IMPROVEMENTS TO
I-95 BETWEEN EXIT 133 AND EXIT 130

Interchange Modification Report Supplement to support the I-95 Rappahannock River Crossing Southbound Project

VDOT | U.S. Department of Transportation Federal Highway Administration

SEPTEMBER 2017

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Interchange Modification Report Supplement

IMPROVEMENTS TO I-95 BETWEEN EXIT 133 AND 130
I-95 Rappahannock River Crossing Southbound Project

Commonwealth of Virginia

State Project Number: 0095-111-259, P101, R201, C501
Federal Project Number: IM-5111(235)
UPC: 101595

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 September 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.

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

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Interchange Modification Report Supplement

IMPROVEMENTS TO I-95 BETWEEN EXIT 133 AND 130
I-95 Rappahannock River Crossing Southbound Project

Commonwealth of Virginia

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-200.9, and in accordance with the FHWA's policy on *Access to the Interstate System* dated August 27, 2009.

Submitted September 2017 to:

U.S. Department of Transportation
Federal Highway Administration

Submitted by:

VDOT Virginia Department of Transportation

Prepared under the direction and review of:

Fredericksburg District Virginia Department of Transportation	Date
Northern Virginia District Traffic Engineer Virginia Department of Transportation	Date
Fredericksburg District Location and Design Engineer Virginia Department of Transportation	Date

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Interchange Modification Report Supplement

IMPROVEMENTS TO I-95 BETWEEN EXIT 133 AND 130
I-95 Rappahannock River Crossing Southbound Project

September 2017

Prepared for:

VDOT Virginia Department of Transportation

Prepared by:

Whitman, Requardt & Associates, LLP

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1. EXECUTIVE SUMMARY

I-95 is the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C. and serves local, commuter, and regional traffic. The existing I-95 facility within the study limits between the Route 17 and Route 3 interchanges includes three northbound and three southbound travel lanes. Within the study area, I-95 suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. The peak period congestion is caused by a combination of through traffic along I-95 and traffic utilizing the Route 17 and Route 3 interchanges including a large portion of the traffic traveling along I-95 between Route 17 and Route 3. Population in the George Washington Region is forecasted to nearly double by 2040 and daily traffic volumes on I-95 are projected to increase from 150,000 in 2013 to 244,000 in 2040. This continued growth in population and traffic volumes will result in a further degradation of traffic operating conditions and increase both the severity and duration of daily congestion.

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), has initiated an Interchange Modification Report (IMR) Supplement for the Improvements to I-95 between Exit 133 and Exit 130 to incorporate improvements associated with the I-95 Rappahannock River Crossing Southbound Project.

1.1 PROJECT BACKGROUND

On July 6, 2016, FHWA approved the Interchange Modification Report (IMR) for Improvements to I-95 from Exit 133 to Exit 130. The proposed access modifications included in the IMR were the result of many years of planning by the Fredericksburg Area Metropolitan Planning Organization (FAMPO) and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along this section of I-95 between the Route 17 and Route 3 interchanges. The preferred alternative approved in the IMR included the following major components:

- Two-lane collector-distributor (C-D) roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

As documented in the IMR, the proposed project will be implemented in different phases due to funding constraints.

- **I-95 Safety Improvements at Route 3 (Exit 130):** The first phase of work is the I-95 Safety Improvements at Route 3 (Exit 130) project that is currently under construction and scheduled to be complete in January 2019.

- **I-95 Rappahannock River Crossing Southbound Project:** Funding for improvements along southbound I-95 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River was secured through the Smart Scale program and $125 million is included in the fiscal year (FY) 2017-2022 Six-Year Improvement Program (SYIP). This portion of the project would be the next phase of improvements.

- **I-95 Northbound C-D Lanes Project:** Improvements along northbound I-95 including the construction of the northbound C-D lanes and associated improvements at the Route 17 interchange remain unfunded and as such, would be the last phase of improvements when funded.

During the Design-Build procurement process for the southbound phase of the project, VDOT decided to reevaluate the configuration of the southbound C-D lanes to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along southbound I-95. In accordance with the FHWA approval letter for the prior IMR, which states that the "IMR will have to be reevaluated if modifications are made to the "accepted" concept detailed on page ES-3 of the document," this IMR Supplement has been prepared to document modifications to the proposed southbound C-D lanes referred to as the I-95 Rappahannock River Crossing Southbound project.

1.2 PURPOSE AND NEED

On July 6, 2016, FHWA approved the Interchange Modification Report (IMR) for Improvements to I-95 from Exit 133 to Exit 130. Based on the previously approved April 2016 IMR, the following project-specific purpose has been identified to address the documented safety and operational deficiencies along I-95 between Route 17 (Exit 133) and Route 3 (Exit 130):

- Advance the recommendations, objectives and policy identified in the FAMPO 2040 Long Range Transportation Plan, adopted April 2013.
- Address recurring safety and congestion challenges associated with study area peak period travel along the I-95 mainline.
- Address recurring safety and congestion challenges associated with peak period activity at the interchanges of Route 3 and Route 17.
- Eliminate I-95 weaving movements wherever possible.
- Remove from the I-95 mainline, as much of the local traffic as possible that uses I-95 to travel between Route 3 and Route 17.
- Provide additional parallel I-95 bridges over the Rappahannock River to allow for needed redundancy and flexibility during incidents, required maintenance, and bridge rehabilitation activities.
- Arrive at a solution that is compatible with the development of park and ride, TDM, and transit opportunities within the I-95 corridor to reduce single occupant vehicle travel.

1.3 SCREENING OF ALTERNATIVES

The proposed access modifications to I-95 from Exit 133 to Exit 130 included in the April 2016 IMR were the result of many years of planning by FAMPO and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along this section of I-95 between the Route 17 and Route 3 interchanges. The I-95 Access Study, which resulted in an approved Interchange Justification Report (IJR) in April 2011, included a new interchange along I-95 between Exit 133 and Exit 130, a four-mile toll road that provided an alternate access to Route 3, and northbound and southbound C-D roads. The toll road project and new interchange project were not pursued; however, VDOT decided to pursue the implementation of portions of the I-95 Access Study, the result of which was the preparation on an IMR for Improvements to I-95 between Exit 133 and 130. As part of the development of the April 2016 IMR, twelve alternatives in addition to the No Build alternative were developed and screened to evaluate each alternative and then select a preferred alternative. The screening and evaluation of the alternatives considered daily traffic volumes, densities, and level of service (LOS) for the AM and PM peak hours along the I-95 mainline lanes and the proposed C-D roads, operations at the Route 17 and Route 3 interchanges including the elimination of weaving, and other relevant factors.

Following the approval of the April 2016 IMR, VDOT decided to reevaluate the configuration of the southbound I-95 C-D lanes project to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along southbound I-95. The revised alternatives considered were evaluated in the context of measurable indicators of future viability including traffic operations, cost, and schedule. A working group, comprised of VDOT Fredericksburg and Northern Virginia District staff as well as technical support staff was formed to guide the development of a Modified Build Alternative. All potential alternatives focused on improving operations and minimizing access points along the southbound I-95 mainline lanes including minimizing the impact of congestion and queues associated with traffic exiting to the Route 3 interchange. The Modified Build Alternative, which relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes was selected based on its ability to accommodate future traffic demands and the elimination of access points along the southbound I-95 mainline at the Route 3 and Route 17 interchanges. With the exception of the diverge to the C-D lanes north of the Route 17 interchange and the merge with the C-D lanes south of the Route 3 interchange, the Modified Build Alternative would not have any access points along the southbound I-95 mainline lanes.

1.4 SUMMARY OF PROPOSED ACTION

The Modified Build Alternative including typical sections for the I-95 Rappahannock River Crossing Southbound Project is depicted in **Figure 4-2**. Improvements along northbound I-95 are depicted in **Figure 4-1** and were not changed from the approved concept depicted in the April 2016 IMR. The proposed project consists of the following improvements along northbound and southbound I-95, Route 17 and Route 3:

Northbound I-95: The April 2016 IMR preferred alternative includes parallel two-lane collector-distributor (C-D) roads in each direction between the Route 3 and Route 17 interchanges. The C-D roads cross the Rappahannock River on a separate bridge structure. The northbound C-D roads would begin at the Route 3 interchange combining traffic from the eastbound Route 3 to northbound I-95 triple left-turn

lanes with the right turn from westbound Route 3 to northbound I-95 on a C-D road. The northbound C-D road would cross the Rappahannock River and then split providing access to I-95 and Route 17, braid with the I-95 northbound to Route 17 off-ramp, and then merge with northbound I-95. The northbound I-95 bridge over Route 17 would be replaced and widened to accommodate the on-ramp acceleration lane and provide additional vertical clearance for Route 17. No changes were made to the northbound I-95 portion of the project with the Modified Build Alternative.

Southbound I-95: The Modified Build Alternative relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes. The diverge from the existing I-95 southbound mainline lanes to the C-D lanes would be located north of the Route 17 interchange and the merge with the C-D lanes would be located south of the Route 3 interchange. There would be three new southbound I-95 mainline lanes between Route 17 and Route 3 for the entire limits of the C-D road. A new three-lane bridge along the I-95 southbound mainline lanes would be constructed over the Rappahannock River within the median.

The repurposed C-D lanes would diverge from the new I-95 mainline lanes as a three-lane exit ramp with the third lane being an option lane serving both the C-D and mainline lanes. The existing three lanes would be maintained along the southbound I-95 C-D road until the Route 3 interchange where one of the three C-D lanes would be dropped onto the ramp to westbound Route 3. South of the off-ramp to westbound Route 3, the C-D road would include two lanes through the weave with the Route 3 loop ramps and the merge with the ramp from eastbound Route 3 to southbound I-95. The two C-D lanes would then merge with the new I-95 mainline lanes as a two-lane entrance ramp.

Improvements to I-95 at Route 17 Interchange: The proposed improvements to the Route 17 interchange require major reconstruction of the interchange:

- The Route 17 interchange merge and diverge points along the southbound I-95 mainline lanes would be located along the repurposed southbound C-D lanes and the locations and alignment of the ramps would remain essentially the same as existing conditions.
- The eastbound Route 17 to I-95 southbound on-ramp would be widened to two lanes.
- The northbound I-95 to westbound Route 17 loop ramp would be removed and replaced with a semi-directional flyover. The flyover would cross over Route 17, I-95, and Sanford Drive and then tie down on the right side of Route 17 prior to the McLane Drive intersection.

Improvements to I-95 at Route 3 Interchange: Improvements to the Route 3 interchange are currently under construction and are the first phase of the overall Improvements to I-95 between Exit 133 and 130.

- The off-ramp from southbound I-95 to Route 3 westbound would be extended and widened.
- A physically-separated lane would be constructed for southbound I-95 traffic destined for Carl D. Silver Parkway at Central Park eliminating any weaving along westbound Route 3 by these vehicles.
- Three right turn lanes would be built for traffic exiting I-95 to Route 3 westbound. These lanes would be signal-controlled at a new signal along westbound Route 3 eliminating merging and

weaving along westbound Route 3. Eastbound Route 3 traffic would not stop at this new traffic signal.

- The loop ramp from eastbound Route 3 to northbound I-95 would be removed thereby eliminating the eastbound weave along Route 3 and the northbound I-95 weave movement.
- Eastbound Route 3 traffic would access I-95 northbound by using three left-turn lanes that would be constructed along Route 3, just east of the I-95 overpass. Traffic would turn left onto the northbound on-ramp at a new intersection controlled by a traffic signal. Eastbound Route 3 traffic would not stop at the new traffic signal.

1.5 SUMMARY OF FINDINGS

1.5.1 TRAFFIC OPERATIONAL ANALYSIS FINDINGS

Traffic operations including level of service (LOS) and other measures of effectiveness were evaluated using a combination of Highway Capacity Software Version 6.90 (HCS) and TSIS-CORSIM Version 6.3 (CORSIM) using the same methodologies as those documented in the April 2016 IMR. The traffic operations analysis was performed for the Modified Build Alternative only and compared to the traffic operations analysis documented in the April 2016 IMR. The capacity and operational analysis demonstrates that the Modified Build Alternative would reduce overall travel times and increase travel speeds along the southbound I-95 mainline lanes and C-D lanes within the study area limits compared to the April 2016 IMR under both 2020 and 2040 Build conditions based on a review of the CORSIM microsimulation analysis.

The Modified Build Alternative would remove all merge, diverge, and weave movements for the Route 3 and Route 17 interchanges from the I-95 southbound mainline lanes and relocate them to the C-D lanes thereby reducing conflict points along the higher speed mainline lanes. Traffic operations along northbound I-95 would be the same with the Modified Build Alternative compared to the April 2016 IMR Build Alternative.

The following are other key operational benefits of the Modified Build Alternative along southbound I-95 compared to the April 2016 Build Alternative in the 2040 design year:

- Travel speeds along the southbound I-95 C-D road between the Rappahannock River bridge and Route 3 would increase from 13 - 42 MPH with the April 2016 IMR Alternative to 58 - 65 MPH with the Modified Build Alternative. Maximum queues approaching Route 3 are approximately 1,175 feet and do not extend to the I-95 southbound C-D lanes diverge to westbound Route 3 under 2040 Modified Build conditions, whereas the April 2016 IMR documented queues on the new southbound I-95 C-D lanes that extend approximately 2.5 miles from Route 3 and almost to the new braided ramps south of the Route 17 interchange. The improvement in operations along the southbound I-95 C-D road with the Modified Build Alternative can be attributed to the addition of a third lane on the C-D road that drops to Route 3 and modifications to the scope of the improvements associated with the I-95 Safety Improvements at Route 3 project.

- Similar to the April 2016 Build Alternative, the eastbound Route 17 to I-95 southbound on-ramp would be widened to two lanes; however, the lane configuration on the eastbound Route 17 approach to Sanford Drive would be revised to convert the right-turn lane to a shared through/right-turn lane that would drop at the ramp to southbound I-95. This would provide two continuous

eastbound lanes beginning west of Sanford Drive that would serve the on-ramp to southbound I-95. Throughput on the on-ramp from eastbound Route 17 to the southbound I-95 C-D road would increase from 60 percent with the April 2016 IMR Alternative to 80 percent with the Modified Build Alternative. This indicates a substantial increase in the throughput volume along eastbound Route 17 destined for southbound I-95 with the Modified Build Alternative resulting in an improvement in operations along eastbound Route 17.

- With the Modified Build Alternative, the southbound weave at the Route 3 ramps and the on-ramp from eastbound Route 3 to southbound I-95 would operate along the C-D road and would not impact operations along the mainline lanes due to the extension of the new southbound I-95 mainline lanes beyond the Route 3 interchange.

- Both the April 2016 IMR and Modified Build Alternative would have congestion along southbound I-95 north of Route 17 and approaching the diverge to the southbound I-95 C-D lanes and operate with similar travel speeds. Congestion on the southbound I-95 mainline lanes approaching the three-lane diverge to the southbound C-D lanes with the Modified Build Alternative is partially caused by the high traffic volumes that must change lanes to access the C-D lanes; however, the Modified Build Alternative would have throughput volumes approximately 233 vehicles greater on the southbound approach to the diverge to the C-D lanes compared to the April 2016 IMR Build Alternative.

- The Modified Build Alternative, as currently proposed, supports the three AASHTO principles of route continuity, lane balance, and basic number of lanes by maintaining three travel lanes on the mainline I-95 lanes without the need to change lanes.

Three of the nine intersections analyzed along Route 17 and Route 3 would have improved operations in 2020 and 2040 with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. One intersection, Route 3 at the I-95 Northbound On-Ramp, would have degraded operations with the Modified Build Alternative and one intersection, Route 17 at Ramp to I-95 SB C-D Road, would be removed with the Modified Build Alternative.

1.5.2 CRASH ANALYSIS FINDINGS

I-95, Route 3, and Route 17 within the study area are characterized by recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. This congestion creates the potential for crashes, especially rear end and sideswipe crashes. During the three-year period from January 1, 2010 through December 31, 2012, a total of 1,180 crashes were reported along the roadway segments that were analyzed along I-95, Route 3 and Route 17. 603 (51 percent) of the crashes were rear end collisions which frequently can be contributed to congested and stop-and-go conditions. In addition, there were 15 percent angle crashes, 15 percent fixed object (off road) crashes, and 13 percent sideswipe (same direction) crashes which frequently can be attributed to conflict points (merges, diverges, and weaves) along both interstates and arterials. Crash rates per 100 million vehicle miles traveled (VMT) were calculated for each of the five roadway segments and compared to VDOT's annually-published statewide averages for the same roadway type. All five of the segments analyzed have a total crash rate greater than the statewide average interstate or primary crash rate. Crash rates along I-95 are greatest in the

vicinity of the Route 3 and Route 17 interchanges. Crash rates along Route 17 and Route 3 are three to five times greater than the statewide average crash rates for primary arterials.

Both the April 2016 IMR Build Alternative and the Modified Build Alternative include the addition of northbound and southbound C-D roads and bridges across the Rappahannock River, major modifications to the Route 17 interchange, as well as modifications to the Route 3 interchange. Both alternatives add capacity along I-95 between Route 3 and Route 17 in the form of additional travel lanes roads reducing the potential for congestion-related crashes compared to No Build conditions as documented in the April 2016 IMR. Safety conditions along northbound I-95 are anticipated to be identical between the two alternatives as there are no differences between the two alternatives.

One of the established purposes of the project is to eliminate I-95 weaving movements and conflict points wherever possible. A primary safety benefit of the Modified Build Alternative compared to the April 2016 IMR Build Alternative is the reduction in the number of conflict points and weaving movements along the I-95 southbound mainline lanes. **Chapter 8** contains a summary of the conflict points in both tabular and graphical formats. There are twelve total conflict points with both the April 2016 IMR Build Alternative and the Modified Build Alternative when summing the conflict points along the southbound I-95 mainline lanes and the C-D lanes; however, the number of conflict points along the mainline lane reduces from seven to two conflict points with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. The number of conflict points along the C-D road increases from five to ten conflict points with the Modified Build Alternative compared to the April 2016 IMR Build Alternative which can be attributed to the extension of the new southbound I-95 mainline lanes to incorporate all ramps serving both Route 17 and Route 3 along the C-D road. The Modified Build Alternative has the potential to improve safety compared to the April 2016 IMR Build Alternative by reducing conflicts points along the higher speed I-95 southbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions. A reduction in the number of conflict points along the mainline facility rather than the C-D road is preferred because travel speeds are expected to be lower on the C-D road, minimizing the severity of crashes.

Crash modification factors (CMFs) were reviewed to document the relative safety of the Modified Build Alternative compared to the April 2016 IMR Alternative. Application of a CMF for the reduction of on-ramp density results in a 2% reduction in injury and fatal crashes along the southbound I-95 mainline lanes with the Modified Build Alternative.

1.6 RESPONSE TO FHWA INTERSTATE ACCESS POLICY REQUIREMENTS

FHWA has established Eight Policy Points as defined in FHWA's *Interstate System Access Informational Guide*. The FHWA's decision to approve a request for a modification to access is dependent on satisfying and documenting the following requirements. This section addresses each of the Eight Policy Points.

1.6.1 POLICY REQUIREMENT 1: NEED FOR THE REVISED ACCESS

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 (23 CFR 625.2(a)).

I-95, the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C., serves local, commuter, and regional traffic, and suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. Traffic demand along the I-95 lanes already exceeds capacity and forecasts for the 2040 design year indicate that demand would continue to increase, thereby increasing congestion and the duration of at-capacity conditions. Additionally, many of the local arterials in the study area including Route 3 and Route 17 also operate at or above capacity during peak periods. Access management and capacity improvements along Route 3 and Route 17 alone would not eliminate the existing congestion and expected worsening of traffic operations along I-95. Additional crossings of I-95 between Route 17 and Route 3 other than Fall Hill Avenue and Cowan Boulevard could improve east-west travel operations, but would not improve access to and from I-95 for local and commuter traffic. Therefore, accommodating both existing and future traffic demands along I-95 cannot be adequately addressed through improvements to adjacent corridors.

In addition to the proposed construction of additional I-95 C-D lanes to increase capacity along the facility and serve local traffic, access modifications are proposed at both the Route 3 and Route 17 interchanges. These interchange modifications are required to accommodate the heavy existing and forecasted ramp traffic volumes and improve safety and operations along the northbound and southbound I-95 mainline and C-D lanes. No new interchanges are proposed as part of this project.

1.6.2 POLICY POINT 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 (23 CFR 625.2(a)).

Transportation System Management (TSM) strategies focus on improving the operational efficiency of the roadway transportation system without adding major system improvements, such as adding lanes or new ramps. The April 2016 IMR documented the consideration of TSM improvements including additional HOV facilities, expanded transit services, improved signal timing and synchronization, and intelligent transportation system improvements. The FAMPO 2040 (Constrained) Long-Range Transportation Plan (CLRP) includes reversible Express Lanes that would be available to HOV 3+ motorists and serve as a TSM improvement; however, the April 2016 IMR documented that other TSM strategies considered would have minimal impact on traffic operations along the I-95 corridor and could not adequately satisfy the project Purpose and Need.

1.6.3 POLICY POINT 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 (23 CFR 625.2(a), 655.603(d) and 771.111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the

proposed change in access, 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 (23 CFR 625.2(a) and 655.603(d)). 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 street network (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

The operational and safety analyses extends along I-95 from north of the Route 17 interchange to south of the Route 3 interchange and along Route 3 and Route 17 in the vicinity of I-95 consistent with the April 2016 IMR. The analysis includes at least one major signalized intersection along Route 17 and Route 3 on both the east and west sides of I-95.

Section 1.5.1 summarizes the traffic operational analysis findings. The capacity and operational analysis demonstrates that the Modified Build Alternative would reduce overall travel times and increase travel speeds along the southbound I-95 mainline lanes and C-D lanes within the study area limits compared to the April 2016 IMR with both 2020 and 2040 Build conditions based on a review of the CORSIM microsimulation analysis. Additionally, the Modified Build Alternative would remove all merge, diverge, and weave movements for the Route 3 and Route 17 interchanges from the I-95 southbound mainline lanes and relocate them to the C-D lanes thereby reducing conflict points along the higher speed mainline lanes. Traffic operations along northbound I-95 would be the same with the Modified Build Alternative compared to the April 2016 IMR Build Alternative.

Section 1.5.2 summarizes the crash analysis finding including an analysis of conflict points. A primary safety benefit of the Modified Build Alternative compared to the April 2016 IMR Build Alternative is the reduction in the number of conflict points and weaving movements along the I-95 southbound mainline lanes. There are twelve total conflict points with both the April 2016 IMR Build Alternative and the Modified Build Alternative; however, the number of conflict points along the mainline lane reduces from seven to two conflict points with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. The number of conflict points along the C-D road increases from five to ten conflict points with the Modified Build Alternative compared to the April 2016 IMR Build Alternative which can be attributed to the extension of the new southbound I-95 mainline lanes to incorporate all ramps serving both Route 17 and Route 3 along the C-D road. A reduction in the number of conflict points along the mainline facility rather than the C-D road is preferred because travel speeds are expected to be lower on the C-D road, minimizing the severity of crashes. Overall it can be concluded that the Modified Build Alternative should have a positive safety benefit along the I-95 southbound mainline lanes compared to the April 2016 Build Alternative due to the reduction in the number of conflicts points along the higher speed I-95 southbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions. CMFs were reviewed to document the relative safety of the Modified Build Alternative compared to the April 2016 IMR Alternative. Application of a CMF for the reduction of on-ramp density results in a 2% reduction in injury and fatal crashes along the southbound I-95 mainline lanes with the Modified Build Alternative.

A conceptual signing and pavement marking plan depicting all major guide signs along the southbound I-95 lanes is included in **Figure 4-2** and key design features of the Modified Build Alternative signing are summarized in **Section 5.4**.

1.6.4 POLICY POINT 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 (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)).

Full interchanges accommodating all traffic movements are currently provided at both the I-95 at Route 3 and I-95 at Route 17 interchanges. The proposed improvements associated with the I-95 Rappahannock River Crossing Southbound Project would not remove any movements and would provide for all traffic movements.

All elements of the I-95 Rappahannock River Crossing Southbound Project have been designed in accordance with American Association of State Highway and Transportation Officials (AASHTO) and VDOT standards to the extent practical. **Chapter 5** contains a summary of the two design waivers required for the project:

- Reduced Inside Shoulder Width on I-95 SB Mainline Lanes on Rappahannock River Crossing Bridge
- Reduced Inside Paved and Total Shoulder Width on I-95 SB Mainline Lanes

1.6.5 POLICY POINT 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 I-95 between Exit 133 and 130 are included in the Fredericksburg Area Master Planning Organization (FAMPO) 2040 (Constrained) Long-Range Transportation Plan (CLRP), adopted April 2013. The Rappahannock River Crossing Project (UPC 101595) is included in the FY 2015 – FY 2018 Statewide Transportation Improvement Program (STIP) and FAMPO's FY 2015 – FY 2018 Transportation Improvement Program (TIP). VDOT has been coordinating with FAMPO, the City of Fredericksburg, and Stafford and Spotsylvania Counties throughout the project development process for improvements to the I-95 corridor including recent changes to the southbound phase of the project. The initial project design for the southbound I-95 C-D lanes project was presented to the public at a design public hearing held on January 25, 2017. A citizen information meeting was held on June 28, 2017 to present the modifications to the improvements along southbound I-95 to the public.

1.6.6 POLICY POINT 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 (23 U.S.C. 09(d), 23 CFR 625.2(a), 655.603(d), and 771.111).

The April 2016 IMR and this IMR Supplement have been coordinated with other relevant studies of the I-95 corridor that have addressed potential improvements at the six existing interchanges along the 17-mile section of I-95 between milepost 126 and milepost 143 including interim and long-term improvements at the I-95 at Exit 126 interchange and improvements at the I-95 at Route 630 interchange (Exit 143).

In addition, an extension of the existing I-95 Express Lanes is included in the FAMPO Constrained Long-Range Plan. Consistent with the April 2016 IMR, it was assumed that a new Express Lanes facility would be constructed within the median continuing through the study area from the existing Express Lanes terminus at Route 610/Garrisonville Road to Massaponax (milepost 126) in Spotsylvania County. A definitive schedule and funding plan have not been developed for the extension of the Express Lanes south of Route 17 (Exit 133); however, the I-95 Express Lanes Extension to Fredericksburg (Fred Ex) project which includes the extension of the Express Lanes from the existing terminus at Route 610/Garrisonville Road to Route 17 is currently under development by VDOT in partnership a concessionaire (95 Express Lanes LLC). At this time, the Fred Ex project and the exact configuration of the project is uncertain due to negotiations between VDOT and 95 Express Lanes LLC and therefore direct ramp connections between the Fred Ex project and the I-95 C-D lanes are not included in the No Build or Build conditions for the April 2016 IMR Build Alternative or the Modified Build Alternative. It is intended that the Fred Ex lanes open to traffic concurrently with the southbound C-D lanes, if possible and therefore there has been extensive coordination between the study teams for the I-95 Rappahannock River Crossing Southbound Project and Fred Ex project to ensure compatibility between the projects in the vicinity of the Route 17 interchange where the project limits for the two projects overlap.

No additional changes in access along I-95 are planned or have been identified at this time.

1.6.7 POLICY POINT 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 improvements (23 CFR 625.2(a) and 655.603(d)). 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 (23 CFR 625.2(a) and 655.603(d)).

The proposed access modifications to I-95 from Exit 133 to Exit 130 are the result of many years of planning by FAMPO and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along this section of I-95 between the Route 17 and Route 3 interchanges. The proposed Improvements to I-95 between Exit 133 and 130 are included in the Fredericksburg Area Master Planning Organization (FAMPO) 2040 (Constrained) Long-Range Transportation Plan (CLRP), adopted April 2013. Coordination has occurred with recently completed improvements, planned improvements, and ongoing studies within the study area vicinity as described in **Section 2.3.**

The request for revised access is not specifically related to changes to future development or land uses, but is in response to the need to address the long term mobility needs of the I-95 Rappahannock River crossing and the Route 17 and Route 3 interchanges in response to regional land use development and increases in interstate travel along the I-95 corridor along the East Coast, particularly between Richmond and Washington, D.C.

1.6.8 POLICY POINT 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 (23 CFR 771.111).

Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA), and in accordance with Federal Highway Administration (FHWA) regulations, an Environmental Assessment (EA) has been prepared and a Finding of No Significant Impact (FONSI) was issued by the FHWA on November 17, 2015. The EA analyzed and documented the potential social, economic, and environmental effects associated with the proposed transportation improvements and the FONSI concluded that the project would not have significant impacts on the environment. Since approval of the EA and issuance of the FONSI, VDOT has proposed design modifications (analyzed in this IMR Supplement). Based on these design modifications, VDOT conducted a Re-evaluation of the EA. The Re-evaluation of the EA is expected to be approved by FHWA in September 2017. The EA and Re-evaluation include information from various technical reviews including those related to historic properties, natural resources, water quality, threatened and endangered species, air quality, noise, etc. The EA and Re-evaluation, identify and further explain the environmental resources that are within the study area and discuss the potential impact that the project would have on those resources.

2. INTRODUCTION

I-95 is the primary north-south interstate serving traffic traveling between Richmond, Fredericksburg, and Washington, D.C. and serves local, commuter, and regional traffic. The existing I-95 facility within the study limits between the Route 17 and Route 3 interchanges includes three northbound and three southbound travel lanes. Within the study area, I-95 suffers from recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. The peak period congestion is caused by a combination of through traffic along I-95 and traffic utilizing the Route 17 and Route 3 interchanges including a large portion of the traffic traveling along I-95 between Route 17 and Route 3. Population in the George Washington Region is forecasted to nearly double by 2040 and daily traffic volumes on I-95 are projected to increase from 150,000 in 2013 to 244,000 in 2040. This continued growth in population and traffic volumes will result in a further degradation of traffic operating conditions and increase both the severity and duration of daily congestion.

The Virginia Department of Transportation (VDOT), in cooperation with the Federal Highway Administration (FHWA), has initiated an Interchange Modification Report (IMR) Supplement for the Improvements to I-95 between Exit 133 and Exit 130 to incorporate improvements associated with the I-95 Rappahannock River Crossing Southbound Project.

2.1 PURPOSE AND NEED

On July 6, 2016, FHWA approved the Interchange Modification Report (IMR) for Improvements to I-95 from Exit 133 to Exit 130. Based on the previously approved April 2016 IMR, the following project-specific purpose has been identified to address the documented safety and operational deficiencies along I-95 between Route 17 (Exit 133) and Route 3 (Exit 130):

- Advance the recommendations, objectives and policy identified in the Fredericksburg Area Metropolitan Planning Organization (FAMPO) 2040 Long Range Transportation Plan, adopted April 2013.
- Address recurring safety and congestion challenges associated with study area peak period travel along the I-95 mainline.
- Address recurring safety and congestion challenges associated with peak period activity at the interchanges of Route 3 and Route 17.
- Eliminate I-95 weaving movements wherever possible.
- Remove from the I-95 mainline, as much of the local traffic as possible that uses I-95 to travel between Route 3 and Route 17.
- Provide additional parallel I-95 bridges over the Rappahannock River to allow for needed redundancy and flexibility during incidents, required maintenance, and bridge rehabilitation activities.
- Arrive at a solution that is compatible with the development of park and ride, TDM, and transit opportunities within the I-95 corridor to reduce single occupant vehicle travel.

