre-approved bridge pier protection system. The standard details require a minimum two feet of space adjacent to the pier column(s) for installation. With the site constraints noted above, the standard 2 feet wide barrier would reduce the shoulders to approximately 2 feet in width.

To maximize the available shoulder width adjacent to the bridge piers of the Duke Street and Edsall Road bridges and ramps over Southbound I-395, nonstandard pier protection barriers are proposed.

The face of the proposed in-fill wall would be vertical and flush with the existing columns. Thus, allowing for four thru lanes within the limited existing 66 ft. between Edsall Road Bridge piers and 68 ft. between Duke Street Bridge piers.

5.6 Design Waivers

Pursuant to VDOT policy, Design Waivers are required when design values meet or exceed AASHTO minimum design guidelines but fall short of VDOT's minimum design guidelines. VDOT considers an Access Management Waiver as a Design Waiver. **Table 5–5** on the following page identifies design elements associated with the Preferred Alternative that will require a Design Waiver.

Table 5–5: Design Waivers in the Preferred Alternative

DW No.	Design Waiver	VDOT Design Guidance	Required Value	Value Provided
DW-01	Gore Geometry, SB I-395 Exit Ramp to HOT Lanes	RDM Appendix C, Section C-8	Varies	Varies
DW-02	SE Transition Length, SB I-395 Exit Ramp to EB Edsall Rd. (Curve ED-B2)	Std. TC-5.11	173 ft	59.95 ft
DW-03	SE Transition Length, SB I-395 Entrance Ramp from Edsall Rd EB (Curve ED-A2)	Std. TC-5.11	196 ft	79.88 ft
DW-04	Access Management - spacing of access points along Duke Street	RDM Appendix F	Varies	Varies
DW-05	Access Management - spacing of access points along Edsall Road	RDM Appendix F	Varies	Varies
DW-18	Lane Width, SB I-395 Entrance Ramp from Duke Street (Ramp A)	RDM Appendix A, GS-R Std.	16 ft.	12 ft.
DW-19	Auxiliary Lanes Shoulder Width, SB I-395 Exit Ramp to EB Edsall Road and Entrance Ramp from WB Duke Street	RDM Appendix A, GS-R Std.	6 ft.	4 ft.
DW-21	Westbound Edsall Road Sidewalk Buffer Strip Width	RDM Appendix A, p. A-126	4 ft.	0 ft.
--	Pier Protection Barrier Route 267 Duke Street	S&BM Std. BPPB-1	Req'd. at 4 locations	Not provided
--	Pier Protection Barrier Route 648 Edsall Road	S&BM Std. BPPB-1	Req'd. at 4 locations	Provided at 3 locations

5.6.1 Gore Geometry, Cross Slope Rollover, Superelevation, Exit Ramp to Express Lanes

The geometry of the existing southbound I-395 slip ramp to HOV is substandard or exceeds VDOT maximum allowable criteria in several aspects. The proposed improvements will transition to match the existing geometry to avoid expanding the projects footprint and impacting the HOV/Express Lanes facility. Correcting the geometry of the slip ramp to the Express Lanes would require extensive

modification to the ramp itself, a portion of the tie in to the Express Lanes, and adjacent ITS elements such as barrier gates, control cabinets, and underground conduits.

5.6.2 Superelevation Transition Length, Edsall Road Ramps

In two cases, the existing site and adjacent geometry limit the space available for superelevation transitions. The curves that adjoin Edsall Road from both ramps A and D (as shown in **Figure 5–1**) will have nonstandard superelevation transition lengths and distributions to accommodate the tight geometry. Right-of-way acquisition and extensive interchange modifications would be required to eliminate the need for this exception.

5.6.3 Access Management, Duke Street and Edsall Road

Under existing conditions, intersections along Duke Street and Edsall Road fail to meet access management requirements set forth by VDOT relative to separation distances. These intersections serve public roadways and major commercial driveways that are well established and which have been in service for many years. Closure, relocation, or reconfiguration of these access points are not practical within the scope of the southbound I-395 improvement project, and are not proposed.

Under proposed conditions, this project will reconfigure existing ramps and will add two new signalized intersections, one along Duke Street and another along Edsall Road. Each of these new intersections will require an Access Management Waiver from VDOT due to proximity to adjacent public road intersections, ramp terminals, and/or commercial driveways.

5.6.4 Lane Width, Southbound I-395 Entrance Ramp (A) from Eastbound Duke Street

The proposed design for this relocated ramp incorporates a 12 ft. ramp lane width within the limits of work. When considered with the reduced shoulder width along this ramp (described below in Section 5.6.5), the overall ramp pavement width complies with AASHTO guidance pursuant to Section 3.3.11 "Widths for Turning Roadways at Intersections" of the Green Book. VDOT guidance requires a 16 ft. ramp lane width. The proposed design reduces the project complexity and cost associated with construction of cut retaining walls in areas having very weak clay soils.

5.6.5 Left and Right Shoulder Widths, Southbound I-395 Entrance Ramp (A) from Eastbound Duke Street

The proposed design for this relocated ramp incorporates a 4 ft. wide left shoulder and a 6 ft. wide right shoulder within the limits of work. When considered with the reduced ramp lane width along this ramp (described above in Section 5.6.4), the overall ramp pavement width complies with AASHTO guidance pursuant to Section 3.3.11 "Widths for Turning Roadways at Intersections" of the Green Book. The design also complies with guidance set forth by Green Book Section 10.9.6 "Ramps"; specifically, left and right minimum shoulder widths are satisfied; total shoulder width (left plus right) is satisfied; and lateral offset requirements to barrier are satisfied. For ramps, VDOT guidance requires a 4 ft. wide left shoulder (adjacent to barrier) and an 8 ft. wide right shoulder (adjacent to barrier). The proposed design reduces the project complexity and cost associated with construction of cut retaining walls in areas having very weak clay soils.

5.6.6 Right Shoulder Widths, Southbound I-395 to Edsall Road Exit Ramp and Duke Street to Southbound I-395 Entrance Ramp (E)

The proposed right shoulder widths along these ramps will vary to allow the relocated ramps to fit beneath existing structures without the need to replace four existing bridges. At each location where the relocated ramp will underpass an existing bridge, the proposed design reduces the right shoulder width(s) to 4 ft. thus allowing for four thru lanes within the limited existing 66 ft. between Edsall Road Bridge piers and 68 ft. between Duke Street Bridge piers.

5.6.7 Pier Protection Barrier, Duke Street

An exemption to the required use of pier protection barrier is proposed at four locations along Route 236 where bridge piers supporting an overpassing ramp are situated adjacent to through lanes. Current VDOT guidance requires protection at four existing bridge piers; however, the 54-inch-tall barrier would interrupt intersection sight lines at the proposed ramp terminal intersection at Route 236. Procedures set forth in Section 3.6.5.1 of the AASHTO LRFD Bridge Design Specifications allow agency latitude in evaluating if pier protection is necessary based on the predicted risk of a truck impacting a given pier. In this case, the predicted risk is below the identified threshold, and pier protection is not required at any of the four locations along Route 236.

5.6.8 Pier Protection Barrier, Edsall Road

Conditions along Edsall Road are similar to those described above for Duke Street, where a ramp overpasses the arterial roadway and bridge piers are situated adjacent to through lanes. Along Edsall Road, placement of pier protection barrier on the median side of westbound Route 648 would require a blunt end treatment that does not fit geometrically within the available median. Using the procedures set forth in Section 3.6.5.1 of the AASHTO LRFD Bridge Design Specifications, pier protection is not required at any of the four locations along Route 648. The project proposes to provide pier protection at the three locations where it can fit.

5.6.9 Sidewalk Buffer Strip Width, Edsall Road

Along Edsall Road the northbound I-395 loop ramp to westbound Edsall Road has existing utilities on the right side of the ramp. Where the proposed sidewalk is located, existing utilities include three light posts and one traffic signal. The required sidewalk footprint with a 4 ft. buffer would require the relocation of all 3 light posts including replacing the existing traffic signal with a longer cantilevered pole as it would have to be placed further away from the roadway.

The proposed sidewalk without any buffer space is designed to provide the required minimum sidewalk width while simultaneously keeping all existing infrastructure in place. While the proposed buffer space is substandard, an additional 4 ft. of shoulder will be between the travelway and face of curb. The proposed work also includes new guardrail that will be placed behind the sidewalk to prevent errant vehicles from hitting the existing poles as well as keep them from traversing down the front slope of the ramp.

5.7 Multilane Turn Movements

The Preferred Alternative incorporates one dual turn lane for the southbound-to-eastbound movement at the intersection of southbound I-395 off-ramp and Duke Street. The intersection is

designed to accommodate a WB-67 design vehicle turning left from the outer turn lane concurrently with an SU-30 single unit truck design vehicle using the inner turn lane.

Figure 5–3 illustrates the proposed intersection geometry for vehicle turning movements that was verified using AutoTurn software, version 10.0. The proposed design provides for a minimum 2 ft. lateral separation from the turning vehicle to curbing or adjacent vehicle turn path. It complies with VDOT guidance for the layout of dual turn lanes and the tapered clear width of the receiving roadway.

All truck drivers will be directed to use the outer-most turn lane using signage provided as part of this project. This is consistent with requirements set forth in the Code of Virginia that pertain to slower traffic keeping to the right lane on multilane roadway segments (§46.2-803 and §46.2-804(4)). The AutoTurn analysis using an SU-40 in the inner turn lane was performed to provide assurances to VDOT and FHWA that the proposed design is inherently flexible, and allows for some degree of motorist failure to properly use the intended lane(s).

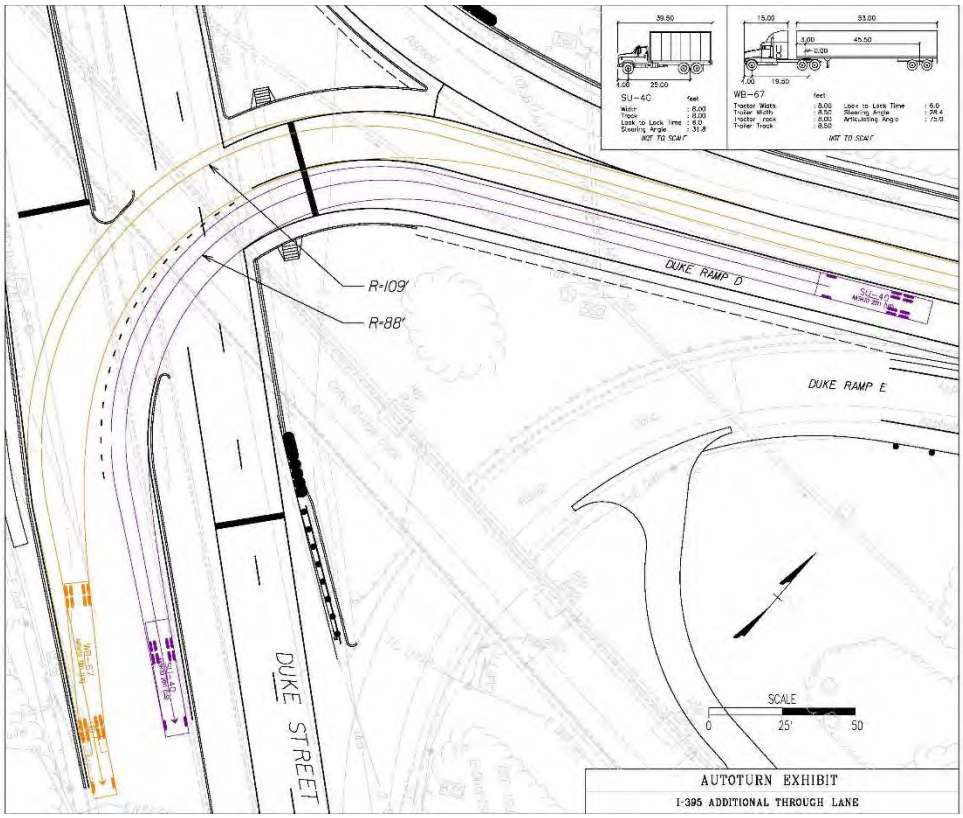

Figure 5–3: Vehicle Turn Paths at SB I-395 Exit Ramp and Duke Street

5.8 Multimodal Accommodations

Fairfax County's Transportation Plan Map[19] designates I-395 as an "Enhanced Public Transportation Corridor", which is defined as a roadway for which "a major transportation facility such as Metrorail,

[19] *Fairfax Countywide Transportation Plan Map*, Fairfax County, 2013.

light rail, bus rapid transit, and high occupancy vehicle lanes are provided". The proposed improvements will provide additional capacity and reduce congestion for all vehicles. The Southbound I-395 Additional Through Lane project is consistent with the County's designation of I-395 as an Enhanced Public Transportation Corridor.

In the 2013 Fairfax Countywide Trails Plan, a Major Regional Trail System is planned along Edsall Road. As a part of it, the County-approved project No. 114[20] is planned to "construct a walkway on north side of Edsall Road over I-395 from Cherokee Avenue to Edsall Gardens Apartments." The Preferred Alternative will not preclude the trail/walkway system. By eliminating one loop ramp at the Edsall Road interchange, the Preferred Alternative will benefit trail/walkway users because it reduces the number of locations where pedestrians cross travel lanes.

The City of Alexandria completed a sidewalk in-fill project that connects pedestrian facilities west of the Duke Street interchange with the raised walkway on the existing bridge carrying Duke Street over I-395. The Preferred Alternative will maintain pedestrian access along Duke Street/Little River Turnpike and will reconstruct portions of the existing sidewalk system that are impacted by the proposed project.

5.9 Interchange Signage

A preliminary interchange signage plan was prepared on a conceptual level for the Preferred Alternative (**Appendix G**). The layout was developed to comply with current MUTCD (2009 Edition) and VDOT Supplement (2011 Edition) requirements for interstates and other state highways.

The layout focuses on large-scale guide signs needed for motorist orientation and directional aid, but does not identify regulatory and warning signs that will be needed. The signing plan is subject to refinement and further detailing during final design activities, and reflects the following considerations:

- Proposed signage has been designed for Edsall Road and Duke Street/Little River Turnpike to provide directional guidance and lane use orientation to vehicles. Specifically, proposed signage provides route number, town destination, and cardinal direction information for each lane.
- Proposed pavement markings for Edsall Road and Duke Street/Little River Turnpike are coordinated with the layout and messages on the proposed overhead signage. Together the proposed signage and pavement markings are designed to enhance opportunities for vehicles to orient themselves to the correct lane in advance of decision points, and minimize the potential for downstream lane changes.

Markings and signage along I-395 will be modified to address the revised ramp terminal locations and orientations. Existing signage and overhead structures will remain in place where possible and will be supplemented by new structures and signs to address the revised geometry.

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[20] *Countywide Dialogue on Transportation: Board of Supervisors Approved Projects*, Fairfax County, January 2014.

CHAPTER 6: TRAFFIC VOLUMES

This chapter provides a broad overview of the assumptions and methodologies used to develop traffic volumes for the project. These volumes are the basis for traffic analyses of existing and future conditions.

6.1 Traffic Analysis Years

Traffic operational analyses were undertaken for the existing conditions (2013), the anticipated opening year (2020) when construction will be completed, and the 20-year design life (2040) of the proposed improvements. The analysis includes both the No-Build and Preferred Build Alternative for the opening (2020) and design year (2040) scenarios.

6.2 Traffic Data Collection

Traffic data collection was completed in early November 2013[21] and included:

- Intersection turning movement counts at 16 intersections in the study area
- Tube-based vehicle classification counts at 24 entrance and exit ramps
- Wavetronix-based vehicle classification counts on the mainline in each direction and at seven interchange ramps in the Springfield Interchange
- Travel time runs along mainline I-395 in the study area

Using the above data, a balanced set of peak hour traffic volumes was developed by following the procedures described in NCHRP 255. **Figure 6–1** through **Figure 6–4** show the existing peak hour volumes on roadways, ramps, and intersections in the study area.

Truck percentages were compiled from the vehicle classification data collected on the ramps and the I-395 mainline in the study area. For arterials, truck percentages were developed using a combination of the count data on the ramps for each interchange, land use around each intersection, and field observations. Truck percentages are listed below:

- Northbound I-395: 4%, AM and PM
- Southbound I-395: 6% AM, 5% PM
- Edsall Road: 5% AM, 3% PM
- Duke Street/Little River Turnpike: 2% AM, 1% PM

[21] Traffic counts conducted as a part of I-395 Express Lane Extension IMR in 2015 showed consistently lower volumes throughout the study area. Hence, this IMR represents a more conservative approach.

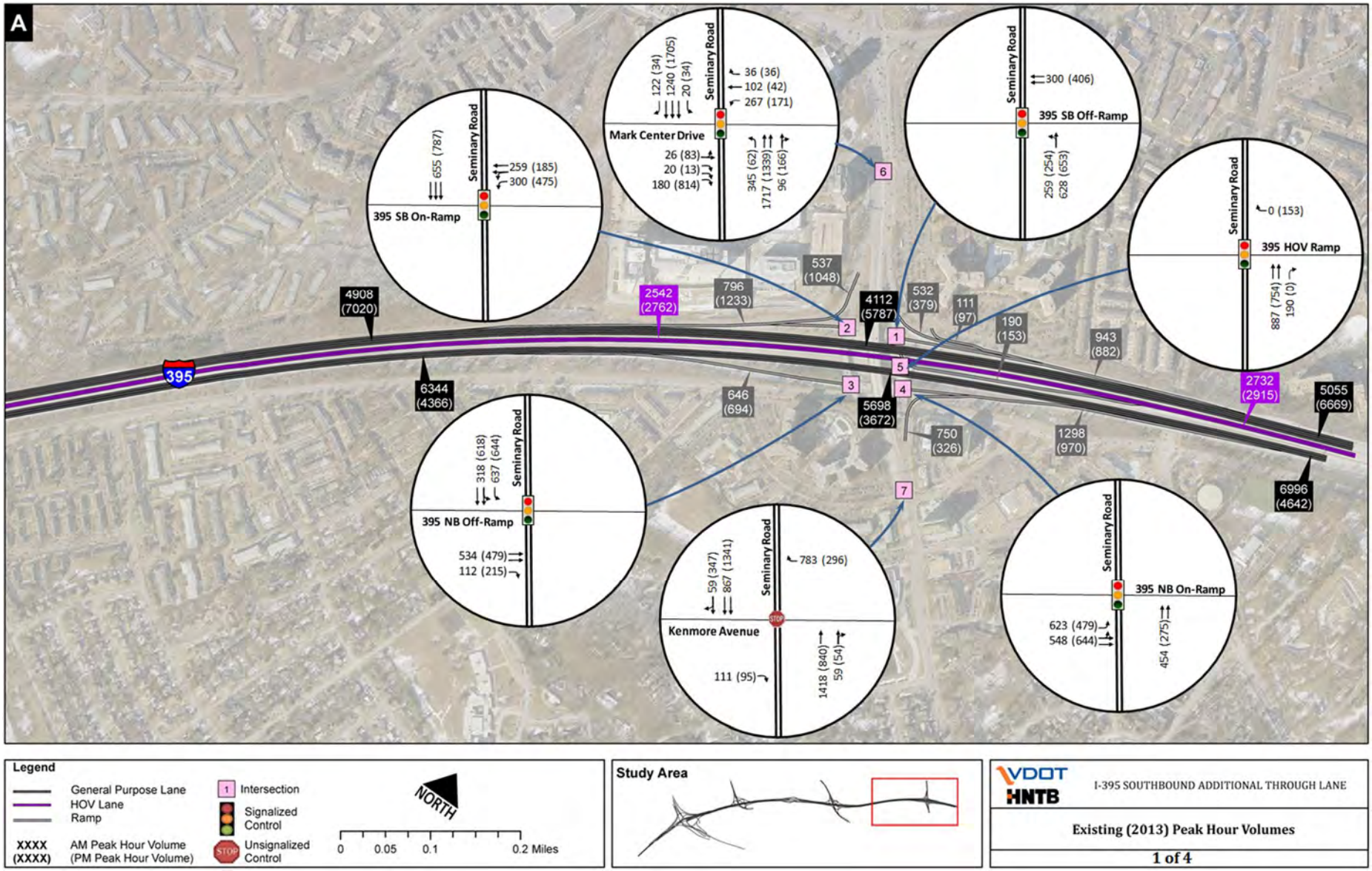


Figure 6–1: 2013 Existing Peak Hour Volumes (Seminary Road Interchange)

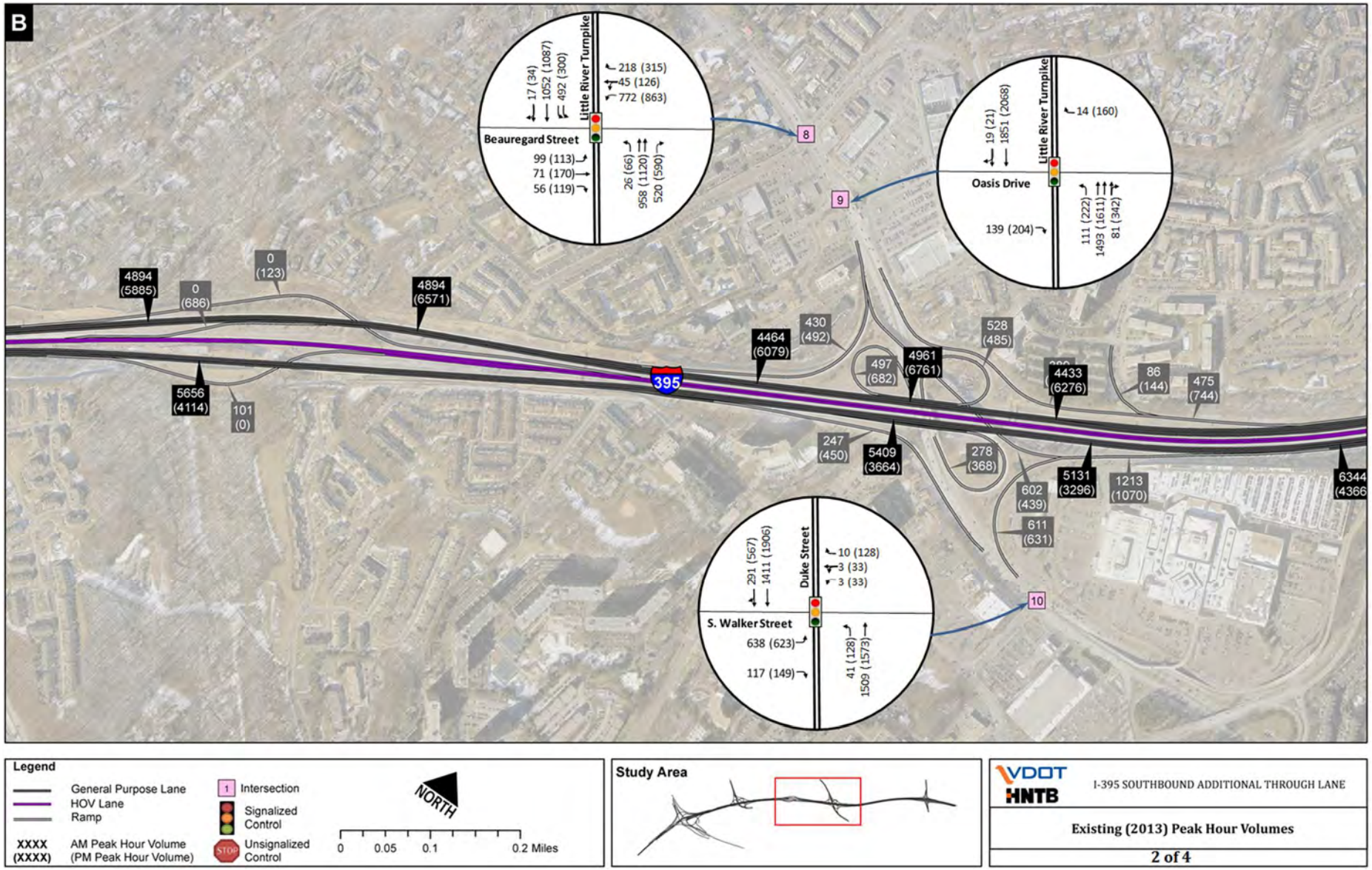


Figure 6–2: 2013 Existing Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

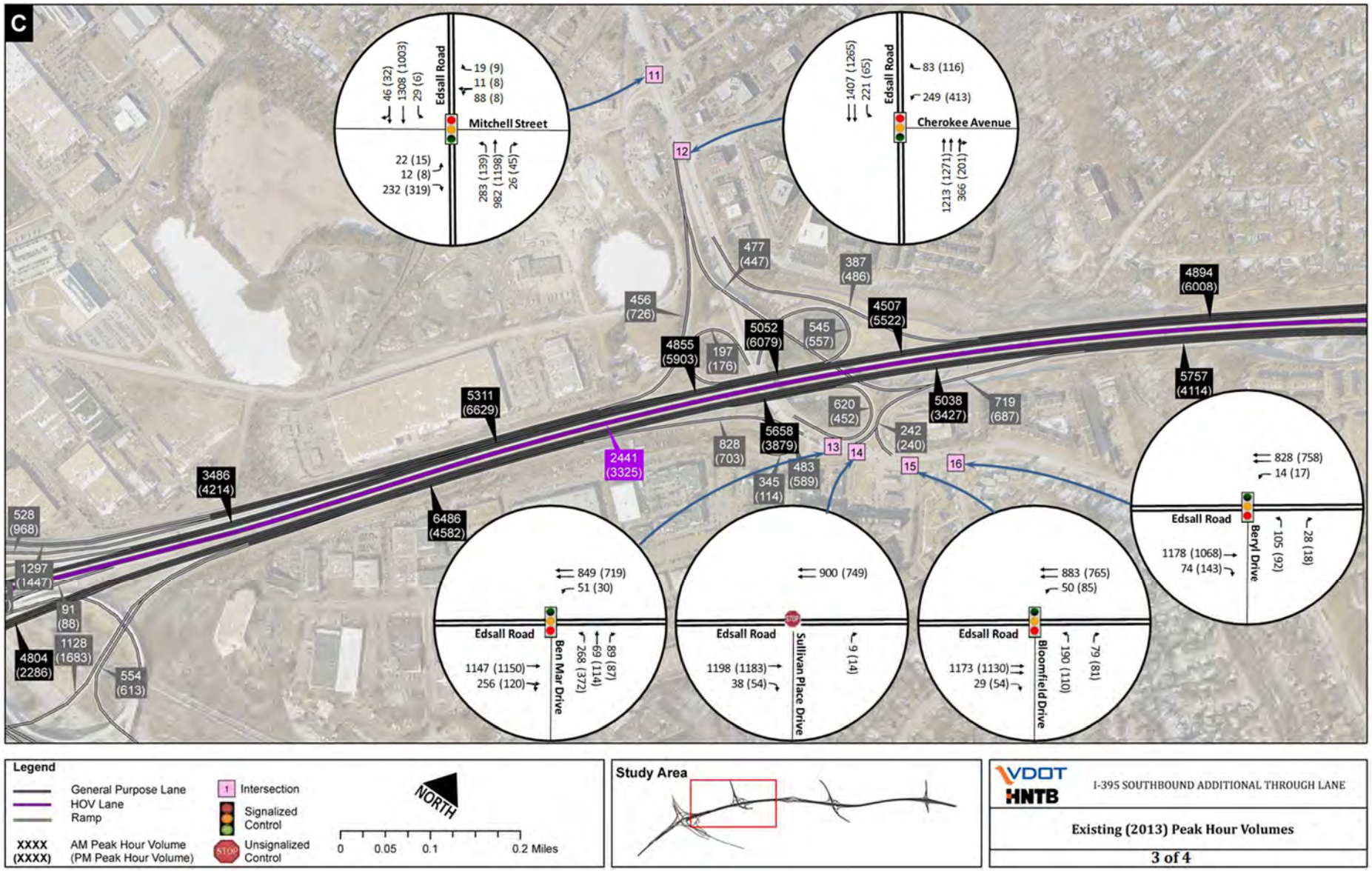


Figure 6–3: 2013 Existing Peak Hour Volumes (Edsall Road Interchange)

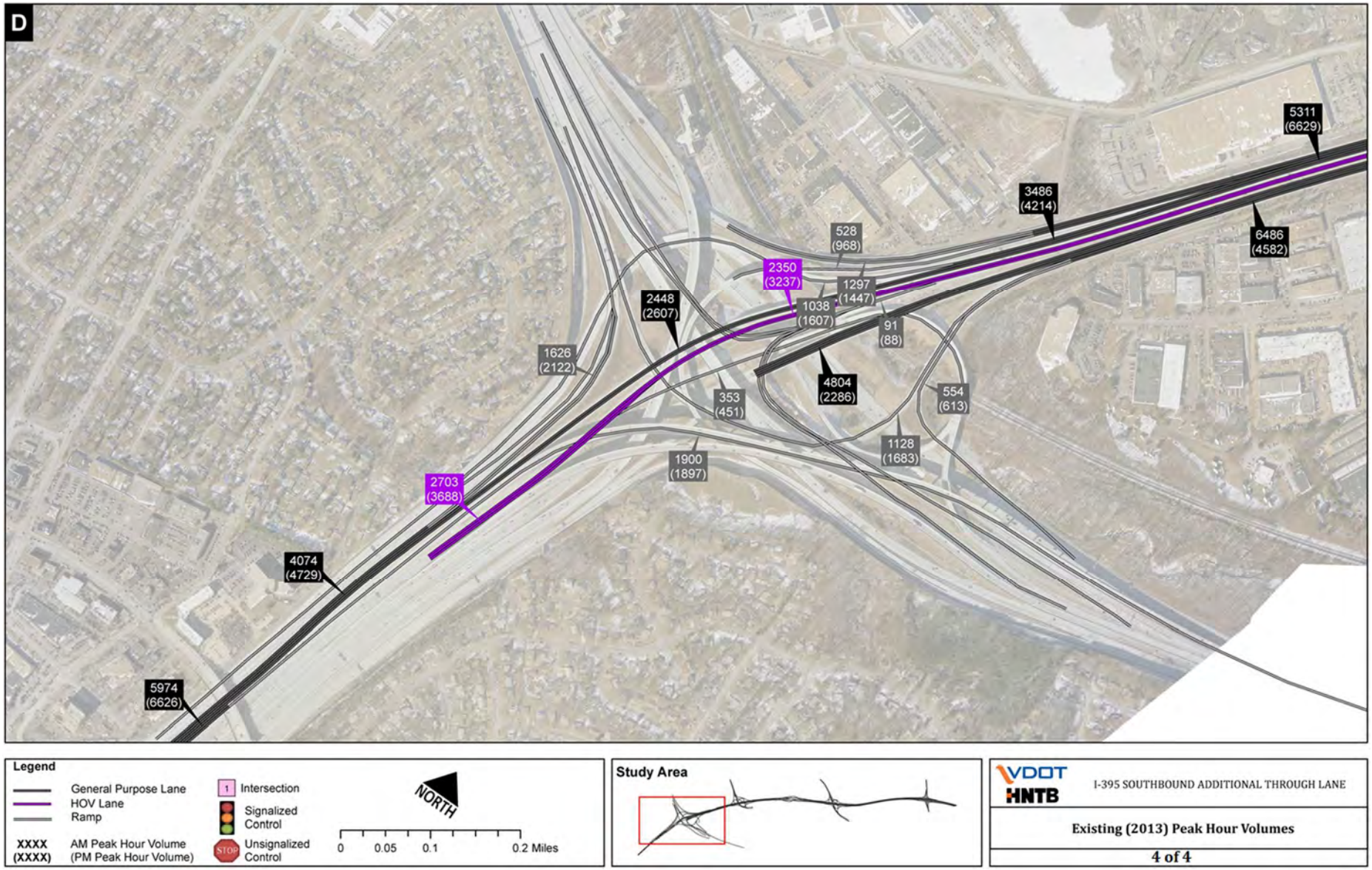


Figure 6–4: 2013 Existing Peak Hour Volumes (Springfield Interchange)

6.3 Projected Future Peak Hour Volumes

Table 6–1 presents the annual linear growth rates for the study area roadways. The I-95 Express Lanes project is estimated to have a marked impact on growth rates. By 2015, the Express Lanes will enable non-HOV traffic to use the current reversible facility in the median, and is expected to cause a shift in traffic from the GP lanes onto the Express Lanes.

Table 6–1: Annual Growth Rates from Existing Conditions

Facility	AM Peak Hour		PM Peak Hour	
	2040 No-Build	2040 Build	2040 No-Build	2040 Build
Northbound I-395	-0.1% to 0.4% [1]	-0.1% to 0.4% [1]	0.7% to 0.8%	0.7% to 0.8%
Southbound I-395	0.8% to 0.9%	0.8% to 0.9%	-0.1% to 0.4%	0.4% to 1.0%
I-395 HOV/ Express Lanes	1.0% to 2.6% [2]	1.0% to 2.6% [2]	0.7% to 1.6%	0.7% to 1.7%
Duke St./Little River Turnpike	1.6%	1.6%	1.3%	1.3%
Edsall Road	0.6%	0.6%	1.6% to 1.9%	1.6% to 1.9%

Notes: All rates are non-compounding.
[1] Growth is negative in the GP lanes south of the Express Lanes egress at Turkeycock Run due to the shift of traffic into the Express Lanes.
[2] Growth rate drops from 2.6% south of to 1.0% north of the Express Lanes egress at Turkeycock Run because all non-HOV vehicles must egress at this point.

The following figures present the forecasted peak hour volumes for future scenarios:

- Opening year 2020 No-Build Conditions: **Figure 6–5** through **Figure 6–8**
- Opening year 2020 Build Conditions: **Figure 6–9** through **Figure 6–12**
- Design year 2040 No-Build Conditions: **Figure 6–13** through **Figure 6–16**
- Design year 2040 Build Conditions: **Figure 6–17** through **Figure 6–20**

VDOT Transportation Mobility and Planning Division has reviewed and approved all the existing traffic data and future traffic forecasting during AM and PM peak hours. Detailed volume diagrams are included in **Appendix D**.

