South Carolina Department of Transportation

U.S. Department of Transportation Federal Highway Administration

DRAFT

I-26 at I-95 System Interchange Improvement

# Interstate Modification Report (IMR)

Updated March 2023

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# EXECUTIVE SUMMARY

The South Carolina Department of Transportation (SCDOT) proposes to improve the I-26 at I-95 system interchange in Orangeburg County, South Carolina. The interchange currently experiences congestion issues that are expected to worsen with anticipated traffic growth. This project will be a full interchange improvement to address the operational deficiencies of the current full cloverleaf configuration. Key elements include removal of the four existing weaving sections (two on I-26 and two on I-95), providing directional ramps for key movements, and improving overall operations.

This Interchange Modification Report (IMR) summarizes the traffic operations and safety analyses performed for the proposed interchange alternatives, resulting in Alternative 1 or 2 being equally viable as the preferred Alternative from a traffic analysis perspective. Nevertheless, Alternative 2 was selected as the Preferred Alternative based on other factors including but not limited to environmental impacts, engineering requirements and construction costs.

Discussion of the two key FHWA policy points for modifying access to an existing interstate interchange follows the analysis.

## *Analysis Assumptions, Methodology & Findings*

As part of this review, multiple assumptions and analysis step were required as documented in this report. Three of the critical analysis steps were a crash analysis of the study area and key interchange, the development of traffic forecasts for 2030 and 2050, and the capacity analysis to compare alternatives and identify key design requirements.

### Crash and Safety Analysis

A crash analysis of the study area is summarized in Chapter 3. Key findings include:

- The total crash rate and the injury crash rate on both I-26 and I-95 are below the statewide average for similar rural interstate facilities.
- On I-26, however, it was noted that both the serious injury and fatal crash rate exceed the statewide average crash rates.
- The crash patterns at the existing I-26 at I-95 interchange were examined and five high frequency crash locations were identified including the southbound I-95 major merge and each of the four existing weaves formed by the four existing loop ramps.

### Traffic Forecast

Traffic forecasts were developed for the project based on multiple sources of data and analysis steps. Baseline traffic data were analyzed, and growth factors were applied to identify 2030 and 2050 traffic volumes for I-26, I-95 and study area interchanges. Some key elements of the analysis included:

- In determining the K-factors for I-26 and I-95, a review of the highest hourly volume data was conducted, focused on identifying the "knee of the curve."
  - On I-26, a K-factor of 10.5 percent was selected reflecting the 78th Highest Hourly Volume (HHV).
  - On I-95, a K-factor of 10.5 percent was also selected reflecting the 98th HHV on I-95 (although the I-95 HHV is likely closer to the 150th HHV if all holiday data for 2019 were available).
- This forecast has been developed assuming a single mid-day peak period (approximately 3 PM to 4 PM) with peak flows in both directions on I-95 and I-26.
- Although there is variation in actual counts, the design period reasonably approximates a typical Friday afternoon in the spring for both I-26 and I-95.

The estimated peak hour volumes developed for this study are presented in Figure 4.2 (2022 Base Year), Figure 4.3 (2030), and Figure 4.4 (2050). The details of the traffic forecasting assumptions and methodologies is detailed in the Appendix D Traffic Forecast Technical Memorandum.

### Initial Capacity Analysis & Comparison of Alternatives

A series of capacity analyses were conducted using multiple software and methods for 2030 and 2050 No Build and three Build alternatives. This analysis was conducted and summarized in Chapters 5, 6 and 7. Key assumptions and findings include:

- Through discussions with SCDOT it was agreed that LOS D will be viewed as an acceptable minimum level of service (LOS) for the 2050 design period.
- The initial Highway Capacity Software (Section 6.2) and TransModeler (Section 6.3) corridor analysis was conducted to identify key constraints or updates that would be needed for the three initially proposed concepts.
- A more detailed comparison of interchange alternatives was conducted and documented in Chapter 7 using TransModeler. This analysis included an assumed widening of I-95 to the south to identify the demand requirements of the interchange ramps and key merge and diverge points.
- Additional analysis was conducted of the key merge constraints for I-26 westbound and I-95 southbound as summarized in Chapter 8. This analysis included a year of failure analysis and identified suggested interim merge lengths.

### Capacity Constraints on I-95 Southbound and I-26 Westbound Two-Lane Merges

Another key issue examined was operations on the I-95 southbound merge as well as the westbound I-26 merge as analyzed in Chapter 8. In both cases, a two-lane ramp must merge with the interstate. The 2050 TransModeler analysis shows LOS F in the 2050 design year with queuing on both the interstate and merging ramps.

On I-95 south of I-26, simulation analyses showed queues extending back into the I-26 at I-95 interchange on I-95 southbound. The queues observed in the simulation model originate at the merge of the proposed two-lane Ramp 1 (which serves I-26 eastbound to I-95 southbound traffic) with I-95 southbound. This queue will back onto I-26 eastbound during peak 2050 conditions as shown in Figure 9.4.

An analysis was conducted of potential alternate merge treatments to reduce queuing at this merge (see Section 8.3) until the I-95 mainline can be widened south of I-26. The key findings at the I-95 southbound merge include:

- A 5,000-foot southbound merge onto I-95 (2 + 2 lanes = 4 lanes) is recommended to minimize queuing back into the proposed interchange. The merge would be evenly divided into two 2,500-foot merges for each merge lane. This recommendation is despite the observation that there is queuing on I-95 southbound and the merging ramp in 2050 with LOS F operations. This merge treatment recommendation is examined in Chapter 8. The proposed length was based on observations from TransModeler analysis and guidance from the Institute of Transportation Engineers (ITE) *Freeway and Interchange Geometric Design Handbook* discussed in Section 8.3.2.
- A similar merge issue was noted on I-26 westbound where the two-lane flyover Ramp 6 (which replaces loop Ramp 6) merges onto I-26 westbound. In this case, however, I-26 has three lanes westbound which helps disperse the traffic at the merge. Regardless, a series of model runs were indicated that a 4,000-foot westbound merge of the two-lane ramp would be needed to minimize potential queuing back into the interchange area in 2050.
- This analysis was done assuming that all ramp traffic from I-95 northbound would be accommodated by flyover Ramp 6. To do this, the TransModeler network assumed an additional I-95 northbound lane. Since an additional lane on I-95 is not planned, the traffic demand may be metered during the highest periods of congestion, reducing the ramp movement and subsequent merge movement that was analyzed to determine the 4,000-foot merge length.

Note that the I-26 westbound merge is less critical than the I-95 southbound merge despite a freeway volume that is 10 percent lower on I-95 than I-26. The key reason is that the lower volume is more than offset by a 50 percent increase in capacity for a three lane I-26 freeway segment compared with a two-lane I-95 freeway segment.

## Comparison of Build Alternatives & Selection of Preferred Alternative

Based on the Chapter 6 comparison of alternatives, the following observations were made:

- All three alternatives operate substantially better than the existing interchange under 2030 and 2050 conditions.
  - The primary improvement is the removal of four weave segments impacting I-95 and I-26 in both directions. In addition to capacity constraints, the elimination of weave segments will also provide safety benefits since the four weave segments are currently the $2^{nd}$ – $5^{th}$ highest frequency crash segments in the study area.
  - The other key improvement is the provision of two lanes on the I-26 eastbound to I-95 southbound ramp (Ramp 1 in the report) and the I-95 northbound to I-26 westbound flyover (Ramp 6) replacing the loop in the northeast quadrant.
- Alternatives 1 and 2 effectively operate the same from traffic operations perspective. Both can successfully meet LOS D or better operations in 2050. There is a slight difference in travel times, but this is related to the longer length on the flyovers in Alternative 2(albeit partially offset by a higher design speed). Nevertheless, from a traffic engineering perspective, there is no key difference.
- Alternative 3 does not meet the LOS D operational goal of the entire interchange through 2030 or 2050. Specifically, the third flyover requires incorporation of a fifth shared ramp segment combining two ramps from I-26 westbound. As currently designed, this single lane shared ramp segment does not provide LOS D operations.
- The preferred alternative from a traffic perspective is either Alternative 1 or 2. After additional analysis related to the environmental impacts, design requirements, and construction costs, Alternative 2 was selected as the Preferred Alternative.  For this traffic analysis, however, Alternative 1 and 2 traffic analysis are effectively the same.

## Analysis of Preferred Alternative & Two-Lane-lane Merge Operations

Based upon this analysis, a refined TransModeler analysis was conducted of the No Build and Preferred Alternative in 2030 and 2050. This analysis is detailed in Chapter 8. The key conclusions were:

- The LOS findings are illustrated in Figure 9.1 through Figure 9.4 for both the No Build and preferred alternative scenarios. These illustrations use color coding to illustrate levels of congestion based on density/LOS thresholds.
- The preferred alternative would include a 5,000-foot merge on I-95 southbound mainline merge with the two-lane ramp from I-26 eastbound. Although this

treatment still operates at LOS F in 2050, it improves operations and minimizes queuing as compared with a shorter merge and is supported for application of ITE guidance for two-lane merges. Although this treatment still operates at LOS F in 2050, it improves operations and minimizes queuing compared to a shorter merge and is supported by ITE guidance for two-lane merges.

- The preferred alternative will also include a 4,000-foot merge on I-26 westbound with the merge of the proposed I-95 northbound to I-26 westbound flyover. This merge is anticipated to operate at LOS F in 2050. Nevertheless, the provision of a 4,000-foot merge is sufficient to prevent queuing back onto the proposed flyover ramp.

Using these assumptions for the preferred alternative, the Alternative 2 model was updated to reflect the final preferred alternative for analysis in TransModeler and comparison with No Build operations. Key observations from this comparison are summarized in Chapter 8.

## ***Interchange Modification Report Requirements***

This IMR is required by FHWA for modifications or changes to existing interchanges on the interstate network. In addition to the capacity analysis, the IMR requires some additional elements be provided in reviewing the document for approval. These elements include:

- Design exceptions are typically identified as part of the IMR. For this project, however, there are no anticipated design exceptions.
- Analysis confirms that all Build Alternatives considered improve operations as compared with the No Build. Key improvements include widening of two key ramps, elimination of four weave sections impacting I-26 and I-95 in all four directions, and improvement of major merge, particularly on I-95 south of the interchange and I-26 west of the interchange.
- There are some operational exceptions, however, to the identified congestion threshold of minimum acceptable LOS D operations in 2050. Detailed analysis of the two-lane merges is included in Section 8.3.2 and addressed as part of this summary. Specifically:
  - The existing four-lane segment of I-95 south of I-26 is expected to exceed capacity and operate at LOS F in the 2050 design year. No widening or capacity improvements are currently identified for the I-95 corridor in SCDOT's 2021-2027 Statewide Transportation Improvement Program. Improvement of the I-95 mainline is beyond the scope of the current I-26 at I-95 interchange improvements.

- The proposed 5,000-foot southbound merge of I-95 and the two-lane ramp from I-26 eastbound will operate at LOS F in 2050. Queuing will extend onto the ramp and I-95 southbound approaches to the merge.
- The proposed 4,000-foot westbound merge of I-26 and the proposed two-lane flyover from I-95 northbound will operate at LOS F in 2050 (even with the assumed widening of I-26 to six lanes in the No Build). Queuing is expected in the merging section but is not anticipated to back up onto the flyover ramp in 2050.
- Additional traffic analysis was conducted to examine operations in five-year increments between 2030 and 2050 for the two high volume merges. This analysis is included in Section 9.2.5.

## *FHWA Policy Points*

FHWA policy requires that all requests for new or revised access to an interstate facility must provide sufficient supporting information to allow FHWA to independently evaluate the request. The FHWA decision to approve a request requires documentation of two key policy points as included in the following table.

| ***Policy Point 1 – Operations & Safety"*** |
| --- |
| ***"An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections."*** <br><br> The proposed modifications to the existing I-26 at I-95 interchange will have a positive impact on both traffic safety and the operations of I-26, I-95 and the I-26 at I-95 interchange overall. Key improvements in the preferred alternative include: <br><br> ***Widening of Key Ramps*** <br> The two highest volume movements within the interchange are between I-26 to the west toward Columbia and I-95 to the south toward Georgia with approximately 4,400 vph (both directions combined) in the 2050 peak period. This movement is currently served by a single lane ramp in the eastbound to southbound direction and a single lane loop ramp in the returning direction. The preferred alternative replaces the existing ramps with a two-lane ramp in the eastbound to southbound direction and a two-lane flyover for northbound to westbound traffic. In addition, the diverge and merge areas for these widened ramps are converted to two lanes at each of the ramp tie-ins to I-26 and I-95. These changes improve traffic operations to an acceptable LOS D from LOS F and improve traffic flow (particularly related to elimination of the existing loop in the northeast quadrant). |

***Elimination of Weaves on I-26 and I-95***

The current interchange configuration is a full cloverleaf with loops in all four quadrants. This type of interchange allows for free flow for all movements in the interstate-to-interstate system interchange. By 2050, however, the weave areas between loop ramps will degrade, resulting in queuing and delays on the freeway segments. The issue affects each of the weave areas in the main interchange, in particular the weave along I-95 northbound which operates at LOS F in 2030. The four weave areas were identified in the crash analysis as having a high frequency of crashes. The elimination of the four weaves is expected to improve operations and safety for both ramp traffic and through vehicles on I-26 and I-95.

***Improvement of Major Merge Areas***

Two major weave areas are proposed to be widening from a single lane merge to dual lane merges on I-26 westbound and I-95 southbound. The capacity improvements are key to improving flow in the future, but it is still anticipated that there will be queuing and operational issues by 2050, particularly for the I-95 southbound merge. In addition to the 2030 and 2050 analysis, interim year operations were examined in 5-year increments. The primary reason for the operational issues at the merge is the future need to widen I-95 south of I-26.

To minimize the future impact of these flow issues, the merge areas have been lengthened in accordance with recommendations from the ITE *Freeway and Interchange Geometric Design Handbook* as discussed in Section 8.3.2. Even with these caveats, the proposed ramp improvements substantially improve traffic operations as compared with the No Build interchange.

Safety is improved at the major merge areas being improved. The I-95 southbound merge is the highest frequency crash location in the study area as shown in Table 3.10 primarily due to rear end crashes likely resulting from queues at the merge congestion point onto I-95. The location of the I-26 westbound merge improvements is also identified as a crash hot spot in Figure 3.2.

***Other Safety Recommendations***

As part of the safety analysis in Chapter 3, three safety recommendations were identified. These included elimination of the weave areas as well as improvements at high volume merge areas (especially at the I-95 southbound merge due to capacity constraints on I-95) that are noted above.

In addition, the analysis of fatal crashes indicated that approximately 70 percent of fatal crashes on I-26 in the study area ultimately involved a vehicle striking a tree off the edge of the road. To minimize this, the proposed design should consider the elimination of trees in the clear zones on both the outer and inner (i.e., the median) sides of I-26 in both directions.

**Policy Point 1(continued) – Adjacent Interchanges**

***"The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f))."***

The study area and network limits examined in this analysis include four adjacent interchanges on each approach to the system interchange. Despite the interchange being located in a rural area, the adjacent interchanges were included in recognition of the key regional importance and high volumes along both I-26 and I-95. Each of these interchanges are spaced more than two miles from the system interchange, as noted below. The four interchanges are detailed in Section 1.3.3 and include:

- I-95 at U.S. 176 Old State Road (Exit 90): 4 miles to the north
- I-95 U.S. 178 Charleston Highway (Exit 82): 2.9 miles to the south
- I-26 at S.C. 210 Vance Road (Exit 165): 3.2 miles to the west
- I-26 at U.S. 15 (Exit 172): 2.4 miles to the east

The HCS analysis in Section 6.2 included freeway operations analysis for each of the four interchanges. As part of the traffic forecasting, however, all four interchanges were identified as serving relatively low volume facilities (maximum 2021 AADT of 3,000 vpd was noted) and low historical and forecasted annual growth rates.

Based on the analysis, it was concluded that the adjacent interchanges are not adversely impacted by the proposed improvements at the I-26 at I-95 interchange. Key observations included:

- The freeway operations analysis indicated that ramp operations were not critical in either 2030 or 2050.
- It was noted that I-95 requires future widening south of I-26 (LOS F in 2050) which would address any merge or diverge improvement needs. Similarly, some LOS E operations were noted on I-26 west of I-95 in 2050 even with a six-lane segment. To address potential modeling issues associated with downstream bottlenecks impacting flows into the key interchange with the TransModeler network, theoretical widening assumptions were applied as detailed in Chapter 8.

Since the operations at the four interchanges do not require future capacity improvements and are spaced more than two miles on all approaches to the I-26 at I-95 interchange, the specific operations are not critical to this IMR. All four adjacent interchanges were included in the TransModeler simulation models to provide proper flow patterns into the interchange.

***Policy Point 1(continued) – Crossroads& Local Street Network***

***"The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d))."***

The local road network at each of the four adjacent interchanges was examined as part of the traffic forecasting process discussed in Chapter 4 and detailed in Appendix D. Key observations included:

- All four interchanges have low AADT volumes based on 2021 AADT data (3,000 vpd or less).
- Growth rates are low at the three diamond interchanges (SC 210, U.S. 176 and U.S. 178) which is reflected by the historical trends noted in both historical AADT volumes and land use patterns for Orangeburg County. In addition, at each of the three diamond interchanges, no traffic signals are currently in place and are not anticipated in the future based on the anticipated traffic growth rates and volumes.
- For the existing full cloverleaf interchange at U.S. 15, a higher growth rate was noted. Nevertheless, the increase in volumes was minimal due to the low existing volumes. The HCS freeway operations capacity analysis confirmed the adequacy of the weaves (LOS C in 2050) on I-26.

Based on these observations, a formal capacity analysis of the local road network and intersection operations was not conducted since it would not impact traffic flows or design requirements at the I-26 at I-95 interchange. The adjacent interchanges were included in the TransModeler network, however, to better reflect flows loading into the study interchange.

| Policy Point 1 (continued) – Conceptual Signing Plan |
|---|
| ***"Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d))."*** <br><br> A conceptual signing plan is provided for the proposed interchange layout and is attached in Appendix S. The conceptual plan focuses on guide signs on the approaches to the interchange as well as guide signs at various ramp exits and splits. |

| Policy Point 2 – Provision of All Movements & Public Road Access |
|---|
| ***"The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design."*** <br><br> The I-26 at I-95 interchange is a system interchange with all movements allowed in a full cloverleaf configuration. The preferred alternative (Alternative 2) maintains and improves all movements including the provision of flyover ramps to replace some loop ramps. All new ramps (including two loops) will be reconstructed and will meet or exceed current design standards. Each of these movements are between I-26 and I-95, which are both public roads serving key national, regional, state and local network connections. |

# 1. INTRODUCTION

## 1.1 Project Background

The South Carolina Department of Transportation (SCDOT) proposes to improve the I-26 at I-95 system interchange in Orangeburg County, South Carolina. The purpose of this project is to improve mobility and operations at the system interchange of I-26 and I-95. The need for the improvements stems from operational issues including weaving movements from on and off loop ramps resulting in rear-end and sideswipe crashes and travel delays due to weaving and merging. Alternative interchange designs were analyzed at the I-26 at I-95 system interchange to mitigate the effects of future traffic projections, in conjunction with analysis of the I-26 and I-95 mainlines.

## 1.2 Study Area

The study area for this widening project is shown in **Figure 1.1**. The study area is focused on the I-26 at I-95 system interchange and four adjacent interchanges including:

- U.S. 176 (Old State Road) at I-95 to the north
- U.S. 178 (Charleston Highway) at I-95 to the south
- S.C. 210 (Vance Road) at I-26 to the west
- U.S. 15 at I-26 to the east

## 1.3 Existing Roadway Conditions

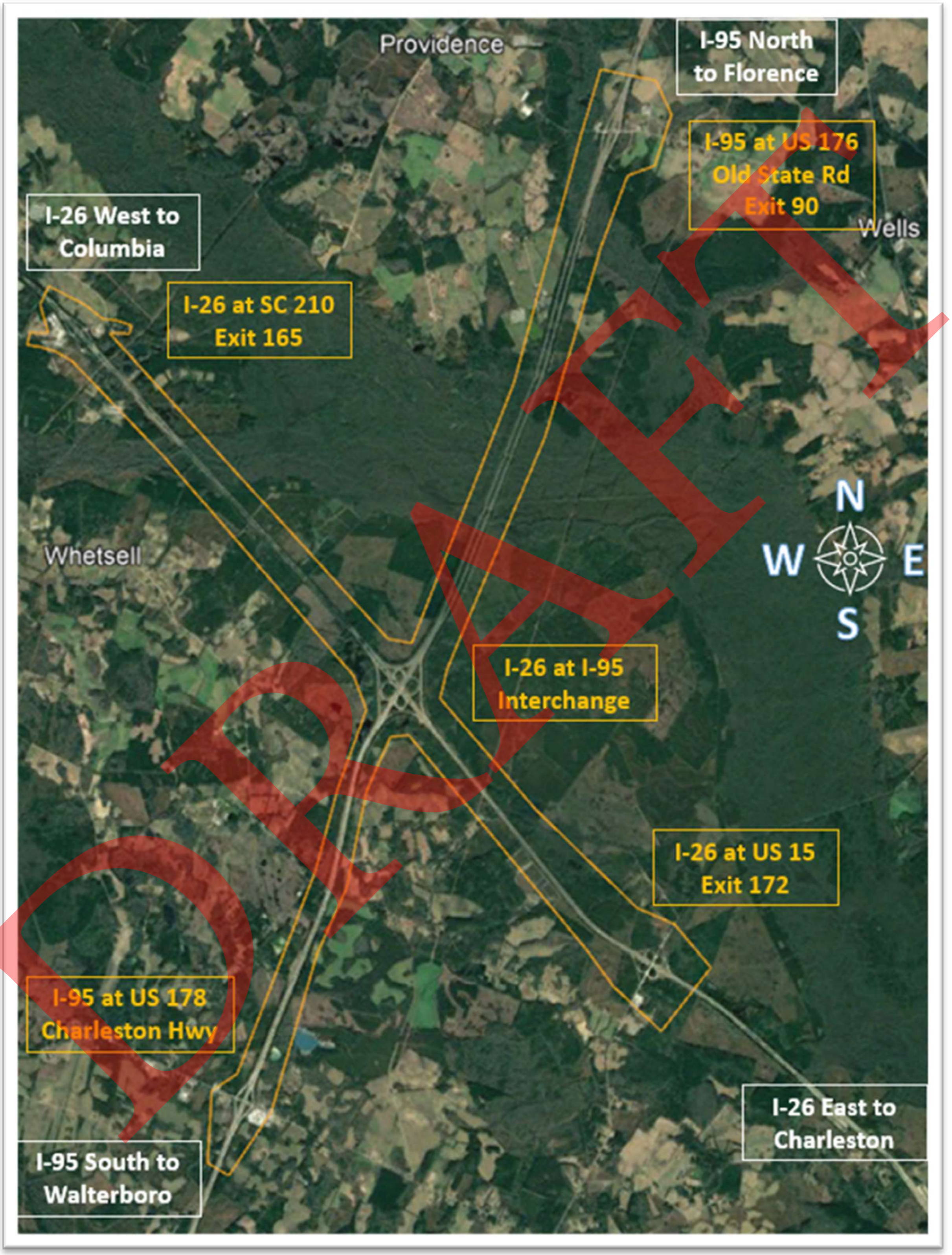
### 1.3.1 Study Corridors

***I-95***

I-95 is a north-south interstate on the east coast that extends from the United States – Canada border in the north to Miami, Florida in the south. In the study area, I-95 is a rural interstate with a speed limit of 70 mph that provides connectivity for local traffic, regional and freight traffic in South Carolina, and interstate traffic along the east coast. In South Carolina, I-95 links Florence in the north to Savannah, Georgia in the south in addition to providing access to multiple municipalities. The following interchanges are present within the study area limits on I-95:

- U.S. 176 Old State Road (Exit 90)
- I-26 (Exit 86)
- U.S. 178 Charleston Highway (Exit 82)

## Figure 1.1: Study Area Location Map




*Source: Google Earth Pro Image, 03/2022, Project Study Area*

## *I-26*

I-26 is an east-west interstate that extends southeast from I-81 in Kingsport, Tennessee to Charleston, South Carolina. In the study area, I-26 is a four-lane divided rural interstate with a speed limit of 70 mph that provides connectivity for local traffic, regional and freight traffic in South Carolina, and interstate traffic. In South Carolina, I-26 links three major municipalities: Spartanburg in the Upstate, Columbia in the Midlands, and Charleston in the coastal area of the Lowcountry. The following interchanges are present within the study area limits on I-26:

- S.C. 210 Vance Road (Exit 165)
- I-95 (Exit 169)
- U.S. 15 (Exit 172)

## *U.S. 176 Old State Road*

Classified as a rural minor arterial with a speed limit of 45 mph, U.S. 176 is located on I-95 northeast of the I-26 at I-95 System interchange. Within the project area U.S. 176 is a two-lane undivided roadway. The I-95 at U.S. 176 interchange is an unsignalized diamond interchange. At the I-26 northbound ramps at U.S. 176 intersection, traffic is controlled by a stop sign on the I-95 northbound ramp while the east and west approaches remain free. At the I-95 southbound ramps at U.S. 176 intersection, traffic is controlled by a stop sign on the I-95 southbound ramp while the east and west approaches remain free. The 2021 AADT is 3,000 vpd west of I-95 and 2,500 vpd east of I-95.

## *U.S. 178 Charleston Highway*

Classified as a rural minor arterial with a speed limit of 45 mph, U.S. 178 intersects with I-95 southwest of the I-26 at I-95 System interchange. Within the project area U.S. 176 is a two-lane undivided roadway. The I-95 at U.S. 176 interchange is an unsignalized diamond interchange. At the I-95 northbound ramps at U.S. 178 intersection, traffic is controlled by a stop sign on the I-95 northbound ramp while the east and west approaches remain free. At the I-95 southbound ramps at U.S. 178 intersection, traffic is controlled by a stop sign on the I-95 southbound ramp while the east and west approaches remain free. The 2021 AADT is 2,500 vpd east of I-95.

## *S.C. 210 Vance Road*

Classified as a rural major arterial with a speed limit of 45 mph, S.C. 210 intersects with I-26 northwest of the I-26 at I-95 System interchange. Within the project area S.C. 210 is a two-lane undivided roadway. The I-26 at SC 210 interchange is an unsignalized diamond interchange. At the I-26 eastbound ramps at S.C. 210 intersection, traffic is controlled by a stop sign on the I-26 eastbound ramp while the north and south approaches remain free. At the I-26 westbound ramps at S.C. 210 intersection, traffic is controlled by a stop sign at each approach. The 2021 AADT is 1,200 vpd north of I-26.

***U.S. 15***

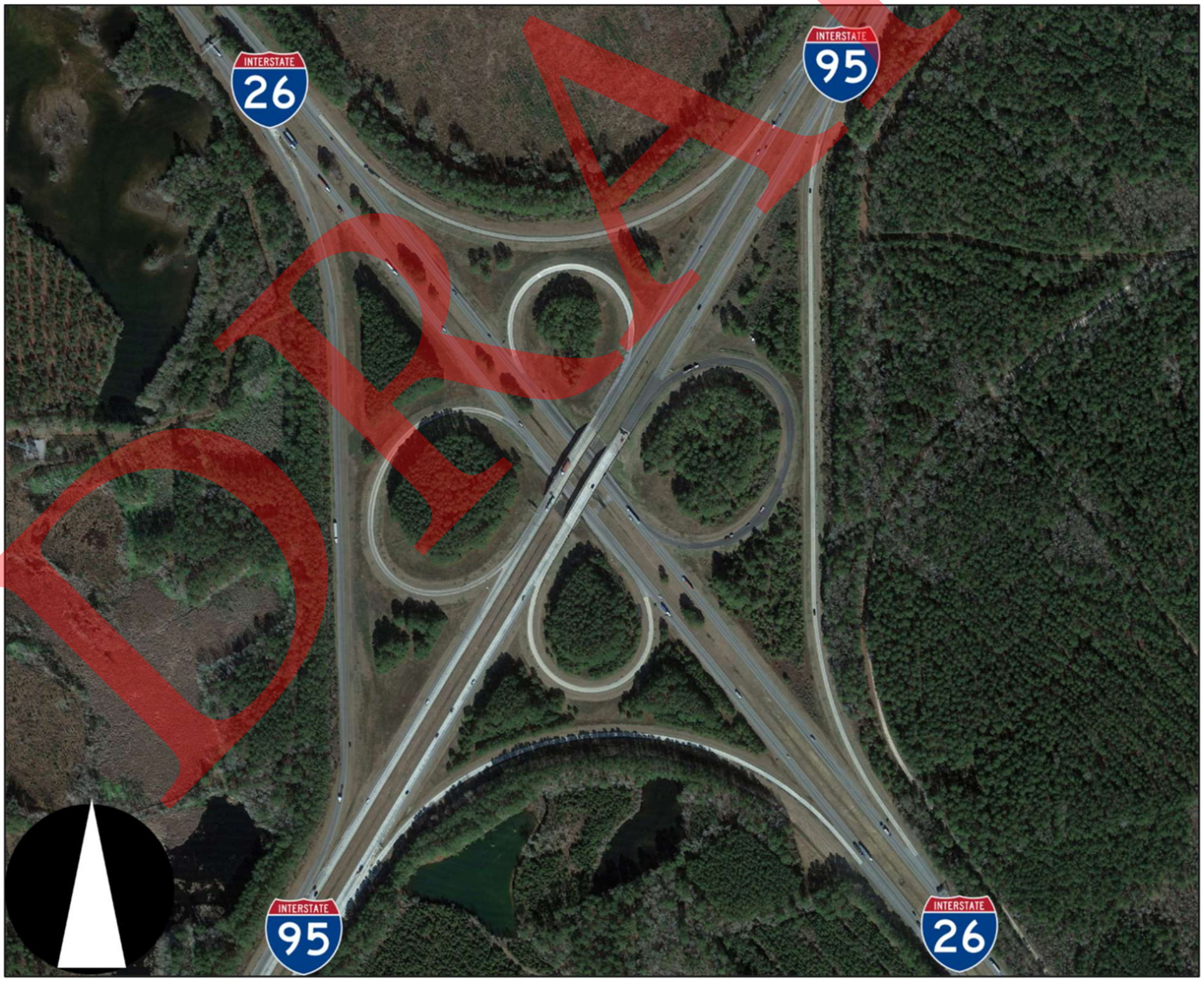
Classified as a rural major arterial with a speed limit of 45 mph, U.S. 15 intersects with I-26 southeast of the I-26 at I-95 System interchange. Within the project area U.S. 15 is a four-lane divided roadway. The I-26 at U.S. 15 interchange is a full cloverleaf interchange with weaves on I-26 and U.S. 15. At the I-26 eastbound and westbound on and off-ramps, movements are free-flow controlled by merging and diverging maneuvers. The 2021 AADT is 2,400 vpd north of I-26.

## 1.3.2 Study Interchange

***I-26 at I-95 System interchange***

The I-26 at I-95 System interchange is a full access cloverleaf interchange where the I-26 mainline runs under the I-95 bridge. No collector-distributor roadway is provided along either I-26 or I-95. Instead, all merges, diverges and weaves occur along the mainline lanes. This interchange will be modified and is the focal point of this analysis. The existing I-26 at I-95 System interchange is shown in **Figure 1.2**.

**Figure 1.2: I-26 at I-95 System interchange**

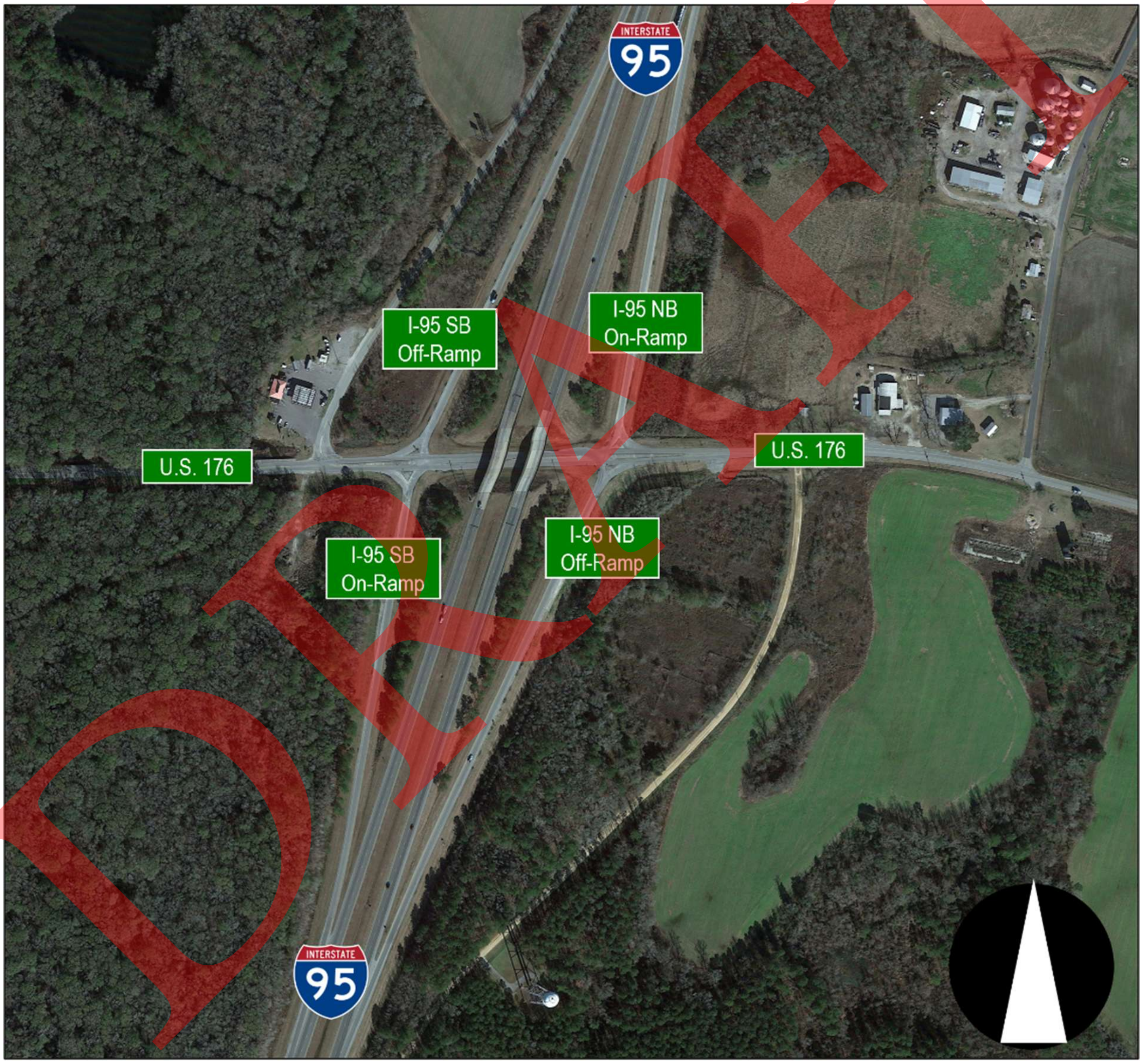


## 1.3.3 Adjacent Interchanges

***U.S. 176 Old State Road to the north***

Located 4 miles north of the system interchange, the U.S. 176 interchange is a diamond interchange where the arterial runs under the I-95 bridge. Each I-95 ramp intersection is unsignalized. While this interchange is not expected to be modified, it is included in this analysis as it is adjacent to the I-26 at I-95 system interchange. The U.S. 176 interchange is shown in **Figure 1.3**.