2.2 BACKGROUND

The proposed access modifications to I-95 from Exit 133 to Exit 130 included in the April 2016 IMR were the result of many years of planning by FAMPO and VDOT to develop a long range comprehensive plan and strategy to address the capacity and safety deficiencies along this section of I-95 between the Route 17 and Route 3 interchanges. The preferred alternative approved in the IMR included the following major components:

- Two-lane collector-distributor (C-D) roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

As documented in the IMR, the proposed project would be implemented in different phases due to funding constraints.

- **I-95 Safety Improvements at Route 3 (Exit 130):** The first phase of work is the I-95 Safety Improvements at Route 3 (Exit 130) project that is currently under construction and scheduled to be complete in January 2019. Details of this project are discussed in more detail in **Section 2.3.4**.
- **I-95 Rappahannock River Crossing Southbound Project:** Funding for improvements along southbound I-95 including construction of the southbound C-D lanes and a new southbound bridge over the Rappahannock River was secured through the Smart Scale program and $125 million is included in the fiscal year (FY) 2017-2022 Six-Year Improvement Program (SYIP). This portion of the project will be the next phase of improvements.
- **I-95 Northbound C-D Lanes Project:** Improvements along northbound I-95 including the construction of the northbound C-D lanes and associated improvements at the Route 17 interchange remain unfunded and as such, will be the last phase of improvements when funded.

During the Design-Build procurement process for the southbound phase of the project, VDOT decided to reevaluate the configuration of the southbound C-D lanes to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along the southbound I-95 mainline lanes. The revised alternatives considered were evaluated in the context of measurable indicators of future viability including traffic operations, cost, and schedule.

In accordance with the FHWA approval letter for the prior IMR which states that the "IMR will have to be reevaluated if modifications are made to the "accepted" concept detailed on page ES-3 of the document," this IMR Supplement has been prepared to document modifications to the proposed southbound C-D lanes referred to as the I-95 Rappahannock River Crossing Southbound project.

2.3 RELATIONSHIP TO OTHER HIGHWAY IMPROVEMENT PLANS/PROGRAMS

The proposed improvements along I-95 overlap with or are located adjacent to several recently completed improvements, planned improvements, and ongoing studies.

2.3.1 I-95 Express Lanes Extension to Fredericksburg (Fred Ex)

The I-95 Express Lanes Extension to Fredericksburg (Fred Ex) is currently under study to the north of the proposed improvements along I-95 between Exit 133 and Exit 130. Fred Ex includes the development of two new reversible HOV/HOT lanes (Express Lanes) along the 10-mile segment within the median between Route 610/Garrisonville Road and the Route 17 interchange at Exit 133. The Express Lanes conceptual design has been developed to include connections to both the northbound and southbound I-95 C-D lanes between Exit 133 and Exit 130. The preparation of an IMR is currently underway for the Fred Ex project to document the traffic operations of the proposed project. The IMR for the Fred Ex project will include the I-95 Rappahannock River Crossing Southbound project as a completed project in both the No Build and Build scenarios. The first draft of this IMR is expected to be complete in September 2017 with the final IMR to be complete in early 2018. While the Fred Ex project is still uncertain due to negotiations between VDOT and the concessionaire (95 Express Lanes LLC), the current project schedule assumes that construction would begin in 2019 and be complete in 2022. It is intended that the Fred Ex lanes open to traffic concurrently with the southbound C-D lanes, if possible.

It should be noted that in addition to the Fred Ex project discussed above, the No Build and Build assumptions for the April 2016 IMR include a new Express Lanes facility continuing through the study area from the existing Express Lanes terminus at Route 610/Garrisonville Road to Massaponax (milepost 126) in Spotsylvania County as included in the FAMPO 2040 Constrained Long-Range Plan. However, a definitive schedule and funding plan have not been developed for the extension of the Express Lanes south of Route 17 (Exit 133).

2.3.2 Fall Hill Avenue

The Fall Hill Avenue project was completed in April 2017 and included the widening of Fall Hill Avenue from two to four lanes and an extension of Mary Washington Boulevard. As part of the project, the Fall Hill Avenue bridge over I-95 was widened to four lanes to provide room for the future northbound and southbound I-95 C-D lanes.

2.3.3 Route 17 Widening

The Route 17 widening project was completed in December 2016 and included the widening of Route 17 from four to six lanes from McLaren Drive to 0.2 mile north of Stafford Lakes Parkway. The project included the installation of sidewalks and upgrades to eight traffic signals.

2.3.4 I-95 Safety Improvements at Route 3 (Exit 130)

This project, currently under construction, was initiated as a results of the April 2016 IMR and is the first phase of the overall Improvements to I-95 between Exit 133 and 130. Construction is scheduled to be complete in January 2019. The I-95 Safety Improvements at Route 3 seeks to enhance safety by reducing

conflict points and merging at the I-95 and Route 3 interchange. The project is being funded with federal Highway Safety Improvement Program (HSIP) funds. The following is a summary of the improvements:

Southbound I-95 Exit Ramp Improvements

- The off-ramp from southbound I-95 to Route 3 westbound will be extended and widened.
- A physically-separated lane will be constructed for southbound I-95 traffic destined for Carl D. Silver Parkway at Central Park eliminating any weaving along westbound Route 3 by these vehicles.
- Three right turn lanes will be built for traffic exiting I-95 to Route 3 westbound. These lanes will be signal-controlled at a new signal along westbound Route 3 eliminating merging and weaving along westbound Route 3. Eastbound Route 3 traffic will not stop at this new traffic signal.

Route 3 Eastbound On-Ramp Improvements

- The existing cloverleaf on-ramp that carries Route 3 eastbound traffic onto I-95 northbound will be removed thereby eliminating the eastbound weave along Route 3 and the northbound I-95 weave movement.
- Eastbound Route 3 traffic will access I-95 northbound by using three left-turn lanes that will be constructed along Route 3, just east of the I-95 overpass. Traffic will turn left onto the northbound on-ramp at a new intersection controlled by a traffic signal. Eastbound Route 3 traffic will not stop at this new traffic signal.

2.4 CONSISTENCY WITH REGIONAL PLANS AND COORDINATION WITH LOCALITIES

The proposed Improvements to I-95 between Exit 133 and 130 are included in the Fredericksburg Area Master Planning Organization (FAMPO) 2040 (Constrained) Long-Range Transportation Plan (CLRP), adopted April 2013. The Rappahannock River Crossing Project (UPC 101595) is included in the FY 2015 – FY 2018 Statewide Transportation Improvement Program (STIP) and FAMPO's FY 2015 – FY 2018 Transportation Improvement Program (TIP). VDOT has been coordinating with FAMPO, the City of Fredericksburg, and Stafford and Spotsylvania Counties throughout the project development process for improvements to the I-95 corridor including recent changes to the southbound phase of the project. The initial project design for the southbound I-95 C-D lanes project was presented to the public at a design public hearing held on January 25, 2017. A citizen information meeting was held on June 28, 2017 to present the modifications to the improvements along southbound I-95 to the public.

3. METHODOLOGY

A meeting was held with VDOT Central Office and Fredericksburg District staff on May 15, 2017 to discuss the scope of the Interchange Modification Supplement to support revisions to the I-95 Rappahannock River Crossing Southbound (Southbound I-95 C-D Lanes) project. In general, it was determined that the methodology to document the operations of the potential revisions to the Southbound I-95 C-D Lanes project should follow the same methodology as the previously approved April 2016 IMR for the overall I-95 Improvements from Exit 133 to 130 to the extent possible and that the IMR Supplement would compare the previously approved improvements along the southbound I-95 lanes (April 2016 IMR Build Alternative) with the revised concept (Modified Build Alternative). The meeting discussions and assumptions for the IMR Supplement were documented and are included in **Appendix A**. The assumptions document was subsequently approved by FHWA on June 1, 2017. The following summarizes the methodology as agreed upon by VDOT and FHWA.

3.1 STUDY AREA / PROJECT LOCATION

Consistent with the April 2016 IMR, the traffic analysis study area includes portions of Spotsylvania County, Stafford County and the City of Fredericksburg as shown in **Figure 3-1.** The study area extends along I-95 from south of the Route 3 interchange to north of the Route 17 interchange. Route 3 and Route 17 are the primary routes providing east-west travel in the study area and access to I-95. Fall Hill Avenue, Truslow Road and Cowan Boulevard are the only other crossings of I-95 in the study area. Along Route 17, the study area extends from west of McLane Drive to east of Short Street. Along Route 3, the study area extends from west of Central Park Boulevard to east of Gateway Boulevard.

For the purposes of this study, although Route 17 is signed as a north-south roadway, it is referred to as an east-west roadway for clarity.

Figure 3-1: Study Area

3.2 TRAFFIC FORECASTS AND ANALYSIS YEARS

Future traffic operations analysis were performed for the same years as the approved April 2016 Interchange Modification Report. At the time of the original IMR preparation, the opening year was anticipated to be 2020 and the design year was assumed to be 2040. The current project construction schedule for the I-95 Rappahannock River Crossing Southbound project is to award the Design-Build contract in early 2018, begin construction in summer 2018, and complete construction in fall 2022. The construction schedule for the improvements along northbound I-95 is not known at this time as discussed in **Section 2.2**.

To maintain consistency with the previously approved IMR, traffic volumes were developed for the Modified Build conditions based on the traffic volumes forecasts for the preferred alternative contained in the April 2016 IMR. Peak hour and daily traffic volumes were assigned to the roadway network based on origins and destinations and the path motorists would take based on the configuration of the Modified Build conditions. The methodology and resulting forecasts for the Modified Build conditions are described in more detail in **Section 6.2**.

It should be noted that to be consistent with the April 2016 IMR, it was assumed that an Express Lanes facility would be constructed within the median continuing through the study area from the existing Express Lanes terminus at Route 610/Garrisonville Road to Massaponax (Milepost 126) in Spotsylvania County as included in the FAMPO Constrained Long-Range Plan. As discussed in **Section 2.3.1**, a definitive schedule and funding plan have not been developed for the extension of the Express Lanes south of Route 17 (Exit 133); however, the Fred Ex project which includes the extension of the Express Lanes from the existing Express Lanes terminus at Route 610/Garrisonville Road to Route 17 is currently under development by VDOT in partnership with a concessionaire (95 Express Lanes LLC). At this time, the Fred Ex project and the exact configuration of the project is uncertain due to negotiations between VDOT and 95 Express Lanes LLC and therefore direct ramp connections between the Fred Ex project and the I-95 C-D lanes are not included in the forecasts for the April 2016 IMR Build Alternative or the Modified Build Alternative.

3.3 TRAFFIC OPERATIONS ANALYSIS

Traffic operations including level of service (LOS) and other measures of effectiveness were evaluated using a combination of Highway Capacity Software Version 6.90 (HCS) and TSIS-CORSIM Version 6.3 (CORSIM) using the same methodologies as those documented in the April 2016 IMR. The traffic operations analysis was performed for Modified Build conditions only and compared to the previous traffic operations analysis documented in the April 2016 IMR.

The HCS and CORSIM files from the April 2016 IMR were used as the basis for the development of capacity analysis files for the Modified Build Alternative. The AM and PM peak hour analysis files for 2020 and 2040 Build conditions from the April 2016 IMR were modified to reflect the geometry and traffic volumes for the Modified Build Alternative. In addition to the changes associated with the Modified Build Alternative, the following modifications were made to both the HCS and CORSIM models to reflect improvements that were recently implemented or are currently under construction:

- Recently completed improvements along Route 17 were incorporated into the Modified Build Alternative models

    - Route 17 at Sanford Drive: Modified the lane configuration on the northbound approach to provide a shared left/through lane and a double right-turn lane and the southbound approach to include two left-turn lanes, a shared left-turn/through lane, and a right-turn lane consistent with existing conditions.
    - Eastbound Route 17: Modified the lane configuration along eastbound Route 17 from east of McLane Drive through the I-95 interchange to provide an eastbound Route 17 lane that drops onto the southbound I-95 ramp and reduces lane changes in the vicinity of the interchange consistent with existing conditions.

- Improvements under construction along Route 3 associated with the I-95 Safety Improvements at Route 3 project were incorporated into the Modified Build Alternative models to reflect deviations from the approved April 2016 IMR:

    - Route 3 at Carl D Silver Parkway: Modified the lane configuration on the westbound Route 3 approach to Carl D Silver Parkway to provide a right-turn lane, a shared through/right-turn lane, three through lanes, and a left-turn lane.
    - Route 3 at Southbound I-95 Off-Ramp (triple right): Provided five westbound through lanes along westbound Route 3 approaching the traffic signal which is an increase compared to the April 2016 IMR.
    - Route 3 at Northbound I-95 On-Ramp (triple left): Removed the channelized westbound Route 3 right-turn movement and provided a signalized westbound right-turn and shared through/right-turn lane that operates under signal control.

It was assumed that the CORSIM model files were appropriately calibrated and validated in order to effectively evaluate future traffic operations. No additional calibration of the models was performed and calibration parameters were not changed except for where required to reflect the Modified Build Alternative. The following is a summary of other key assumptions:

- Consistent with the April 2016, the CORSIM analysis includes a seeding period to ensure the models were properly loaded prior to producing measures of effectiveness. Both the AM and PM peak hour models include a one hour analysis period consistent with the April 2016 IMR.
- Traffic signal timings along Route 3 were modified for 2020 and 2040 PM peak hour conditions from the April 2016 IMR signal timings to improve operations and in response to the modified geometry associated with the I-95 Safety Improvements at Route 3 project. Signal cycle lengths were not modified. No changes were made to the signal timings along Route 17.
- Measures of effectiveness (MOEs) were calculated based on an average of 10 microsimulation runs, consistent with the April 2016 IMR. Default random number seeds were used.

3.3.1 Measures of Effectiveness

Measures of effectiveness (MOEs) from the HCS and CORSIM outputs were used to compare the operations for the April 2016 Build Alternative to the Modified Build Alternative. HCS was used to document operations along both the freeways and arterials. CORSIM was used to document operations along the freeways only. The following is a summary of the MOEs documented for each scenario. The MOEs for the April 2016 IMR Build Alternative were obtained directly from the previously approved

IMR and the CORSIM models and HCS analysis files were not rerun. Two additional corridor-wide MOEs noted below were calculated in order to compare the two alternatives under consideration.

- Freeways performance measures including segments, merges, diverges and weaves (CORSIM)
  - Speed (MPH) for each lane and an average of all lanes
  - Density (vehicles per mile per lane) for each lane and an average of all lanes
  - Input and simulated volumes (vehicles per hour) for all lanes
  - Total travel times by facility for northbound and southbound I-95 mainline and C-D lanes *(not included in the April 2016 IMR)*
  - Average travel speed (MPH) by facility for northbound and southbound I-95 mainline and C-D lanes *(not included in the April 2016 IMR)*
- Freeways performance measures including segments, merges, diverges and weaves (HCS)
  - LOS
  - Speed (MPH)
  - Density (passenger cars per mile per lane)
- Signalized intersections (HCS)
  - LOS for overall intersection
  - Average delay for overall intersection (seconds / vehicle)
  - Average delay by intersection movement (seconds / vehicle)
  - Average delay by intersection approach (seconds / vehicle)
  - 50th percentile queue length by movement (feet)

Operational conditions from the CORSIM outputs for the I-95 mainline and C-D lanes were categorized to reflect various congestion levels based on density thresholds established in the Highway Capacity Manual 2010. **Table 3-1** summarizes the thresholds for freeways segments, weaves, merges, and diverges.

Table 3-1: CORSIM Freeway Measures of Effectiveness

Congestion Level	Freeways	Weave/Ramp	C-D Road Weave
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28	≤ 32
Moderate Traffic	>26 - 35	>28 - 35	>32 - 36
Heavy Congestion	>35 - 45	>35 - 45	>36 - 45
Severe Congestion	>45	>45	>45

Source: VDOT TOSAM - Version 1.0 (page F-17)

3.4 SAFETY ANALYSIS METHODOLOGY

Crash data was obtained from the Highway Traffic Roadway Information System (HTRIS) as part of the April 2016 IMR efforts. This data was not updated to provide consistency with the April 2016 IMR and a comparison to April 2016 IMR Build Alternative analysis. Crash data along northbound and southbound I-95 and along Route 3 and Route 17 was summarized for a three-year period from 2010 through 2012. The crash rates along I-95, Route 3, and Route 17 were compared to statewide crash rates. The safety analysis focused on a comparison of the safety operations of the Modified Build Alternative compared to the April 2016 IMR Build Alternative. Crash modification factors (CMFs) were identified to document the potential safety benefits of the Modified Build Alternative related to the removal of access points along the I-95 southbound mainline lanes.

4. ALTERNATIVES CONSIDERED

4.1 BACKGROUND

The alternatives development process typically involves developing conceptual alternatives that address the Purpose and Need of the project. Public and agency coordination is then conducted to receive input on the conceptual alternatives. The process of developing alternatives to address the documented safety and operational deficiencies along I-95 between Route 17 (Exit 133) and Route 3 (Exit 130) has been ongoing for several years. The I-95 Access Study, which resulted in an approved Interchange Justification Report (IJR) in April 2011, included a new interchange along I-95 between Exit 133 and Exit 130, a four-mile toll road that provided an alternate access to Route 3, and northbound and southbound C-D roads.

The toll road project and new interchange project were not pursued; however, VDOT decided to pursue the implementation of portions of the I-95 Access Study. As part of the development of the April 2016 IMR, twelve alternatives in addition to the No Build alternative were developed and screened to evaluate each alternative and then select a preferred alternative. The screening and evaluation of the alternatives considered daily traffic volumes, densities, and LOS for the AM and PM peak hours along the I-95 mainline lanes and the proposed C-D roads, operations at the Route 17 and Route 3 interchanges including the elimination of weaving, and other relevant factors. As a result of the screening process, Alternative 3A with some modifications was selected as the preferred alternative in the April 2016 IMR to meet the project purpose and need. **Section 4.3** describes the April 2016 IMR preferred alternative in more detail.

4.2 DEVELOPMENT OF MODIFIED BUILD ALTERNATIVE

As discussed in **Section 2.2,** during the Design-Build procurement process for the southbound phase of the project, VDOT decided to reevaluate the configuration of the southbound I-95 C-D lanes project to determine if there was a more effective way to fulfill the goals of the project while minimizing access and conflict points along southbound I-95. The revised alternatives considered were evaluated in the context of measurable indicators of future viability including traffic operations, cost, and schedule.

A working group, comprised of VDOT Fredericksburg and Northern Virginia District staff as well as technical support staff was formed to guide the development of a Modified Build Alternative. The group convened for an all day workshop and discussed design issues and constraints in order to reach a consensus on a potential modified project design. All alternatives discussed focused on improving operations and minimizing access points along the southbound I-95 mainline lanes including minimizing the impact of congestion and queues associated with traffic exiting to the Route 3 interchange.

The result of the working group discussions led to a Modified Build Alternative that relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes. The diverge from the I-95 southbound mainline to the C-D lanes would be located north of the Route 17 interchange and the merge with the C-D lanes would be located south of the Route 3 interchange. No changes are proposed to the improvements proposed along northbound I-95 as presented in the April 2016 IMR.

Section 4.4 describes the Modified Build Alternative in more detail.

4.3 APRIL 2016 IMR PREFERRED ALTERNATIVE

The preferred alternative from the April 2016 IMR consists of the following major components and is depicted in **Figure 4-1 (Sheets 1 through 5)**:

- Two-lane C-D roads between Route 3 and Route 17 parallel to both the northbound and southbound I-95 mainline lanes
- New two-lane parallel structures over the Rappahannock River along both northbound and southbound I-95 serving the C-D roads
- Interchange improvements at Route 17 including braided ramps along northbound and southbound I-95 between the C-D roads and the mainlines lanes
- Interchange improvements at Route 3
- Improvements to the Virginia Welcome Center

New Collector-Distributor (C-D) Roads: The April 2016 IMR preferred alternative includes parallel two-lane collector-distributor (C-D) roads in each direction between the Route 3 and Route 17 interchanges. The C-D roads cross the Rappahannock River on a separate bridge structure. The southbound C-D road would start at the Route 17 interchange, diverge from I-95 and braid with the Route 17 on-ramp to southbound I-95 and cross the Rappahannock River. The southbound C-D road would proceed to Route 3 and become a two-lane off-ramp at Route 3. The Virginia Welcome Center would have an on-ramp and off-ramp to and from the new C-D road requiring realignment of the Welcome Center ramps and modifications to the Welcome Center parking areas. A single lane slip ramp located just south of Cowan Boulevard would provide access to the southbound I-95 mainline lanes for drivers accessing the Welcome Center.

The northbound C-D road would begin at the Route 3 interchange combining traffic from the eastbound Route 3 to northbound I-95 triple left-turn lanes with the ramp from westbound Route 3 to northbound I-95 on a four-lane C-D road. The four lanes would transition to three lanes before the Cowan Boulevard underpass and then down to two lanes prior to the Fall Hill Avenue underpass. The northbound C-D road would cross the Rappahannock River and then split providing access to I-95 and Route 17, braid with the I-95 northbound to Route 17 off-ramp, and then merge with northbound I-95. The northbound I-95 bridge over Route 17 would be replaced and widened to accommodate the on-ramp acceleration lane and provide additional vertical clearance for Route 17.

Improvements to I-95 at Route 17 Interchange: The proposed improvements to the Route 17 interchange require major reconstruction of the interchange:

- The southbound I-95 off-ramps to eastbound and westbound Route 17 would combine and diverge from I-95 to create a C-D road that would drop at the loop ramp to eastbound Route 17.
- The westbound Route 17 to southbound I-95 loop ramp would be removed and replaced with a signalized left-turn movement from westbound Route 17 that would merge with the eastbound Route 17 on-ramp to southbound I-95.
- The eastbound Route 17 to I-95 southbound on-ramp would be widened to two lanes (a portion would be three lanes to accommodate the signalized left turn from westbound Route 17).
- The southbound I-95 to westbound Route 17 ramp would be realigned to intersect Route 17 farther from the Sanford Drive intersection due to the loop ramp removal in the northwest quadrant.

- The northbound I-95 to westbound Route 17 loop ramp would be replaced with a semi-directional flyover. The flyover would cross over Route 17, I-95, and Sanford Drive and then tie down on the right side of Route 17 prior to the McLane Drive intersection.

Improvements to I-95 at Route 3 Interchange: As discussed in **Section 2.3.4**, improvements to the Route 3 interchange are currently under construction and are the first phase of the overall Improvements to I-95 between Exit 133 and 130.

Southbound I-95 Exit Ramp Improvements

- The off-ramp from southbound I-95 to Route 3 westbound would be extended and widened.
- A physically-separated lane would be constructed for southbound I-95 traffic destined for Carl D. Silver Parkway at Central Park eliminating any weaving along westbound Route 3 by these vehicles.
- Three right turn lanes would be built for traffic exiting southbound I-95 to westbound Route 3. These lanes would be signal-controlled at a new signal along westbound Route 3 eliminating merging and weaving along westbound Route 3. Eastbound Route 3 traffic would not stop at this new traffic signal.

Route 3 Eastbound On-Ramp Improvements

- The existing loop ramp for eastbound Route 3 to northbound I-95 would be removed thereby eliminating the eastbound weave along Route 3 and the northbound I-95 weave movement.
- Eastbound Route 3 traffic would access I-95 northbound by using three left-turn lanes that would be constructed along Route 3, just east of the I-95 overpass. Traffic would turn left onto the northbound on-ramp at a new intersection controlled by a traffic signal. The triple left turn would merge with the westbound Route 3 to northbound I-95 on-ramp to form a four lane northbound C-D road that would taper down to three lanes prior to the Cowan Boulevard bridge. Eastbound Route 3 traffic would not stop at the new traffic signal.

Figure 4-1: April 2016 IMR Build Alternative (Sheet 1 of 5)

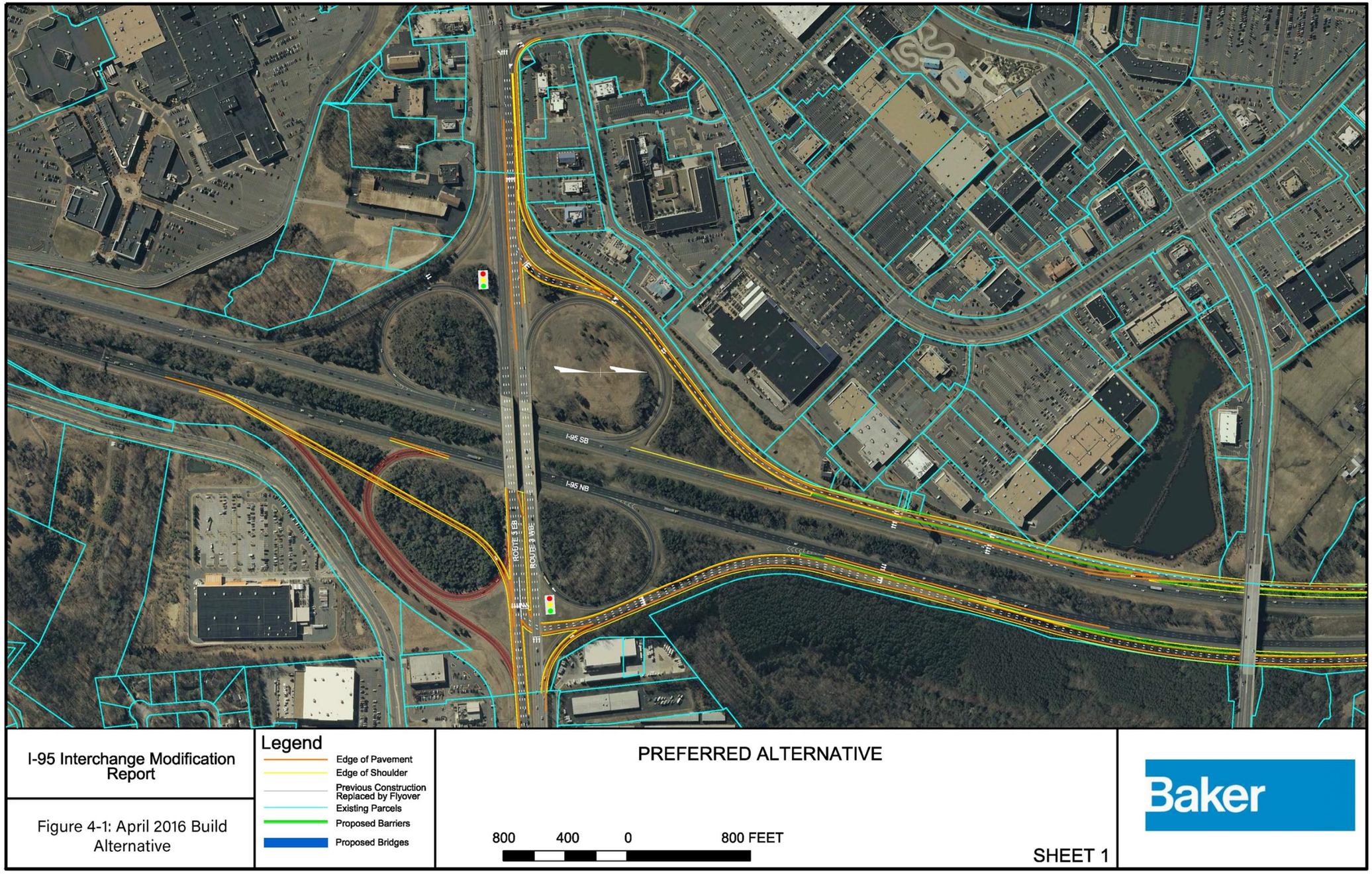


Figure 4-1: April 2016 IMR Build Alternative (Sheet 2 of 5)

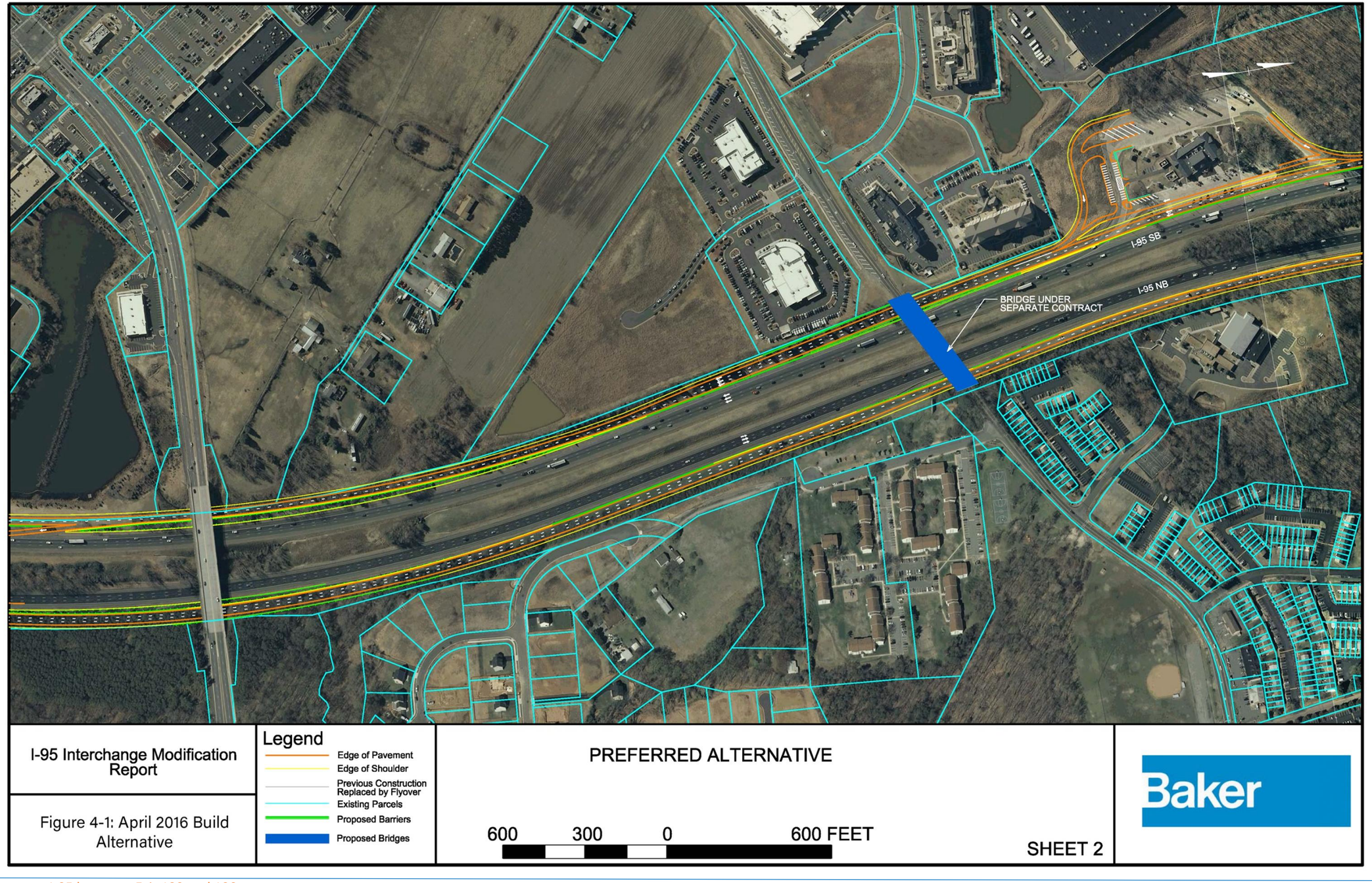


Figure 4-1: April 2016 IMR Build Alternative (Sheet 3 of 5)