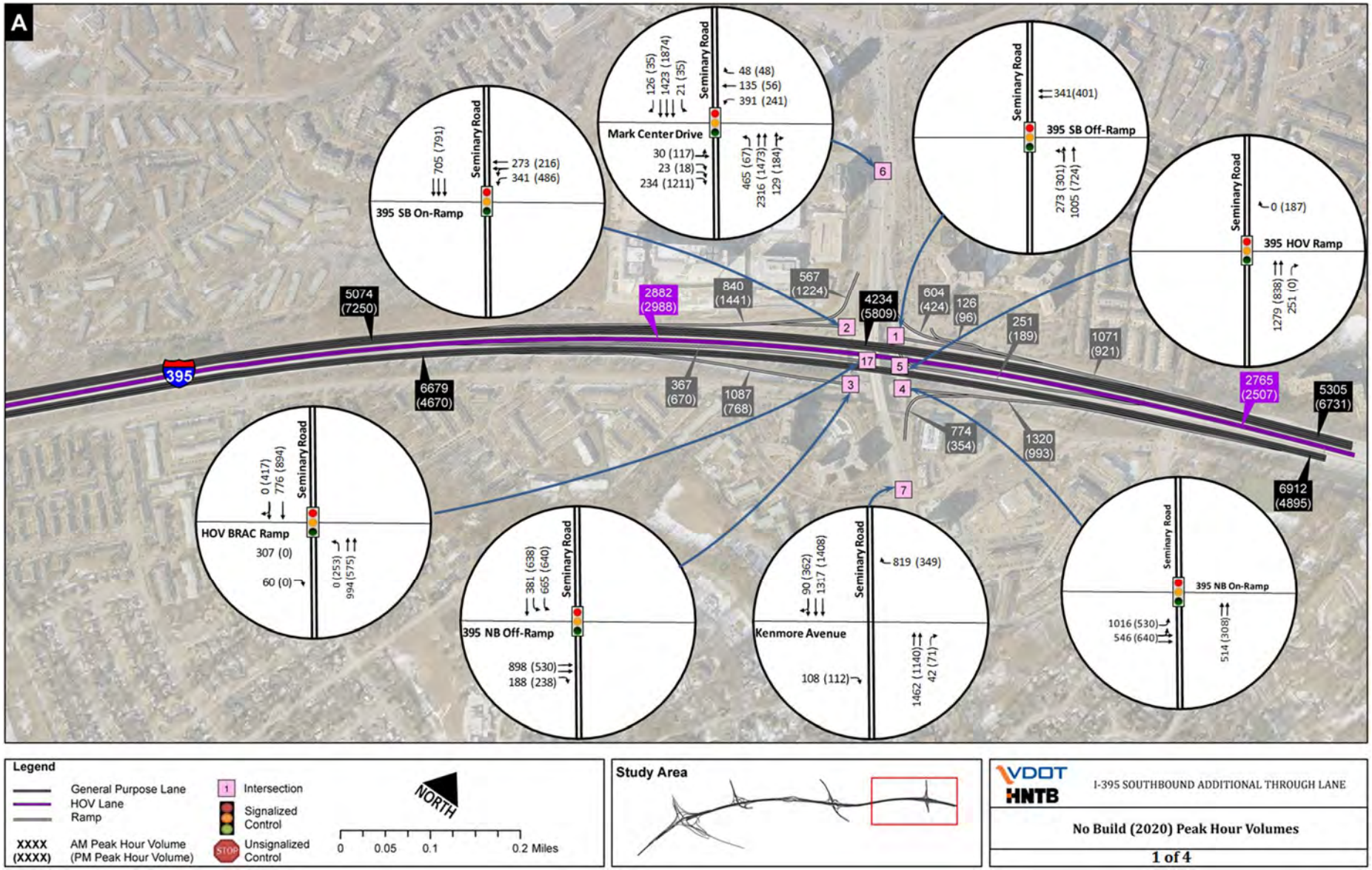


Figure 6–5: 2020 No-Build Peak Hour Volumes (Seminary Road Interchange)

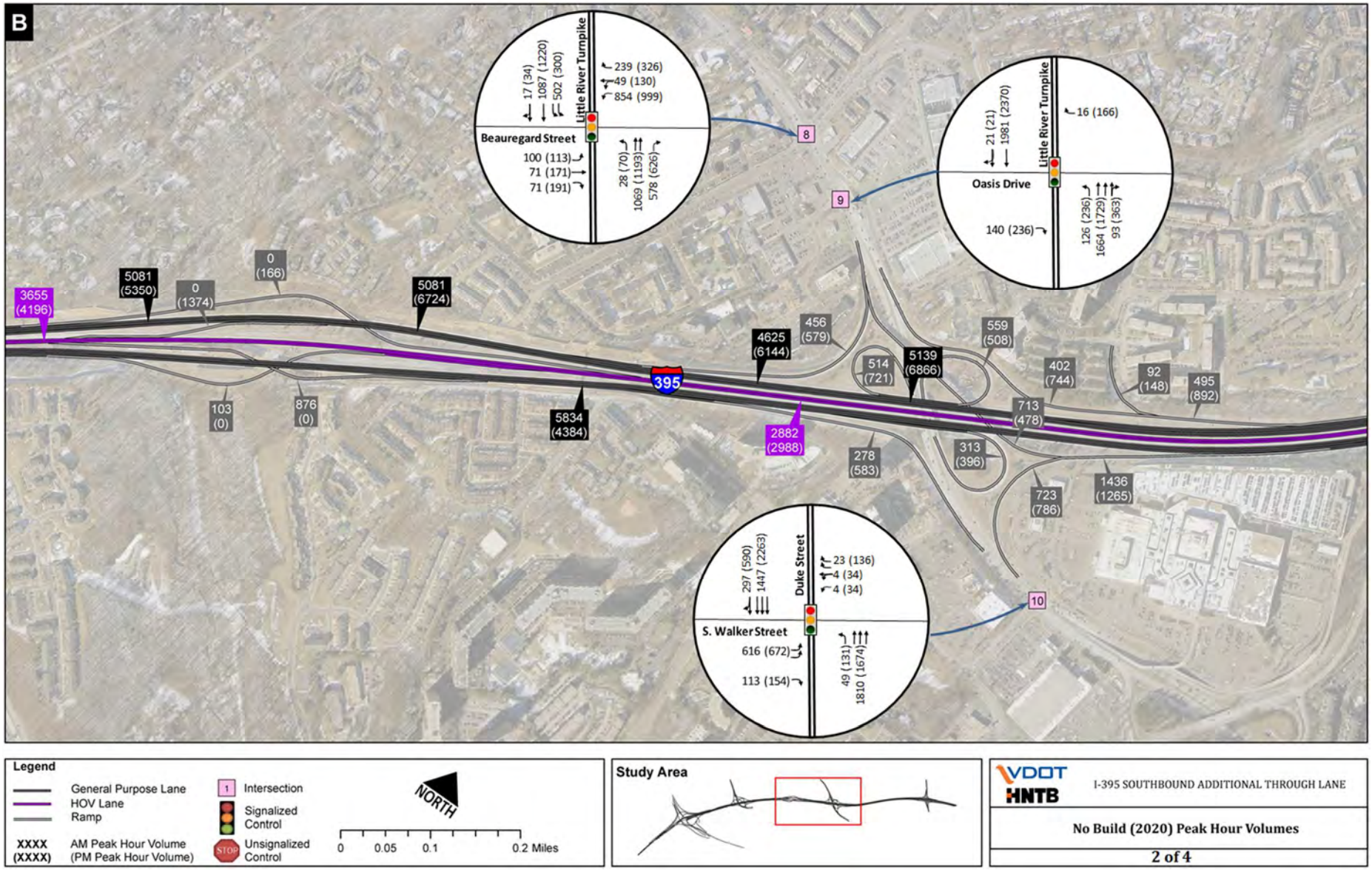


Figure 6–6: 2020 No-Build Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

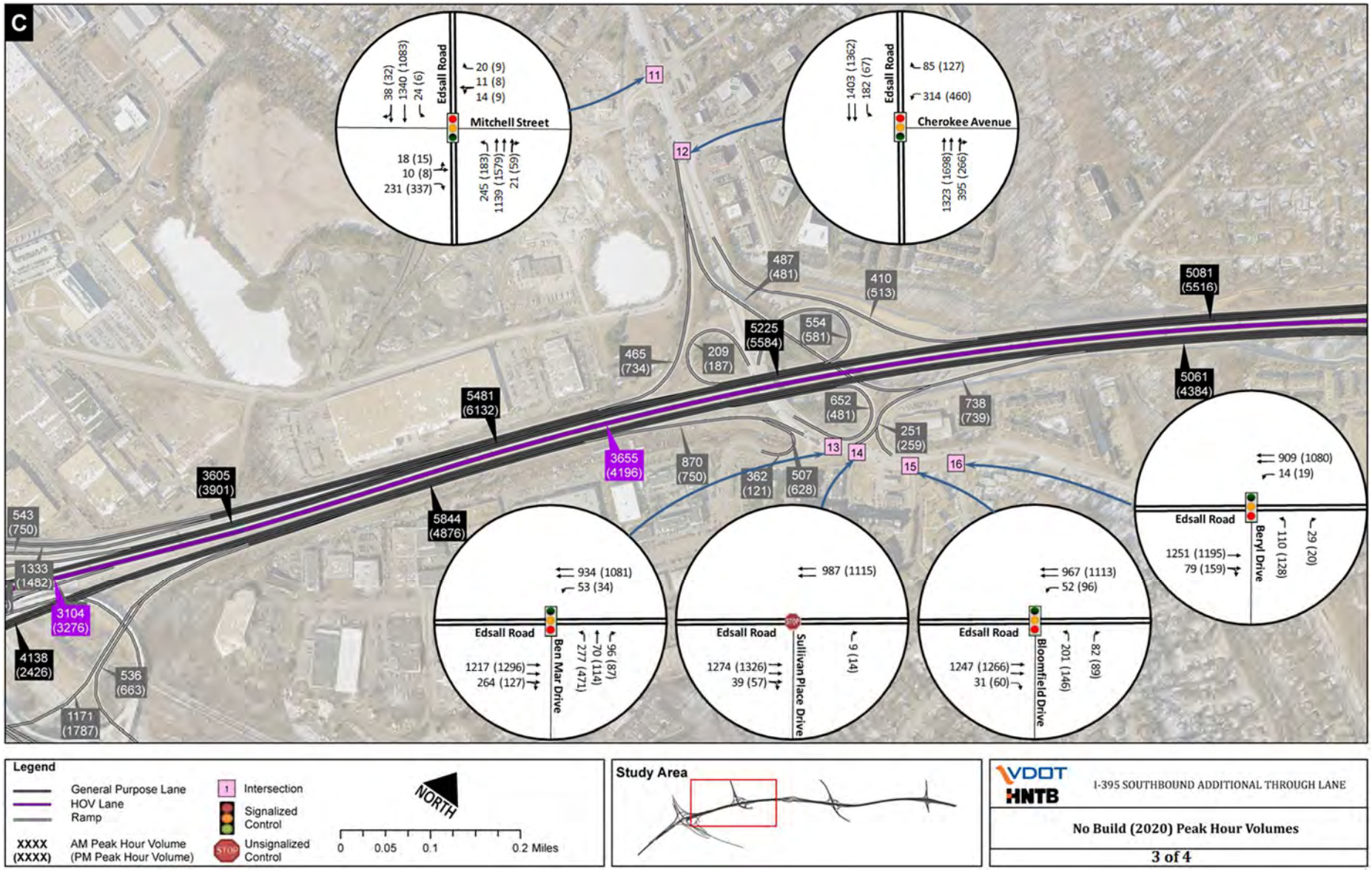


Figure 6–7: 2020 No-Build Peak Hour Volumes (Edsall Road Interchange)

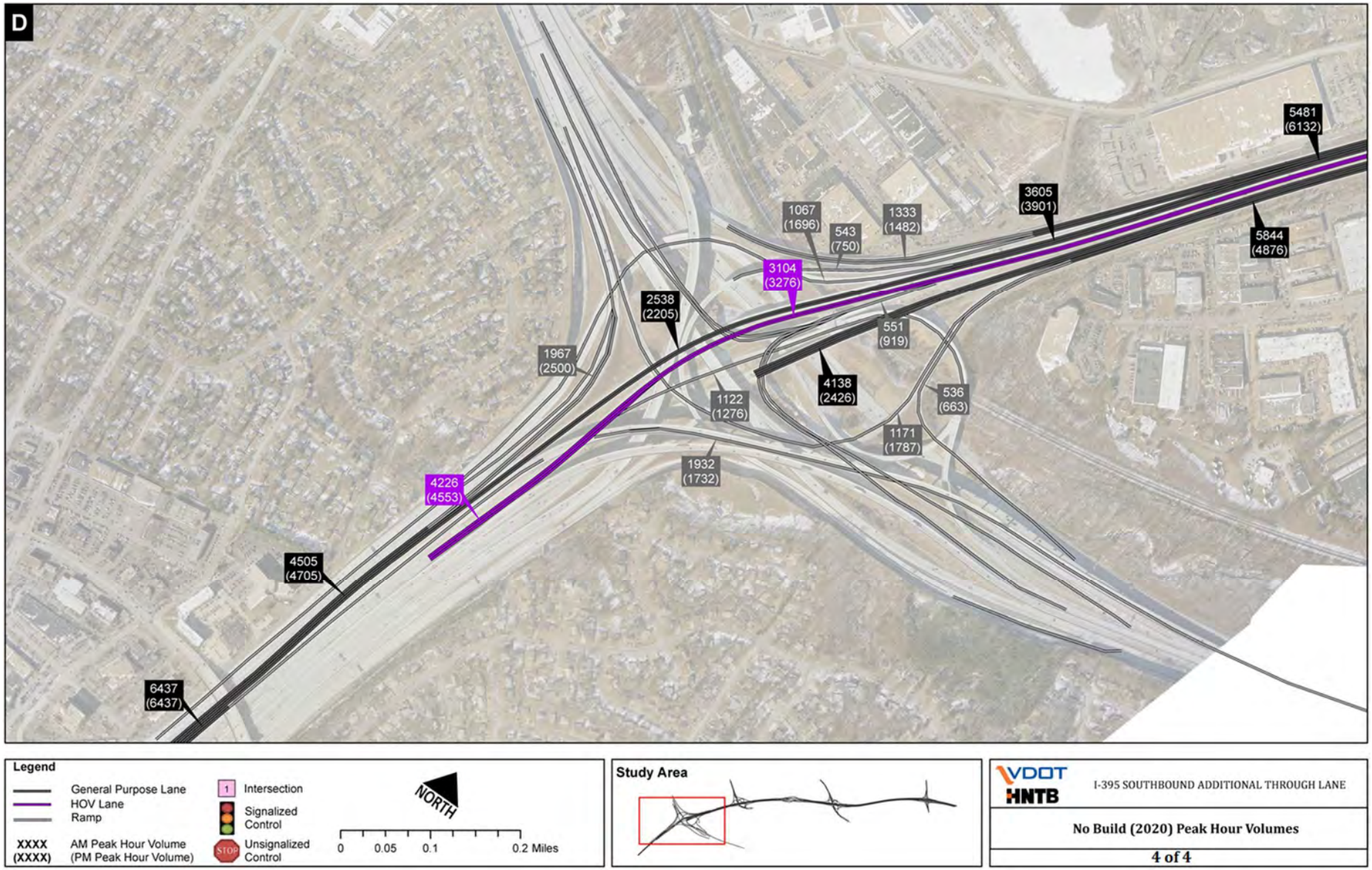


Figure 6–8: 2020 No-Build Peak Hour Volumes (Springfield Interchange)

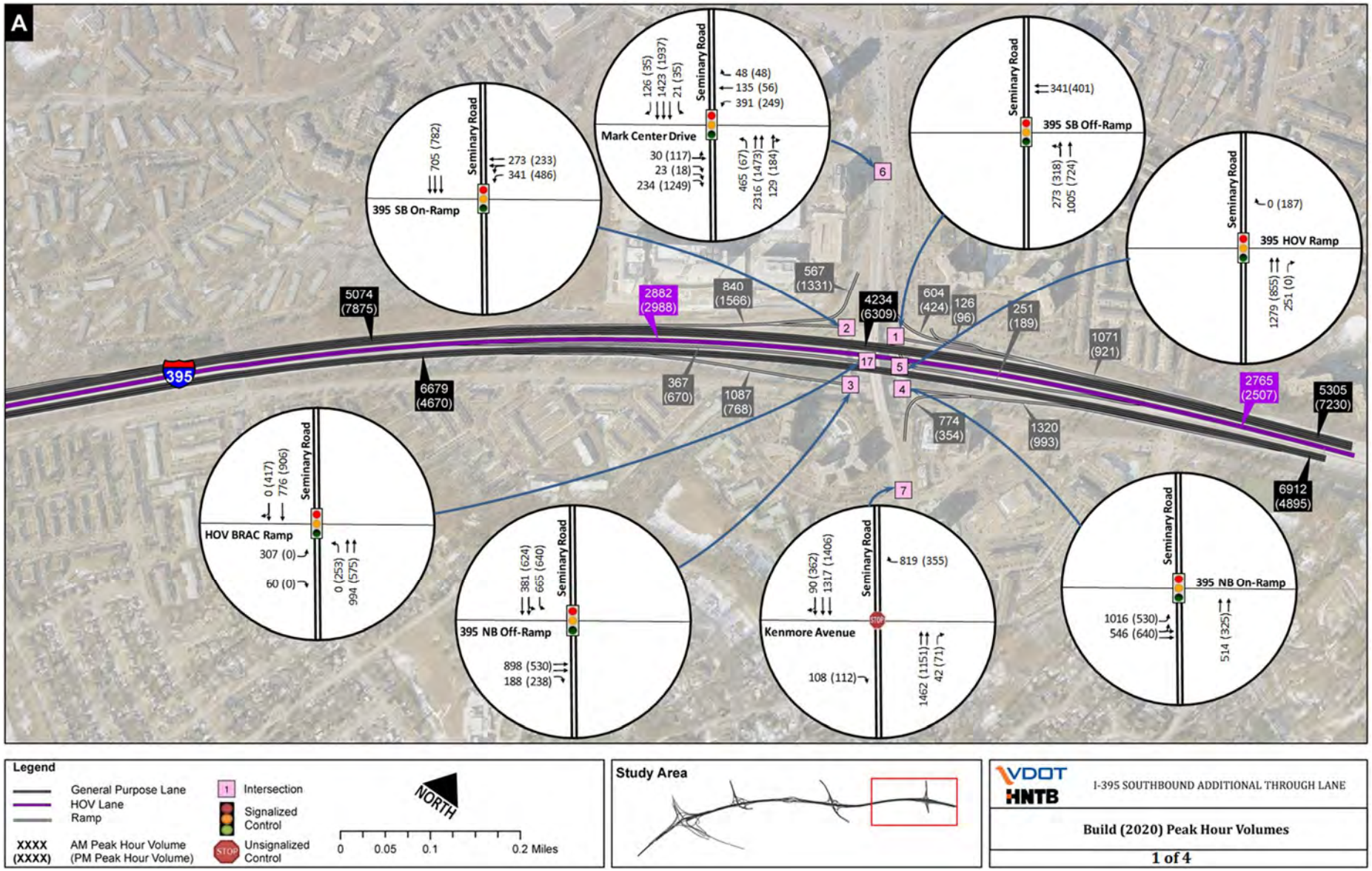
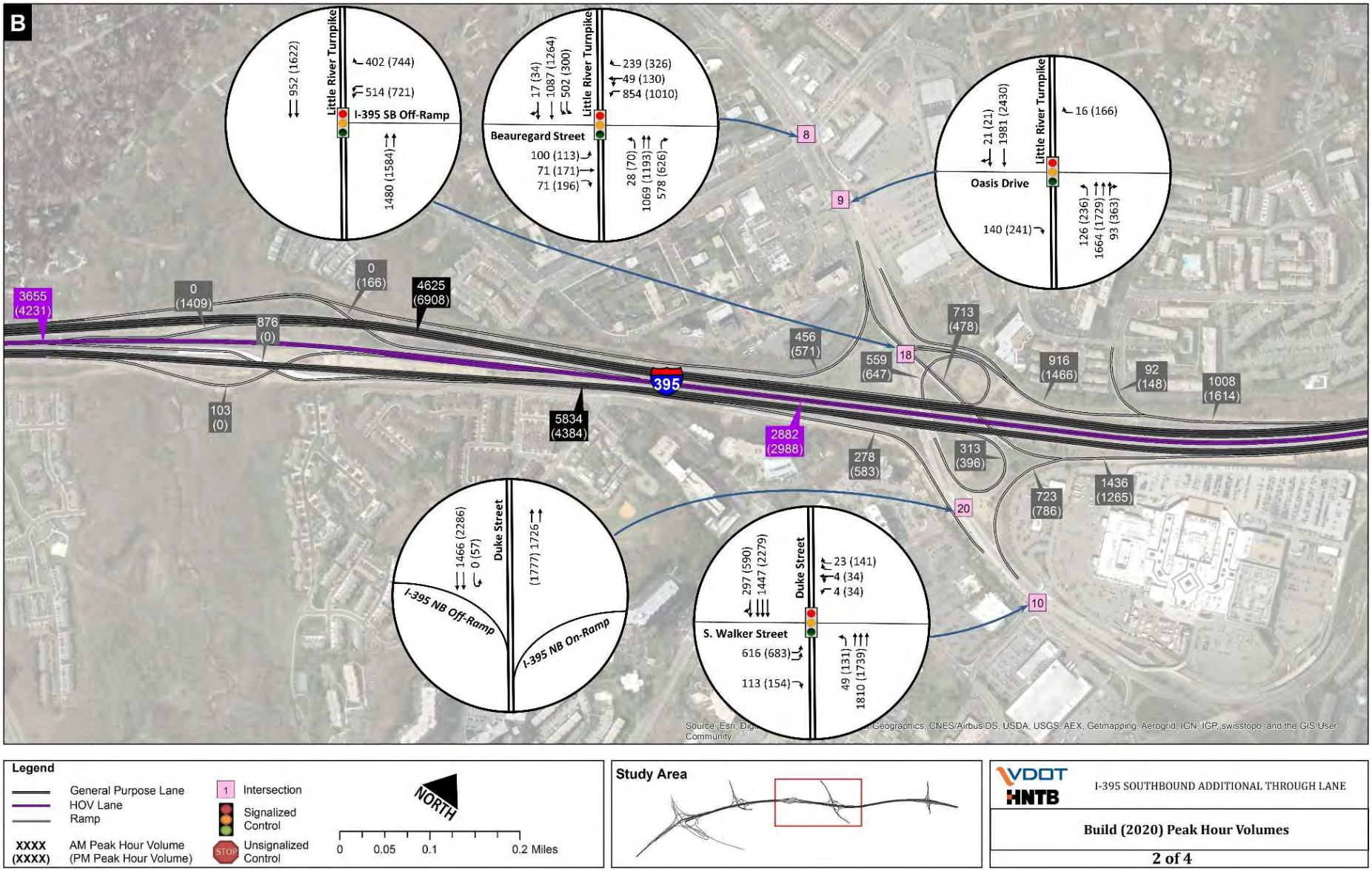


Figure 6–9: 2020 Build Peak Hour Volumes (Seminary Road Interchange)



Legend

General Purpose Lane
HOV Lane
Ramp
XXXX (XXXX) AM Peak Hour Volume (PM Peak Hour Volume)
Intersection
Signalized Control
Unsignalized Control
NORTH
0 0.05 0.1 0.2 Miles

Study Area

VDOT HNTB

I-395 SOUTHBOUND ADDITIONAL THROUGH LANE

Build (2020) Peak Hour Volumes

2 of 4

Figure 6–10: 2020 Build Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

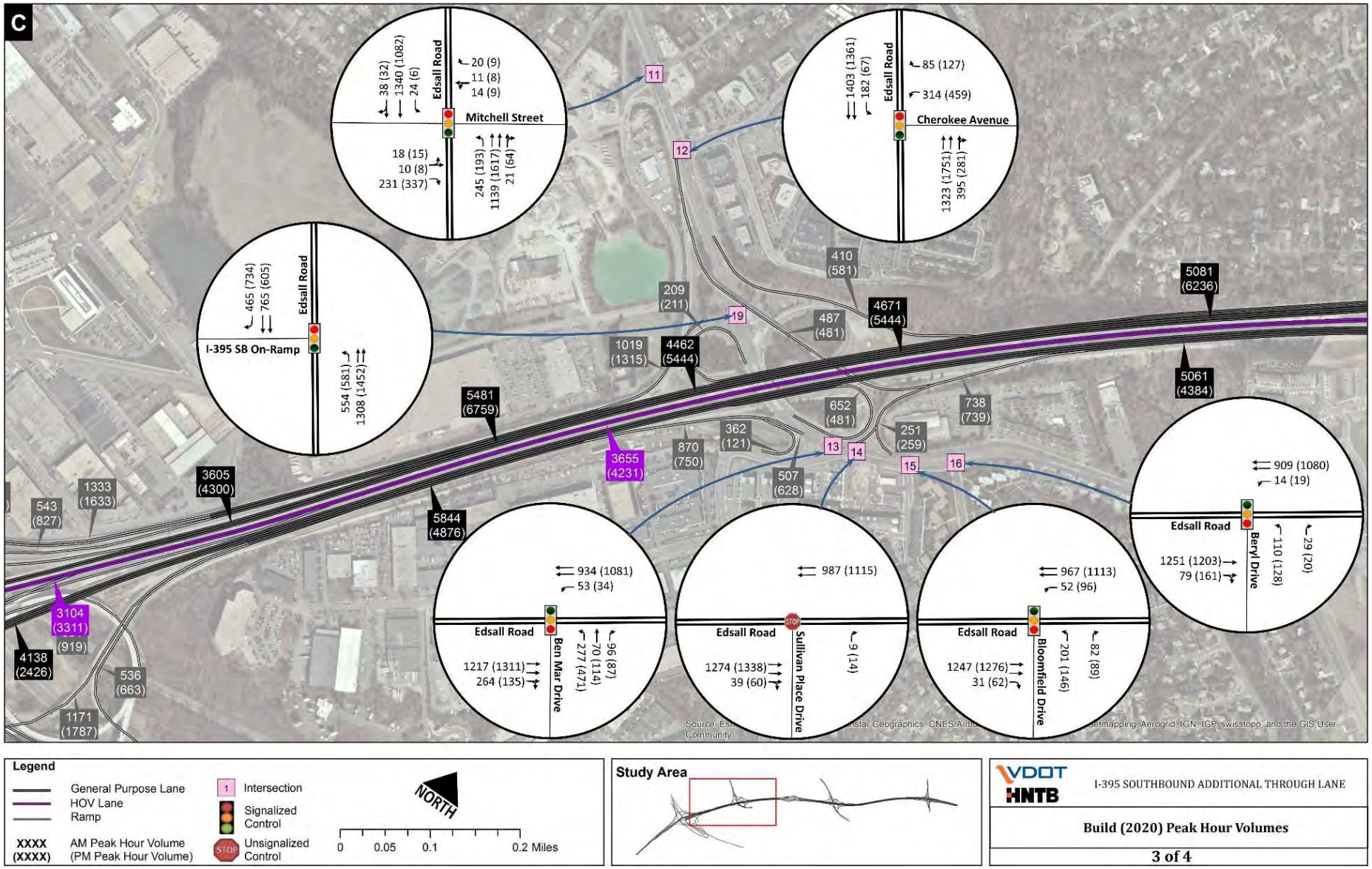


Figure 6–11: 2020 Build Peak Hour Volumes (Edsall Road Interchange)

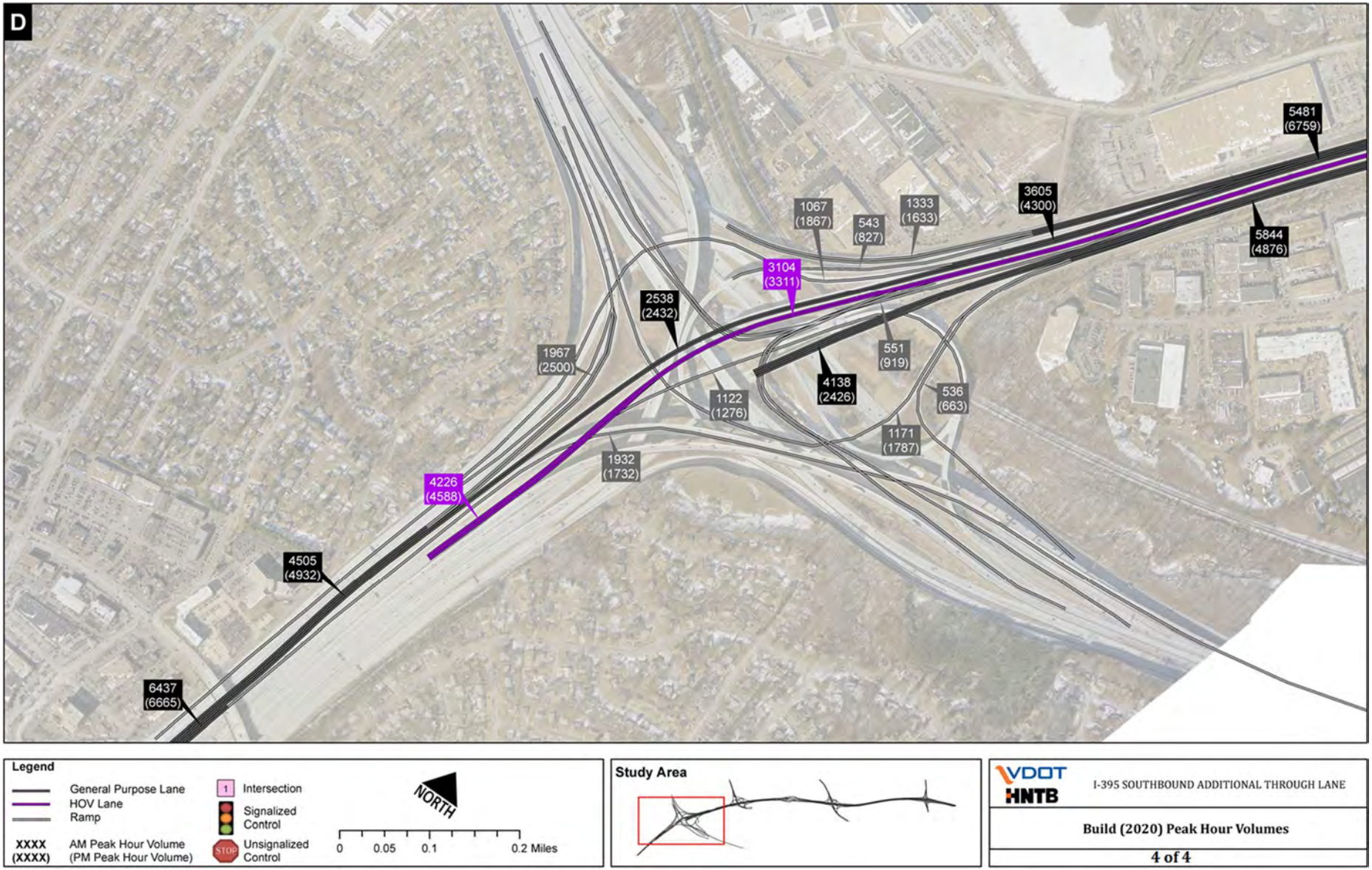


Figure 6–12: 2020 Build Peak Hour Volumes (Springfield Interchange)

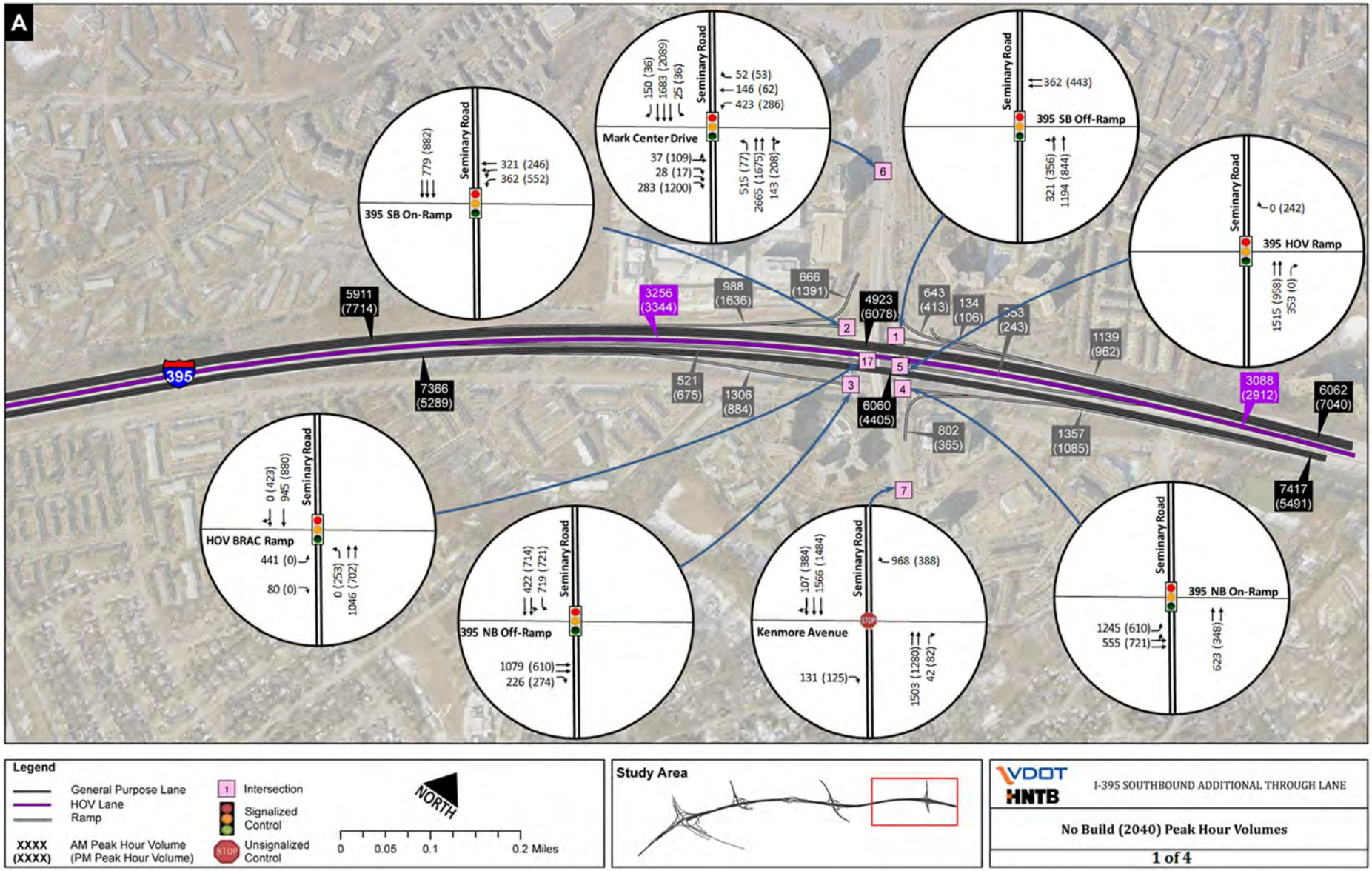


Figure 6–13: 2040 No-Build Peak Hour Volumes (Seminary Road Interchange)