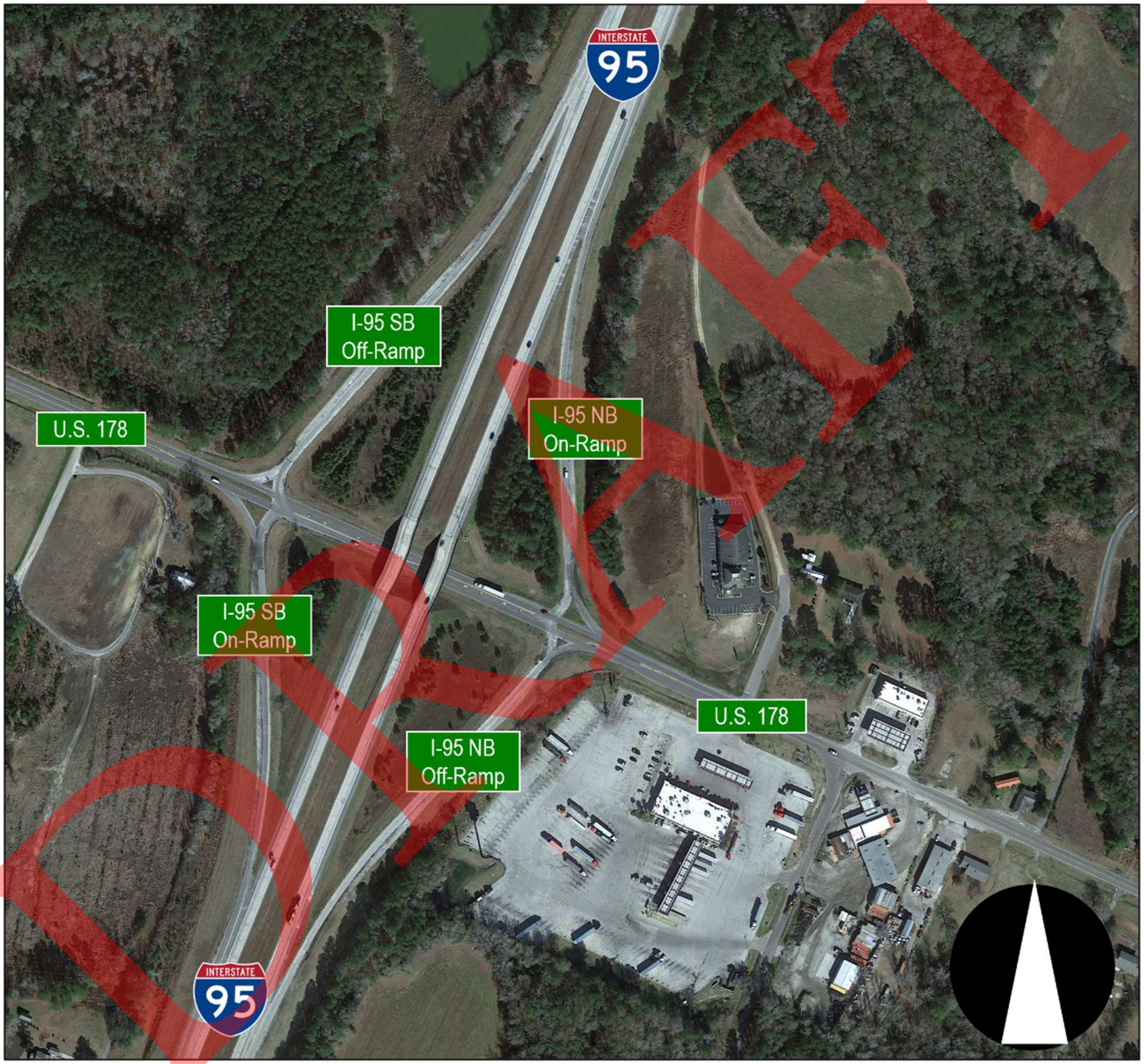
**Figure 1.3: U.S. 176 Interchange**



## U.S. 178 Charleston Highway to the south

Located 2.9 miles south of the system interchange, the U.S. 178 interchange is a diamond interchange where the arterial runs under the I-95 bridge. Each I-95 ramp intersection is unsignalized. While this interchange is not expected to be modified, it is included in this analysis as it is adjacent to the I-26 at I-95 System interchange. The U.S. 178 interchange is shown in **Figure 1.4**.

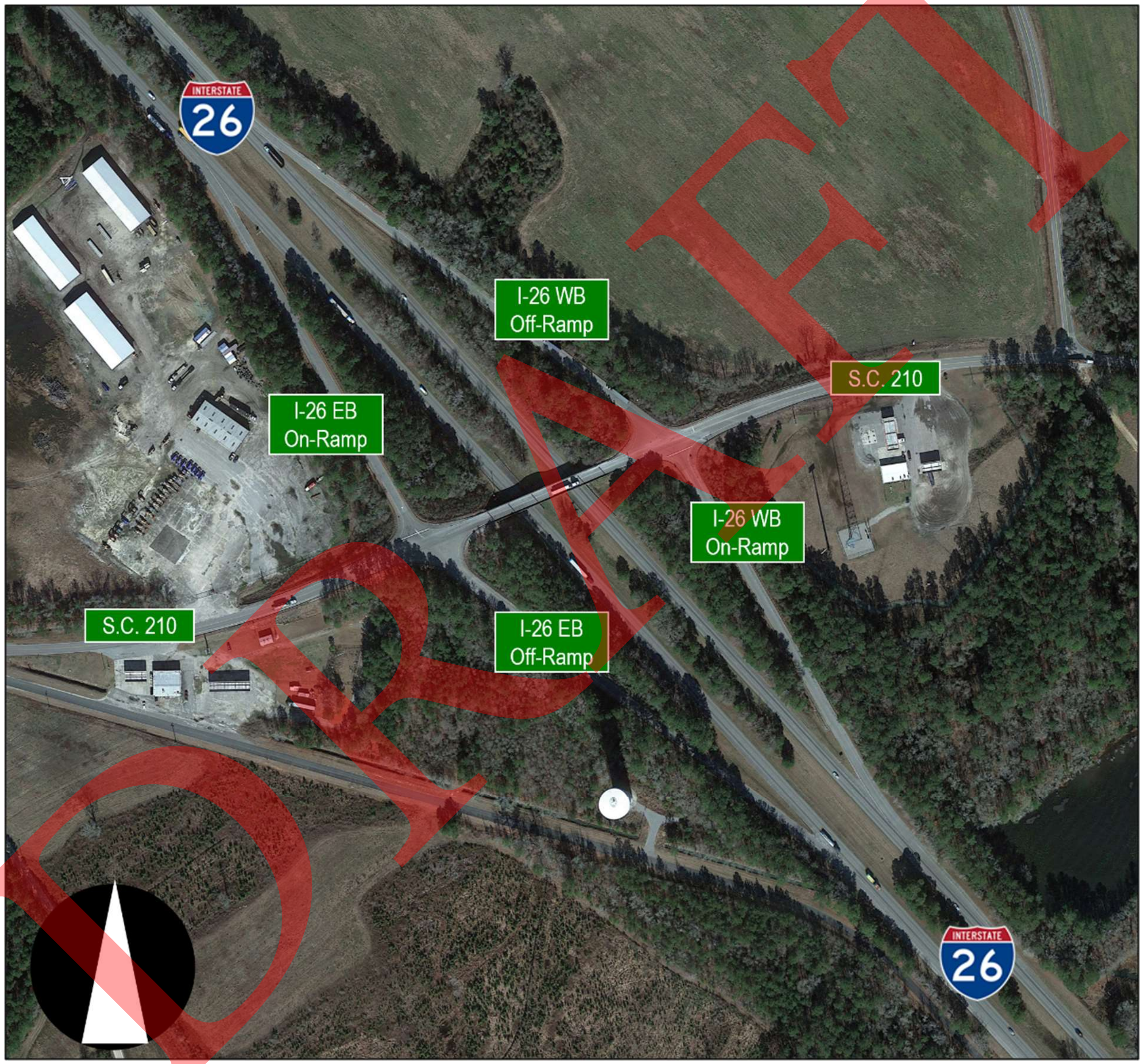
### Figure 1.4: U.S. 178 Interchange



## S.C. 210 Vance Road to the west

Located 3.2 miles west of the system interchange, the S.C. 210 interchange is a diamond interchange with a bridge over I-26. Each I-26 ramp intersection is unsignalized. While this interchange is not expected to be modified, it is included in this analysis as it is adjacent to the I-26 at I-95 System interchange. The S.C. 210 interchange is shown in **Figure 1.5.**

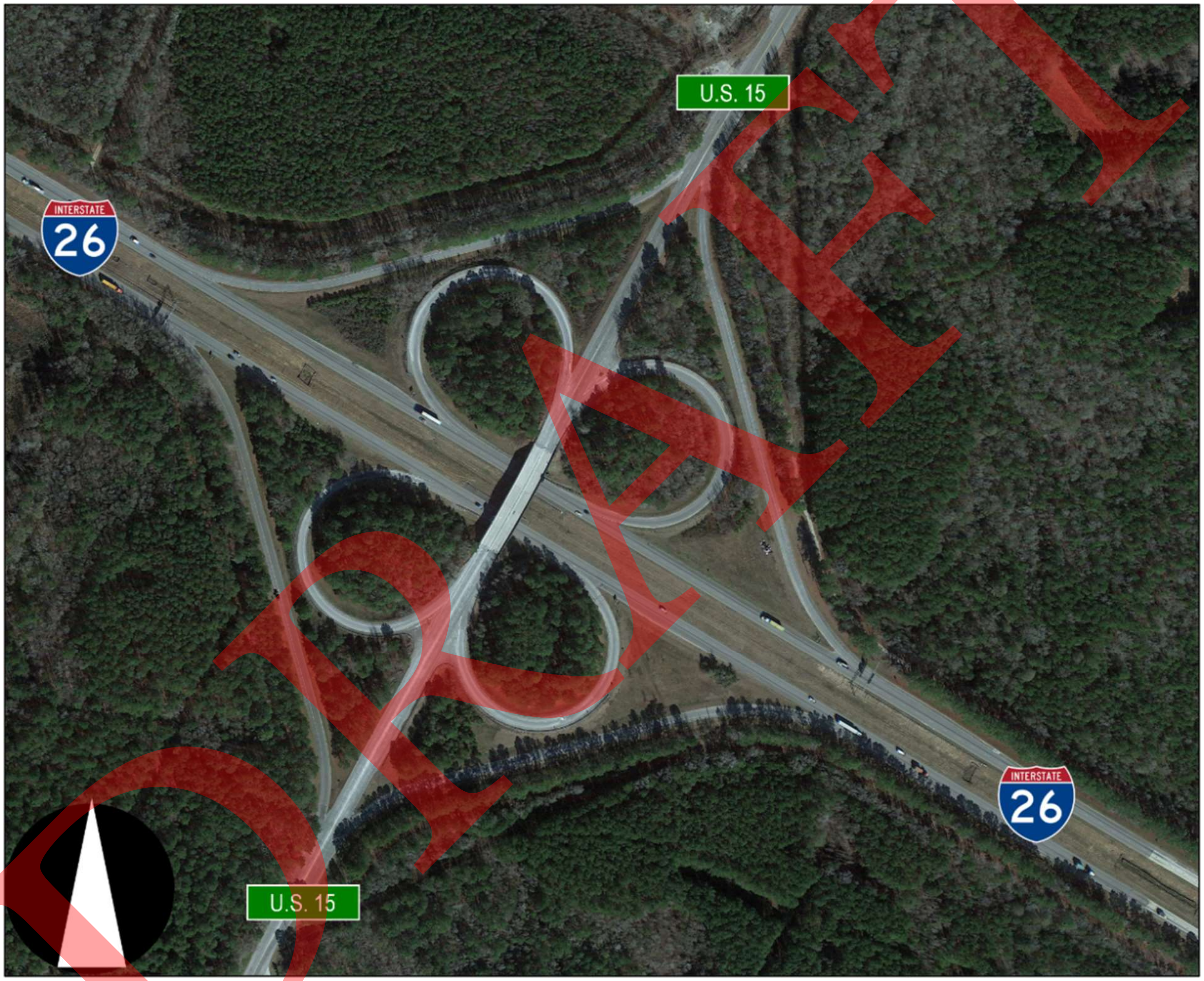
### Figure 1.5: S.C. 210 Interchange



## ***U.S. 15 to the east***

Located 2.4 miles from the system interchange, the U.S. 15 interchange is a full cloverleaf interchange with a bridge over I-26. There are four cloverleaf ramps in each quadrant and four slip ramps. No collector distributors are in place along either I-26 or U.S. 15. While this interchange is not expected to be modified, it is included in this analysis as it is adjacent to the I-26 at I-95 System interchange. The U.S. 15 interchange is shown in **Figure 1.6**.

### Figure 1.6: U.S. 15 Interchange



## 1.4 Proposed Study Area Improvements

SCDOT is currently planning for widening of I-26 to six lanes through the entire study area as part of the widening of I-26 between Columbia and Charleston under multiple projects separate from this study. The section of I-26 through the study area is part of the I-26 widening project between MM 165 to MM 176. The widening of I-26 is therefore incorporated into this analysis as part of the baseline No Build future conditions to accurately assess future traffic operations. The widening on I-26 will expand the existing four lane section to six lanes east and west of I-95 through the study area.

## 1.5 Proposed Design Years

Project design years were developed using the South Carolina Roadway Design Manual (SCRDM) guidelines. The SCRDM recommends a design year 20 years after the date of the completion of the project's plans, specifications and estimates package. For this project, the anticipated opening year was shifted to 2030 to be conservative, which results in a design year of 2050.

Based on the design criteria for rural freeways presented in SCDOT's 2021 Roadway Design Manual, Highway Capacity Manual (HCM) LOS C is the preferred minimum LOS for a rural interstate analysis. Through discussions with SCDOT it was agreed that LOS D will be viewed as an acceptable minimum level of service (LOS) for the 2050 design period.

# 2. DATA COLLECTION

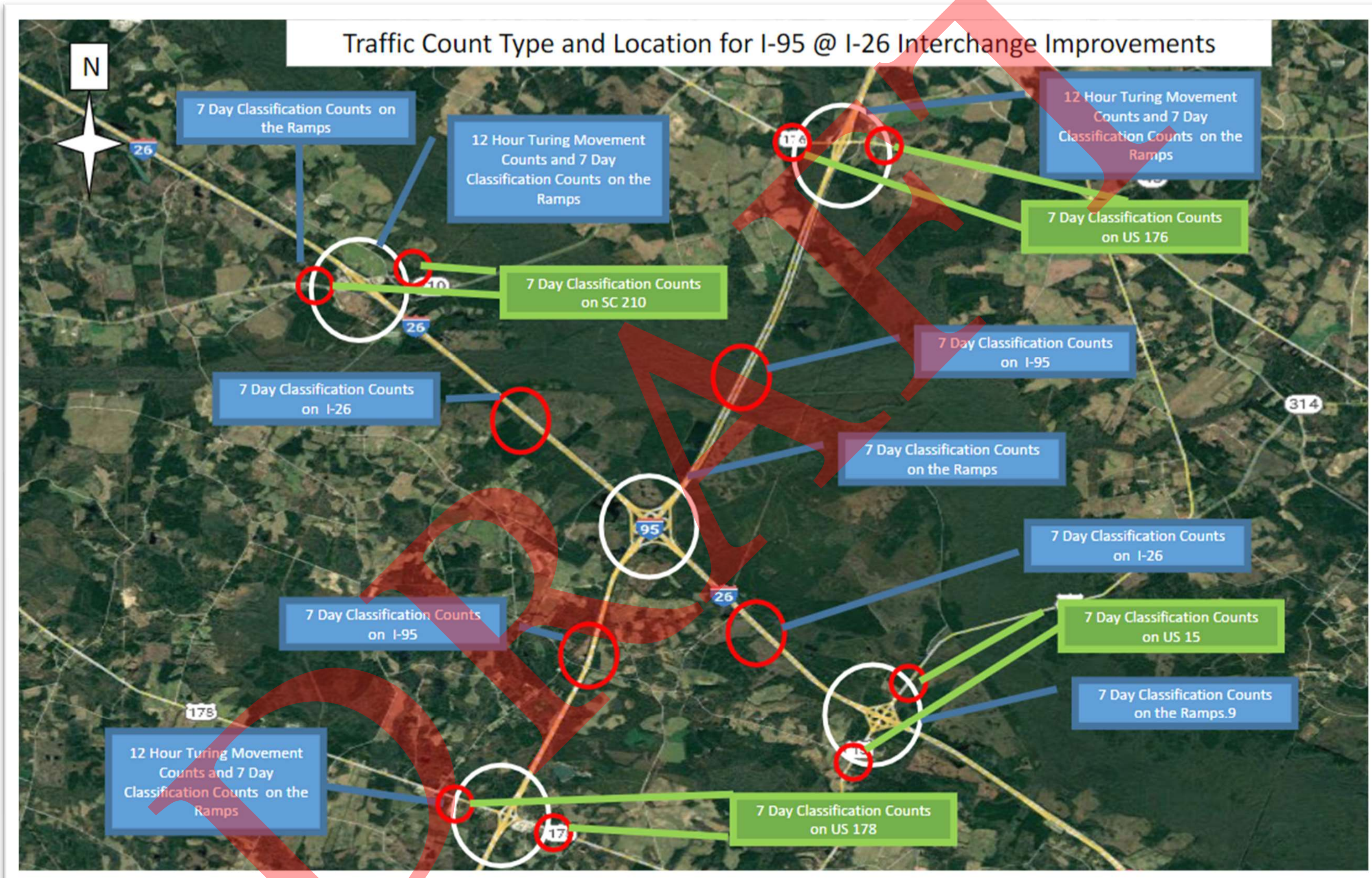
The following section describes the data collection activities performed for this analysis.

## 2.1 Traffic Count Collection

Interstate volumes from SCDOT's Traffic Monitoring Program were obtained via SCDOT's traffic counts website for two permanent ATR count stations: station #0056 on I-95 and station #0020 on I-26. In addition, historic AADT data were utilized for all approaches to the interchanges on I-95 and I-26 as well at the ramps for the I-26 at I-95 System interchange and the four adjacent interchanges.

Bi-directional interstate classification counts were also collected from Friday, March 1 to Thursday, March 7, 2022, on I-95 and I-26. Similar classification counts were taken at the four local roads at adjacent interchanges (U.S. 178, U.S. 176, SC 210 and U.S. 15), and ramps at each of the five interchanges in the study area. These counts identified the percentages of different vehicle types in the traffic stream. In addition, speed profiles were collected and summarized to be used in calibration of a traffic simulation. As part of the field effort, intersection turning movement counts were collected at the study intersections on Friday, March 1, 2022. The reports for these counts are provided in **Appendix A**. An illustration of the count locations is shown in **Figure 2.1**.

## Figure 2.1: Count Location Map




Source: Google Earth Pro Image, 03/2022, Project Count Location

## 2.2 Vehicle Classification Data

Vehicle classification data was collected with the interstate traffic volume data and intersection turning movement counts to be used in this analysis. The project counts were compared with SCDOT online data and the Statewide travel demand model to estimate existing and future truck percentages on both I-26 and I-95.

Truck composition exceeds 20 percent on both I-26 and I-95, with I-95 linking freight along the eastern seaboard and I-26 serving a critical link to the SC Port facilities in Charleston. Each of the SCDOT permanent traffic counters on I-26 and I-95 summarizes the truck percentages based on FHWA's breakdown of 13 vehicle types.

The data sets and forecasted truck percentages for 2030 and 2050 are summarized in **Table 2.1**.

### Table 2.1: Truck Percentages for I-26 and I-95

| Location | Site Summary from SCDOT Website | Site Dashboard (Class 5-13) | Statewide Model 2015 & 2045 | Project Counts (3/1-3/7) | Forecast Truck Percentages | |
|---|---|---|---|---|---|---|
| | | | | | 2030 | 2050 |
| I-95 North | 12% | 23.1% | 26.3% 2015 27.5% 2045 | 35% weekday 29% weekend 33% overall | **22%** | **22%** |
| I-95 South | 21% | 24.5% | 27.7% 2015 29.7% 2045 | 31% weekday 19% weekend 29% overall | **22%** | **22%** |
| I-26 West | 24% | 21.0% | 30.8% 2015 41.3% 2045 | 31% weekday 16% weekend 28% overall | **22%** | **28%** |
| I-26 East | 21% | 21.0% | 29.2% 2015 45.6% 2045 | 23% weekday 17% weekend 22% overall | **22%** | **28%** |

Note that higher truck percentages are forecast for I-26 in 2050 (28 percent) than 2030 (22 percent). This increase is based on input from the official 2045 Statewide Model Version 4 (SCSWMv4) and existing counts. The Statewide model is used by SCDOT for freight planning purposes and includes anticipated increases in freight volumes related to the SC Ports facilities in Charleston as well as other shipping and truck focused industries along the corridor. Note that the forecasted 28 percent trucks for 2050 is still substantially lower than the more than 40 percent identified by the 2045 Statewide model. The future 28 percent truck percentage for 2050 was based on coordination with SCDOT as a balance between the Statewide model and existing conditions.

## 2.3 Travel Speed Data

Travel speed data was obtained with the collected count data. March 2022 data was analyzed for the calibration of the existing conditions TransModeler model. **Table 2.2** provides the existing conditions travel speeds that were averaged for the week of data collection and used for the TransModeler model calibration purposes. The reports for these travel speeds are provided in **Appendix B.**

**Table 2.2: I-26 at I-95 Project Corridor Collected Travel Speeds**

| Location | Average Speed (mph) |
|---|---|
| I-26 Eastbound | 70 |
| I-26 Westbound | 70 |
| I-95 Northbound | 69 |
| I-95 Southbound | 70 |

# 3. CRASH ANALYSIS

A safety analysis of crashes from January 2015 to December 2019 was conducted for the project study area with crash data provided by the South Carolina Department of Public Safety (SCDPS). Data was analyzed for key roadways within the study area including:

- Within the study area, a total of 1,022 crashes were reported as presented in **Table 3.1**.
- Along I-95, data was analyzed on 9.22 freeway miles from south of the U.S. 178 interchange (MP 81.64) to north of the U.S. 176 interchange (MP 90.86).
- Along I-26, crash data was analyzed on 7.42 miles from west of the SC 210 interchange (MP 164.49) to the east of the U.S. 15 interchange (MP 171.91).
- Ramp crash data at the I-95 at I-26 interchange
- The crossroads at the four adjacent interchanges to the project (U.S. 178, U.S. 176, SC 210 and U.S. 15).

### Table 3.1: Number of Crashes and Crash Severity by Year

| Crash Severity | 2015 | 2016 | 2017 | 2018 | 2019 | Total | Proportion |
|---|---|---|---|---|---|---|---|
| Fatality | 2 | 4 | 1 | 4 | 3 | ***14*** | 1% |
| Injury | 39 | 43 | 46 | 33 | 50 | ***211*** | 21% |
| Property Damage Only | 141 | 158 | 166 | 169 | 163 | ***797*** | 78% |
| ***Total*** | ***182*** | ***205*** | ***213*** | ***206*** | ***216*** | ***1,022*** | ***100%*** |

The following sections discuss these crashes by facility, location, type, and severity.

## 3.1 Statewide Crash and Fatality Rates

Between 2015 and 2019, there were 534 crashes on I-95 and 488 crashes on I-26. Of these, there were 3 fatal crashes with 5 deaths on I-95 and 11 fatal crashes on I-26 with 12 deaths. In order to better understand the crash issues, crash rates were calculated for both I-95 and I-26 in the study area and compared with statewide average crash rates.

Crash rates are calculated by taking the number of crashes on a certain segment of roadway and dividing it by the exposure rate. The exposure rate is the number of vehicle miles travelled on the segment during the study period. Crash rates are typically reported based on the number of crashes per 100 million vehicle miles traveled which is computed using the following equations.

### Equation 3-1: Segment Crash Rate Calculations

$$\textbf{Exposure per 100 MVM} = \frac{\text{AADT x segment length (miles) x 365 x number of years}}{100{,}000{,}000}$$

$$\textbf{Segment Crash Rate} = \frac{\text{Number of Crashes in the n Year Period}}{\text{Exposure for the n Year period (in 100 MVM)}}$$

Using these formulas, four types of crash rates were computed for both I-95 and I-26. These rates include:

- Total Crash Rate (all crashes including property damage only, injury and fatal)
- Serious Injury Crash Rates (incapacitating injury crashes only)
- Total Injury Crash Rate (all injuries and possible injuries)
- Fatal Crash Rates (fatal crashes only)

These rates are then compared to average crash rates for similar facilities in South Carolina. **Table 3.2** provides a summary of the crash rates on I-95 and I-26 within the study area as well as a comparison to statewide averages. Key observations include:

- The total crash rate on both I-95 (72.46 crashes per 100mvm) and I-26 (79.55 crashes per 100 mvm) are less than half the statewide average total crash rate (167.27 crashes/100mvm) for rural principal arterial interstates.
- I-95 generally has lower crash rates than I-26 in the study area.
- I-26 has a high serious injury crash rate (2.45 serious injury crashes/100 mvm) and fatal crash rate (1.79 fatal crashes per 100mvm) that exceed the statewide averages of 2.08 serious injury crashes per 100mvm and 1.17 fatal crashes per 100mvm.

### Table 3.2: Crash Rate Comparison between I-95, I-26 and Statewide Averages

| Description | Dist (mi.) | AADT (vpd) | Total Crash Rate | Injury Crash Rate | Serious Injury Crash Rate | Fatal Crash Rate |
|---|---|---|---|---|---|---|
| Statewide Average – 2019 Rural Principal Arterial (interstate) | Varies | Varies | **167.27** | **35.20** | **2.08** | **1.17** |
| Interstate 95 in study area | 9.22 | 43,800 | 72.46 | 13.43 | 0.81 | 0.41 |
| Interstate 26 in study area | 7.42 | 45,300 | 79.55 | 18.26 | **2.45** | **1.79** |

*Notes: Crash rates are shown in terms of the number of crashes per 100 million vehicle miles (crashes per 100Mvm)*
*Red text identifies crash rates that exceed the statewide average.*

Calculations are provided in **Appendix C**. Recommendations for safety improvements are provided at the end of this section.

## 3.2 I-95 Crash Patterns

As identified in Table 3.2, all crash rate types in the study area on I-95 are substantially lower than the statewide average (less than 50 percent in all cases).

### 3.2.1 Crash Severity

**Table 3.3** summarizes I-95 crash severity types by year. Of the 534 crashes, 19 percent involved some level of injury and 1 percent involved a fatality. Using the same table, the number and severity of crashes varied by year, but in general was stable between years reflecting little variation. For this reason, the analysis focuses on total crashes over the five-year period. In addition to the analysis in this section, Section 3.6 examines the fatal crashes in more detail.

**Table 3.3: I-95 Crash Severity**

| Crash Severity | 2015 | 2016 | 2017 | 2018 | 2019 | *Total* | Proportion |
|---|---|---|---|---|---|---|---|
| Fatality | 0 | 1 | 0 | 1 | 1 | ***3*** | 1% |
| Injury | 22 | 18 | 23 | 18 | 18 | ***99*** | 19% |
| Property Damage Only | 69 | 91 | 90 | 96 | 86 | ***432*** | 81% |
| ***Total*** | ***91*** | ***110*** | ***113*** | ***115*** | ***105*** | ***534*** | 100% |

*Source: SC Department of Public Safety Crash Reports, 2015-2019*

### 3.2.2 Crash Types

The crash types on I-95 are summarized in **Table 3.4.**

**Table 3.4: Type of Crash by Severity on I-95**

| Crash Type | Fatality | Injury | Property Damage Only | Total | Percent of All Crashes |
|---|---|---|---|---|---|
| Rear End | 1 | **50** | 195 | **246** | **46%** |
| Head On | 0 | 0 | 0 | **0** | **0%** |
| Angle | 0 | 2 | 23 | **25** | **5%** |
| Sideswipe | 1 | 3 | 55 | **59** | **11%** |
| Off Road | 0 | **40** | 106 | **146** | **27%** |
| Rollover | 0 | 2 | 2 | **4** | **1%** |
| Animal | 1 | 1 | 27 | **29** | **5%** |
| Other | 0 | 1 | 24 | **25** | **5%** |
| *Total* | **3** | **99** | **432** | **534** | |
| Percent of All Crashes | **0.6%** | **19%** | **81%** | | |

*Note: Red highlighting used to identify fatal crashes and crash types with high number of injuries. High number of injuries was estimated based on crash type exceeding 12 percent of total injury crashes.*

Key observations on total crashes on I-95 by crash type include:

- The most common crash type is rear end crashes (46 percent) which typically occur in areas with extensive queuing or, in the case of a freeway, substantially reduced speeds.

- On a freeway, sideswipe (11 percent) and angle (5 percent) crashes typically involve lane changes and merge, diverge and weaving movements. These account for 16 percent of crashes on I-95.
- Off-road crashes (27 percent) are the second most common crash type. Crashes of this type typically involve higher speed vehicles losing control and exiting the roadway.

Observations regarding crash severity as it varies by crash type include:

- Three fatal crashes occurred on I-95 with all being of different types (rear end, sideswipe and animal)
- Of the 99 injury crashes, 50 percent were rear end crashes and 40 percent were off road crashes.

### 3.2.3 Prime Contributing Factor

Understanding the causes of crashes is important to identifying roadway issues and developing countermeasures. Although there can be multiple contributing causes to a crash, the crash reports identify one key or "prime" contributing factor for each crash. **Table 3.5** provides a summary of the prime contributing factor for crashes on I-95 as it varies by crash severity.

**Table 3.5: Prime Contributing Factor of Crashes on I-95 (Total Number of Crashes and Percent of Crashes by Key Type of Factor and Severity)**

| Prime Contributing Factor | Fatality | Injury | Property Damage Only | Total | Percent of All Crashes |
|---|---|---|---|---|---|
| **Driving Action/Error** | **0.2%** | **14.8%** | **64.6%** | **425** | **79.6%** |
| Driving too Fast for Conditions | 0 | **66** | 237 | 303 | 56.7% |
| Improper Lane use/change | **1** | **9** | 73 | 83 | 15.5% |
| Following too Closely | 0 | 2 | 15 | 17 | 3.2% |
| Failure to Yield ROW | 0 | 1 | 2 | 3 | 0.6% |
| Improper Turn | 0 | 0 | 2 | 2 | 0.4% |
| Other Improper Action | 0 | 0 | 7 | 7 | 1.3% |
| Ran off Road | 0 | 0 | 7 | 7 | 1.3% |
| Swerving to Avoid Object | 0 | 1 | 1 | 2 | 0.4% |
| Wrong side or Wrong Way | 0 | 0 | 1 | 1 | 0.2% |
| **Driver Condition** | **0.0%** | **2.6%** | **4.7%** | **39** | **7.3%** |
| Distracted/Inattention | 0 | **4** | 17 | 21 | 3.9% |
| Fatigued/Asleep | 0 | 1 | 2 | 3 | 0.6% |
| Medical Related | 0 | **5** | 1 | 6 | 1.1% |
| Under the Influence | 0 | **4** | 5 | 9 | 1.7% |

| Prime Contributing Factor | Fatality | Injury | Property Damage Only | Total | Percent of All Crashes |
|---|---|---|---|---|---|
| **Road Condition/ Hazard** | **0.2%** | **0.2%** | **6.9%** | **38** | **7.1%** |
| Animal in Road | 1 | 1 | 27 | 29 | 5.4% |
| Debris | 0 | 0 | 7 | 7 | 1.3% |
| Obstruction in Roadway | 0 | 0 | 1 | 1 | 0.2% |
| Other (environmental) | 0 | 0 | 1 | 1 | 0.2% |
| Road Surface Condition | 0 | 0 | 1 | 1 | 0.2% |
| **Vehicle Issues** | **0.0%** | **0.9%** | **2.8%** | **20** | **3.7%** |
| Brakes | 0 | 0 | 1 | 1 | 0.2% |
| Cargo | 0 | 0 | 2 | 2 | 0.4% |
| Steering | 0 | 0 | 1 | 1 | 0.2% |
| Tires/Wheel | 0 | 5 | 11 | 16 | 3.0% |
| **Unknown** | **0.2%** | **0.0%** | **1.9%** | **11** | **2.1%** |
| Unknown | 1 | 0 | 10 | 11 | 2.1% |
| **Total** | **3** | **99** | **432** | **534** | |
| | 0.6% | 18.5% | 80.9% | | |

*Note: Red highlighting used to identify fatal crashes and contributing factors with high number of injuries. High number of injuries was estimated based on prime contributing factor exceeding 4 percent of total injury crashes.*

Key observations from Table 3.5 on total crashes by prime contributing factor include:

- The prime contributing factor can be looked at in multiple ways. By combining some of the detailed factors, five key types of contributing factors can be identified:
  - Driver Actions or Errors – 79 percent of crashes
  - Driver Condition – 7 percent
  - Road Condition or Hazard – 7 percent
  - Vehicle Issues – 4 percent
  - Other – 2 percent
- On I-95, the majority of crashes have prime contributing factors related to driver actions or errors (79 percent). Of these, two specific factors are noted:
  - Driving too fast for conditions (72 percent of driver action related crashes and 57 percent of total crashes): On the existing I-95, this could be related to either the primary freeway speed (posted 70 mph) or exiting from I-95 at a ramp at too fast of speed.
  - Improper lane use or change (20 percent of driver action related crashes and 16 percent of total crashes): On the existing I-95, this is likely related to lane change crashes related to blind spots in driver mirrors and underestimation of available gaps for lane shifts. In addition, weaving areas at the existing I-95 at I-26 full cloverleaf interchange require traffic to weave

into and out of the weaving area simultaneously while accelerating or decelerating.

 – One observation is that running off the road is only the prime contributing factor in 1 percent of crashes compared with the off road crash type accounting for 27 percent of total crashes. This illustrates that other contributing factors can cause a run off the road crash (such as driving under the influence or an animal in the road).

- Driver condition is only identified as the primary cause in 7 percent of crashes on I-95. Of these, the majority (54 percent) involve distracted or inattentive drivers.
- Road conditions are only identified as the primary cause in 7 percent of crashes. Of these, the majority (74 percent) involve animals on the road. Note that of the 7 percent of crashes that were caused by an animal, 5 percent involved hitting the animal and 2 percent involved vehicles impacting a tree, median barrier, guardrail, or other off road hazard.
- Vehicle issues only account for 4 percent of crashes of which 80 percent of the crashes involve issues with the tires.

A review of crash severity and prime contributing factor was also completed to determine what prime contributing factors resulted in crashes with injuries or fatalities. Key observations include:

- The three fatal crashes that occurred in I-95 all have different prime contributing factors (improper lane use/ change, animal and unknown). The crash with an unknown primary cause was a two-vehicle rear end crash that resulted in hitting a median barrier.
- Of the 99 injury crashes, 67 percent have a primary contributing factor of driving too fast for conditions. The second most common prime contributing factor was also related to driver action/error with 9 percent of injury crashes involving improper lane use/ changes.
- Driver condition accounts for 14 percent of all injury crashes on I-95 with a relatively even distribution of specific driver condition factors.
- Vehicles issues relating to tire/ wheel failures account for 5 percent of injury crashes.