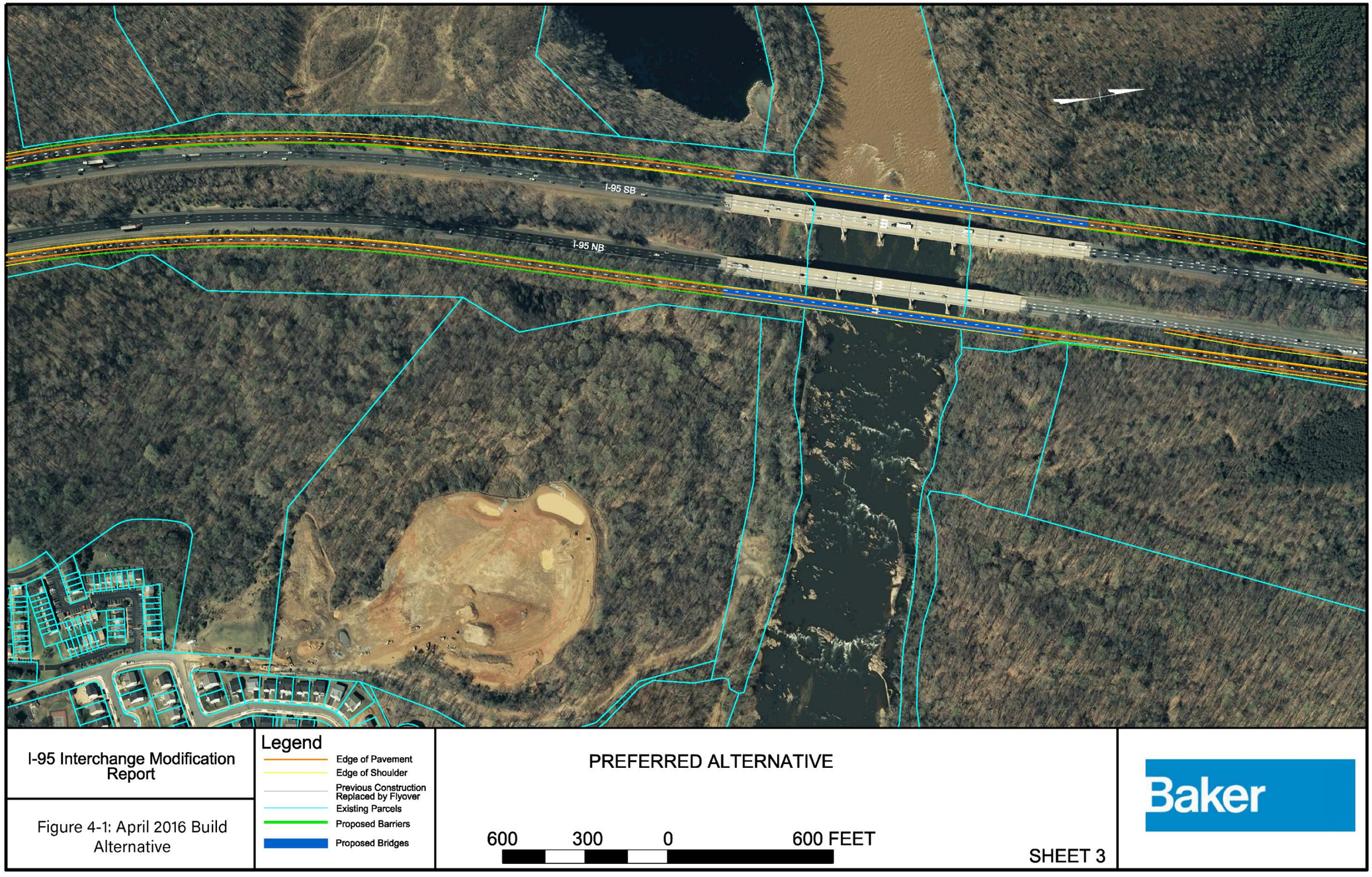
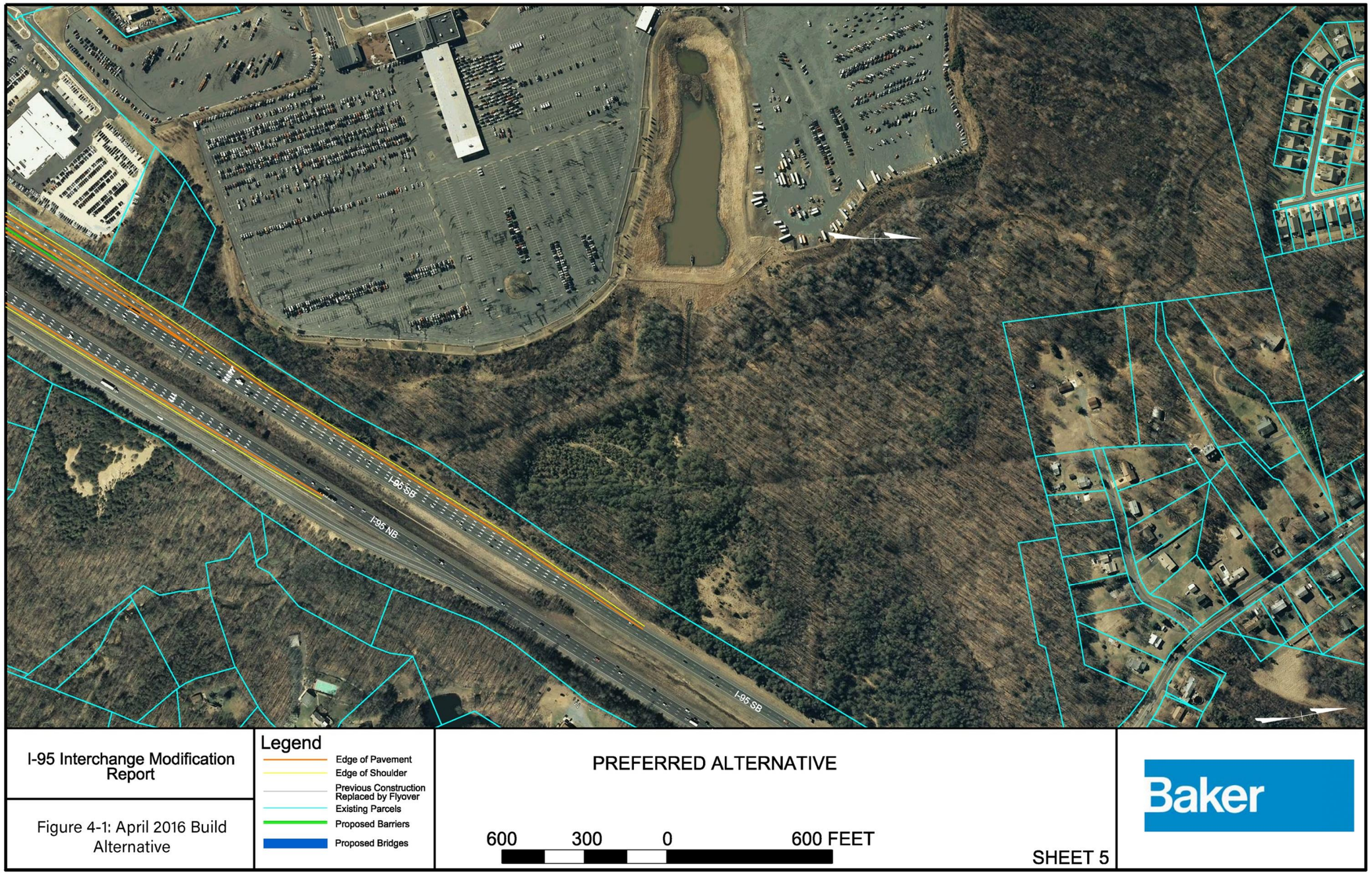


Figure 4-1: April 2016 IMR Build Alternative (Sheet 4 of 5)

Figure 4-1: April 2016 IMR Build Alternative (Sheet 5 of 5)



4.4 MODIFIED BUILD ALTERNATIVE

The Modified Build Alternative along the I-95 southbound lanes is shown in in **Figure 4-2** (**Sheets 1 through 5**) and at the following location:
www.virginiadot.org/projects/resources/Fredericksburg/SB_Rappahannock_River_Crossing_Citizen_Information_Meeting_Display_Boards.pdf (accessed 9/8/17)
The Modified Build Alternative consists of the following differences compared to the April 2016 IMR.

Collector-Distributor (C-D) Roads and new I-95 Southbound Mainline Lanes: The Modified Build Alternative relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes. The diverge from the existing I-95 southbound mainline lanes to the C-D lanes would be located north of the Route 17 interchange and the merge with the C-D lanes would be located south of the Route 3 interchange. There would be three new southbound I-95 mainline lanes between Route 17 and Route 3 for the entire limits of the C-D road. A new three-lane bridge along the I-95 southbound mainline lanes would be constructed over the Rappahannock River within the median.

The repurposed C-D lanes would diverge from the new I-95 mainline lanes as a three-lane exit ramp with the third lane being an option lane serving both the C-D and mainline lanes. The existing three lanes would be maintained along the southbound I-95 C-D road until the Route 3 interchange where one of the three C-D lanes would be dropped onto the ramp to westbound Route 3. South of the off-ramp to westbound Route 3, the C-D road would include two lanes through the weave with the Route 3 loop ramps and the merge with the ramp from eastbound Route 3 to southbound I-95. The two C-D lanes would then merge with the new I-95 mainline lanes as a two-lane entrance ramp.

The braided ramps serving Route 17 and southbound I-95 located south of the Route 17 interchange would be eliminated. Additionally, impacts to the Welcome Center ramps and parking areas would be eliminated since the construction of the new mainline lanes would occur within the median. The slip ramp from the southbound I-95 C-D lanes to the mainline lanes located south of Cowan Boulevard would no longer be needed since the southbound C-D lanes would continue through the Route 3 interchange and connect with the southbound I-95 mainline lanes.

No changes are proposed to the northbound C-D roads compared to the April 2016 Build Alternative.

Improvements to I-95 at Route 17 Interchange: Changes compared to the April 2016 IMR include the following:

- The Route 17 interchange merge and diverge points along the southbound I-95 mainline lanes would be located along the repurposed southbound C-D lanes and the locations and alignment of the ramps would remain essentially the same as existing conditions. The loop ramp in the northwest quadrant serving westbound Route 17 to southbound I-95 would remain.
- Similar to the April 2016 Build Alternative, the eastbound Route 17 to I-95 southbound on-ramp would be widened to two lanes; however, the lane configuration on the eastbound Route 17 approach to Sanford Drive would be revised to convert the right-turn lane to a shared through/right-turn lane that would drop at the ramp to southbound I-95. This would provide two continuous eastbound lanes beginning west of Sanford Drive that would serve the on-ramp to southbound I-95.

- No changes are proposed to the northbound I-95 ramps serving the Route 17 interchange compared to the April 2016 IMR Build Alternative.

Improvements to I-95 at Route 3 Interchange: Changes compared to the April 2016 IMR include the following and are currently under construction as part of the I-95 Safety Improvements at Route 3 project:

- The Route 3 interchange merge and diverge points along the southbound I-95 mainline lanes would be located along the repurposed southbound C-D lanes and the locations and alignment of the ramps would remain essentially the same as existing conditions. Along the southbound I-95 C-D road, one of the three C-D lanes would be dropped onto the ramp to westbound Route 3 providing a two-lane exit including a drop lane and a shared lane. South of the diverge to Route 3, the a two-lane C-D road would continue through the two Route 3 loop ramps and the merge with the ramp from Route 3 before merging with the I-95 southbound mainline lanes.
- Route 3 at Carl D Silver Parkway: Modified the lane configuration on the westbound Route 3 approach to Carl D Silver Parkway to provide a right-turn lane, a shared through/right-turn lane, three through lanes, and a left-turn lane.
- Route 3 at Southbound I-95 Off-Ramp (triple right): Provided five westbound through lanes along westbound Route 3 approaching the traffic signal which is an increase compared to the April 2016 IMR which proposed four westbound Route 3 through lanes approaching the traffic signal.
- Route 3 at Northbound I-95 On-Ramp (triple left): Removed the channelized westbound Route 3 right-turn movement and provided a signalized westbound right-turn and shared through/right-turn lane that operates under signal control onto a three-lane northbound C-D road rather than a four-lane northbound C-D proposed with the April 2016 IMR Build Alternative.

Figure 4-2: 2017 Modified Build Alternative (Sheet 1 of 5)

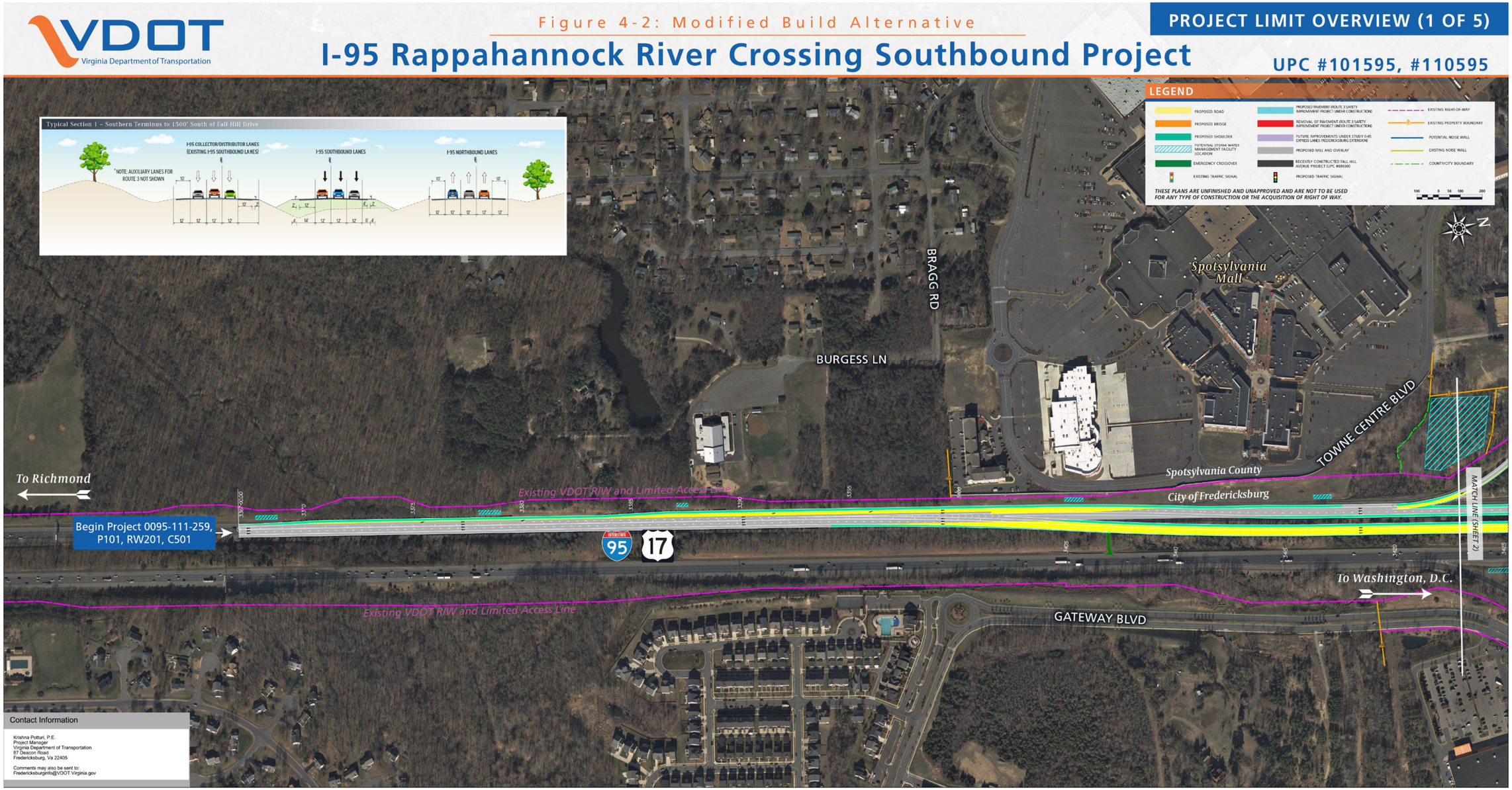


Figure 4-2: 2017 Modified Build Alternative (Sheet 2 of 5)

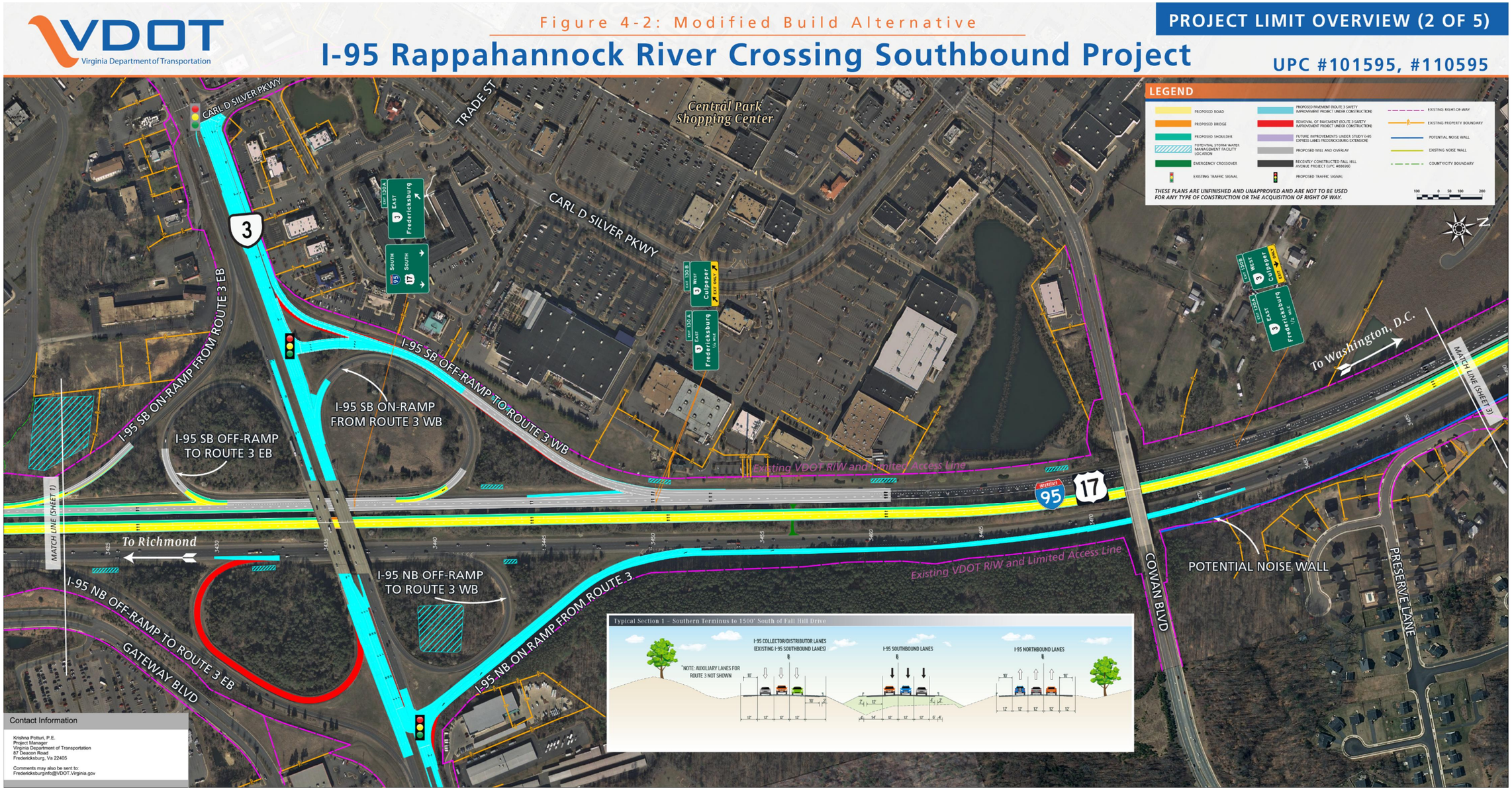


Figure 4-2: 2017 Modified Build Alternative (Sheet 3 of 5)

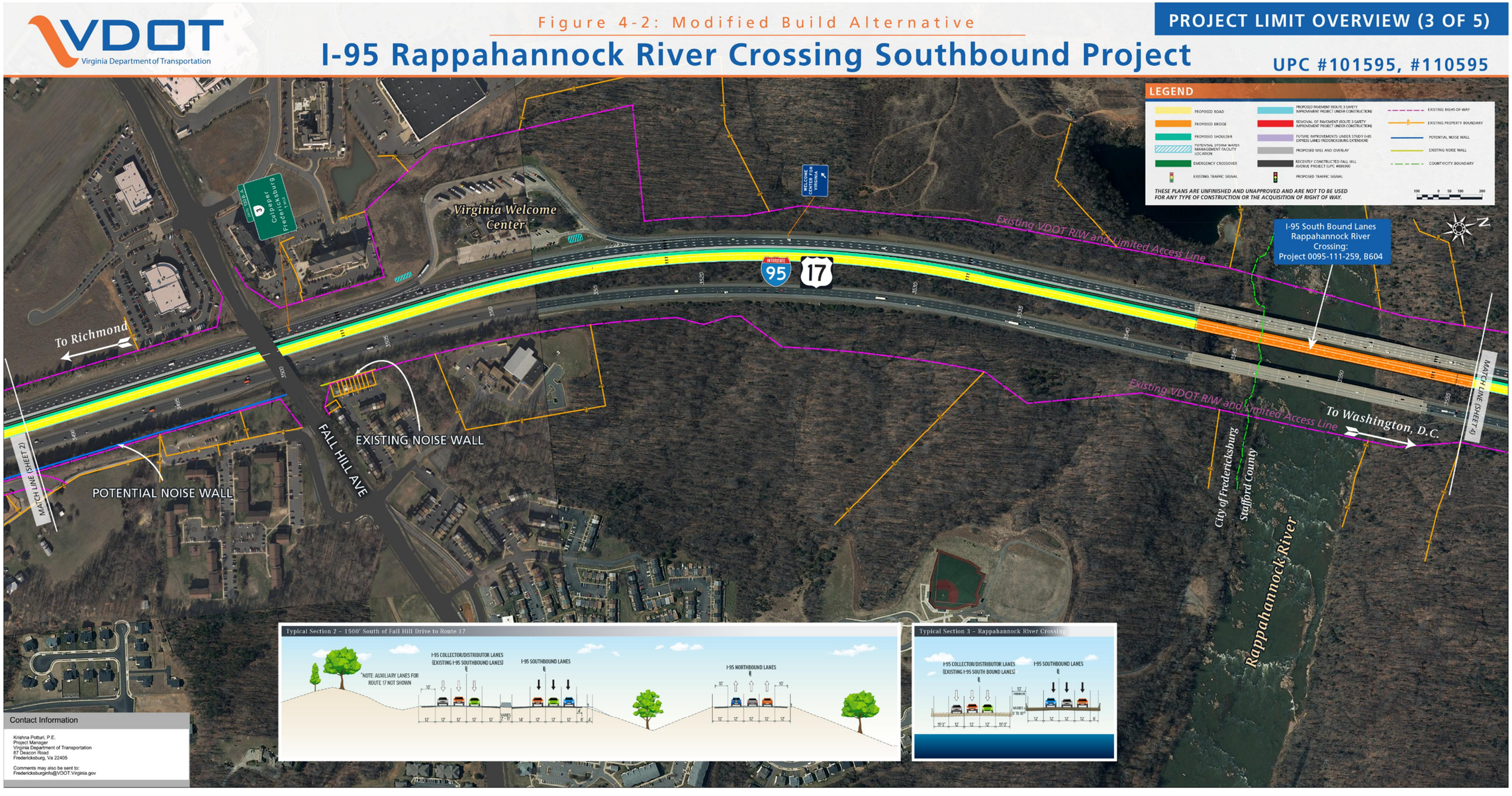


Figure 4-2: 2017 Modified Build Alternative (Sheet 4 of 5)

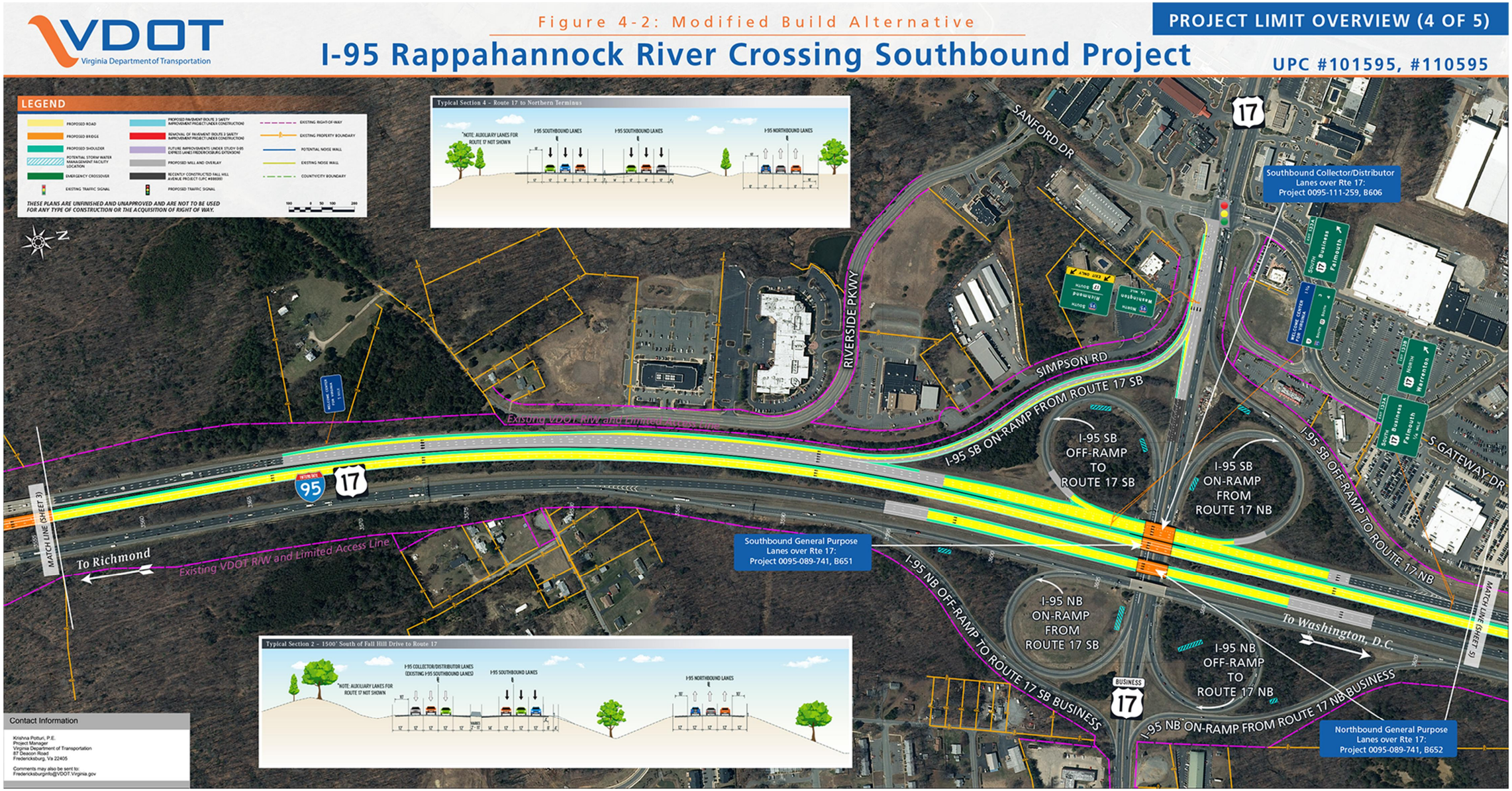
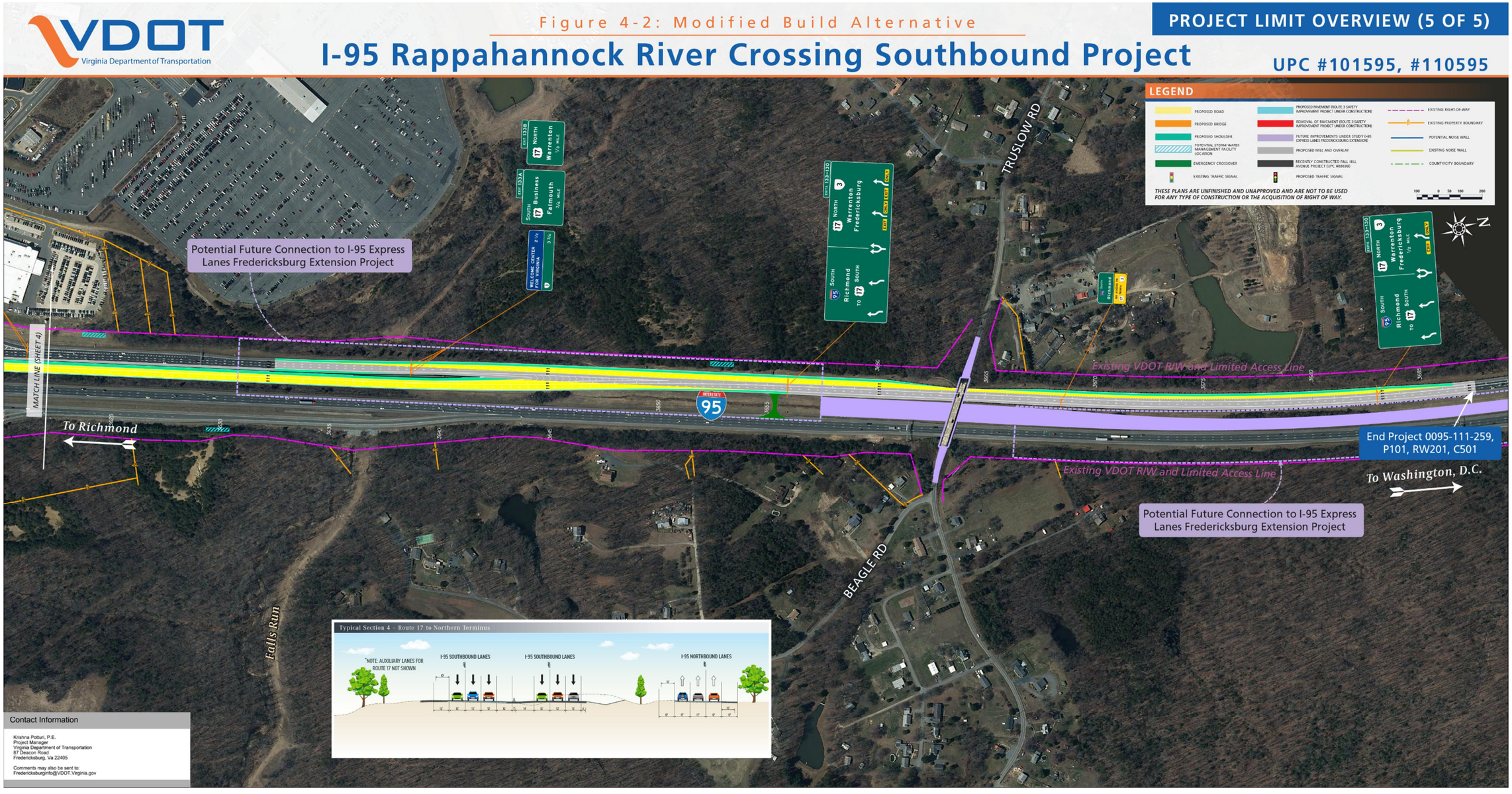


Figure 4-2: 2017 Modified Build Alternative (Sheet 5 of 5)



4.5 COMPARISON OF APRIL 2016 IMR AND MODIFIED BUILD ALTERNATIVES

4.5.1 Traffic Operations

Chapter 7 documents a comparison of the traffic operations for the April 2016 IMR Alternative compared to the Modified Build Alternative.