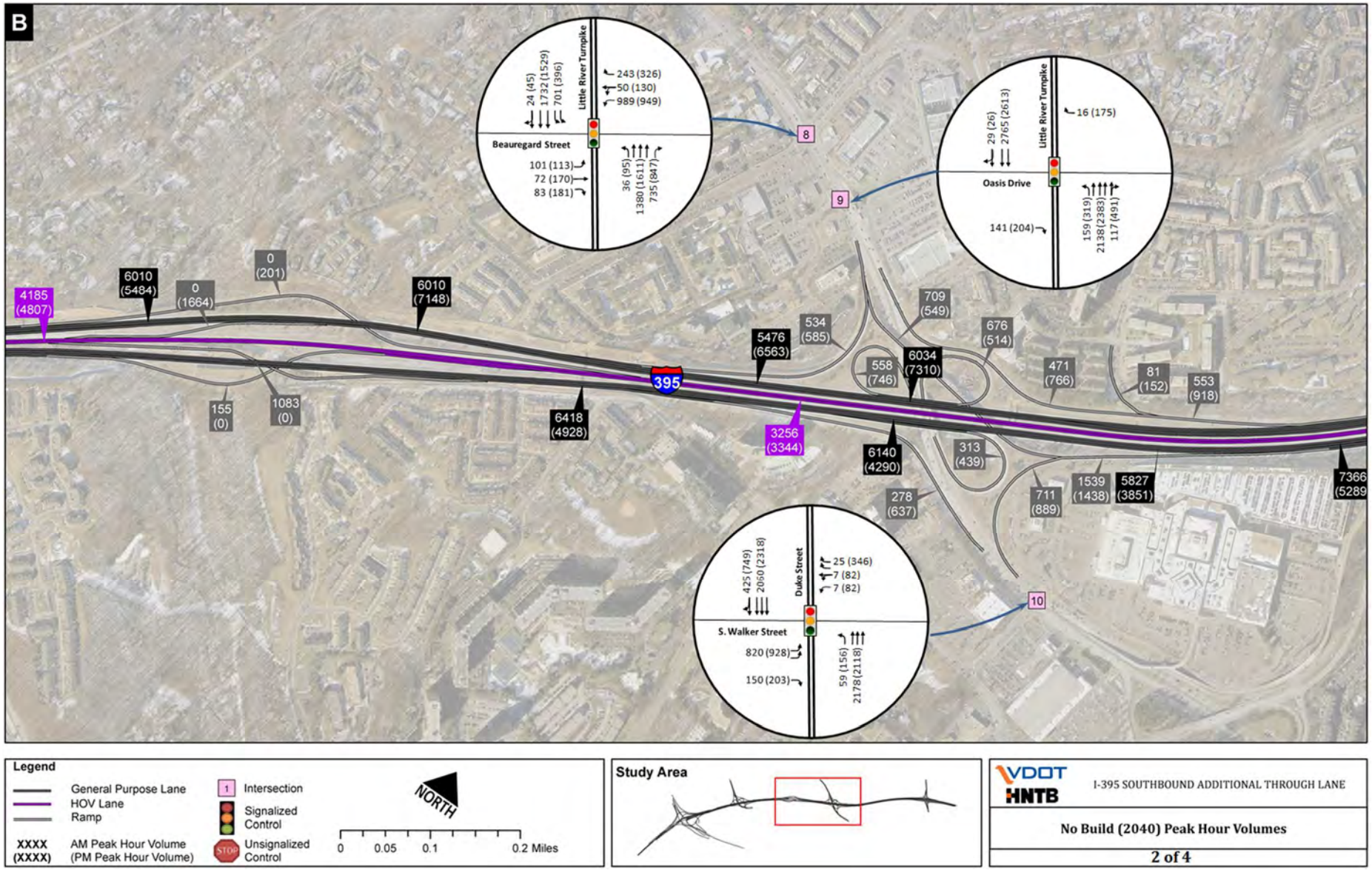


Figure 6–14: 2040 No-Build Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

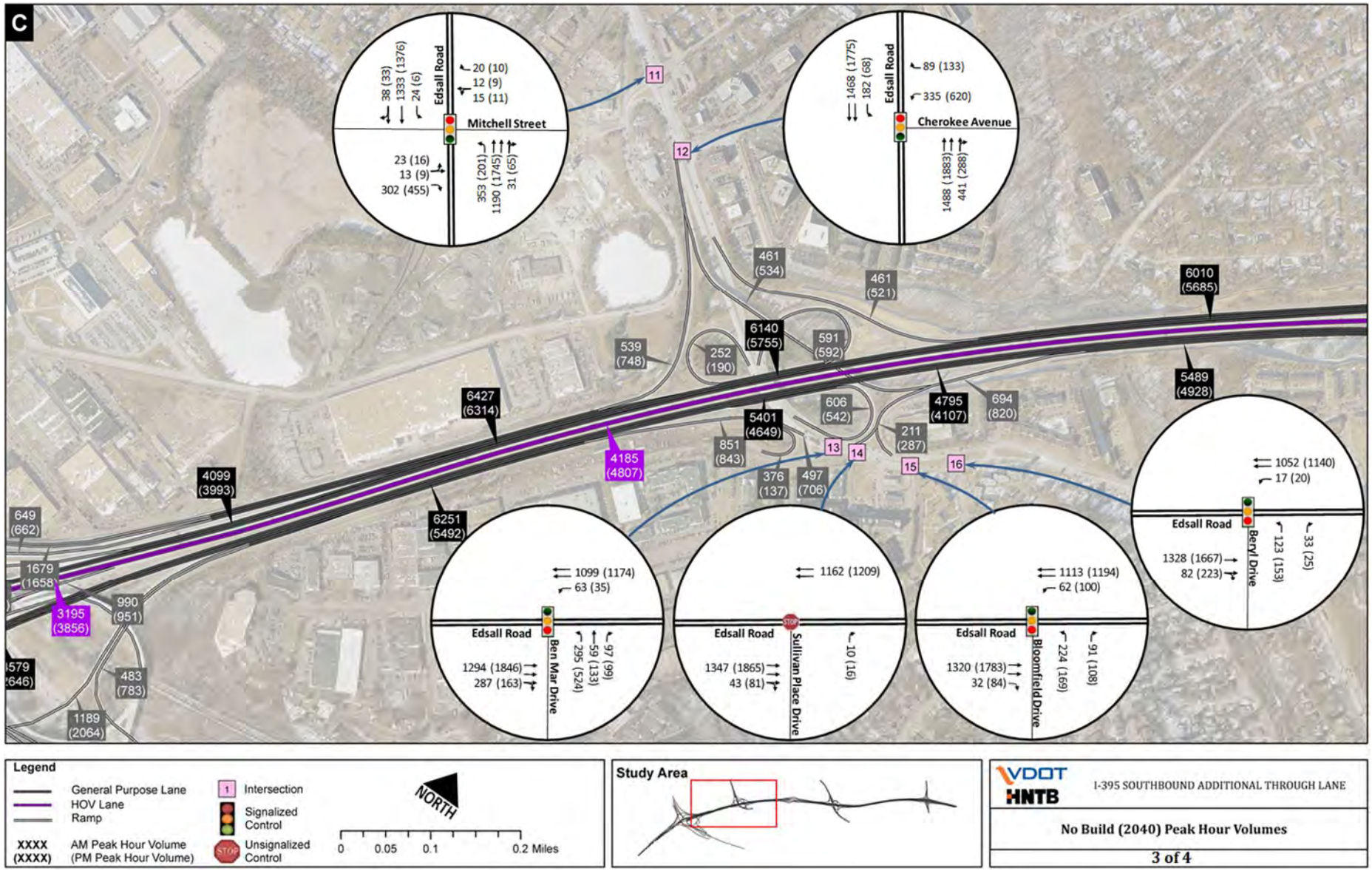


Figure 6–15: 2040 No-Build Peak Hour Volumes (Edsall Road Interchange)

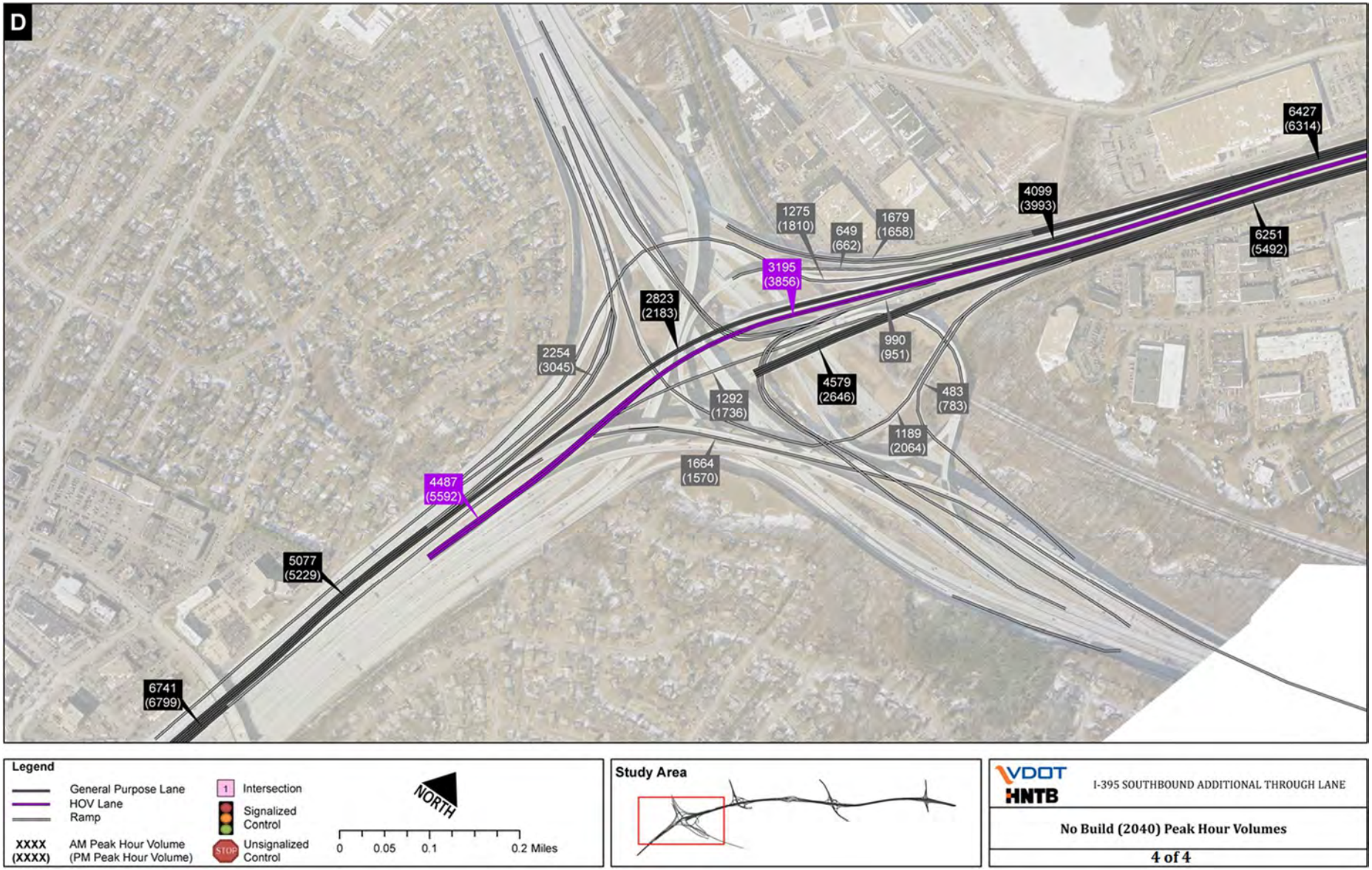


Figure 6–16: 2040 No-Build Peak Hour Volumes (Springfield Interchange)

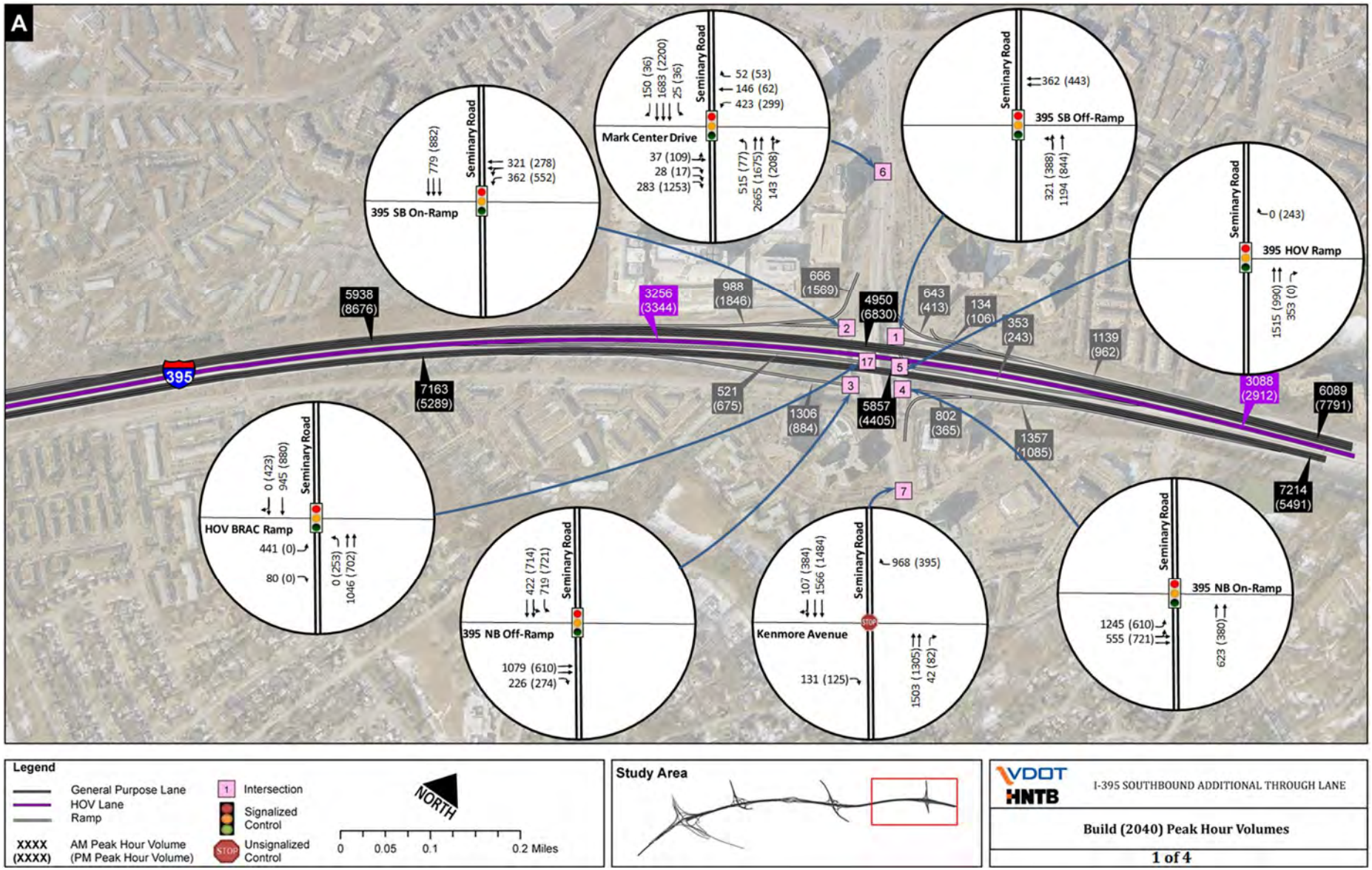


Figure 6–17: 2040 Build Peak Hour Volumes (Seminary Road Interchange)

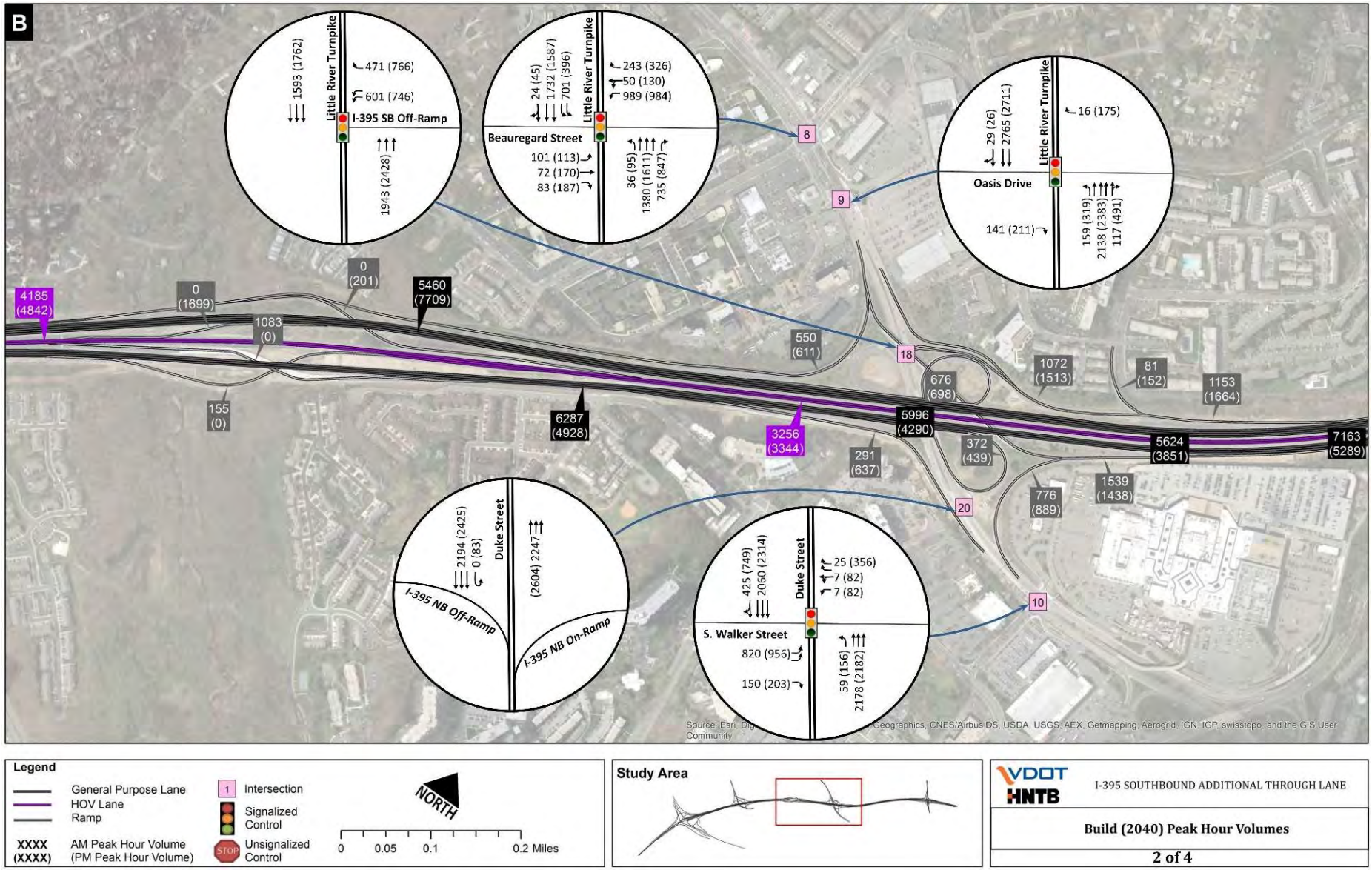


Figure 6–18: 2040 Build Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

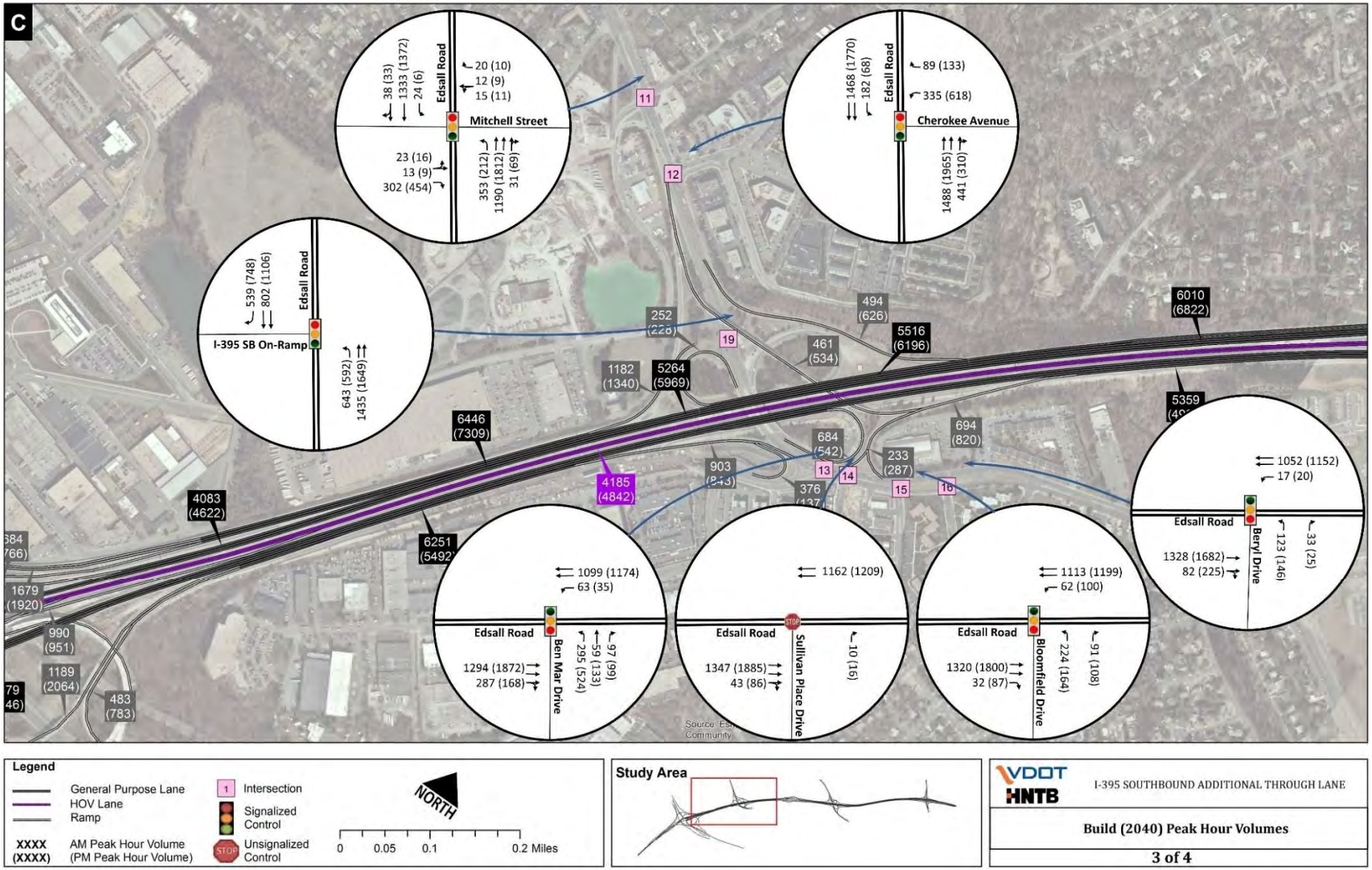


Figure 6–19: 2040 Build Peak Hour Volumes (Duke Street and Turkeycock Interchanges)

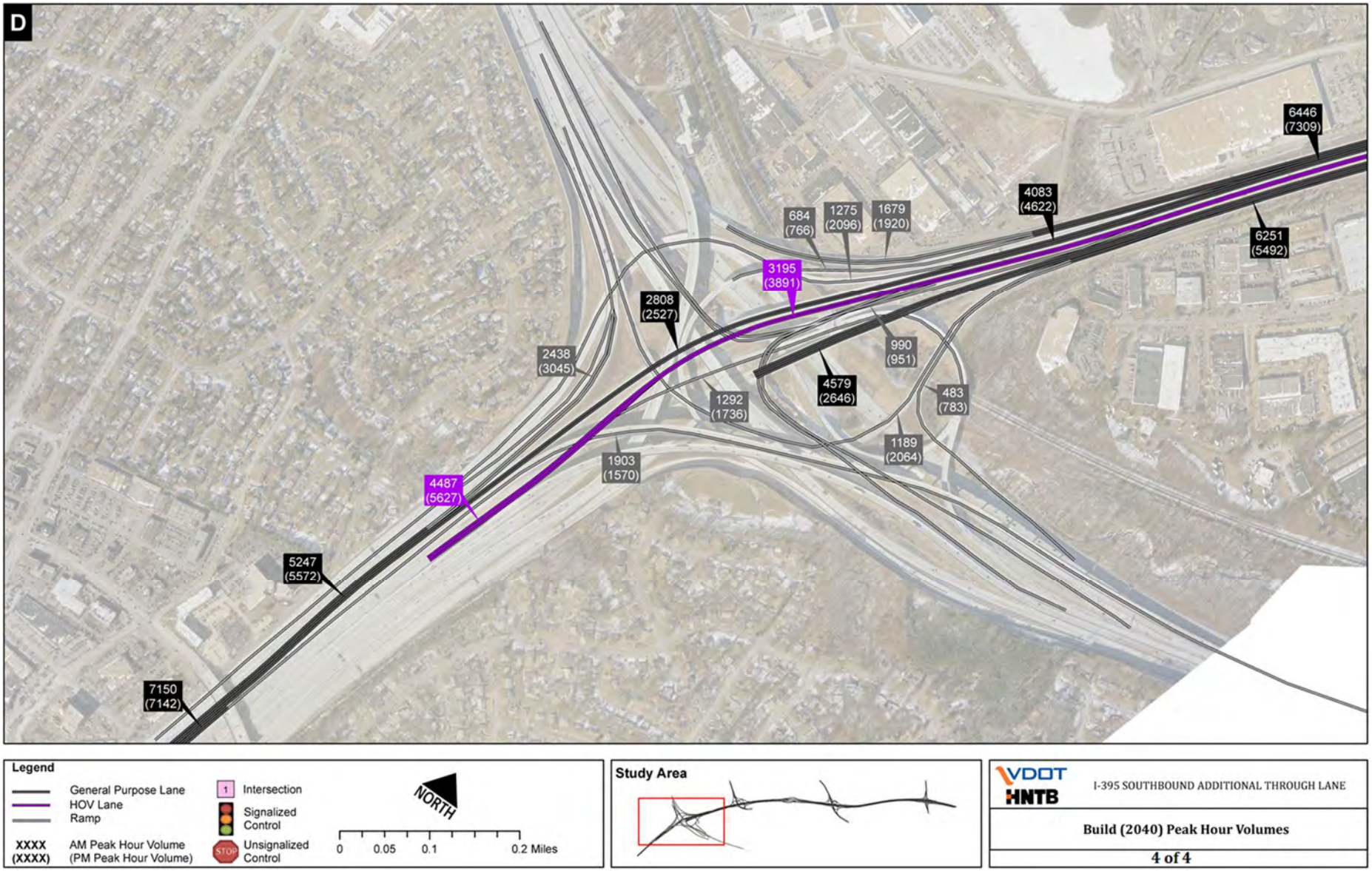


Figure 6–20: 2040 Build Peak Hour Volumes (Springfield Interchange)

CHAPTER 7: TRAFFIC AND SAFETY ANALYSIS

7.1 Traffic Operational Analysis

AM and PM peak hour traffic operations along I-395 within the study area were evaluated for three analysis years: existing year (2013), opening year (2020) and design year (2040). The analysis includes the No-Build and Build conditions in both 2020 and 2040. The No-Build conditions include planned and/or programmed improvements within the study area as defined in the National Capital Region CLRP, excluding the additional southbound through lane. Build conditions include the Preferred Alternative on southbound I-395 in addition to the planned and programmed improvements. Both AM and PM peak hour traffic operations during a typical weekday were considered for each condition. In all, ten scenarios were analyzed in this study.

1. 2013 Existing Conditions AM peak hour
2. 2013 Existing Conditions PM peak hour
3. 2020 No-Build Conditions AM peak hour
4. 2020 No-Build Conditions PM peak hour
5. 2020 Build Conditions AM peak hour
6. 2020 Build Conditions PM peak hour
7. 2040 No-Build Conditions AM peak hour
8. 2040 No-Build Conditions PM peak hour
9. 2040 Build Conditions AM peak hour
10. 2040 Build Conditions PM peak hour

7.1.1 Highlights of the Traffic Operational Analysis

Southbound I-395 GP lanes currently experience gridlock conditions during the PM peak hour. Traffic operational analysis, based on VISSIM microsimulation results, confirms the No-Build conditions will continuously produce operational deficiencies in the southbound direction during the PM peak hour through 2040. Most of these operational deficiencies in the southbound direction are focused at the following locations:

- Southbound I-395 GP lanes at the Duke Street interchange
- Southbound I-395 GP lanes at the Seminary Road on-ramp merge area

Heavy southbound traffic during the PM peak hour is constrained by the lane drop near the Duke Street interchange which forms severe upstream congestion. The conditions are worsened at the merge area of Seminary Road because of the heavy on-ramp traffic entering southbound I-395.

The operational analysis of the Preferred Alternative demonstrates the effectiveness of the proposed additional through lane on southbound I-395. **Table 7–1** summarizes the MOEs used in the analysis and compares the scenarios presented in this chapter. A qualitative score is given for

Table 7–1: Traffic Operations Comparison, PM Peak Hour, Future Build and No-Build Conditions

MOE	Description	Unit	Opening Year (2020)			Design Year (2040)		
			No-Build PM Peak	Build PM Peak	Build vs. No-Build	No-Build PM Peak	Build PM Peak	Build vs. No-Build
GP Lanes Travel Time	Peak direction travel time, measured within the study area (5.7 miles)	Seconds	772	395	●	783	404	●
Average Speed	Average speed for all freeway segments in the peak direction (southbound)	mph	23.2	51.6	●	22.9	50.7	●
Average Density	Average vehicle densities for all freeway segment in the peak direction (southbound)	pc/mi/ln	54.3	28.6	●	55.1	31.8	●
Number of Bottlenecks	Locations along I-395 in the peak direction where traffic volumes are heavily constrained	Number	2	1	◉	2	1	◉
Average Throughputs	Average served traffic volumes measured on key segments along I-395 in the peak direction.	veh/hr	5514	5885	●	5502	6379	●
Average Unserved Demand	Percentage of unserved demand measured on key segments along I-395 in the peak direction	%	2.2%	0.9%	◉	7.1%	1.7%	●
Freeway Segments under Congestion	Percentage of freeway length in the peak direction operating under heavy or severe congestions	%	50.1%	5.8%	●	50.1%	33.7%	●
Intersection at LOS E	Number of intersections within the study area operating at LOS E	Number	2	1	◉	2	2	○
Intersection at LOS F	Number of intersections within the study area operating at LOS F	Number	0	0	○	1	1	○

●	◉	○	□	■
Better	<<<<	Neutral	>>>>	Worse

each MOE to indicate the impacts of the Build conditions on traffic operations in comparison with the No-Build conditions. The Build conditions show an improvement in operation compared to the No-Build conditions in terms of travel time, average speeds, congestion bottlenecks, served/unserved demand, and percent of freeway length under congestion.

With the additional through lane added as part of the Preferred Alternative, the bottleneck near the Duke Street interchange is expected to be eliminated because traffic will no longer be metered by the lane drop. Consequently, the congestion upstream at the Seminary Road on-ramp merge area to southbound I-395 will be relieved with the downstream bottleneck eliminated. Therefore, the Preferred Alternative will provide relief to the southbound operational issues during the PM peak hour.

7.1.2 Microsimulation Analysis Results

This section presents the key results of the traffic operation analysis using VISSIM microsimulation. Detailed VISSIM analysis results are documented in **Appendix H**.

As mentioned in previous chapters, the proposed freeway improvements will be on southbound I-395 and will benefit traffic flow during PM peak hours. Therefore, for each analysis year and scenario, emphasis is placed on the results of the PM peak hour operations analysis, with a primary focus on southbound GP lanes. The Preferred Alternative is not expected to have an influence on the northbound GP lanes or on the reversible Express Lanes. The northbound GP mainline is the peak direction during the AM peak hour. Therefore, discussions of the AM peak hour operations analysis results are brief.

7.1.2.1 Existing (2013) Conditions

PM Peak Hour

The analyses of travel times, vehicle densities, and speeds show that southbound I-395 GP lanes experience severe recurring congestion during the PM peak hour at the lane drop location near the Duke Street interchange.