## 3.2.4 Other Crash Findings

The I-95 crash data were examined for multiple other issues to identify trends or unique issues. This included looking at the road surface (wet or dry), lighting condition (day or night), and the time or day of the crash.

### ***Weekend Crashes on I-95***

As shown in **Table 3.6,** an observation was found regarding crash frequency on the weekends versus weekdays.

**Table 3.6: Comparison of Crashes & Volumes on Weekday versus Weekend on I-95**

| Day of Week | Total Crashes | Daily Percentage of Crashes | 2019 Daily Average (vpd) | Daily Percentage of Traffic |
|---|---|---|---|---|
| Monday | 71 | 13% | 31,068 | 14% |
| Tuesday | 41 | 8% | 27,712 | 12% |
| Wednesday | 35 | 7% | 28,208 | 12% |
| Thursday | 49 | 9% | 31,477 | 14% |
| Friday | 100 | 19% | 37,748 | 16% |
| Saturday | 118 | 22% | 37,024 | 16% |
| Sunday | 120 | 22% | 35,735 | 16% |
| ***Total*** | ***534*** | ***100%*** | ***228,972*** | ***100%*** |
| | | | | |
| **Average M, T, W & H Weekday** | 49 | | 29,616 | |
| **Average F, S & S Weekend** | 113 | **130% higher** | 36,836 | **24% higher** |

The key item noted in this review was:

- 63 percent of crashes occur on Friday through Sunday compared with 48 percent of the traffic volume. Looked at in terms of daily frequency of crashes, each Friday, Saturday, and Sunday crash rates have more than double the crashes than occur on each of the other 4 days of the week.
- The 2019 AADT at SCDOT's permanent I-95 count station (#56) was evaluated to determine typical traffic volumes each day of the week. The extended Friday-Saturday-Sunday weekend had an average daily volume of 36,800 vpd. In comparison, the other four days of the week had an average daily volume of 29,600 vpd.
- Typically, crash rates increase proportionately with an increase in volume. I-95, however, has a higher percent of crashes occurring on the weekend (130

percent higher) as compared with the increase in traffic volumes (24 percent higher). The reason for this is unclear, but two potential factors are:

- Weekend traffic could have a higher percentage of less experienced or older drivers that may not be familiar with the area due to long distance travel.
- The higher volumes on the weekend reach a high enough volume that capacity is reached at key junction points or bottlenecks resulting in traffic slowdowns and queuing. This slowing of traffic is not typical of a rural freeway facility and may result in a higher proportion of crashes when these unexpected bottlenecks occur on the weekend.

### *Other Crash Observations*

Other miscellaneous observations of I-95 crashes include:

- Speed cited as issue in less than 10 percent of crashes.
- Crashes involving a single vehicle make up 33 percent of crashes on I-95. 53 percent involve two vehicles, and 12 percent involve three vehicles. Only 2 percent involve greater than three vehicles.
- Of the crashes indicating a motor unit was hit by another vehicle, 34 percent involved a stopped vehicle and 66 percent involved a moving vehicle.
- Trees were the ultimate harmful event in 10 percent of crashes on I-95. Median barriers accounted for 11 percent of the harmful events.
- Crash direction was distributed fairly evenly with 53 percent of crashes in the southbound direction and 47 percent in the northbound direction.

## 3.3 I-26 Crash Patterns

A similar crash analysis was prepared for I-26 in the study area. As identified in Table 3.6, crash rates on I-26 are slightly higher than I-95. Key observations include:

- I-26 has total crash rate of 79.55 crashes per 100mvm compared to 72.46 crashes per 100mvm on I-95.
- Similar to I-95, the total crash rate on I-26 is less than half the statewide average total crash rate (167.27 crashes/100mvm) for rural principal arterial interstates.
- Unlike I-95, I-26 has a serious injury crash rate (2.45 serious injury crashes/100 mvm) and fatal crash rate (1.79 fatal crashes per 100mvm) that exceed the statewide averages of 2.08 serious injury crashes per 100mvm and 1.17 fatal crashes per 100mvm.

### 3.3.1 Crash Severity

As noted, crash severity on I-26 is higher than on I-95 and higher than statewide averages. **Table 3.7** summarizes I-26 crash severity types by year. Of the 488 crashes, 23 percent involved some level of injury and 2 percent involved a fatality. In addition to the analysis in this section, Section 3.6 examines the fatal crashes in more detail.

**Table 3.7: I-26 Crash Severity**

| Crash Severity | 2015 | 2016 | 2017 | 2018 | 2019 | *Total* | Proportion |
|---|---|---|---|---|---|---|---|
| Fatality | 2 | 3 | 1 | 3 | 2 | ***11*** | 2% |
| Injury | 17 | 25 | 23 | 15 | 32 | ***112*** | 23% |
| Property Damage Only | 72 | 67 | 76 | 73 | 77 | ***365*** | 75% |
| ***Total*** | ***91*** | ***95*** | ***100*** | ***91*** | ***111*** | ***488*** | 100% |

*Source: SC Department of Public Safety Crash Reports, 2015-2019*

### 3.3.2 Crash Types

The crash types on I-26 and the respective severity of these crashes are summarized in **Table 3.8.**

**Table 3.8: Crash Types on I-26**

| Crash Type | Fatality | Injury | Property Damage Only | Total | Percent of All Crashes |
|---|---|---|---|---|---|
| Rear End | **2** | **29** | 99 | **130** | **27%** |
| Head On | 0 | 1 | 0 | **1** | **0%** |
| Angle | 0 | 9 | 42 | **51** | **10%** |
| Sideswipe | 0 | **13** | 89 | **102** | **21%** |
| Off Road | **9** | **53** | 96 | **158** | **32%** |
| Rollover | 0 | 2 | 4 | **6** | **1%** |
| Animal | 0 | 3 | 14 | **17** | **3%** |
| Other | 0 | 2 | 21 | **23** | **5%** |
| *Total* | **11** | **112** | **365** | **488** | |
| Percent of All Crashes | **2.3%** | **23%** | **75%** | | |

*Note: Red highlighting used to identify fatal crashes and crash types with high number of injuries. High number of injuries was estimated based on crash type exceeding 12 percent of total injury crashes.*

Key observations on total crashes by crash type include:

- The most common crash type is rear end crashes (27 percent) which typically occur in areas with extensive queuing or, in the case of a freeway, reduced speeds. Note that this is lower on I-26 than on I-95 (46 percent).
- On a freeway, sideswipe (21 percent) and angle (10 percent) crashes typically involve lane changes and merge, diverge and weaving movements. These

account for 31 percent of crashes on I-26. Note that I-95 crashes had a lower percentage (16 percent) following into these two crash type categories.

- Off-road crashes (32 percent) are more common on I-26 than the combined sideswipe and angle crashes (31 percent). Crashes of this type typically involve high speed vehicles losing control and exiting the roadway. This percentage is similar to what was observed on I-95 for off-road crashes (27 percent).

Observations regarding crash severity as it varies by crash type include:

- Eleven fatal crashes occurred on I-26 in the study area. Over 80 percent of fatal crashes involved off road crashes. The other 20 percent were rear end crashes.
- Of the 112 injury crashes, 47 percent were off road crashes further enforcing the need to examine this type of crash on I-26. 26 percent of injury crashes are rear end crashes and 20 percent were either angle or sideswipe crashes.

### 3.3.3 Prime Contributing Factor

**Table 3.9** provides a summary of the prime contributing factor for crashes as well as how severity varies based on the primary contributing factors on I-26.  Key observations from Table 3.9 include:

- The prime contributing factor can be looked at in multiple ways. By combining some of the detailed factors, five key types of crash factors can be identified:
  - Driver Actions or Errors – 80 percent of crashes
  - Driver Condition – 5 percent
  - Road Condition or Hazard – 7 percent
  - Vehicle Issues – 7 percent
  - Other – 3 percent
- On I-26, the majority of prime contributing factors are related to driver actions or errors (80 percent). Of these, two specific factors are noted:
  - Driving too fast for conditions (50 percent of driver action related crashes and 40 percent of total crashes): On the existing I-26, this could be related to either the primary freeway speed (posted 70 mph) or exiting from I-95 at a lower speed ramp. Note that this is lower than noted on I-95 where 72 percent of crashes involved vehicles driving too fast.
  - Improper lane use or change (39 percent of driver action related crashes and 31 percent of total crashes): On the existing I-26, this likely results from lane change crashes related to blind spots and underestimation of available gaps for lane shifts. In addition, the full cloverleafs at the I-26 at I-95 interchange and the I-26 at U.S. 15 interchange have weaving sections requiring more complex lane changing maneuvers between vehicles.

- Driver conditions are only identified as the primary cause in 5 percent of crashes. Of these, the majority (55 percent) involve drivers under the influence. This is higher than the findings noted on I-95.
- Road condition is only identified as the primary cause in 7 percent of crashes. Of these, 47 percent involve animals on the road. Debris or other obstructions in the road account for 51 percent of road condition crashes on I-26.
- Vehicle issues only account for 7 percent of crashes of which 80 percent of the crashes involve issues with the tires.
- Of the 11 fatal crashes on I-26, driver action or error is identified as the primary cause in 72 percent of crashes. This may be higher since 18 percent were attributed to unknown causes.

### Table 3.9: Prime Contributing Factor of Crashes on I-26

| Prime Contributing Factor | Fatality | Injury | Property Damage Only | Total | Percent of All Crashes |
|---|---|---|---|---|---|
| **Driving Action/Error** | **1.7%** | **17.7%** | **60.2%** | **382** | **79.6%** |
| Driving too Fast for Conditions | **1** | **49** | 140 | 190 | 39.6% |
| Improper Lane use/change | **2** | **27** | 118 | 147 | 30.6% |
| Following too Closely | 0 | 1 | 6 | 7 | 1.5% |
| Failure to Yield ROW | 0 | 1 | 8 | 9 | 1.9% |
| Improper Turn | 0 | 0 | 1 | 1 | 0.2% |
| Other Improper Action | **1** | 2 | 8 | 11 | 2.3% |
| Ran off Road | **3** | 4 | 6 | 13 | 2.7% |
| Swerving to Avoid Object | 0 | 0 | 1 | 1 | 0.2% |
| Aggressive Operation | **1** | 1 | 0 | 2 | 0.4% |
| Wrong side or Wrong Way | 0 | 0 | 1 | 1 | 0.2% |
| **Driver Condition** | **0.0%** | **2.7%** | **1.9%** | **22** | **4.6%** |
| Distracted/Inattention | 0 | 0 | 4 | 4 | 0.8% |
| Fatigued/Asleep | 0 | 3 | 1 | 4 | 0.8% |
| Medical Related | 0 | 0 | 2 | 2 | 0.4% |
| Under the Influence | 0 | **10** | 2 | 12 | 2.5% |
| **Road Condition/ Hazard** | **0.0%** | **0.6%** | **6.9%** | **36** | **7.5%** |
| Animal in Road | **0** | 3 | 14 | 17 | 3.5% |
| Debris | 0 | 0 | 10 | 10 | 2.1% |
| Obstruction in Roadway | 0 | 0 | 8 | 8 | 1.7% |
| Other (environmental) | 0 | 0 | 0 | 0 | 0.0% |
| Road Surface Condition | 0 | 0 | 0 | 0 | 0.0% |
| Work Zone | 0 | 0 | 1 | 1 | 0.2% |
| **Vehicle Issues** | **0.2%** | **2.3%** | **4.0%** | **31** | **6.5%** |
| Brakes | 0 | 0 | 0 | 0 | 0.0% |
| Cargo | 0 | 1 | 1 | 2 | 0.4% |
| Steering | 0 | 0 | 1 | 1 | 0.2% |
| Tires/Wheel | **1** | **8** | 16 | 25 | 5.2% |
| Other (vehicle defect) | 0 | **2** | 1 | 3 | 0.6% |
| **Unknown** | **0.4%** | **0.0%** | **2.3%** | **13** | **2.7%** |
| Unknown | **2** | 0 | 11 | 13 | 2.7% |
| **Total** | **11** | **110** | **359** | **480** | |
| | 2.3% | 22.9% | 74.8% | | |

*Note: Red highlighting used to identify fatal crashes and contributing factors with high number of injuries. High number of injuries was estimated based on factor exceeding 4 percent of total injury crashes.*

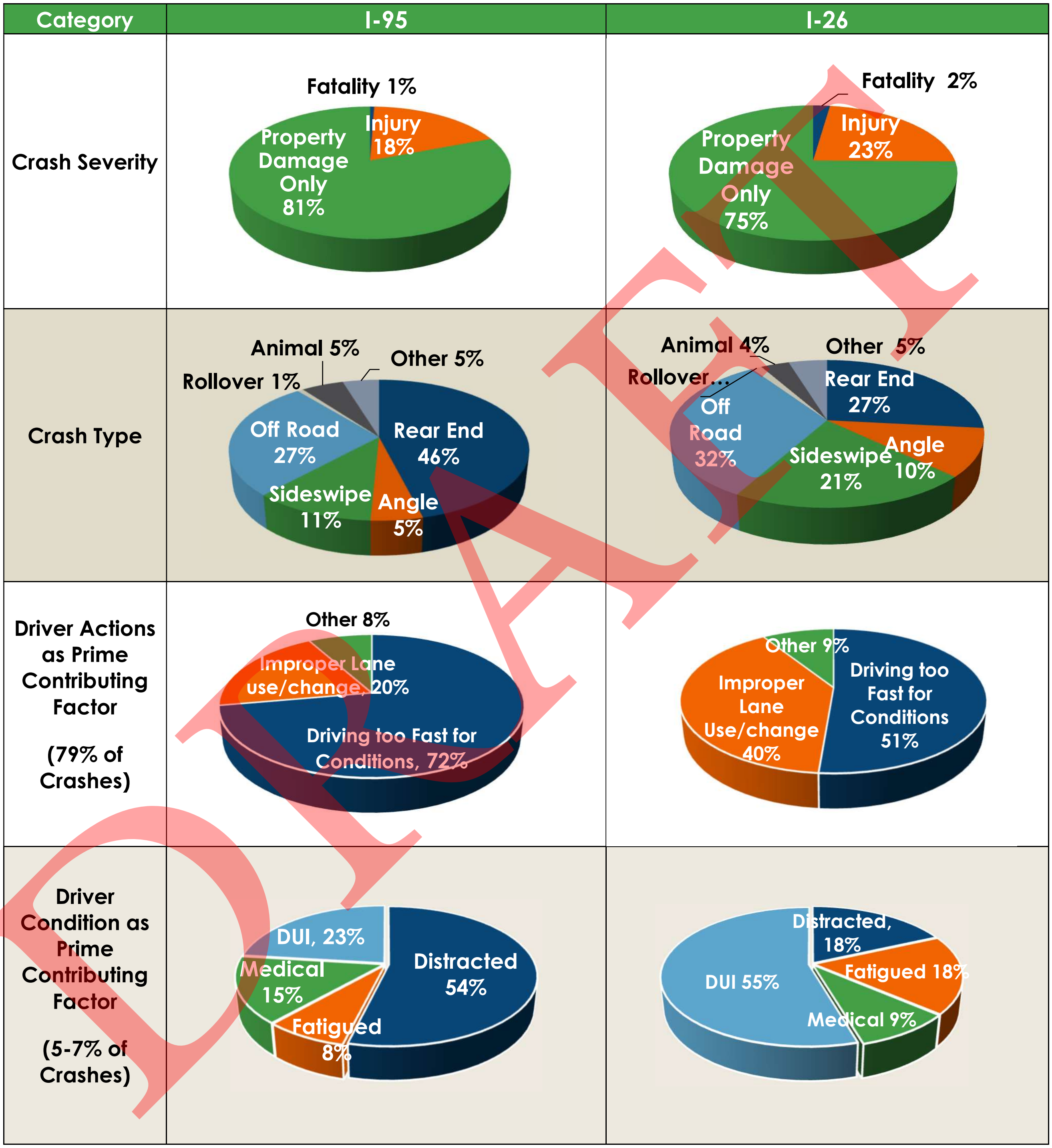
### 3.3.4 Other Crash Findings

- The crash data were examined for multiple other issues to identify trends or unique issues. On I-26, the key item that stood out, however, is the high number of fatal crashes. These are examined in Section 3.6.
- A review of the weekday versus weekend crashes indicated that I-26 does not have the same issue of higher crashes than expected occurring on the weekend that was observed on I-95.
- Speed cited as issue in only 12 percent of crashes.
- Crashes involving a single vehicle make up 35 percent of crashes on I-26. 59 percent involve two vehicles, and 4 percent involve three vehicles. Only 1 percent involve greater than three vehicles.
- Of the crashes indicating a motor unit that was hit by another vehicle, 11 percent involved a stopped vehicle and 89 percent involved a moving vehicle. This is likely because I-26 has fewer times when traffic is completely stopped or reduced to very slow speeds as compared with I-95.
- Trees were the ultimate harmful event in 26 percent of crashes on I-26, more than double noted on I-95. Median barriers accounted for 2 percent of the harmful events which is lower than on I-95. It is not known if this is due to more barriers separating trees from the roadway on I-95.
- Crashes were distributed fairly evenly with 53 percent of crashes in the southbound direction and 47 percent in the northbound direction.

## 3.4 Comparison of I-95 and I-26 Crash Patterns

As noted in the previous two sections, the crash patterns on I-95 and I-26, although similar, also have different characteristics. Some of the key differences are illustrated in **Figure 3.1**.

## Figure 3.1: Comparison of I-95 and I-26 Crash Pattern Differences



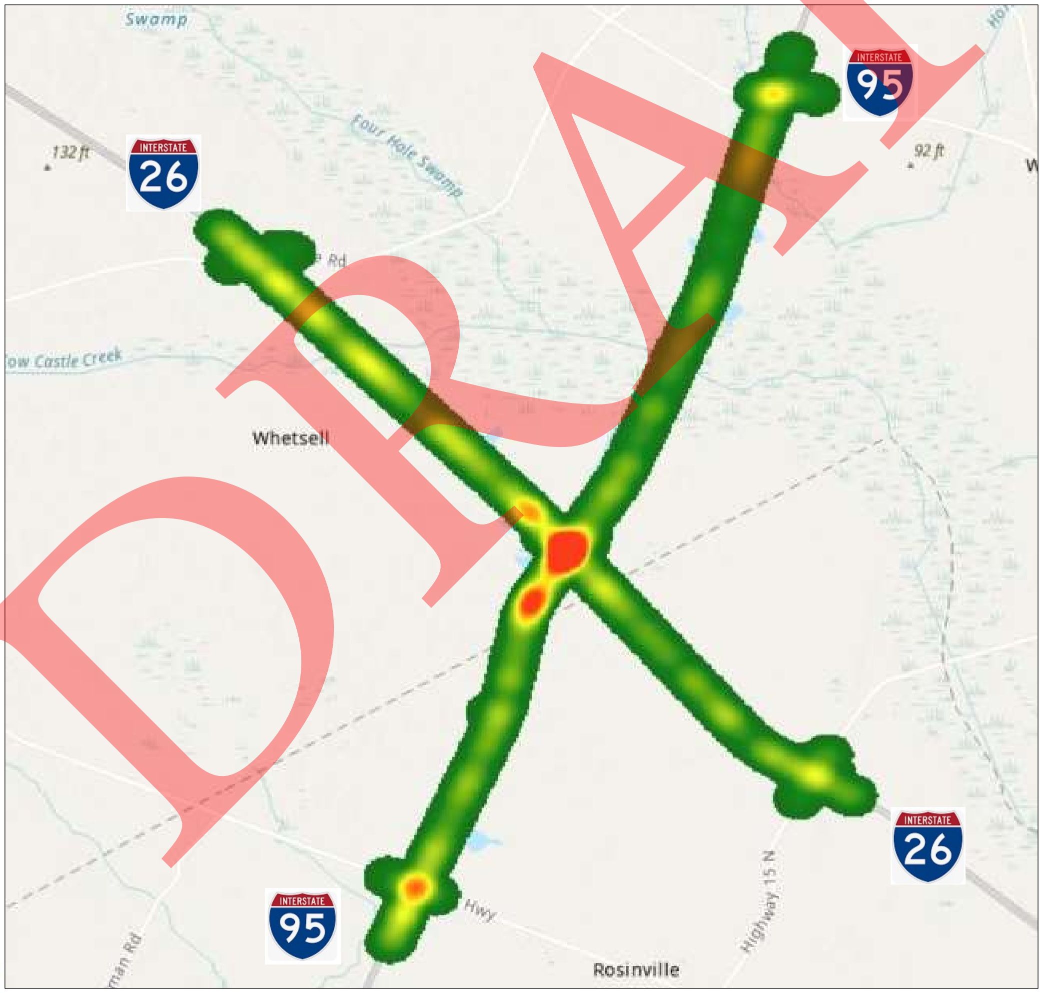
## 3.5 High Frequency Crash Locations

A key to understanding crashes is observing the location of crashes on the corridor. Using GIS based on milepost data and the direction of flow the traffic occurred in, an overview of the project corridor.

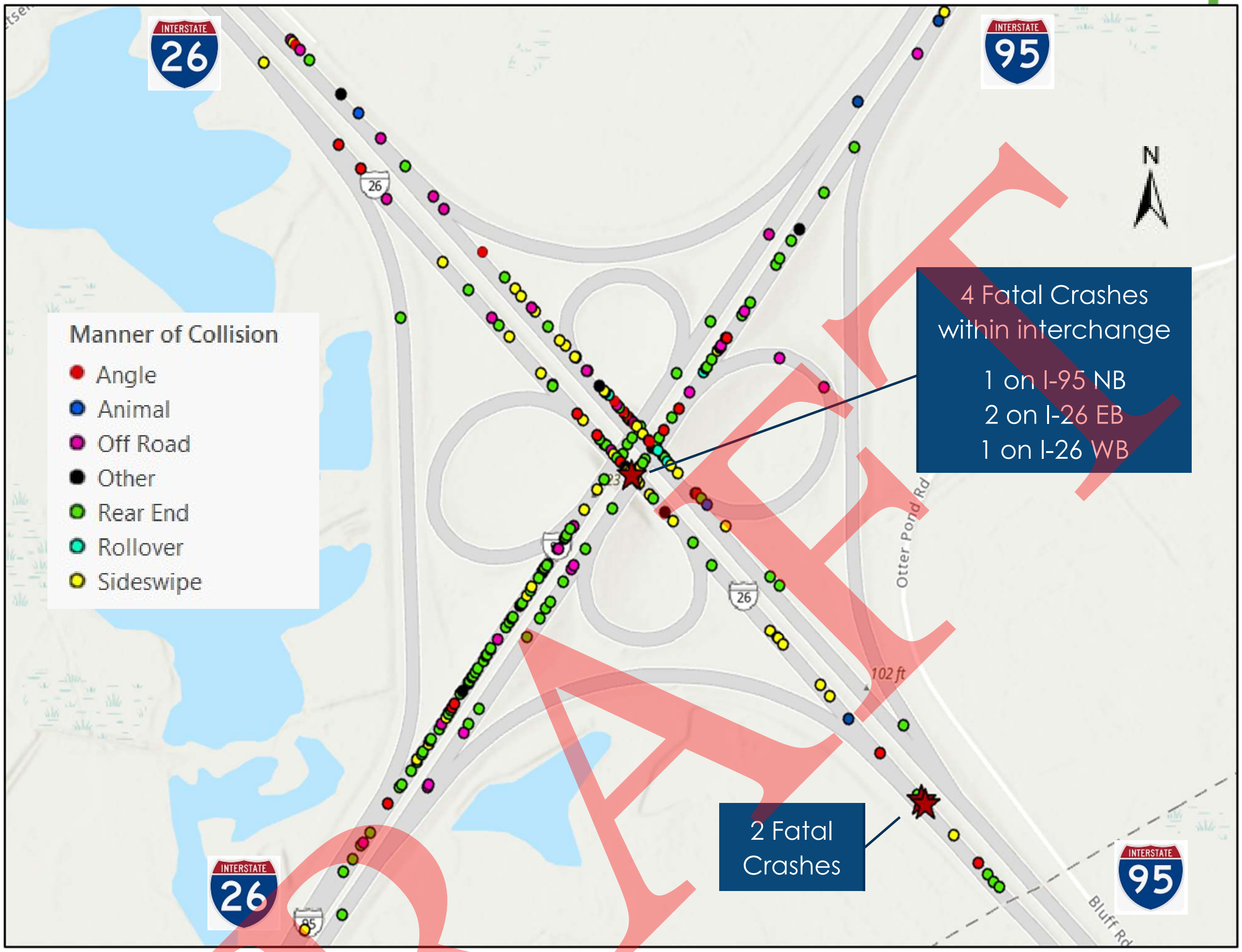
**Figure 3.2** shows the hotspots of crashes on I-95. The densest concentration of crashes on I-95 between U.S. 178 and U.S. 176 as well as on I-26 between the SC 210 and U.S. 15 interchanges.

Within the study area, the highest concentration of crashes is focused around the I-26 and I-95 full cloverleaf interchange that is being improved as part of this project. There is also a section of I-95 just south of the interchange with a high frequency of crashes. Based on this information, **Figure 3.3** was prepared to illustrate the type, locations, and direction of travel for crashes occurring within the I-26 at I-95 interchange.

**Figure 3.2: Heat Map of Crashes on I-26 and I-95 within Study Area**



### Figure 3.3: Crash Locations and Types at the I-26 and I-95 Interchange




*Note: More detailed information on fatal crashes is included in Section 3.6.*

Examining Figure 3.3, five locations were identified as locations with a high frequency of crashes. These include all four weave areas within the existing cloverleaf interchange as well as on I-95 southbound approaching the merge with the ramp serving I-26 eastbound traffic exiting to I-95 southbound.

Weave operations occur when two ramps or loops are located close to each other with traffic merging onto the freeway being forced to weave or change lanes to the left onto the freeway in the same segment where exiting traffic from the freeway must change lanes to take the next exit. These types of sections are relatively common on older interstates, but weaves are no longer preferred on interstate mainlines. Instead, weave sections are being removed or converted to collector distributors in many areas as freeway interchanges are upgraded. At the I-26 at I-95 interchange the four weave sections between the four loops all appear to be areas with a high frequency of crashes.

In addition to the four weaves, there is a high crash location on I-95 southbound downstream from the weave where the ramp from I-26 eastbound merges on mainline I-95 southbound.

Recognizing these issues, **Table 3.10** was developed to examine the crash types observes at the five high crash locations. Note that the 204 crashes identified within the five high crash locations account for 20 percent of the 1,022 crashes within the project study area despite representing less than 3 percent of directional interstate mileage in the study area.

**Table 3.10: Crash Types at the high crash frequency locations at the I-26/I-95 Interchange**

| Crash Type | I-95 NB Weave | I-95 SB Weave | I-26 WB Weave | I-26 EB Weave | I-95 SB Merge | Total in High Frequency Areas |
|---|---|---|---|---|---|---|
| Rear End | **29** | **24** | 11 | 7 | **36** | **107** |
| Angle | 4 | 0 | **6** | **10** | 5 | **25** |
| Sideswipe | 0 | 3 | **10** | **19** | 6 | **38** |
| Off Road | 6 | 3 | 3 | 5 | 6 | 23 |
| Rollover | 1 | 0 | 1 | 3 | 0 | 5 |
| Animal | 0 | 0 | 0 | 1 | 0 | 1 |
| Other | 1 | 0 | 1 | 1 | 2 | 5 |
| ***Total*** | ***41*** | ***30*** | ***32*** | ***46*** | ***55*** | ***204*** |

*Note: Red text indicates the most common type of crash within each high frequency crash segment.*

Key crash and safety observation at each weave and the southbound merge are:

## Weave on I-95 Northbound:

- 41 crashes have occurred within the weave on I-95 northbound.
- Over 70 percent of crashes in the weave are rear end crashes which can be the result of slowing down to merge into a weave or due to queuing occurring upstream of a weave in the mainline traffic flow.
- Angle and sideswipe only comprise 10 percent of crashes.
- The loop in the northeast quadrant (I-95 northbound to I-26 westbound) carries the highest volume of all the loops with 15,800 vpd based on the latest 2021 AADT data. The weave LOS has existing LOS F operations during peak periods which will worsen in the future as traffic volumes raise. Also note that 15,800 vpd is essentially at the estimated capacity for a single lane loop ramp (excluding the consideration of over 20 percent trucks on the loop).

***Weave on I-95 Southbound:***

- 30 crashes have occurred within the weave on I-95 southbound.
- Over 80 percent of crashes in the weave are rear end crashes which can be the result of slowing down to merge into a weave or due to queuing occurring upstream of a weave in the mainline traffic flow.
- Angle and sideswipe only comprise 10 percent of crashes.

***Weave on I-26 Eastbound:***

- 32 crashes have occurred within the weave on I-26 eastbound.
- Only 34 percent of crashes in the weave are rear end crashes (unlike I-95 weaves).
- 50 percent of crashes are angle and sideswipe crashes that indicate that traffic is moving within the weave area but having issues finding gaps or openings to merge or diverge.

***Weave on I-26 Westbound:***

- 46 crashes have occurred within the weave on I-26 westbound which is the highest frequency of the four weave areas.
- Only 15 percent of crashes in the weave are rear end crashes (much lower than the 70 to 80 percent noted on the I-95 weaves).
- 63 percent of crashes in the weave are angle and sideswipe crashes indicating that traffic is moving within the weave area but having issues finding gaps or openings to merge or diverge.
- Three rollover crashes were noted in this weave area. This may be related to inadequate loop radii for exiting from a high-speed interstate facility. This type of crash can be of a higher severity in addition to requiring more time to clear and reopen the facility to traffic in all lanes. These response issues can lead to more crashes.
- The loop in the northeast quadrant is the loop with the highest demand (15,800 vpd AADT in 2021). This traffic merges into the weave area first congesting operations and allowing for minimal gaps for vehicles exiting from I-26 eastbound. In addition, this high volume of traffic is likely merging onto I-26 westbound at a lower speed effectively restricting flow in the rightmost lane of I-26.

***Merge on I-95 Southbound:***

- The crash heat map in Figure 3.2 and the interchange crash diagram in Figure 3.3 both indicate that there is a high crash location in the vicinity where I-95 southbound merges with the ramp serving I-26 eastbound to I-95 southbound.

This ramp movement is the opposite movement of the highest volume loop in the northeast quadrant. At this merge, the merging ramp volume from I-26 is forecast to exceed the I-95 southbound flow.

- There are 55 crashes observed in this merge area, a higher number of crashes than any of the weave areas.
- Of these crashes, 65 percent are rear end crashes, indicative of queuing and congested flow is occurring under existing conditions on I-95 southbound or the ramp itself.
- Only 20 percent of crashes in the weave are related to sideswipe and angle crashes.

### *Other Crash Observations at the I-26/I-95 Interchange*

- The crash heat map in Figure 3.2 does show a hot spot to the west of the interchange. Although there are fewer crashes, these are related to a similar issue as on I-95 southbound with a high volume of traffic encountering westbound queuing. This queuing and resultant crashes may be alleviated with the planned widening of I-26 as part of a separate project.
- On I-95 and I-26 through each of the five high crash locations, approximately 10 percent of crashes are off road crashes. While the reasons are unclear, these typically result on roads with high travel speeds. Note that Section 3.5 examines these in more detail as the majority of fatal crashes on I-26 are also off road crashes.
- Within the interchange area, there are six fatal crashes in the five years of data examined (one on I-95, five on I-26). Unfortunately, the location data is insufficient to reliably identify the location of four of the crashes. Fatal crashes are also examined in Section 3.6.
- As shown in Figure 3.3, there is limited crash data tied directly to ramp crashes at the I-26/I-95 interchange. These crashes were likely coded as occurring at the nearest merge/diverge areas with I-26 or I-95 since typically the friction on ramps is less than at the beginning and end of merges and diverges.

# 3.6 Fatal Crashes

As noted in previous sections, the crash data indicated that there were 14 total fatal crashes in the study in 2015 through 2019. Three of these crashes were on I-95 and eleven on I-26. The location of these crashes is illustrated in **Figure 3.4**. Key observations from the data sets include:

## 3.6.1 I-95 Fatalities

Within the study area, the fatal crash rate for I-95 is 0.81 fatal crashes per 100mvm. This is lower than the statewide averages of 1.17 fatal crashes per 100mvm on similar rural interstate facilities.

- I-95 has three fatal crashes in the study area. Details on these three fatal crashes include:
  - Each of the crashes was of a different crash type (rear end, sideswipe and animal related)
  - All three crashes have different prime contributing factors (improper lane use/ change, animal and unknown).
  - Two of the crashes occurred at night.
  - All three crashes occurred despite a dry road surface.
  - The harmful event all involved drifting from the travel lane including running off the road, hitting a tree and hitting the median barrier.
  - Two of these crashes were mapped to within the I-26/I-95 interchange.
  - Each fatal crash is mapped in Figure 3.4 and shown in **Table 3.11.**
  - In addition to the three fatal crashes, there were six crashes with incapacitating injuries on I-95.

## 3.6.2 I-26 Fatalities

Unlike I-95, I-26 has a serious injury crash rate (2.45 serious injury crashes/100 mvm) and fatal crash rate (1.79 fatal crashes per 100mvm) that exceeds the statewide averages of 2.08 serious injury crashes per 100mvm and 1.17 fatal crashes per 100mvm.