4.5.2 Safety Operations

Chapter 8 documents a comparison of the safety benefits of the April 2016 IMR Alternative compared to the Modified Build Alternative. The Modified Build Alternative would reduce the number of conflict points along the I-95 mainline lanes from seven to two conflict points.

4.5.3 Right of Way Impacts

Table 4-1 shows a comparison of the right of way requirements for the April 2016 IMR Alternative and the Modified Build Alternative. Conservative right of way impacts were calculated based on the preliminary designs; however, the right of way impacts may be adjusted as the design is advanced through the design process. Preliminary right of way impacts for each of the two alternatives include only those related to the southbound I-95 C-D lanes project, as the northbound I-95 phase of the project has not progressed to the point where right of way impacts can be estimated. As shown in the table, the right of way requirements are much lower for the Modified Build Alternative due to the location of the mainline lanes within the I-95 median compared to the April 2016 IMR Alternative which primarily included outside widening to construct the southbound I-95 C-D lanes.

Table 4-1: Comparison of Right of Way Impacts

Land Use	April 2016 IMR Alternative	Modified Build Alternative	Difference
Partial Acquisitions			
Residential (acres)	7.6	0.0	-7.6
Commercial (acres)	6.5	2.8	-3.7
Easements			
Residential (SF)	6,897	6,929	32
Commercial (SF)	71,916	0	-71,916

4.5.4 Project Cost

Preliminary cost estimates were prepared for the both the April 2016 IMR Alternative and the Modified Build Alternative. Construction unit costs and pay items were kept consistent between the two alternatives to provide an apt comparison. Similar to the right of way impacts, a cost comparison was prepared for the southbound phase of the project. As shown in **Table 4-2**, preliminary engineering and construction costs for the Modified Build Alternative are greater than the costs for the April 2016 IMR Alternative; however, the right of way cost is greater for the April 2016 IMR resulting in similar overall project costs for both alternatives.

Table 4-2: Cost Comparison

Phase	April 2016 IMR Alternative	Modified Build Alternative
Preliminary Engineering	$4.5M	$6.1M
Right of Way	$6.5M	$0.7M
Construction	$114.0M	$118.2M
Total	**$125M**	**$125M**

5. ROADWAY GEOMETRY

5.1 DESIGN CRITERIA

The proposed project design was established in accordance with AASHTO, FHWA, and VDOT design guidelines. The following documents were used in the development of the design criteria table provided in **Appendix B** for the I-95 Rappahannock River Crossing Southbound project:

- AASHTO, Green Book, 2011
- AASHTO, A Policy on Design Standards – Interstate System, 5th Edition, 2005
- AASHTO, Roadside Design Guide, 4th Edition, 2011
- VDOT, Road Design Manual, August 2016
- VDOT, Manual of the Structure and Bridge Division, Volume V, Part 2, 2011
- VDOT, Drainage Manual, July 2016
- VDOT, Guardrail Installation Training Manual, August 2017
- VDOT, Instructional and Informational Memoranda

Where the design standards could not be met, appropriate design exceptions or waivers have been prepared for the I-95 Rappahannock River Crossing Southbound project. An overview of the criteria shown in **Table 5-1** reflects the selected standards for each roadway classification.

Table 5-1: Design Criteria - I-95 Rappahannock River Crossing Southbound Project

Criteria	Southbound I-95 Mainline Lanes	Existing Southbound I-95 / Future I-95 SB C-D Road	Route 17 /Warrenton Road	I-95 Interchange Ramps
Functional Classification	Rural Principal Arterial Interstate GS-1	Rural Principal Arterial Interstate GS-1	Urban Other Principal Arterial GS-5	Interchange Ramp GS-R
Average Daily Traffic (ADT) 2040	34,800	85,800	108,300	4,100 - 38,600
Design Speed	75 MPH	75 MPH	45 MPH	30 - 50 MPH
Design Vehicle	WB-67	WB-67	WB-67	WB-67
Lane Width	12 ft	12 ft	12 ft	16 ft (One Lane Ramp) 24 ft (Two Lane Ramp)
Paved Shoulder Width	4 ft – 12 ft	10 ft (Existing)	8 ft or Curb and Gutter	8 ft Right – 4 ft Left
Superelevation Standard, Max Rate	TC-5.11R, 8% Max	TC-5.11R 8% Max	TC-5.11U, 4% Max	TC-5.11R, 8% Max
Min. Vertical Clearance	16.5 ft	16.5 ft	16.5 ft	16.5 ft
Max. Vertical Grade	4%	4%	7%	7% at 30 MPH 4% at 50 MPH

5.2 RIGHT-OF-WAY AND LIMITED ACCESS REQUIREMENTS

The I-95 corridor through Fredericksburg is a moderately developed area with varying opportunities for outside widening of the existing roadway. Some locations have ample right of way for widening while others have been heavily developed limiting opportunities for widening.

The Modified Build Alternative relocates the I-95 southbound mainline lanes into the I-95 median while repurposing the existing I-95 southbound lanes as the southbound C-D lanes. The diverge from the I-95 southbound mainline to the C-D lanes would be located north of the Route 17 interchange and the merge with the C-D lanes would be located south of the Route 3 interchange. The Modified Build Alternative would optimize the available existing right of way and minimize impacts to the surrounding existing infrastructure since the relocated I-95 southbound mainline lanes would be constructed within the median. No changes are proposed to the improvements proposed along northbound I-95 as presented in the April 2016 IMR.

Table 5-2 summarizes the right of way impacts for the I-95 Rappahannock River Crossing Southbound project. Approximately 2.8 acres of commercial property would need to be acquired and added to the limited access right of way near the Route 3 interchange for stormwater management use. In addition, it is anticipated that the project would require temporary easements for construction of slopes south of Route 3. These individual temporary easements are less than 7,000 square feet in impact to three residential parcels. No further right of way impacts are anticipated as a result of this project.

Table 5-2: Right of Way Impacts

Right of Way	Required Value
Partial Acquisitions	
Commercial	2.815 acres
Temporary Easements	
Residential	6,929 SF

5.3 DESIGN WAIVERS

The Modified Build Alternative was developed using current design guidelines including the AASHTO *A Policy on the Geometric Design of Highways and Streets, 2011* (Green Book) and the VDOT *Road Design Manual*. Based on these requirements, design waivers were developed in situations where the Modified Build Alternative did not meet the specific design standards. Two design waivers are required as summarized in **Table 5-3** for the I-95 Rappahannock River Crossing Southbound project. The design waivers are included in **Appendix B**. Safety and mitigation strategies pertaining to the usage of design waivers are discussed in their respective reports. Potential design waivers and/or exceptions that may be required for the I-95 Northbound C-D Lanes project are discussed in the April 2016 IMR.

Table 5-3: Summary of Design Waivers

Design Waiver Number	Design Waiver	Required Value	Value Provided
DW-1	Reduced Inside Paved and Total Shoulder Width on I-95 SB Mainline Lanes	10 ft Paved 12 ft Total	4 ft Paved 8 ft Total
DW-2	Reduced Inside Shoulder Width on I-95 SB Mainline Lanes on Rappahannock River Crossing Bridge	12 ft	6 ft

5.3.1 Reduced Inside Paved and Total Shoulder Width on I-95 SB Mainline Lanes (DW-1)

The purpose of this design wavier is to request reduction of the inside left shoulder width below the minimum width required by VDOT standards for paved and total width on shoulders when the mainline is 6 or more lanes.

The total inside left shoulder width for the I-95 southbound proposed mainline lanes is less than the 12 feet required by VDOT standards, and the paved inside left shoulder width proposed is less than the 10 feet required by VDOT standards. The VDOT *Road Design Manual* notes that the paved inside left shoulder should be equal to the paved right shoulder when the mainline facility is 6 or more lanes. The minimum total inside left shoulder width is proposed to be 8 feet, and the minimum paved inside left shoulder width is proposed to be 4 feet where the I-95 southbound mainline lanes have been realigned into the median. The inside left shoulder width has been reduced to provide space for potential future widening of I-95 within the median along this corridor. VDOT anticipates that a portion of the existing median beyond the proposed footprint of this alternative would be required for future improvements along this corridor. The additional space required for a full width inside left shoulder on this project would impact the space available for future projects and could significantly impact their scope of work at pinch points along the corridor.

It is recognized that total shoulder widths have a significant effect on both safety and traffic operations. AASHTO's *A Policy on Design Standards – Interstate System, 5th Edition, 2005*, maintains that by providing the minimum allowable outside and inside shoulder widths, the mainline lanes would have a functional recovery area for drivers on both sides of the travel way, and an outside shoulder that can accommodate stopped vehicles during emergencies. The separated three-lane C-D facility causes a direct reduction of traffic on the three I-95 southbound mainline lanes and presents a unique difference and opportunity to modify the general six-lane facility described in the VDOT *Road Design Manual*. The C-D lanes and mainline lanes on I-95 southbound would essentially function as two separate but parallel three-lane facilities between their diverge and merge points north of Route 17 and south of Route 3, respectively. This segment would allow ample space for enforcement, maintenance, disabled vehicles, emergency responder access, and snow removal on the outside right shoulder within the confines of a three-lane interstate facility. Providing a reduced inside left shoulder in this area of reduced traffic volumes would prevent significant site impacts, maintenance of traffic issues, and increased costs on future projects along the corridor. The proposed three-lane mainline facility was chosen primarily to provide a uniform lane distribution throughout the I-95 corridor. The 2040 PM peak hour volume is significantly lower than the capacity of this three-lane section as discussed in **Chapter 7** and lower than the traffic volumes on the existing I-95 lanes in this area. Combined with the absence of merge points between Route 17 and Route 3, the mainline lanes would operate more safely and with higher capacity. The reduced inside left paved

shoulder width of 4 feet would also directly align with the proposed mainline lane bridges over the Rappahannock River Crossing and Route 17. The bridge structure proposes a 4-foot shoulder with 2-foot barrier offset. A design waiver for a reduced inside left shoulder width on the new southbound Rappahannock River Bridge was approved by VDOT in June 2017. A draft design waiver for a reduced inside shoulder width has been prepared and will be completed during final design.

5.3.2 Reduced Left Shoulder Width on I-95 SB Mainline Lanes on Rappahannock River Crossing Bridge (DW-2)

The purpose of this Design Wavier is to request reduction of the inside shoulder width below the minimum width required by VDOT standards for paved shoulders when the mainline is 6 or more lanes.

The paved inside shoulder width for the I-95 southbound proposed mainline lanes on the Rappahannock River Crossing bridge are less than the 12 feet required by VDOT standards. For a freeway with three lanes of traffic, the VDOT Structure and Bridge Design Manual, Volume 5, Part 2, File No. 06.02-1, requires a bridge curb to curb width of sixty (60) feet, which includes thirty-six (36) feet for the three twelve (12) feet travel lanes and twelve (12) feet for each shoulder. The proposed minimum paved inside shoulder width would be 6 feet for the entire bridge span, functioning as a standard 4-foot left side shoulder plus a 2-foot buffer from the bridge barrier.

It is recognized that total shoulder widths have a significant effect on both safety and traffic operations. The project objectives in requesting this design waiver are to minimize right of way acquisition costs, because the properties in the vicinity are commercial. For that reason, the revised C-D lanes layout makes use of the median which is within VDOT right of way between the existing I-95 northbound and southbound bridges, instead of widening on the outside (west) side of I-95 southbound. The current barrier-to-barrier spacing between the bridges on I-95 southbound and northbound is 164 feet.

The reduction of the inside shoulder on the bridge is necessary for several reasons. The paved inside shoulder reduction has been proposed as to not preclude future widening in the median for the northbound phase of the I-95 project in this area. If a full width inside shoulder is provided, future bridge construction may be difficult within the existing footprint of the median. Providing a reduced inside shoulder in this area could prevent significant site impacts, maintenance of traffic issues, and increased costs on future projects along the corridor. Maintenance requirements also dictate that enough spacing must be provided between existing and proposed bridges for future upkeep. Adequate space must be provided to allow for easy bridge safety inspections to avoid installing costly permanent under bridge access systems. The reduced shoulder better aligns with the approach roadway width as well, which includes a 4-foot inside shoulder. Overall, the proposed three-lane mainline typical section with a reduced paved inside shoulder provides one fully functional shoulder, allowing space for enforcement, maintenance, disabled vehicles, emergency responder access, and snow removal on the outside shoulder. The potential cost savings have been approximated at $4.4 million and future widening would be less restricted for subsequent projects.

5.4 CONCEPTUAL SIGNING PLAN AND PAVEMENT MARKING PLAN

Figure 4-2 depicts a conceptual signing and pavement marking plan for the Modified Build Alternative. The conceptual signing and pavement marking plan was developed using current design standards and guidelines including the *2009 Manual on Uniform Traffic Control Devices (MUTCD)* and the *2011 Virginia*

Supplement to the MUTCD, Revision 1. The following is a brief summary of some key design features of the Modified Build Alternative signing:

- Sign panels were designed in accordance with the latest edition of the *MUTCD* and *2011 Virginia Supplement to the MUTCD, Revision 1*.
- The location, age, anticipated construction impacts, and significant increase in the size of sign panels prevent the re-use of existing sign structures; therefore new sign structures are generally proposed.
- The signing concept directs through traffic to stay on the I-95 mainline lanes and traffic accessing Route 17, Route 3, and the Welcome Center to use the C-D lanes.
- Overhead arrow-per-lane signs are proposed for the I-95 Mainline Lanes / C-D Lane split since an interior option lane serving both movements is proposed.
- Due to the length of the C-D lane system, additional advance guide signs and interchange sequence style signs are provided on the C-D lane system for the Welcome Center for Virginia and the Route 3 interchange.
- It is not possible to provide supplemental destination and specific service signs for both the Route 17 and Route 3 interchanges in advance of the C-D lane split due to the close proximity of the Centerport Parkway interchange to the north, which limits locations for these signs. The existing supplemental and specific services signs would generally remain in their existing location and an additional sign would be provided to alert C-D lane users that additional destinations and services are located farther south on the C-D lane system at the Route 3 interchange.

The conceptual signing and pavement marking plan was included in the Request for Proposals (RFP) to potential Design-Build teams. The technical requirements document issued to the offerors prohibits the Design-Build teams from deviating from the concept plan without approval by VDOT.

6. TRAFFIC VOLUMES

6.1 FUTURE ANALYSIS YEARS

Future traffic operations analysis were performed for the same years as the approved April 2016 Interchange Modification Report. At the time of the original IMR preparation, the opening year was anticipated to be 2020 and the design year was assumed to be 2040. The current project construction schedule for the I-95 Rappahannock River Crossing Southbound project is to award the Design-Build contract in early 2018, begin construction in summer 2018, and complete construction in fall 2022. The construction schedule for the improvements along northbound I-95 is not know at this time as discussed in **Section 2.2**.

6.2 FORECASTING METHODOLOGY AND FUTURE TRAFFIC VOLUMES

To maintain consistency with the original IMR efforts, traffic volumes were developed for the Modified Build conditions based on the traffic volumes forecasts for the preferred alternative contained in the April 2016 IMR. Peak hour and daily traffic volumes were assigned to the roadway network based on origins and destinations and the path motorists would take based on the configuration of the Modified Build conditions. The primary difference in the traffic volumes between the April 2016 IMR Build conditions and the Modified Build conditions is the proportion of traffic along the southbound I-95 mainline lanes versus the collector-distributor lanes between Route 17 and Route 3. As shown in the highlighted cells, between Route 17 and Route 3, the proportion of traffic in the C-D lanes is greater under the Modified Build conditions compared to the April 2016 Build conditions. This change can be attributed to the removal of the braided ramps along southbound I-95 south of Route 17. Under the Modified Build Alternative, traffic from Route 17 destined for southbound I-95 would continue on the CD lanes through the Route 3 interchange. Under the April 2016 IMR Alternative, Route 17 traffic entered the I-95 southbound mainline lanes via the braided ramps located just south of the Route 17 interchange. Forecasted traffic volumes along Route 17 and Route 3 approaching the I-95 interchanges as well as along the northbound I-95 mainline lanes and collector-distributor road are assumed to be identical between the two scenarios.

As noted in **Sections 2.3.1 and 3.2** and consistent with the April 2016 IMR, it was assumed that a new Express Lanes facility would be constructed within the median continuing through the study area from the existing Express Lanes terminus at Route 610/Garrisonville Road to Massaponax (Milepost 126) in Spotsylvania County as included in the FAMPO Constrained Long-Range Plan. Traffic volumes along the new Express Lanes facility were assumed to be identical between the April 2016 IMR and Modified Build Alternatives. Although direct ramp connects are proposed between the Fred Ex project and the I-95 C-D lanes north of Route 17 as part of the Fred Ex project, due to the uncertainty of the Fred Ex project and schedule and the ongoing negotiations between VDOT and the concessionaire, the direct ramp connections north of Route 17 are not included in the forecasts or traffic analyses for the April 2016 IMR Build Alternative or the Modified Build Alternative.

Table 6-1: Build Conditions Average Daily Traffic (ADT) Volume Summary

Location	Facility		2020 Build Conditions		2040 Build Conditions	
			April 2016 IMR	Modified	April 2016 IMR	Modified
North of Route 17	NB	I-95 Mainline Lanes	80,600	80,600	104,100	104,100
		Express Lanes	N/A	N/A	6,700	6,700
		Total	**80,600**	**80,600**	**110,800**	**110,800**
	SB	I-95 Mainline Lanes	78,300	78,300	99,700	99,700
		Express Lanes	N/A	N/A	7,800	7,800
		Total	**78,300**	**78,300**	**107,500**	**107,500**
Route 17 to Route 3	NB	I-95 Mainline Lanes	57,800	57,800	76,400	76,400
		I-95 C-D Lanes	35,900	35,900	46,800	46,800
		Express Lanes	N/A	N/A	6,700	6,700
		Total	**93,700**	**93,700**	**129,900**	**129,900**
	SB	I-95 Mainline Lanes	63,200	28,100	82,600	34,800
		I-95 C-D Lanes	29,300	64,500	38,000	85,800
		Express Lanes	N/A	N/A	7,800	7,800
		Total	**92,500**	**92,600**	**128,400**	**128,400**
South of Route 3	NB	I-95 Mainline Lanes	68,200	68,200	90,500	90,500
		Express Lanes	N/A	N/A	6,700	6,700
		Total	**68,200**	**68,200**	**97,200**	**97,200**
	SB	I-95 Mainline Lanes	67,100	67,100	87,800	87,800
		Express Lanes	N/A	N/A	7,800	7,800
		Total	**67,100**	**67,100**	**95,600**	**95,600**

Figures 6-1 through 6-4 depict the forecasted AM and PM peak hour traffic volumes for the future 2020 and 2040 No Build and Build conditions for both the April 2016 IMR Build Alternative and the Modified Build Alternative.

Figure 6-1: 2020 Peak Hour Volumes – April 2016 IMR Build Conditions (Sheet 1 of 2)

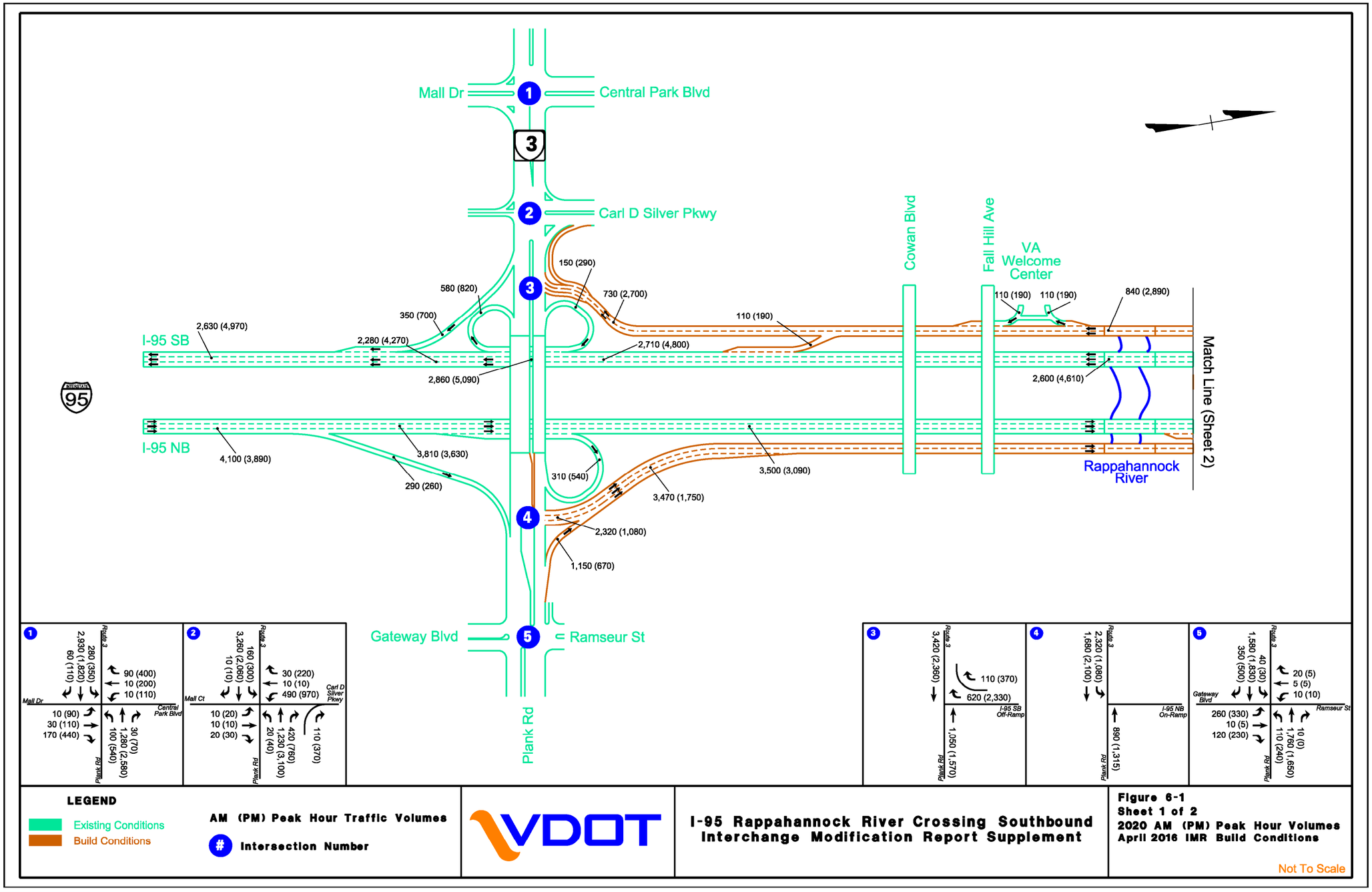


Figure 6-1: 2020 Peak Hour Volumes – April 2016 IMR Build Conditions (Sheet 2 of 2)

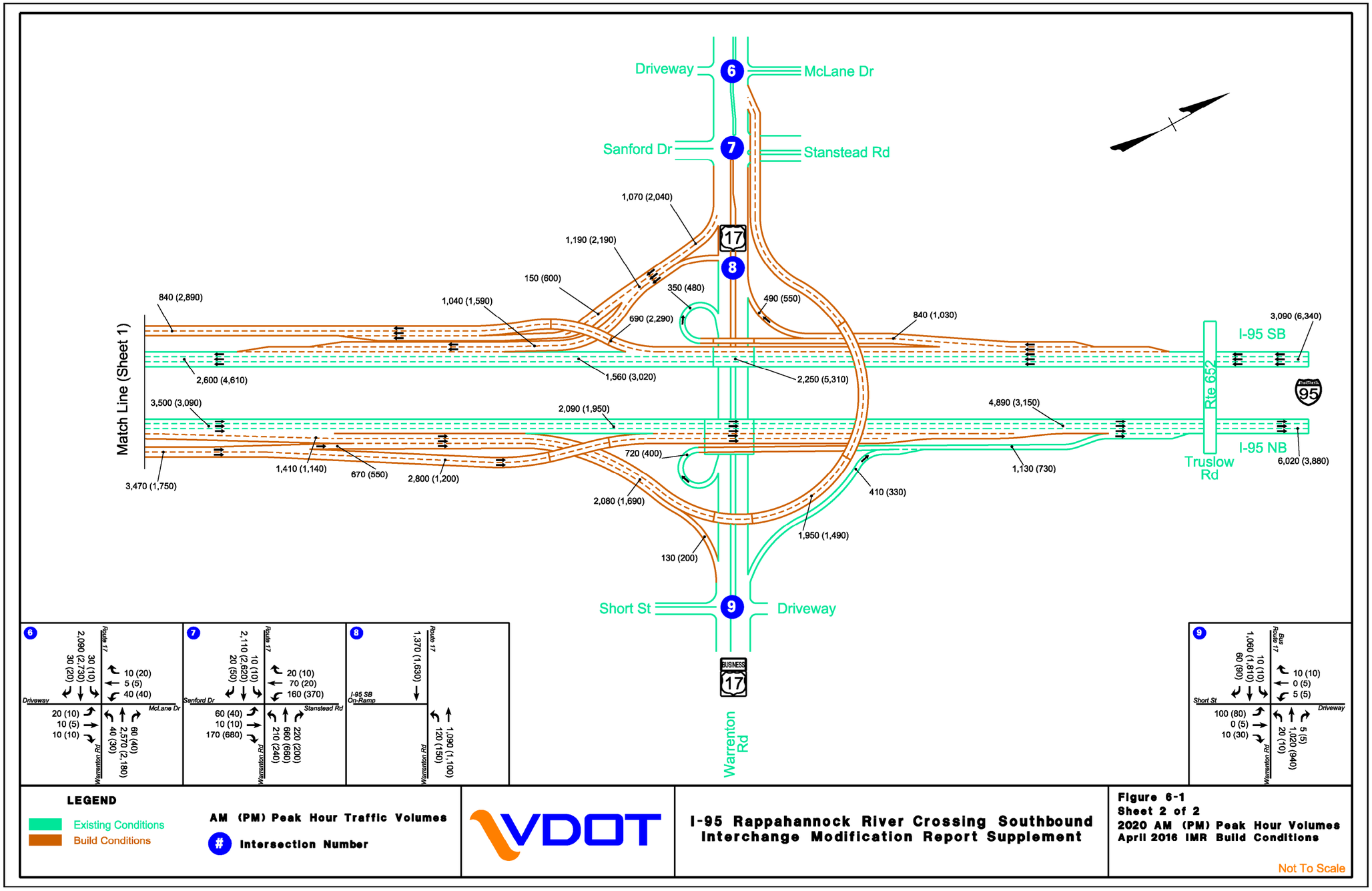


Figure 6-2: 2020 Peak Hour Volumes – Modified Build Conditions (Sheet 1 of 2)

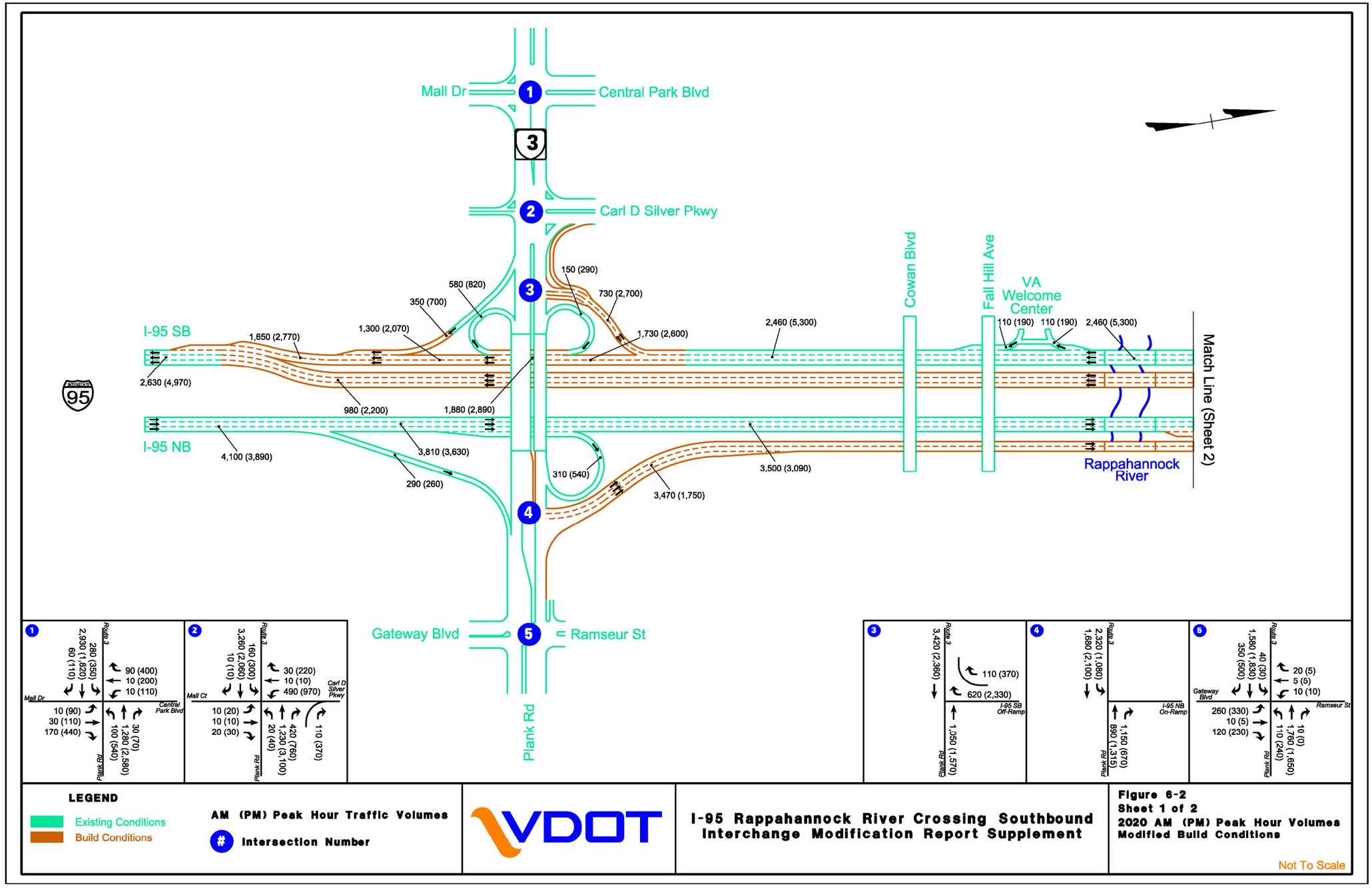


Figure 6-2: 2020 Peak Hour Volumes – Modified Build Conditions (Sheet 2 of 2)