Freeway Density and Congestion Level Analysis

Table 7-2 summarizes the freeway operations during the existing conditions PM peak hour, including speeds, densities and congestion levels, color coded by segments. For I-395 within the study area, model throughputs of all freeway links are within five percent of the corresponding field counts. Based on freeway densities, the southbound I-395 GP segments between Seminary Road and Duke Street are severely congested. The freeway densities on these segments are greater than 100 passenger-cars per lane per mile. Traffic flow is heavily congested between the Duke Street interchange and the Turkeycock Run HOV ramps. A short segment under the Edsall Road interchange is also congested because of weaving maneuvers in this area. The remaining southbound GP segments experience light or moderate traffic conditions. In the off-peak direction of northbound I-395, as well as the southbound HOV segments, no congestion is present.

Table 7–2: Freeway Operations, Existing PM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	15.9	84.3
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	12.1	118.2
	S03-M	Merge Area at Seminary Road On-Ramp	14.7	107.7
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	16.9	102.5
	S05-D	Diverge Area at WB Duke Street Off-Ramp	17.2	100.7
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	20.7	75.8
	S07-W	Between WB Duke Street On-Ramp and EB Off-Ramp	43.7	44.3
	S08-W	Between EB Duke Street On-Ramp and Turkeycock Slip Ramp	47.6	43.8
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	53.2	37.5
	S10-W	Between Turkeycock Flyover Ramp and Edsall Road Off-Ramp	50.7	32.6
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	38.8	47.5
	S12-W	Between Edsall Road and I-495 Ramp	51.7	26.9
	S12-D	Diverge Area at I-495 Inner Loop Ramps	53.5	15.5
	S13-D	Diverge Area at Franconia Ramp	47.2	31.4
	S14-B	I-95 SB Mainline through Springfield Interchange	52.8	26.3
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	22.9
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.2	21.5
Southbound I-395 HOV	H01-D	North of Seminary Road HOV Off-Ramp	63.5	19.6
	H02-B	Between Seminary Road HOV Off-Ramp and Turkeycock Flyover Ramp	63.6	21.9
	H03-D	Diverge Area at Turkeycock Flyover Ramp	63.5	21.9
	H04-B	Between Turkeycock Flyover Ramp and Slip Ramp	63.6	20.8
	H05-M	Merge Area at Turkeycock Slip Ramp	61.6	23.3
	H06-B	Between Turkeycock Slip Ramp and Off-Ramp to I-495 HOT Lanes	63.5	26.1
	H07-D	Diverge Area at Off-Ramp to I-495 HOT Lanes	62.9	23.7
	H08-B	Between I-495 HOT Off-Ramp and On-Ramp	63.5	25.2
	H09-M	Merge Area at On-Ramp from I-495 HOT Lanes	63.6	19.4
Northbound I-395 GP	N01-B	I-95 NB Mainline through Springfield Interchange	53.9	10.8
	N02-B	I-95 NB Mainline through Springfield Interchange	53.8	14.5
	N03-W	Between Springfield Interchange and Edsall Road	50.4	22.2
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	43.1	27.6
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	43.4	26.9
	N06-M	Merge Area at Edsall Road On-Ramp	43.1	24.4
	N07-B	Between Edsall Road On-Ramp and Turkeycock Flyover Ramp	43.4	23.9
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	44.2	31.7
	N09-D	Diverge Area at Duke Street EB Off-Ramp	46.2	28.4
	N10-D	Diverge Area at Duke Street WB Off-Ramp	47.6	23.4
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	48.6	23.1
	N12-M	Merge Area at Duke Street WB On-Ramp	51.7	21.1
	N13-B	Between Duke Street and Seminary Road	52.9	28.0
	N14-D	Diverge Area at Seminary Road Off-Ramp	49.8	26.7
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	51.6	24.0
	N16-M	North of Seminary Road On-Ramp	52.6	19.9

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

Freeway Travel Time Analysis

Figure 7–1 plots average travel time trajectories of VISSIM model runs and field runs on southbound GP lanes in comparison with free flow conditions. In the southbound direction, travel time along I-395 from VA Route 7 King Street to I-95 is estimated at 756 seconds by the model, and was measured to be 768 seconds in the field. The overall difference in travel time between the model and field runs is less than two percent, which is within the allowable calibration criteria. In comparison, the free flow travel time on this section is 316 seconds, assuming a free flow speed of 65 mph. The southbound travel time during the PM peak hour is more than twice as long as that under free flow conditions. From the trajectories, the majority of the deviation is due to the bottleneck at the Duke Street interchange. After the Turkeycock Run slip ramp, the field/model trajectories largely parallel the free flow condition trajectory.

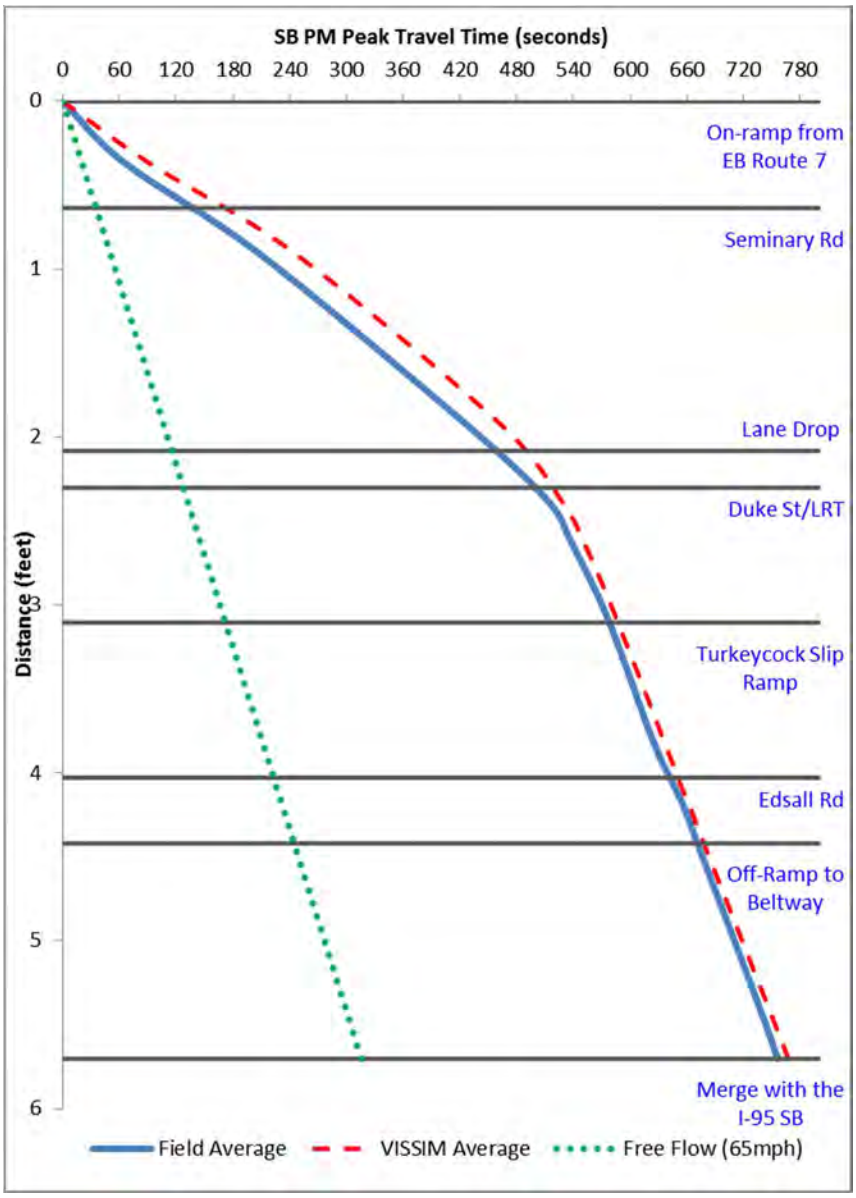


Figure 7–1: Southbound I-395 GP Lanes Travel Times, Existing PM Peak Hour

Freeway Speed Analysis

Figure 7–2 illustrates the southbound GP speed profiles from the VISSIM model in comparison to INRIX field data during the existing PM peak hour. The calibrated VISSIM models generally replicated the field-observed speeds on freeway mainline segments, especially the speed changes and queuing conditions at the southbound lane drop location. The field contour maps show more fluctuations than the speed outputs from the simulation model mainly because traffic demand in the field is more dynamic.

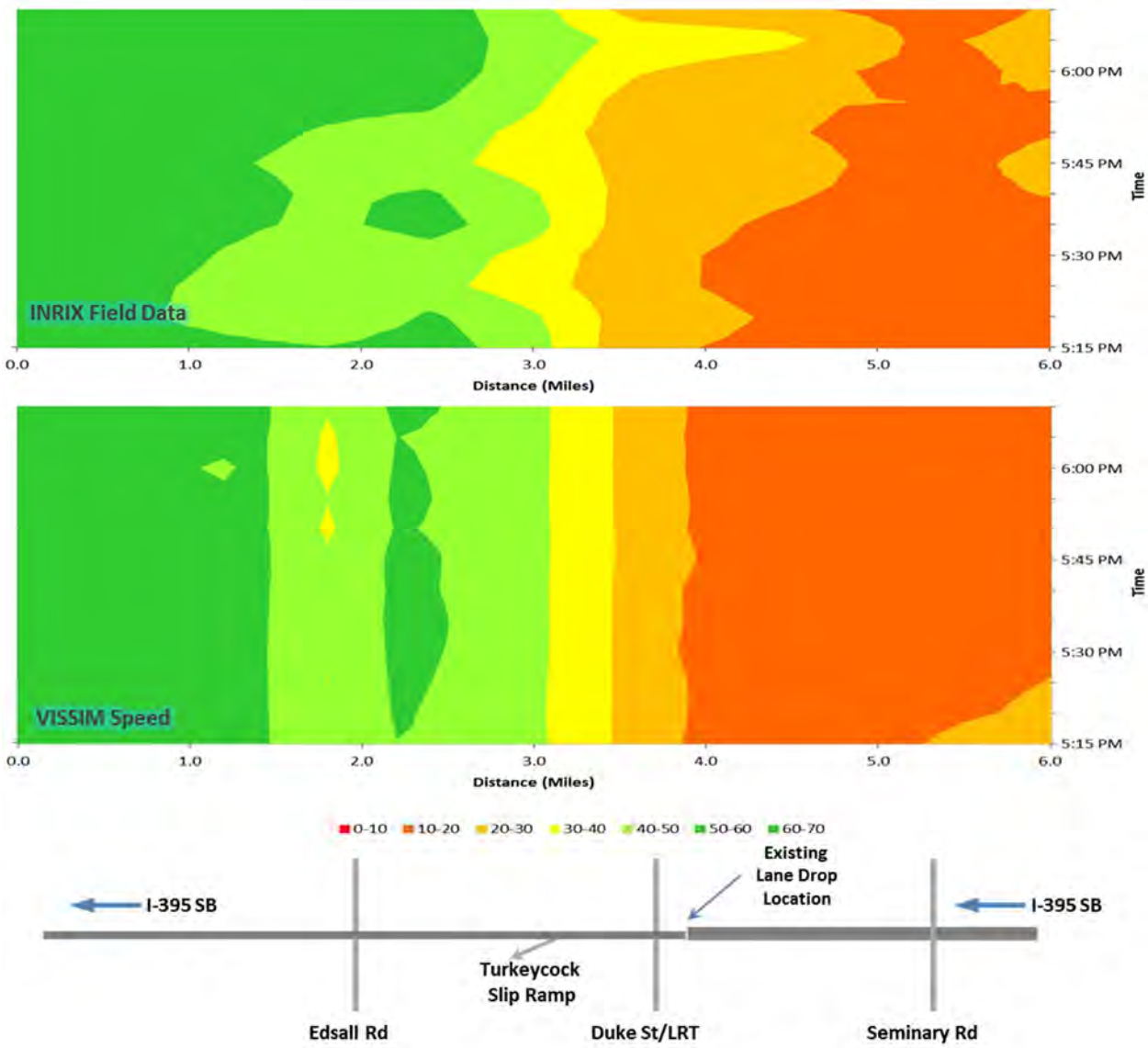


Figure 7–2: SB I-395 GP Speed Contour Maps (Field vs. VISSIM), Existing PM Peak Hour

The speed contours generally match the travel time trajectories, but present more detailed information of the congestion development at key bottleneck locations, two of which are located on

southbound I-395 during the PM peak hour:

- Seminary Road on-ramp merge area
- Lane drop near Duke Street interchange

Southbound I-395 Lane Drop near Duke Street Interchange

Currently, the southbound I-395 mainline drops from four to three lanes at the Duke Street interchange. This is a key bottleneck location along I-395 during the PM peak hour, and it is the focus point for the proposed improvements. Heavy southbound traffic is metered due to the capacity constraint of the mainline lane drop, and traffic flows frequently break down at this location during the entire PM peak period. On an average weekday, combined with other upstream bottlenecks, queues starting at this location consistently spill back beyond the Seminary Road interchange, and may extend as far as the Glebe Road interchange. Based on INRIX field data, the average travel speed is 10 mph to 20 mph throughout this section. In addition to the lane reduction, the close spacing of the interchanges further impedes traffic operations in this section.

After being discharged from the lane drop location, drivers are still unable to accelerate immediately back to their desired speeds. Southbound congestion continues between the Duke Street interchange and the Turkeycock Run HOV ramps. This is mainly because the close spacing of the Duke Street on-ramps, off-ramps, and the left-side slip ramp to the HOV lanes at Turkeycock Run results in frequent merging, diverging and weaving maneuvers. Thus, drivers maintain larger following distances and do not fully accelerate to desired speeds. The average travel speed is 20 mph to 30 mph in this section, and gradually rises to normal speeds after the diverge point of the HOV slip ramp at Turkeycock Run.

Seminary Road On-Ramp Merge Area

The other bottleneck location is at the Seminary Road entrance ramp merge area to southbound I-395. During the PM peak hour, more than 1,200 vehicles per hour from the nearby Mark Center and other parts of the City of Alexandria use this ramp to enter the already-congested southbound I-395 mainline. The result is frequent acceleration/deceleration and aggressive lane changing which leads to slow moving vehicles and queuing during the PM peak hour. According to INRIX field data, the average travel speed is 10 mph to 20 mph in this section. Moreover, the downstream queues from the lane drop at the Duke Street interchange quickly reach this location once the PM peak hour begins, further increasing the congestion at this bottleneck location.

Intersection Analysis

As listed in **Table 7–3**, all signalized intersections within the study area operate at LOS D or better during the existing PM peak hour, except for the intersection of Little River Turnpike and Beauregard Street. This intersection operates under a heavily congested condition (LOS E). At this intersection, maximum queues of the northbound and southbound approaches extend beyond the available storage distances. No other intersection approaches within the study area have queuing issues.

Table 7–3: Signalized Intersection Delays and LOS during Existing PM Peak Hour

No.	Intersection	2013 Existing	
		Average Delay (sec/veh)	Intersection LOS
1	Seminary Road & I-395 SB Off-Ramp	23.7	C
2	Seminary Road & I-395 SB On-Ramp	40.6	D
3	Seminary Road & I-395 NB Off-Ramp	18.2	B
4	Seminary Road & I-395 NB On-Ramp	13.8	B
6	Seminary Road & Mark Center Avenue	45.8	D
8	Little River Turnpike & Beauregard Street	68.9	E
9	Little River Turnpike & Oasis Drive	9.7	A
10	Duke Street & S Walker Street	23.6	C
11	Edsall Road & Mitchell Street	4.7	A
12	Edsall Road & Cherokee Avenue	12.5	B
13	Edsall Road & Bren Mar Drive	18.1	B
15	Edsall Road & Bloomfield Drive	5.7	A
16	Edsall Road & Beryl Road	1.2	A

[1] Detailed intersection analysis results by movements are provided in **Appendix H**.

AM Peak Hour

Freeway Analysis

Northbound is the peak direction of travel along I-395 during the AM peak hour. In existing conditions, the northbound GP mainline constantly experiences heavy to severe congestion throughout the entire study area. It takes an average of 577 seconds (9.6 minutes) for a vehicle to travel along northbound I-395 from the Springfield Interchange to the King Street off-ramp, nearly twice as long as under free flow conditions. **Table 7–4** presents the freeway analysis results during the existing AM peak hour. Heavy inbound travel demand and high interchange density on I-395 are the main contributing factors for congestion during the AM peak hour. Between the Springfield Interchange and Seminary Road, there are four merge sections within a four-mile span. Hourly volumes range from 700 to nearly 1,700 vehicles per on-ramp in the existing AM peak hour. Mainline traffic is forced to repeatedly slow down or stop at various locations along I-395 due to merging traffic. Northbound I-395 segments downstream of the study area are also severely congested on a recurring basis during the AM peak hour, and queues spill back to the study area. In addition, during the time of this study, there were multiple active construction zones along I-395, including those located at the northbound ramp overpass from the I-95 Express Lanes to the northbound GP lane; the northbound I-395 auxiliary lane located between Duke Street and Seminary Road; and the HOV reversible ramp at Seminary Road. These construction zones temporarily reduce the mainline capacities, primarily in the northbound direction, and increase the congestion severity.

In the northbound HOV and southbound GP lanes, there are no recurring operation issues found during the existing AM peak hour. None of these segments are congested. As indicated in **Figure 7–3**, average vehicle travel time in the southbound direction is close to the free flow condition.

Table 7–4: Freeway Operations, Existing AM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	63.9	16.3
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	64.1	16.7
	S03-M	Merge Area at Seminary Road On-Ramp	63.4	17.7
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	63.9	19.8
	S05-D	Diverge Area at WB Duke Street Off-Ramp	63.2	20.0
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	60.7	18.9
	S07-W	Between WB Duke Street On-Ramp and EB On-Ramp	47.8	30.1
	S08-B	Between EB Duke Street Off-Ramp and WB Edsall Road On-Ramp	48.9	31.4
	S08-M	Merge Area at EB Duke Street On-Ramp	48.3	33.0
	S09-B	Between EB Duke Street On-Ramp and WB Edsall Road Off-Ramp	51.6	30.2
	S10-D	Diverge Area at WB Edsall Road Off-Ramp	53.1	23.7
	S11-B	Between WB Edsall Road Off-Ramp and EB On-Ramp	52.7	29.4
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	50.2	29.4
	S12-W	Between Edsall Road and I-495 Ramp	53.2	21.4
	S12-D	Diverge Area at I-495 Inner Loop Ramp	57.2	11.4
	S13-D	Diverge Area at Franconia Ramp	52.1	23.3
	S14-B	I-95 SB Mainline through Springfield Interchange	53.3	23.8
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.5	19.6
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.3	19.4
Northbound I-395 HOV	H01-M	Seminary Road HOV On-Ramp	62.9	18.6
	H02-B	Between Turkeycock HOV On-Ramp and Seminary Road HOV On-Ramp	63.5	20.3
	H04-M	Turkeycock HOV On-Ramp	63.2	16.7
	H05-B	Between I-495 HOV On-Ramp and Turkeycock HOV On-Ramp	63.7	18.2
	H06-B	Between I-495 HOV On-Ramp and Turkeycock HOV On-Ramp	63.8	19.5
	H07-M	I-495 HOV On-Ramp	63.2	17.8
	H08-B	Between I-495 HOV Off-Ramp and HOV On-Ramp	62.0	19.3
	H09-D	I-495 HOV Off-Ramp	54.7	16.1
Northbound I-395 GP	N01-B	I-95 NB Mainline through Springfield Interchange	40.3	33.9
	N02-B	I-95 NB Mainline through Springfield Interchange	37.9	46.1
	N03-W	Between Springfield Interchange and Edsall Road	35.4	44.1
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	35.3	49.1
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	24.1	69.5
	N06-W	Between Edsall Road On-Ramp and Turkeycock HOV Ramp	22.9	71.4
	N08-B	Between Turkeycock Ramp and Duke Street EB Off-Ramp	29.3	64.4
	N09-D	Diverge Area at Duke Street EB Off-Ramp	26.5	64.6
	N10-D	Diverge Area at Duke Street WB Off-Ramp	18.0	86.5
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	15.6	107.7
	N12-M	Merge Area at Duke Street WB On-Ramp	19.6	79.6
	N13-B	Between Duke Street and Seminary Road	33.4	62.2
	N14-D	Diverge Area at Seminary Road Off-Ramp	48.2	39.9
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	47.1	40.2
	N16-M	North of Seminary Road On-Ramp	43.8	35.8

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

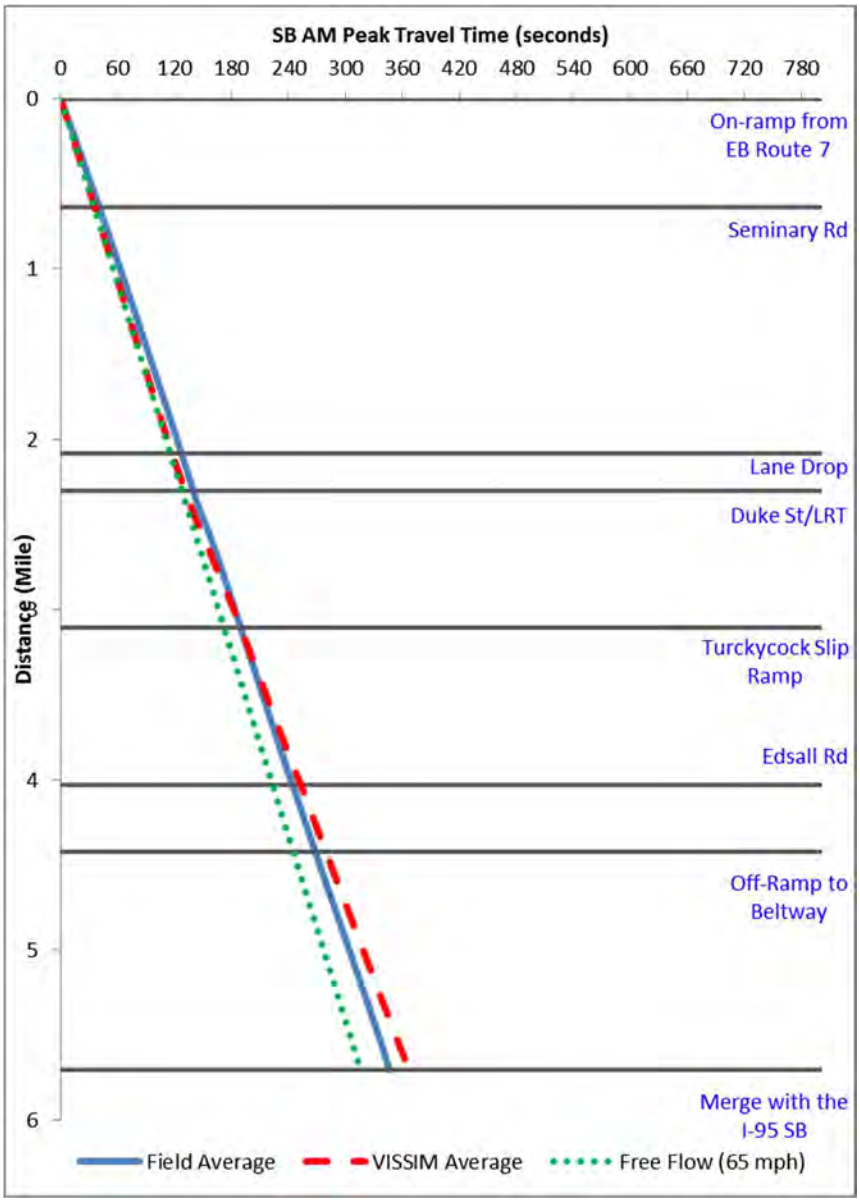


Figure 7–3: SB I-395 GP Lanes Travel Times, Existing AM Peak Hour

Intersection Analysis

Similar to the existing PM peak hour, the intersection of Little River Turnpike and Beauregard Street operates at LOS E during the existing AM peak hour. All other signalized intersections within the study area operate at LOS C or better. **Table 7-5** summarizes the delay and LOS during the AM peak hour. The only approach where the maximum queue exceeds the storage length is the southbound left turn approach at the intersection of Edsall Road and Cherokee Avenue.

Table 7–5: Signalized Intersection Delays and LOS, Existing AM Peak Hour

No.	Intersection	2013 Existing	
		Average. Delay (sec/veh)	Intersection LOS
1	Seminary Road & I-395 SB Off-Ramp	17.8	B
2	Seminary Road & I-395 SB On-Ramp	30.2	C
3	Seminary Road & I-395 NB Off-Ramp	21.6	C
4	Seminary Road & I-395 NB On-Ramp	21.0	C
6	Seminary Road & Mark Center Avenue	34.1	C
8	Little River Turnpike & Beauregard Street	58.7	E
9	Little River Turnpike & Oasis Drive	9.3	A
10	Duke Street & S Walker Street	19.8	B
11	Edsall Road & Mitchell Street	17.2	B
12	Edsall Road & Cherokee Avenue	11.6	B
13	Edsall Road & Bren Mar Drive	13.4	B
15	Edsall Road & Bloomfield Drive	7.8	A
16	Edsall Road & Beryl Road	7.2	A

[1] Detailed intersection analysis results by movements are provided in **Appendix H**.

7.1.2.2 Opening Year (2020) Conditions (No-Build vs. Build)

PM Peak Hour

Freeway Demand and Throughput Analysis

Table 7–6 provides a summary of projected demand during the 2020 PM peak hour for both the No-Build and Build conditions on southbound I-395.

Table 7–6: 2020 PM Peak Hour Demand in Southbound GP Lanes

Southbound I-395 GP Segment	2020 No-Build Demand	2020 Build Demand	Difference (%)
North of Seminary Rd. Interchange	6,731	7,230	7%
Between Seminary Rd. Interchange and Duke St. Interchange	7,250	7,875	9%
Between Duke St. Interchange and Turkeycock Run Ramps	6,724	6,834	2%
Between Turkeycock Run Ramps and Edsall Rd. Interchange	5,516	6,236	13%
Between Edsall Rd. Interchange and I-495	6,132	6,759	10%
South of I-495	6,437	6,710	4%

As discussed in the previous chapters, the I-95/395 Express Lanes opened in December 2014, which is expected to change peak hour traffic patterns within the study area over time. It is expected that portions of GP traffic will shift to the Express Lanes in the 2020 No-Build conditions, resulting in a slight decline in GP lane demand on the segments south of the Turkeycock Run Express ramps. In

the 2020 Build conditions, the proposed southbound additional through lane is expected to induce more traffic to the GP lanes. Therefore, the demand in the GP lanes in the southbound direction during the PM peak hour is projected to be 2%-14% higher in the Build conditions as compared to the No-Build conditions. **Figure 7–4** compares the vehicle throughputs and unserved demand percentages by segments on the southbound GP mainline during the PM peak hour between the 2020 No-Build and Build conditions. In the 2020 PM Peak No-Build Condition, between 1.5%-5% of demand between Seminary Road and I-495 is unserved. The Build Condition would reduce unserved demand between the Seminary Road and Edsall Road Interchanges (to 0.4%-1.9%).

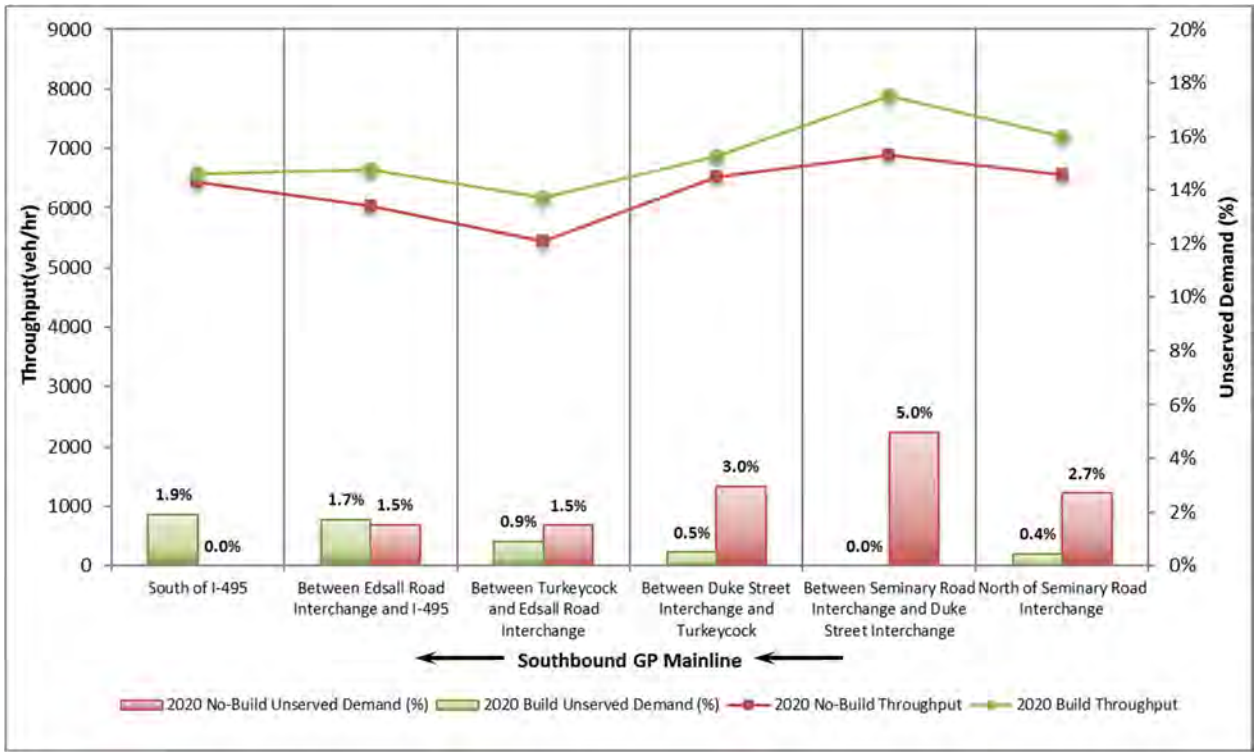


Figure 7–4: SB I-395 GP Lanes PM Peak Hour Throughput/Unserved Demand in 2020 (No-Build vs. Build)

Freeway Density and Congestion Level Analysis

The traffic operations on I-395 during the 2020 PM peak hour under No-Build and Build conditions are summarized in **Table 7–7** and **Table 7–8**, respectively. The congestion level diagrams are presented in **Figure 7–5**.