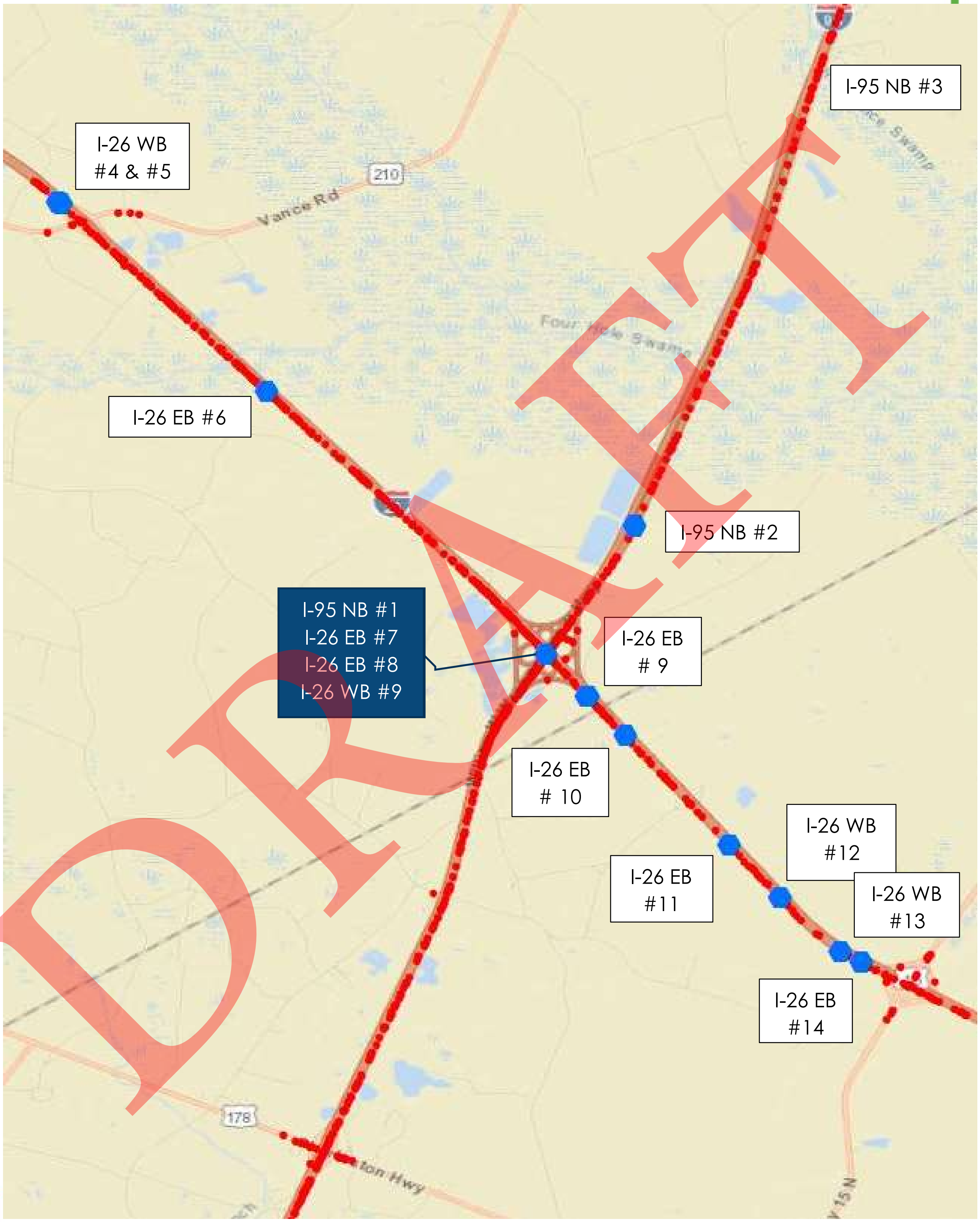
- I-26 has eleven fatal crashes in the study area. Details on these three fatal crashes include:
  - Over 80 percent of fatal crashes involved off road crashes. The other 20 percent were rear end crashes.
  - Driver action or error is identified as the primary cause in 72 percent of crashes and may be higher since 18 percent were unknown causes.
  - Three of the eleven fatal crashes occurred at night.
  - Two of the crashes involved a wet roadway surface.
  - Eight of the eleven crashes involved only one vehicle.
  - The harmful event all involved running off the road, two after a rear end crash. Eight of the 11 crashes specifically note hitting a tree.

- Five of these crashes were mapped to the I-26/ I-95 interchange area (or in the merge area just beyond the interchange).
- The eleven fatal crash locations are shown in Table 3.11 and mapped in Figure 3.4.
- In addition to the eleven fatal crashes, there were 15 crashes with incapacitating injuries.

### Table 3.11: Fatal Crashes on I-95 and I-26 in the Study Area

| Route | Date | Crash # | Number of Fatalities & Injuries | Direction of Flow | Crash Type | Prime Contributing Factor | Harmful Event |
|---|---|---|---|---|---|---|---|
| I-95 | 9/25/2016 | 1 | 1 fatality<br>5 injured | NB within I-26 interchange (MP 86.7) | Sideswipe | Improper Lane Use/Change | Ran Off Road |
| | 5/7/2018 | 2 | 3 fatalities | NB within I-26 interchange (MP 86.7) | Animal | Animal in Road | Tree |
| | 10/9/2019 | 3 | 1 fatality | NB near U.S. 176 interchange (MP 90.5) | Rear End | Unknown | Median Barrier |
| I-26 | 4/15/2017 | 4 | 1 fatality | WB near NC 210 interchange (MP 164.7) | Off Road | Unknown | Tree |
| | 10/30/2015 | 5 | 1 fatality | WB near NC 210 interchange (MP 164.7) | Rear End | Driving too Fast for Conditions | Ran off Road Left |
| | 10/16/2018 | 6 | 2 fatalities | EB (MP 166.4) | Off Road | Tires/Wheel | Tree |
| | 11/7/2016 | 7 | 1 fatality | EB within I-95 interchange (MP 168.7) | Off Road | Improper Lane use/change | Other (Post, Pole, Support) |
| | 9/9/2019 | 8 | 1 fatality | EB within I-95 interchange (MP 168.9) | Rear End | Other Improper Action | Tree |
| | 5/22/2015 | 9 | 1 fatality | EB within I-95 interchange (MP 168.9) | Off Road | Unknown | Tree |
| | 11/29/2016 | 10 | 1 fatality | WB (MP 169.3) | Off Road | Aggressive Operation | Tree |
| | 8/8/2018 | 11 | 1 fatality | EB (MP 170.2) | Off Road | Ran off Road | Tree |
| | 12/5/2019 | 12 | 1 fatality<br>1 injured | WB (MP 170.6) | Off Road | Ran off Road | Tree |
| | 10/22/2016 | 13 | 1 fatality | WB (MP 171.1) | Off Road | Ran off Road | Tree |
| | 9/27/2018 | 14 | 1 fatality | EB (MP 171.2) | Off Road | Improper Lane use/change | Ran off Road Left |

### Figure 3.4: Fatal Crashes in the Study Area



## 3.7 Safety Recommendations

FHWA's Proven Safety Countermeasures (PSC) are improvements that can be implemented to keep vehicles on the roadway, provide space for safe recovery, and reduce crash severity. This guide was consulted for the recommendations below. Overall, three critical crash issues need considered as part of the project design.

### *Weave Sections at the Existing I-26 at I-95 Full Cloverleaf*

As documented in Section 3.5, the existing interchange has four weave areas as part of the existing interchange along both I-26 and I-95. These weaves are bounded by lower speed loop ramps for traffic entering and exiting the interchange. All four weaves were also identified as high frequency crash locations in the study area.

Modern design practice recommends avoiding the use of weave sections on freeways (unless a parallel collector distributor is provided to serve the weave), especially with high volume movements and in rural areas with expectations for higher speeds and less congestion. In addition to safety concerns, the existing weaves are anticipated to become more congested in the future resulting in additional congestion and periods with queuing on the interstates.

To address this issue, there is no formal guidance except to avoid the use of weaves in new projects or in the improvement of existing facilities. For the I-26 at I-95 interchange, it is recommended that a directional interchange alternative be provided that eliminates the existing four weave sections. Note that the inclusion of loop ramps (with 30 mph or greater design speeds) for lower volume movements is still viable and included in the proposed alternatives under review.

### *Run Off Road Collisions*

Single-vehicle collisions account for 33 percent of crashes on I-95 and 35 percent on I-26. Related to this, on I-95 run off the road collisions account for 27 percent of all crashes, 40 percent of injury crashes, and none of the fatal crashes (although all three fatal crashes ultimately resulted in a vehicle hitting an object off the travelway even if it was not the initial cause of a crash). On I-26 the percentages of run off the road crashes are higher with 32 percent of all crashes, 47 percent of injury crashes, and 82 percent of fatal crashes (although like I-95, the two remaining "rear end" collision ultimately involved vehicles going off the road).

This type of crash is often the result of roadway departures and may include collisions with objects such as trees or guardrails. On I-26 in particular, trees were noted as being hit in 8 of the 11 fatal crashes. Overall, trees were identified in 26 percent of I-26 crashes and 10 percent of I-95 crashes. It was noted that median barriers and guard rails were involved in 15 percent of I-95 crashes and only 5 percent of I-26 crashes. A review of aerial mapping does indicate that there were trees in the median of I-26 west of I-95 and on I-95 north of I-26. Recent median improvement projects removed a good percentage of the trees in the median. In addition, based on the same aerial mapping, it appears that the clear zone on I-95 is wider and that trees are located closer to the travelway on I-26.

Potential countermeasures for reducing roadway departures include:

- Increasing pavement friction
- Implementation of rumble strips and stripes
- Speed-feedback signing
- Installing median barriers
- Evaluating horizontal curve safety
- Improving nighttime visibility
- Increasing clear zones
- Flattening side slopes

Rumble strips are currently installed on I-95 and I-26 in the project corridor. It is recommended that additional clear zones and flattening side slopes be implemented with the future improvements on I-95 in the project corridor.

### *Rear End Collisions*

Rear-end collisions were another common type of collision, especially on I-95. Rear-end collisions are typically the result of congestion on the roadway, following too closely, and driving too fast for conditions. On I-95, rear end crashes made up 46 percent of all crashes, 50 percent of injury crashes and 33 percent of fatal crashes. On I-26, rear end crashes made up 27 percent of all crashes, 26 percent of injury crashes and 18 percent of fatal crashes. In addition, 34 percent of rear end crashes on I-95 involve a stopped vehicle compared to 11 percent on I-26.

Potential countermeasures that may reduce rear-end collisions include:

- Improving pavement friction
- Increasing the number of lanes
- Increasing the length of acceleration/deceleration lanes
- Installing dynamic collision warning signs

Note that the higher percentage of rear end collisions is likely resulted high congestion and slowdowns on I-95, especially related to holidays and weekends. No widening is currently planned for I-95, but based on the crash patterns and capacity analysis, the provision of a longer southbound merge would be beneficial. A similar treatment can be considered on I-26 westbound.

I-26 has fewer rear end crashes than I-95. In addition, the planned widening of I-26 will reduce incidences of rear end crashes resulting from queuing vehicles on I-26.

All of the above countermeasures are recommended to be implemented with future improvements for the current project as well as future improvements on I-26 or I-95.

# 4. DEVELOPMENT OF ESTIMATED TRAFFIC

The development of traffic volumes for use in this study was documented in the approved *I-26 I-95 Traffic Forecast Tech Memo (September 2022)* which can be found in **Appendix D.**

## 4.1 Key Assumptions

Key assumptions utilized in the development of estimated future traffic volumes include:

- Traffic Forecasts were calculated for three years:
  - 2022 Existing
  - 2030 Year of Opening
  - 2050 Design Year
- Future growth rates and traffic forecasts were developed using multiple sources and factors including:
  - Traffic counts collected as part of the project effort in May 2022.
  - Historic AADT traffic data obtained from SCDOT's traffic count website.
  - Results from the South Carolina Statewide Model Version 4 for 2015 and 2045. This model also provided insights into anticipated future freight and truck on the roadway network.
  - Historic and projected population trends.
- Annual growth rates applied to the traffic forecasts varied by facility. Estimated annual growth rates (assuming annual compounding) included:
  - I-95 .................................................. 1.6 percent growth per year
  - I-26 .................................................. 1.8 percent growth per year
  - U.S. 176, U.S. 178 and SC 210 .............. 0.5 percent growth per year
  - U.S. 15 ................................................ 2.4 percent growth per year
- Detailed analysis of hourly, daily directional traffic flows was analyzed from two permanent count stations.
  - On I-26, station#0020 is located just west of the study area west of the SC 210 interchange.
  - On I-95, station #0056 is located in the study area between I-95 and U.S. 176 north of the I-26 at I-95 interchange.
  - In addition, other count stations were utilized at the key crossroads and other segments on I-26 and I-95.

## 4.2 Examination of Annual Hourly Traffic Patterns

A detailed examination of the appropriate peak periods for analysis was conducted using historical trends for peak volumes examining 365 days per year. Key findings and assumption were:

- 2019 historical data was utilized to develop a review of the normal annualized patterns of traffic reflecting all 12 months as well as daily flow patterns through the week. 2019 was selected to avoid any Covid-related impacts to traffic flow.
- Both I-26 and I-95 exhibit unique travel patterns reflecting a high-volume rural freeway serving both local, regional, and national travel patterns. Differences from a typical urban travel pattern include:
  - Neither I-26 or I-95 fit a typical urban weekday pattern with a distinct AM and PM peak period. Instead, traffic volumes are relatively high from 7 AM to 9 PM. The highest volumes occur between 12 noon and 5 PM with peaking occurring near 3 PM on both I-26 and I-95.
  - The peak period is not subject to heavy flows in one direction followed by a reverse pattern at a later point in the day. In the peak hour each day, traffic flows peak in both directions on I-26 and I-95.
  - The highest volumes occur on the Friday through Sunday weekend with typical daily volumes being 10 percent higher on these days than on the weekday.
- Based on these observations, this forecast has been developed assuming a single mid-day peak period (approximately 3 PM to 4 PM) with peak flows in both directions on I-95 and I-26.

More detailed analysis was conducted to identify an appropriate peak period based on examining annual flows and the highest hourly volumes over the year. Heavy variations in flow were noted throughout the year – both on weekdays and weekends. Key variations included:

- There is a heavy variation depending upon time of year and holiday travel.
  - On I-95, the highest volume days are before and after Thanksgiving and Christmas holidays.
  - I-26 experiences similar spikes at Thanksgiving and Christmas, but also has increased volumes between March and September likely associated with summer tourism at the coast.

- A review of highest hourly volumes was conducted for the hourly flows on both I-26 and I-95.
  - 2019 data was used to eliminate any Covid-related impacts to traffic flow.
  - Given the data set was based on 2019 data, the percent of hourly traffic was compared to the 2019 AADT to identify an appropriate design hour percentage (k). When an appropriate k-value was determined, it was applied to the 2022 baseline traffic forecast.

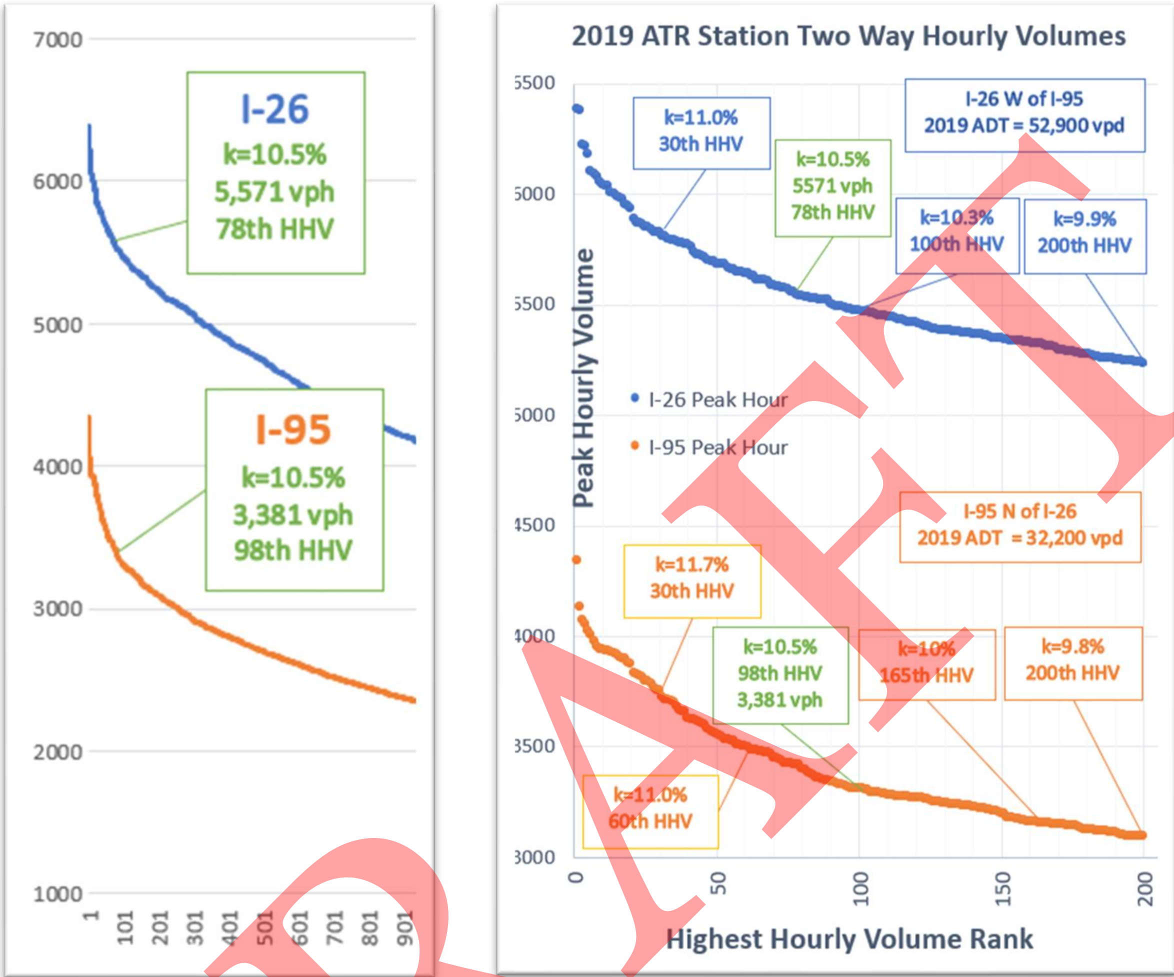
## 4.3 Identification of Peak Period Volumes

For most projects, AASHTO-recommended practice is to select an hour between the 30th and 100th highest hour of the year for roadway design. This approach allows for a balancing of construction costs for economic efficiency by avoiding over-designing for holidays and other events.

- In determining the k percentages for I-26 and I-95, a review of the highest hourly volume data was conducted, focused on identifying the "knee of the curve" as shown **Figure 4.1**. Selected k percentages include:
  - On I-26, a k-factor of 10.5 percent was selected reflecting the 78th Highest Hourly Volume (HHV).
  - On I-95, a k-factor of 10.5 percent was also selected reflecting the 98th HHV on I-95 (although the I-95 HHV is likely closer to the 150th HHV if all holiday data for 2019 were available).
- Although there is variation in actual counts, the design period reasonably approximates a typical Friday afternoon in the spring for I-26 and a higher volume Friday afternoon in the spring for I-95.

The estimated peak hour volumes developed for this study are presented in **Figure 4.2** (2022 Base Year), **Figure 4.3** (2030), and **Figure 4.4** (2050). The details of the traffic forecasting assumptions and methodologies is detailed in the Appendix D Traffic Forecast Technical Memorandum.

## Figure 4.1: Top 200 Highest Hourly Volumes on I-26 and I-95 for 2019




*1. The SCDOT 2019 automatic counter data for I-95 north of I-26 did not include weeks of Thanksgiving, Christmas, New Years as well as 3 summer weekends in 2019. After comparison to the complete I-26 data set, it is estimated that approx. 20 of top 150 HHV are missing on I-95.*

*2. To examine the highest hourly volume, 2019 data was used to get a clean data set without impacts of Covid. The data was used to develop k percentages for application to 2022 and future years.*

**Figure 4.2: 2022 Design Hour Traffic Volumes**

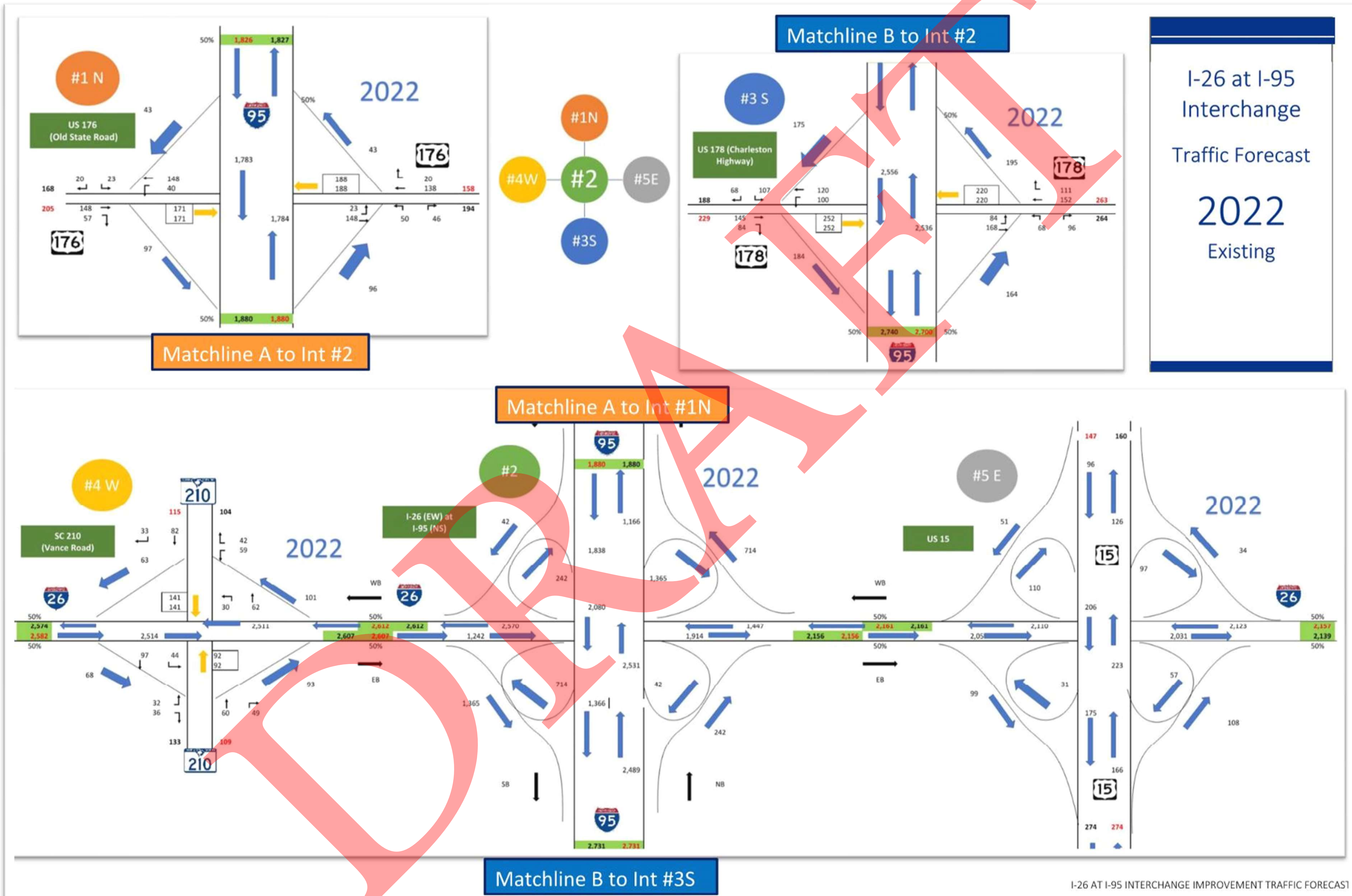


**Figure 4.3: 2030 Design Hour Traffic Volumes**

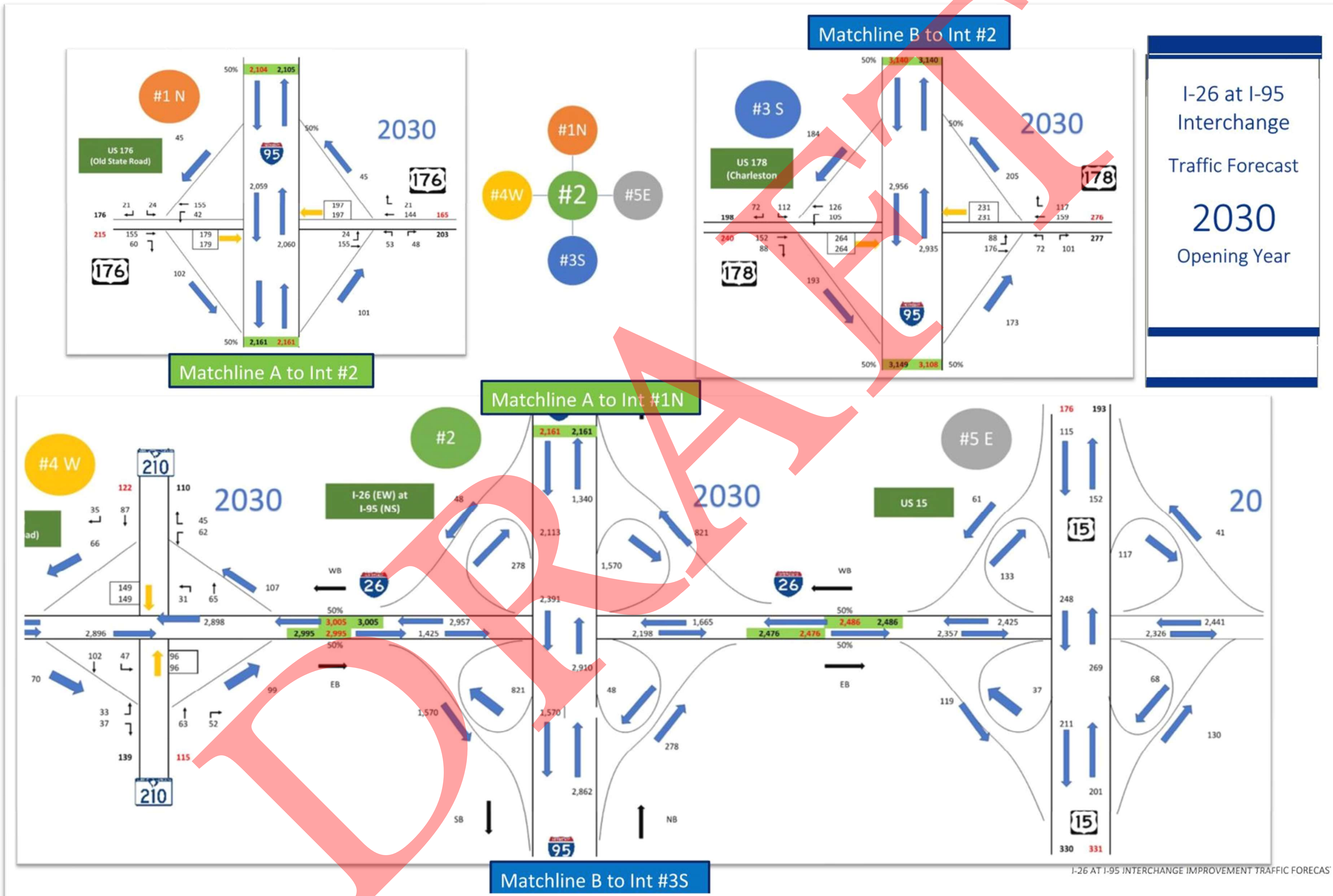
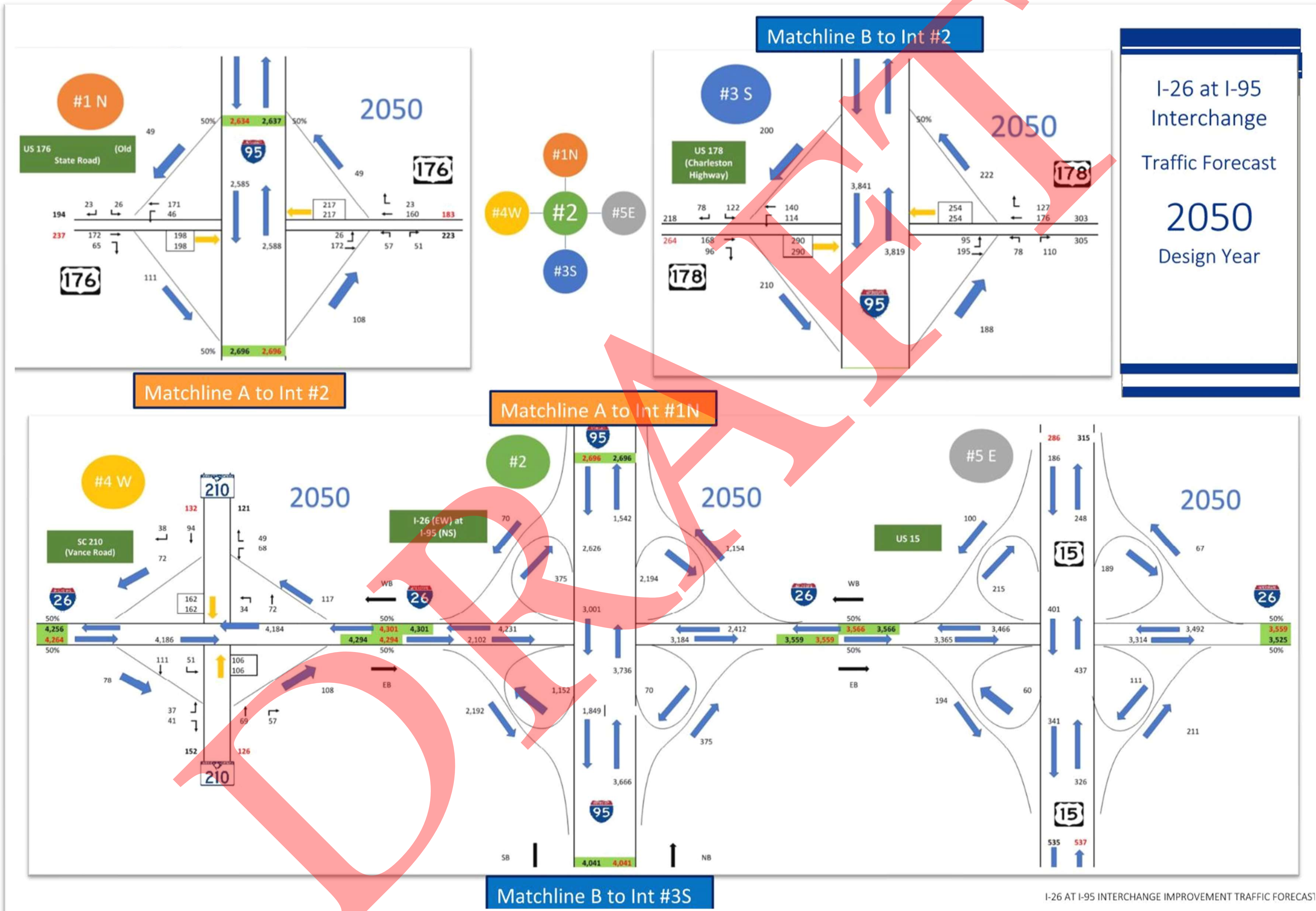


**Figure 4.4: 2050 Design Hour Traffic Volumes**



# 5. BUILD ALTERNATIVES

The existing I-26 at I-95 interchange is a full-clover interchange that currently experiences congestion issues that are expected to worsen with anticipated traffic growth. This project will be a full interchange improvement to address the operational deficiencies of the current full cloverleaf configuration. Key elements include removal of the four existing weaving sections (two on I-26 and two on I-95), providing directional ramps for key movements, and improving overall operations.

Three Build alternatives were developed and tested as replacements for the existing full-clover interchange. Primary features of all alternatives include the removal of multiple loop ramps and replacement with flyover movements combined with widening, improvements and realignments of specific ramp segments. Illustrations for each of the Build alternatives are included in **Figure 5.1**, **Figure 5.2** and **Figure 5.3**. Detailed capacity analysis is summarized in Sections 6 and 7.

## 5.1 Alternative 1: Stacked 4-Level Flyover with Two Loops

The key feature with Alternative 1 (see Figure 5.1) is the replacement of two loops with flyover ramps. The first flyover ramp would be two lanes connecting Interstate 95 northbound to Interstate 26 westbound, replacing the loop ramp in the northeast quadrant. The second flyover ramp would be a single lane connecting Interstate 95 southbound to Interstate 26 eastbound, replacing the loop ramp in the southwest quadrant. The two loop-ramps in the northwest and southeast quadrants will remain operational, albeit with an improved alignment and relocation. The most critical improvement related to the replacement of the two loop ramps is the elimination of the four weaving areas – two on I-95 and two on I-26.

The two loop-ramps that will be replaced with flyover ramps, carry higher traffic volumes than the loop-ramps that will be retained. The new flyover ramps would be higher speed lanes and provide more efficient movement when exiting from one interstate and merging onto the other interstate. In Alternative 1, the two flyovers will cross each other twice in order to keep reconstruction within the existing interchange footprint requiring a stacked four-level interchange design.

Two-lane ramps will be provided for the I-95 northbound to I-26 westbound flyover movement as well as the I-26 eastbound to I-95 southbound movement. Alternative 1 would keep the six remaining ramps as single-lane ramps. Of these ramps, LOS C is expected at the four lowest volume ramps, while LOS D is expected on the ramp from I-26 westbound to I-95 northbound as well as the flyover ramp from I-95 southbound to I-26 eastbound. Detailed capacity analysis is summarized in Sections 6 and 7.

## 5.2 Alternative 2: Modified Turbine with Two Loops

Similar to Alternative 1, Alternative 2 (see Figure 5.2) replaces the two loops in the northeast and southwest quadrant with flyover ramps. The first flyover ramp would connect Interstate 95 northbound to Interstate 26 westbound with a two-lane section. The second flyover ramp would connect Interstate 95 southbound to Interstate 26 eastbound on a single lane flyover. As in Alternative 1, the two loop-ramps in the northwest and southeast quadrants will remain operational although realignment is needed. The most critical improvement related to the replacement of two loop ramps is the elimination of the four weaving areas – two on I-95 and two on I-26.

The two loop-ramps that will be replaced with flyover ramps, carry higher traffic volumes than the loop-ramps that will be retained. The flyover ramps for Alternative 2 vary from Alternative 1 in that they would be constructed outside the limits of the existing loop ramps utilizing a modified turbine type layout. The primary impact of this treatment is a reduction in the length and complexity of bridges (although more bridges are required) as compared with Alternative 1. Overall, Alternative 1 and 2 have the same traffic patterns and volumes with the primary differences being the alignments, footprint and other design features.

Two-lane ramps will be provided for the I-95 northbound to I-26 westbound flyover movement (LOS D) as well as the I-26 eastbound to I-95 southbound movement. Alternative 2 would keep the six remaining ramps as single-lane ramps. Of these ramps, LOS C or better is expected at the four lowest volume ramps, while LOS D is expected on the ramp from I-26 westbound to I-95 northbound as well as the flyover ramp from I-95 southbound to I-26 eastbound. From a traffic capacity perspective, however, Alternative 1 and Alternative 2 operate very similarly. Detailed capacity analysis is summarized in Sections 6 and 7.

## 5.3 Alternative 3: Modified Turbine with One Loop

Alternative 3 (see Figure 5.3) is similar to Alternative 2 except that it includes three flyover ramps (instead of two) and eliminates three loop ramps (instead of two). The first flyover ramp would connect Interstate 95 northbound to Interstate 26 westbound, replacing a one loop-ramp with a two-lane flyover. The second flyover ramp would connect Interstate 95 southbound to Interstate 26 eastbound, replacing a one lane loop-ramp with a one lane flyover. Alternative 3 adds a third flyover ramp that would connect Interstate 26 westbound to Interstate 95 southbound, replacing the loop in the northwest quadrant. The fourth loop ramp (serving the lowest volumes) connecting Interstate 26 eastbound to Interstate 95 northbound would remain operational. Similar to Alternatives 1 and 2, Alternative 3 eliminates the four weaving areas within the existing interchange.

The new flyover ramps that would replace the loops would be higher speed lanes and provide more efficient movement when exiting from one interstate and merging onto the other interstate. The flyover ramps for Alternative 3 are similar to Alternative 2 in that they would be constructed outside the limits of the existing loop ramps utilizing a modified turbine type layout (instead of a stacked design of multiple levels). The primary impact of this treatment is a reduction in the length and complexity of bridges (although more bridges are required for Alternative 3 than Alternative 2).

Two-lane ramps will be provided for the I-95 northbound to I-26 westbound flyover movement (LOS D) as well as the I-26 eastbound to I-95 southbound movement (LOS C). Alternative 3 would maintain the six remaining ramps as single-lane ramps. Of these ramps, LOS C or better is expected at the four lowest volume ramps, while LOS D is expected on the ramp from I-26 westbound to I-95 northbound as well as the flyover ramp from I-95 southbound to I-26 eastbound. The capacity results will be examined in detail in the following sections.