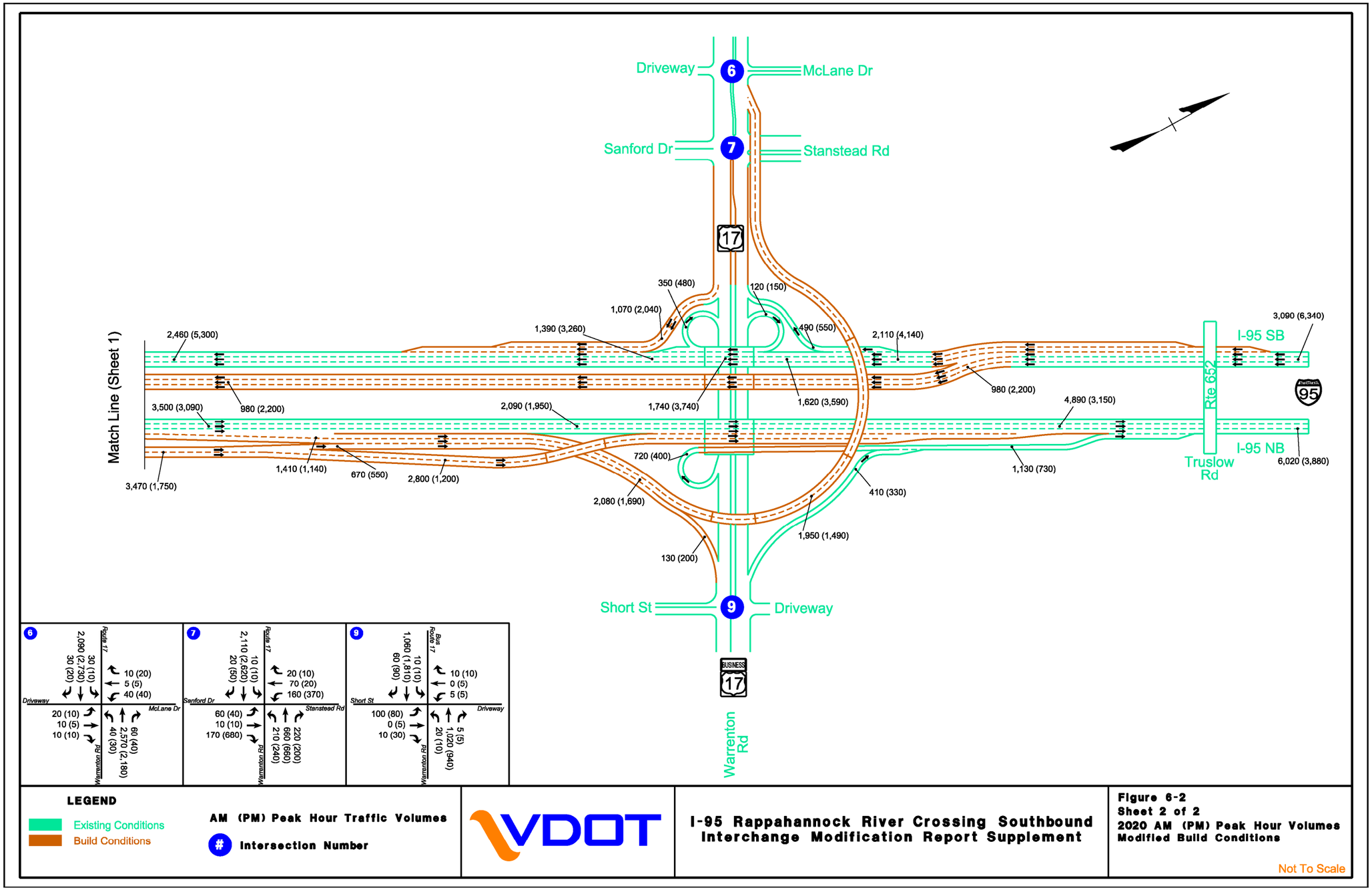


Figure 6-3: 2040 Peak Hour Volumes – April 2016 IMR Build Conditions (Sheet 1 of 2)

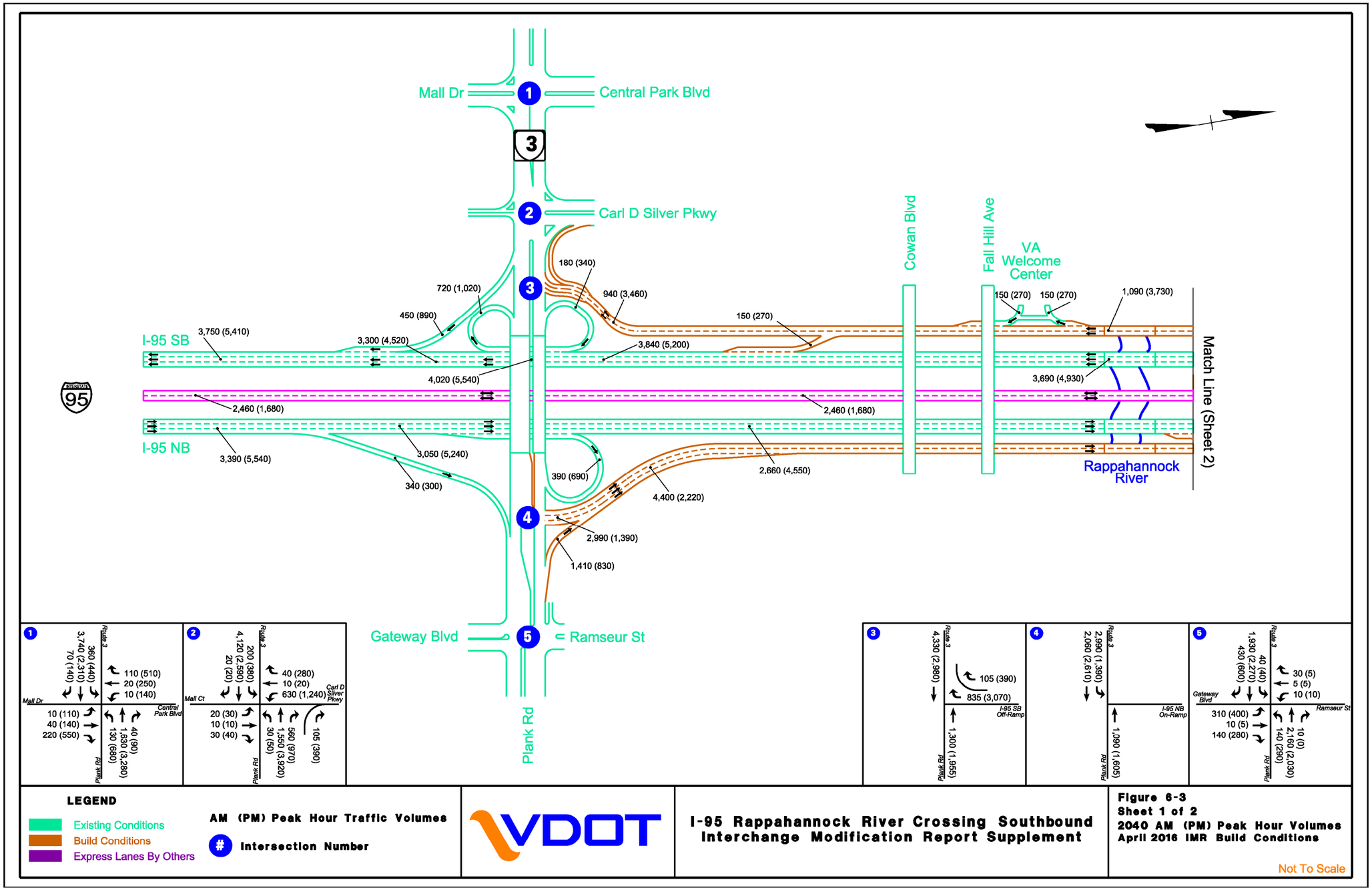


Figure 6-3: 2040 Peak Hour Volumes – April 2016 IMR Build Conditions (Sheet 2 of 2)

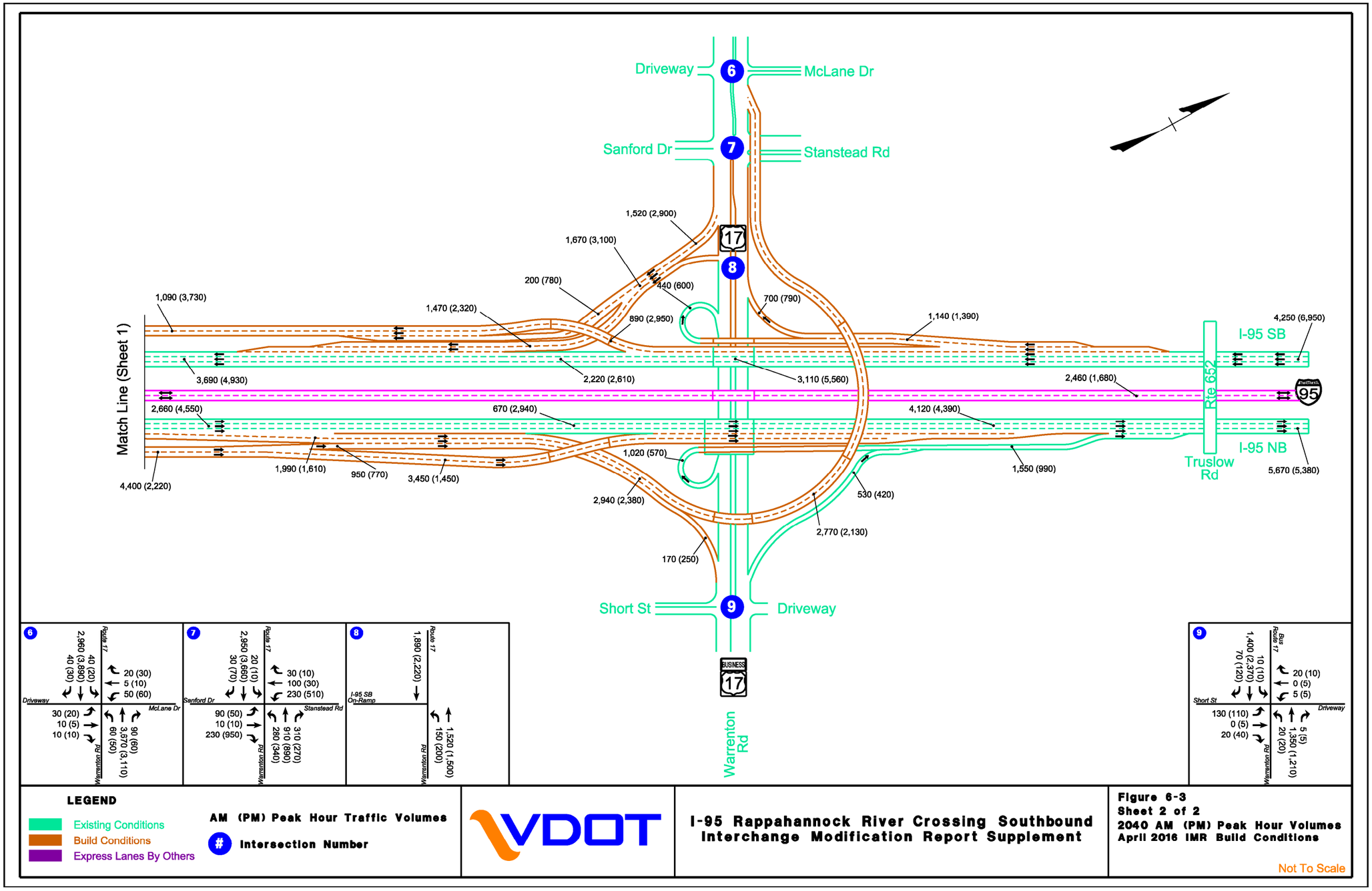


Figure 6-4: 2040 Peak Hour Volumes – Modified Build Conditions (Sheet 1 of 2)

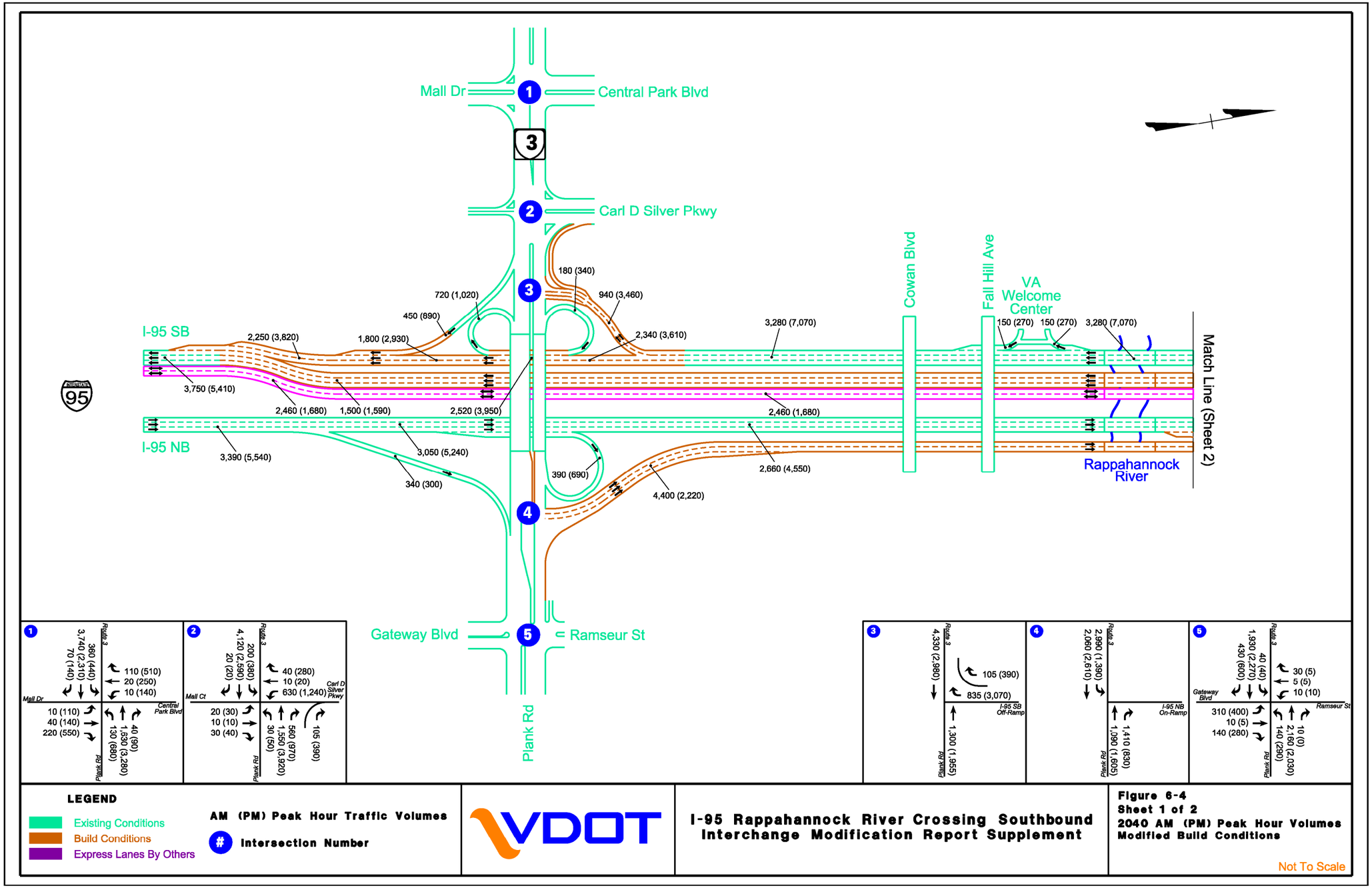
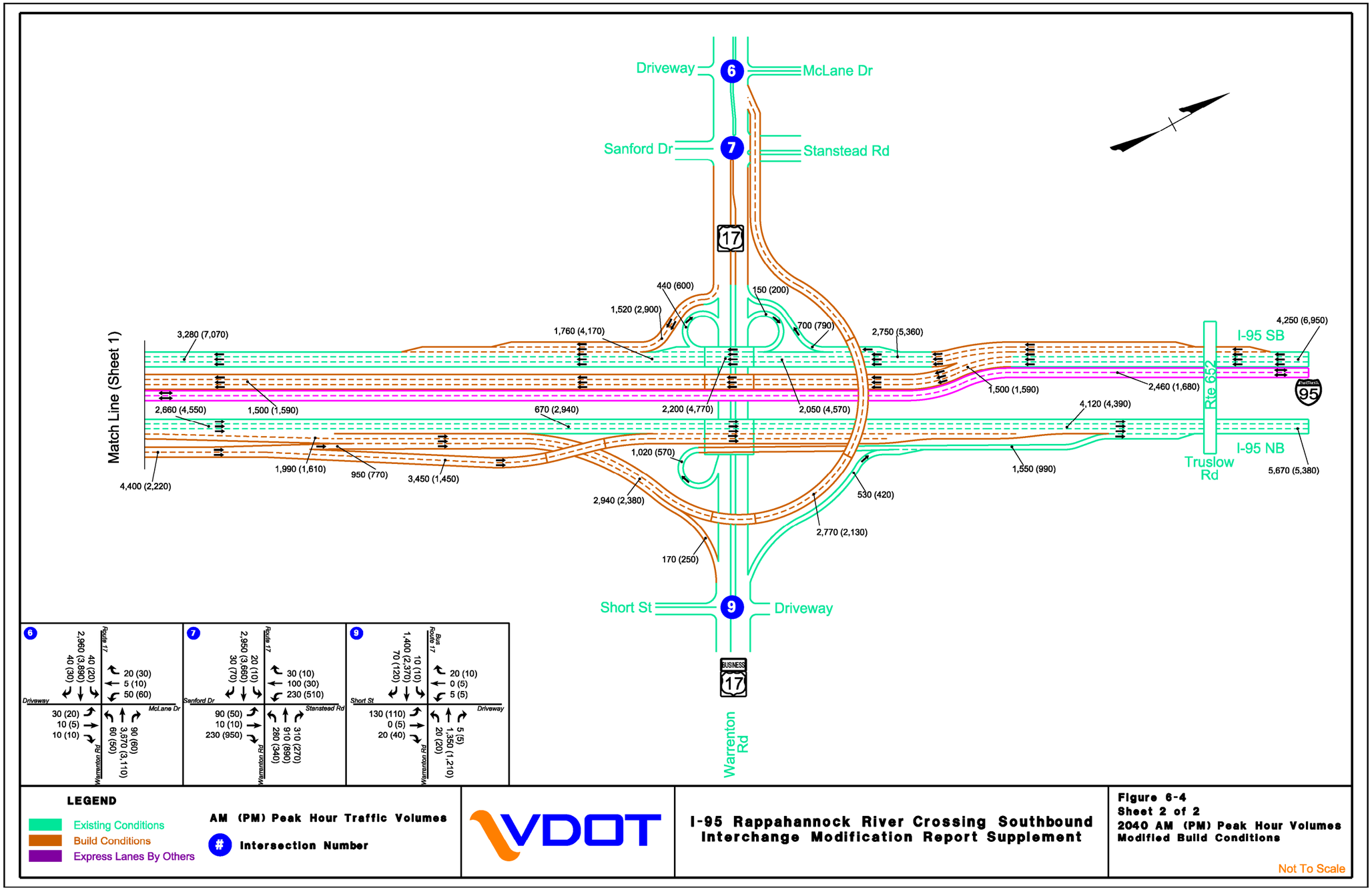


Figure 6-4: 2040 Peak Hour Volumes – Modified Build Conditions (Sheet 2 of 2)



7. TRAFFIC ANALYSIS

Section 3.3 describes the methodology and measures of effectiveness used to evaluate and compare the April 2016 IMR Alternative and the Modified Build Alternative. Traffic operations analysis using both HCS and CORSIM was performed for the 2020 and 2040 Build conditions consistent with the previously approved April 2016 IMR. This section describes the results of the traffic analysis and a comparison of the operations of the two alternatives for 2020 and 2040 Build conditions.

7.1 2020 BUILD CONDITIONS TRAFFIC OPERATIONS

7.1.1 I-95 Travel Times and Speeds

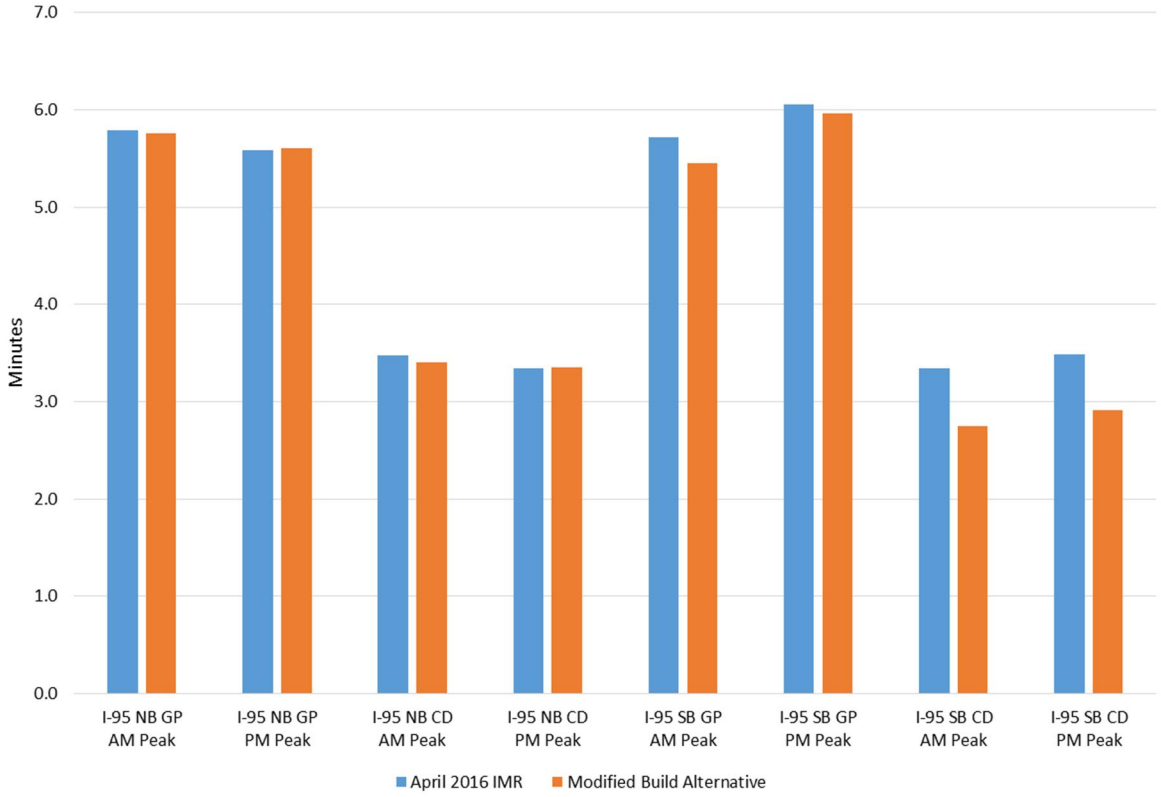
Overall travel times and average speeds from the CORSIM analysis were calculated for the entire length of the I-95 mainline lanes and the C-D lanes within the study area limits to provide a comparison of the April 2016 IMR Build Alternative and the Modified Build Alternative with 2020 Build conditions. **Table 7-1** and **Figures 7-1** and **7-2** summarize the travel times and speeds for the northbound and southbound I-95 mainline lanes and C-D lanes. As noted, travel times along the southbound C-D lanes for the Modified Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative since the C-D lanes terminate at Route 3 with the April 2016 Build Alternative.

Table 7-1: 2020 Build Conditions Travel Time and Speed Summary

Intersection	April 2016 IMR Build Alternative		Modified Build Alternative	
	AM Peak	PM Peak	AM Peak	PM Peak
Travel Time (seconds)				
Northbound Mainline Lanes	347.7	335.1	345.5	336.8
Northbound C-D Lanes	208.7	200.6	204.3	201.0
Southbound Mainline Lanes	343.6	363.3	327.4	358.0
Southbound C-D Lanes [1]	200.5	209.2	165.0	175.0
Average Speeds (MPH)				
Northbound Mainline Lanes	63.8	66.2	64.2	65.9
Northbound C-D Lanes	52.8	55.2	54.5	55.4
Southbound Mainline Lanes	64.5	61.2	68.0	62.2
Southbound C-D Lanes	56.4	54.1	66.1	62.2

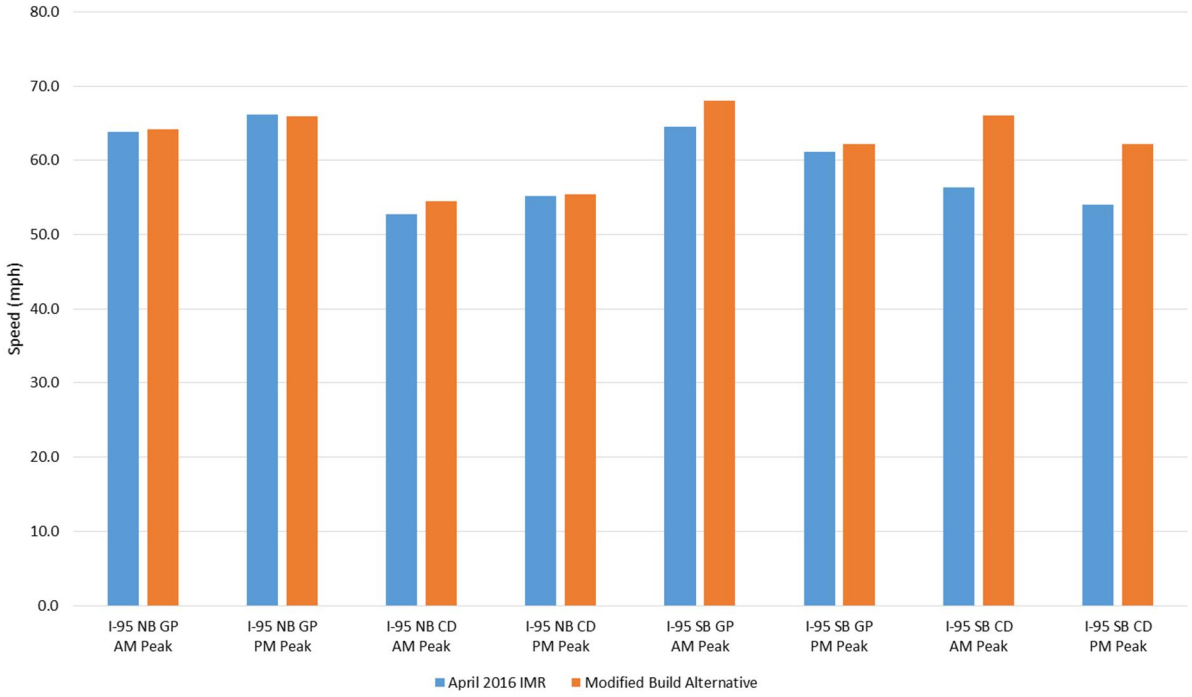
[1] Travel times along the southbound C-D Lanes for the Modified Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative

Figure 7-1: 2020 Build Conditions Travel Time Summary



Note: Travel times along the southbound C-D Lanes for the Modified Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative

Figure 7-2: 2020 Build Conditions Speed Summary



Northbound I-95 Travel Times and Speeds: The CORSIM models for the northbound I-95 lanes are nearly identical for the two alternatives with the exception of minor modifications associated with the I-95 Safety Improvements at Route 3. Along the northbound I-95 mainline lanes and C-D lanes, the corridor-wide travel times are similar and do not differ by more than 2 percent in the AM peak hour and 1 percent in the PM peak hour. Average speeds are also similar with average speed differences of 2 MPH or less in the AM peak hour and 1 MPH or less in the PM peak hour. The corridor-wide travel time and speed results document that the Modified Build Alternative CORSIM models are accurately replicating the results from the April 2016 IMR CORSIM models.

Southbound I-95 Travel Times and Speeds: Along the southbound I-95 mainline lanes and C-D lanes, there is a reduction in travel times and an increase in speeds in both the AM and PM peak hours with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. Travel time reductions in the southbound I-95 mainline lanes are 16 seconds during the AM peak hour and 5 seconds during the PM peak hour indicating similar results when comparing the two alternatives. Travel speeds are approximately 1 to 4 MPH greater with the Modified Build Alternative during the AM and PM peak hours.

Along the southbound I-95 C-D lanes, travel time reductions and speed increases with the Modified Build Alternative are more substantial than along the mainline lanes. This can be attributed to the addition of a third southbound C-D lane, improvements along Route 3 associated with the I-95 Safety Improvements at Route 3 that were not included in the April 2016 IMR, and corresponding signal timing modifications along Route 3. Travel times along the southbound C-D lanes decrease by approximately 35 seconds with the Modified Build Alternative during both the AM and PM peak hours and travel speeds increase by 8 to 10 MPH during the AM and PM peak hours.

7.1.2 I-95 Operations Analysis

Figures 7-3 and 7-4 summarize 2020 Build traffic operations from the HCS analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively. The figures depict vehicle density, vehicle speeds, and LOS for each freeway segment, weave segment, and merge/diverge junction. **Appendices C-1 and C-2** contain the detailed summaries from the HCS analysis for April 2016 IMR Build Alternative and the Modified Build Alternative, respectively.

Tables 7-2 and 7-3 summarize 2020 Build traffic operations from the CORSIM analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively. The tables depict vehicle density and vehicle speeds for each freeway segment, weave segment, and merge/diverge junction. **Appendices C-1 and C-2** contain the detailed summaries from the CORSIM analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively.

7.1.2.1 Northbound I-95

HCS Analysis: The HCS results along the northbound I-95 mainline lanes and C-D lanes are identical between the April 2016 Build Alternative and the Modified Build Alternative. During the AM peak hour, with the exception of the I-95 mainline segment north of Route 17 and the merge between the existing C-D road from Route 17 and northbound I-95 which both operate at LOS F, all other segments and junctions operate at LOS D or better during the AM and PM peak hours.

CORSIM Analysis: The CORSIM analysis indicates similar operations between the April 2016 Build Alternative and the Modified Build Alternative.

7.1.2.2 Southbound I-95

HCS Analysis: The HCS analysis for the Modified Build Alternative indicates that with the exception of the southbound I-95 mainline segment north of the Route 17 interchange in the PM peak hour, all mainline segments, weave segments, and merge/diverge junctions operate at LOS D or better during both the AM and PM peak hours. The southbound I-95 mainline segment north of Route 17 operates at LOS F during the PM peak hour. It should be noted that under 2020 conditions, it is assumed that the Express Lanes are not yet constructed resulting in no additional capacity improvements in this area compared to existing conditions. The LOS and operations along this segment of southbound I-95 are consistent between the April 2016 IMR Alternative and the Modified Build Alternative.

The southbound I-95 mainline lanes between Route 17 and Route 3 would operate at LOS B (AM peak) and LOS D (PM peak) with the April 2016 IMR Alternative and LOS A (AM peak) and LOS B (PM peak) with the Modified Build Alternative resulting in a significant improvement in operations along the mainline lanes between Route 17 and Route 3. In contrast, the southbound I-95 C-D lanes would operate at LOS A (AM peak) and C (PM peak) with the April 2016 IMR Build Alternative and LOS B (AM peak) and LOS D (PM peak) with the Modified Build Alternative due to the higher traffic volumes in the C-D lanes with the Modified Build Alternative.

With the April 2016 IMR Build Alternative, the diverge along southbound I-95 to the Route 17 ramps operates at LOS F during the PM peak hour with a two-lane off-ramp including an option lane. The Modified Build Alternative includes a three-lane off-ramp diverge to the new C-D road including an option lane that serves all traffic destined for Route 17, Route 3, and the Welcome Center. This diverge cannot be analyzed using traditional HCS methodologies due to the three-lane off-ramp configuration (a maximum of two lanes are permitted on an off-ramp in HCS). Therefore, the diverge to the southbound C-D lanes was treated as a "major diverge" in accordance with Chapter 13 (page 13-26) of the *Highway Capacity Manual 2010*. The approach density was checked in accordance with Equation 13-26 and compared to the criteria in Table 13-2 and it was determined that the diverge would operate at LOS B in the AM peak hour and LOS C in the PM peak hour. Additionally, the departure legs of the diverge were also analyzed and confirmed to operate under capacity.