Table 7–7: Freeway Operations, 2020 No-Build PM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	13.4	101.1
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	12.1	119.9
	S03-M	Merge Area at Seminary Road On-Ramp	15.3	106.2
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	17.4	101.8
	S05-D	Diverge Area at WB Duke Street Off-Ramp	17.4	101.5
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	20.3	77.5
	S07-W	Between WB Duke Street On-Ramp and EB On-Ramp	43.5	44.5
	S08-W	Between EB Duke Street On-Ramp and Turkeycock Slip Ramp	47.2	43.9
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	53.4	34.0
	S10-W	Between Turkeycock Flyover Ramp and Edsall Road Off-Ramp	52.9	28.4
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	48.1	34.0
	S12-W	Between Edsall Road and I-495 Ramp	52.4	24.6
	S12-D	Diverge Area at I-495 Inner Loop Ramp	53.7	14.2
	S13-D	Diverge Area at Franconia Ramp	50.5	26.8
	S14-B	I-95 SB Mainline through Springfield Interchange	53.3	21.7
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	22.7
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.2	20.9
Southbound I-395 HOV/ Express	H00-D	North of Seminary Road HOV Off-Ramp	63.6	16.9
	H01-B	Between Seminary Road HOV Off-Ramp and HOV On- Ramp	63.9	18.4
	H02-M	Merge from Seminary Road HOV On-Ramp	62.2	20.1
	H02-B	Between Seminary Road HOV On-Ramp and Turkeycock Flyover Ramp	63.1	23.6
	H03-D	Diverge Area at Turkeycock Flyover Ramp	63.4	23.5
	H04-B	Between Turkeycock Flyover Ramp and Slip Ramp	63.6	22.1
	H05-M	Merge Area at Turkeycock Slip Ramp	62.3	19.6
	H06-B	Between Turkeycock Slip Ramp and Off-Ramp to I-495 HOT Lanes	63.6	21.4
	H07-D	Diverge Area at Off-Ramp to I-495 HOT Lanes	62.1	20.2
	H08-B	Between I-495 HOT Off-Ramp and On-Ramp	63.8	16.5
	H09-M	Merge Area at On-Ramp from I-495 HOT Lanes	63.5	18.6
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.9	11.6
	N02-B	I-95 NB mainline through Springfield Interchange	53.8	15.4
	N03-W	Between Springfield Interchange and Edsall Road	52.5	21.6
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.7	24.1
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.5	23.3
	N06-M	Merge Area at Edsall Road On-Ramp	52.6	21.4
	N07-B	Between Edsall Road On-Ramp and Turkeycock Flyover Ramp	52.6	21.1
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	52.6	28.4
	N09-D	Diverge Area at Duke Street EB Off-Ramp	51.9	21.5
	N10-D	Diverge Area at Duke Street WB Off-Ramp	52.6	18.5
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	53.2	21.8
	N12-M	Merge Area at Duke Street WB On-Ramp	52.9	21.9
	N13-B	Between Duke Street and Seminary Road	53.2	22.2
	N14-D	Diverge Area at Seminary Road Off-Ramp	51.0	20.9
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	51.2	25.7
	N16-M	North of Seminary Road On-Ramp	52.5	20.7

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

Table 7–8: Freeway Operations, 2020 Build PM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)	LOS
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	52.3	28.3	D
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	53.0	30.6	D
	S03-M	Merge Area at Seminary Road On-Ramp	51.9	34.3	D
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	48.2	43.4	E
	S05-D	Diverge Area at Duke Street Off-Ramp	51.7	34.6	D
	S06-B	Between Duke Street Off-Ramp and WB On-Ramp	51.4	31.2	D
	S08-W	Between Duke Street WB On-Ramp and Turkeycock Slip Ramp	47.6	34.1	D
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	53.5	26.3	D
	S10-B	After Turkeycock Flyover Ramp	53.3	23.8	C
	S10-D	Diverge at Edsall Road WB Off-Ramp	51.7	24.2	C
	S11-B	Between Edsall Road WB Off-Ramp and EB Off-Ramp	52.1	22.1	C
	S12-B	Between Edsall EB Off Ramp and On Ramp	52.3	26.3	D
	S12-W	Between Edsall Road and I-495 Ramp	51.8	26.8	C
	S12-D	Diverge Area at I-495 Inner Loop Ramps	52.8	16.6	B
	S13-D	Diverge Area at Franconia Ramp	52.7	27.5	C
	S14-B	I-95 SB Mainline through Springfield Interchange	53.4	22.7	C
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	23.3	C
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.2	21.3	C
Southbound I-395 HOV/ Express	H00-D	North of Seminary Road HOV Off-Ramp	63.7	16.8	B
	H01-B	Between Seminary Road HOV Off-Ramp and On-Ramp	63.9	18.3	C
	H02-M	Merge Area at Seminary Road HOV On-Ramp	62.0	20.4	C
	H02-B	Between Seminary Road HOV On-Ramp and Turkeycock Flyover Ramp	63.4	23.7	C
	H03-D	Diverge Area at Turkeycock Flyover Ramp	63.4	23.6	C
	H04-B	Between Turkeycock Flyover Ramp and Slip Ramp	63.6	22.2	C
	H05-M	Merge Area at Turkeycock Slip Ramp	62.1	20.6	C
	H06-B	Between Turkeycock Slip Ramp and Off-Ramp to I-495 HOT Lanes	63.6	22.4	C
	H07-D	Diverge Area at Off-Ramp to I-495 HOT Lanes	62.1	21.0	C
	H08-B	Between I-495 HOT Off-Ramp and On-Ramp	63.8	17.4	B
	H09-M	Merge Area at On-Ramp from I-495 HOT Lanes	63.6	18.3	B
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.9	11.5	B
	N02-B	I-95 NB mainline through Springfield Interchange	53.8	15.3	B
	N03-W	Between Springfield Interchange and Edsall Road	52.5	21.7	C
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.6	24.3	C
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.5	23.3	C
	N06-M	Merge Area at Edsall Road On-Ramp	52.7	21.2	C
	N07-B	Between Edsall Road On-Ramp and Turkeycock Flyover Ramp	52.6	21.0	C
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	52.7	28.3	D
	N09-D	Diverge Area at Duke Street EB Off-Ramp	52.0	21.4	C
	N10-D	Diverge Area at Duke Street WB Off-Ramp	52.5	18.6	B
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	53.2	21.8	C
	N12-M	Merge Area at Duke Street WB On-Ramp	52.9	22.0	C
	N13-B	Between Duke Street and Seminary Road	53.2	22.2	C
	N14-D	Diverge Area at Seminary Road Off-Ramp	51.1	20.8	C
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	51.2	25.9	C
	N16-M	North of Seminary Road On-Ramp	52.4	21.1	C

Severely congested condition Heavily congested condition Moderate traffic condition Light traffic condition

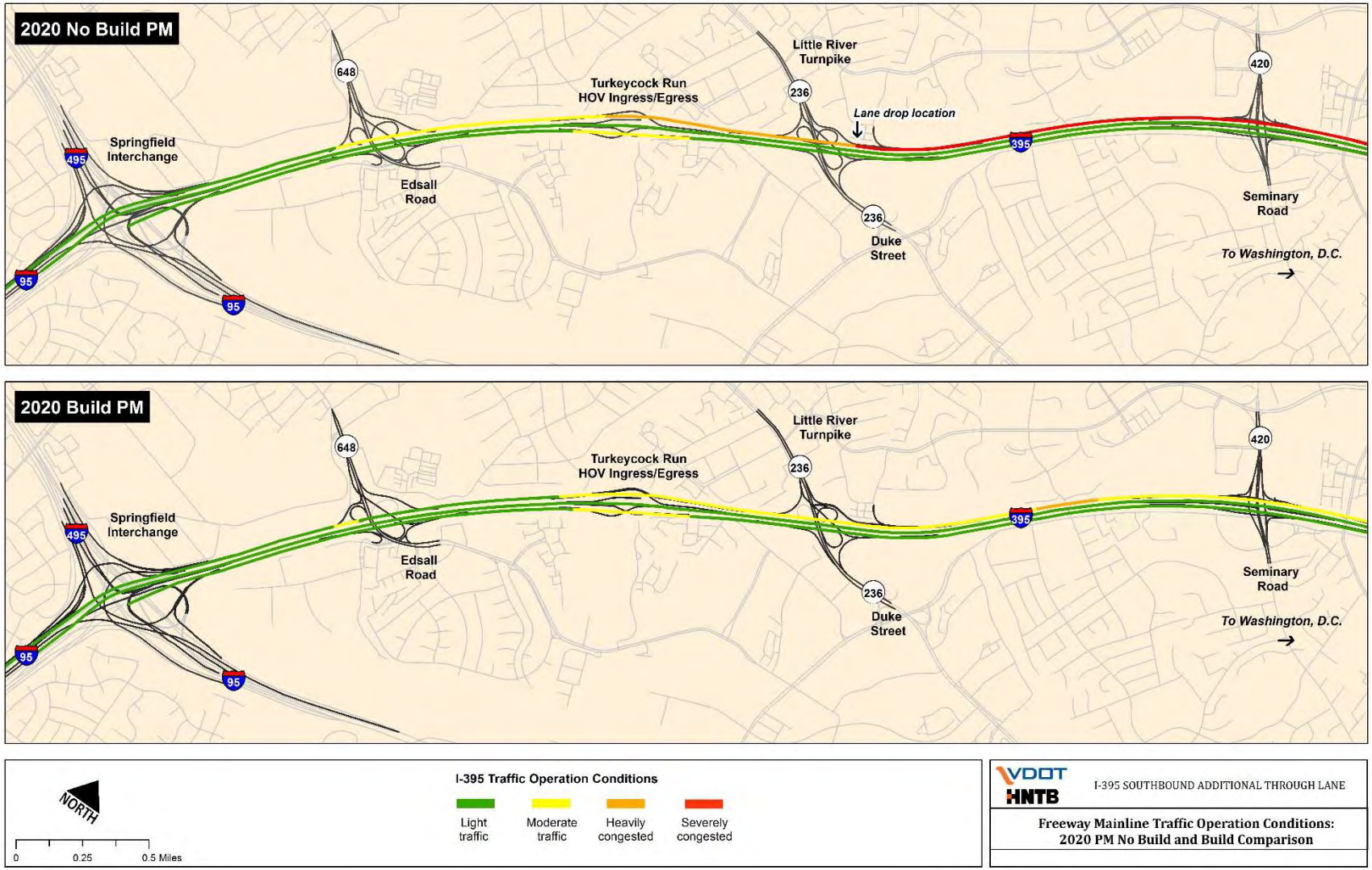


Figure 7–5: Freeway Operations, 2020 PM Peak Hour (No-Build vs. Build)

The changes in congestion levels generally match with the changes in traffic demand discussed in the previous section. In the 2020 No-Build conditions, the lane drop near the Duke Street interchange will continue to cause severe traffic congestion on all upstream segments. The vehicle

densities in the 2020 No-Build conditions will be slightly higher than the existing conditions. However, segments south of the Turkeycock Run Express ramp will experience improved traffic operations, due to traffic diverting to the Express Lanes at Turkeycock Run. Similar to the existing conditions, most of the northbound GP lanes and the southbound Express Lanes in the PM peak hour will remain uncongested.

In the 2020 Build conditions, the proposed southbound improvements will provide an additional through lane between Duke Street and Edsall Road. Therefore, the southbound travel demand will no longer be metered at this location during the PM peak hour. VISSIM analysis results show that with the elimination of the bottleneck, traffic operations on most segments upstream of the existing bottleneck are expected to improve in the 2020 Build PM peak hour in comparison with the No-Build conditions. The only exception is the segment between the Seminary Road and Duke Street interchanges. Travel demand is projected to be over 7,800 vehicles per hour, the highest among all southbound segments in the PM peak hour. Although this segment will be heavily congested, vehicle density will be decreased from over 100 passenger-cars per lane per mile (pc/ln/mi) in the 2020 No-Build conditions to 44 pc/ln/mi in the 2020 Build conditions.

In all, the percentage of southbound GP freeway segments under heavy or severe congestion in the PM peak hour will reduce from 50% in the 2020 No-Build conditions to 6% in the Build conditions, as illustrated in **Figure 7–6**.

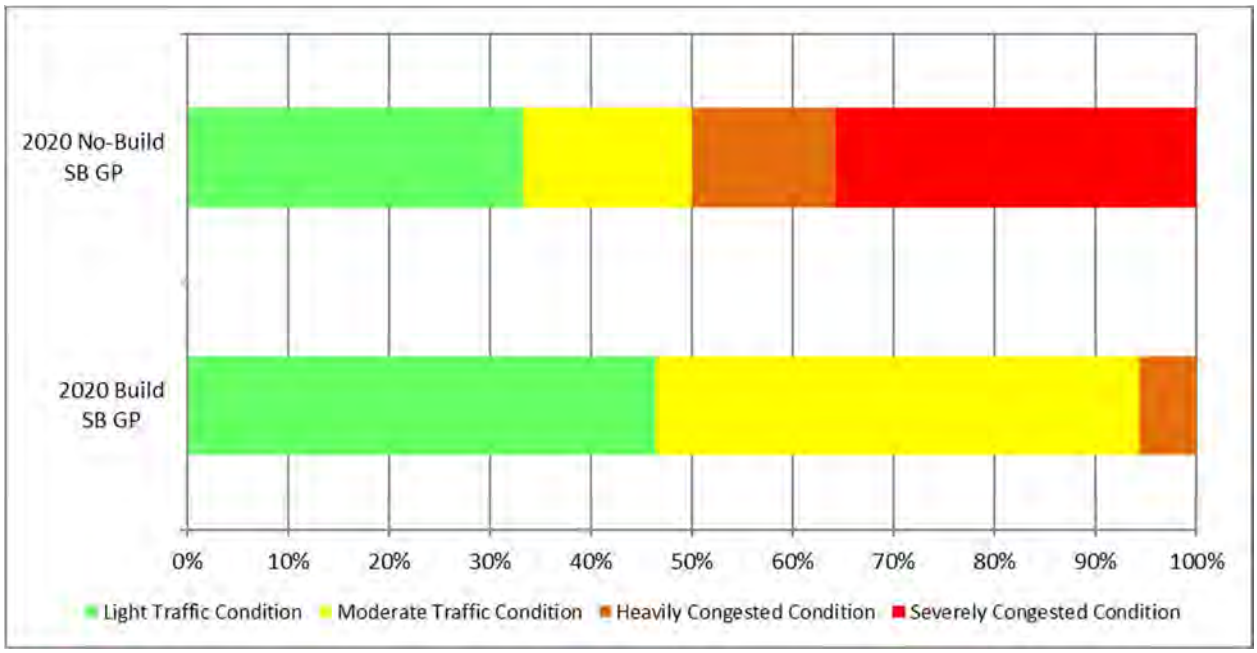


Figure 7–6: Congestion Levels by Percent Length of SB I-395, 2020 PM Peak Hour (No-Build vs. Build)

Freeway Travel Time Analysis

Figure 7–7 compares the PM peak hour travel time trajectories on southbound I-395 among free flow, existing, 2020 No-Build, and 2020 Build conditions.

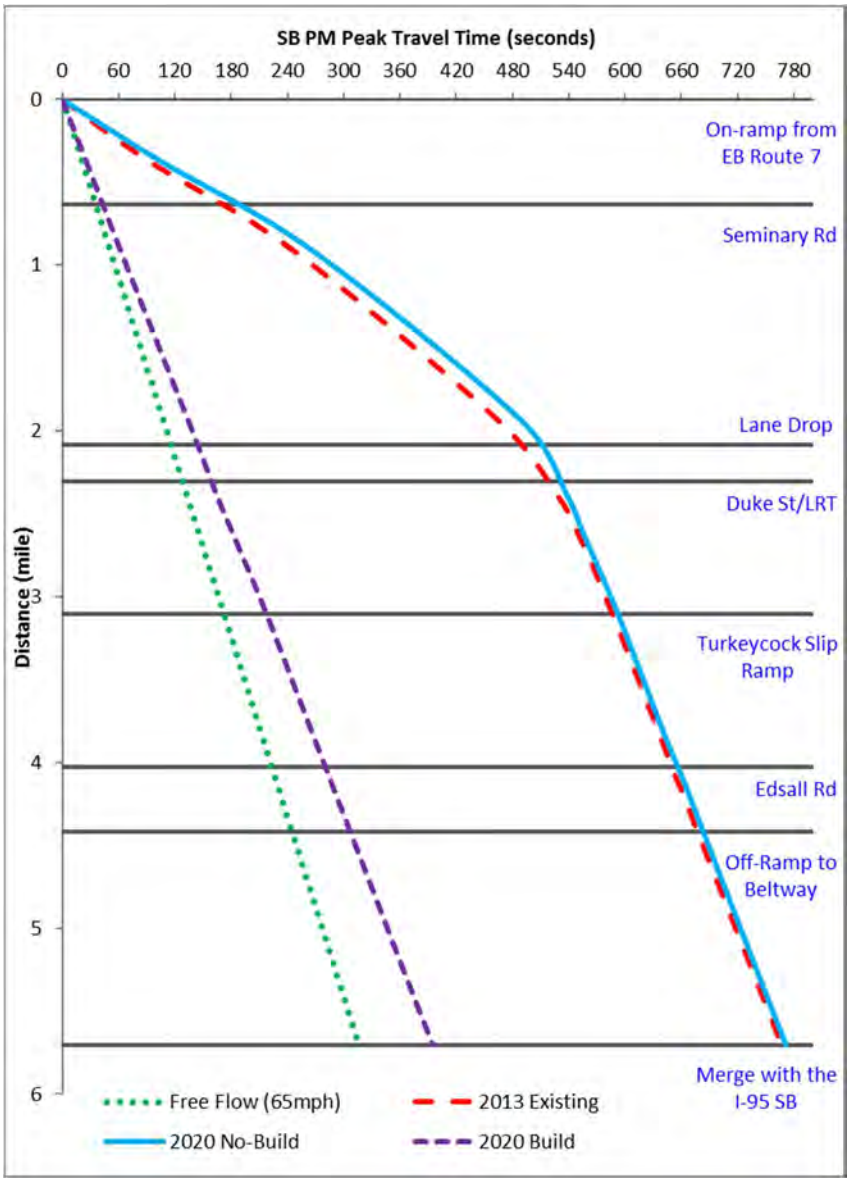


Figure 7–7: SB I-395 GP Lanes Travel Times, 2020 PM Peak Hour (No-Build vs. Build)

Travel times in the southbound GP lanes are almost the same in the 2020 No-Build conditions as in the existing conditions during the PM peak hour with less than one percent difference. In contrast, travel times in the southbound GP lanes are projected to decrease from 770 seconds (12.8 minutes) in the 2020 No-Build conditions to less than 400 seconds (6.6 minutes) in the 2020 Build conditions. A vehicle traveling on southbound I-395 is expected to have a 49% reduction in travel time under the Build conditions as compared to the No-Build conditions. In addition, the 2020 Build condition travel times are 25% higher than free flow conditions. The majority of the travel time savings are seen on the segments north of the Duke Street interchange.

The travel times on the northbound GP mainline between the 2020 No-Build and Build conditions during the PM peak hour are the same. Both the 2020 No-Build and Build conditions result in an approximately 10% decrease in travel time as compared with the existing conditions travel time. This reduction is primarily due to the existing construction projects in the northbound direction, and the addition of a northbound auxiliary lane between Duke Street and Seminary Road.

Freeway Speed Analysis

Figure 7–8 compares the average speed contours for the southbound I-395 GP lanes under 2020 No-Build and Build conditions. In general, traffic flows are expected to be less congested during the PM peak hour under the 2020 Build conditions as compared with the 2020 No-Build conditions. Vehicle speeds increase at both bottlenecks under the 2020 Build conditions.

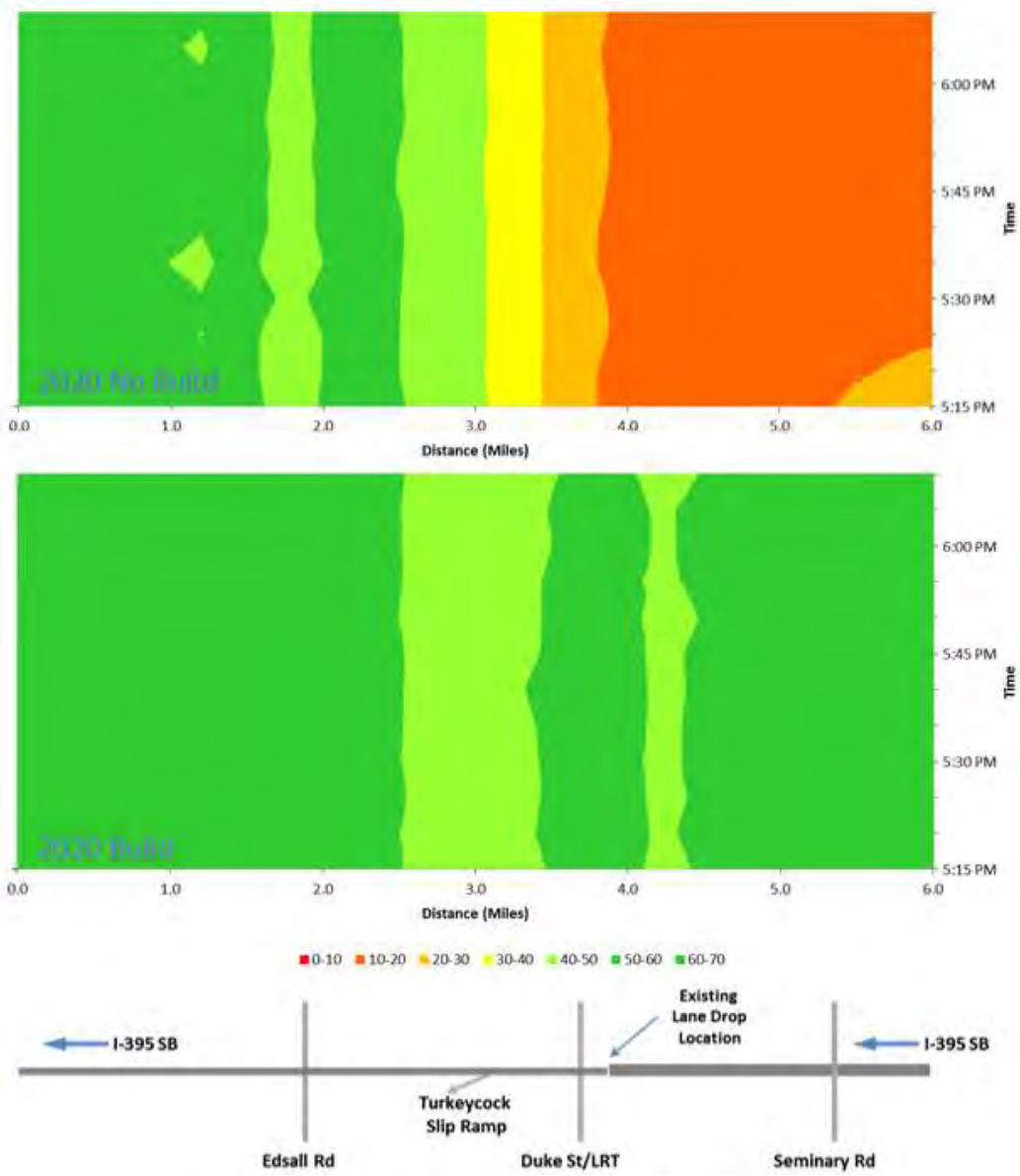


Figure 7–8: SB I-395 GP Speed Contour Maps, 2020 PM Peak Hour (No-Build vs. Build)

In the 2020 No-Build condition, southbound congestion is caused by the same factors as evidenced under the existing conditions. The two southbound bottlenecks will remain at their existing locations: the Seminary Road on-ramp merge area and the lane drop location near the Duke Street interchange. The average speeds will remain consistently lower than 20 mph upstream of the lane drop location, and the queue will spill back beyond the Seminary Road interchange in the 2020 No-Build conditions.

With the additional through lane, the bottleneck on southbound I-395 at the Duke Street interchange is expected to be eliminated. Traffic will no longer be metered by the lane drop at this location. As a result, average speeds are expected to increase to 40 mph to 50 mph north of the Turkeycock Run Express ramp in the 2020 Build conditions.

Intersection Analysis

The Preferred Alternative will have no adverse impacts on the crossing arterials and intersections during the PM peak hour under 2020 Build conditions. As summarized in **Table 7–9**, all intersections within the study area, except for Edsall Road at Bren Mar Drive, will operate at the similar or better LOS in the 2020 Build conditions as compared to the 2020 No-Build conditions. Queuing lengths at all intersections in the Build conditions will be similar to those in the No-Build conditions. Maximum queue lengths will extend beyond the storage distance at the intersection of Little River Turnpike and Beauregard Street, which is an existing issue.

Table 7–9: Signalized Intersection Delays and LOS, 2020 PM Peak Hour (No-Build vs. Build)

No.	Intersection	2020 No Build		2020 Build	
		Avg. Delay (sec/veh)	Int LOS	Avg. Delay (sec/veh)	Int LOS
1	Seminary Road & I-395 SB Off-Ramp	20.4	C	21.3	C
2	Seminary Road & I-395 SB On-Ramp	39.0	D	36.8	D
3	Seminary Road & I-395 NB Off-Ramp	23.2	C	22.3	C
4	Seminary Road & I-395 NB On-Ramp	19.8	B	20.7	C
6	Seminary Road & Mark Center Avenue	62.1	E	38.5	D
8	Little River Turnpike & Beauregard Street	78.8	E	77.8	E
9	Little River Turnpike & Oasis Drive	43.0	D	19.9	B
10	Duke Street & S Walker Street	45.3	D	29.6	C
11	Edsall Road & Mitchell Street	6.1	A	5.1	A
12	Edsall Road & Cherokee Avenue	13.3	B	12.5	B
13	Edsall Road & Bren Mar Drive	19.0	B	20.4	C
15	Edsall Road & Bloomfield Drive	6.3	A	6.1	A
16	Edsall Road & Beryl Road	5.9	A	6.0	A
17	Seminary Road & I-395 BRAC HOV Ramp[1]	4.7	A	6.1	A
18	Little River Turnpike & I-395 SB Off-Ramp[2]	---	---	13.7	B
19	Edsall Road & I-395 SB Off-Ramp[2]	---	---	4.1	A

[1] New signalized intersections in 2020 No-Build conditions.
[2] New signalized intersection in 2020 Build conditions.
[3] Detailed intersection analysis results by movements are provided in **Appendix H**.

The 2020 Build conditions include two new signalized intersections at the ramp termini of Little River Turnpike and the southbound off-ramp, and Edsall Road and the southbound on-ramp. **Table 7–10** summarizes the operational performance at these two intersections in the 2020 Build conditions. Both intersections will operate at LOS B or better with all movements at LOS D or better. In addition, the maximum queue lengths will not exceed the available storage lengths any approaches.

Table 7–10: New Intersections at Ramp Termini, 2020 Build PM Peak Hour

Intersection	Movement	Avg. Delay (sec)	LOS	Int Delay (sec)	Int LOS	Storage (ft)	Max. Queue (ft)
Little River Turnpike & I-395 SB Off-Ramp	EBT	8.6	A	13.7	B	780	619
	WBT	15.3	B			950	601
	SBL	35.2	D			660	366
	SBR	0.8	A			920	226
Edsall Road & I-395 SB On-Ramp	EBT	5.0	A	4.1	A	975	140
	EBR	1.6	A			650	0
	WBL	16.0	B			650	359
	WBT	0.2	A			900	0

The 2020 Build conditions include an unsignalized intersection where eastbound vehicles on Duke Street destined for the Express Lanes, execute a U-turn movement with a dedicated turn bay. The turn bay is located between the ramp from westbound Duke Street to I-395 GP northbound and the loop ramp from I-395 GP northbound to westbound Duke Street. The overall intersection will operate at LOS A with the U-turn movement at LOS E with an average delay of 45.1 seconds as show in **Table 7-11.**

Table 7–11: Duke Street U-turn, 2020 PM Peak Hour

Intersection	Movement	Avg. Delay (sec)	LOS	Int Delay (sec)	Int LOS	Storage (ft)	Max. Queue (ft)
Duke Street U-turn	EB U-turn	48.7	E	2.0	A	180	106
	WBT	0.8	A			550	66

AM Peak Hour

Freeway Analysis

Table 7–12 and **Table 7–13** summarize traffic operations on I-395 during the 2020 AM peak hour for the No-Build and Build conditions, respectively.

In 2020, traffic operations on northbound I-395 GP lanes will be similar under No-Build and Build conditions. Only three segments will be heavily to severely congested, and traffic on the majority of the northbound GP lanes will have light to moderate traffic. As mentioned previously, three projects were completed by 2016. Therefore, traffic impacts due to the current construction zones will be removed by 2020. In addition, this series of improvements will help in relieving northbound congestion in the AM peak hour.

Table 7–12: Freeway Operations, 2020 No-Build AM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	63.7	17.2
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	64.1	17.1
	S03-M	Merge Area at Seminary Road On-Ramp	63.4	18.2
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	63.8	20.5
	S05-D	Diverge Area at WB Duke Street Off-Ramp	63.3	20.6
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	60.7	19.4
	S07-W	Between WB Duke Street On-Ramp and EB On-Ramp	47.4	31.2
	S08-M	Between EB Duke Street On-Ramp and Turkeycock Slip Ramp	47.8	34.6
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	51.5	31.3
	S10-D	Between Turkeycock Flyover Ramp and Edsall Road Off-Ramp	53.0	24.5
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	50.1	30.3
	S12-W	Between Edsall Road and I-495 Ramp	52.7	22.3
	S12-D	Diverge Area at I-495 Inner Loop Ramp	53.8	12.4
	S13-D	Diverge Area at Franconia Ramp	51.7	24.0
	S14-B	I-95 SB Mainline through Springfield Interchange	53.1	24.6
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	21.7
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.3	20.9
Northbound I-395 HOV/ Express	H00-M	Seminary Road HOV On-Ramp	62.8	18.8
	H01-B	Between Seminary Road HOV Off-Ramp andHOV On- Ramp	62.5	20.4
	H02-D	Seminary Road HOV Off-Ramp	52.4	23.7
	H02-B	Between Seminary Road HOV Off-Ramp and Turkeycock Flyover Ramp	60.7	23.1
	H04-M	Between Turkeycock Flyover HOV Off-Ramp and On-Ramp	63.4	18.9
	H05-B	Between Turkeycock Ramps	61.9	20.6
	H06-B	Between Turkeycock Off-Ramp to I-495	63.0	19.5
	H07-M	I-495 Express Lanes On-Ramp	62.6	18.3
	H08-B	Between I-495 Express Lanes Ramps	64.0	16.4
	H09-D	I-495 Express Lanes Off-Ramp	63.7	18.9
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.3	20.4
	N02-B	I-95 NB mainline through Springfield Interchange	53.1	27.2
	N03-W	Between Springfield Interchange and Edsall Road	51.1	28.5
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.4	30.1
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.4	28.5
	N06-W	Weave Area at Edsall Road On-Ramp	52.3	26.4
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	48.5	35.9
	N09-D	Diverge Area at Duke Street EB Off-Ramp	50.7	29.7
	N10-D	Diverge Area at Duke Street WB Off-Ramp	51.2	28.4
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	52.8	34.7
	N12-M	Merge Area at Duke Street WB On-Ramp	52.5	33.1
	N13-B	Between Duke Street and Seminary Road	52.5	33.1
	N14-D	Diverge Area at Seminary Road Off-Ramp	50.3	31.4
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	42.5	46.8
	N16-M	North of Seminary Road On-Ramp	40.5	40.1

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

Table 7–13: Freeway Operations, 2020 Build AM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	63.6	17.2
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	64.0	17.2
	S03-M	Merge Area at Seminary Road On-Ramp	62.5	18.5
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	63.8	20.5
	S05-D	Diverge Area at Duke Street Off-Ramp	63.9	18.3
	S06-B	Between Duke Street Off-Ramp and WB On-Ramp	63.5	16.4
	S08-M	Merge Area at WB Duke Street On-Ramp	63.4	15.8
	S09-B	Between Duke WB On-Ramp and Flyover Ramp	58.6	19.6
	S10-B	After Turkeycock Flyover Ramp	53.5	19.4
	S10-D	Diverge at Edsall Road WB Off-Ramp	52.4	19.7
	S11-B	Between Edsall Road WB Off-Ramp and EB Off-Ramp	52.6	18.3
	S12-B	Between Edsall EB Off Ramp and On Ramp	53.1	21.6
	S12-W	Between Edsall Road and I-495 Ramp	52.8	21.8
	S12-D	Diverge Area at I-495 Inner Loop Ramps	56.8	11.8
	S13-D	Diverge Area at Franconia Ramp	51.6	24.0
	S14-B	I-95 SB Mainline through Springfield Interchange	53.3	24.6
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	21.7
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.3	20.9
Southbound I-395 HOV/ Express	H00-M	Seminary Road HOV On-Ramp	62.8	18.7
	H01-B	Between Seminary Road HOV Off-Ramp and HOV On- Ramp	62.3	20.5
	H02-D	Seminary Road HOV Off-Ramp	50.3	25.6
	H02-B	Between Seminary Road HOV Off-Ramp and Turkeycock Flyover Ramp	60.1	23.1
	H04-M	Between Turkeycock Flyover HOV Off-Ramp and On-Ramp	63.3	18.9
	H05-B	Between Turkeycock Ramps	61.8	20.6
	H06-B	Between Turkeycock Off-Ramp to I-495	62.6	19.5
	H07-M	I-495 Express Lanes On-Ramp	62.4	18.3
	H08-B	Between I-495 Express Lanes Ramps	62.2	16.8
	H09-D	I-495 Express Lanes Off-Ramp	57.9	18.0
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.3	20.4
	N02-B	I-95 NB mainline through Springfield Interchange	53.1	27.2
	N03-W	Between Springfield Interchange and Edsall Road	51.1	28.5
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.4	30.1
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.6	28.4
	N06-W	Merge Area at Edsall Road On-Ramp	52.6	26.2
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	51.3	33.9
	N09-D	Diverge Area at Duke Street EB Off-Ramp	52.3	28.9
	N10-D	Diverge Area at Duke Street WB Off-Ramp	50.4	28.9
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	52.5	34.8
	N12-M	Merge Area at Duke Street WB On-Ramp	52.5	33.0
	N13-B	Between Duke Street and Seminary Road	52.7	33.0
	N14-D	Diverge Area at Seminary Road Off-Ramp	49.2	31.8
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	40.4	48.9
	N16-M	North of Seminary Road On-Ramp	39.6	41.3

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

In the northbound Express Lanes and southbound GP lanes, VISSIM analysis results show that traffic flows under the 2020 Build conditions will be similar to or slightly better than the 2020 No-Build conditions. The entire southbound GP facility will be under light traffic conditions in the 2020 Build conditions, as compared to light and moderate traffic conditions in the 2020 No-Build conditions.

Intersection Analysis

Table 7–14 compares the traffic performance at intersections between the 2020 No-Build and Build conditions. All intersections will operate at the same LOS under both conditions, with the exception of the intersection of Seminary Road and the southbound I-395 on-ramp which will degrade from LOS C to LOS D. As summarized in **Table 7–15,** the two new intersections under the Build conditions will operate at LOS B or better with all movements at LOS C or better. The queues for the westbound left turn at the proposed intersection of the Edsall Road to southbound I-395 on-ramp will occasionally spill beyond the available storage length. However, the average queue length of 133 feet is within the available storage length.

No vehicles are anticipated to make the U-turn on Duke Street during the AM Peak Hour as the HOV/HOT lanes operate in the northbound direction in the morning peak.

Table 7–14: Signalized Intersection Delay and LOS, 2020 AM Peak Hour (No-Build vs. Build)

No.	Intersection	2020 No Build		2020 Build	
		Avg. Delay (sec/veh)	Int LOS	Avg. Delay (sec/veh)	Int LOS
1	Seminary Road & I-395 SB Off-Ramp	18.3	B	18.0	B
2	Seminary Road & I-395 SB On-Ramp	32.8	C	41.1	D
3	Seminary Road & I-395 NB Off-Ramp	20.2	C	24.6	C
4	Seminary Road & I-395 NB On-Ramp	22.0	C	17.9	B
6	Seminary Road & Mark Center Avenue	36.5	D	37.9	D
8	Little River Turnpike & Beauregard Street	59.1	E	58.8	E
9	Little River Turnpike & Oasis Drive	13.8	B	11.9	B
10	Duke Street & S Walker Street	18.9	B	18.9	B
11	Edsall Road & Mitchell Street	11.6	B	11.3	B
12	Edsall Road & Cherokee Avenue	12.3	B	11.9	B
13	Edsall Road & Bren Mar Drive	17.7	B	16.0	B
15	Edsall Road & Bloomfield Drive	15.8	B	15.3	B
16	Edsall Road & Beryl Road	5.8	A	5.6	A
17	Seminary Road & I-395 BRAC HOV Ramp[1]	10.6	B	11.0	B
18	Little River Turnpike & I-395 SB Off-Ramp[2]	---	---	11.9	B
19	Edsall Road & I-395 SB Off-Ramp[2]	---	---	9.3	A

[1] New signalized intersections in 2020 No-Build conditions.
[2] New signalized intersection in 2020 Build conditions.
[3] Detailed intersection analysis results by movements are provided in **Appendix H**.