**Figure 5.1: Alternative 1 Layout**

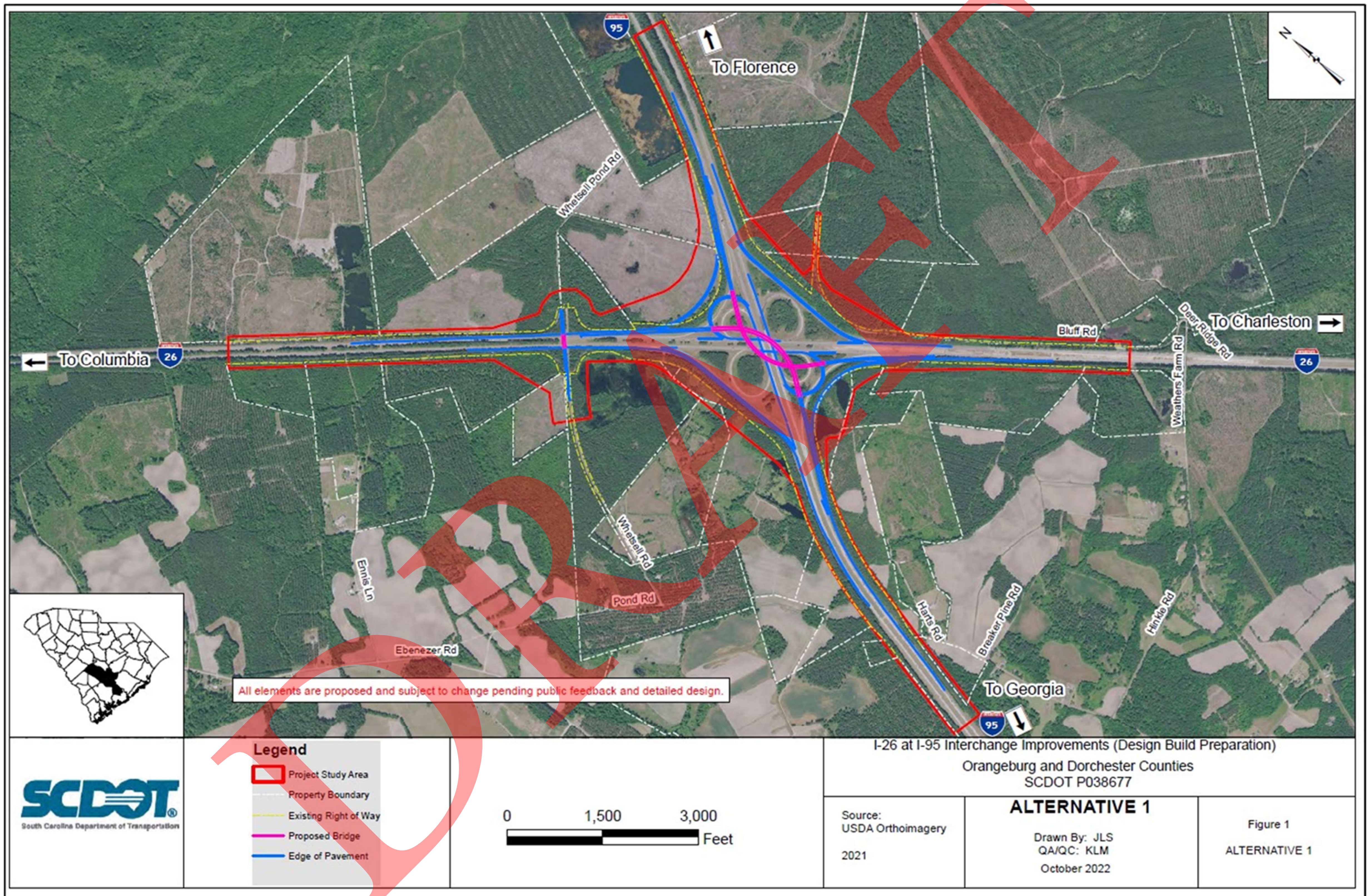


**Figure 5.2: Alternative 2 Layout**

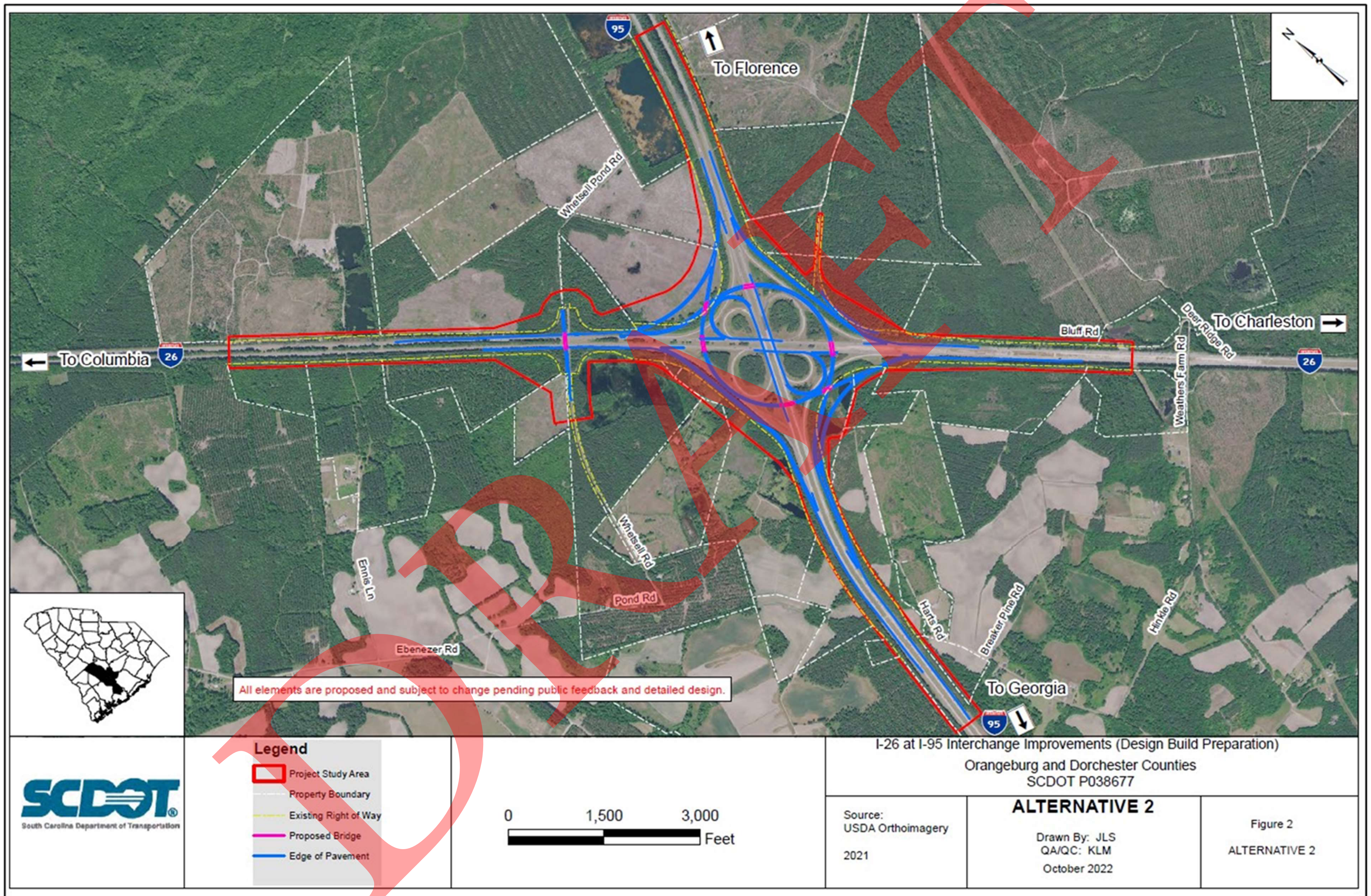
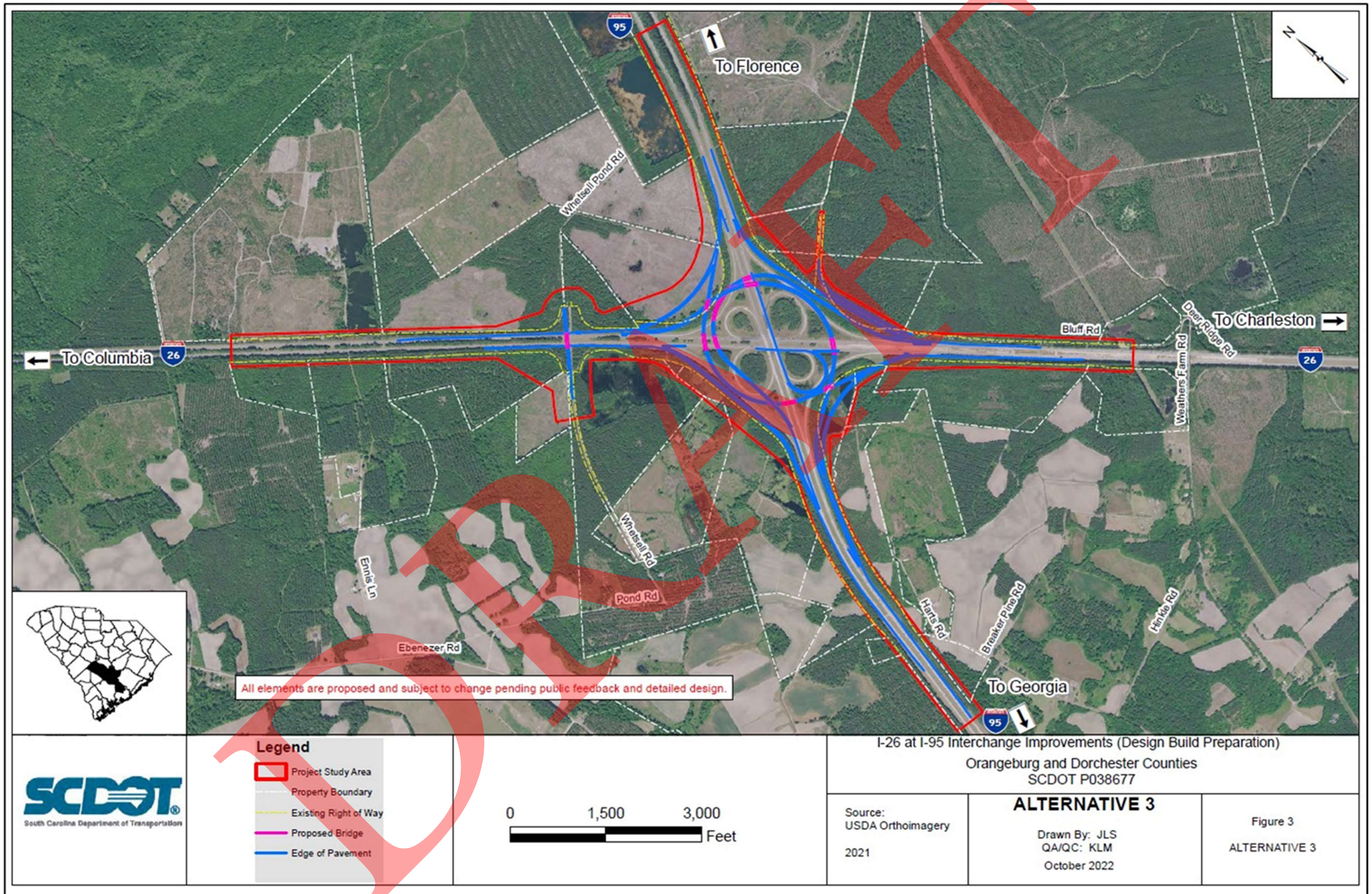


**Figure 5.3: Alternative 3 Layout**



# 6. CORRIDOR CAPACITY ANALYSIS - HCS

A series of capacity analyses were performed based on the methodologies and guidelines in the **Highway Capacity Manual (HCM) - 6th Edition**. Various software analysis and simulation packages based on the HCM were used in performing the analyses. These included:

- McTrans HCS 7 (Version 7.9.6)
  - Freeway Segments
  - Ramp Merge/Diverge Areas
- Caliper's TransModeler (version 6.1 Build 8570)
  - Network Simulation
  - Freeway Segments
  - Ramp Merge/Diverge Areas

## 6.1 Freeway Level of Service Criteria

**Table 6.1** shows the HCM LOS criteria for basic freeway segments. LOS F occurs when either the segment density exceeds 45 pc/mi/ln or when the segment v/c ratio exceeds 1.0 (regardless of the segment density). The two are distinguished by color because a v/c > 1.0 indicates flow breakdown.

### Table 6.1: HCM Basic Segment LOS Criteria

| LOS | Density (pc/mi/ln) |
|---|---|
| A | < 11 |
| B | > 11 - 18 |
| C | > 18 - 26 |
| D | > 26 - 35 |
| E | > 35 - 45 |
| F | > 45 |
| F* | v/c > 1.0 |

**Table 6.2** shows the HCM LOS criteria for ramp merge and diverge areas.

**Table 6.2: HCM Merge/Diverge LOS Criteria**

| LOS | Density (pc/mi/ln) |
|---|---|
| A | < 10 |
| B | > 10 - 20 |
| C | > 20 - 28 |
| D | > 28 - 35 |
| E | > 35 |
| F | v/c > 1.0 |

**Table 6.3** shows the HCM LOS criteria for rural freeway facilities. This is used to describe the overall corridor LOS. LOS F and v/c > 1.0 are distinguished by color because a v/c > 1.0 indicates flow breakdown.

**Table 6.3: HCM Freeway Facility LOS Criteria (Rural)**

| LOS | Density (pc/mi/ln) |
|---|---|
| A | ≤ 6 |
| B | > 6 - 14 |
| C | > 14 - 22 |
| D | > 22 - 29 |
| E | > 29- 39 |
| F | > 39 |
| F* | v/c > 1.0 |

**Table 6.4** shows the HCM LOS criteria for ramp weave areas.

**Table 6.4: HCM Weave LOS Criteria**

| LOS | Density (pc/mi/ln) |
|---|---|
| A | < 10 |
| B | > 10 - 20 |
| C | > 20 - 28 |
| D | > 28 - 35 |
| E | > 35 - 43 |
| F | > 43 |

## 6.2 HCS Freeway Analysis – Existing & No Build

This section presents the peak hour HCS corridor analysis for 2022 existing conditions, 2030 and 2050 under No Build and Build conditions. Based on the design criteria for rural freeways presented in SCDOT's 2021 Roadway Design Manual, Highway Capacity Manual (HCM) LOS C is the preferred minimum LOS for a rural interstate analysis. SCDOT guidance for this project is that a LOS D will be viewed as an acceptable minimum LOS.

Using the projected traffic by the travel demand model analysis, future truck percentages are expected to be higher on I-26 than on I-95. For 2030 peak analysis both I-26 and I-95 expect 22 percent of volumes to be trucks, but by 2050 the truck percentage on I-26 will increase to 28 percent while I-95 will remain at 22 percent. In this section, the truck percentages are shown on the tables below for all segments in existing and future conditions.

The Freeway Facilities module of the 2022 Highway Capacity Software (HCS) was used for the majority of the analysis. This module summarizes LOS with the freeway being divided into separate segments for basic segments (i.e. freeway), merges, diverges and weave segments.

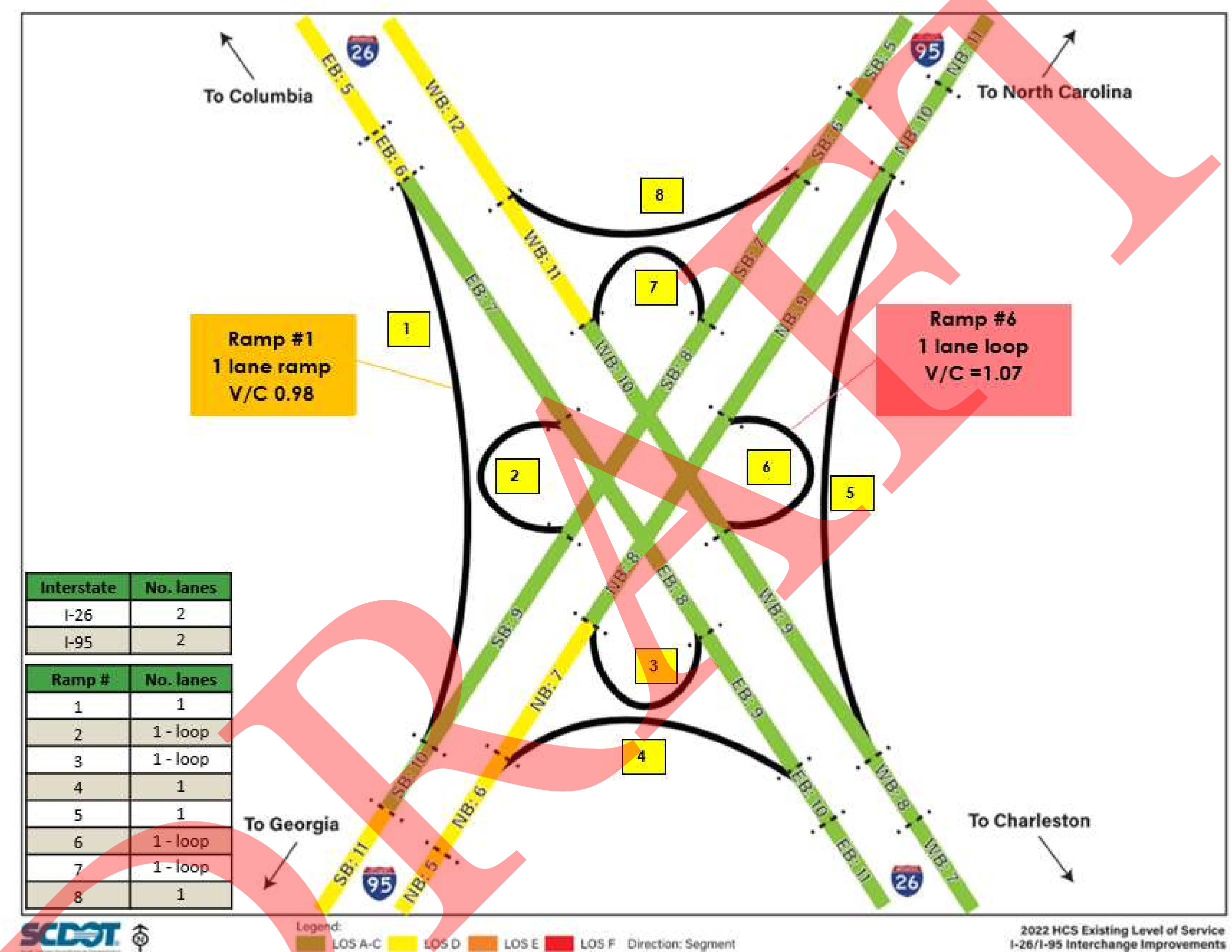
Unfortunately, the latest version of the HCS does not provide a simply defined methodology for estimating ramp roadway capacity. Instead, it assumes that the capacity of a ramp is defined by the critical merge, diverge or weave segment on the ramp. While this is strictly true from an operations standpoint, a simplified volume to capacity ratio was also performed based on ramp capacities from the HCS software. Recognizing that this method does not define a true LOS, the V/C ratios can still be used to provide a basic analysis of the adequacy of a given ramp.

The results indicate that the freeway currently exceeds acceptable LOS conditions in some segments. The planned addition of a travel lane in each direction of I-26 will improve the performance of the interstate compared to the unwidened scenario, but multiple segments still exceed LOS D in both directions. Detailed HCS reports from the Freeway segment analysis and the V/C ramp analysis are available in **Appendix E**.

## 6.2.1 2022 Existing Conditions

A visual representation of the estimated 2022 Existing conditions LOS is shown in **Figure 6.1**. This includes both a summary of ramp capacity thresholds based on V/C ratios and a formal HCS Freeway Facility analysis. Ramp LOS and density are also examined in the TransModeler analysis included in Chapter 7.

### Figure 6.1: HCS Estimated 2022 Existing LOS & Critical V/C Ramps






### ***Ramp V/C Analysis***

Since the current HCS methodology does not provide a method to report ramp LOS, a volume to capacity analysis was performed to identify if and when ramps may need to be considered for widening. In performing this analysis, forecasted ramp volumes and ramp capacities were converted into passenger car per hour equivalents taking into account truck percentages as reported in the HCS Freeway analysis for the merge, diverge and weave analyses. These volumes were then placed into a spreadsheet analysis to develop a V/C ratio.

Although a V/C ratio is not utilized to determine LOS, it does provide a general measure to identify if and when a ramp is reaching near capacity and could require widening or other improvements. This can be especially useful when developing interchange alternatives and concepts. **Table 6.5** illustrates the key thresholds identified for ramp operations in this study. As noted, these thresholds are used to present context, but do not reflect official HCM LOS analysis. The ramp V/C analysis for 2022 existing conditions is summarized in **Table 6.6**.

### Table 6.5: V/C Ramp Analysis Thresholds

| Capacity Status | V/C Ratio |
|---|---|
| Substantially Under Capacity | <0.30 |
| Under Capacity | 0.30 - 0.60 |
| Stable Flow but Nearing Capacity | 0.60 - 0.80 |
| Unstable Flow/ At or Near Capacity | 0.80 - 1.00 |
| Over Capacity | 1.00 - 1.20 |
| Substantially Over Capacity | > 1.20 |

### Table 6.6: 2022 Existing V/C Ramp Analysis

| Movement/ Ramp # | Movement | # Lanes | Ramp Type | Volume (pcph) | Capacity (pcph) | V/C | Capacity |
|---|---|---|---|---|---|---|---|
| 1 | I-26 EB to I-95 SB | 1 | Ramp | 1,841 | 1,878 | 0.98 | Unstable Flow At/ Near Capacity |
| 2 | I-95 SB to I-26 EB | 1 | Loop | 924 | 1,784 | 0.52 | Under |
| 3 | I-26 EB to I-95 NB | 1 | Loop | 53 | 1,784 | 0.03 | Substantially Under |
| 4 | I-95 NB to I-26 EB | 1 | Ramp | 313 | 1,878 | 0.17 | Substantially Under |
| 5 | I-26 WB to I-95 NB | 1 | Ramp | 916 | 1,878 | 0.49 | Under |
| 6 | I-95 NB to I-26 WB | 1 | Loop | 1,918 | 1,784 | 1.07 | Over |
| 7 | I-26 WB to I-95 SB | 1 | Loop | 313 | 1,784 | 0.18 | Substantially Under |
| 8 | I-95 SB to I-26 WB | 1 | Ramp | 59 | 1,878 | 0.03 | Substantially Under |

## ***Freeway Facility HCS Analysis***

The results of the 2022 Existing conditions indicate that I-26 eastbound and westbound directions are currently operating at an acceptable LOS threshold. Only the segments east of the I-26 and I-95 interchange show LOS D, and the majority of the segments operate at LOS C or better. On I-95, all segments are operating at LOS D or better. The segments south of the interchange are expected to have a higher density especially at the merge from I-26 eastbound and diverge to the westbound direction.

**Table 6.7** and **Table 6.8** show the capacity analysis results for 2022 peak conditions for I-26 eastbound and westbound directions. Note that segments west and east of the I-26 at I-95 interchange are shown in grey. Also note that Corridor LOS is provided by the HCS Freeway Facilities module to represent an overall LOS for the entire section. It can be substantially impacted by a single section of roadway, however, and is not intended to determine whether operations are acceptable.

The key segments pertaining to the I-26 at I-95 interchange are shown with color shading for the LOS as identified in Table 6.1 through Table 6.4.

### Table 6.7: 2022 Existing Conditions HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 2 | 2582 | 24% | D | 28.1 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 2 | 2582 | 24% | D | 31.3 |
| | | | 1 | 68 | 27% | | 30.2 |
| 3 | Between SC 210 Ramps | Basic | 2 | 2514 | 24% | D | 27.0 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 2 | 2514 | 24% | C | 30.5 |
| | | | 1 | 93 | 14% | | 27.5 |
| 5 | Between SC 210 and I-95 | Basic | 2 | 2607 | 23% | D | 28.1 |
| 6 | I-26 Off-Ramp to I-95 | Diverge | 2 | 2607 | 23% | D | 33.7 |
| | | | 1 | 1365 | 24% | | 32.1 |
| 7 | Between I-95 Ramps | Basic | 2 | 1242 | 22% | B | 12.2 |
| 8 | Between I-95 Ramps | Weaving | 3 | 1242 | 21% | B | 15.4 |
| | | | 1 | 42 | 17% | | 15.4 |
| | | | 1 | 714 | 19% | | 15.4 |
| 9 | Between I-95 Ramps | Basic | 2 | 1914 | 21% | C | 18.8 |
| 10 | I-26 On-Ramp from I-95 | Merge | 2 | 1914 | 21% | C | 24.0 |
| | | | 1 | 242 | 28% | | 22.4 |
| 11 | Between I-95 and U.S. 15 | Basic | 2 | 2156 | 22% | C | 25.5 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 2 | 2156 | 22% | C | 21.5 |
| | | | 1 | 99 | 28% | | 23.7 |
| 13 | Between U.S. 15 Ramps | Basic | 2 | 2057 | 22% | C | 20.4 |
| 14 | Between U.S. 15 Ramps | Weaving | 3 | 2000 | 22% | B | 14.8 |
| | | | 1 | 31 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 2 | 2031 | 22% | C | 20.1 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 2 | 2031 | 22% | C | 24.0 |
| | | | 1 | 108 | 20% | | 22.3 |
| 17 | East of U.S. 15 | Basic | 2 | 2139 | 21% | C | 21.2 |
| | | | | | Corridor | D | 23.3 |

### Table 6.8: 2022 Existing Conditions HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 2 | 2157 | 21% | C | 21.4 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 2 | 2157 | 21% | C | 23.4 |
| | | | 1 | 34 | 11% | | 24.5 |
| 3 | Between U.S. 15 Ramps | Basic | 2 | 2123 | 21% | C | 21.0 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 2 | 2013 | 22% | B | 16.4 |
| | | | 1 | 97 | 38% | | 16.4 |
| 5 | Between U.S. 15 Ramps | Basic | 2 | 2110 | 22% | C | 20.7 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 2 | 2110 | 22% | C | 24.1 |
| | | | 1 | 51 | 17% | | 22.7 |
| 7 | Between U.S. 15 and I-95 | Basic | 2 | 2161 | 22% | C | 21.6 |
| 8 | I-26 Off-Ramp to I-95 | Diverge | 2 | 2161 | 22% | C | 27.4 |
| | | | 1 | 714 | 18% | | 26.3 |
| 9 | Between I-95 Ramps | Basic | 2 | 1447 | 24% | B | 14.5 |
| 10 | Between I-95 Ramps | Weaving | 3 | 1447 | 24% | C | 27.5 |
| | | | 1 | 242 | 19% | | 27.5 |
| | | | 1 | 1365 | 19% | | 27.5 |
| 11 | Between I-95 Ramps | Basic | 2 | 2560 | 27% | D | 28.7 |
| 12 | I-26 On-Ramp from I-95 | Merge | 2 | 2560 | 27% | D | 31.4 |
| | | | 1 | 42 | 30% | | 29.5 |
| 13 | Between SC 210 and I-95 | Basic | 2 | 2602 | 27% | D | 29.5 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 2 | 2602 | 27% | D | 29.8 |
| | | | 1 | 101 | 20% | | 31.1 |
| 15 | Between SC 210 Ramps | Basic | 2 | 2501 | 27% | D | 27.7 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 2 | 2501 | 27% | C | 30.9 |
| | | | 1 | 63 | 19% | | 27.6 |
| 17 | West of SC 210 | Basic | 2 | 2564 | 27% | D | 28.8 |
| | | | | | Corridor | D | 25.3 |

**Table 6.9** and **Table 6.10** show the capacity analysis results for 2022 peak conditions on I-95 northbound and southbound.

### Table 6.9: 2022 Existing Conditions HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 2700 | 26% | D | 30.6 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 2700 | 26% | D | 33.1 |
| | | | 1 | 164 | 23% | | 34.0 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 2536 | 26% | D | 27.7 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2536 | 26% | D | 33.1 |
| | | | 1 | 195 | 39% | | 29.5 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 2731 | 27% | D | 31.7 |
| 6 | I-95 Off-Ramp to I-26 EB | Diverge | 2 | 2731 | 27% | D | 34.9 |
| | | | 1 | 242 | 28% | | 34.6 |
| 7 | Between I-26 Ramps | Basic | 2 | 2489 | 27% | D | 27.3 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 42 | 29% | C | 24.1 |
| | | | 3 | 2531 | 27% | | |
| | | | 1 | 1365 | 29% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1166 | 24% | B | 11.5 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1166 | 24% | B | 20.7 |
| | | | 1 | 714 | 18% | | 18.6 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 1880 | 22% | C | 18.3 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 1880 | 22% | B | 22.2 |
| | | | 1 | 96 | 17% | | 18.5 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 1784 | 22% | B | 17.4 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 1784 | 22% | B | 20.2 |
| | | | 1 | 43 | 20% | | 19.4 |
| 15 | North of U.S. 176 | Basic | 2 | 1827 | 22% | B | 17.8 |
| | | | | | Corridor | D | 23.4 |

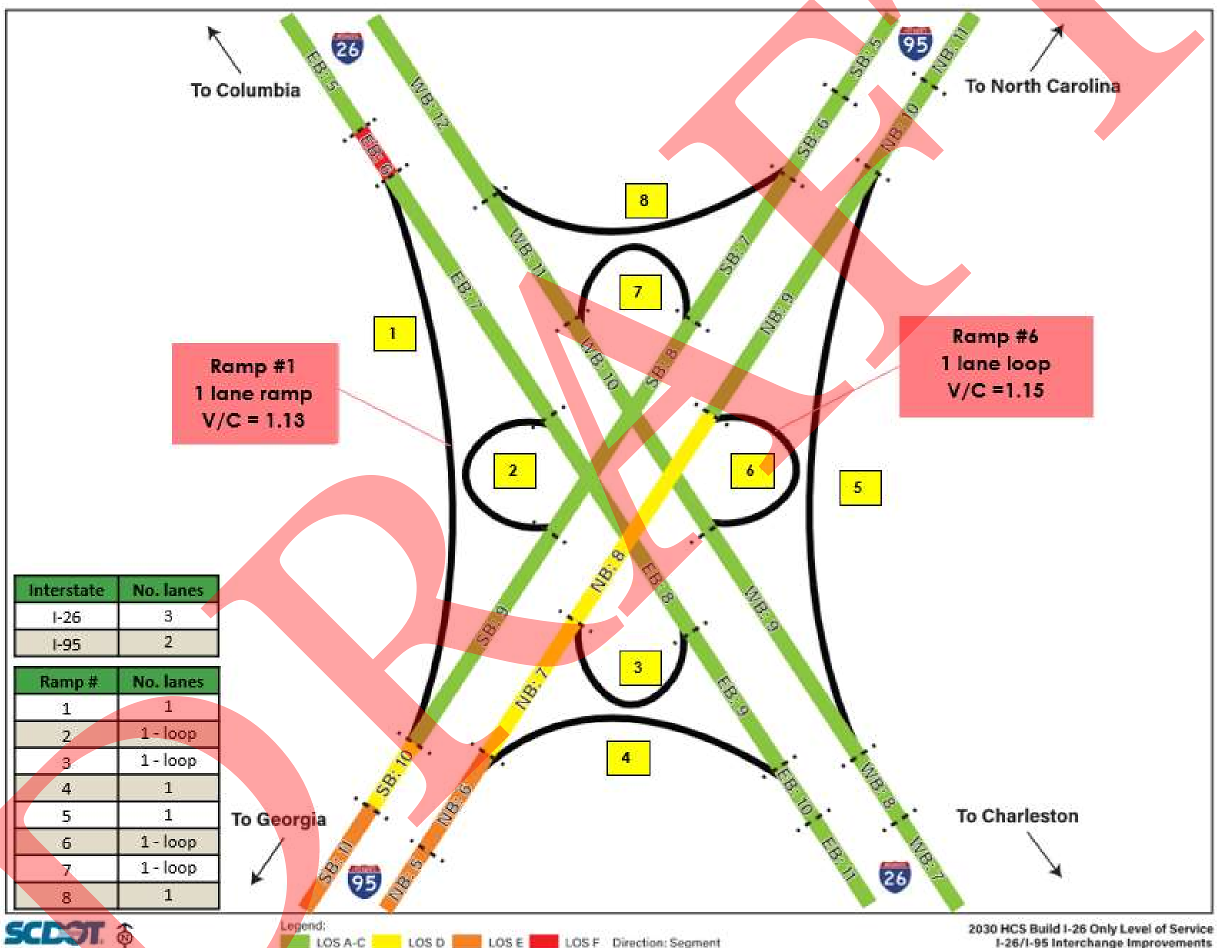
## Table 6.10: 2022 Existing Conditions HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 1826 | 22% | B | 17.8 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 1826 | 22% | C | 21.5 |
| | | | 1 | 43 | 19% | | 22.5 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 1783 | 22% | B | 17.4 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 1783 | 22% | B | 20.6 |
| | | | 1 | 97 | 17% | | 18.6 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 1880 | 22% | C | 18.3 |
| 6 | I-95 Off-Ramp to I-26 WB | Diverge | 2 | 1880 | 22% | C | 22.8 |
| | | | 1 | 42 | 30% | | 24.2 |
| 7 | Between I-26 Ramps | Basic | 2 | 1838 | 22% | B | 17.9 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 242 | 19% | B | 16.6 |
| | | | 3 | 2080 | 22% | | |
| | | | 1 | 714 | 19% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1366 | 22% | B | 13.2 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1366 | 22% | C | 31.3 |
| | | | 1 | 1365 | 24% | | 26.7 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 2731 | 23% | D | 30.0 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 2731 | 23% | D | 32.7 |
| | | | 1 | 175 | 31% | | 33.4 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2556 | 23% | D | 27.1 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2556 | 23% | C | 31.2 |
| | | | 1 | 184 | 19% | | 27.5 |
| 15 | South of U.S. 178 | Basic | 2 | 2740 | 22% | D | 29.8 |
| | | | | | Corridor | D | 22.5 |

## 6.2.2 2030 No Build Conditions

A visual representation of the estimated 2030 Year of Opening LOS analysis is shown in **Figure 6.2**. This includes both a summary of ramp capacity thresholds based on V/C ratios at critical links and a formal HCS Freeway Facility analysis. As stated previously, the V/C analysis is intended to provide additional information as part of the alternative development process but is not a formal HCS criteria. It can also be indicative of where a ramp junction may be subject to queuing that could impact operations on adjacent links.

### Figure 6.2: HCS Estimated 2030 No Build LOS & Critical V/C Ramps






### *Ramp V/C Analysis*

Since the current HCS methodology does not provide a method to report ramp LOS, a volume to capacity analysis was performed in order to identify if and when ramps may need to be considered for widening. The ramp V/C analysis for 2030 No Build conditions is summarized in **Table 6.11**.