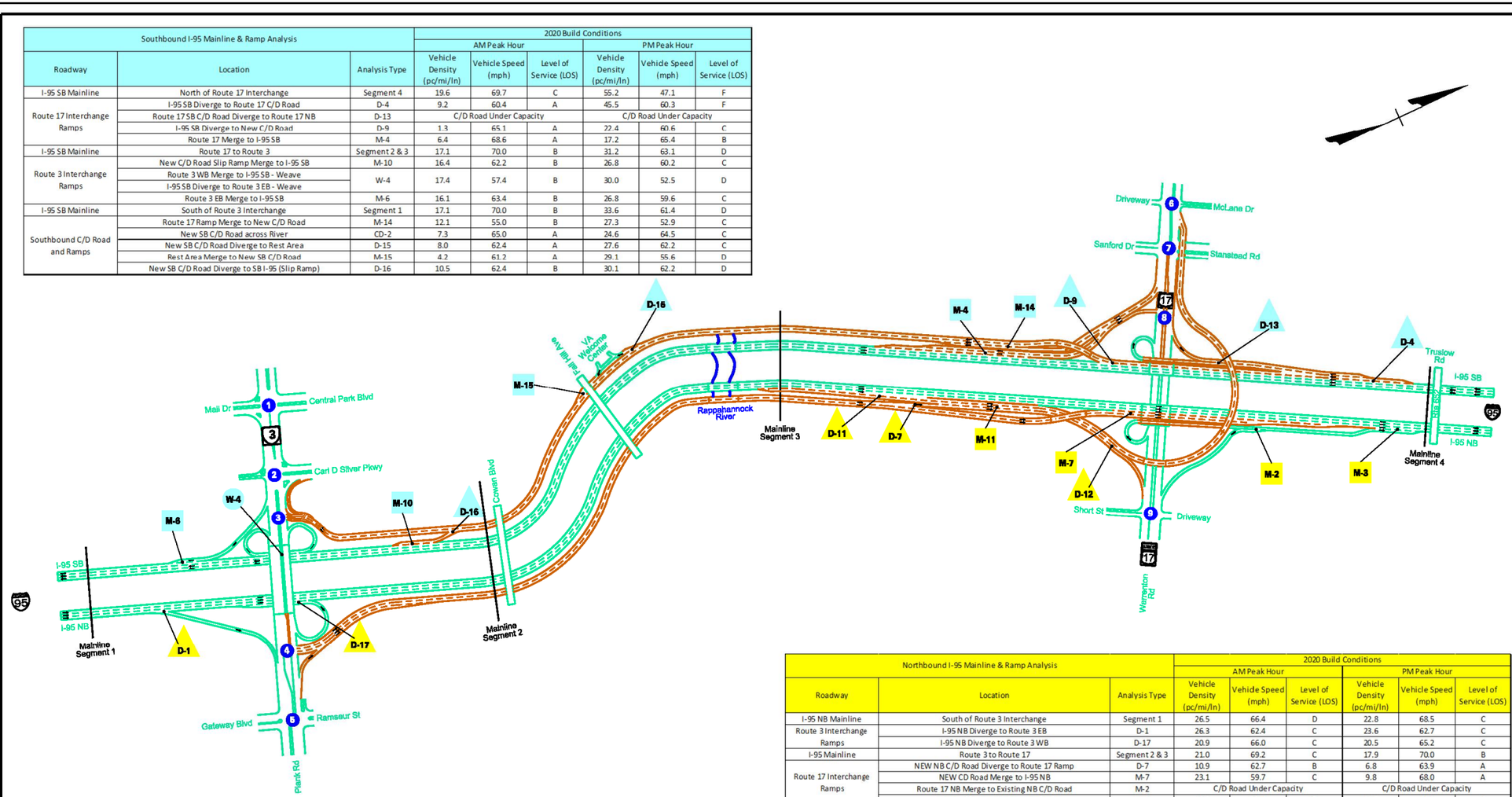
The southbound Route 3 on-ramp and off-ramp and weave would operate with LOS C or D during the PM peak hour with both the April 2016 IMR Alternative and the Modified Build Alternative; however, with the Modified Build Alternative, these junctions would operate along the C-D road and would not impact operations along the mainline lanes due to the extension of the new southbound I-95 mainline lanes beyond the Route 3 interchange.

CORSIM Analysis: The CORSIM analyses for the Modified Build Alternative indicates that during the AM peak hour, all mainline segments, weave segments, and merge/diverge junctions operate with "light" traffic conditions based on the density thresholds established in the HCM similar to April 2016 IMR Build Alternative. During the PM peak hour, the southbound I-95 mainline segment north of the Route 17 interchange operates with "moderate" traffic conditions and transitions to "moderate" to "heavy" traffic conditions at the diverge to the southbound I-95 C-D lanes with average travel speeds across all lanes of

approximately 42 MPH. This is due to the heavy volume of traffic exiting to the southbound I-95 C-D road at the three-lane off-ramp. The I-95 mainline lanes between Route 17 and Route 3 operate with “light” traffic conditions during the PM peak hour. The I-95 southbound C-D lanes between Route 17 and Route 3 and the diverge from the I-95 southbound C-D lanes to westbound Route 3 operate with “moderate” traffic conditions due to the high volume of traffic entering from Route 17 and the high volume of traffic exiting to westbound Route 3, respectively.

Figure 7-3: 2020 Traffic Operations – April 2016 IMR Build Alternative (HCS Analysis)

Southbound I-95 Mainline & Ramp Analysis			2020 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	19.6	69.7	C	55.2	47.1	F
Route 17 Interchange Ramps	I-95 SB Diverge to Route 17 C/D Road	D-4	9.2	60.4	A	45.5	60.3	F
	Route 17 SB C/D Road Diverge to Route 17 NB	D-13	C/D Road Under Capacity			C/D Road Under Capacity		
	I-95 SB Diverge to New C/D Road	D-9	1.3	65.1	A	22.4	60.6	C
	Route 17 Merge to I-95 SB	M-4	6.4	68.6	A	17.2	65.4	B
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	17.1	70.0	B	31.2	63.1	D
Route 3 Interchange Ramps	New C/D Road Slip Ramp Merge to I-95 SB	M-10	16.4	62.2	B	26.8	60.2	C
	Route 3 WB Merge to I-95 SB - Weave	W-4	17.4	57.4	B	30.0	52.5	D
	I-95 SB Diverge to Route 3 EB - Weave							
	Route 3 EB Merge to I-95 SB	M-6	16.1	63.4	B	26.8	59.6	C
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	17.1	70.0	B	33.6	61.4	D
Southbound C/D Road and Ramps	Route 17 Ramp Merge to New C/D Road	M-14	12.1	55.0	B	27.3	52.9	C
	New SB C/D Road across River	CD-2	7.3	65.0	A	24.6	64.5	C
	New SB C/D Road Diverge to Rest Area	D-15	8.0	62.4	A	27.6	62.2	C
	Rest Area Merge to New SB C/D Road	M-15	4.2	61.2	A	29.1	55.6	D
	New SB C/D Road Diverge to SB I-95 (Slip Ramp)	D-16	10.5	62.4	B	30.1	62.2	D



Northbound I-95 Mainline & Ramp Analysis			2020 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	26.5	66.4	D	22.8	68.5	C
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	26.3	62.4	C	23.6	62.7	C
	I-95 NB Diverge to Route 3 WB	D-17	20.9	66.0	C	20.5	65.2	C
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	21.0	69.2	C	17.9	70.0	B
Route 17 Interchange Ramps	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	10.9	62.7	B	6.8	63.9	A
	NEW CD Road Merge to I-95 NB	M-7	23.1	59.7	C	9.8	68.0	A
	Route 17 NB Merge to Existing NB C/D Road	M-2	C/D Road Under Capacity			C/D Road Under Capacity		
	Existing CD Road Merge to I-95 NB	M-3	40.6	39.7	F	24.7	60.8	C
I-95 Mainline	North of Route 17 Interchange	Segment 4	57.4	46.0	F	23.9	67.9	C
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	31.2	61.3	D	14.7	65.0	B
	I-95 NB Diverge to I-95 C/D Roadway	D-11	32.0	61.1	D	16.7	61.3	B
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	23.7	53.7	C	19.1	54.0	B
	Route 17 Ramp East/West Diverge	D-12	24.5	57.9	C	18.4	57.8	B

LEGEND

Existing Conditions
Build Conditions

NB	SB	
M-#	M-#	Merge Junction
W-#	W-#	Weave Junction
D-#	D-#	Diverge Junction

VDOT

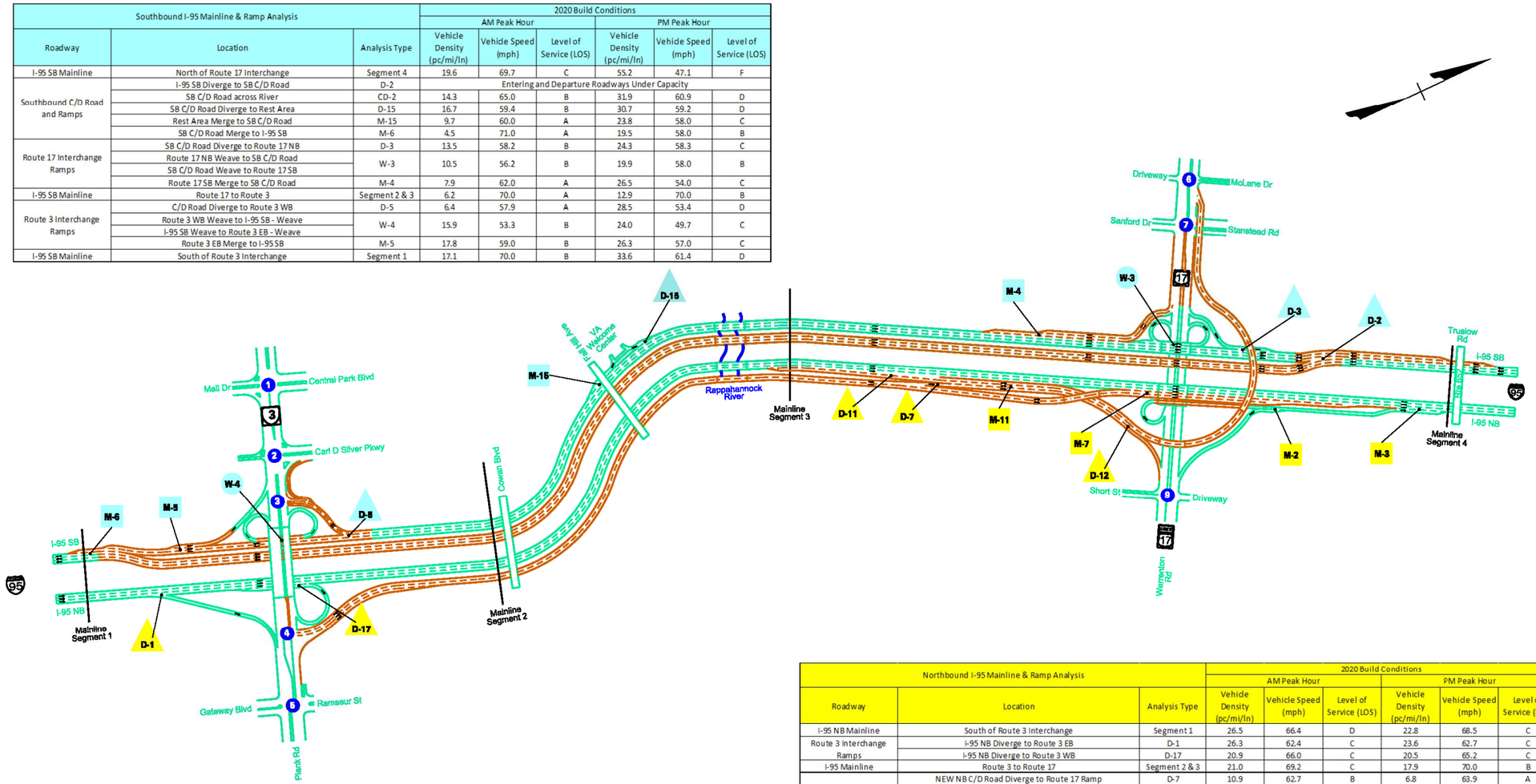
I-95 Rappahannock River Crossing Southbound Interchange Modification Report Supplement

Figure 7-3
Sheet 1 of 1
2020 Traffic Operations (HCS)
April 2016 IMR Build Conditions

Not To Scale

Figure 7-4: 2020 Traffic Operations – Modified Build Alternative (HCS Analysis)

Southbound I-95 Mainline & Ramp Analysis			2020 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	19.6	69.7	C	55.2	47.1	F
Southbound C/D Road and Ramps	I-95 SB Diverge to SB C/D Road	D-2	Entering and Departure Roadways Under Capacity					
	SB C/D Road across River	CD-2	14.3	65.0	B	31.9	60.9	D
	SB C/D Road Diverge to Rest Area	D-15	16.7	59.4	B	30.7	59.2	D
	Rest Area Merge to SB C/D Road	M-15	9.7	60.0	A	23.8	58.0	C
	SB C/D Road Merge to I-95 SB	M-6	4.5	71.0	A	19.5	58.0	B
Route 17 Interchange Ramps	SB C/D Road Diverge to Route 17 NB	D-3	13.5	58.2	B	24.3	58.3	C
	Route 17 NB Weave to SB C/D Road	W-3	10.5	56.2	B	19.9	58.0	B
	SB C/D Road Weave to Route 17 SB							
	Route 17 SB Merge to SB C/D Road	M-4	7.9	62.0	A	26.5	54.0	C
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	6.2	70.0	A	12.9	70.0	B
Route 3 Interchange Ramps	C/D Road Diverge to Route 3 WB	D-5	6.4	57.9	A	28.5	53.4	D
	Route 3 WB Weave to I-95 SB - Weave	W-4	15.9	53.3	B	24.0	49.7	C
	I-95 SB Weave to Route 3 EB - Weave							
	Route 3 EB Merge to I-95 SB	M-5	17.8	59.0	B	26.3	57.0	C
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	17.1	70.0	B	33.6	61.4	D



Northbound I-95 Mainline & Ramp Analysis			2020 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	26.5	66.4	D	22.8	68.5	C
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	26.3	62.4	C	23.6	62.7	C
	I-95 NB Diverge to Route 3 WB	D-17	20.9	66.0	C	20.5	65.2	C
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	21.0	69.2	C	17.9	70.0	B
Route 17 Interchange Ramps	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	10.9	62.7	B	6.8	63.9	A
	NEW CD Road Merge to I-95 NB	M-7	23.1	59.7	C	9.8	68.0	A
	Route 17 NB Merge to Existing NB C/D Road	M-2	C/D Road Under Capacity			C/D Road Under Capacity		
	Existing CD Road Merge to I-95 NB	M-3	40.6	39.7	F	24.7	60.8	C
I-95 Mainline	North of Route 17 Interchange	Segment 4	57.4	46.0	F	23.9	67.9	C
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	31.2	61.3	D	14.7	65.0	B
	I-95 NB Diverge to I-95 C/D Roadway	D-11	32.0	61.1	D	16.7	61.3	B
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	23.7	53.7	C	19.1	54.0	B
	Route 17 Ramp East/West Diverge	D-12	24.5	57.9	C	18.4	57.8	B

LEGEND

Existing Conditions
Build Conditions
Express Lanes By Others

NB	SB	
M-#	M-#	Merge Junction
W-#	W-#	Weave Junction
D-#	D-#	Diverge Junction

I-95 Rappahannock River Crossing Southbound Interchange Modification Report Supplement

Figure 7-4
Sheet 1 of 1
2020 Traffic Operations (HCS)
Modified Build Conditions

Not To Scale

Table 7-2: 2020 Build Conditions CORSIM Analysis – April 2016 IMR Build Alternative

Northbound I-95 Mainline & Ramp Analysis			2020 April 2016 IMR Build Conditions			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density (veh/mi/ln)	Vehicle Speed (mph)	Vehicle Density (veh/mi/ln)	Vehicle Speed (mph)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	21.3	67.2	20.1	67.4
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	19.7	66.7	18.6	67.1
	I-95 NB Diverge to Route 3 WB	D-17	15.0	66.0	13.9	65.2
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	17.6	66.2	15.5	66.8
Route 17 Interchange Ramps	I-95 NB diverge to I-95 C/D Roadway	D-11	15.6	62.1	13.3	64.4
	NEW CD Road merge to I-95 NB	M-7	18.8	61.2	11.4	65.4
	Route 17 WB merge to Exist NB CD Road	M-2	17.8	44.8	10.5	45.5
	Existing CD Road merge to I-95 NB	M-3	33.7	50.1	17.1	63.2
I-95 Mainline	North of Route 17 Interchange	Segment 4	33.2	61.0	19.8	65.7
Northbound CD Road and Ramps	NEW NB CD Road across River	CD-1	31.8	55.6	15.5	56.3
	NEW NB CD Road diverge to Route 17 ramp	D-7	33.4	53.1	15.6	55.2
	NEW NB CD Braided Ramp merge to Rt 17 ramp	M-11	12.5	55.4	9.0	58.8
	Route 17 ramp East/West diverge	D-12	12.8	54.2	9.7	54.8
Southbound I-95 Mainline & Ramp Analysis			**2020 April 2016 IMR Build Conditions**			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density (veh/mi/ln)	Vehicle Speed (mph)	Vehicle Density (veh/mi/ln)	Vehicle Speed (mph)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	17.7	59.3	34.7	63.1
Route 17 Interchange Ramps	I-95 SB diverge to Route 17 CD Road	D-4	11.6	66.3	34.8	59.0
	Route 17 SB CD road diverge to Route 17 WB	D-13	10.7	38.9	17.4	36.6
	I-95 SB diverge to NEW CD Road	D-9	7.9	67.0	16.6	64.5
	Route 17 merge to I-95 SB	M-4	9.3	61.3	19.0	57.9
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	12.9	67.3	24.1	65.1
Route 3 Interchange Ramps	NEW CD Road slip ramp merge to I-95 SB	M-10	11.4	60.2	19.5	62.5
	Route 3 WB Merge to I-95 SB - Weave	W-4	11.5	67.1	21.7	59.3
	I-95 SB diverge to Route 3 EB - Weave					
	Route 3 EB merge to I-95 SB	M-6	11.4	65.8	22.0	62.7
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	13.2	67.3	25.0	64.9
Southbound CD Road and Ramps	Route 17 ramp merge to NEW CD Road	M-14	5.7	47.4	18.9	53.2
	NEW SB CD Road across River	CD-2	6.8	59.1	21.4	57.0
	NEW SB CD Road diverge to rest area	D-15	5.0	58.7	15.6	56.8
	Rest Area merge to NEW SB CD Road	M-15	4.9	59.4	15.6	56.9
	NEW SB CD Road diverge to SB I-95 (slip ramp)	D-16	5.9	59.3	21.7	56.8

Congestion Level	Freeways	Weave/Ramp	C-D Road Weave
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28	≤ 32
Moderate Traffic	>26 - 35	>28 - 35	>32 - 36
Heavy Congestion	>35 - 45	>35 - 45	>36 - 45
Severe Congestion	>45	>45	>45

Table 7-3: 2020 Build Conditions CORSIM Analysis – Modified Build Alternative

Northbound I-95 Mainline & Ramp Analysis			2020 Modified Build Conditions			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	21.3	67.1	20.2	67.2
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	19.6	66.8	18.6	67.1
	I-95 NB Diverge to Route 3 WB	D-17	14.5	65.7	14.0	65.2
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	17.6	66.1	15.4	66.7
Route 17 Interchange Ramps	I-95 NB Diverge to I-95 C/D Roadway	D-11	17.2	56.4	14.1	61.0
	NEW CD Road Merge to I-95 NB	M-7	17.7	61.8	11.6	65.0
	Route 17 NB Merge to Existing NB C/D Road	M-2	14.6	45.2	9.8	45.9
	Existing CD Road Merge to I-95 NB	M-3	27.3	56.8	16.7	63.3
I-95 Mainline	North of Route 17 Interchange	Segment 4	30.3	62.5	19.6	65.7
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	33.7	55.7	17.5	56.6
	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	29.9	54.5	15.7	55.1
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	12.4	54.5	9.3	56.4
	Route 17 Ramp East/West Diverge	D-12	12.9	52.4	9.6	54.7
Southbound I-95 Mainline & Ramp Analysis			**2020 Modified Build Conditions**			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	15.2	68.5	32.3	66.0
Southbound C/D Road and Ramps	I-95 SB Diverge to SB C/D Road	D-2	9.5 - 10.7	65.4 - 67.2	29.8 - 35.2	42.3 - 42.5
	SB C/D Road across River	CD-2	12.0	67.5	27.9	63.8
	SB C/D Road Diverge to Rest Area	D-15	9.1	67.6	20.1	65.3
	Rest Area Merge to SB C/D Road	M-15	10.9	66.8	24.3	63.8
	SB C/D Road Merge to I-95 SB	M-6	7.6 – 9.7	65.2 - 66.5	14.9 - 24.7	48.8 - 64.1
Route 17 Interchange Ramps	SB C/D Road Diverge to Route 17 WB	D-3	8.0	67.5	17.2	59.8
	Route 17 WB Weave to SB C/D Road	W-3	6.9	63.0	15.3	60.4
	SB C/D Road Weave to Route 17 EB					
	Route 17 EB Merge to SB C/D Road	M-4	7.9 – 9.2	60.8 - 67.4	17.2 – 22.6	58.2 - 64.9
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	4.8	68.8	11.1	67.5
Route 3 Interchange Ramps	C/D Road Diverge to Route 3 WB	D-5	12.3	65.2	29.8	57.4
	Route 3 WB Weave to I-95 SB - Weave	W-4	9.8	60.7	15.5	58.6
	I-95 SB Weave to Route 3 EB - Weave					
	Route 3 EB Merge to I-95 SB	M-5	9.1	63.4	15.6	61.4
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	12.7	66.2	26.3	60.8

Congestion Level	Freeways	Weave/Ramp	C-D Road Weave
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28	≤ 32
Moderate Traffic	>26 - 35	>28 - 35	>32 - 36
Heavy Congestion	>35 - 45	>35 - 45	>36 - 45
Severe Congestion	>45	>45	>45

[1] Cells with multiple values indicate segments and junctions with multiple analysis segments

7.1.3 Arterial Intersection Operations

Measures of effectiveness (MOEs) from the HCS analysis were used to compare operations at the signalized intersections for 2020 Build conditions for the two alternatives. Overall intersection LOS and delay, average delay by approach and movement, and 50th percentile queue lengths were reported for each intersection. **Table 7-4** depicts overall intersection LOS and delay for the signalized intersections within the study area for the AM and PM peak hours for 2020 Build conditions. **Appendices C-1 and C-2** contain a tabular summary of average delays by approach and movement, 50th percentile queue lengths, and storage lengths.

Table 7-4: Intersection LOS and Delay Summary (2020 Build Conditions)

Intersection		April 2016 IMR Build Alternative				Modified Build Alternative			
		AM Peak		PM Peak		AM Peak		PM Peak	
		LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)
1	Route 3 at Mall Drive/Central Park Boulevard	B	19.5	F	120.0	B	19.5	F	120.0
2 *	Route 3 at Carl D. Silver Parkway	C	34.5	F	126.7	C	34.3	F	105.4
3 *	Route 3 at Ramp from SB I-95 (New Signal with Triple Rights)	C	28.1	E	67.0	C	27.7	D	48.0
4	Route 3 at Ramp to NB I-95 (New Signal with Triple Lefts)	C	25.6	B	19.5	F	138.2	B	20.0
5	Route 3 at Gateway Boulevard	C	22.8	C	31.1	C	22.8	C	31.1
6	Route 17 at McLane Drive	D	53.6	C	28.0	D	53.6	C	28.0
7 *	Route 17 at Sanford Drive	D	38.0	F	170.9	C	30.9	F	93.5
8	Route 17 at Ramp to SB I-95 C-D Road (New Signal)	A	3.8	A	5.4	-	-	-	-
9	Route 17 at Short Street	D	35.7	F	112.0	D	35.7	F	112.0

* Improved LOS and reduced delay with Modified Build Alternative

The following is a summary of signalized intersections when comparing the April 2016 IMR conditions to the Modified Build Conditions for both the AM and PM peak hours:

- **Intersection #1 - Route 3 at Mall Drive / Central Park Boulevard:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #2 - Route 3 at Carl D. Silver Parkway:** Average intersection delays would decrease with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project, which will change lane configurations along Route 3 by providing an additional right-turn lane. During the PM peak hour, average intersections delays are projected to decrease by approximately 21 seconds.

- **Intersection #3 - Route 3 at I-95 SB Off-Ramp (New Signal with Triple Rights):** Average intersection delays would decrease with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project which adds additional through lanes along the westbound Route 3 approach. Average delays would be reduced by approximately 19 seconds in the PM peak hour.

- **Intersection #4 - Route 3 at I-95 NB On-Ramp (New Signal with Triple Lefts):** Average delays at this new signalized intersection would increase with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project. The April 2016 IMR depicted the westbound right-turn movement at this intersection as a free-flowing right-turn lane that was not controlled by the traffic signal. The I-95 Safety Improvements at Route 3 operates the westbound right turn under signal control, resulting in increases in overall intersection delay compared to the April 2016 IMR Build conditions.

- **Intersection #5 - Route 3 at Gateway Boulevard:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #6 - Route 17 at McLane Drive:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #7 - Route 17 at Sanford Drive:** Average intersection delays at this intersection would decrease in the AM and PM peak hours with the Modified Build Alternative due to the revised lane configuration proposed on the eastbound Route 17 approach that would convert the right-turn lane to a shared through/right-turn lane, providing an additional eastbound through lane that would serve the downstream ramp to southbound I-95. PM peak hour overall average delays are projected to decrease by approximately 77 seconds. Eastbound through delays are projected to decrease from 107 seconds to 37 seconds and eastbound through queues are projected to decrease from 1,181 feet to 596 feet.

- **Intersection #8 - Route 17 at Ramp to I-95 SB C-D Road (New Signal):** This intersection is not proposed in the Modified Build Alternative, since it would retain the existing loop ramp from northbound Route 17 to the southbound I-95 C-D road.

- **Intersection #9 - Route 17 at Short Street:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

In summary, three of the nine intersections analyzed would have improved operations in 2020 with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. One intersection, Route 3 at the I-95 Northbound On-Ramp, would have degraded operations with the Modified Build Alternative and one intersection, Route 17 at Ramp to I-95 SB C-D Road, would be removed with the Modified Build Alternative.

7.2 2040 BUILD CONDITIONS TRAFFIC OPERATIONS

7.2.1 I-95 Travel Times and Speeds

Overall travel times and average speeds from the CORSIM analysis were calculated for the entire length of the I-95 mainline lanes and the C-D lanes within the study area limits to provide a comparison of the April 2016 IMR Build Alternative and the Modified Build Alternative with 2040 Build conditions. **Table 7-5** and **Figures 7-5 and 7-6** summarize the travel times and speeds for the northbound and southbound I-95 mainline lanes and C-D lanes. As noted, travel times along the southbound C-D lanes for the Modified

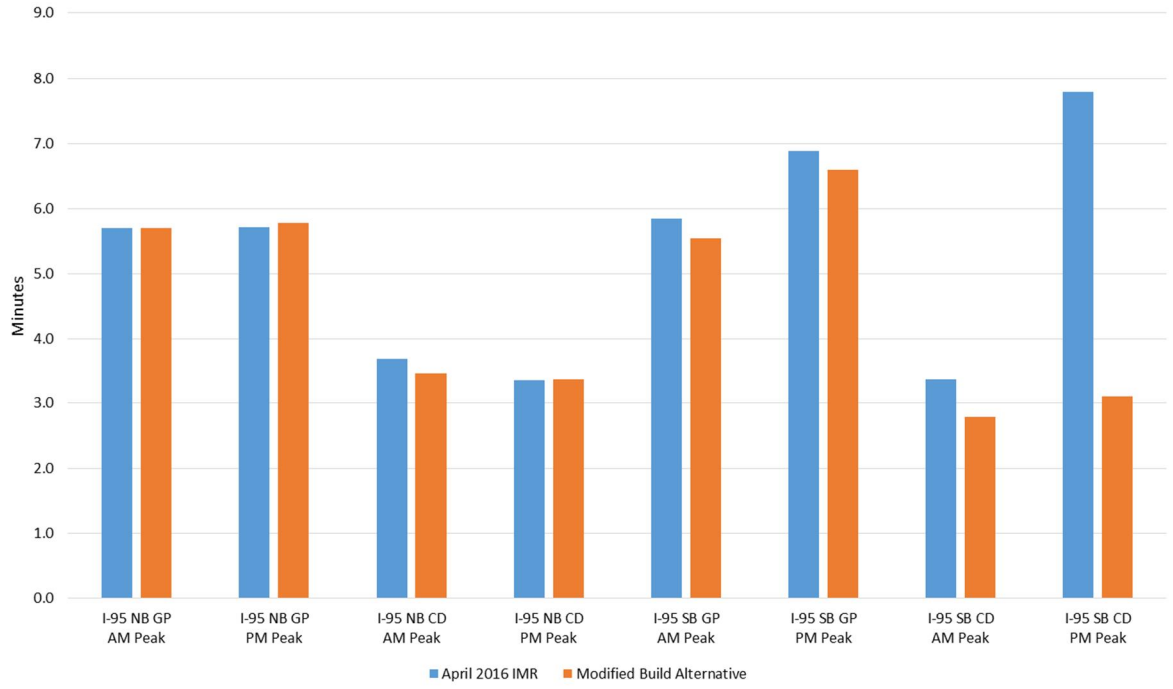
Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative since the C-D lanes terminate at Route 3 with the April 2016 Build Alternative.