Table 7–15: New Intersections at Ramp Termini, 2020 Build AM Peak Hour

Intersection	Movement	Avg. Delay (sec)	LOS	Int Delay (sec)	Int LOS	Storage (ft)	Max. Queue (ft)
Little River Tpke & I-395 SB Off-Ramp	EBT	4.7	A	11.8	B	780	0
	WBT	12.9	B			950	508
	SBL	31.4	C			660	274
	SBR	0.0	A			920	0
Edsall Rd & I-395 SB On-Ramp	EBT	13.6	B	9.4	A	975	221
	EBR	1.1	A			650	0
	WBL	32.3	C			650	707
	WBT	0.2	A			900	0

[1] Through movement storage lengths are the distances to the upstream controlling points.
[2] The LTR southbound off-ramp turning movement lengths are the distance to the ramp physic gore point.

7.1.2.3 Year 2025 Build Conditions: Duke Street Analysis

A quick analysis of the four intersections along Duke Street/Little River Turnpike within the study area was performed for the year 2025 Build conditions using Synchro 9. It is assumed that this condition is just before Duke Street is widened to six lanes. Therefore, it is the worst-case scenario for operations on Duke Street.

The analysis results for PM peak hour show that the intersection of Little River Turnpike and Beauregard Street will operate at LOS F during both AM and PM peak hours in 2025, which is the pre-existing condition. The other three intersections will operate at LOS D or better. The new ramp intersection will operate at LOS B in AM and LOS C in PM, with no queuing issue at all approaches.

The U-turn is assumed to operate under yield control prior to the Duke Street widening. SimTraffic was used to analyze the queues at the U-turn location for the PM peak hour. The average and 95th percentile queues were contained within the available U-turn bay storage length of 180 feet.

7.1.2.4 Design Year (2040) Conditions (No-Build vs. Build)

PM Peak Hour

Freeway Demand and Throughput Analysis

Similar to 2020 conditions, the projected travel demand in the southbound GP lanes is 5%-20% higher in the 2040 Build conditions than the No-Build conditions within the study area due to the elimination of the key bottleneck. **Table 7–16** compares the projected demand for the 2040 PM peak hour for both the No-Build and Build conditions on southbound I-395.

The southbound I-395 mainline will serve more traffic during the PM peak hour under the 2040 Build conditions as compared to the 2040 No-Build conditions. Southbound I-395 currently operates at oversaturated conditions in the PM peak hour and therefore, few changes are expected in the throughput volumes under the 2040 No-Build conditions as compared with the existing conditions. Under the 2040 No-Build conditions, 9%-11% of demand north of the Turkeycock Run Express ramps will not be served. In contrast, unserved demand under the 2040 Build conditions varies

between 0.5%-2.6% at all freeway segments. As illustrated in **Figure 7–9**, the PM peak hour throughput volumes are 5%-26% higher under the 2040 Build conditions as compared to the No-Build conditions. The greatest throughput volume difference is found between the Seminary Road and Duke Street interchanges, which is located immediately upstream of the existing lane drop bottleneck.

Table 7–16: 2040 PM Peak Hour Demand in Southbound GP Lanes

Southbound I-395 GP Segment	2040 No-Build Demand	2040 Build Demand	Difference (%)
North of Seminary Road Interchange	7,040	7,791	11%
Seminary Road Interchange to Duke Street Interchange	7,714	8,676	12%
Duke Street Interchange to Turkeycock Run Access Ramps	7,148	7,709	8%
Turkeycock Run Access Ramps to Edsall Road Interchange	5,685	6,822	20%
Edsall Road Interchange to I-495	6,314	7,309	16%
South of I-495	6,799	7,142	5%

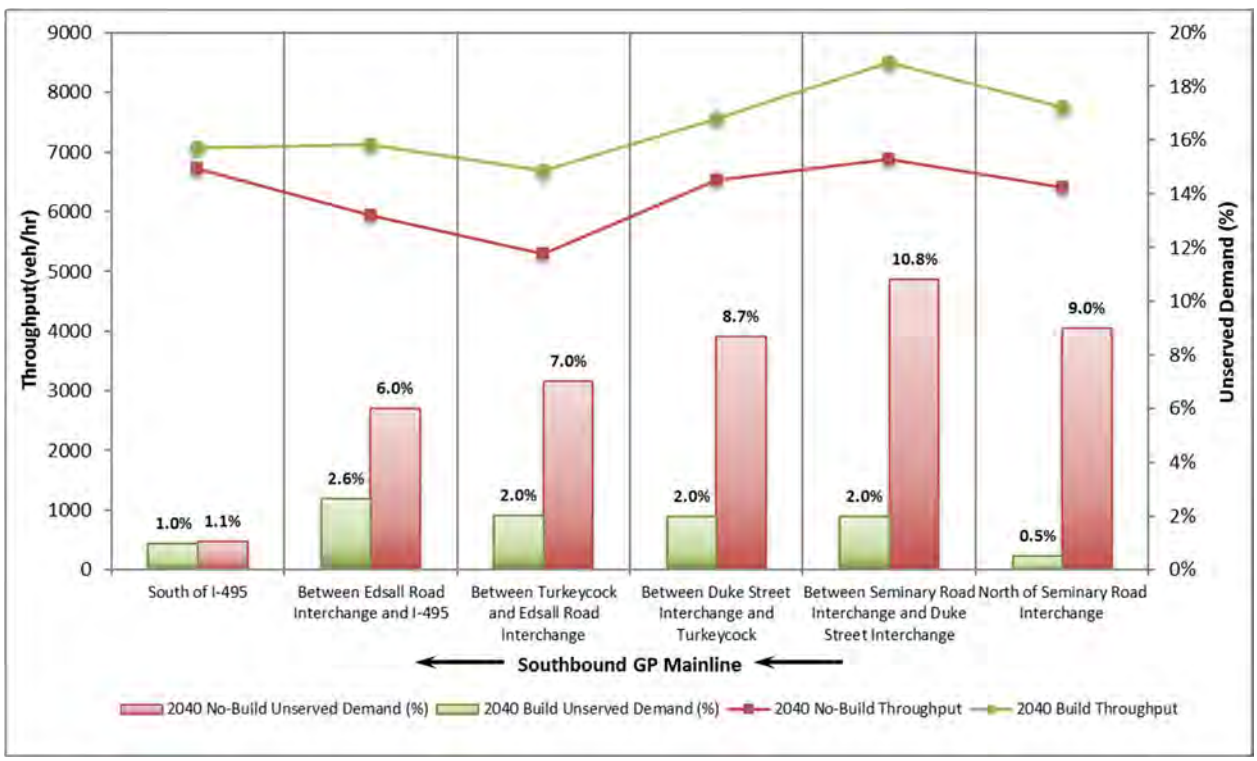


Figure 7–9: SB I-395 GP Lanes 2040 PM Peak Hour Throughput/Unserved Demand (No-Build vs. Build)

Freeway Density and Congestion Level Analysis

The traffic operations on I-395 during the 2040 PM peak hour under No-Build and Build conditions are summarized in **Table 7–17** and **Table 7–18,** and demonstrated in **Figure 7–10.**

Table 7–17: Freeway Operations, 2040 No-Build PM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	11.3	117.0
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	12.0	120.7
	S03-M	Merge Area at Seminary Road On-Ramp	15.1	106.4
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	17.3	101.8
	S05-D	Diverge Area at WB Duke Street Off-Ramp	17.4	101.3
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	20.3	77.2
	S07-W	Between WB Duke Street On-Ramp and EB On-Ramp	43.6	44.3
	S08-W	Between EB Duke Street On-Ramp and Turkeycock Slip Ramp	46.6	44.4
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	53.4	32.8
	S10-W	Between Turkeycock Flyover Ramp and Edsall Road Off-Ramp	53.0	27.6
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	48.7	32.6
	S12-W	Between Edsall Road and I-495 Ramp	52.4	24.1
	S12-D	Diverge Area at I-495 Inner Loop Ramps	53.7	14.1
	S13-D	Diverge Area at Franconia Ramp	51.0	25.9
	S14-B	I-95 SB Mainline through Springfield Interchange	53.3	20.5
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.4	24.8
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.1	21.8
Southbound I-395 HOV/ Express	H00-D	North of Seminary Road HOV Off-Ramp	63.4	19.6
	H01-B	Between Seminary Road HOV Off-Ramp and HOV On- Ramp	63.8	21.2
	H02-M	Merge from Seminary Road HOV On-Ramp	62.0	22.2
	H02-B	Between Seminary Road HOV On-Ramp and Turkeycock Flyover Ramp	62.9	26.1
	H03-D	Diverge Area at Turkeycock Flyover Ramp	63.3	26.0
	H04-B	Between Turkeycock Flyover Ramp and Slip Ramp	63.5	24.3
	H05-M	Merge Area at Turkeycock Slip Ramp	62.2	21.9
	H06-B	Between Turkeycock Slip Ramp and Off-Ramp to I-495 HOT Lanes	63.5	23.9
	H07-D	Diverge Area at Off-Ramp to I-495 HOT Lanes	61.1	22.6
	H08-B	Between I-495 HOT Off-Ramp and On-Ramp	63.5	19.0
	H09-M	Merge Area at On-Ramp from I-495 HOT Lanes	63.5	21.2
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.8	12.6
	N02-B	I-95 NB mainline through Springfield Interchange	53.7	16.8
	N03-W	Between Springfield Interchange and Edsall Road	52.0	24.0
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.3	27.3
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.4	26.3
	N06-M	Merge Area at Edsall Road On-Ramp	52.2	24.1
	N07-B	Between Edsall Road On-Ramp and Turkeycock Flyover Ramp	52.3	23.8
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	52.4	32.0
	N09-D	Diverge Area at Duke Street EB Off-Ramp	51.8	24.1
	N10-D	Diverge Area at Duke Street WB Off-Ramp	52.5	20.8
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	53.1	24.5
	N12-M	Merge Area at Duke Street WB On-Ramp	52.8	24.8
	N13-B	Between Duke Street and Seminary Road	53.0	25.1
	N14-D	Diverge Area at Seminary Road Off-Ramp	49.5	24.1
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	50.8	29.0
	N16-M	North of Seminary Road On-Ramp	52.1	22.9

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

Table 7–18: Freeway Operations, 2040 Build PM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	51.9	30.7
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	52.8	33.3
	S03-M	Merge Area at Seminary Road On-Ramp	45.4	42.3
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	45.2	53.0
	S05-D	Diverge Area at Duke Street Off-Ramp	51.3	37.6
	S06-B	Between Duke Street Off-Ramp and WB On-Ramp	50.3	35.1
	S08-W	Between Duke Street WB On-Ramp and Turkeycock Slip Ramp	46.0	38.6
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	53.5	28.3
	S10-B	After Turkeycock Flyover Ramp	53.3	25.7
	S10-D	Diverge at Edsall Road WB Off-Ramp	50.9	26.4
	S11-B	Between Edsall Road WB Off-Ramp and EB Off-Ramp	51.0	24.6
	S12-B	Between Edsall EB Off Ramp and On Ramp	51.8	28.8
	S12-W	Between Edsall Road and I-495 Ramp	51.3	29.1
	S12-D	Diverge Area at I-495 Inner Loop Ramps	52.9	17.0
	S13-D	Diverge Area at Franconia Ramp	52.5	29.5
	S14-B	I-95 SB Mainline through Springfield Interchange	53.3	23.6
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.3	26.5
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.0	23.0
Southbound I-395 HOV/ Express	H00-D	North of Seminary Road HOV Off-Ramp	63.5	19.5
	H01-B	Between Seminary Road HOV Off-Ramp and On-Ramp	63.8	21.0
	H02-M	Merge Area at Seminary Road HOV On-Ramp	61.9	22.6
	H02-B	Between Seminary Road HOV On-Ramp and Turkeycock Flyover Ramp	63.3	26.2
	H03-D	Diverge Area at Turkeycock Flyover Ramp	63.0	26.3
	H04-B	Between Turkeycock Flyover Ramp and Slip Ramp	63.5	24.5
	H05-M	Merge Area at Turkeycock Slip Ramp	61.9	23.2
	H06-B	Between Turkeycock Slip Ramp and Off-Ramp to I-495 HOT Lanes	63.5	25.3
	H07-D	Diverge Area at Off-Ramp to I-495 HOT Lanes	61.6	23.8
	H08-B	Between I-495 HOT Off-Ramp and On-Ramp	63.5	20.2
	H09-M	Merge Area at On-Ramp from I-495 HOT Lanes	63.5	22.2
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.8	12.6
	N02-B	I-95 NB mainline through Springfield Interchange	53.7	16.7
	N03-W	Between Springfield Interchange and Edsall Road	50.2	27.1
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.3	27.4
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.4	26.1
	N06-M	Merge Area at Edsall Road On-Ramp	52.5	23.8
	N07-B	Between Edsall Road On-Ramp and Turkeycock Flyover Ramp	52.5	23.5
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	52.5	31.7
	N09-D	Diverge Area at Duke Street EB Off-Ramp	51.9	24.0
	N10-D	Diverge Area at Duke Street WB Off-Ramp	52.3	20.9
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	53.1	24.6
	N12-M	Merge Area at Duke Street WB On-Ramp	52.7	25.0
	N13-B	Between Duke Street and Seminary Road	53.0	25.3
	N14-D	Diverge Area at Seminary Road Off-Ramp	49.1	24.5
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	50.5	29.6
	N16-M	North of Seminary Road On-Ramp	52.1	23.5

Severely congested condition Heavily congested condition Moderate traffic condition Light traffic condition

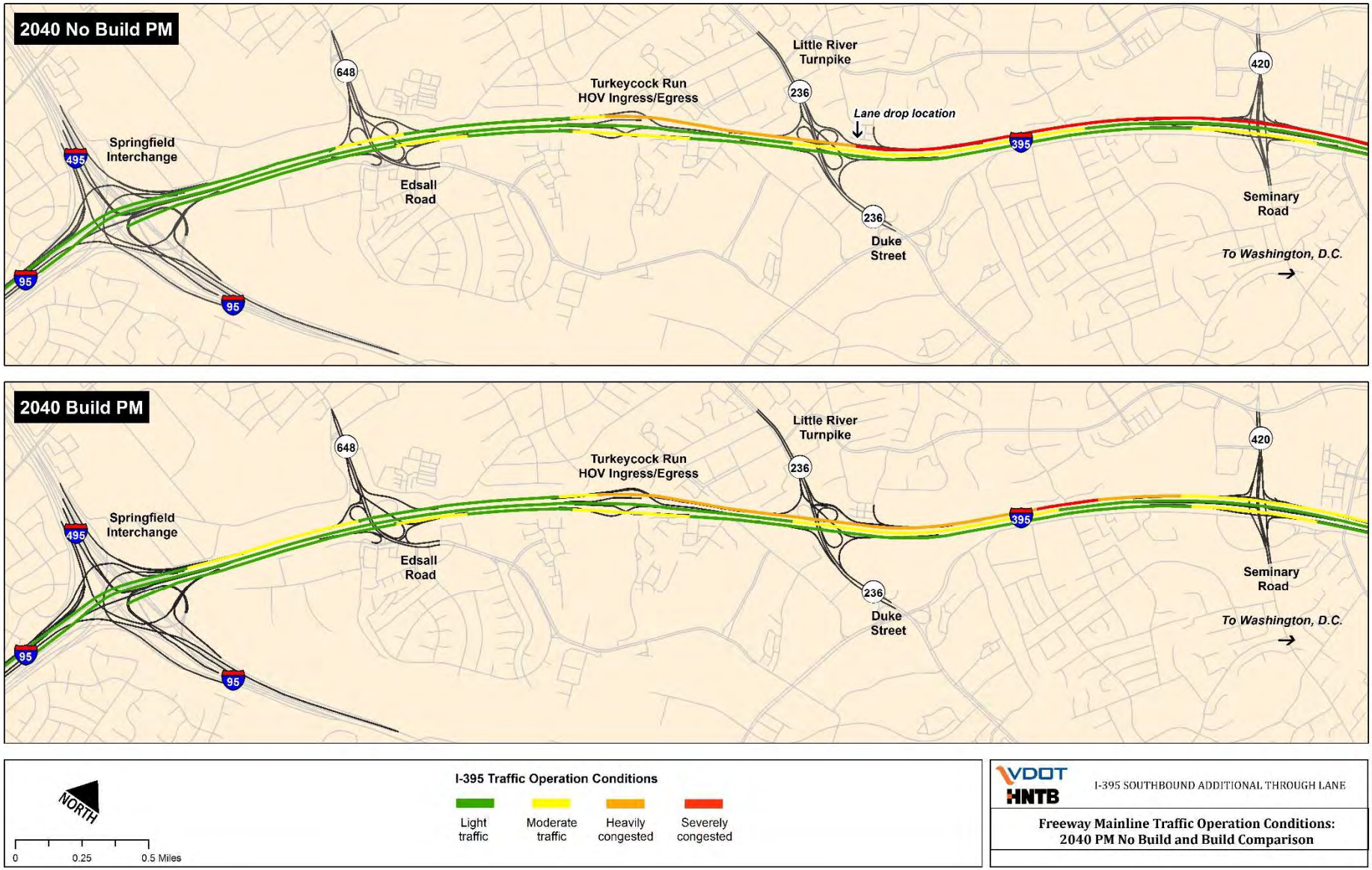


Figure 7–10: Freeway Operations, 2040 PM Peak Hour (No-Build vs. Build)

The overall traffic operations in the 2040 No-Build condition are similar to the 2020 No-Build conditions, but with congestion levels deteriorating further in the 2040 No-Build conditions. Southbound GP segments north of the Duke Street interchange will all be severely congested, with projected vehicle densities as high as 120 pc/ln/mi.

In the 2040 Build conditions, operations in the southbound GP segments will be improved and vehicle densities will be reduced by more than 50%. The heavy merging volumes from the Seminary Road on-ramp will still result in two segments being heavily or severely congested. From Duke Street to the Turkeycock slip ramp, southbound traffic will be heavily congested under both the No-Build and Build conditions, but the vehicle densities will be lower in 2040 Build conditions. Downstream of the Turkeycock Run Express ramps, vehicles will experience light to moderate traffic under both the No-Build and Build conditions. The percentage of southbound GP freeway segments under heavy or severe congestion in the PM peak hour will reduce from 50% in the 2040 No-Build conditions to 34% in the 2040 Build conditions, as illustrated in **Figure 7–11**.

On southbound Express Lanes and northbound GP lanes, light to moderate traffic conditions are projected for the PM peak hour.

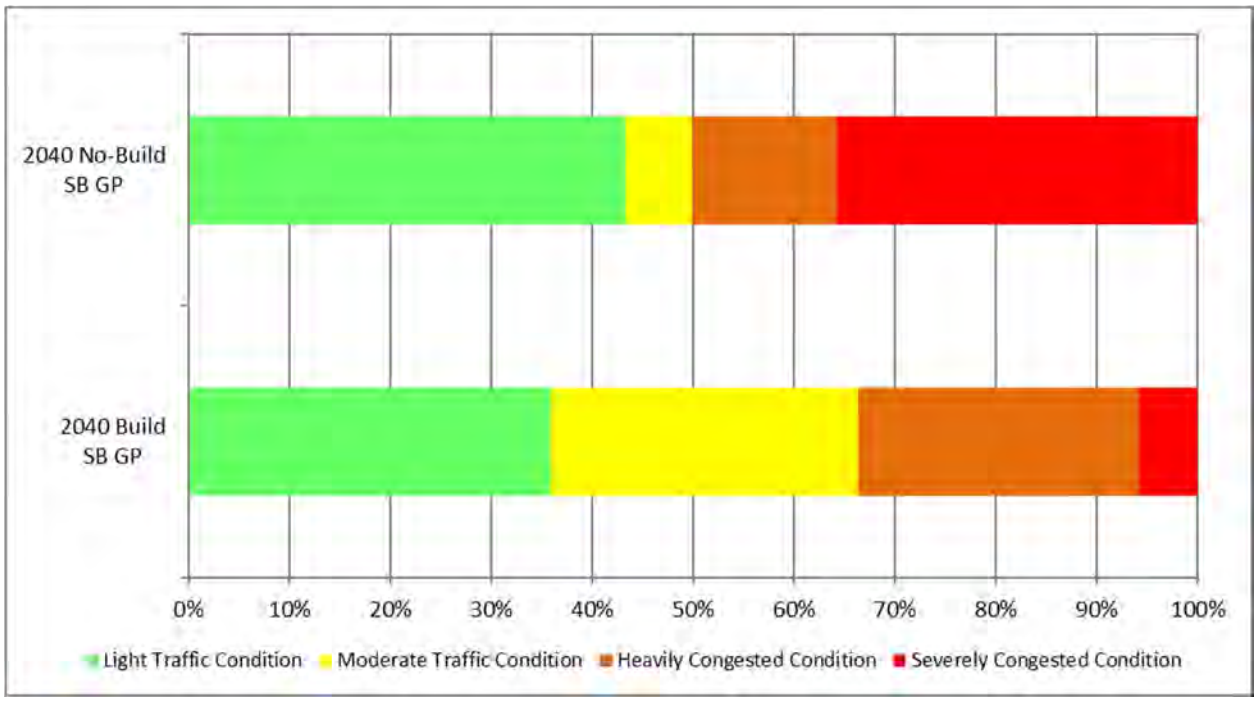


Figure 7–11: Congestion Levels by Percent Length of SB I-395, 2040 PM Peak Hour (No-Build vs. Build)

Freeway Travel Time Analysis

Figure 7–12 shows the PM peak hour travel time trajectories on southbound I-395 for the 2040 No-Build and Build conditions.

End-to-end travel times on the southbound GP lanes in the 2040 No-Build conditions are projected to be about 783 seconds (13.1 minutes), more than twice as long as the free flow condition. Under the 2040 Build conditions, travelers are expected to have a 48% reduction in travel times in the

southbound GP lanes as compared to the No-Build conditions. Average travel times are projected to reduce to 404 seconds (6.7 minutes), which is only 1.5 minutes longer than the free flow condition. The majority of the travel time savings are seen on the segments north of the Duke Street interchange.

For the northbound GP lanes, the travel times associated with the 2040 No-Build and Build conditions are almost identical. Under both the 2040 No-Build and Build conditions, vehicles are expected to travel at or near free flow conditions.

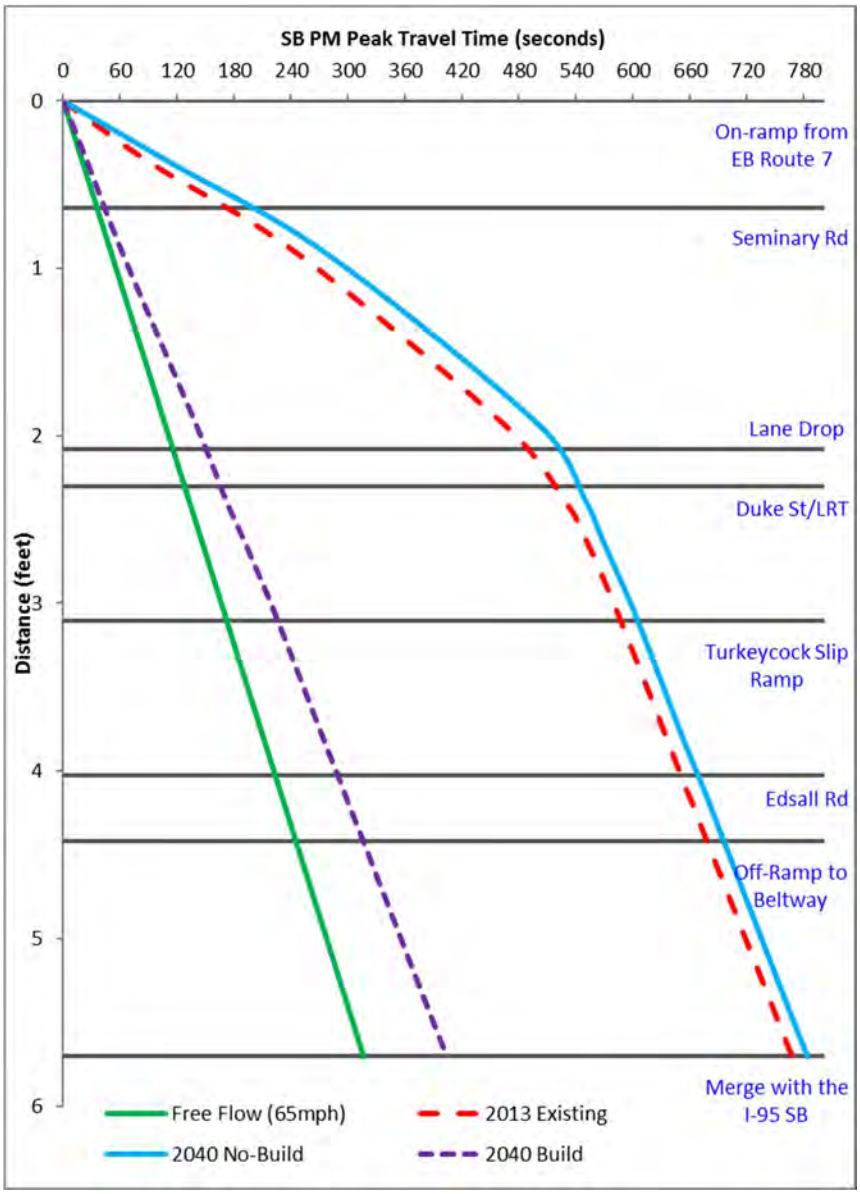


Figure 7–12: SB I-395 GP Lanes Travel Times, 2040 PM Peak Hour (No-Build vs. Build)

Freeway Speed Analysis

In the 2040 Build conditions, freeway speeds will be higher along I-395, especially in the southbound direction, as compared to the No-Build conditions. **Figure 7–13** compares the average speed contours for the southbound I-395 GP lanes under 2040 No-Build and Build conditions.

The existing southbound bottleneck, at the lane drop location will be eliminated under the Build conditions. However, the Seminary Road on-ramp merge area will still experience moderate traffic in the 2040 Build conditions. More than 1,800 vehicles per hour from this on-ramp will try to merge to southbound GP lanes during the PM peak hour. It is expected that traffic flows will slow down on the segments near the ramp gore area due to frequent accelerating, decelerating and aggressive lane-changing maneuvers. However,

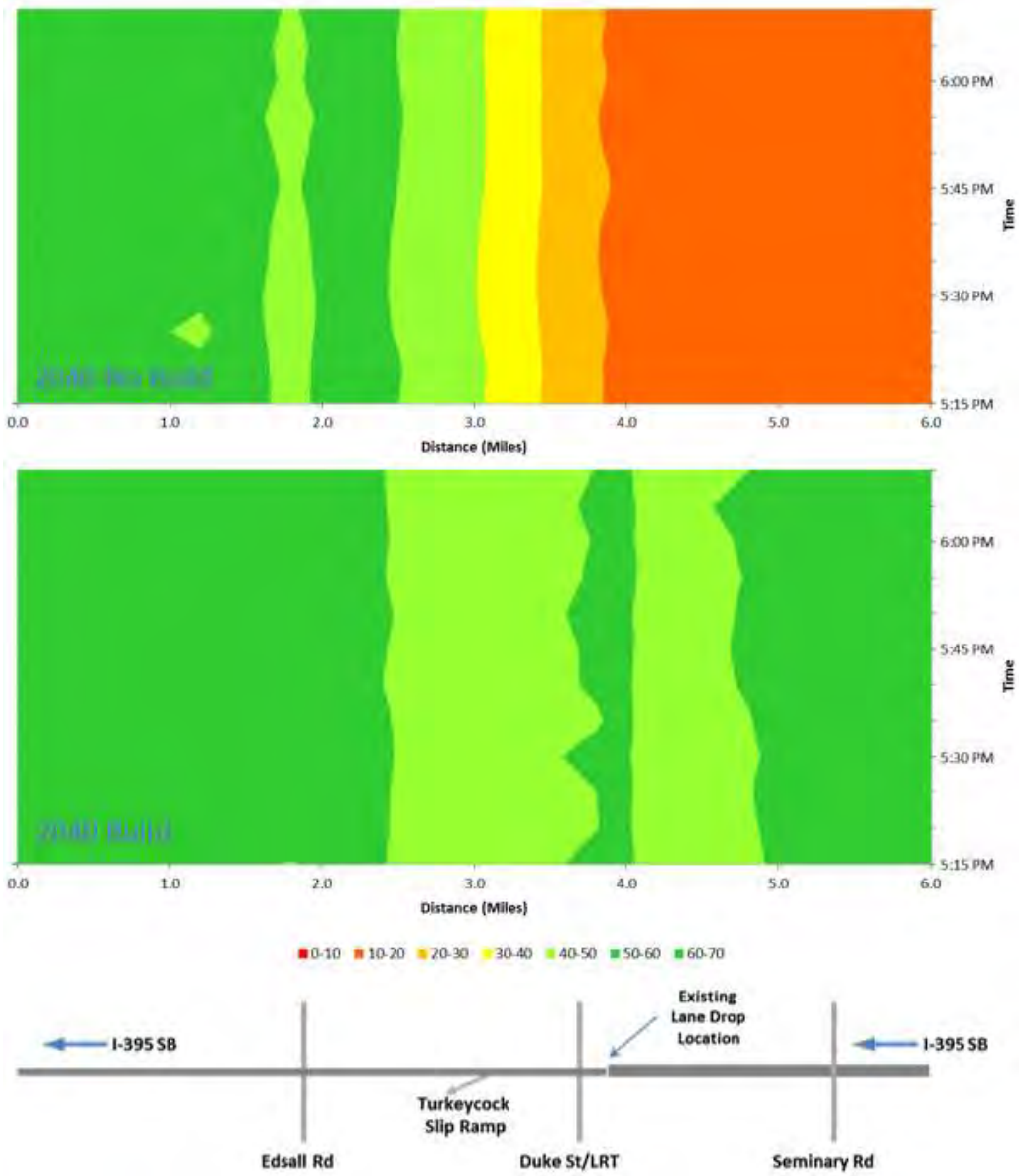


Figure 7–13: SB I-395 GP Speed Contour Maps during 2040 PM Peak Hour (No-Build vs. Build)

downstream traffic will no longer be metered by the lane drop with queuing back to Seminary Road. Merge friction for vehicles entering I-395 will be reduced. The Seminary Road on-ramp merge area is expected to be the slowest segment along southbound I-395, with vehicles an average speed as low as 44 mph. Along the southbound I-395 GP lanes from Seminary Road to the Turkeycock Express

ramps, vehicles will be able to maintain speeds of 40 mph to 50 mph. South of the Turkeycock Express ramps, average speeds will gradually increase to 50 mph or above.

Intersection Analysis

Table 7–19 compares the intersection delays and LOS in the 2040 conditions (No-Build vs. Build). Almost all existing signalized intersections are projected to operate at the same LOS or better. The only exception is the intersection of Duke Street at S Walker Street. In the 2040 Build condition, the intersection delay will increase by less than 2.2 seconds/vehicle, in comparison with will remain the same or will be reduced in the Build condition. At the intersections of Seminary Road and Mark Center Avenue, and Little River Turnpike and Beauregard Street, there are several approaches where queues will exceed storage distances in both the No-Build and Build conditions. In all, no degradation in arterial traffic conditions is expected from the proposed project.

the No- Build condition that degrades the LOS from D to E. Queues at most of the intersections

Table 7–19: Signalized Intersection Delay and LOS, 2040 PM Peak Hour (No-Build vs. Build)

No.	Intersection	2040 No Build		2040 Build	
		Avg. Delay (sec/veh)	Int LOS	Avg. Delay (sec/veh)	Int LOS
1	Seminary Road & I-395 SB Off-Ramp	44.1	D	22.0	C
2	Seminary Road & I-395 SB On-Ramp	67.1	E	42.4	D
3	Seminary Road & I-395 NB Off-Ramp	35.6	D	25.1	C
4	Seminary Road & I-395 NB On-Ramp	37.3	D	30.2	C
6	Seminary Road & Mark Center Avenue	112.7	F	89.6	F
8	Little River Turnpike & Beauregard Street	69.2	E	69.2	E
9	Little River Turnpike & Oasis Drive	18.5	B	18.2	B
10	Duke Street & S Walker Street	54.9	D	57.2	E
11	Edsall Road & Mitchell Street	21.0	C	9.8	A
12	Edsall Road & Cherokee Avenue	16.7	B	14.8	B
13	Edsall Road & Bren Mar Drive	25.6	C	33.1	C
15	Edsall Road & Bloomfield Drive	8.7	A	8.0	A
16	Edsall Road & Beryl Road	7.0	A	6.0	A
17	Seminary Road & I-395 BRAC HOV Ramp	3.8	A	5.0	A
18	Little River Turnpike & I-395 SB Off-Ramp	---	---	14.4	B
19	Edsall Road & I-395 SB Off-Ramp	---	---	7.9	A
20	Duke Street U-turn	---	---	5.7	A

[1] New signalized intersections in 2040 No-Build conditions.
[2] New signalized intersection in 2040 Build conditions.
[3] Detailed intersection analysis results by movements are provided in **Appendix H**.

In 2040 Build Conditions include three new signalized intersections: two at the modified ramps at Duke Street and Edsall Road interchanges and one at the U-turn along Duke Street. The ramp terminal intersections will operate at LOS B or better with all movements at LOS D or better (**Table 7–20**).

For safety and operational considerations, due to the increase in conflicting volume and widening of Duke Street, the U-turn will be under signal control in the 2040 Build Condition. The intersection will operate at LOS A with the U-turn movement at LOS D.

Storage for each movement these three intersections will accommodate the maximum queues.