**Table 6.11: 2030 No Build V/C Ramp Analysis**

| Movement/ Ramp # | Movement | # Lanes | Ramp Type | Volume (pcph) | Capacity (pcph) | V/C | Capacity |
|---|---|---|---|---|---|---|---|
| 1 | I-26 EB to I-95 SB | 1 | Ramp | 2,117 | 1,878 | 1.13 | Over |
| 2 | I-95 SB to I-26 EB | 1 | Loop | 1,062 | 1,784 | 0.60 | Under |
| 3 | I-26 EB to I-95 NB | 1 | Loop | 61 | 1,784 | 0.03 | Substantially Under |
| 4 | I-95 NB to I-26 EB | 1 | Ramp | 387 | 1,878 | 0.21 | Substantially Under |
| 5 | I-26 WB to I-95 NB | 1 | Ramp | 1,054 | 1,878 | 0.56 | Under |
| 6 | I-95 NB to I-26 WB | 1 | Loop | 2,053 | 1,784 | 1.15 | Over |
| 7 | I-26 WB to I-95 SB | 1 | Loop | 360 | 1,784 | 0.20 | Substantially Under |
| 8 | I-95 SB to I-26 WB | 1 | Ramp | 68 | 1,878 | 0.04 | Substantially Under |

## ***Freeway Facility HCS Analysis***

The results of the 2030 No Build conditions indicate that I-26 eastbound and westbound direction are expected to operate at an acceptable LOS. The diverge segment from I-26 eastbound to I-95 southbound exceeds capacity showing LOS F despite the No Build assumption of a six lane I-26. This is the result of the existing one-lane ramp from I-26 eastbound to I-95 southbound that carries a high volume of vehicles. The congestion on the one lane ramp facility also results in LOS F corridor capacity based on the HCS analysis methods. The westbound direction shows acceptable LOS.

As previously explained, corridor LOS is provided by the HCS Freeway Facilities module to represent an overall LOS for the entire section. It can be substantially impacted by a single section of roadway, however, and is not intended to determine whether operations are acceptable. Nevertheless, for freeway corridors that have a LOS E or LOS F operation, some explanation is provided as a footnote for each table.

On I-95, most segments are operating at LOS D or better. However, the segments south of the interchange shows LOS E, at the southbound merge segment from I-26 eastbound and at the northbound diverge to the I-26 eastbound. It is not shown in Figure 6.2, but is shown in **Table 6.14**, but note that I-95 northbound has an overall corridor LOS F due to the volume on the I-95 northbound to I-26 westbound loop ramp operating at overcapacity conditions.

**Table 6.12** and **Table 6.13** show the capacity analysis results for the 2030 peak No Build condition for I-26 eastbound and westbound direction.

## Table 6.12: 2030 No Build HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 2966 | 24% | C | 19.9 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 2966 | 24% | C | 22.1 |
| | | | 1 | 70 | 27% | | 23.1 |
| 3 | Between SC 210 Ramps | Basic | 3 | 2896 | 24% | C | 19.4 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 2896 | 24% | B | 22.0 |
| | | | 1 | 99 | 14% | | 19.4 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 2995 | 23% | C | 20.1 |
| 6 | I-26 Off-Ramp to I-95 | Diverge | 3 | 2995 | 23% | F | 45.0 |
| | | | 1 | 1570 | 24% | | 29.6 |
| 7 | Between I-95 Ramps | Basic | 3 | 1425 | 22% | A | 9.4 |
| 8 | Between I-95 Ramps | Weaving | 4 | 1425 | 22% | B | 13.5 |
| | | | 1 | 48 | 17% | | 13.5 |
| | | | 1 | 821 | 19% | | 13.5 |
| 9 | Between I-95 Ramps | Basic | 3 | 2198 | 21% | B | 14.4 |
| 10 | I-26 On-Ramp from I-95 | Merge | 3 | 2198 | 21% | B | 17.9 |
| | | | 1 | 278 | 28% | | 16.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 2476 | 22% | B | 16.3 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2476 | 22% | B | 17.2 |
| | | | 1 | 119 | 28% | | 16.4 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 2357 | 22% | B | 15.5 |
| 14 | Between U.S. 15 Ramps | Weaving | 4 | 2289 | 22% | B | 12.7 |
| | | | 1 | 37 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 2326 | 22% | B | 15.3 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 2326 | 22% | C | 17.6 |
| | | | 1 | 130 | 20% | | 16.0 |
| 17 | East of U.S. 15 | Basic | 3 | 2456 | 21% | C | 16.1 |
| | | | | | Corridor | D | 18.0 |

*Note: LOS F operations occur on Segment 6 despite widening of I-26 to 6 lanes because the No Build conditions assumes that Ramp #1 (I-26 EB to I-95 SB) requires widening to two lanes. As a result, queuing and poor operations may occur onto I-26 EB upstream of the diverge that is not reflected in the HCS methodology.*

## Table 6.13: 2030 No Build HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 2482 | 21% | B | 16.2 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2482 | 21% | B | 17.0 |
| | | | 1 | 41 | 11% | | 19.2 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 2441 | 21% | B | 15.9 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 2308 | 22% | B | 14.1 |
| | | | 1 | 117 | 38% | | 14.1 |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 2425 | 22% | B | 15.6 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 2425 | 22% | B | 17.7 |
| | | | 1 | 61 | 17% | | 16.0 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 2486 | 22% | B | 16.3 |
| 8 | I-26 Off-Ramp to I-95 | Diverge | 3 | 2486 | 22% | C | 19.1 |
| | | | 1 | 821 | 18% | | 22.8 |
| 9 | Between I-95 Ramps | Basic | 3 | 1665 | 24% | B | 11.1 |
| 10 | Between I-95 Ramps | Weaving | 4 | 1665 | 24% | C | 22.0 |
| | | | 1 | 278 | 19% | | 22.0 |
| | | | 1 | 1570 | 29% | | 22.0 |
| 11 | Between I-95 Ramps | Basic | 3 | 2742 | 27% | C | 18.8 |
| 12 | I-26 On-Ramp from I-95 | Merge | 3 | 2742 | 27% | B | 21.1 |
| | | | 1 | 48 | 30% | | 19.6 |
| 13 | Between SC 210 and I-95 | Basic | 3 | 2790 | 27% | C | 19.1 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 2790 | 27% | C | 21.3 |
| | | | 1 | 107 | 20% | | 22.3 |
| 15 | Between SC 210 Ramps | Basic | 3 | 2683 | 27% | C | 18.4 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 2683 | 27% | C | 20.6 |
| | | | 1 | 66 | 19% | | 18.1 |
| 17 | West of SC 210 | Basic | 3 | 2749 | 27% | D | 18.8 |
| | | | | | Corridor | F | 17.9 |

*Note: HCS reports LOS F operations for the overall corridor (although no segment is worse than LOS D) due to the HCS methodology for weave analysis. HCS calculates the weaving LOS using volumes that do not exceed the loop ramps on either end. In this case, Ramp #6 (the highest volume loop from I-95 NB to I-26 WB) volumes exceed the loop capacity and the methodology analyzes the weave with a lower constrained volume. The corridor is reported at LOS F, however, because the demand to enter I-26 westbound from the loop is not being served. As a result, queuing and poor operations may occur onto I-26 WB upstream of the weave that is not reflected in the HCS methodology except in the corridor LOS. TransModeler analysis is required.*

**Table 6.14** and **Table 6.15**, show the capacity analysis results for 2030 peak conditions on I-95 northbound and southbound.

### Table 6.14: 2030 No Build HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 3108 | 26% | E | 40.1 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3108 | 26% | E | 38.1 |
| | | | 1 | 173 | 23% | | 38.8 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 2935 | 26% | E | 35.6 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2935 | 26% | E | 40.4 |
| | | | 1 | 205 | 39% | | 33.9 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 3140 | 27% | E | 41.8 |
| 6 | I-95 Off-Ramp to I-26 EB | Diverge | 2 | 3140 | 27% | E | 40.2 |
| | | | 1 | 278 | 28% | | 39.5 |
| 7 | Between I-26 Ramps | Basic | 2 | 2862 | 27% | D | 34.5 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 48 | 17% | D | 28.9 |
| | | | 3 | 2910 | 27% | | |
| | | | 1 | 1570 | 29% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1340 | 24% | B | 13.3 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1340 | 24% | C | 24.0 |
| | | | 1 | 821 | 18% | | 21.4 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2161 | 22% | C | 25.5 |
| | | | 1 | 101 | 17% | | 21.7 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2060 | 22% | C | 20.3 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2060 | 22% | C | 23.4 |
| | | | 1 | 45 | 20% | | 22.3 |
| 15 | North of U.S. 176 | Basic | 2 | 2105 | 22% | C | 20.8 |
| | | | | | Corridor | F | 28.7 |

*Note: HCS reports LOS F operations for the overall corridor (although no segment is worse than LOS E) due to the HCS methodology for weave analysis. HCS calculates the weaving LOS using volumes that do not exceed the loop ramps on either end. In this case, Ramp #6 (the highest volume loop from I-95 NB to I-26 WB) volumes exceed the loop capacity and the methodology analyzes the weave with a lower constrained volume. On I-95 NB, the inability of the loop to handle the true demand will result in substantial queuing upstream as vehicles will queue through the weave and further down obstructing I-95 NB traffic which is reflected in the corridor being reported at LOS F. TransModeler analysis is required.*

## Table 6.15: 2030 No Build HCM Capacity Analysis Results (I-95 Southbound)

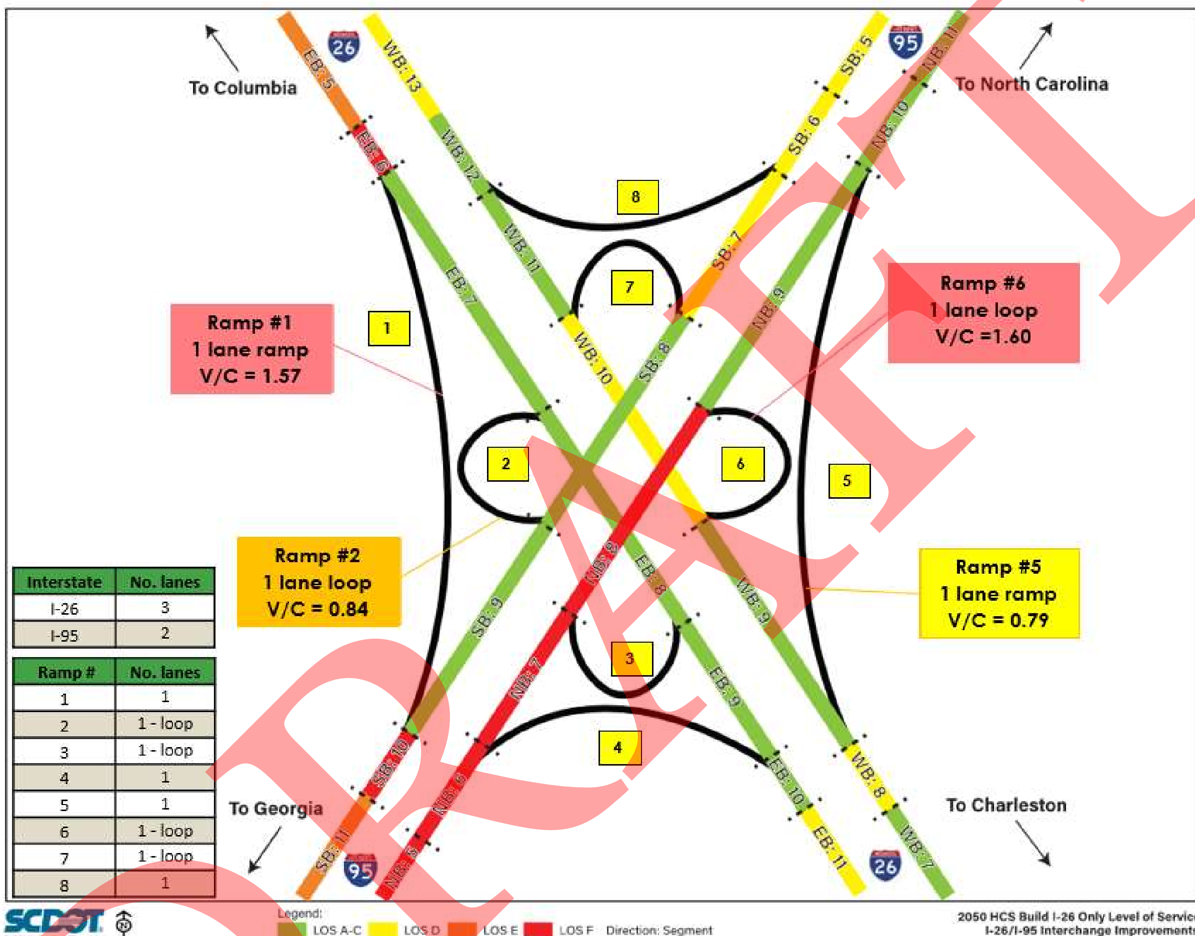
| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2104 | 22% | C | 20.8 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2104 | 22% | C | 24.8 |
| | | | 1 | 45 | 19% | | 25.6 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2059 | 22% | C | 20.3 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2059 | 22% | C | 23.9 |
| | | | 1 | 102 | 17% | | 21.5 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 6 | I-95 Off-Ramp to I-26 WB | Diverge | 2 | 2161 | 22% | C | 26.2 |
| | | | 1 | 48 | 30% | | 27.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 2113 | 22% | C | 20.9 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 278 | 19% | B | 19.8 |
| | | | 3 | 2391 | 22% | | |
| | | | 1 | 821 | 19% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1570 | 23% | B | 15.4 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1570 | 23% | D | 36.1 |
| | | | 1 | 1570 | 24% | | 29.9 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 3140 | 23% | E | 36.2 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3140 | 23% | E | 37.4 |
| | | | 1 | 184 | 31% | | 36.9 |
| 13 | Between U.S. 178 Ramps | Basic | 2 | 2956 | 23% | D | 32.2 |
| 14 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2956 | 23% | D | 36.6 |
| | | | 1 | 193 | 19% | | 30.6 |
| 15 | South of U.S. 178 | Basic | 2 | 3149 | 22% | E | 36.4 |
| | | | | | Corridor | D | 26.5 |

*Note: HCS reports LOS D operations for the corridor with an unacceptable LOS E south of the merge on I-95 SB. This indicates a capacity constraint in the future with the existing four lane I-95 typical section. No improvements are currently planned for I-95 south of I-26. TransModeler analysis is needed to examine potential impacts to the I-26 at I-95 interchange.*

## 6.2.3 2050 No Build Conditions

A visual representation of the estimated 2050 No Build conditions LOS is shown in **Figure 6.3**. This includes both a summary of ramp capacity thresholds based on V/C ratios at critical links and a formal HCS Freeway Facility analysis.

### Figure 6.3: HCS Estimated 2050 No Build Conditions LOS



## *Ramp V/C Analysis*

Since the current HCS methodology does not provide a method to report ramp LOS, a volume to capacity analysis was performed in order to identify if and when ramps may need to be considered for widening. The ramp V/C analysis for 2050 No Build conditions is summarized in **Table 6.16**.

### Table 6.16: 2050 No Build V/C Ramp Analysis

| Movement/ Ramp # | Movement | # Lanes | Ramp Type | Volume (pcph) | Capacity (pcph) | V/C | Capacity |
|---|---|---|---|---|---|---|---|
| 1 | I-26 EB to I-95 SB | 1 | Ramp | 2,956 | 1,878 | 1.57 | Substantially Over |
| 2 | I-95 SB to I-26 EB | 1 | Loop | 1,491 | 1,784 | 0.85 | Unstable Flow/ At or Near Capacity |
| 3 | I-26 EB to I-95 NB | 1 | Loop | 61 | 1,784 | 0.05 | Substantially Under |
| 4 | I-95 NB to I-26 EB | 1 | Ramp | 522 | 1,878 | 0.28 | Substantially Under |
| 5 | I-26 WB to I-95 NB | 1 | Ramp | 1,481 | 1,878 | 0.79 | Stable Flow/ Nearing Capacity |
| 6 | I-95 NB to I-26 WB | 1 | Loop | 2,053 | 1,784 | 1.60 | Substantially Over |
| 7 | I-26 WB to I-95 SB | 1 | Loop | 485 | 1,784 | 0.27 | Substantially Under |
| 8 | I-95 SB to I-26 WB | 1 | Ramp | 99 | 1,878 | 0.05 | Substantially Under |

## *Freeway Facility HCS Analysis*

The results of the 2050 No Build conditions are summarized below:

I-26 eastbound and westbound directions are expected to operate at an acceptable LOS except for the diverge segment from I-26 eastbound to I-95 southbound which exceeds capacity showing LOS F, primarily due to the existing one lane ramp. The westbound direction shows all segments meeting the LOS criteria. HCS also indicated overcapacity conditions on the ramps where ramp capacity on the diverge to I-95 southbound and merge to I-95 northbound exceeded capacity.

As previously explained, corridor LOS is provided by the HCS Freeway Facilities module to represent an overall LOS for the entire section. It can be substantially impacted by a single section of roadway, however, and is not intended to determine whether operations are acceptable. For freeway corridors with multiple poorly operating segments, LOS E or F may be appropriate. For this project, corridors that have a LOS E or LOS F corridor operation are explained with a footnote.

On I-95 most of the segments are operating at capacity or exceeding the acceptable LOS. Only the segments north of the interchange show LOS D and above. The merge segment from I-26 eastbound and diverge to the westbound direction show LOS F with volume exceeding capacity at the ramps. Additionally, Segment 7 and 8 on I-95 northbound shows LOS F at the cloverleaf ramps.

**Table 6.17** and **Table 6.18** show the capacity analysis results for the 2050 No Build peak condition for I-26 eastbound and westbound.

## Table 6.17: 2050 No Build HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 4264 | 29% | E | 35.3 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4264 | 29% | D | 33.2 |
| | | | 1 | 78 | 27% | | 31.8 |
| 3 | Between SC 210 Ramps | Basic | 3 | 4186 | 29% | D | 34.1 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 4186 | 29% | D | 34.4 |
| | | | 1 | 108 | 14% | | 28.7 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 4294 | 28% | E | 35.6 |
| 6 | I-26 Off-Ramp to I-95 SB | Diverge | 3 | 4294 | 28% | F | 45.0 |
| | | | 1 | 2192 | 24% | | 40.0 |
| 7 | Between I-95 Ramps | Basic | 3 | 2102 | 33% | B | 15.1 |
| 8 | Between I-95 Cloverleaf Ramps | Weaving | 1 | 1152 | 17% | C | 22.5 |
| | | | 3 | 3254 | 28% | | |
| | | | 1 | 70 | 19% | | |
| 9 | Between I-95 Ramps | Basic | 3 | 3184 | 28% | C | 22.6 |
| 10 | I-26 On-Ramp from I-95 NB | Merge | 3 | 3184 | 28% | C | 27.5 |
| | | | 1 | 375 | 28% | | 25.0 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 3559 | 28% | D | 26.2 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 28% | C | 26.1 |
| | | | 1 | 194 | 28% | | 24.4 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 3365 | 28% | C | 24.2 |
| 14 | Between U.S. 15 Ramps | Weaving | 1 | 111 | 21% | B | 20.0 |
| | | | 3 | 3365 | 28% | | |
| | | | 2 | 60 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 3314 | 28% | C | 23.7 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 3314 | 28% | C | 27.2 |
| | | | 1 | 211 | 21% | | 24.0 |
| 17 | East of U.S. 15 | Basic | 2 | 3525 | 27% | C | 25.6 |
| | | | | | Corridor | F | 29.2 |

*Note: LOS F operations occur on Segment 6 despite widening of I-26 to 6 lanes because the 2050 No Build conditions require Ramp #1 (I-26 EB to I-95 SB) to be widened to two lanes. As a result of having a one lane ramp, queuing and poor operations will occur onto I-26 EB upstream of the diverge resulting in LOS F for the overall corridor despite acceptable operations at other junctions. TransModeler analysis is recommended.*

### Table 6.18: 2050 No Build HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 3559 | 27% | C | 25.7 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 27% | C | 25.6 |
| | | | 1 | 67 | 5% | | 27.1 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 3492 | 27% | C | 25.0 |
| 4 | Between U.S. 15 Ramps | Weaving | 1 | 215 | 22% | C | 22.7 |
| | | | 3 | 3277 | 27% | C | |
| | | | 1 | 189 | 38% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 3466 | 28% | C | 24.8 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 3466 | 28% | C | 27.3 |
| | | | 1 | 100 | 17% | | 23.9 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 3566 | 28% | C | 26.0 |
| 8 | I-26 Off-Ramp to I-95 NB | Diverge | 3 | 3566 | 28% | D | 29.9 |
| | | | 1 | 1154 | 18% | | 31.4 |
| 9 | Between I-95 Ramps | Basic | 3 | 2412 | 33% | B | 17.2 |
| 10 | Between I-95 Cloverleaf Ramps | Weaving | 1 | 2194 | 29% | D | 29.2 |
| | | | 3 | 4606 | 31% | | |
| | | | 1 | 375 | 19% | | |
| 11 | Between I-95 Ramps | Basic | 3 | 4231 | 32% | C | 25.3 |
| 12 | I-26 On-Ramp from I-95 SB | Merge | 3 | 4231 | 32% | C | 27.5 |
| | | | 1 | 70 | 30% | | 24.8 |
| 13 | Between I-95 and SC 210 | Basic | 3 | 4301 | 32% | D | 26.1 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4301 | 32% | C | 27.4 |
| | | | 1 | 117 | 20% | | 27.5 |
| 15 | Between SC 210 Ramps | Basic | 3 | 4184 | 32% | C | 24.9 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 4184 | 32% | C | 27.1 |
| | | | 1 | 72 | 19% | | 23.2 |
| 17 | West of SC 210 | Basic | 3 | 4256 | 32% | C | 25.6 |
| | | | | | Corridor | F | 25.9 |

*Note: HCS reports LOS F operations for the overall corridor (although no segment is worse than LOS D) due to the HCS methodology for weave analysis. HCS calculates the weaving LOS using volumes that do not exceed the loop ramps on either end. In this case, Ramp #6 (the highest volume loop from I-95 NB to I-26 WB) volumes far exceed the loop capacity and the methodology analyzes the weave with a lower constrained volume. The corridor is reported at LOS F, however, because the demand to enter I-26 westbound from the loop is not being served. As a result, queuing and poor operations will occur onto I-26 WB upstream of the weave that is not reflected in the HCS methodology except in the corridor LOS. TransModeler analysis is required.*

**Table 6.19** and **Table 6.20**, show the capacity analysis results for 2050 No Build peak conditions on I-95 northbound and southbound.

## Table 6.19: 2050 No Build HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 4007 | 27% | F | 56.9 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4007 | 27% | F | 36.8 |
| | | | 1 | 188 | 23% | | 37.5 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 3819 | 27% | F | 55.0 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 3819 | 27% | F | 37.2 |
| | | | 1 | 222 | 39% | | 32.2 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 4041 | 27% | F | 46.1 |
| 6 | I-95 Off-Ramp to I-26 EB | Diverge | 2 | 4041 | 27% | F | 54.4 |
| | | | 1 | 375 | 28% | | 50.2 |
| 7 | Between I-26 Ramps | Basic | 2 | 3666 | 27% | F | 74.7 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 70 | 17% | F | 23.7 |
| | | | 3 | 3736 | 27% | | |
| | | | 1 | 2194 | 29% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1542 | 25% | A | 2.7 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1542 | 25% | B | 15.0 |
| | | | 1 | 1154 | 18% | | 13.3 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2696 | 22% | B | 13.5 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2696 | 22% | B | 15.1 |
| | | | 1 | 108 | 17% | | 13.0 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2588 | 22% | B | 12.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2588 | 22% | B | 14.5 |
| | | | 1 | 49 | 20% | | 14.4 |
| 15 | North of U.S. 176 | Basic | 2 | 2637 | 22% | B | 13.0 |
| | | | | | Corridor | F | 27.1 |

*Note: HCS reports LOS F operations for the overall corridor with all I-95 northbound segments located south of I-26 northbound weave operating at LOS F. TransModeler analysis is required.*

## Table 6.20: 2050 No Build HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2634 | 22% | D | 27.9 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2634 | 22% | D | 31.0 |
| | | | 1 | 49 | 19% | | 31.7 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2585 | 22% | D | 27.2 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2585 | 22% | C | 30.7 |
| | | | 1 | 111 | 17% | | 27.0 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2696 | 22% | D | 28.9 |
| 6 | I-95 Off-Ramp to I-26 WB | Diverge | 2 | 2696 | 22% | D | 32.6 |
| | | | 1 | 70 | 30% | | 33.5 |
| 7 | Between I-26 Ramps | Basic | 2 | 2626 | 22% | D | 27.6 |
| 8 | Between I-26 Cloverleaf Ramps | Weaving | 1 | 375 | 19% | C | 27.0 |
| | | | 3 | 3001 | 22% | | |
| | | | 1 | 1152 | 19% | | |
| 9 | Between I-26 Ramps | Basic | 2 | 1849 | 23% | C | 18.1 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1849 | 23% | F | 40.7 |
| | | | 1 | 2192 | 24% | | 32.5 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 4041 | 23% | E | 43.3 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4041 | 23% | F | 39.4 |
| | | | 1 | 200 | 31% | | 40.0 |
| 13 | Between U.S. 178 Ramps | Basic | 2 | 3841 | 23% | E | 37.5 |
| 14 | I-95 On-Ramp from U.S. 178 | Merge | 3 | 3841 | 23% | D | 41.2 |
| | | | 2 | 210 | 19% | | 33.3 |
| 15 | South of U.S. 178 | Basic | 2 | 4051 | 23% | E | 43.0 |
| | | | | | Corridor | F | 25.2 |

*Note: HCS reports LOS F operations for the I-95 southbound corridor with an unacceptable LOS F at the Segment 10 merge and LOS E and F operations on I-95 to the south. No improvements are currently planned for I-95 south of I-26. TransModeler analysis is needed to examine potential impacts to the I-26 at I-95 interchange.*

# 6.3 HCS Freeway Analysis - Build Alternatives

The Build conditions presents analysis results for three proposed interchange alternatives to replace the current interchange at I-26 and I-95. Primary features of all alternatives include the removal of the four primary weave areas between the existing four loop ramps as well as widening, improvements and realignments of specific ramp segments.

- Alternative 1: Stacked 4-Level Flyover with Two Loops.
- Alternative 2: Modified Turbine with Two Loops
- Alternative 3: Modified Turbine with One Loop

Each of these Build alternatives are described and illustrated in Section 5. The following section outlines the proposed operations for all three alternatives in both 2030 and 2050.

## 6.3.1 2050 Ramp Capacity Analysis – All Alternatives

One key initial analysis element for each Build alternative is the treatment of the ramp movements and identification of ramp widening needs. This analysis was conducted using V/C analysis of the No Build ramps based on planning level ramp capacity methods. The analysis conducted for the 2050 No Build was utilized to develop an initial estimate of the number of lanes required for future traffic volumes. These improvements were identified based on the 2050 No Build ramp analysis in Table 6.16.

The identified 2050 laneage requirements for the is analysis was assumed, tested and verified as applicable as part of the more detailed HCS Freeway (Section 6.3) and ultimately TransModeler analysis (Section 7).

Recommended number of lanes on each ramp for the Build alternatives is included in Table 6.21. Note that for Ramp #2 and Ramp #5, a single lane is proposed as it meets the minimum acceptable LOS D (although consideration was given to providing LOS C with two lane ramps). Alternatives were developed using these configurations; therefore, no additional V/C analysis of ramps was completed for the HCS Alternative analysis.

**Table 6.21: Recommended Future Ramp Lanes based on V/C Analysis**

| Ramp # | Movement | # Lanes No Build | Ramp Type | 2050 No Build V/C | 2050 No Build Capacity | # Lanes Needed | V/C with Ramp Widened | Recommended Ramp Type |
|---|---|---|---|---|---|---|---|---|
| 1 | I-26 EB to I-95 SB | 1 | Ramp | 1.57 | Substantially Over | 2 | 0.78 | Directional |
| 2 | I-95 SB to I-26 EB | 1 | Loop | 0.85 | Unstable Flow/ At or Near Capacity | 1 for LOS D* (2 for LOS C) | NA | Directional Flyover |
| 3 | I-26 EB to I-95 NB | 1 | Loop | 0.05 | Substantially Under | 1 | NA | Loop |
| 4 | I-95 NB to I-26 EB | 1 | Ramp | 0.28 | Substantially Under | 1 | NA | Typical ramp |
| 5 | I-26 WB to I-95 NB | 1 | Ramp | 0.79 | Stable Flow/ Nearing Capacity | 1 for LOS D* (2 for LOS C) | NA | Directional |
| 6 | I-95 NB to I-26 WB | 1 | Loop | 1.60 | Substantially Over | 2 | 0.76 | Directional Flyover |
| 7 | I-26 WB to I-95 SB | 1 | Loop | 0.27 | Substantially Under | 1 | NA | Loop |
| 8 | I-95 SB to I-26 WB | 1 | Ramp | 0.05 | Substantially Under | 1 | NA | Typical ramp |

*Notes:*
*TransModeler analysis required to verify queuing (or metering) on ramps and how it may impact design requirements.*
**LOS D operation in 2050 identified as acceptable for this project. Therefore, a single lane ramp has been utilized in the proposed alternatives for Ramps 2 and 6. Two lane ramp shown for information only.*

A freeway facility HCS analysis has been conducted for each Alternative under 2030 and 2050 conditions. The key information is the LOS given for each segment whether it is a basic freeway, merge, or diverge segment. As in the No Build analysis, corridor LOS is provided by HCS to represent an overall LOS for the entire section but is not intended to determine whether operations are acceptable. Unlike the No Build, LOS E or F only appear in 2050 under the Build alternatives. Footnote explanations of overall corridor LOS E or F are provided.

## 6.3.2 2030 Build Alternative 1

Build Alternative 1 is a Stacked 4-Level Flyover interchange with two loops as detailed in Section 5.1. The results of the 2030 Build Alternative 1 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS. The diverge segment from I-26 eastbound to I-95 southbound improves to LOS B from LOS F in the No Build. The westbound direction shows an improvement in multiple segments. The oversaturation conditions on ramp are reduced making the facility LOS C. A more detailed report is shown in the tables below.

On I-95 most of the segments are operating at the acceptable LOS threshold. However, the two-lane diverge shows LOS D on the northbound direction. The merge segment on the southbound direction from I-26 eastbound also shows LOS D. The alternative improves the merge sections between the loops for the 2030 traffic volumes. Additional segment density and LOS are shown in the tables below.

A visual representation of the estimated 2030 Build Alternative 1 LOS is shown in **Figure 6.4.**

### Figure 6.4: HCS Estimated 2030 Build Alternative 1 LOS

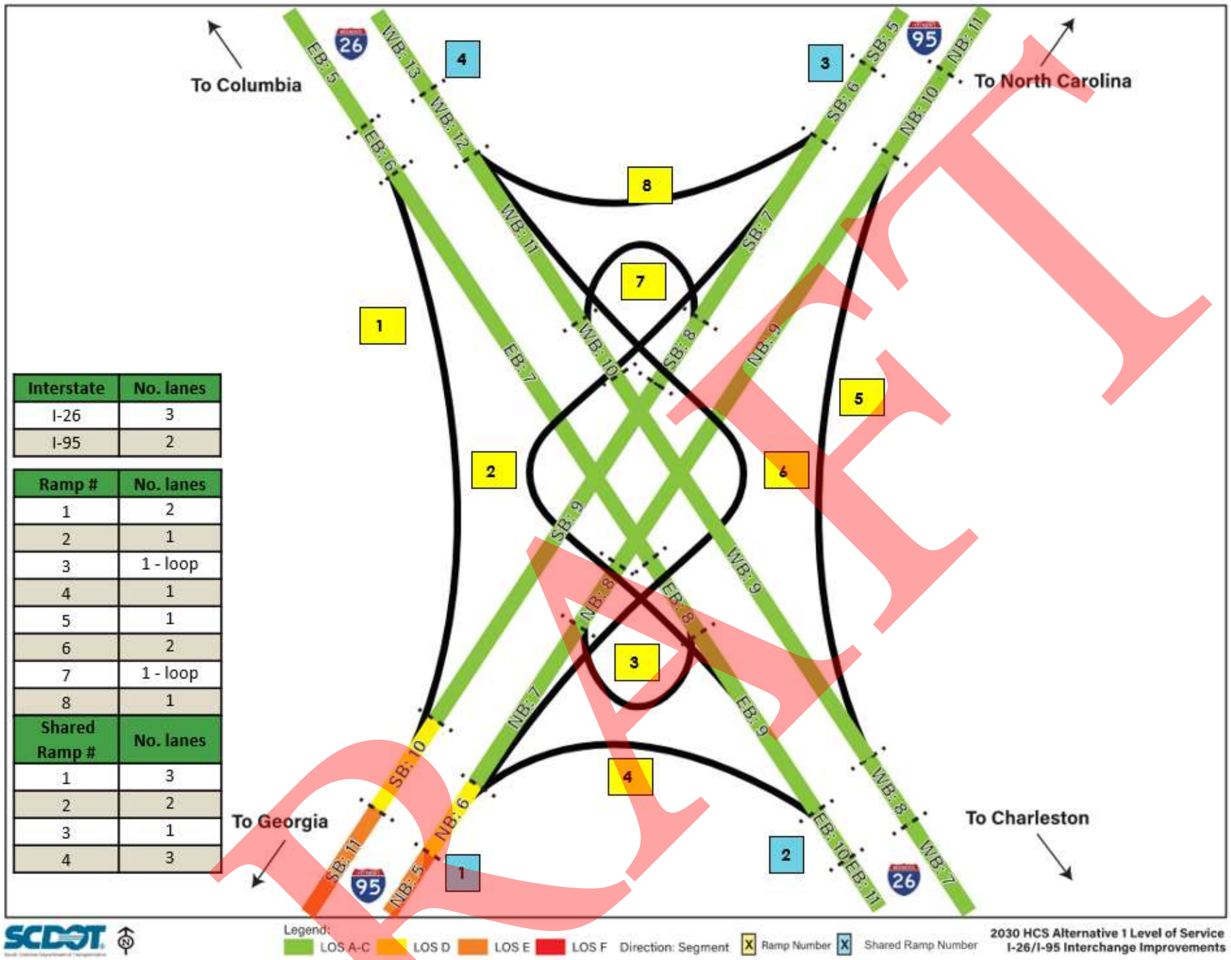


**Table 6.22** and **Table 6.23** present capacity analysis results for Alternative 1 2030 Build conditions on I-26 eastbound and westbound.