Table 7-5: 2040 Build Conditions Travel Time and Speed Summary

Intersection	April 2016 IMR Build Alternative		Modified Build Alternative	
	AM Peak	PM Peak	AM Peak	PM Peak
Travel Time (seconds)				
Northbound Mainline Lanes	342.3	342.7	342.5	347.2
Northbound C-D Lanes	220.7	201.3	207.3	202.2
Southbound Mainline Lanes	350.9	412.8	332.7	395.6
Southbound C-D Lanes [1]	201.6	467.4	167.5	186.0
Average Speeds (MPH)				
Northbound Mainline Lanes	64.8	64.7	64.8	63.9
Northbound C-D Lanes	49.9	55.1	53.7	55.1
Southbound Mainline Lanes	63.1	53.9	66.9	56.3
Southbound C-D Lanes	56.1	24.2	65.1	59.2

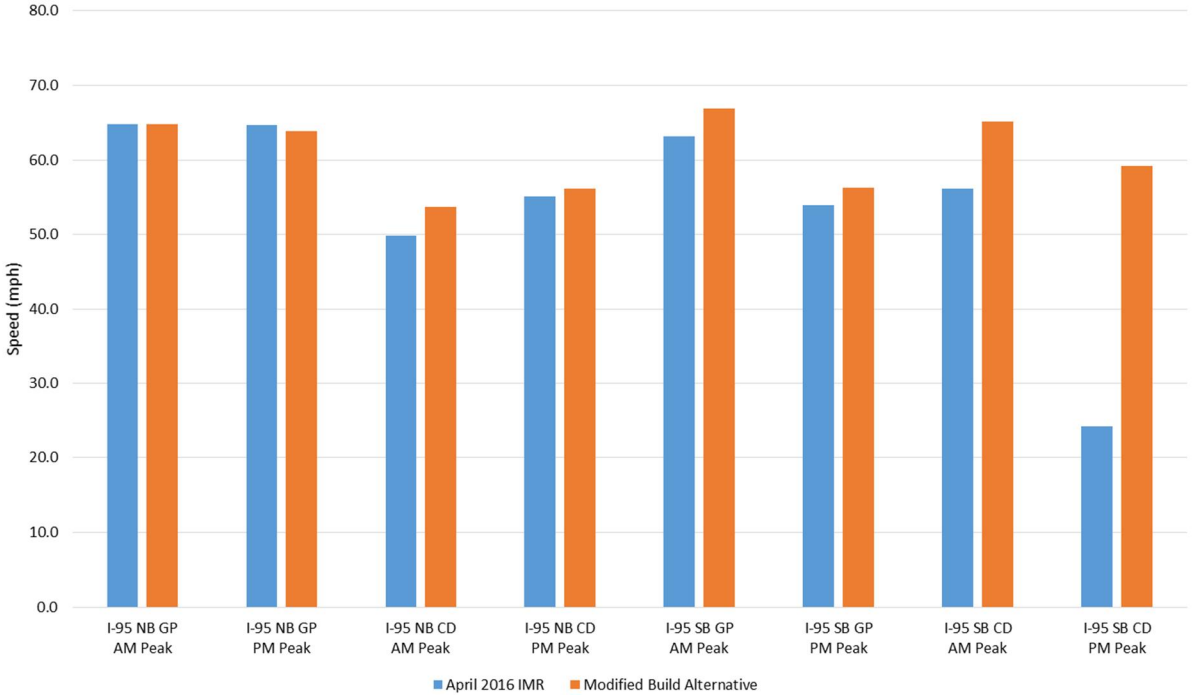
[1] Travel times along the southbound C-D Lanes for the Modified Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative

Figure 7-5: 2040 Build Conditions Travel Time Summary



Note: Travel times along the southbound C-D Lanes for the Modified Build Alternative were adjusted to provide a similar segment length compared to the April 2016 IMR Build Alternative

Figure 7-6: 2040 Build Conditions Speed Summary



Northbound I-95 Travel Times and Speeds: The CORSIM models for the northbound I-95 lanes are nearly identical for the two alternatives with the exception of minor modifications associated with the I-95 Safety Improvements at Route 3. Along the northbound I-95 mainline lanes and C-D lanes, the corridor-wide travel times are similar and do not differ by more than 6 percent in the AM peak hour and 1 percent in the PM peak hour with differences less than 15 seconds. Average speeds are also similar with average speed differences of 4 MPH or less in the AM peak hour and 1 MPH or less in the PM peak hour. The corridor-wide travel time and speed results document that the Modified Build Alternative CORSIM models are accurately replicating the results from the April 2016 IMR CORSIM models.

It should be noted that when comparing 2020 Build and 2040 Build conditions, the 2040 Build conditions includes the reversible Express Lanes within the median which results in lower traffic volumes in the AM peak hour in the northbound I-95 mainline lanes under 2040 Build conditions. The lower traffic volumes in the AM peak hour in the northbound I-95 mainline lanes result in higher travel speeds and lower travel times under 2040 Build conditions compared to 2020 Build conditions.

Southbound I-95 Travel Times and Speeds: Along the southbound I-95 mainline lanes and C-D lanes, there is a reduction in travel times and an increase in speeds in both the AM and PM peak hours with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. Travel time reductions in the southbound I-95 mainline lanes are 17 to 18 seconds during the AM peak and PM peak hours indicating similar results when comparing the two alternatives. Travel speeds are approximately 2 to 4 MPH greater with the Modified Build Alternative.

Along the southbound I-95 C-D lanes, travel time reductions and speed increases with the Modified Build Alternative are more substantial than along the mainline lanes. This can be attributed to the addition of a third southbound C-D lane, improvements along Route 3 associated with the I-95 Safety Improvements at Route 3 that were not included in the April 2016 IMR, and corresponding signal timing modifications along Route 3. Travel times along the southbound C-D lanes decrease by approximately 4.7 minutes with the Modified Build Alternative during the PM peak hour and average travel speeds increase by 35 MPH from 24 MPH to 59 MPH during the PM peak hour. During the AM peak hour, travel times decrease by 34 seconds and travel speeds increase by 9 MPH with the Modified Build Alternative.

7.2.2 I-95 Operations Analysis

Figures 7-7 and 7-8 summarize 2040 Build traffic operations from the HCS analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively. The figures depict vehicle density, vehicle speeds, and LOS for each freeway segment, weave segment, and merge/diverge junction. **Appendices C-1 and C-2** contain the detailed summaries from the HCS analysis for April 2016 IMR Build Alternative and the Modified Build Alternative, respectively.

Tables 7-6 and 7-7 summarize 2040 Build traffic operations from the CORSIM analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively. The tables depict vehicle density and vehicle speeds for each freeway segment, weave segment, and merge/diverge junction. **Appendices C-1 and C-2** contain the detailed summaries from the CORSIM analysis for the April 2016 IMR Build Alternative and the Modified Build Alternative, respectively.

7.2.2.1 Northbound I-95

HCS Analysis: The HCS results along the northbound I-95 mainline lanes and C-D lanes are identical between the April 2016 Build Alternative and the Modified Build Alternative. During the AM peak hour, although there is substantial improvement in LOS for the northbound I-95 mainline segments and ramp junctions compared to the No Build conditions, several segments and junctions operate at LOS F with 2040 Build conditions. The new northbound I-95 C-D road across the Rappahannock River is projected to operate at LOS F in the AM peak hour and LOS C in the PM peak hour. The April 2016 IMR notes that obtaining a LOS better than LOS F during the AM peak hour would require widening the proposed northbound C-D road to three lanes. In addition, during the AM peak hour, the northbound I-95 mainline lanes diverge to the I-95 C-D road, the merge between the existing northbound I-95 C-D road and northbound I-95, and the I-95 northbound mainline segment north of Route 17 are anticipated to operate at LOS F in the AM peak hour.

During the PM peak hour, the I-95 mainline segments north of Route 17 and south of Route 3 would operate at LOS E. All other segments and junctions would operate at LOS D or better.

CORSIM Analysis: The CORSIM analysis indicates similar operations between the April 2016 Build Alternative and the Modified Build Alternative.

7.2.2.2 Southbound I-95

HCS Analysis: The southbound I-95 mainline lanes between Route 17 and Route 3 would operate at LOS C (AM peak) and D (PM peak) with the April 2016 IMR Alternative and LOS A during the AM and PM peak hours with the Modified Build Alternative resulting in a substantial improvement in operations along the mainline lanes between Route 17 and Route 3 compared to the April 2016 IMR Alternative. The southbound I-95 C-D lanes would operate at LOS A (AM peak) and D (PM peak) with the April 2016 IMR Build Alternative and LOS C (AM peak) and LOS F (PM peak) with the Modified Build Alternative due to the higher traffic volumes in the C-D lanes with the Modified Build Alternative. Similar to the April 2016 IMR, the I-95 mainline segment north of Route 17 would operate at LOS F during the PM peak hour with the Modified Build Alternative.

With the April 2016 IMR Build Alternative, the diverge along southbound I-95 to the Route 17 ramps operates at LOS F during the PM peak hour with a two-lane off-ramp including an option lane. As noted in the discussion of 2020 Build conditions, the Modified Build Alternative includes a three-lane off-ramp diverge to the new C-D road including an option lane that serves all traffic destined for Route 17, Route 3, and the Welcome Center. This diverge cannot be analyzed using traditional HCS methodologies due to the three-lane off-ramp configuration. Therefore, the diverge to the southbound C-D lanes was treated as a "major diverge." The approach density was checked in accordance with Equation 13-26 and it was determined that the diverge would operate at LOS B in the AM peak hour and LOS C in the PM peak hour. Additionally, the departure legs of the diverge were also analyzed and confirmed to operate under capacity.

LOS F conditions are predicted during the PM peak hour at several locations along the southbound I-95 C-D road with the Modified Build Alternative; however, it should be noted that traditional HCS considers mainline freeway segments, weave segments, and ramp junctions as independent facilities and does not take into account the interaction between components of the freeway network or upstream capacity constraints that may limit downstream flow rates. HCS analysis considers forecasted (or unconstrained)

volumes rather than constrained volumes that are likely to be experienced due to upstream capacity constraints

For example, the forecasted traffic volume along southbound I-95 approaching the Route 17 interchange is 6,950 vehicles per hour compared to a simulated (CORSIM) traffic volume of 6,465 vehicles per hour during the PM peak hour, a reduction of 485 vehicles per hour entering the network from the north. Similarly, the forecasted traffic volume for the ramp from eastbound Route 17 to southbound I-95 is 2,900 vehicles per hour during the PM peak hour compared to a simulated (CORSIM) traffic volume of 2,323 vehicles per hour, a reduction of 577 vehicles per hour entering the network from the east. The combined sum of the volumes along these two major entry links that were "denied" access to the southbound I-95 facility is over 1,000 vehicles per hour resulting in lower traffic volumes along both the mainline lanes and the C-D road compared to forecasted traffic volumes.

Due to the over-capacity conditions anticipated along many of the roadway segments in the study area under 2040 Build conditions, the results of the CORSIM analysis discussed below are a more appropriate and reliable source for predicting peak hour operations for both the April 2016 IMR Build Alternative and Modified Build Alternative.

CORSIM Analysis: The CORSIM analyses for the Modified Build Alternative indicates that during the AM peak hour, all mainline segments, weave segments, and merge/diverge junctions operate with "light" traffic conditions based on the density thresholds established in the HCM.

During the PM peak hour, the southbound I-95 mainline segment north of the Route 17 interchange operates with "heavy congestion" conditions and transitions to "severe congestion" and then "moderate" traffic conditions approaching the three-lane diverge to the southbound I-95 C-D lanes with average travel speeds across all five lanes approaching the diverge ranging from 22 to 43 MPH. This is due to the heavy volume of traffic exiting to the southbound I-95 C-D road at the three-lane off-ramp. In comparison, the April 2016 IMR documented a 35 MPH speed at the diverge to the off-ramp to Route 17 indicating similar operations at the diverge north of Route 17 when comparing the two alternatives. Throughput volumes were compared along southbound I-95 approaching the diverge to the C-D lanes (Modified Build Alternative) and the diverge to the off-ramp to Route 17 (April 2016 IMR Build Alternative) where the demand volume is 6,950. The throughput volume for the Modified Build Alternative would be 6,458 vehicles per hour compared to 6,225 vehicles per hour with the April 1026 IMR Build Alternative indicating that 233 more vehicles would be accommodated with the Modified Build Alternative at this location.

As noted above, congestion in the southbound I-95 mainline lanes approaching the three-lane diverge to the southbound C-D lanes is partially caused by the high traffic volumes (5,360 vehicles per hour) that must change lanes to access the C-D lanes. To reduce lane changing on the approach to the diverge, consideration was given to dropping the southbound I-95 mainline lanes onto the C-D lanes, thereby requiring motorists continuing through on I-95 to make lane changes. Section 10.9.5 of the AASHTO Green Book discusses the concepts of route continuity, lane balance, and basic number of lanes. The Modified Build Alternative as currently proposed supports these three principals by maintaining three travel lanes on the mainline I-95 lanes without the need to change lanes. AASHTO states that "desirably, the driver, especially one unfamiliar with the route, should be provided a continuous through route on which changing lanes is not needed to continue on the through route." Therefore, dropping the I-95 southbound mainline lanes onto the C-D road to reduce required lane changes was not considered further.

It should also be noted that improvements under consideration as part of the Fred Ex project include the construction of a southbound flyover ramp from the Express Lanes that would tie into the southbound I-95 C-D lanes north of Route 17. This flyover ramp would reduce traffic volumes on the ramp from southbound I-95 to the C-D lanes thereby improving operations at the three-lane diverge to the southbound I-95 C-D lanes. As discussed in **Section 2.3.1**, it is intended that the Fred Ex lanes open to traffic concurrently with the southbound C-D lanes; however, a definitive schedule and funding plan have not been developed for the extension of the Express Lanes south of Route 17 (Exit 133) and therefore were not included in the analysis for the Modified Build Alternative.

During the PM peak hour, the I-95 mainline lanes between Route 17 and Route 3 operate with "light" traffic conditions during the PM peak hour with both the April 2016 IMR and Modified Build Alternative.

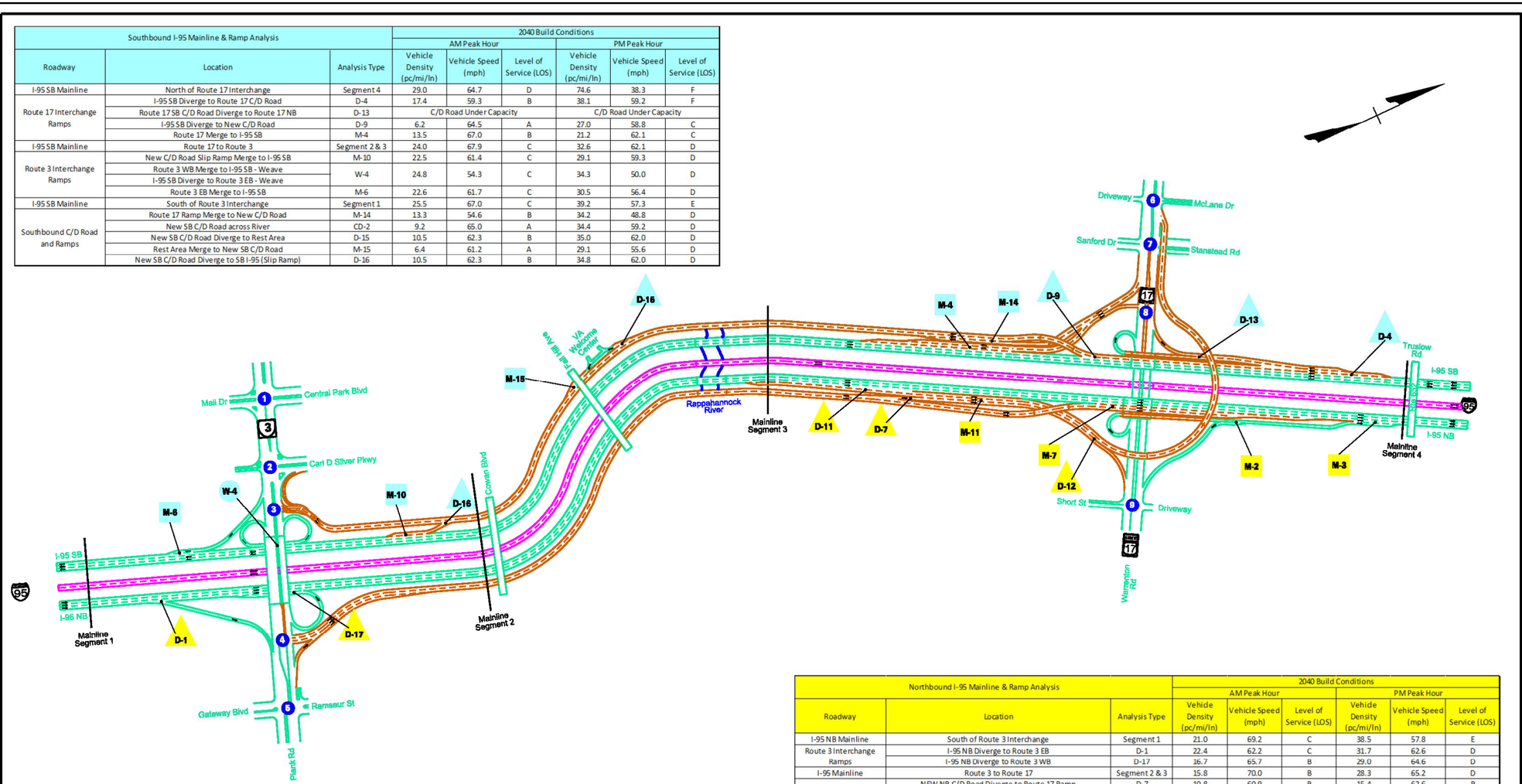
During the PM peak hour, "moderate" traffic conditions are projected at the two-lane on-ramp merge from eastbound Route 17 onto the southbound C-D road with speeds ranging from 49 to 64 MPH. "Heavy congestion" is predicted for the C-D road between Route 17 and Route 3; however, average travel speeds are predicted to be 58 to 65 MPH including the merge and diverge junctions at the Welcome Center. The diverge from the I-95 southbound C-D lanes to westbound Route 3 operates with "heavy congestion" and speeds of 48 MPH due to the high volume of traffic exiting to westbound Route 3; however, maximum queues approaching Route 3 are approximately 1,175 feet do not extend to the I-95 southbound C-D lanes diverge to westbound Route 3. In comparison, the April 2016 IMR Build Alternative would have travel speeds along the southbound I-95 C-D road between the Rappahannock River bridge and Route 3 ranging from 13 to 42 MPH with "heavy" to "severe congestion" primarily due to downstream congestion along westbound Route 3 approaching Carl D. Silver Parkway. The April 2016 IMR documented queues on the new southbound I-95 C-D lanes that extend approximately 2.5 miles from Route 3 and almost to the new braided ramps south of the Route 17 interchange. The improvements in operations along the southbound I-95 C-D road with the Modified Build Alternative can be attributed to the addition of a third lane on the C-D road that drops to Route 3, modifications to the scope of the improvements associated with the I-95 Safety Improvements at Route 3 project and corresponding signal timing modifications.

Another improvement with the Modified Build Alternative compared to the April 2016 IMR Alternative is the increase in throughput on the on-ramp from eastbound Route 17 to the southbound I-95 C-D road resulting from lane configuration modifications proposed along eastbound Route 17 approaching Sanford Drive and the southbound I-95 on-ramp with the Modified Build Alternative. With the April 2016 IMR, 1,867 (simulated volume) of 3,100 vehicles per hour (demand volume) from Route 17 were able to access the southbound I-95 braided ramps indicating that 60 percent of the demand volume was served. With the Modified Build Alternative, 2,323 (simulated volume) of 2,900 vehicles per hour (demand volume) were able to access the two-lane entrance ramp to the southbound I-95 C-D lanes indicating that 80 percent of the demand volume was served. This indicates a substantial increase in the throughput volume along eastbound Route 17 destined for southbound I-95 with the Modified Build Alternative resulting in an improvement in operations along eastbound Route 17.

The southbound weave at the Route 3 ramps and the on-ramp from eastbound Route 3 to southbound I-95 would operate with "light" traffic conditions with both the April 2016 IMR Alternative and the Modified Build Alternative; however, with the Modified Build Alternative, these junctions would operate along the C-D road and would not impact operations along the mainline lanes due to the extension of the new southbound I-95 mainline lanes beyond the Route 3 interchange.

Figure 7-7: 2040 Traffic Operations – April 2016 IMR Build Alternative (HCS Analysis)

Southbound I-95 Mainline & Ramp Analysis			2040 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	29.0	64.7	D	74.6	38.3	F
Route 17 Interchange Ramps	I-95 SB Diverge to Route 17 C/D Road	D-4	17.4	59.3	B	38.1	59.2	F
	Route 17 SB C/D Road Diverge to Route 17 NB	D-13	C/D Road Under Capacity			C/D Road Under Capacity		
	I-95 SB Diverge to New C/D Road	D-9	6.2	64.5	A	27.0	58.8	C
	Route 17 Merge to I-95 SB	M-4	13.5	67.0	B	21.2	62.1	C
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	24.0	67.9	C	32.6	62.1	D
Route 3 Interchange Ramps	New C/D Road Slip Ramp Merge to I-95 SB	M-10	22.5	61.4	C	29.1	59.3	D
	Route 3 WB Merge to I-95 SB - Weave	W-4	24.8	54.3	C	34.3	50.0	D
	I-95 SB Diverge to Route 3 EB - Weave							
	Route 3 EB Merge to I-95 SB	M-6	22.6	61.7	C	30.5	56.4	D
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	25.5	67.0	C	39.2	57.3	E
Southbound C/D Road and Ramps	Route 17 Ramp Merge to New C/D Road	M-14	13.3	54.6	B	34.2	48.8	D
	New SB C/D Road across River	CD-2	9.2	65.0	A	34.4	59.2	D
	New SB C/D Road Diverge to Rest Area	D-15	10.5	62.3	B	35.0	62.0	D
	Rest Area Merge to New SB C/D Road	M-15	6.4	61.2	A	29.1	55.6	D
	New SB C/D Road Diverge to SB I-95 (Slip Ramp)	D-16	10.5	62.3	B	34.8	62.0	D



Northbound I-95 Mainline & Ramp Analysis			2040 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	21.0	69.2	C	38.5	57.8	E
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	22.4	62.2	C	31.7	62.6	D
	I-95 NB Diverge to Route 3 WB	D-17	16.7	65.7	B	29.0	64.6	D
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	15.8	70.0	B	28.3	65.2	D
Route 17 Interchange Ramps	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	10.8	60.9	B	15.4	62.6	B
	NEW CD Road Merge to I-95 NB	M-7	20.4	62.4	C	17.2	65.4	B
	Route 17 NB Merge to Existing NB C/D Road	M-2	C/D Road Under Capacity			C/D Road Under Capacity		
	Existing CD Road Merge to I-95 NB	M-3	39.9	41.0	F	34.5	53.0	D
I-95 Mainline	North of Route 17 Interchange	Segment 4	48.9	50.8	F	39.4	57.2	E
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	47.4	50.7	F	18.7	65.0	C
	I-95 NB Diverge to I-95 C/D Roadway	D-11	43.1	60.5	F	23.8	60.8	C
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	31.5	52.2	D	25.0	53.5	C
	Route 17 Ramp East/West Diverge	D-12	33.7	57.8	D	25.1	57.7	C

LEGEND

Existing Conditions
Build Conditions
Express Lanes By Others

NB	SB	
M-#	M-#	Merge Junction
W-#	W-#	Weave Junction
D-#	D-#	Diverge Junction

VDOT

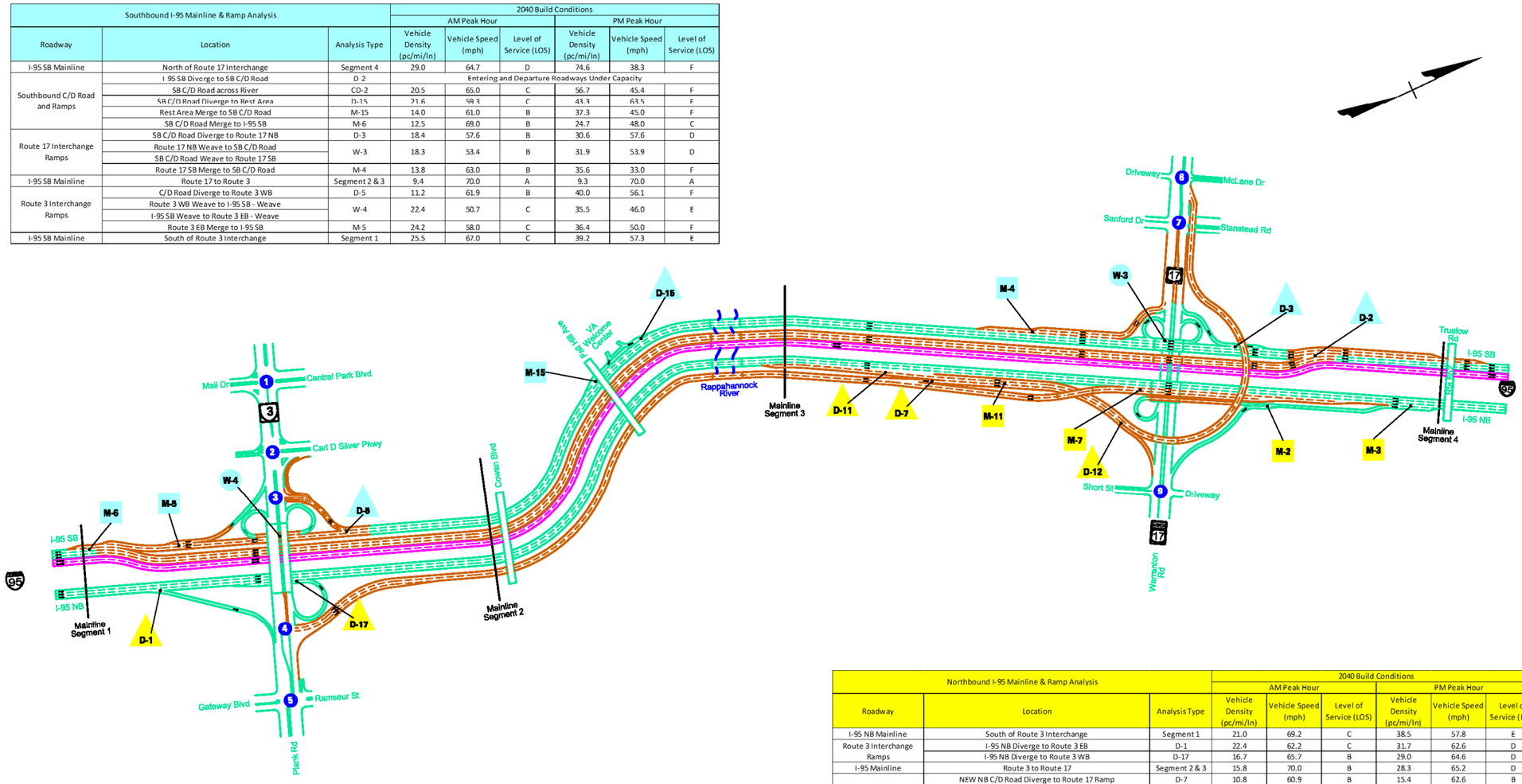
I-95 Rappahannock River Crossing Southbound Interchange Modification Report Supplement

Figure 7-7
Sheet 1 of 1
2040 Traffic Operations (HCS)
April 2016 IMR Build Conditions

Not To Scale

Figure 7-8: 2040 Traffic Operations – Modified Build Alternative (HCS Analysis)

Southbound I-95 Mainline & Ramp Analysis			2040 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	29.0	64.7	D	74.6	38.3	F
Southbound C/D Road and Ramps	I-95 SB Diverge to SB C/D Road	D-2	Entering and Departure Roadways Under Capacity					
	SB C/D Road across River	CD-2	20.5	65.0	C	56.7	45.4	F
	SB C/D Road Diverge to Rest Area	D-15	21.6	59.3	C	43.3	63.5	F
	Rest Area Merge to SB C/D Road	M-15	14.0	61.0	B	37.3	45.0	F
	SB C/D Road Merge to I-95 SB	M-6	12.5	69.0	B	24.7	48.0	C
Route 17 Interchange Ramps	SB C/D Road Diverge to Route 17 NB	D-3	18.4	57.6	B	30.6	57.6	D
	Route 17 NB Weave to SB C/D Road	W-3	18.3	53.4	B	31.9	53.9	D
	SB C/D Road Weave to Route 17 SB							
	Route 17 SB Merge to SB C/D Road	M-4	13.8	63.0	B	35.6	33.0	F
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	9.4	70.0	A	9.3	70.0	A
Route 3 Interchange Ramps	C/D Road Diverge to Route 3 WB	D-5	11.2	61.9	B	40.0	56.1	F
	Route 3 WB Weave to I-95 SB - Weave	W-4	22.4	50.7	C	35.5	46.0	E
	I-95 SB Weave to Route 3 EB - Weave							
	Route 3 EB Merge to I-95 SB	M-5	24.2	58.0	C	36.4	50.0	F
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	25.5	67.0	C	39.2	57.3	E



Northbound I-95 Mainline & Ramp Analysis			2040 Build Conditions					
			AM Peak Hour			PM Peak Hour		
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Level of Service (LOS)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	21.0	69.2	C	38.5	57.8	E
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	22.4	62.2	C	31.7	62.6	D
	I-95 NB Diverge to Route 3 WB	D-17	16.7	65.7	B	29.0	64.6	D
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	15.8	70.0	B	28.3	65.2	D
Route 17 Interchange Ramps	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	10.8	60.9	B	15.4	62.6	B
	NEW CD Road Merge to I-95 NB	M-7	20.4	62.4	C	17.2	65.4	B
	Route 17 NB Merge to Existing NB C/D Road	M-2	C/D Road Under Capacity			C/D Road Under Capacity		
	Existing CD Road Merge to I-95 NB	M-3	39.9	41.0	F	34.5	53.0	D
I-95 Mainline	North of Route 17 Interchange	Segment 4	48.9	50.8	F	39.4	57.2	E
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	47.4	50.7	F	18.7	65.0	C
	I-95 NB Diverge to I-95 C/D Roadway	D-11	43.1	60.5	F	23.8	60.8	C
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	31.5	52.2	D	25.0	53.5	C
	Route 17 Ramp East/West Diverge	D-12	33.7	57.8	D	25.1	57.7	C

LEGEND

Existing Conditions
Build Conditions
Express Lanes By Others

NB	SB	
M-#	M-#	Merge Junction
W-#	W-#	Weave Junction
D-#	D-#	Diverge Junction

I-95 Rappahannock River Crossing Southbound Interchange Modification Report Supplement

Figure 7-8
Sheet 1 of 1
2040 Traffic Operations (HCS)
Modified Build Conditions

Not To Scale

Table 7-6: 2040 Build Conditions CORSIM Analysis – April 2016 IMR Alternative

Northbound I-95 Mainline & Ramp Analysis			2040 Build Conditions			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	17.4	67.7	29.3	66.0
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	16.1	67.3	27.0	65.7
	I-95 NB Diverge to Route 3 WB	D-17	11.8	66.8	20.4	64.2
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	13.1	67.1	23.1	65.5
Route 17 Interchange Ramps	I-95 NB diverge to I-95 C/D Roadway	D-11	12.2	59.8	20.7	60.8
	NEW CD Road merge to I-95 NB	M-7	13.0	64.4	15.3	64.1
	Route 17 WB merge to Exist NB CD Road	M-2	30.4	39.9	12.0	45.3
	Existing CD Road merge to I-95 NB	M-3	30.7	48.3	22.7	61.3
I-95 Mainline	North of Route 17 Interchange	Segment 4	27.8	63.9	26.0	64.2
Northbound CD Road and Ramps	NEW NB CD Road across River	CD-1	34.1	55.4	16.5	56.3
	NEW NB CD Road diverge to Route 17 ramp	D-7	35.9	52.7	17.3	55.1
	NEW NB CD Braided Ramp merge to Rt 17 ramp	M-11	19.8	49.0	12.4	58.6
	Route 17 ramp East/West diverge	D-12	34.8	33.8	13.4	54.2
Southbound I-95 Mainline & Ramp Analysis			**2040 Build Conditions**			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)	Vehicle Density (pc/mi/ln)	Vehicle Speed (mph)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	24.6	58.7	51.3	49.1
Route 17 Interchange Ramps	I-95 SB diverge to Route 17 CD Road	D-4	16.2	65.3	60.2	34.8
	Route 17 SB CD road diverge to Route 17 WB	D-13	13.4	38.6	53.4	13.7
	I-95 SB diverge to NEW CD Road	D-9	11.7	65.7	14.1	62.0
	Route 17 merge to I-95 SB	M-4	13.1	60.6	16.2	58.3
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	18.5	65.9	20.6	65.3
Route 3 Interchange Ramps	NEW CD Road slip ramp merge to I-95 SB	M-10	16.3	59.1	16.7	63.1
	Route 3 WB Merge to I-95 SB - Weave	W-4	16.7	65.7	18.4	65.2
	I-95 SB diverge to Route 3 EB - Weave					
	Route 3 EB merge to I-95 SB	M-6	15.8	64.9	19.6	62.5
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	18.2	66.1	22.2	65.1
Southbound CD Road and Ramps	Route 17 ramp merge to NEW CD Road	M-14	7.7	47.1	25.8	46.6
	NEW SB CD Road across River	CD-2	9.2	58.9	45.5	40.0
	NEW SB CD Road diverge to rest area	D-15	6.8	58.4	43.8	32.1
	Rest Area merge to NEW SB CD Road	M-15	6.7	59.1	59.9	25.4
	NEW SB CD Road diverge to SB I-95 (slip ramp)	D-16	7.9	59.1	107.5	16.8