Table 7–20: New Intersections at Ramp Termini LOS, 2040 Build PM Peak Hour

Intersection	Movement	Avg. Delay (sec)	LOS	Int Delay (sec)	Int LOS	Storage (ft)	Max. Queue (ft)
Little River Turnpike & I-395 SB Off-Ramp	EBT	6.7	A	14.4	B	780	389
	WBT	17.9	B			950	800
	SBL	34.4	C			660	501
	SBR	1.7	A			920	670
Edsall Road & I-395 SB On-Ramp	EBT	13.1	B	7.9	A	975	359
	EBR	1.5	A			650	0
	WBL	27.4	C			650	552
	WBT	0.2	A			900	0
Duke Street U-turn	EB U-turn	47.4	E	5.7	A	180	155
	WBT	4.4	A			550	394

AM Peak Hour

Freeway Analysis

Table 7–21 and **Table 7–22** present traffic operations on I-395 in the 2040 AM peak hour for the No-Build and Build conditions, respectively. The freeway traffic flows under the Build conditions will be slightly improved in comparison with the No-Build conditions. In the southbound direction, traffic flows in the AM peak hour will not experience heavy congestion under the 2040 Build conditions.

Intersection Analysis

Table 7–23 presents the traffic performance at intersections between the 2040 No-Build and Build conditions during the AM peak hour. All intersections within the study area will operate at the same or better LOS during the AM peak hour in the 2040 Build conditions as compared to the No-Build conditions.

Table 7–24 summarizes the two new intersections under the 2040 Build condition. Both intersections will operate at LOS B or better, and all movements at LOS C or better. The WB left-turn movement at the Edsall Road on-ramp is expected to occasionally spill beyond the available storage length.

Table 7–21: Freeway Operation, 2040 No-Build AM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	63.5	19.8
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	64.0	20.1
	S03-M	Merge Area at Seminary Road On-Ramp	63.2	21.1
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	63.6	23.7
	S05-D	Diverge Area at WB Duke Street Off-Ramp	63.1	23.9
	S06-B	Between WB Duke Street Off-Ramp and On-Ramp	57.5	23.8
	S07-W	Between WB Duke Street On-Ramp and EB On-Ramp	45.6	37.9
	S08-M	Between EB Duke Street On-Ramp and Turkeycock Slip Ramp	47.4	40.5
	S09-B	Between Turkeycock Slip Ramp and Flyover Ramp	51.2	36.5
	S10-D	Between Turkeycock Flyover Ramp and Edsall Road Off-Ramp	51.4	29.5
	S11-W	Between WB Edsall Road On-Ramp and EB Off-Ramp	40.8	44.2
	S12-W	Between Edsall Road and I-495 Ramp	52.1	25.7
	S12-D	Diverge Area at I-495 Inner Loop Ramp	53.6	15.4
	S13-D	Diverge Area at Franconia Ramp	51.0	27.0
	S14-B	I-95 SB Mainline through Springfield Interchange	53.1	26.1
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.3	24.7
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.1	22.9
Southbound I-395 HOV/ Express	H00-M	Seminary Road HOV On-Ramp	62.2	21.2
	H01-B	Between Seminary Road HOV Off-Ramp and HOV On- Ramp	63.5	21.9
	H02-D	Seminary Road HOV Off-Ramp	61.8	22.5
	H02-B	Between Seminary Road HOV Off-Ramp and Turkeycock Flyover Ramp	62.6	26.2
	H04-M	Between Turkeycock Flyover HOV Off-Ramp and On-Ramp	62.9	21.5
	H05-B	Between Turkeycock Ramps	59.4	23.6
	H06-B	Between Turkeycock Off-Ramp to I-495	60.5	22.7
	H07-M	I-495 Express Lanes On-Ramp	61.2	21.2
	H08-B	Between I-495 Express Lanes Ramps	61.3	17.6
	H09-D	I-495 Express Lanes Off-Ramp	58.0	20.1
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.0	22.7
	N02-B	I-95 NB mainline through Springfield Interchange	52.6	30.4
	N03-W	Between Springfield Interchange and Edsall Road	48.8	32.3
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	49.9	34.1
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	51.6	31.1
	N06-W	Weave Area at Edsall Road On-Ramp	36.2	49.0
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	36.7	49.8
	N09-D	Diverge Area at Duke Street EB Off-Ramp	47.9	33.6
	N10-D	Diverge Area at Duke Street WB Off-Ramp	48.0	32.5
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	52.6	37.2
	N12-M	Merge Area at Duke Street WB On-Ramp	52.2	35.2
	N13-B	Between Duke Street and Seminary Road	52.2	35.3
	N14-D	Diverge Area at Seminary Road Off-Ramp	47.6	35.1
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	33.9	61.2
	N16-M	North of Seminary Road On-Ramp	38.4	43.8

Severely congested condition | Heavily congested condition | Moderate traffic condition | Light traffic condition

Table 7–22: Freeway Operations, 2040 Build AM Peak Hour

Direction	Segment	Location	Speed (mph)	Density (pc/ln/mi)
Southbound I-395 GP	S01-D	North of Seminary Road Off-Ramp	63.5	19.8
	S02-B	Between Seminary Road Off-Ramp and On-Ramp	63.8	20.1
	S03-M	Merge Area at Seminary Road On-Ramp	61.7	21.7
	S04-B	Between Seminary Road On-Ramp and Duke Street Off-Ramp	63.6	23.9
	S05-D	Diverge Area at Duke Street Off-Ramp	63.7	21.2
	S06-B	Between Duke Street Off-Ramp and WB On-Ramp	63.2	19.2
	S08-M	Merge Area at WB Duke Street On-Ramp	63.2	18.5
	S09-B	Between Duke WB On-Ramp and Flyover Ramp	58.5	23.0
	S10-B	After Turkeycock Flyover Ramp	53.4	22.6
	S10-D	Diverge at Edsall Road WB Off-Ramp	50.4	23.6
	S11-B	Between Edsall Road WB Off-Ramp and EB Off-Ramp	50.9	21.6
	S12-B	Between Edsall EB Off Ramp and On Ramp	52.7	25.0
	S12-W	Between Edsall Road and I-495 Ramp	52.3	25.3
	S12-D	Diverge Area at I-495 Inner Loop Ramps	56.1	14.8
	S13-D	Diverge Area at Franconia Ramp	50.5	27.4
	S14-B	I-95 SB Mainline through Springfield Interchange	53.2	26.2
	S15-M	Merge Area with I-495 Outer Loop Ramp	53.3	24.8
	S16-M	Merge Area with I-495 Inner Loop Ramp	53.1	22.9
Northbound I-395 HOV/ Express	H00-M	Seminary Road HOV On-Ramp	62.2	21.2
	H01-B	Between Seminary Road HOV Off-Ramp and HOV On- Ramp	63.4	22.0
	H02-M	Seminary Road HOV Off-Ramp	60.8	22.9
	H02-B	Between Seminary Road HOV Off-Ramp and Turkeycock Flyover Ramp	62.2	26.3
	H04-M	Between Turkeycock Flyover HOV Off-Ramp and On-Ramp	63.0	21.5
	H05-B	Between Turkeycock Ramps	59.7	23.5
	H06-B	Between Turkeycock Off-Ramp to I-495	61.0	22.6
	H07-M	I-495 Express Lanes On-Ramp	61.1	21.2
	H08-B	Between I-495 Express Lanes Ramps	63.8	16.9
	H09-D	I-495 Express Lanes Off-Ramp	63.0	18.0
Northbound I-395 GP	N01-B	I-95 NB mainline through Springfield Interchange	53.0	22.7
	N02-B	I-95 NB mainline through Springfield Interchange	52.8	30.3
	N03-W	Between Springfield Interchange and Edsall Road	49.7	31.8
	N04-D	Diverge Area at Edsall Road WB Off-Ramp	52.2	32.5
	N05-B	Between Edsall Road WB Off-Ramp and On-Ramp	53.5	30.7
	N06-W	Merge Area at Edsall Road On-Ramp	52.6	27.9
	N08-B	Between Turkeycock Flyover Ramp and Duke Street EB Off-Ramp	49.6	36.9
	N09-D	Diverge Area at Duke Street EB Off-Ramp	50.1	32.2
	N10-D	Diverge Area at Duke Street WB Off-Ramp	48.8	32.1
	N11-B	Between Duke Street WB Off-Ramp and On-Ramp	52.7	37.3
	N12-M	Merge Area at Duke Street WB On-Ramp	52.1	35.5
	N13-B	Between Duke Street and Seminary Road	51.2	36.4
	N14-D	Diverge Area at Seminary Road Off-Ramp	41.7	33.9
	N15-B	Between Seminary Road Off-Ramp and On-Ramp	28.5	58.9
	N16-M	North of Seminary Road On-Ramp	37.7	42.8

Severely congested condition Heavily congested condition Moderate traffic condition Light traffic condition

Table 7–23: Signalized Intersection Delay and LOS, 2040 AM Peak Hour (No-Build vs. Build)

No.	Intersection	2040 No Build		2040 Build	
		Avg. Delay (sec/veh)	Int LOS	Avg. Delay (sec/veh)	Int LOS
1	Seminary Road & I-395 SB Off-Ramp	19.2	B	23.1	C
2	Seminary Road & I-395 SB On-Ramp	32.4	C	34.7	C
3	Seminary Road & I-395 NB Off-Ramp	22.5	C	22.9	C
4	Seminary Road & I-395 NB On-Ramp	31.6	C	30.1	C
6	Seminary Road & Mark Center Avenue	40.5	D	43.8	D
8	Little River Turnpike & Beauregard Street	74.7	E	76.2	E
9	Little River Turnpike & Oasis Drive	15.4	B	15.2	B
10	Duke Street & S Walker Street	25.0	C	24.0	C
11	Edsall Road & Mitchell Street	17.7	B	13.2	B
12	Edsall Road & Cherokee Avenue	15.8	B	13.0	B
13	Edsall Road & Bren Mar Drive	18.5	C	18.4	B
15	Edsall Road & Bloomfield Drive	10.5	B	15.6	B
16	Edsall Road & Beryl Road	6.6	A	6.5	A
17	Seminary Road & I-395 BRAC HOV Ramp	19.9	B	14.6	B
18	Little River Turnpike & I-395 SB Off-Ramp	19.2	---	12.8	B
19	Edsall Road & I-395 SB Off-Ramp	---	---	9.7	A

[1] New signalized intersections in 2040 No-Build conditions.
[2] New signalized intersection in 2040 Build conditions.
[3] Detailed intersection analysis results by movements are provided in **Appendix H**.

Table 7–24: New Intersections at Ramp Termini LOS, 2040 Build AM Peak Hour

Intersection	Movement	Avg. Delay (sec)	LOS	Int Delay (sec)	Int LOS	Storage (ft)	Max. Queue (ft)
Little River Turnpike & I-395 SB Off-Ramp	EBT	6.6	A	12.8	B	780	293
	WBT	16.3	B			950	541
	SBL	26.7	C			660	280
	SBR	0.0	A			920	0
Edsall Road & I-395 SB On-Ramp	EBT	17.1	B	9.7	A	975	263
	EBR	1.3	A			650	0
	WBL	28.5	C			650	825
	WBT	0.2	A			900	0

7.2 Safety Analysis

This chapter presents the safety analysis for the existing conditions, future No-Build, and Build conditions. The safety analysis was based on reported crash data available from 2011 to 2013 for I-395, arterials, and intersections in the study area.

7.2.1 Crash Data

Crash data within the study area was obtained from VDOT for the three-year period between 2011 and 2013. The database only includes crashes that were reported to police. In all, there were 1,753 reported crashes on I-395, ramps and crossing arterials between Seminary Road and the Springfield Interchange in the three-year period.

7.2.1.1 Work Zone Crashes

Work zone activities are temporary and represent abnormal travel conditions. To conduct a more accurate comparison among segments of I-395, the safety analysis only considered long-term crash patterns that occurred during non-work zone conditions. Therefore, the first step in processing the crash data was to review the frequency of work zone-related crashes. **Table 7–25** shows the number of work zone and non-work zone-related crashes in the study area from 2011 to 2013. As a result of the I-95 Express Lanes project construction activities ramping up in 2013, the number of work zone crashes increased from 23 in 2011 to 106 in 2013. Therefore, all work zone-related crashes were removed from the analysis.

Table 7–25: Work Zone and Non-Work Zone Annual Crash Totals,

Work Zone Condition	2011	2012	2013	Average
Work Zone	23	24	106	51
Non-Work Zone	525	541	534	533
Total	548	565	640	584

7.2.1.2 Crash Data Summary

After removing work zone-related crashes from the analysis, the remaining 1,600 crashes within the study area for the three-year period were plotted by location and type, and are presented in **Figure 7–14**. The plotted data illustrate that the southbound lane drop location at the Duke Street interchange has a higher concentration of crash occurrence as compared to other locations in the southbound direction.

Table 7–26 summarizes the number of crashes on the freeway, ramps, arterials, and intersections annually between 2011 and 2013. The number of annual crashes was consistent, varying from 525 to 541 per year during the study period, a difference of 3%. Crashes on freeways account for 57% of all crashes. Of the 908 freeway crashes, one resulted in a fatality.

Table 7–26: Crash Total Summary by Facility Type in the Study Area, 2011–2013

Facility Type	Year			Total	Average	Percentage
	2011	2012	2013			
Freeway	303	312	293	908	303	57%
Ramps[1]	105	103	109	317	106	20%
Arterials[1]	13	8	15	36	12	2%
Intersections	104	118	117	339	113	21%
Total	525	541	534	1600	533	100%

[1] Excludes crashes that are within 250 ft of intersections

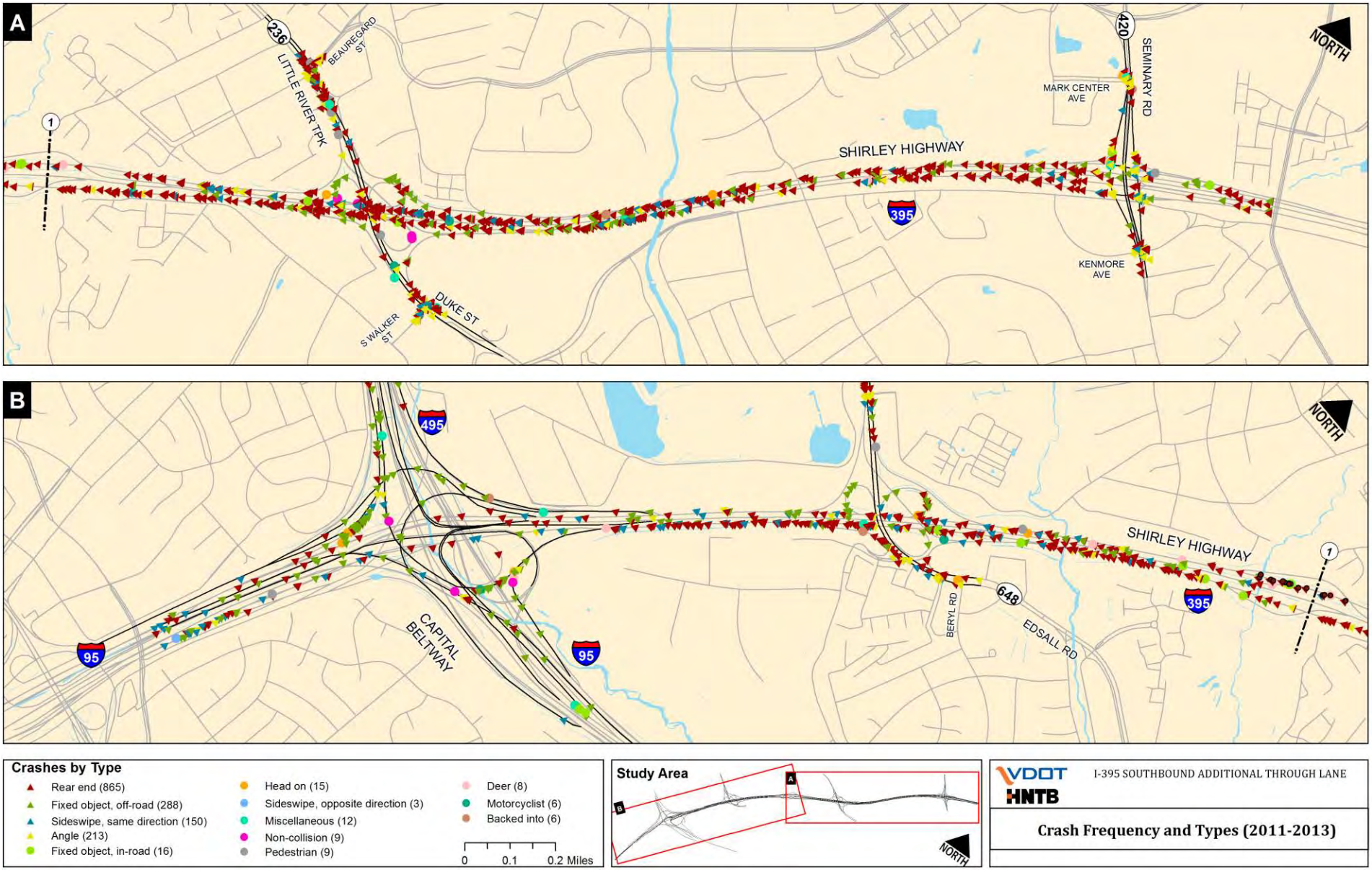


Figure 7–14: Crash Experience in the Study Area, 2011–2013

7.2.2 Crash Analysis

7.2.2.1 Freeway Mainline Segments

Freeway Crash Patterns

A total of 908 crashes were reported to have occurred on the I-395 GP and HOV lanes within the study area from 2011 to 2013, with an average of 303 crashes per year. **Figure 7–15** summarizes total crashes by facility type, and **Figure 7–16** presents the number of crashes on I-395 in the study area by collision type.

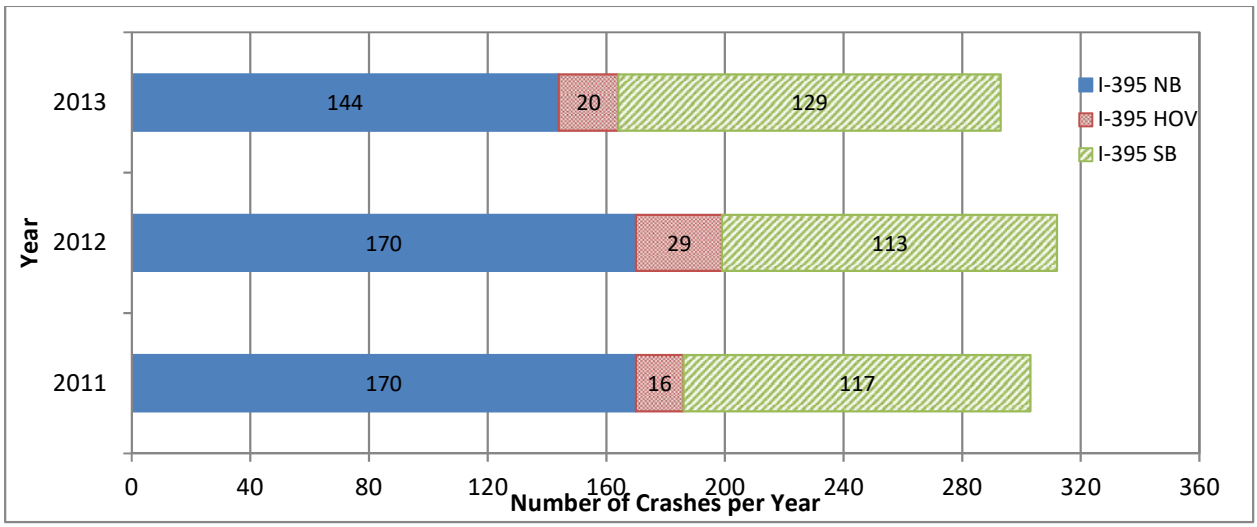


Figure 7–15: Annual Crash Totals by Year on I-395, 2011-2013

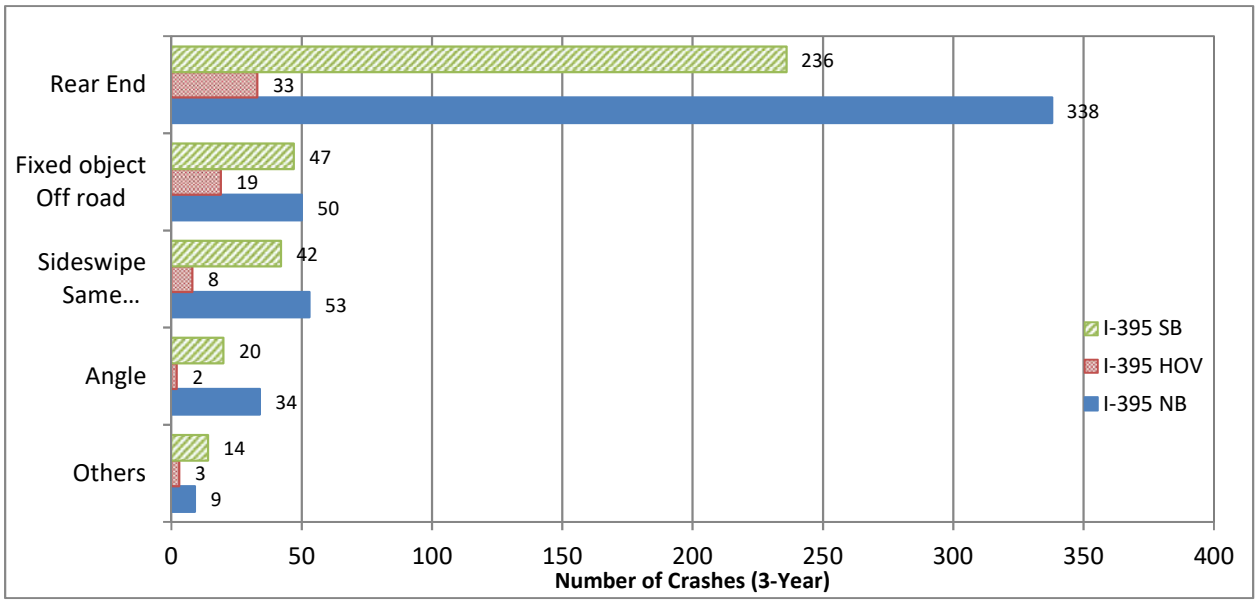


Figure 7–16: Number of Crashes on I-395 by Type, 2011–2013

The number of crashes on the mainline between the three study years was consistent, ranging from 293 crashes in 2013 to a high of 312 crashes in 2012. The most common crash type was rear-end (607) which accounted for 67% of all crashes in the study area. In the northbound direction, rear-end crashes occurred with no specific location concentration. In the southbound direction, the majority of rear-end crashes occurred at and north of the Duke Street interchange, which correlates to observed congestion during peak hours. Fixed object off-road crashes (116) and same-direction sideswipe crashes (103) accounted for 13% and 11% of the total crashes, respectively. Angle crashes (56) represented 6% of the total crashes, and all other crash types accounted for 3% of the total.

Figure 7–17 illustrates the distribution of freeway crashes by time of day. As expected, the data indicate that crash frequency is highest during peak travel periods. On northbound I-395, the number of crashes peaked during both the AM and PM peak periods with a slight increase during the mid-day period. In the southbound direction, the number of crashes peaked during the PM peak period, which aligns with the commuter peak for this facility.

The injury severity in crashes on I-395 in the study area over the three-year period is summarized in **Figure 7–18**. During the three-year period, one out of the 908 crashes on the I-395 mainline resulted in a fatality and 243 crashes (27%) resulted in injuries. The remaining crashes resulted in property damage only.

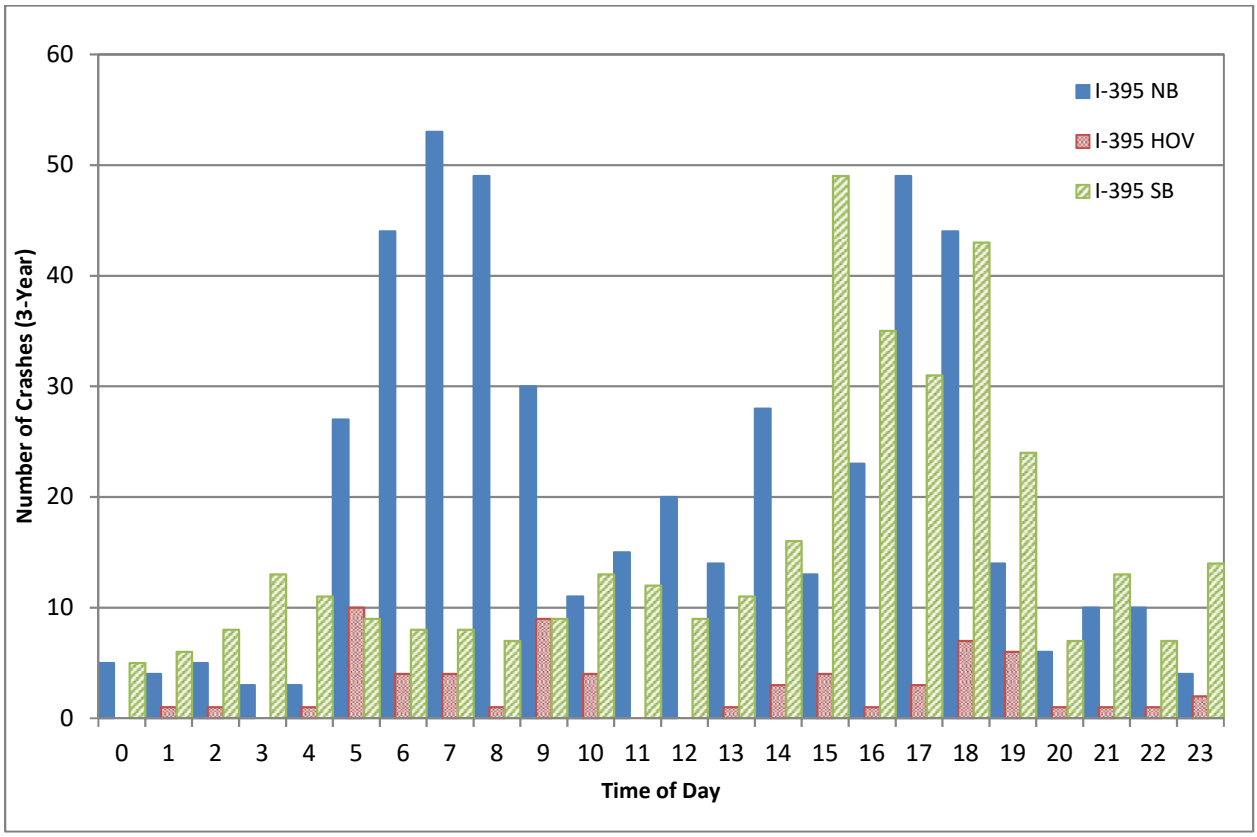


Figure 7–17: Number of Crashes on I-395 by Time of Day, 2011–2013

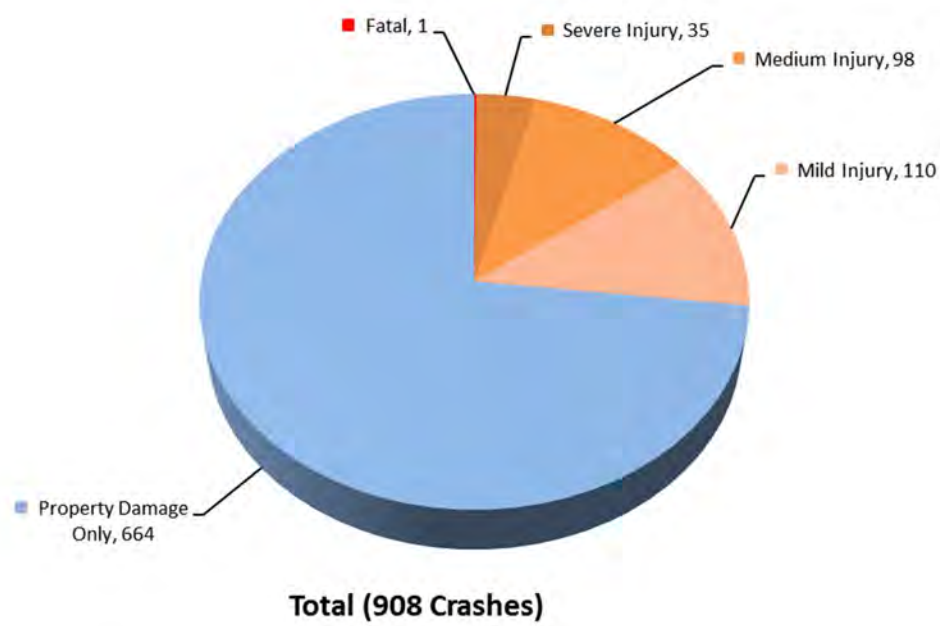


Figure 7–18: Severity of Crashes on I-395, 2011–2013

Crash Rate Analysis

Crash rate is an effective way to compare the safety of similar facilities and to identify high crash locations. Crash rates on I-395 within the study area were compared against the statewide urban interstate crash rate.[22] Each direction of the freeway (southbound, northbound, and HOV) was divided into five operating segments, one for each interchange area, to calculate the crash rates. Each of the operating segments was further split into quarter mile roadway segments to calculate crash rates, crash density and crash injury severity. The crash rate of a roadway segment was calculated by:

$$R = \frac{C \times 100{,}000{,}000}{V \times 365 \times N \times L}$$

where,

R = Crash rate for the road segment expressed as crashes per hundred-million vehicle miles of travel (HMVMT)
C = Total number of crashes in the roadway segment during the study period
V = Traffic volumes using Average Annual Daily Traffic volumes
N = Number of years of data
L = Length of the roadway segment in miles

Table 7–27 on the following page summarizes the mainline crash rates by segment in comparison with the statewide average, and **Figure 7–19** shows crash rates, crash density and crash injury

[22] According to VDOT's *2012 Crash Data Summary*, for an urban interstate, the statewide-average crash rate is 76.64 crashes per HMVMT, injury rate is 36.69 crashes per HMVMT, and fatality rate is 0.29 crashes per HMVMT.

Table 7–27: Crash Summary for I-395 Mainline, 2011–2013

Facility	From	To	Number of Crashes	Average Crash Rate	Number of Injuries	Injury Rate	Number of Fatal Crashes	Fatality Rate
I-395 NB	South end	North of on-ramp from I-495 to I-395 NB	71	66.5	33	30.9	0	0.0
	North of on-ramp from I-495	I-395 NB to North of on-ramp from Edsall Road	135	157.6	46	53.7	0	0.0
	North of on-ramp from Edsall Road	North of Turkeycock Run Interchange	65	102.8	32	50.6	0	0.0
	North of Turkeycock Run Interchange	North of on-ramp from Duke Street to I-395 NB	163	153.7	66	62.2	0	0.0
	East of on-ramp from Duke Street	East of on-ramp from Seminary Road (north end)	50	45.9	15	13.8	0	0.0
I-395 HOV	South End	North of off-ramp from I-395 HOV to I-495	14	34.1	3	7.3	0	0.0
	North of off-ramp from I-395 HOV	I-495 to North of Edsall Road Interchange	15	45.7	10	30.4	0	0.0
	North of Edsall Road Interchange	North of I-395 SB to I-395 HOV (Turkeycock Run)	11	45.4	5	20.6	0	0.0
	North of Turkeycock Run Interchange	North of Duke Street Interchange	11	27.7	2	5.0	0	0.0
	North of Duke Street Interchange	North of I-395 HOV off-ramp to Seminary Road (north end)	14	35.3	5	12.6	0	0.0
I-395 SB	North of off-ramp to Seminary Road (north end)	North of off-ramp to Duke Street	75	68.5	34	31.1	0	0.0
	North of off-ramp from I-395 SB to Duke Street	North of Turkeycock Run Interchange	172	159.1	59	54.6	1	0.9
	North of Turkeycock Interchange	North of off-ramp to Edsall Road	34	57.1	14	23.5	0	0.0
	North of off-ramp to Edsall Road	North of off-ramp from I-395 SB to I-495	61	76.8	22	27.7	0	0.0
	North of off-ramp from I-395 SB to I-495	South end	17	16.2	7	6.7	0	0.0
2012 Statewide Average for Urban Interstate Freeway[1]			**N.A.**	**76.6**	**N.A.**	**36.7**	**N.A.**	**0.29**

XX.X – crash rate higher than statewide average
[1] Source: *2012 Summary of Crash Data*, VDOT, Traffic Engineering Division

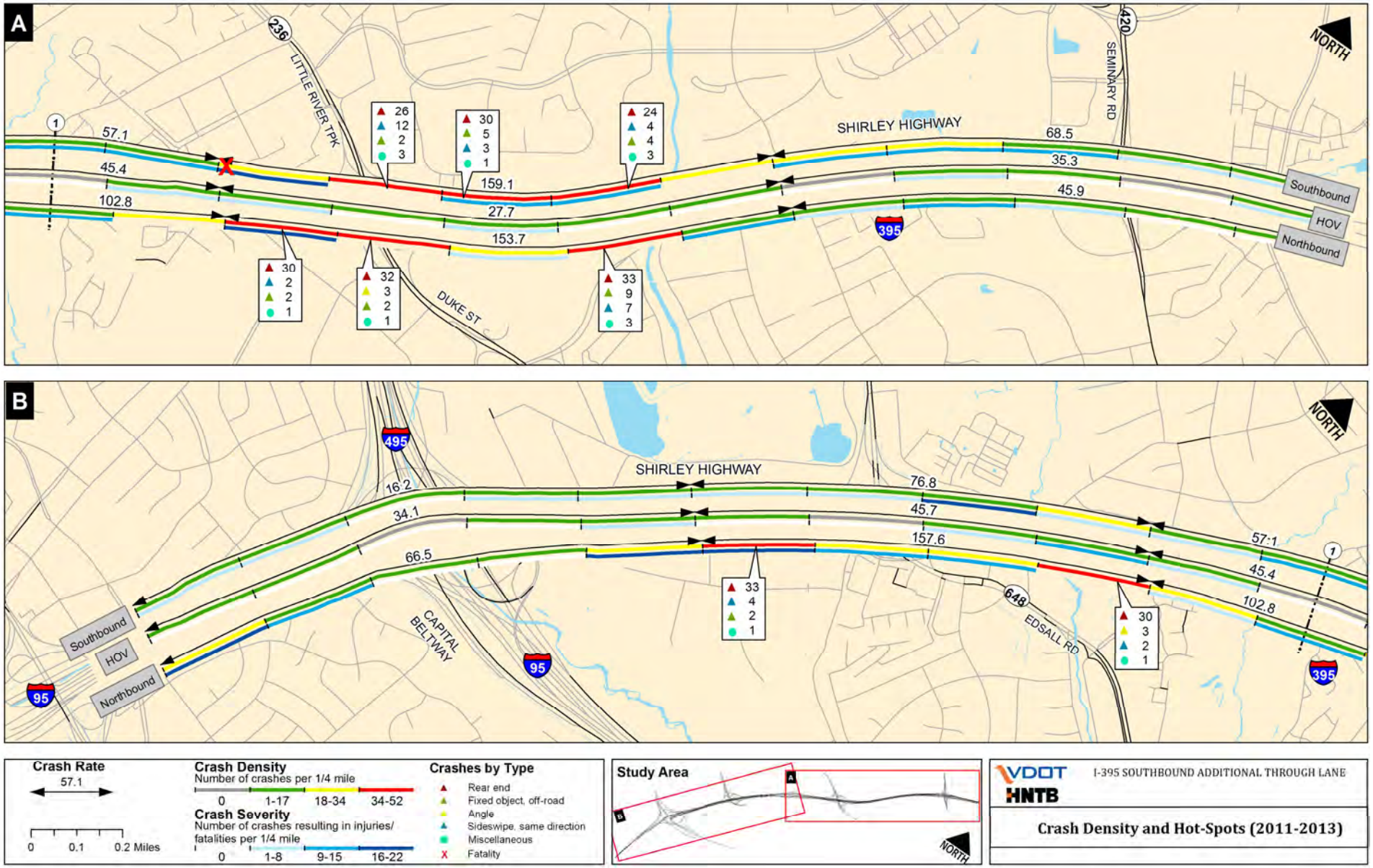


Figure 7–19: Crash Density and Crash Rate by Segment, 2011–2013

severity along I-395 in the study area. Crash rates on I-395 HOV were lower than the statewide average, while northbound and southbound I-395 had multiple segments with higher-than-average crash rates. Three locations were identified to have higher crash rates and injury rates than the statewide-average:

- Southbound I-395 at the lane drop location and weaving area of the Duke Street interchange
- Northbound I-395 at merge and diverge areas of the Edsall Road interchange
- Northbound I-395 at merge and diverge areas of the Duke Street interchange

The segment of I-395 with the southbound lane drop evidenced the highest crash rate in the study area during the study period with 159.1 crashes per HMVMT, which was more than double the statewide-average crash rate of 76.64. The injury and fatality rates in this segment were 38.8 and 0.9, respectively, which were also higher than the statewide-average rates of 36.39 and 0.29, respectively. The only crash involving a fatality on I-395 within the study area during the past three years occurred in this segment, just downstream of the lane drop location in December 2012. Of all 117 crashes in this segment, the predominant crash types were rear-end (80) and off-road fixed object (21). The lane drop at the Duke Street interchange causes recurring congestion, long queues and abrupt stops in traffic flows, which may contribute to the high crash rates at this location. The Preferred Alternative will eliminate the lane drop by adding a through lane to southbound I-395, which is expected to reduce the crash potential at this location.