### Table 6.22: 2030 Build Alternative 1 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 2966 | 24% | C | 19.7 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 2966 | 24% | C | 21.9 |
| | | | 1 | 70 | 27% | | 23.1 |
| 3 | Between SC 210 Ramps | Basic | 3 | 2896 | 24% | C | 19.2 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 2896 | 24% | B | 21.8 |
| | | | 1 | 99 | 14% | | 19.4 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 2995 | 23% | C | 19.8 |
| 6 | I-26 Off-Ramp to I-95 SB | Diverge | 3 | 2995 | 23% | B | 22.2 |
| | | | 2 | 1570 | 24% | | 16.3 |
| 7 | Between I-95 Ramps | Basic | 3 | 1425 | 22% | A | 9.2 |
| 8 | I-26 Off-Ramp Loop to I-95 NB | Diverge | 3 | 1425 | 22% | B | 10.4 |
| | | | 1 | 48 | 17% | | 11.5 |
| 9 | Between I-95 Ramps | Basic | 3 | 1377 | 22% | A | 8.5 |
| 10 | I-26 On-Ramp from I-95 NB | Merge | 3 | 1377 | 22% | B | 16.3 |
| | | | 2 | 1099 | 21% | | 14.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 2476 | 22% | B | 16.0 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2476 | 22% | C | 16.9 |
| | | | 1 | 119 | 28% | | 20.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 2357 | 22% | B | 15.3 |
| 14 | Between U.S. 15 Ramps | Weaving | 1 | 68 | 21% | B | 13.2 |
| | | | 4 | 2289 | 22% | | |
| | | | 1 | 37 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 2326 | 22% | B | 15.1 |
| 16 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 2326 | 22% | B | 17.3 |
| | | | 1 | 130 | 20% | | 16.0 |
| 17 | East of U.S. 15 | Basic | 3 | 2456 | 21% | B | 15.8 |
| | | | | | Corridor | C | 17.3 |

## Table 6.23: 2030 Build Alternative 1 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 2482 | 21% | B | 16.1 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2482 | 21% | B | 16.9 |
| | | | 1 | 41 | 11% | | 19.2 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 2441 | 21% | B | 15.8 |
| 4 | Between U.S. 15 Ramps | Weaving | 1 | 117 | 38% | B | 14.1 |
| | | | 4 | 2308 | 22% | | |
| | | | 1 | 133 | 22% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 2425 | 22% | B | 15.8 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 2425 | 22% | B | 17.6 |
| | | | 1 | 61 | 17% | | 16.0 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 2486 | 22% | B | 16.2 |
| 8 | I-26 Off-Ramp to I-95 NB | Diverge | 3 | 2486 | 22% | C | 18.2 |
| | | | 1 | 821 | 18% | | 22.8 |
| 9 | Between I-95 Ramps | Basic | 3 | 1665 | 24% | B | 11.1 |
| 10 | I-26 Off-Ramp Loop to I-95 SB | Diverge | 4 | 1665 | 24% | B | 12.6 |
| | | | 1 | 278 | 19% | | 14.1 |
| 11 | Between I-95 Ramps | Basic | 3 | 1387 | 18% | A | 8.8 |
| 12 | I-26 On-Ramp from I-95 | Merge | 3 | 1387 | 18% | C | 21.9 |
| | | | 2 | 1618 | 29% | | 20.7 |
| 13 | Between I-95 & SC 210 | Basic | 3 | 3005 | 27% | C | 20.7 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 3005 | 27% | C | 22.9 |
| | | | 1 | 107 | 20% | | 23.8 |
| 15 | Between SC 210 Ramps | Basic | 3 | 2898 | 27% | C | 19.9 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 2898 | 27% | B | 22.3 |
| | | | 1 | 66 | 19% | | 19.5 |
| 17 | West of SC 210 | Basic | 3 | 2964 | 27% | C | 20.4 |
| | | | | | Corridor | C | 17.5 |

**Table 6.24** and **Table 6.25** present capacity analysis results for Alternative 1 2030 Build conditions on I-95 northbound and southbound.

### Table 6.24: 2030 Build Alternative 1 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 3108 | 26% | E | 40.1 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3108 | 26% | E | 38.1 |
| | | | 1 | 173 | 23% | | 38.8 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 2935 | 26% | E | 36.2 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2935 | 26% | D | 40.4 |
| | | | 1 | 205 | 39% | | 33.9 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 3140 | 27% | E | 41.8 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 3140 | 27% | D | 39.4 |
| | | | 2 | 1848 | 29% | | 28.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1292 | 24% | B | 14.6 |
| | | | 1 | 48 | 17% | | 11.9 |
| 9 | Between I-26 Ramps | Basic | 2 | 1340 | 24% | B | 13.3 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1340 | 24% | C | 23.7 |
| | | | 1 | 821 | 18% | | 21.4 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2161 | 22% | C | 25.5 |
| | | | 1 | 101 | 17% | | 26.4 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2060 | 22% | C | 20.3 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2060 | 22% | C | 23.4 |
| | | | 2 | 45 | 20% | | 22.3 |
| 15 | North of U.S. 176 | Basic | 2 | 2105 | 22% | C | 20.8 |
| | | | | | Corridor | D | 27.4 |

## Table 6.25: 2030 Build Alternative 1 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2104 | 22% | C | 20.8 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2104 | 22% | C | 24.8 |
| | | | 1 | 45 | 19% | | 25.6 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2059 | 22% | C | 20.3 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2059 | 22% | C | 23.9 |
| | | | 1 | 102 | 17% | | 21.5 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2161 | 22% | C | 24.4 |
| | | | 1 | 869 | 20% | | 25.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp Loop from I-26 WB | Merge | 2 | 1292 | 24% | B | 17.1 |
| | | | 1 | 278 | 19% | | 14.1 |
| 9 | Between I-26 Ramps | Basic | 2 | 1570 | 23% | B | 15.4 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1570 | 23% | D | 37.2 |
| | | | 2 | 1570 | 24% | | 28.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 3140 | 23% | E | 38.9 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3140 | 23% | E | 37.6 |
| | | | 1 | 184 | 31% | | 38.1 |
| 13 | Between U.S. 178 Ramps | Basic | 2 | 2956 | 23% | D | 34.5 |
| 14 | I-95 On-Ramp from U.S. 178 | Merge | 3 | 2956 | 23% | D | 38.3 |
| | | | 2 | 193 | 19% | | 31.8 |
| 15 | South of U.S. 178 | Basic | 2 | 3149 | 23% | E | 39.1 |
| | | | | | Corridor | D | 27.4 |

## 6.3.3 2030 Build Alternative 2

Build Alternative 2 is a Modified Turbine interchange with two loops as detailed in Section 5.2. The results of the 2030 Build Alternative 2 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS. The diverge segment from I-26 eastbound to I-95 southbound improves to LOS B from LOS F in the no build like alternative 1. The westbound direction shows an improvement in multiple segments and the oversaturation conditions are reduced making the facility LOS C. A more detailed report is shown in the tables below.

On I-95 most of the segments are operating at the acceptable LOS threshold. However, the two-lane diverge shows LOS D on the northbound direction. The merge segment on the southbound direction from I-26 eastbound still shows LOS D. The alternative improves the merge sections between the loops for the 2030 traffic volumes. Additional segment density and LOS are shown in the tables below.

A visual representation of the estimated 2030 Build Alternative 2 LOS is shown in **Figure 6.5.**



### Figure 6.5: HCS Estimated 2030 Build Alternative 2 LOS

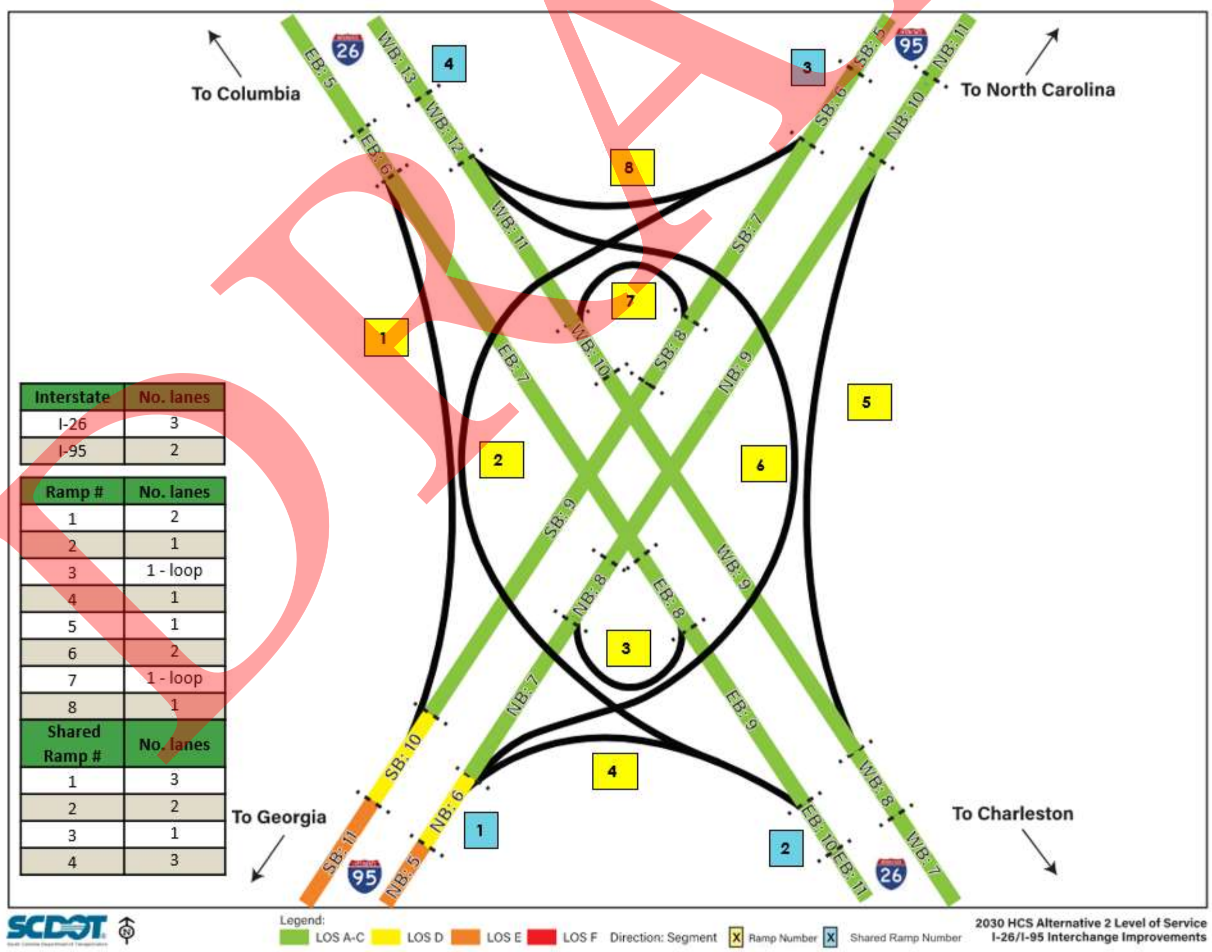


**Table 6.26** and **Table 6.27** present capacity analysis results for Alternative 2 2030 Build conditions on I-26 eastbound and westbound.

### Table 6.26: 2030 Build Alternative 2 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 2966 | 24% | C | 19.7 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 2966 | 24% | C | 21.9 |
| | | | 1 | 70 | 27% | | 23.1 |
| 3 | Between SC 210 Ramps | Basic | 3 | 2896 | 24% | C | 19.2 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 2896 | 24% | B | 21.8 |
| | | | 1 | 99 | 14% | | 19.4 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 2995 | 23% | C | 19.8 |
| 6 | I-26 EB Off-Ramp to I-95 SB | Diverge | 3 | 2995 | 23% | B | 22.2 |
| | | | 2 | 1570 | 24% | | 16.3 |
| 7 | Between I-95 Ramps | Basic | 3 | 1425 | 22% | A | 9.2 |
| 8 | I-26 Off-Ramp Loop to I-95 | Diverge | 3 | 1425 | 22% | B | 10.4 |
| | | | 1 | 48 | 17% | | 11.5 |
| 9 | Between I-95 Ramps | Basic | 3 | 1377 | 22% | A | 8.5 |
| 10 | I-26 On-Ramp from I-95 | Merge | 3 | 1377 | 22% | B | 16.3 |
| | | | 2 | 1099 | 21% | | 14.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 2476 | 22% | B | 16.0 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2476 | 22% | C | 16.9 |
| | | | 1 | 119 | 28% | | 20.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 2357 | 22% | B | 15.3 |
| 14 | Between U.S. 15 Ramps | Weaving | 4 | 2357 | 22% | B | 12.5 |
| | | | 1 | 37 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 2326 | 22% | B | 15.1 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 2326 | 22% | B | 17.4 |
| | | | 1 | 130 | 20% | | 16.0 |
| 17 | East of U.S. 15 | Basic | 3 | 2456 | 21% | B | 15.8 |
| | | | | | Corridor | C | 17.3 |

## Table 6.27: 2030 Build Alternative 2 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 2482 | 21% | B | 16.0 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2482 | 21% | B | 16.8 |
| | | | 1 | 41 | 11% | | 19.2 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 2441 | 21% | B | 15.7 |
| 4 | Between U.S. 15 Loops | Weaving | 1 | 117 | 38% | B | 14.0 |
| | | | 4 | 2308 | 22% | | |
| | | | 1 | 133 | 22% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 2425 | 22% | B | 15.7 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 2425 | 22% | B | 17.5 |
| | | | 1 | 61 | 17% | | 16.0 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 2486 | 22% | B | 16.1 |
| 8 | I-26 WB Off-Ramp to I-95 NB | Diverge | 3 | 2486 | 22% | C | 19.4 |
| | | | 1 | 821 | 18% | | 21.9 |
| 9 | Between I-95 Ramps | Basic | 3 | 1665 | 24% | A | 11.0 |
| 10 | I-26 Off-Ramp Loop to I-95 SB | Diverge | 3 | 1665 | 24% | B | 12.5 |
| | | | 1 | 278 | 19% | | 14.1 |
| 11 | Between I-95 Ramps | Basic | 3 | 1387 | 18% | A | 8.7 |
| 12 | I-26 On-Ramp from I-95 | Merge | 3 | 1387 | 18% | C | 21.8 |
| | | | 2 | 1618 | 29% | | 20.7 |
| 13 | Between I-95 & SC 210 | Basic | 3 | 3005 | 27% | C | 20.6 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 3005 | 27% | C | 21.4 |
| | | | 1 | 107 | 20% | | 23.8 |
| 15 | Between SC 210 Ramps | Basic | 3 | 2898 | 27% | C | 19.8 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 2898 | 27% | B | 22.1 |
| | | | 1 | 66 | 19% | | 19.5 |
| 17 | West of SC 210 | Basic | 3 | 2964 | 27% | C | 20.3 |
| | | | | | Corridor | C | 17.6 |

**Table 6.28** and **Table 6.29** present capacity analysis results for Alternative 2 2030 Build conditions on I-95 northbound and southbound.

### Table 6.28: 2030 Build Alternative 2 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 3108 | 26% | E | 40.1 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3108 | 26% | E | 38.1 |
| | | | 1 | 173 | 23% | | 38.8 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 2935 | 26% | E | 35.6 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2935 | 26% | E | 40.4 |
| | | | 1 | 205 | 39% | | 33.9 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 3140 | 27% | E | 41.8 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 3140 | 27% | D | 39.3 |
| | | | 2 | 1848 | 29% | | 28.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1292 | 24% | B | 14.6 |
| | | | 1 | 48 | 17% | | 11.9 |
| 9 | Between I-26 Ramps | Basic | 2 | 1340 | 24% | B | 13.3 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1340 | 24% | C | 23.7 |
| | | | 1 | 821 | 18% | | 21.4 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2161 | 22% | C | 25.5 |
| | | | 1 | 101 | 17% | | 26.4 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2060 | 22% | C | 20.3 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2060 | 22% | C | 23.4 |
| | | | 2 | 45 | 20% | | 22.3 |
| 15 | North of U.S. 176 | Basic | 2 | 2105 | 22% | C | 20.8 |
| | | | | | Corridor | D | 27.4 |

## Table 6.29: 2030 Build Alternative 2 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2104 | 22% | C | 20.8 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2104 | 22% | C | 24.8 |
| | | | 1 | 45 | 19% | C | 25.6 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2059 | 22% | C | 20.3 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2059 | 22% | C | 23.9 |
| | | | 1 | 102 | 17% | C | 21.5 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2161 | 22% | C | 24.4 |
| | | | 1 | 869 | 20% | | 25.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp Loop from I-26 WB | Merge | 2 | 1292 | 24% | B | 17.1 |
| | | | 1 | 278 | 19% | | 14.1 |
| 9 | Between I-26 Ramps | Basic | 2 | 1570 | 23% | B | 15.4 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1570 | 23% | D | 37.2 |
| | | | 2 | 1570 | 24% | | 28.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 3140 | 23% | E | 38.9 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3140 | 23% | E | 37.6 |
| | | | 1 | 184 | 31% | | 38.1 |
| 13 | Between U.S. 178 Ramps | Basic | 2 | 2956 | 23% | D | 34.5 |
| 14 | I-95 On-Ramp from U.S. 178 | Merge | 3 | 2956 | 23% | D | 38.3 |
| | | | 2 | 193 | 19% | | 31.8 |
| 15 | South of U.S. 178 | Basic | 2 | 3149 | 23% | E | 39.1 |
| | | | | | Corridor | D | 27.4 |

### 6.3.4 2030 Build Alternative 3

Build Alternative 3 is a Modified Turbine interchange with one loop ramp as detailed in Section 5.3. The results of the 2030 Build Alternative 3 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS. The diverge segment from I-26 eastbound to I-95 southbound improves to LOS B from LOS F in the no build much like alternative 1 and 2. The westbound direction shows an improvement in multiple segments. The oversaturation ramp conditions are also reduced making the facility LOS C.

On I-95 most of the segments are operating at the acceptable LOS threshold. However, the two-lane diverge shows LOS D on the northbound direction. The merge segment on the southbound direction from I-26 eastbound still shows LOS D. The alternative improves the merge sections between the loops for the 2030 traffic volumes. Additional segment density and LOS are shown in the tables below.

A visual representation of the estimated 2030 Build Alternative 3 LOS is shown in **Figure 6.6.**

**Figure 6.6: HCS Estimated 2030 Build Alternative 3 LOS**

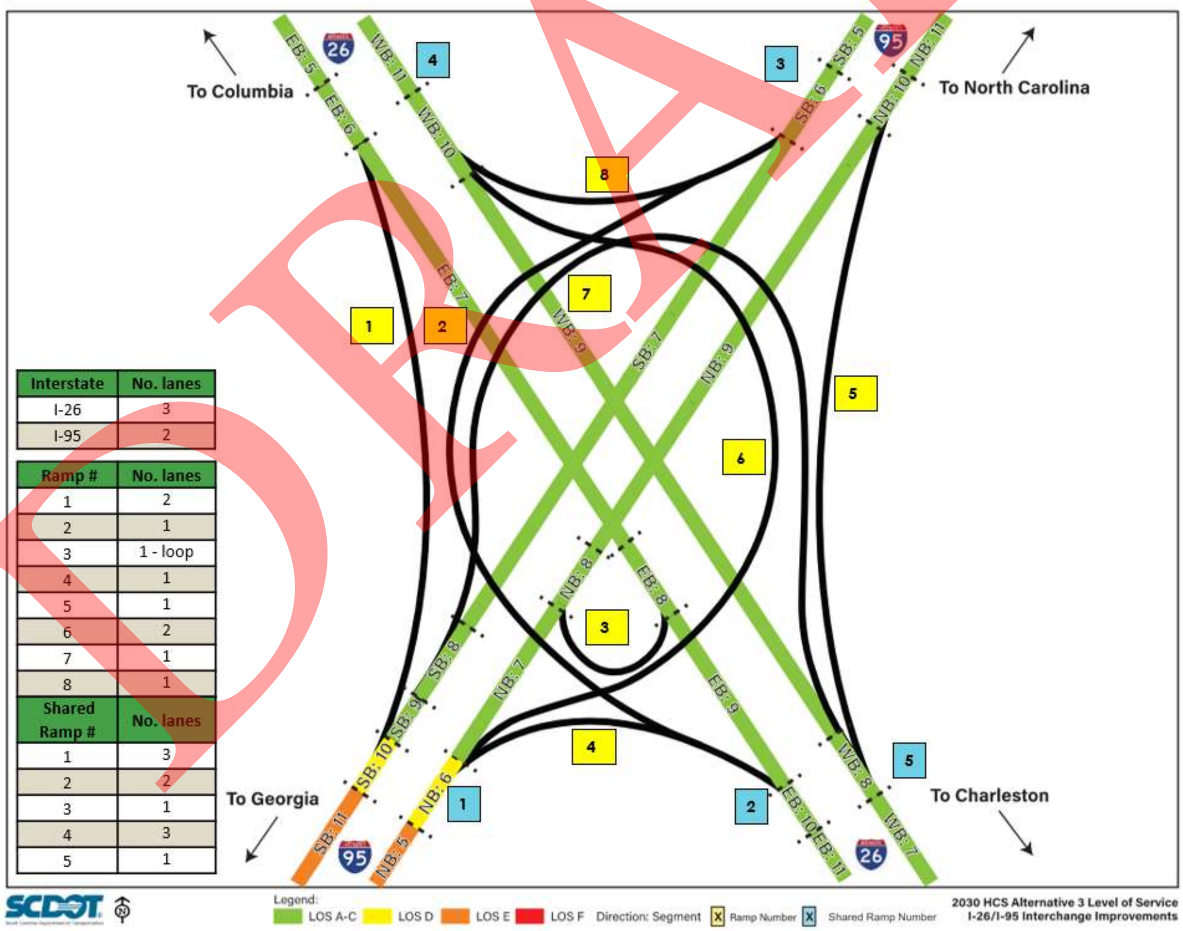


**Table 6.30** and **Table 6.31** present capacity analysis results for Alternative 3 2030 Build conditions on I-26 eastbound and westbound.

### Table 6.30: 2030 Build Alternative 3 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 2966 | 24% | C | 35.0 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 2966 | 24% | C | 32.8 |
| | | | 1 | 70 | 27% | | 31.8 |
| 3 | Between SC 210 Ramps | Basic | 3 | 2896 | 24% | C | 33.9 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 2896 | 24% | C | 34.0 |
| | | | 1 | 99 | 14% | | 28.7 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 2995 | 23% | C | 35.0 |
| 6 | I-26 Off-Ramp to I-95 SB | Diverge | 3 | 2995 | 23% | B | 34.2 |
| | | | 2 | 1570 | 24% | | 27.9 |
| 7 | Between I-95 Ramps | Basic | 3 | 1425 | 22% | A | 14.9 |
| 8 | I-26 Off-Ramp Loop to I-95 NB | Diverge | 3 | 1425 | 22% | B | 16.0 |
| | | | 1 | 48 | 17% | | 17.3 |
| 9 | Between I-95 Ramps | Basic | 3 | 1377 | 22% | A | 13.8 |
| 10 | I-26 On-Ramp from I-95 NB | Merge | 3 | 1377 | 22% | B | 25.7 |
| | | | 2 | 1099 | 21% | | 23.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 2476 | 22% | B | 25.8 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2476 | 22% | C | 25.7 |
| | | | 1 | 119 | 28% | | 28.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 2357 | 22% | B | 23.9 |
| 14 | Between U.S. 15 Ramps | Weaving | 4 | 2357 | 22% | B | 19.6 |
| | | | 1 | 37 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 2326 | 22% | B | 23.4 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 2326 | 22% | B | 26.7 |
| | | | 1 | 130 | 20% | | 23.9 |
| 17 | East of U.S. 15 | Basic | 3 | 2456 | 21% | B | 25.2 |
| | | | | | Corridor | C | 28.7 |

### Table 6.31: 2030 Build Alternative 3 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 2482 | 21% | B | 16.0 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 2482 | 21% | B | 17.1 |
| | | | 1 | 41 | 11% | | 19.2 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 2441 | 21% | B | 15.7 |
| 4 | Between U.S. 15 Ramps | Weaving | 4 | 2308 | 38% | B | 14.0 |
| | | | 1 | 133 | 22% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 2425 | 22% | B | 15.7 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 2425 | 22% | B | 17.5 |
| | | | 1 | 61 | 17% | | 16.0 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 2486 | 22% | B | 16.1 |
| 8 | I-26 Off-Ramp to I-95 | Diverge | 3 | 2486 | 22% | C | 18.4 |
| | | | 1 | 1099 | 18% | | 22.8 |
| 9 | Between I-95 Ramps | Basic | 3 | 1387 | 25% | A | 9.2 |
| 10 | I-26 On-Ramp from I-95 | Merge | 3 | 1387 | 25% | C | 22.4 |
| | | | 2 | 1618 | 29% | | 21.2 |
| 11 | Between I-95 & SC 210 | Basic | 3 | 3005 | 27% | C | 20.6 |
| 12 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 3005 | 27% | C | 22.8 |
| | | | 1 | 107 | 20% | | 23.8 |
| 13 | Between SC 210 Ramps | Basic | 3 | 2898 | 27% | C | 19.8 |
| 14 | I-26 On-Ramp from SC 210 | Merge | 3 | 2898 | 27% | B | 22.1 |
| | | | 1 | 66 | 19% | | 19.5 |
| 15 | West of SC 210 | Basic | 3 | 2964 | 27% | C | 20.3 |
| | | | | | Corridor | C | 17.3 |

**Table 6.32** and **Table 6.33** present capacity analysis results for Alternative 3 2030 Build conditions on I-95 northbound and southbound.

### Table 6.32: 2030 Build Alternative 3 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 3108 | 26% | E | 40.1 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3108 | 26% | E | 38.1 |
| | | | 1 | 173 | 23% | | 38.8 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 2935 | 26% | E | 35.6 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 2935 | 26% | E | 40.4 |
| | | | 1 | 205 | 39% | | 33.9 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 3140 | 27% | E | 41.8 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 3140 | 27% | D | 39.3 |
| | | | 1 | 1848 | 29% | | 28.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1292 | 24% | B | 14.6 |
| | | | 1 | 48 | 17% | | 11.9 |
| 9 | Between I-26 Ramps | Basic | 2 | 1340 | 24% | B | 13.3 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1340 | 24% | C | 23.7 |
| | | | 1 | 821 | 18% | | 21.4 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2161 | 22% | C | 25.5 |
| | | | 1 | 101 | 17% | | 26.4 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2060 | 22% | C | 20.3 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2060 | 22% | C | 23.4 |
| | | | 2 | 45 | 20% | | 22.3 |
| 15 | North of U.S. 176 | Basic | 2 | 2105 | 22% | C | 20.8 |
| | | | | | Corridor | D | 27.4 |

## Table 6.33: 2030 Build Alternative 3 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2104 | 22% | C | 20.8 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2104 | 22% | C | 24.8 |
| | | | 1 | 45 | 19% | | 25.6 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2059 | 22% | C | 20.3 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2059 | 22% | C | 23.9 |
| | | | 1 | 102 | 17% | | 21.5 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2161 | 22% | C | 21.4 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2161 | 22% | C | 24.4 |
| | | | 1 | 869 | 20% | | 25.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1292 | 24% | B | 12.8 |
| 8 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1292 | 24% | B | 17.5 |
| | | | 1 | 278 | 19% | | 18.1 |
| 9 | Between I-26 Ramps | Basic | 2 | 1570 | 23% | B | 15.4 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1570 | 23% | D | 37.2 |
| | | | 2 | 1570 | 24% | | 28.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 3140 | 23% | E | 38.9 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 3140 | 23% | E | 34.6 |
| | | | 1 | 184 | 31% | | 38.1 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2956 | 23% | D | 34.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2956 | 23% | D | 37.8 |
| | | | 2 | 193 | 19% | | 31.8 |
| 15 | South of U.S. 178 | Basic | 2 | 3149 | 23% | E | 39.1 |
| | | | | | Corridor | D | 27.5 |

## 6.3.5 2050 Build Alternative 1

Build Alternative 1 is a Stacked 4-Level Flyover interchange with two loops as detailed in Section 5.1. The results of the 2050 Build Alternative 1 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS except westbound Segment 13. The diverge segment from I-26 eastbound to I-95 southbound improves to LOS C with a two-lane ramp. The westbound direction shows an improvement in multiple sections but the diverge to I-95 northbound and merge segment from I-95 northbound/southbound show LOS D (although widening the ramp to two lanes would result in LOS C).

On I-95 southbound most of the segments are operating at the acceptable LOS. However, the shared ramp serving to split the ramps to both I-26 westbound and I-26 eastbound shows LOS D. South of the interchange, both the two-lane merge segment from I-26 eastbound to I-95 southbound and the I-95 northbound diverge indicate LOS F operations with volumes exceeding capacity at the ramps. Additional segment density and LOS are shown in the tables below.

The estimated 2050 Build Alternative 1 LOS is shown in **Figure 6.7.**

**Figure 6.7: HCS Estimated 2050 Build Alternative 1 LOS**

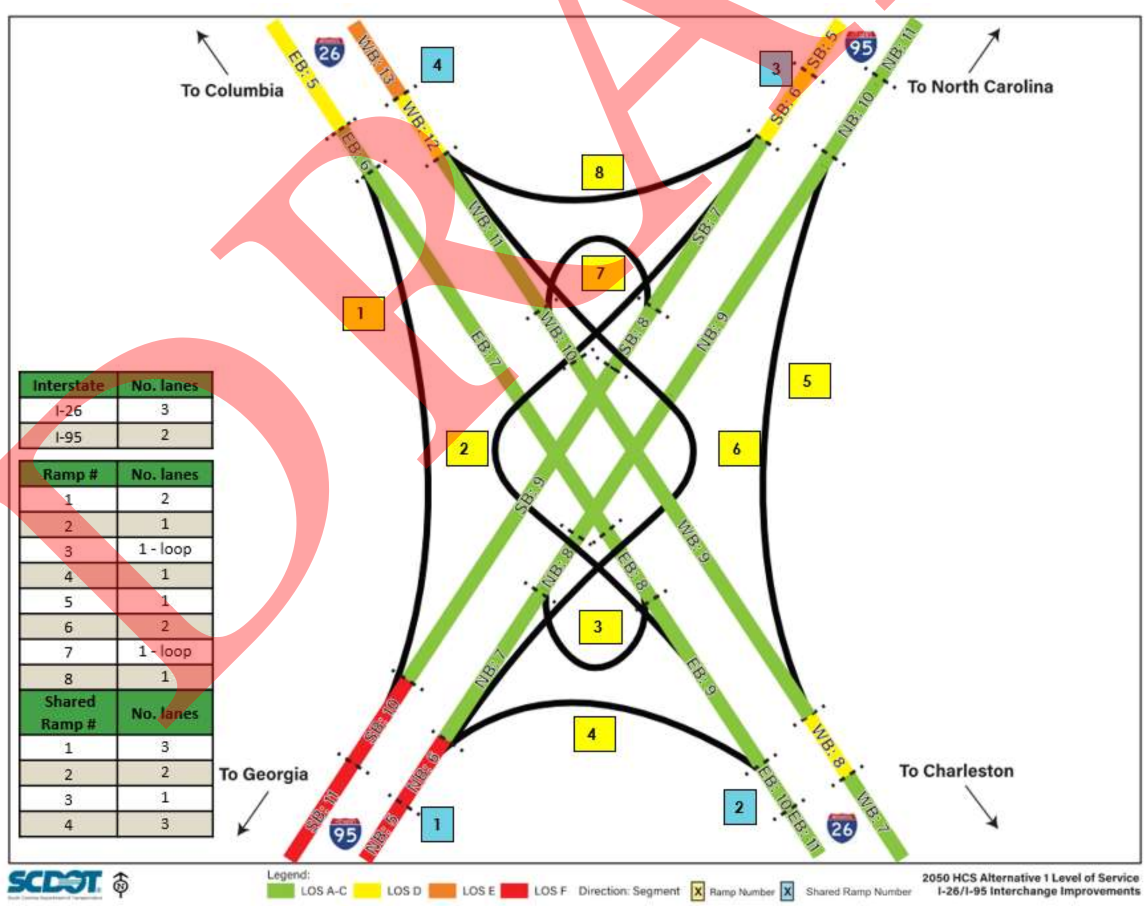


**Table 6.34** and **Table 6.35** present capacity analysis results for Alternative 1 2050 Build conditions on I-26 eastbound and westbound.

### Table 6.34: 2050 Build Alternative 1 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 4264 | 29% | D | 35.0 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4264 | 29% | D | 32.8 |
| | | | 1 | 78 | 27% | | 31.8 |
| 3 | Between SC 210 Ramps | Basic | 3 | 4186 | 29% | D | 33.9 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 4186 | 29% | D | 34.0 |
| | | | 1 | 108 | 14% | | 28.7 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 4294 | 28% | D | 35.0 |
| 6 | I-26 Off-Ramp to I-95 SB | Diverge | 3 | 4294 | 28% | C | 34.2 |
| | | | 2 | 2192 | 24% | | 27.9 |
| 7 | Between I-95 Ramps | Basic | 3 | 2102 | 33% | B | 14.9 |
| 8 | I-26 Off-Ramp Loop to I-95 NB | Diverge | 3 | 2102 | 33% | B | 16.0 |
| | | | 1 | 70 | 17% | | 17.3 |
| 9 | Between I-95 Ramps | Basic | 3 | 2032 | 33% | B | 13.8 |
| 10 | I-26 On-Ramp from I-95 NB | Merge | 3 | 2032 | 33% | C | 25.7 |
| | | | 2 | 1527 | 21% | | 23.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 3559 | 28% | C | 25.8 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 28% | D | 25.7 |
| | | | 1 | 194 | 28% | | 28.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 3365 | 28% | C | 23.9 |
| 14 | Between U.S. 15 Ramps | Weaving | 1 | 111 | 21% | B | 19.6 |
| | | | 4 | 3365 | 28% | | |
| | | | 1 | 60 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 3425 | 28% | C | 23.4 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 3425 | 28% | C | 26.7 |
| | | | 1 | 111 | 21% | | 23.9 |
| 17 | East of U.S. 15 | Basic | 3 | 3524 | 11% | C | 25.2 |
| | | | | | Corridor | D | 28.7 |

## Table 6.35: 2050 Build Alternative 1 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 3559 | 27% | C | 25.6 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 27% | C | 25.6 |
| | | | 1 | 67 | 5% | | 27.1 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 3492 | 27% | C | 25.0 |
| 4 | Between U.S. 15 Ramps | Weaving | 1 | 189 | 22% | D | 22.7 |
| | | | 4 | 3681 | 27% | | |
| | | | 1 | 215 | 38% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 3466 | 28% | C | 25.0 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 3466 | 28% | C | 27.3 |
| | | | 1 | 100 | 17% | | 23.9 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 3566 | 28% | C | 26.0 |
| 8 | I-26 Off-Ramp to I-95 NB | Diverge | 3 | 3566 | 28% | D | 27.6 |
| | | | 1 | 1154 | 18% | | 31.4 |
| 9 | Between I-95 Ramps | Basic | 3 | 2412 | 33% | B | 17.2 |
| 10 | I-26 Off-Ramp Loop to I-95 SB | Diverge | 4 | 2412 | 33% | C | 19.4 |
| | | | 1 | 375 | 19% | | 20.8 |
| 11 | Between I-95 Ramps | Basic | 3 | 2037 | 31% | B | 14.3 |
| 12 | I-26 On-Ramp from I-95 | Merge | 3 | 2037 | 31% | D | 38.6 |
| | | | 2 | 2264 | 29% | | 32.5 |
| 13 | Between I-95 & SC 210 | Basic | 3 | 4301 | 32% | E | 37.4 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4301 | 32% | D | 34.2 |
| | | | 1 | 117 | 20% | | 32.5 |
| 15 | Between SC 210 Ramps | Basic | 3 | 4184 | 32% | E | 35.5 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 4184 | 32% | D | 34.9 |
| | | | 1 | 72 | 19% | | 28.9 |
| 17 | West of SC 210 | Basic | 3 | 4256 | 32% | E | 36.6 |
| | | | | | Corridor | E | 29.8 |

*Note: HCS reports LOS E operations for the overall corridor (reflecting the worst LOS on a specific segment). The corridor is reported at LOS E primarily due to the westbound merge of the ramp from I-95 in Segment 13. Despite the planned widening to six-lanes, queuing and poor operations will occur onto I-26 WB. TransModeler analysis is required to examine merge improvements.*

**Table 6.36** and **Table 6.37**, present capacity analysis results for Alternative 1 2050 Build conditions on I-95 northbound and southbound.