Congestion Level	Freeways	Weave/Ramp	C-D Road Weave
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28	≤ 32
Moderate Traffic	>26 - 35	>28 - 35	>32 - 36
Heavy Congestion	>35 - 45	>35 - 45	>36 - 45
Severe Congestion	>45	>45	>45

Table 7-7: 2040 Build Conditions CORSIM Analysis – Modified Build Alternative

Northbound I-95 Mainline & Ramp Analysis			2040 Modified Build Conditions			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)
I-95 NB Mainline	South of Route 3 Interchange	Segment 1	17.5	67.7	29.4	65.6
Route 3 Interchange Ramps	I-95 NB Diverge to Route 3 EB	D-1	16.1	67.5	27.0	65.6
	I-95 NB Diverge to Route 3 WB	D-17	11.4	66.0	20.5	64.1
I-95 Mainline	Route 3 to Route 17	Segment 2 & 3	13.0	67.0	23.2	65.2
Route 17 Interchange Ramps	I-95 NB Diverge to I-95 C/D Roadway	D-11	14.6	50.0	23.3	54.2
	NEW CD Road Merge to I-95 NB	M-7	12.4	63.7	15.9	63.4
	Route 17 NB Merge to Existing NB C/D Road	M-2	21.1	43.6	12.4	45.6
	Existing CD Road Merge to I-95 NB	M-3	22.9	56.6	23.3	60.5
I-95 Mainline	North of Route 17 Interchange	Segment 4	24.6	64.5	27.1	63.5
Northbound C/D Road and Ramps	NEW NB C/D Road across River	CD-1	37.8	55.2	20.7	56.4
	NEW NB C/D Road Diverge to Route 17 Ramp	D-7	32.9	53.5	18.5	54.3
	NEW NB C/D Braided Ramp Merge to Route 17 Ramp	M-11	17.0	53.4	13.1	55.8
	Route 17 Ramp East/West Diverge	D-12	18.1	50.3	13.5	54.0
Southbound I-95 Mainline & Ramp Analysis			**2040 Modified Build Conditions**			
			AM Peak Hour		PM Peak Hour	
Roadway	Location	Analysis Type	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)	Vehicle Density [1] (veh/mi/ln)	Vehicle Speed [1] (mph)
I-95 SB Mainline	North of Route 17 Interchange	Segment 4	21.2	67.6	44.6	41.4
Southbound C/D Road and Ramps	I-95 SB Diverge to SB C/D Road	D-2	13.7 - 15.0	62.1 - 65.9	30.3 - 68.5	22.1 - 42.7
	SB C/D Road across River	CD-2	16.4	66.4	35.5	61.4
	SB C/D Road Diverge to Rest Area	D-15	12.3	66.8	24.3	64.1
	Rest Area Merge to SB C/D Road	M-15	14.8	65.7	30.0	61.7
	SB C/D Road Merge to I-95 SB	M-6	10.8 - 14.5	60.8 - 65.2	15.6 - 25.6	45.8 - 59.9
Route 17 Interchange Ramps	SB C/D Road Diverge to Route 17 WB	D-3	10.7	64.1	22.1	56.1
	Route 17 WB Weave to SB C/D Road	W-3	8.8	62.1	19.3	57.7
	SB C/D Road Weave to Route 17 EB					
	Route 17 EB Merge to SB C/D Road	M-4	10.8 – 12.6	59.7 - 66.5	20.7 – 31.7	49.3 - 64.1
I-95 SB Mainline	Route 17 to Route 3	Segment 2 & 3	7.4	68.2	7.5	68.1
Route 3 Interchange Ramps	C/D Road Diverge to Route 3 WB	D-5	17.0	63.5	42.9	47.7
	Route 3 WB Weave to I-95 SB - Weave	W-4	13.2	60.5	19.0	58.3
	I-95 SB Weave to Route 3 EB - Weave					
	Route 3 EB Merge to I-95 SB	M-5	11.9	63.6	19.6	60.7
I-95 SB Mainline	South of Route 3 Interchange	Segment 1	18.4	63.7	25.6	60.8

Congestion Level	Freeways	Weave/Ramp	C-D Road Weave
	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)	Average Density (veh/mi/ln)
Light Traffic	≤ 26	≤ 28	≤ 32
Moderate Traffic	>26 - 35	>28 - 35	>32 - 36
Heavy Congestion	>35 - 45	>35 - 45	>36 - 45
Severe Congestion	>45	>45	>45

[1] Cells with multiple values indicate segments and junctions with multiple analysis segments

7.2.3 Arterial Intersection Operations

Measures of effectiveness (MOEs) from the HCS analysis were used to compare operations at the signalized intersections for 2040 Build conditions for the two alternatives. Overall intersection LOS and delay, average delay by approach and movement, and 50th percentile queue lengths were reported for each intersection. **Table 7-8** depicts overall intersection LOS and delay for the signalized intersections within the study area for the AM and PM peak hours for 2040 Build conditions. **Appendices C-1 and C-2** contain a tabular summary of average delays by approach and movement, 50th percentile queue lengths, and storage lengths.

Table 7-8: Intersection LOS and Delay Summary (2040 Build Conditions)

Intersection		April 2016 IMR Build Alternative				Modified Build Alternative			
		AM Peak		PM Peak		AM Peak		PM Peak	
		LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)	LOS	Delay (sec)
1	Route 3 at Mall Drive/Central Park Boulevard	E	78.7	F	170.8	E	78.7	F	170.8
2 *	Route 3 at Carl D. Silver Parkway	F	83.9	F	225.5	F	83.6	F	198.1
3 *	Route 3 at Ramp from SB I-95 (New Signal with Triple Rights)	C	29.8	F	206.9	C	28.9	F	152.2
4	Route 3 at Ramp to NB I-95 (New Signal with Triple Lefts)	C	33.5	C	21.1	F	285.6	C	26.8
5	Route 3 at Gateway Boulevard	D	38.6	D	54.3	D	38.6	D	54.3
6	Route 17 at McLane Drive	F	216.3	F	143.3	F	216.3	F	143.3
7 *	Route 17 at Sanford Drive	F	91.3	F	272.5	E	62.0	F	111.7
8	Route 17 at Ramp to SB I-95 C-D Road (New Signal)	A	8.8	A	6.8	-	-	-	-
9	Route 17 at Short Street	F	80.2	F	219.5	F	80.2	F	219.5

* Improved LOS and reduced delay with Modified Build Alternative

The following is a summary of signalized intersections when comparing the April 2016 IMR conditions to the Modified Build Conditions for both the AM and PM peak hours:

- **Intersection #1 - Route 3 at Mall Drive / Central Park Boulevard:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #2 - Route 3 at Carl D. Silver Parkway:** Average intersection delays would decrease with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project, which will change lane configurations along Route 3 by providing an additional right-turn lane. During the PM peak hour, average intersections delays are projected to decrease by approximately 27 seconds.

- **Intersection #3 - Route 3 at I-95 SB Off-Ramp (New Signal with Triple Rights):** Average intersection delays would decrease with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project which adds additional through lanes along the westbound Route 3 approach. Average delays would be reduced by approximately 55 seconds in the PM peak hour.

- **Intersection #4 - Route 3 at I-95 NB On-Ramp (New Signal with Triple Lefts):** Average delays at this new signalized intersection would increase with the Modified Build Alternative due to the I-95 Safety Improvements at Route 3 project. The April 2016 IMR depicted the westbound right-turn movement at this intersection as a free-flowing right-turn lane that was not controlled by the traffic signal. The I-95 Safety Improvements at Route 3 operates the westbound right turn under signal control, resulting in increases in overall intersection delay compared to the April 2016 IMR Build conditions.

- **Intersection #5 - Route 3 at Gateway Boulevard:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #6 - Route 17 at McLane Drive:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

- **Intersection #7 - Route 17 at Sanford Drive:** Average intersection delays at this intersection would decrease in the AM and PM peak hour with the Modified Build Alternative due to the revised lane configuration proposed on the eastbound Route 17 approach that would convert the right-turn lane to a shared through/right-turn lane providing an additional eastbound through lane that would serve the downstream ramp to southbound I-95. PM peak hour overall average delays are projected to decrease by approximately 161 seconds. Eastbound through delays are projected to decrease from 223 seconds to 48 seconds and eastbound through queues are projected to decrease from 2,091 feet to 1,013 feet. AM peak hour overall average delays are projected to decrease by approximately 29 seconds.

- **Intersection #8 - Route 17 at Ramp to I-95 SB C-D Road (New Signal):** This intersection is not proposed in the Modified Build Alternative, since it would retain the existing loop ramp from northbound Route 17 to the southbound I-95 C-D road.

- **Intersection #9 - Route 17 at Short Street:** The congestion level at this intersection would remain the same between the 2016 IMR Build Alternative and the Modified Build Alternative due to no intersection changes being proposed for this intersection.

In summary, three of the nine intersections analyzed would have improved operations in 2040 with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. One intersection, Route 3 at the I-95 Northbound On-Ramp, would have degraded operations with the Modified Build Alternative and one intersection, Route 17 at Ramp to I-95 SB C-D Road, would be removed with the Modified Build Alternative.

7.3 TRAFFIC ANALYSIS FINDINGS

The capacity and operational analysis demonstrates that the Modified Build Alternative would reduce overall travel times and increase travel speeds along the southbound I-95 mainline lanes and C-D lanes within the study area limits compared to the April 2016 IMR under both 2020 and 2040 Build conditions based on a review of the CORSIM microsimulation analysis. The Modified Build Alternative would remove all merge, diverge, and weave movements for the Route 3 and Route 17 interchanges from the I-95 southbound mainline lanes and relocate them to the C-D lanes thereby reducing conflict points along the higher speed mainline lanes. Traffic operations along northbound I-95 would be the same with the Modified Build Alternative compared to the April 2016 IMR Build Alternative.

The following are other key operational benefits of the Modified Build Alternative along southbound I-95 compared to the April 2016 Build Alternative in the 2040 design year:

- The April 2016 IMR Build Alternative would have travel speeds along the southbound I-95 C-D road between the Rappahannock River bridge and Route 3 ranging from 13 to 42 MPH with "heavy" to "severe congestion" primarily due to downstream congestion along westbound Route 3 approaching Carl D. Silver Parkway with queues on the new southbound I-95 C-D lanes that extend approximately 2.5 miles from Route 3. With the Modified Build Alternative, "heavy congestion" is predicted for the C-D road between Route 17 and Route 3; however, average travel speeds are predicted to be 58 to 65 MPH. The diverge from the I-95 southbound C-D lanes to westbound Route 3 operates with "heavy congestion" due to the high volume of traffic exiting to westbound Route 3; however, maximum queues approaching Route 3 are approximately 1,175 feet and do not extend to the I-95 southbound C-D lanes diverge to westbound Route 3. The improvements in operations along the southbound I-95 C-D road with the Modified Build Alternative can be attributed to the addition of a third lane on the C-D road that drops to Route 3 and modifications to the scope of the improvements associated with the I-95 Safety Improvements at Route 3 project.

- Similar to the April 2016 Build Alternative, the eastbound Route 17 to I-95 southbound on-ramp would be widened to two lanes; however, the lane configuration on the eastbound Route 17 approach to Sanford Drive would be revised to convert the right-turn lane to a shared through/right-turn lane that would drop at the ramp to southbound I-95. This would provide two continuous eastbound lanes beginning west of Sanford Drive that would serve the on-ramp to southbound I-95. Throughput on the on-ramp from eastbound Route 17 to the southbound I-95 C-D road would increase from 60 percent with the April 2016 IMR Alternative to 80 percent with the Modified Build Alternative. This indicates a substantial increase in the throughput volume along eastbound Route 17 destined for southbound I-95 with the Modified Build Alternative resulting in an improvement in operations along eastbound Route 17.

- The southbound weave at the Route 3 ramps and the on-ramp from eastbound Route 3 to southbound I-95 would operate with "light" traffic conditions with both the April 2016 IMR Alternative and the Modified Build Alternative; however, with the Modified Build Alternative, these junctions would operate along the C-D road and would not impact operations along the mainline lanes due to the extension of the new southbound I-95 mainline lanes beyond the Route 3 interchange.

- Both the April 2016 IMR and Modified Build Alternative would have congestion along southbound I-95 north of Route 17 and approaching the diverge to the southbound I-95 C-D lanes and operate

with similar travel speeds. Congestion on the southbound I-95 mainline lanes approaching the three-lane diverge to the southbound C-D lanes with the Modified Build Alternative is partially caused by the high traffic volumes that must change lanes to access the C-D lanes; however, the Modified Build Alternative would have throughput volumes approximately 233 vehicles greater on the southbound approach to the diverge to the C-D lanes compared to the April 2016 IMR Build Alternative.

- The Modified Build Alternative as currently proposed supports the three AASHTO principles of route continuity, lane balance, and basic number of lanes by maintaining three travel lanes on the mainline I-95 lanes without the need to change lanes. Therefore, dropping the I-95 southbound mainline lanes onto the C-D road to reduce required lane changes was not considered further.

Three of the nine intersections analyzed along Route 17 and Route 3 would have improved operations in 2020 and 2040 with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. One intersection, Route 3 at the I-95 Northbound On-Ramp, would have degraded operations with the Modified Build Alternative and one intersection, Route 17 at Ramp to I-95 SB C-D Road, would be removed with the Modified Build Alternative.

8. SAFETY AND CRASH ANALYSIS

8.1 EXISTING SAFETY CONDITIONS

I-95, Route 3, and Route 17 within the study area are characterized by recurring congestion during peak commuter periods that extends for several hours during the morning and evening peak periods. This congestion creates the potential for crashes, especially rear end and sideswipe crashes.

This section summarizes existing crash data reviewed as part of the April 2016 IMR study efforts. Crash data from the Highway Traffic Roadway Information System (HTRIS) was reviewed within the study area for both 2005 through 2008 and 2010 through 2012 as part of the April 2016 IMR in order to provide a comparison of historic crash trends. During the three-year period from January 1, 2010 through December 31, 2012, a total of 1,180 crashes were reported along the five roadway segments that were analyzed:

- Route 3 - Gateway Boulevard to Carl D. Silver Parkway
- I-95 within the Route 3 interchange area
- I-95 - Route 3 to Route 17
- I-95 within the Route 17 interchange area
- Route 17 - Sanford Drive to Short Street

Table 8-1 summarizes the crashes by collision type and severity. As shown, 358 crashes (31 percent) resulted in personal injuries and six (1 percent) crashes resulted in fatalities. Four of the fatal crashes occurred on I-95 and two occurred on Route 17. 603 (51 percent) of the crashes were rear end collisions which frequently can be contributed to congested and stop-and-go conditions. In addition, there were 15 percent angle crashes, 15 percent fixed object (off road) crashes, and 13 percent sideswipe (same direction) crashes which frequently can be attributed to conflict points (merges, diverges, and weaves) along both interstates and arterials.

Table 8-2 summarizes crashes by time of day. As shown, 10 percent of all crashes occurred between 5:00 and 6:00 PM and 8 percent occurred between 3:00 and 4:00 PM and between 4:00 and 5:00 PM. Along northbound I-95, the highest percentage of crashes occurs from 7:00 AM to 8:00 AM. Thirty nine (39) percent of the crashes along southbound I-95 occur during the four-hour period between 3:00 PM and 7:00 PM. The crash trends along northbound and southbound I-95 correspond to the time periods with the most congestion (i.e., northbound during the AM peak period and southbound during the PM peak period).

Table 8-1: Crash Type and Severity Summary (2010 – 2012)

Crash Type		Number of Crashes				Total Crashes	% of Crashes
		NB I-95	SB I-95	Route 17	Route 3		
Collision Type	Rear End	155	144	102	202	603	51%
	Angle	43	24	32	77	176	15%
	Head On	1	0	0	0	1	<1%
	Sideswipe - Same Direction	42	43	30	36	151	13%
	Sideswipe – Opposite Direction	0	1	1	1	3	<1%
	Fixed Object - In Road	4	2	1	2	9	1%
	Non-Collision	6	12	1	7	26	2%
	Fixed Object - Off Road	65	53	15	40	173	15%
	Deer	10	10	1	1	22	2%
	Pedestrian	0	0	4	2	6	1%
	Motorcyclist	1	0	1	0	2	<1%
	Miscellaneous or Other	2	1	2	3	8	1%
Crash Severity [1]	Pedestrian Fatality	0	0	0	0	0	0%
	Vehicle Occupant Fatality	3	1	2	0	6	1%
	Pedestrian Injury	0	0	4	3	7	1%
	Vehicle Occupant Injury	90	64	50	147	351	30%
	No Injury/Fatality	236	225	134	221	816	69%
Total Crashes by Facility		**329**	**290**	**190**	**371**	**1180**	**-**

[1] Values shown reflect the number of crashes, not number of injuries or fatalities

Table 8-2: Crashes by Time of Day

Hour of Day	Number of Crashes (2010 – 2012)					% of Crashes
	NB I-95	SB I-95	Route 17	Route 3	Total	
12:00 AM	4	12	0	3	19	2%
1:00 AM	5	1	2	7	15	1%
2:00 AM	3	3	0	2	8	1%
3:00 AM	8	9	2	2	21	2%
4:00 AM	11	3	1	5	20	2%
5:00 AM	10	3	3	6	22	2%
6:00 AM	9	5	5	10	29	2%
7:00 AM	34	12	10	21	77	7%
8:00 AM	25	8	11	22	66	6%
9:00 AM	4	4	10	14	32	3%
10:00 AM	12	8	12	13	45	4%
11:00 AM	14	20	7	15	56	5%
12:00 PM	19	13	15	19	66	6%
1:00 PM	8	5	10	23	46	4%
2:00 PM	21	13	10	26	70	6%
3:00 PM	28	22	15	25	90	8%
4:00 PM	24	31	16	29	100	8%
5:00 PM	28	31	17	44	120	10%
6:00 PM	17	30	12	24	83	7%
7:00 PM	11	14	15	20	60	5%
8:00 PM	10	11	4	16	41	3%
9:00 PM	7	11	5	11	34	3%
10:00 PM	10	12	4	7	33	3%
11:00 PM	7	9	4	7	27	2%
Total	**329**	**290**	**190**	**371**	**1180**	**-**

Crash rates per 100 million vehicle miles traveled (VMT) were calculated for each of the five roadway segments (see **Table 8-3**) and compared to VDOT's annually-published statewide averages for the same roadway type (interstates and primary arterials). The VDOT statewide average crash rate (2012) for interstates was 72 crashes per 100 million VMT and the VDOT statewide average crash rate for primary roadways was 108 crashes per 100 million VMT. All five of the segments analyzed have a total crash rate greater than the statewide average interstate or primary crash rate. Crash rates along I-95 are greatest in the vicinity of the Route 3 and Route 17 interchanges. Crash rates along Route 17 and Route 3 are three to five times greater than the statewide average crash rates for primary arterials.

Table 8-3: 2010 – 2012 Crash Rates (per 100 million Vehicle Miles Traveled [VMT])

Roadway Segment	From/To	Segment Length (mi)	Average Annual Crash Total	Crash Rate (100 million VMT)	Statewide Average Rate (100 million VMT)
I-95	Route 3 Interchange	0.7	37	127	72
	Route 3 to Route 17	2.3	93	78	72
	Route 17 Interchange	1.2	47	105	72
Route 17 – Interchange Area	Short Street to McLane Drive	0.91	63	366	108
Route 3 - Interchange Area	Gateway Blvd to Central Park Blvd	1.09	124	517	108

8.2 SAFETY COMPARISON OF BUILD ALTERNATIVES

Both the April 2016 IMR Build Alternative and the Modified Build Alternative include the addition of northbound and southbound C-D roads and bridges across the Rappahannock River, major modifications to the Route 17 interchange, as well as modifications to the Route 3 interchange. Both alternatives add capacity along I-95 between Route 3 and Route 17 in the form of additional travel lanes reducing the potential for congestion-related crashes compared to No Build conditions as documented in the April 2016 IMR. Safety conditions along northbound I-95 are anticipated to be identical between the two alternatives as there are no differences between the two alternatives.

One of the established purposes of the project is to eliminate I-95 weaving movements and conflict points wherever possible. A primary safety benefit of the Modified Build Alternative compared to the April 2016 IMR Build Alternative is the reduction in the number of conflict points and weaving movements along the I-95 southbound mainline lanes. **Table 8-4** summarizes the number of conflict points including on-ramps and off-ramps along the southbound I-95 C-D road and mainline lanes with the April 2016 IMR Build Alternative and the Modified Build Alternative. The conflict points are also depicted graphically in **Figure 8-1**. As shown, there are twelve total conflict points with both the April 2016 IMR Build Alternative and the Modified Build Alternative when summing the conflict points along the southbound I-95 mainline lanes and the C-D lanes; however, the number of conflict points along the mainline lane reduces from seven to two conflict points with the Modified Build Alternative compared to the April 2016 IMR Build Alternative. The number of conflict points along the C-D road increases from five to ten conflict points with the

Modified Build Alternative compared to the April 2016 IMR Build Alternative which can be attributed to the extension of the new southbound I-95 mainline lanes to incorporate all ramps serving both Route 17 and Route 3 along the C-D road. The Modified Build Alternative has the potential to improve safety compared to the April 2016 IMR Build Alternative by reducing conflicts points along the higher speed I-95 southbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions. A reduction in the number of conflict points along the mainline facility rather than the C-D road is preferred because travel speeds are expected to be lower on the C-D road, minimizing the severity of crashes.

Additionally, as noted in **Table 8-3**, crash rates along Route 17 and Route 3 are three to five times greater than the statewide average crash rates for primary arterials. This can be partially attributed to the peak hour congestion along these arterials which contributes to the high frequency of rear end crashes (54 percent of all crashes on Route 17 and Route 3). Specifically, existing congestion and long delays along eastbound Route 17 approaching the I-95 interchange during the PM peak period can be attributed to peak period delays along the existing southbound I-95 mainline lanes. With the Modified Build Alternative, congestion along the southbound I-95 mainline and C-D lanes would be reduced compared to the existing mainline lanes, thereby reducing the potential for crashes along Route 17.

Table 8-4: Comparison of Build Alternative Conflict Points along Southbound I-95

Southbound I-95 Location		April 2016 IMR Build Alternative			Modified Build Alternative		
		SB Mainline Lanes	SB C-D Road	Total	SB Mainline Lanes	SB C-D Road	Total
Route 17 Interchange Area	On-Ramp	1	1	2	-	2	2
	Off-Ramp	2	1	4	1	2	3
Welcome Center	On-Ramp	-	1	1	-	1	1
	Off-Ramp	-	1	1	-	1	1
Route 3 Interchange Area	On-Ramp	3	-	3	1	2	3
	Off-Ramp	1	1	2	-	2	2
Total Conflict Points	**On-Ramp**	**4**	**2**	**6**	**1**	**5**	**6**
	Off-Ramp	**3**	**3**	**6**	**1**	**5**	**6**
	Total	**7**	**5**	**12**	**2**	**10**	**12**

AASHTO's *Highway Safety Manual* (HSM), published in 2010, presents a variety of methods for estimating crash frequency or severity for various facility types including the application of Crash Modification Factors (CMFs). The Crash Modification Factors Clearinghouse is a web-based comprehensive listing of available crash modification factors (CMF) including both those included and not included in the HSM. A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. The review of CMFs in these sources focused on CMFs associated with differences between the April 2016 IMR Build alternative and the Modified Build

alternative. The Crash Modification Factors Clearinghouse and the HSM do not provide a CMF specific to the overall differences between the two alternatives; however, CMF 2475 (Increase freeway on-ramp density from X to Y on-ramps per mile) documents the safety impacts of on-ramp density based on the number of on-ramps per mile and is reflected in the formula below which indicates a reduction in injury and fatal crashes with a decrease in on-ramp density per mile:

$$\mathrm{CMF} = e^{0.0321(Y-X)}$$

Where

CMF = Crash modification factor for injury and fatal crashes
Y = the number of on-ramps per mile before implementation
X = the number of on-ramps per mile after implementation

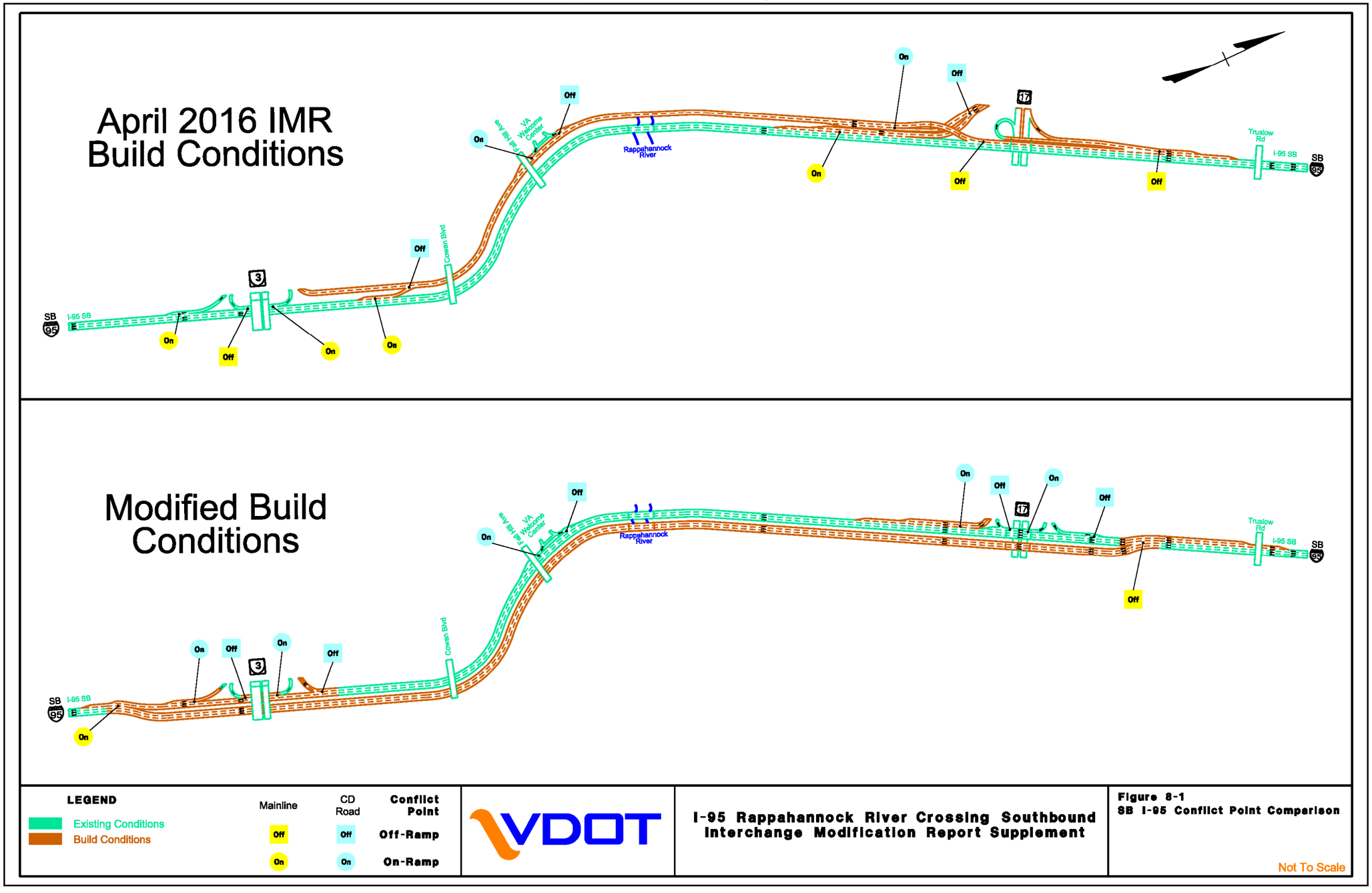
The Modified Build Alternative has only two conflict points along the southbound I-95 mainline lanes including one on-ramp. The Modified Build Alternative reduces the number of on-ramps along the 5-mile section of the southbound I-95 mainline lanes from four on-ramps to one on-ramp (on-ramp density changes from 0.8 ramps per mile to 0.2 ramps per mile), yielding a 2% reduction in injury and fatal crashes along the I-95 southbound mainline lanes.

8.3 SAFETY AND CRASH ANALYSIS FINDINGS

Overall it can be concluded that the Modified Build Alternative should have a positive safety benefit along the I-95 southbound mainline lanes compared to the April 2016 Build Alternative based on a review of conflict points with each alternative. There are twelve total conflict points with both the April 2016 IMR Build Alternative and the Modified Build Alternative when summing the conflict points along the southbound I-95 mainline lanes and the C-D lanes; however, five of the conflict points along the higher speed mainline lanes would be relocated to the lower speed C-D lanes as a result of the extension of the new I-95 southbound mainline lanes to the south beyond the Route 3 interchange and the removal of the braided ramps south of Route 17. The Modified Build Alternative has the potential to improve safety compared to the April 2016 IMR Build Alternative by reducing conflicts points along the higher speed I-95 southbound mainline lanes which are frequently a contributing factor in crashes especially under congested conditions.

CMFs were reviewed to document the relative safety of the Modified Build Alternative compared to the April 2016 IMR Alternative. Application of a CMF for the reduction of on-ramp density results in a 2% reduction in injury and fatal crashes along the I-95 southbound mainline lanes with the Modified Build Alternative.

Figure 8-1: Conflict Point Comparison



9. LAND USE

There is no change to the existing and proposed land uses in the study area from the previously approved IMR.

10. ENVIRONMENTAL COMPLIANCE

Pursuant to the National Environmental Policy Act of 1969, as amended (NEPA), and in accordance with Federal Highway Administration (FHWA) regulations[1], an Environmental Assessment (EA) has been prepared and a Finding of No Significant Impact (FONSI) was issued by the FHWA on November 17, 2015. The EA analyzed and documented the potential social, economic, and environmental effects associated with the proposed transportation improvements and the FONSI concluded that the project would not have significant impacts on the environment. Since approval of the EA and issuance of the FONSI, VDOT has proposed design modifications (analyzed in this IMR). Based on these design modifications, VDOT conducted a Re-evaluation of the EA. The Re-evaluation of the EA is expected to be approved by FHWA in September 2017. The EA and Re-evaluation include information from various technical reviews including those related to historic properties, natural resources, water quality, threatened and endangered species, air quality, noise, etc. The EA and Re-evaluation, identify and further explain the environmental resources that are within the study area and discuss the potential impact that the project would have on those resources.

Permits that are likely needed, as identified through NEPA analysis may include the following: a Section 404 permit from the United States Army Corps of Engineers (USACE), a Virginia Water Protection Permit from the Virginia Department of Environmental Quality (VDEQ), and a subaqueous bottomland permit from Virginia Marine Resources Commission (VMRC). The permit type would be determined during the design phase of the project.

The project will continue to be coordinated with the appropriate federal, state, and local agencies as part of the environmental review and approval processes required throughout project development and construction. All required environmental clearances and permits will be obtained prior to commencement of construction. Strict compliance with all environmental conditions and commitments resulting from regulatory approvals and implementation of VDOT's specifications and standard best management practices will protect the environment during construction.

[1] NEPA and FHWA's regulations for Environmental Impact and Related Procedures can be found at 42 USC § 4332(c), as amended, and 23 CFR § 771, respectively.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