7.2.2.2 Interchange Ramps

Table 7–28 summarizes the number of crashes on interchange ramps within the study area.

Table 7–28: Crash Totals on Ramps by Interchange

Interchange Ramp[1]	Year			Average
	2011	2012	2013	
I-395 GP & HOV Ramps at Turkeycock Run	2	1	3	2
Duke Street Interchange	18	16	17	17
Edsall Road Interchange	17	13	9	13

[1] Excludes crashes that are within 250 ft of intersections

Duke Street Interchange

The Duke Street interchange is a partial cloverleaf interchange with eight ramps. The number of crashes on these ramps has been consistent since 2011 with an average of 17 crashes per year. The ramp from southbound I-395 to westbound Little River Turnpike had the highest number of crashes with five per year. There was one fatal fixed object off-road crash on this ramp in 2012. The remaining ramps at this interchange had one to three crashes per year. The leading crash type at this interchange was fixed object off-road (eight per year) followed by rear-end (seven per year).

Edsall Road Interchange

This interchange experienced an average of 13 crashes per year. The leading crash type was rear-end (six per year) followed by fixed object off-road (five per year). The ramps from northbound I-395 to eastbound Edsall Road and from westbound Edsall Road to southbound I-395 had the highest number of crashes with four per year. On the ramp from northbound I-395 to eastbound Edsall Road,

the leading crash type was rear-end. When northbound I-395 is congested, drivers use the exit lane to Edsall Road as a by-pass lane and try to merge into mainline traffic near the exit ramp gore. This is a possible cause for many of the rear-end crashes at this location. On the loop ramp from westbound Edsall Road to southbound I-395, fixed object off-road crashes were more frequent.

7.2.2.3 Arterials and Intersections

The intersection area of influence was defined as 250 ft from the center of the intersection pursuant to VDOT guidelines. The remaining portions of the arterials were assessed separately. Over the three-year period, only 36 crashes occurred on the three arterials outside the influences of intersections. Crash totals along each arterial by year is shown in **Table 7–29**.

Table 7–29: Crash Totals Along Arterials

Crossing Arterial	Year			Average
	2011	2012	2013	
Seminary Road	1	0	2	1
Duke Street/Little River Turnpike	10	8	9	9
Edsall Road	2	0	4	2

There was a total of 339 crashes at 16 intersections over the three-year period. These crashes are summarized by intersection in **Table 7–30**. Crash pattern analysis reveals that the crashes which occurred on crossing arterials and intersections had no correlation to freeway mainline congestion.

Table 7–30: Crashes Totals at Arterial Intersections

Arterial	No	Intersection	Year			Average
			2011	2012	2013	
Seminary Road	1	Seminary Road & SB off-ramp	2	9	6	6
	2	Seminary Road & SB on-ramp	7	3	3	4
	3	Seminary Road & NB off-ramp	1	7	7	5
	4	Seminary Road & NB on-ramp	11	3	8	7
	6	Seminary Road & Mark Center Drive	9	4	8	7
	7	Seminary Road & Kenmore Avenue	11	6	5	7
Duke Street/ Little River Turnpike	8	Little River Turnpike & Beauregard Street	15	16	20	17
	9	Little River Turnpike & Oasis Drive	7	13	10	10
	10	Duke Street & S Walker Street	12	23	19	18
Edsall Road	11	Edsall Road & Mitchell Street	6	11	12	10
	12	Edsall Road & Cherokee Avenue	10	14	6	10
	13	Edsall Road & Bren Mar Drive	10	4	4	6
	15	Edsall Road & Bloomfield Drive	1	3	7	4
	16	Edsall Road & Beryl Road	2	2	2	2

Duke Street/Little River Turnpike Intersections

During the study period, 135 crashes occurred at the three study intersections located along Duke Street. Of those crashes, 51 (38%) occurred at the Beauregard Street intersection and 54 (40%)

occurred at the South Walker Street intersection. These two intersections had the highest number of crashes among the 16 intersections in the study area. Congestion caused by heavy traffic volumes, signal cycle failure and excessive queue lengths during peak hours were possible contributing factors to the high crash frequency at the intersection of Little River Turnpike and Beauregard Street. At the intersection of Duke Street and South Walker Street, red light running, multiple driveways/ramps in close vicinity and aggressive lane changing were possible contributing factors to the high crash occurrences. Along Duke Street/Little River Turnpike, 37% of crashes resulted in injuries and 63% of crashes resulted in property damage only. There were no fatalities reported along Duke Street during the study period.

Edsall Road Intersections

At the intersections along Edsall Road, 94 crashes occurred during the study period. The majority of these occurred at the intersections of Mitchell Street and Cherokee Avenue. Angle (39 crashes). Rear-end crashes accounted for 77% (33) of the 94 crashes. Along Edsall Road, 52% of crashes resulted in property damage only while the rest resulted in injuries with no fatalities.

7.2.3 Safety Consideration under No-Build Conditions

Several improvement projects on I-395 have been constructed since 2014. These projects include the I-95 Express Lanes with northern terminus at Turkeycock Run, the northbound I-395 auxiliary lane between Duke Street and Seminary Road, and the I-395 HOV ramp at Seminary Road.

The opening of the I-95 Express Lanes with the northern terminus at Turkeycock Run is expected to change travel patterns in the I-395 corridor. Increased southbound weaving volumes could increase the potential for sideswipe crashes. This would be due to an increase in lane change maneuvers from the Little River Turnpike/Duke Street entrance ramps to the left exit ramp serving the Express Lanes. The other projects are expected to have minimal impact to the southbound operations and crash potential.

Under future No-Build conditions, no improvements are planned at the bottleneck location. With an anticipated increase in travel demand into the future, the southbound traffic congestion at this location in the PM peak period will incrementally worsen over the years. Therefore, the crash potential could increase on southbound I-395 under future No-Build conditions.

7.2.4 Safety Effects of the Preferred Alternative

The Preferred Alternative consists of an additional through lane on southbound I-395 for 2.1 miles and improvements to ramps at the Edsall Road and Duke Street interchanges. Where possible, the effects of the Preferred Alternative on safety were quantified using CMFs from Highway Safety Manual and VDOT's planning level CMFs as part of the Smart Scale process[23]. CMFs quantify the effects of geometric and operational treatments to the expected number of crashes at a specific location.

[23] http://vasmartscale.org/documents/hb2_planning_level_cmfs_201508_final.pdf, Accessed 3/3/17.

There were 359 reported crashes between 2011 and 2013 within the study area along I-395 southbound. The CMFs indicate a potential reduction of 64 crashes (18%) due to the various geometric and operational changes of the Preferred Alternative. As CMFs were applied to the crash data from 2011-2013, the reduction might be higher in the opening year 2025 and beyond as the traffic volumes are higher.

Additional Through Lane

As discussed previously, 80 of the total 117 crashes that occurred at the lane drop location in the southbound direction were rear-end crashes. **Table 7–31** presents FHWA's summary of the possible causes for different crash types on freeway mainline facilities and possible countermeasures.

Table 7–31: Possible Crash Causes and Countermeasures of Rear-End and Sideswipe Crashes

Collision Type	Possible Cause	Possible Countermeasures
Rear-End	• Mainline lane drops • Lack of lane continuity • Lack of route continuity • Lack of lane balance • Inadequate application of auxiliary lanes	• Eliminate reduction of basic number of lanes • Improve freeway operational LOS • Correct lane balance issues • Correct lane continuity issues
Sideswipe, Same Direction	• Excessive driver workload in merge/diverge area • Inadequate acceleration length • Too many lane changes • Weaving distances too short • Spacing between ramps too short • Inadequate decision sight distance • Driver confusion/indecision	• Reduce/simplify signing • Lengthen acceleration lanes • Correct lane balance issues • Correct lane continuity issues • Reduce number of required lane changes • Improve or eliminate weaving sections • Provide decision sight distance • Provide consistency in ramp locations

Source: *Interstate System Access Informational Guide*, p.53, FHWA, August 2010

The additional through lane will reduce the congestion and queueing upstream of the Duke Street interchange with the lane drop at the Duke Street interchange. The CMF associated with eliminating a lane drop is not available. However, based on **Table 7–31** the Preferred Alternative is expected to function as a countermeasure toward reducing the potential for rear-end crashed on southbound I-395 north of the lane drop location.

Downstream of the lane drop up to Edsall Road interchange, the additional lane has a VDOT Planning Level CMF of 0.8. As presented in **Table 7–32** is expected to reduce approximately 35 crashes (in a three-year period) in this section.

Table 7–32: Projected Crashes with Preferred Alternative

Description (¼ mi Segments)	Crashes (2011-2013)			CMFs					Δ in Crashes		
	Injury/ Fatal	PDO	Total	Lane Add[24]	Lane Width[25]	Shoulder Width[26]		Accel/ Decel Lane[24]	Injury/ Fatal	PDO	Total
				All	Injury /Fatal	Injury /Fatal	PDO	All			
South of I-495	1	2	3	-	-	-	-	-	0	0	0
	1	3	4	-	-	-	-	-	0	0	0
I-495 Interchange	0	3	3	-	-	-	-	-	0	0	0
	1	1	2	-	-	-	-	-	0	0	0
Between I-495 and Edsall Rd	2	3	5	-	-	-	-	-	0	0	0
	1	9	10	-	-	-	-	-	0	0	0
Diverge to WB Edsall Rd Off-Ramp	2	13	15	0.8	1.0	1.05	1.05	0.85	-1	-4	-5
	5	10	15	0.8	-	-	-	0.85	-2	-3	-5
Diverge to WB Edsall Rd Off-Ramp	4	17	21	0.8	-	-	-	-	-1	-3	-4
Merge after Turkeycock On-Ramp	1	5	6	0.8	-	-	-	-	0	-1	-1
Diverge to Turkeycock Off-Ramp	4	10	14	0.8	-	-	-	-	-1	-2	-3
Between Duke St & Turkeycock Interchanges	3	11	14	0.8	-	-	-	-	-1	-2	-3
Acceleration area for Duke St On-Ramp	9	12	21	0.8	1.0	1.03	1.03	0.55	-5	-7	-12
	9	34	43	0.8	-	-	-	0.55	-5	-19	-23
Between Duke St Off-Ramp & On-Ramp	7	32	39	0.8	-	-	-	-	-1	-6	-8
Between Duke St & Seminary Rd Interchanges	5	30	35	-	-	-	-	-	0	0	0
	9	25	34	-	-	-	-	-	0	0	0
Merge after Seminary Rd On-Ramp	6	16	22	-	-	-	-	-	0	0	0
	6	16	22	-	-	-	-	-	0	0	0
Seminary Rd Interchange	5	12	17	-	-	-	-	-	0	0	0
	4	6	10	-	-	-	-	-	0	0	0
Diverge area for Seminary Rd	1	3	4	-	-	-	-	-	0	0	0
TOTAL	**86**	**273**	**359**						**-17**	**-47**	**-64**

[24] http://vasmartscale.org/documents/hb2_planning_level_cmfs_201508_final.pdf, Accessed 3/3/17.
[25] Equation 18-41, Highway Safety Manual, 1st Edition, Supplement (2014). CMF for Lane Width is only available for Injury/Fatal Crashes.
[26] Equation 18-42 Highway Safety Manual, 1st Edition, Supplement (2014).

The additional southbound through lane will result in higher throughput volumes during the PM peak hour. The Duke Street on-ramp traffic destined to the I-95 Express Lanes ramp will not only compete with higher mainline through volumes, but will also have to weave across one additional through lane (three in No-Build, four in Build conditions). However, the operational analysis results show that traffic flows under the 2020 and 2040 Build conditions will be improved compared with the No-Build conditions. The microsimulation also shows that weaving vehicles will have little trouble maneuvering against the through traffic. Therefore, no adverse impacts on safety are expected due to the additional through lane.

Interchange Configuration / Loop Ramp Removal

One loop ramp at each interchange will be removed as part of the reconfiguration of the Edsall Road and Duke Street interchanges. This will eliminate the short weave sections (400-500 ft.) that exist at these locations between successive loop ramps. The CMF associated with eliminating a short-weave is not available. However, as suggested in **Table 7–31**, eliminating the short weave sections will decrease the potential for sideswipe crashes on the mainline at these locations.

With the removal of the off-ramp (from I-395 southbound to Duke Street eastbound), the length of the acceleration lane for the on-ramp (from Duke Street westbound to I-395 southbound) will also be increased to 1200 ft. The VDOT planning level CMF for extending a ramp acceleration length to ~750 ft. is 0.55 reducing the expected crashes by 29[27].

The VDOT planning level CMF for extending a deceleration lane by 500 ft. is 0.85. Although the increase in deceleration lane length for the eastbound Edsall Road off-ramp is longer than 500 ft., the CMF of 0.85 provides a conservative estimate of this change in geometry. There were 30 reported crashes in the I-395 southbound segment between the Edsall Road loop ramps. The number of crashes would have been reduced by approximately 5 due to the extended deceleration lane.

The proposed improvements include reduced shoulder widths along the subject exit ramps to fit the ramps beneath existing overpass structures, and will include advance "curve ahead" and advisory speed limit signage. These measures will tend to suppress ramp travel speeds, and therefore mitigate the potential for higher crash rates on the exit ramps along initial horizontal curves.

Mainline Shoulder Widths

The proposed improvements will widen both the left and right shoulder widths along southbound I-395, and will achieve a more consistent width for each within the project limits. The left shoulder width will measure predominantly 6 ft. wide and the right shoulder width will measure predominantly 10 ft., except beneath the existing overpass structures.

The inside shoulder between ramps at the Duke Street Interchange will have a width of 4 ft in between the bridges. The CMF for such a condition is 1.03, indicating a potential for increase in the crashes by 2.

[27] CMF was interpolated between values for 500 ft. and 1000 ft. extensions.

Similarly, the inside shoulder between exit ramps at the Edsall Road Interchange will be reduced to an average of 3 ft. The CMF for this condition is approximately 1.05 which might result in a potential of 1 crash.

As part of the proposed shoulder width reductions, the left-lane adjacent to these sections will be reduced in width from 12 ft. to 11 ft.[28] Equation 18-41 of the Highway Safety Manual defines the CMF for Lane Widths speed-change lane segments. However, since the HSM utilizes the average cross-section lane-width rounded to the nearest 0.5 ft., the proposed narrowing will have virtually no effect on the CMF.

The large majority of reported crashes (62% rear-end collisions) were of a type that are not directly associated with roadway geometry or shoulder widths, but are more likely associated with heavy, recurrent congestion. The proposed shoulder widths will limit, at certain locations, opportunities for disabled vehicles to take full refuge outside the active travel lanes. However, these limitations are present and are worse under existing conditions.

While the resulting shoulder widths will be less than required at several locations within the project limits, the proposed improvements enhance the functional value of the shoulders provided by increasing the width to meet current guidelines where possible, and achieving more consistent shoulder widths than those that are in service today. In all, the proposed improvements are expected to reduce crash potential within the project limits.

Intersections

New signalized intersections will be added along Edsall Road and along Duke Street to accommodate vehicle turning movements at relocated ramp terminals. Operational analyses indicate that favorable traffic progression can be maintained, and the new signals are expected to operate at LOS B or better during 2020 and 2040 analysis periods. The analyses demonstrate that resultant queuing will be contained within available storage, with no operational effects to traffic flow on I-395.

The HSM does not provide any CMFs associated with replacement of free-flow interchange ramp terminals with a new at-grade signalized intersection. Free-flow ramp terminals along urban arterials are generally characterized by high-speed entry and exit maneuvers to/from the arterial roadway; uncontrolled pedestrian crossings; and an acute angle of merging/diverging traffic. At-grade signalized intersections operate with high-angle collision paths; a range of operating speeds; and controlled pedestrian crossings. With respect to crash potential, it is reasonable to project that these factors will at least partially offset each other with the proposed change in access from a free-flow ramp terminal to an at-grade signalized intersection along Duke Street and along Edsall Road. While the potential for certain crash types are expected to be reduced (sideswipe crashes and those involving pedestrians), the potential for certain other crash types is expected to increase (angle, rear-end).

[28] The acceleration lane from the Duke Street loop ramp will also be reduced to 11 ft. in width. However, as the acceleration lane is less than 1600 ft. long it is not included in the calculation of the average lane width.

Under the Preferred Alternative, vehicles traveling eastbound on Duke Street destined for the southbound Express Lanes could cross I-395, execute a U-turn movement along Duke Street and use the entrance ramp from westbound Duke Street to southbound I-395, from which they can access the Express Lanes facility. This new movement introduces conflicts at the proposed U-turn location which could increase the frequency of angle collisions.

However, the microsimulation analysis for 2020 indicates that there will be sufficient gaps in westbound through traffic to accommodate the U-turn demand (of 57 vehicles/hour). In 2040 or before, depending on when traffic signal warrants are met, the U-turn location will be signalized to increase the safety and operational efficiency of the U-turn. There is a potential for an increase in rear-end collisions at this location due to the introduction of a new signal.

7.3 Summary

7.3.1 Traffic Operational Analysis

Heavy travel demand on southbound I-395 in the PM peak hour is metered by the existing lane drop near the Duke Street interchange, which causes recurring congestion and excessive queuing conditions upstream of this location.

Under the 2020 and 2040 No-Build conditions, congestion on southbound I-395 will increase as travel demand grows. There are several improvement projects currently under construction along I-395. However, analysis of traffic operations show that these projects will not provide relief from the congestion caused by the existing lane drop at the Duke Street interchange.

The Preferred Alternative will enhance the traffic flow along southbound I-395. Overall, the 2020 and 2040 PM peak hour Build conditions operate better than the No-Build conditions relative to the following metrics:

- Increase in speed and decrease in overall travel time
- Elimination of key congestion bottlenecks
- Improved vehicle throughput and percent of demand served along southbound I-395
- Lower traffic flow density and less congestion along most freeway segments
- No adverse impacts to arterials and intersections

These findings confirm that widening of southbound I-395 to provide an additional through lane is needed to address current and projected levels of traffic demand.

7.3.2 Safety Analysis

Analysis of three-year crash data identifies the lane drop location on southbound I-395 near the Duke Street interchange as a high crash location. The crash rate at this location for the 2011–2013 period was the highest in the study area, and two times higher than the statewide average crash rate for urban interstate freeways. The predominant crash type at this location was a rear-end collision, which is likely attributable to severe congestion caused by the lane drop.

The Preferred Alternative will eliminate the lane drop on southbound I-395 at the Duke Street interchange, and relieve recurrent congestion during peak hours. As a result, the Preferred

Alternative will reduce the crash potential at this location. Moreover, one loop ramp at each interchange will be removed as part of the reconfiguration of the Edsall and Duke Street interchanges, which will eliminate the short weave sections that exist at these locations.

Using CMFs, a potential reduction of 64 crashes (18%) in a three-year period is expected due to the various geometric and operational changes of the Preferred Alternative. This reduction is projected without including the effect of reducing the ramp density (from 4.5 ramps/mile to 2.8 ramp/mile), eliminating two short weave segments and adding signalized intersections.

CHAPTER 8: LAND USE COMPATIBILITY

8.1 Current Land Use

Figure 8–1 presents the current land use in the study area. The predominant land use within the study area is residential, with a density mix ranging from single-family detached homes to multi-story apartment complexes. Commercial development is concentrated along arterial routes, particularly at Landmark Mall in Alexandria and along Edsall Road east of I-395 in Fairfax County. Industrial land use is concentrated in the Beltway South Industrial Park in Fairfax County.

8.2 Land Use Plans and Future Land Use

Figure 8–2 highlights redevelopment plans listed in the 1992 City of Alexandria Master Plan (as amended) and the 2013 Fairfax County Comprehensive Plan.

8.2.1 City of Alexandria

With little remaining vacant land, projected land use changes focus mainly on redevelopment initiatives. The Beauregard Small Area Plan jurisdiction, which encompasses the Mark Center and surrounding commercial and residential land uses, is planned to undergo high-density redevelopment around new transit stops and other multimodal facilities serving the Beauregard Street and Sanger Avenue corridors. Landmark Mall is slated for redevelopment and conversion into a mixed-use residential and commercial area.

8.2.2 Fairfax County

The County Comprehensive Plan reflects few changes to existing land use in the I-395 corridor. Residential infill development is designed to be low-density and generally consistent with the existing residential pattern of the area. Commercial development is restricted along arterial routes. Industrial development is restricted to the Beltway South Industrial Park. Green open spaces are planned to segregate industrial and residential land uses.

8.3 Activity Centers

MWCOG identifies three regional activity centers within the study area[29]: Beauregard and Landmark-Van Dorn areas in the City of Alexandria, and the Beltway South Industrial Park in Fairfax County. In the 2014 report, *Place + Opportunity: Strategies for Creating Great Communities and a Stronger Region*, MWCOG highlights the potential for cross-development opportunities in the areas of Beauregard and Landmark-Van Dorn. The report considers the Beltway South Industrial Park a stable industrial activity center.

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[29] Regional Activity Centers Map, http://www.mwcog.org/store/item.asp?PUBLICATION_ID=455, MWCOG, Accessed on November 5, 2014.

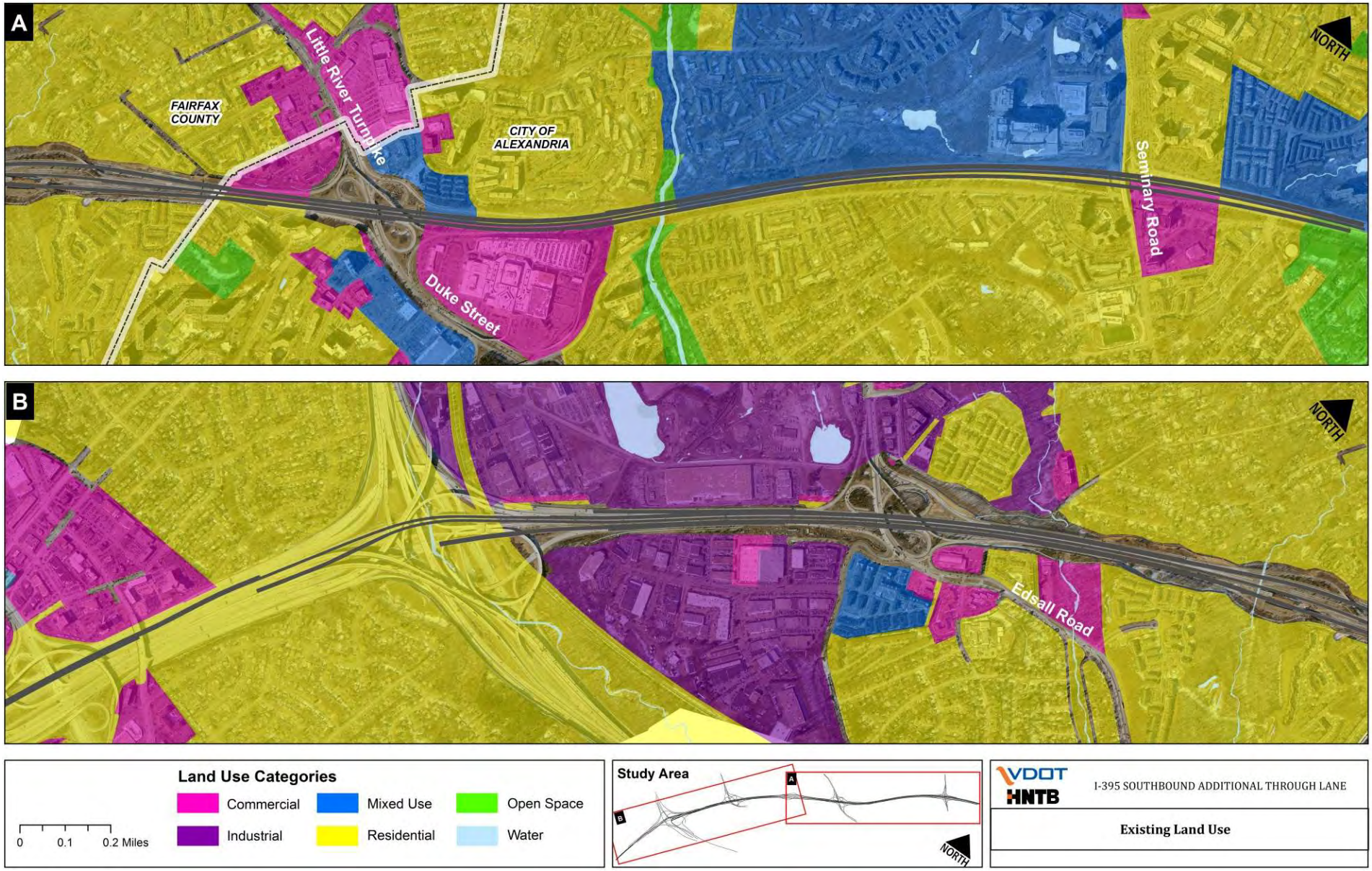

Figure 8–1: Existing Land Use in Study Area

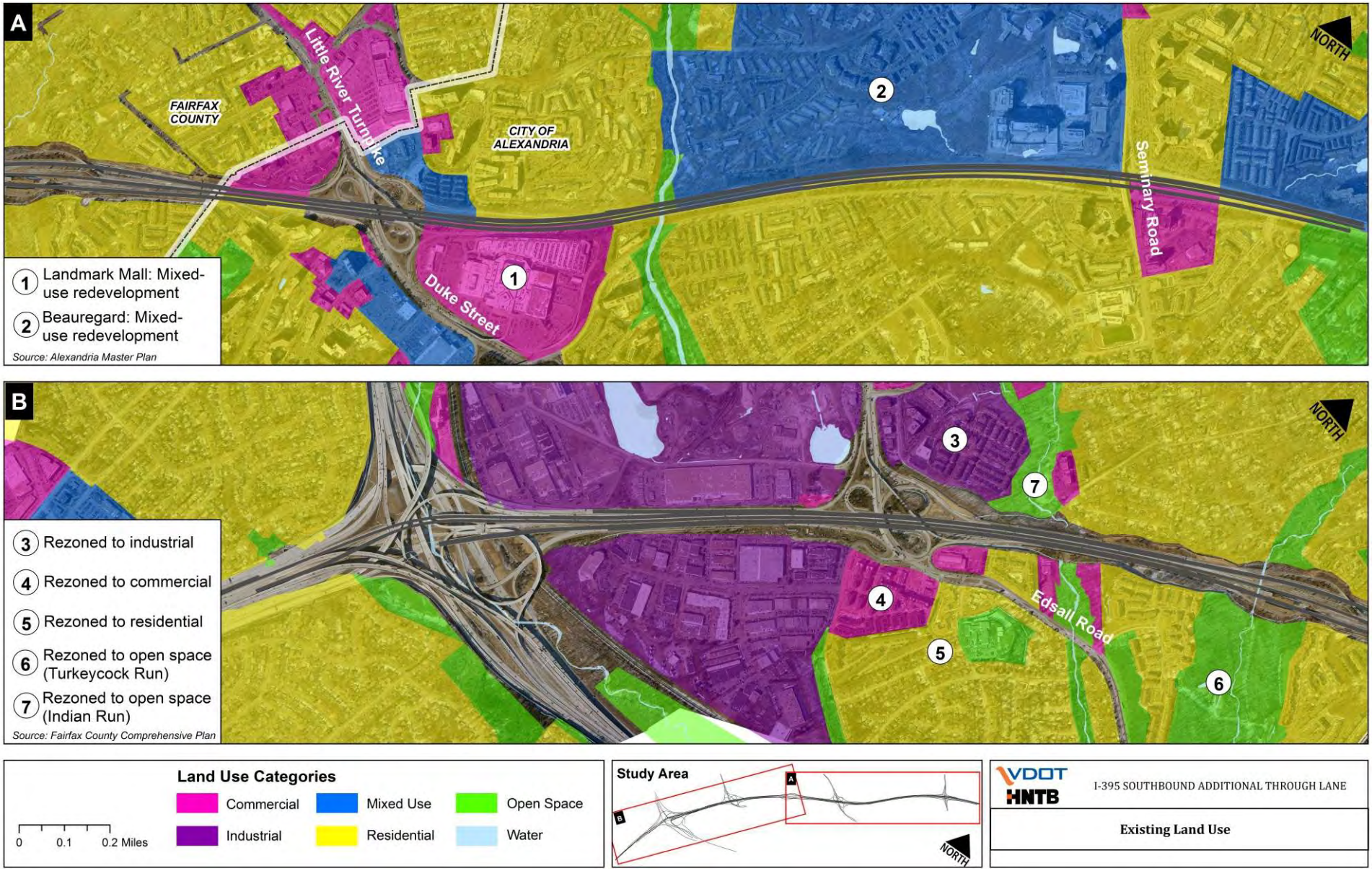

Figure 8–2: Projected Future Land Use in Study Area

8.4 Utilities

In the City of Alexandria, the Holmes Run Trunk Sewer is situated parallel to Holmes Run under I-395. This sanitary sewer main serves the several communities within the study area, but is deep enough such that proposed improvements should not affect the facility. Other utilities include electrical transmission lines, telecommunications lines, and water delivery systems.

The Preferred Alternative will be designed to avoid utility conflicts where possible, and address utility relocations where required.

8.5 Right-of-Way

Under the Preferred Alternative, the majority of construction is planned to occur within existing right-of-way. Additional right-of-way will be required along the north side of I-395 near Turkeycock Run, Lincoln Avenue, and Strawbridge Square Drive.

8.6 Consistency with Plans and Policies

The proposed improvements to I-395 are consistent with the Comprehensive Plans for Fairfax County and the City of Alexandria, as exemplified in the Plan Goals below:

- *An integrated, multimodal transportation system that efficiently and effectively gets people from point "A" to point "B".*[30]
- *Ensure that the roadway system provides adequate local access and capacity for through movements, consistent with financial, social, and environmental constraints and with the county's goal of reducing SOV [single occupancy vehicle] use.* [31]

Conversely, maintaining No-Build conditions would worsen congestion and would be inconsistent with the City of Alexandria's and Fairfax County's goals.

As a programmed CLRP improvement, the Preferred Alternative is consistent with other improvements within the study area, such as the implementation of I-95 Express Lanes and providing auxiliary lanes along northbound I-395 between Duke Street and Seminary Road.

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[30] *City of Alexandria 2004-2015 Strategic Plan*, City of Alexandria, 2004.
[31] *Fairfax County Comprehensive Plan 2013 Edition*, Fairfax County, 2013.

CHAPTER 9: ENVIRONMENTAL COMPLIANCE

In consultation with the FHWA, VDOT has determined that a Categorical Exclusion (CE) is the appropriate level of environmental documentation for this project pursuant to NEPA guidelines. The CE has identified environmental resources that are expected to be impacted by the proposed improvements. Environmental commitments, if any, identified in the NEPA process will be reflected in the final design of the project. The CE for this project has been approved by VA Division of FHWA.

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