### Table 6.36: 2050 Build Alternative 1 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 4007 | 27% | F | 56.8 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4007 | 27% | F | 36.8 |
| | | | 1 | 188 | 23% | | 37.5 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 3819 | 27% | F | 55.0 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 3819 | 27% | F | 37.4 |
| | | | 1 | 222 | 39% | | 32.2 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 4041 | 27% | F | 37.2 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 4041 | 27% | F | 39.0 |
| | | | 2 | 2569 | 29% | | 26.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1472 | 25% | A | 3.7 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1472 | 25% | A | 4.8 |
| | | | 1 | 70 | 17% | | 2.4 |
| 9 | Between I-26 Ramps | Basic | 2 | 1542 | 25% | A | 4.4 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1542 | 25% | B | 16.9 |
| | | | 1 | 1154 | 18% | | 15.1 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2696 | 22% | B | 15.2 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2696 | 22% | B | 18.5 |
| | | | 1 | 108 | 17% | | 19.6 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2588 | 22% | B | 14.2 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2588 | 22% | B | 16.6 |
| | | | 2 | 49 | 20% | | 16.1 |
| 15 | North of U.S. 176 | Basic | 2 | 2637 | 22% | B | 14.7 |
| | | | | | Corridor | F | 23.5 |

*Note: HCS reports LOS F operations for the overall corridor with all I-95 northbound segments from the southern model limit to the I-26 northbound diverge weave operating at LOS F. TransModeler analysis is required. Key issue is inadequate capacity on I-95 south of the I-26 interchange in 2050.*

## Table 6.37: 2050 Build Alternative 1 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2634 | 22% | D | 28.0 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2634 | 22% | D | 31.1 |
| | | | 1 | 49 | 19% | | 31.7 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2585 | 22% | D | 27.2 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2585 | 22% | C | 30.8 |
| | | | 1 | 111 | 17% | | 27.0 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2696 | 22% | D | 28.9 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2696 | 22% | D | 31.0 |
| | | | 1 | 1222 | 20% | | 31.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1474 | 24% | B | 14.5 |
| 8 | I-95 On-Ramp Loop from I-26 WB | Merge | 2 | 1474 | 24% | B | 20.2 |
| | | | 1 | 375 | 19% | | 16.8 |
| 9 | Between I-26 Ramps | Basic | 2 | 1849 | 23% | C | 18.1 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1849 | 23% | F | 39.9 |
| | | | 2 | 2192 | 24% | | 29.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 4041 | 23% | F | 43.3 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4041 | 23% | F | 39.5 |
| | | | 1 | 200 | 31% | | 39.9 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 3841 | 23% | F | 37.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 3841 | 23% | F | 41.2 |
| | | | 2 | 210 | 19% | | 33.3 |
| 15 | South of U.S. 178 | Basic | 2 | 4051 | 23% | F | 43.0 |
| | | | | | Corridor | F | 32.7 |

*Note: HCS reports LOS F operations for the I-95 southbound corridor with an unacceptable LOS F at the Segment 10 merge and LOS E and F operations on I-95 to the south. No improvements are currently planned for I-95 south of I-26. TransModeler analysis is needed to examine potential impacts to the I-26 at I-95 interchange.*

## 6.3.6 2050 Build Alternative 2

Build Alternative 2 is a Modified Turbine interchange with two loops as detailed in Section 5.2. The results of the 2050 Build Alternative 2 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS except westbound Segment 13. Like alternative 1, the diverge segment from I-26 eastbound to I-95 southbound (Segment EB 6) improves to LOS C. The westbound direction shows an improvement in multiple sections but the diverge to I-95 northbound and merge segment from I-95 northbound/southbound show LOS D. A more detailed report is shown in the tables below.

On I-95 southbound most of the segments are operating at an acceptable LOS. However, the shared ramp on I-95 southbound shows LOS D. The merge segment from I-26 eastbound and diverge segment to the westbound direction show LOS F with volume exceeding capacity at the ramps. Additional segment density and LOS are shown in the tables below.

A visual representation of the estimated 2050 Build Alternative 2 LOS is shown in **Figure 6.8.**

### Figure 6.8: HCS Estimated 2050 Build Alternative 2 LOS

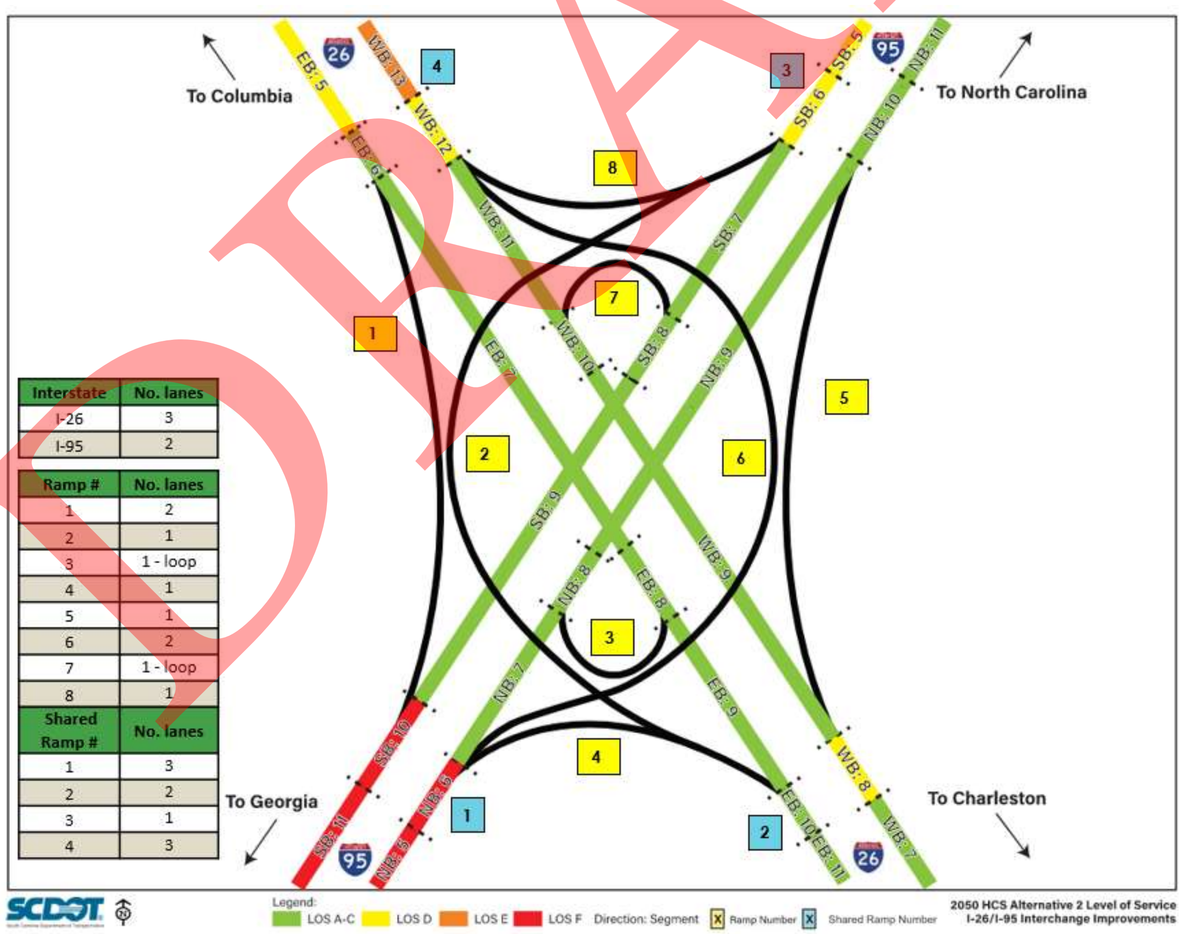


**Table 6.38** and **Table 6.39** present capacity analysis results for Alternative 2 2050 Build conditions on I-26 eastbound and westbound.

### Table 6.38: 2050 Build Alternative 2 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 4264 | 29% | D | 35.0 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4264 | 29% | D | 32.8 |
| | | | 1 | 78 | 27% | | 31.8 |
| 3 | Between SC 210 Ramps | Basic | 3 | 4186 | 29% | D | 33.9 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 4186 | 29% | D | 34.0 |
| | | | 1 | 108 | 14% | | 28.7 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 4294 | 28% | D | 35.0 |
| 6 | I-26 EB Off-Ramp to I-95 SB | Diverge | 3 | 4294 | 28% | C | 34.2 |
| | | | 2 | 2192 | 24% | | 27.9 |
| 7 | Between I-95 Ramps | Basic | 3 | 2102 | 33% | B | 14.9 |
| 8 | I-26 Off-Ramp Loop to I-95 | Diverge | 3 | 2102 | 33% | B | 16.0 |
| | | | 1 | 70 | 17% | | 17.3 |
| 9 | Between I-95 Ramps | Basic | 3 | 2032 | 33% | B | 13.8 |
| 10 | I-26 On-Ramp from I-95 | Merge | 3 | 2032 | 33% | C | 25.7 |
| | | | 2 | 1527 | 21% | | 23.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 3559 | 28% | C | 25.8 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 28% | D | 25.7 |
| | | | 1 | 194 | 28% | | 28.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 3365 | 28% | C | 23.9 |
| 14 | Between U.S. 15 Ramps | Weaving | 4 | 3365 | 28% | B | 19.6 |
| | | | 1 | 60 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 3425 | 28% | C | 23.4 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 3425 | 28% | C | 26.7 |
| | | | 1 | 111 | 21% | | 23.9 |
| 17 | East of U.S. 15 | Basic | 3 | 3314 | 11% | C | 25.2 |
| | | | | | Corridor | D | 28.7 |

## Table 6.39: 2050 Build Alternative 2 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 3559 | 27% | C | 25.5 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 27% | C | 25.4 |
| | | | 1 | 67 | 5% | | 27.1 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 3492 | 27% | C | 24.9 |
| 4 | Between U.S. 15 Loops | Weaving | 1 | 215 | 22% | D | 22.5 |
| | | | 4 | 3277 | 27% | | |
| | | | 1 | 189 | 38% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 3466 | 28% | C | 24.9 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 3466 | 28% | C | 27.1 |
| | | | 1 | 100 | 17% | | 23.9 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 3566 | 28% | C | 25.8 |
| 8 | I-26 WB Off-Ramp to I-95 NB | Diverge | 3 | 3566 | 28% | D | 29.4 |
| | | | 1 | 1154 | 18% | | 30.5 |
| 9 | Between I-95 Ramps | Basic | 3 | 2412 | 33% | B | 17.0 |
| 10 | I-26 Off-Ramp Loop to I-95 SB | Diverge | 3 | 2412 | 33% | C | 19.3 |
| | | | 1 | 375 | 19% | | 20.8 |
| 11 | Between I-95 Ramps | Basic | 3 | 2037 | 31% | B | 14.2 |
| 12 | I-26 On-Ramp from I-95 | Merge | 3 | 2037 | 31% | D | 38.3 |
| | | | 2 | 2264 | 29% | | 32.5 |
| 13 | Between I-95 & SC 210 | Basic | 3 | 4301 | 32% | E | 37.2 |
| 14 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4301 | 32% | D | 32.2 |
| | | | 1 | 117 | 20% | | 32.5 |
| 15 | Between SC 210 Ramps | Basic | 3 | 4184 | 32% | E | 35..3 |
| 16 | I-26 On-Ramp from SC 210 | Merge | 3 | 4184 | 32% | D | 34.6 |
| | | | 1 | 72 | 19% | | 28.9 |
| 17 | West of SC 210 | Basic | 3 | 4256 | 32% | E | 36.5 |
| | | | | | Corridor | E | 29.8 |

*Note: HCS reports LOS E operations for the overall corridor (reflecting the worst LOS on a specific segment). The corridor is reported at LOS E primarily due to the westbound merge of the ramp from I-95 in Segment 13. Despite the planned widening to six-lanes, queuing and poor operations will occur onto I-26 WB. TransModeler analysis is required to examine merge improvements.*

**Table 6.40** and **Table 6.41** present capacity analysis results for Alternative 2 2050 Build conditions on I-95 northbound and southbound.

### Table 6.40: 2050 Build Alternative 2 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 4007 | 27% | F | 56.8 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4007 | 27% | F | 36.8 |
| | | | 1 | 188 | 23% | | 37.5 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 3819 | 27% | F | 55.0 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 3819 | 27% | F | 37.4 |
| | | | 1 | 222 | 39% | | 32.2 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 4041 | 27% | F | 37.2 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 4041 | 27% | F | 38.9 |
| | | | 2 | 2569 | 28% | | 26.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1472 | 24% | A | 3.9 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1472 | 24% | A | 5.0 |
| | | | 1 | 70 | 17% | | 2.7 |
| 9 | Between I-26 Ramps | Basic | 2 | 1542 | 24% | A | 4.6 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1542 | 24% | B | 17.2 |
| | | | 1 | 1154 | 18% | | 15.3 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2696 | 22% | B | 15.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2696 | 22% | B | 18.8 |
| | | | 1 | 108 | 17% | | 19.9 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2588 | 22% | B | 14.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2588 | 22% | B | 16.8 |
| | | | 2 | 49 | 20% | | 16.4 |
| 15 | North of U.S. 176 | Basic | 2 | 2637 | 22% | B | 14.9 |
| | | | | | Corridor | F* | 23.6 |

*Note: HCS reports LOS F operations for the overall corridor with all I-95 northbound segments from the southern model limit to the I-26 northbound diverge weave operating at LOS F. TransModeler analysis is required. Key issue is inadequate capacity on I-95 south of the I-26 interchange in 2050.*

## Table 6.41: 2050 Build Alternative 2 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2634 | 27% | D | 28.0 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2634 | 27% | D | 31.0 |
| | | | 1 | 49 | 23% | | 31.7 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2585 | 27% | D | 27.2 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2585 | 27% | C | 30.8 |
| | | | 1 | 111 | 39% | | 27.0 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2696 | 27% | D | 28.9 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2696 | 27% | D | 31.0 |
| | | | 1 | 1222 | 28% | | 31.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1474 | 27% | B | 14.5 |
| 8 | I-95 On-Ramp Loop from I-26 WB | Merge | 2 | 1474 | 27% | B | 20.2 |
| | | | 1 | 375 | 29% | | 16.8 |
| 9 | Between I-26 Ramps | Basic | 2 | 1849 | 25% | B | 18.1 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1849 | 25% | F | 39.9 |
| | | | 2 | 2192 | 18% | | 29.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 4041 | 22% | F | 43.3 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4041 | 22% | F | 39.5 |
| | | | 1 | 200 | 17% | | 39.9 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 3841 | 22% | F | 37.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 3841 | 22% | F | 41.2 |
| | | | 2 | 210 | 20% | | 33.3 |
| 15 | South of U.S. 178 | Basic | 2 | 4051 | 22% | F | 43.0 |
| | | | | | Corridor | F* | 32.7 |

*Note: HCS reports LOS F operations for the I-95 southbound corridor with an unacceptable LOS F at the Segment 10 merge and LOS E and F operations on I-95 to the south. No improvements are currently planned for I-95 south of I-26. TransModeler analysis is needed to examine potential impacts to the I-26 at I-95 interchange.*

## 6.3.7 2050 Build Alternative 3

Build Alternative 3 is a Modified Turbine interchange with one loop ramp as detailed in Section 5.3. The results of the 2050 Build Alternative 3 conditions indicate that I-26 eastbound and westbound direction operate at an acceptable LOS except westbound Segment 13. The diverge segment from I-26 eastbound to I-95 southbound (Segment EB 6) improves to LOS C in this alternative. The westbound direction shows an improvement in multiple sections but the diverge to I-95 northbound and merge segment from I-95 northbound/southbound show LOS D. A more detailed report is shown in the tables below.

On I-95 southbound most of the segments are operating at an acceptable LOS. However, the shared ramp shows LOS D. The merge segment from I-26 eastbound and diverge segment to the westbound direction show LOS F with volume exceeding capacity at the ramps. Additional segment density and LOS are shown in the tables below. A visual representation of the estimated 2050 Build Alternative 3 LOS is shown in **Figure 6.9.**

**Figure 6.9: HCS Estimated 2050 Build Alternative 3 LOS**

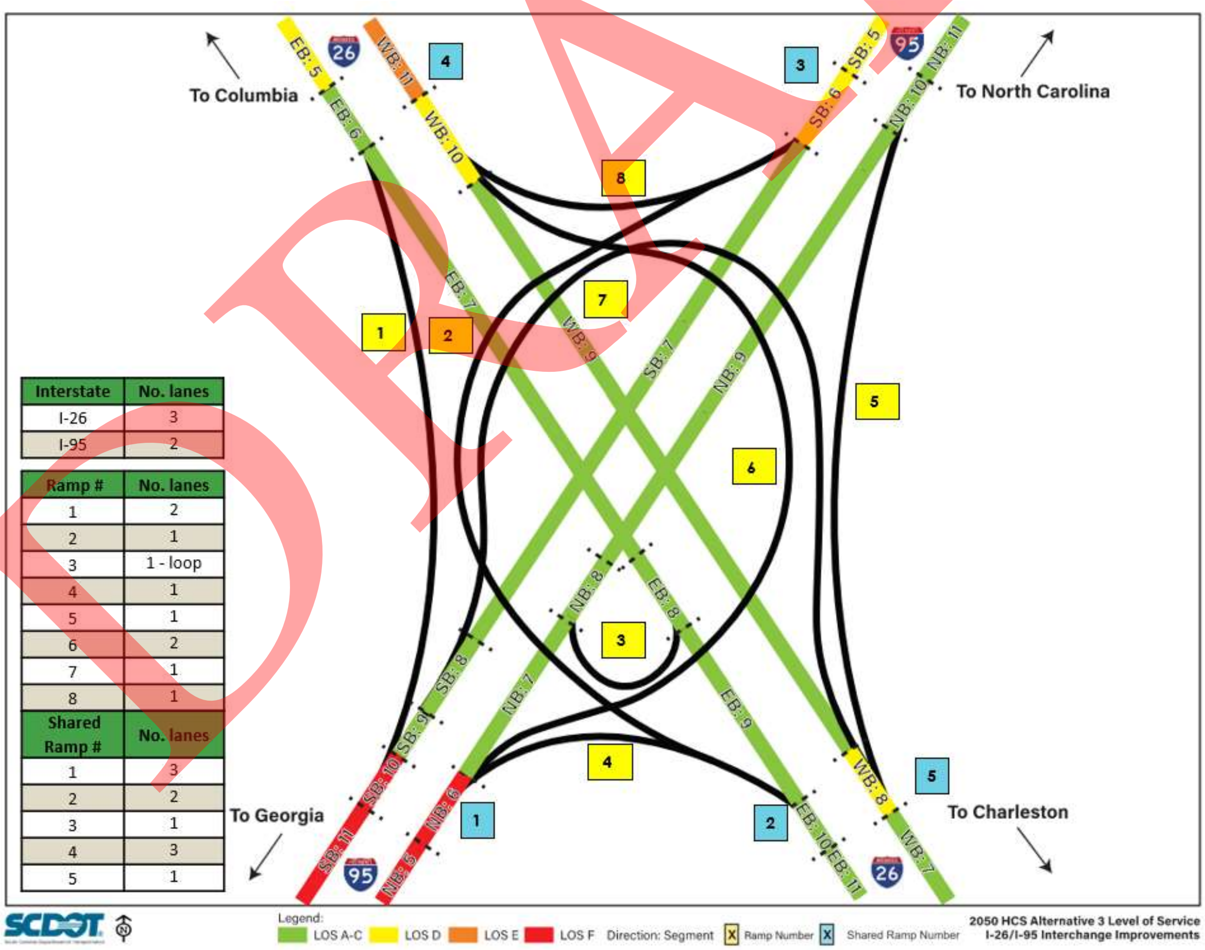


**Table 6.42** and **Table 6.43** present capacity analysis results for Alternative 3 2050 Build conditions on I-26 eastbound and westbound.

### Table 6.42: 2050 Build Alternative 3 HCM Capacity Analysis Results (I-26 Eastbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | West of SC 210 | Basic | 3 | 4264 | 29% | D | 35.0 |
| 2 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4264 | 29% | D | 32.8 |
| | | | 1 | 78 | 27% | | 31.8 |
| 3 | Between SC 210 Ramps | Basic | 3 | 4186 | 29% | D | 33.9 |
| 4 | I-26 On-Ramp from SC 210 | Merge | 3 | 4186 | 29% | D | 34.0 |
| | | | 1 | 108 | 14% | | 28.7 |
| 5 | Between SC 210 and I-95 | Basic | 3 | 4294 | 28% | D | 35.0 |
| 6 | I-26 Off-Ramp to I-95 SB | Diverge | 3 | 4294 | 28% | C | 34.2 |
| | | | 2 | 2192 | 24% | | 27.9 |
| 7 | Between I-95 Ramps | Basic | 3 | 2102 | 33% | B | 14.9 |
| 8 | I-26 Off-Ramp Loop to I-95 NB | Diverge | 3 | 2102 | 33% | B | 16.0 |
| | | | 1 | 70 | 17% | | 17.3 |
| 9 | Between I-95 Ramps | Basic | 3 | 2032 | 33% | B | 13.8 |
| 10 | I-26 On-Ramp from I-95 NB | Merge | 3 | 2032 | 33% | C | 25.7 |
| | | | 2 | 1527 | 21% | | 23.7 |
| 11 | Between I-95 and U.S. 15 | Basic | 3 | 3559 | 28% | C | 25.8 |
| 12 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 28% | D | 25.7 |
| | | | 1 | 194 | 28% | | 28.3 |
| 13 | Between U.S. 15 Ramps | Basic | 3 | 3365 | 28% | C | 23.9 |
| 14 | Between U.S. 15 Ramps | Weaving | 4 | 3365 | 28% | B | 19.6 |
| | | | 1 | 60 | 11% | | |
| 15 | Between U.S. 15 Ramps | Basic | 3 | 3425 | 28% | C | 23.4 |
| 16 | I-26 On-Ramp from U.S. 16 | Merge | 3 | 3425 | 28% | C | 26.7 |
| | | | 1 | 111 | 21% | | 23.9 |
| 17 | East of U.S. 15 | Basic | 3 | 3314 | 11% | C | 25.2 |
| | | | | | Corridor | D | 28.7 |

## Table 6.43: 2050 Build Alternative 3 HCM Capacity Analysis Results (I-26 Westbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | East of U.S. 15 | Basic | 3 | 3559 | 27% | C | 25.5 |
| 2 | I-26 Off-Ramp to U.S. 15 | Diverge | 3 | 3559 | 27% | C | 25.9 |
| | | | 1 | 67 | 5% | | 27.1 |
| 3 | Between U.S. 15 Ramps | Basic | 3 | 3492 | 27% | C | 24.9 |
| 4 | Between U.S. 15 Ramps | Weaving | 4 | 3277 | 27% | C | 22.5 |
| | | | 1 | 189 | 38% | | |
| 5 | Between U.S. 15 Ramps | Basic | 3 | 3466 | 28% | C | 24.9 |
| 6 | I-26 On-Ramp from U.S. 15 | Merge | 3 | 3466 | 28% | C | 27.1 |
| | | | 1 | 100 | 17% | | 23.9 |
| 7 | Between U.S. 15 and I-95 | Basic | 3 | 3566 | 28% | C | 25.8 |
| 8 | I-26 Off-Ramp to I-95 | Diverge | 3 | 3566 | 28% | D | 28.0 |
| | | | 1 | 1529 | 18% | | 31.7 |
| 9 | Between I-95 Ramps | Basic | 3 | 2037 | 35% | B | 14.6 |
| 10 | I-26 On-Ramp from I-95 | Merge | 3 | 2037 | 35% | D | 39.1 |
| | | | 2 | 2264 | 29% | | 32.8 |
| 11 | Between I-95 & SC 210 | Basic | 3 | 4301 | 32% | E | 37.2 |
| 12 | I-26 Off-Ramp to SC 210 | Diverge | 3 | 4301 | 32% | D | 34.0 |
| | | | 1 | 117 | 20% | | 32.5 |
| 13 | Between SC 210 Ramps | Basic | 3 | 4184 | 32% | E | 35.3 |
| 14 | I-26 On-Ramp from SC 210 | Merge | 3 | 4184 | 32% | D | 34.6 |
| | | | 1 | 72 | 19% | | 28.9 |
| 15 | West of SC 210 | Basic | 3 | 4256 | 32% | E | 36.5 |
| | | | | | Corridor | E | 29.3 |

*Note: HCS reports LOS E operations for the overall corridor (reflecting the worst LOS on a specific segment). The corridor is reported at LOS E primarily due to the westbound merge of the ramp from I-95 in Segment 13. Despite the planned widening to six-lanes, queuing and poor operations will occur onto I-26 WB. TransModeler analysis is required to examine merge improvements.*

**Table 6.44** and **Table 6.45**, present capacity analysis results for Alternative 3 2050 Build conditions on I-95 northbound and southbound.

### Table 6.44: 2050 Build Alternative 3 HCM Capacity Analysis Results (I-95 Northbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | South of U.S. 178 | Basic | 2 | 4007 | 27% | F | 56.8 |
| 2 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4007 | 27% | F | 36.8 |
| | | | 1 | 188 | 23% | | 37.5 |
| 3 | Between U.S. 178 Ramps | Basic | 2 | 3819 | 27% | F | 55.0 |
| 4 | I-95 On-Ramp from U.S. 178 | Merge | 2 | 3819 | 27% | F | 37.4 |
| | | | 1 | 222 | 39% | | 32.2 |
| 5 | Between U.S. 178 and I-26 | Basic | 2 | 4041 | 27% | F | 37.2 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 4041 | 27% | F | 38.9 |
| | | | 1 | 2569 | 28% | | 26.1 |
| 7 | Between I-26 Ramps | Basic | 2 | 1472 | 24% | A | 3.9 |
| 8 | I-95 On-Ramp Loop from I-26 EB | Merge | 2 | 1472 | 24% | A | 5.0 |
| | | | 1 | 70 | 17% | | 2.7 |
| 9 | Between I-26 Ramps | Basic | 2 | 1542 | 24% | A | 4.6 |
| 10 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1542 | 24% | B | 17.2 |
| | | | 1 | 1154 | 18% | | 15.3 |
| 11 | Between I-26 and U.S. 176 | Basic | 2 | 2696 | 22% | B | 15.4 |
| 12 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2696 | 22% | C | 18.8 |
| | | | 1 | 108 | 17% | | 19.9 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 2588 | 22% | B | 14.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 2588 | 22% | B | 16.8 |
| | | | 2 | 49 | 20% | | 16.4 |
| 15 | North of U.S. 176 | Basic | 2 | 2637 | 22% | B | 14.9 |
| | | | | | Corridor | F* | 23.6 |

*Note: HCS reports LOS F operations for the overall corridor with all I-95 northbound segments from the southern model limit to the I-26 northbound diverge weave operating at LOS F. TransModeler analysis is required. Key issue is inadequate capacity on I-95 south of the I-26 interchange in 2050.*

## Table 6.45: 2050 Build Alternative 3 HCM Capacity Analysis Results (I-95 Southbound)

| Segment No. | Segment Name | Type | # of Lanes | Volume (pc/hr) | HV% | LOS | Density (pc/mi/ln) |
|---|---|---|---|---|---|---|---|
| 1 | North of U.S. 176 | Basic | 2 | 2634 | 27% | D | 28.0 |
| 2 | I-95 Off-Ramp to U.S. 176 | Diverge | 2 | 2634 | 27% | D | 31.1 |
| | | | 1 | 49 | 23% | | 31.7 |
| 3 | Between U.S. 176 Ramps | Basic | 2 | 2585 | 27% | D | 27.2 |
| 4 | I-95 On-Ramp from U.S. 176 | Merge | 2 | 2585 | 27% | C | 30.8 |
| | | | 1 | 111 | 39% | | 27.0 |
| 5 | Between U.S. 176 and I-26 | Basic | 2 | 2696 | 27% | D | 28.9 |
| 6 | I-95 Off-Ramp to I-26 | Diverge | 2 | 2696 | 27% | D | 31.0 |
| | | | 1 | 1222 | 28% | | 31.4 |
| 7 | Between I-26 Ramps | Basic | 2 | 1474 | 27% | B | 14.5 |
| 8 | I-95 On-Ramp from I-26 WB | Merge | 2 | 1474 | 27% | C | 20.6 |
| | | | 1 | 375 | 29% | | 20.9 |
| 9 | Between I-26 Ramps | Basic | 2 | 1849 | 25% | C | 18.1 |
| 10 | I-95 On-Ramp from I-26 EB | Merge | 2 | 1849 | 25% | F | 39.9 |
| | | | 2 | 2192 | 18% | | 29.1 |
| 11 | Between I-26 and U.S. 178 | Basic | 2 | 4041 | 22% | F | 43.3 |
| 12 | I-95 Off-Ramp to U.S. 178 | Diverge | 2 | 4041 | 22% | F | 36.3 |
| | | | 1 | 200 | 17% | | 39.9 |
| 13 | Between U.S. 176 Ramps | Basic | 2 | 3841 | 22% | F | 37.5 |
| 14 | I-95 On-Ramp from U.S. 176 | Merge | 3 | 3841 | 22% | F | 40.6 |
| | | | 2 | 210 | 20% | | 33.3 |
| 15 | South of U.S. 178 | Basic | 2 | 4051 | 22% | F | 43.0 |
| | | | | | Corridor | F* | 32.9 |

*Note: HCS reports LOS F operations for the I-95 southbound corridor with an unacceptable LOS F at the Segment 10 merge and LOS E and F operations on I-95 to the south. No improvements are currently planned for I-95 south of I-26. TransModeler analysis is needed to examine potential impacts to the I-26 at I-95 interchange.*

# 7. INITIAL TRANSMODELER ANALYSIS

Macroscopic tools such as HCS are limited in their ability to model congested corridors where queueing impacts performance, so TransModeler was also used to analyze future conditions in the study corridor. Microscopic models like TransModeler simulate dynamic conditions and include additional parameters such as driver behavior and can be a better indicator of field conditions.

## 7.1 Calibration and Lane Adjustments for Initial Testing

The 2022 existing conditions TransModeler model was calibrated to documented volume and travel speed conditions using FHWA criteria. This model is intended to establish baseline traffic conditions, in the form of quantifiable performance measures for both the existing and future year No Build conditions. **Table 7.1** shows a summary of the 2022 existing conditions model meeting all targets and confirms calibration. The calibration is described in detail in the TransModeler calibration memo in **Appendix F.**

**Table 7.1: 2022 Existing Conditions Calibration Criteria**

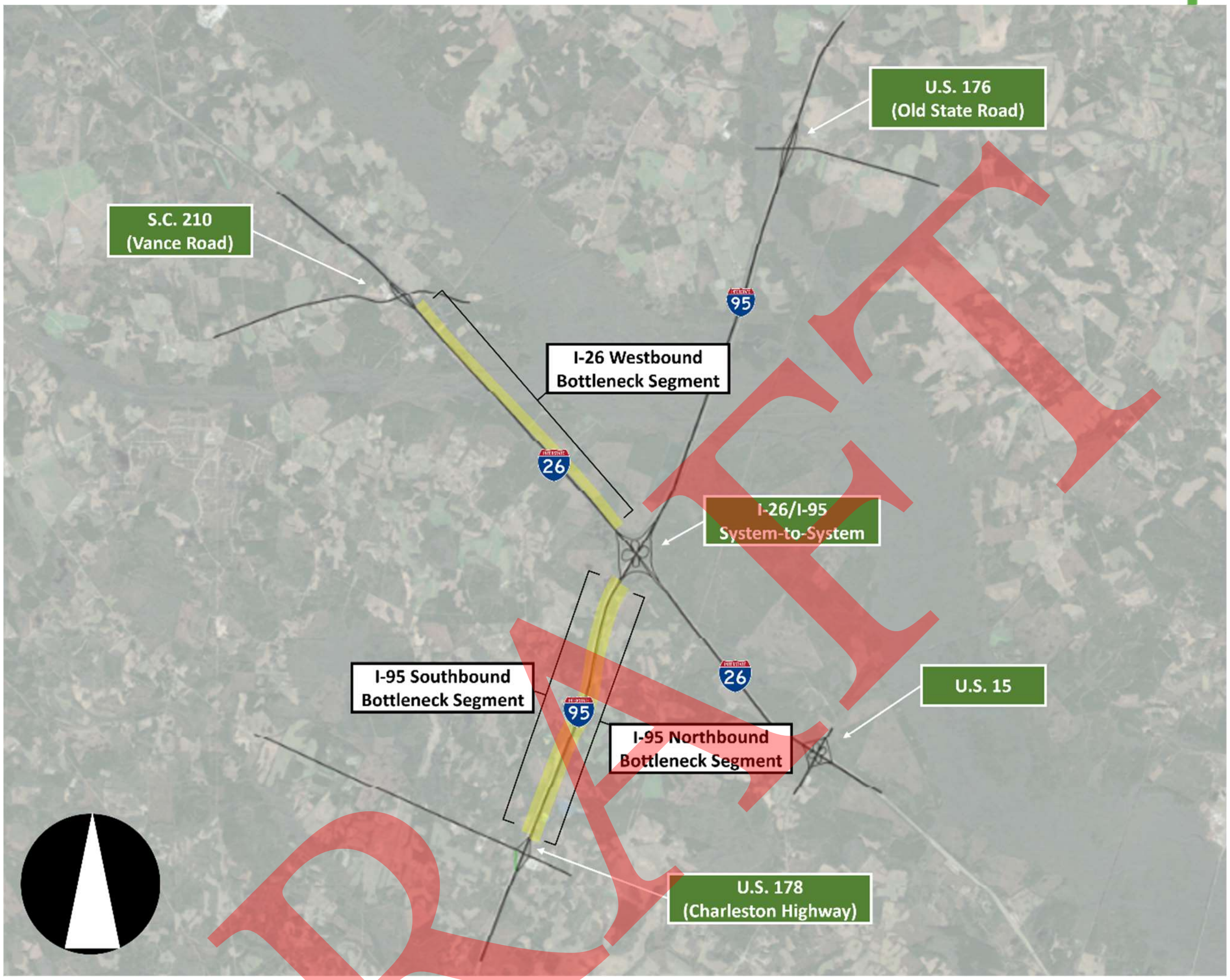
| FHWA Calibration Criteria | Metric | Met? |
|---|---|---|
| Sum of all link flows | 1% | Met |
| Within 15%, for 700 veh/h < Flow < 2700 veh/h | 100% | Met |
| Within 100 veh/h, for Flow < 700 veh/h | 100% | Met |
| Within 400 veh/h, for Flow > 2700 veh/h | 100% | Met |
| GEH Statistic < 5 for Individual Link Flows | 100% | Met |
| Travel speeds with a difference of 15% for greater than 85% of the cases | 100% | Met |

### 7.1.1 I-26 and I-95 Mainline Capacity Observations

The existing model scenario assumes existing geometry. Future year scenarios consist of one additional lane in each direction of I-26. Initial analysis of 2050 conditions with one additional lane in each direction of I-26 indicated flow constraints at three locations adjacent to the I-26 at I-95 system interchange. **Figure 7.1** illustrates the constraints identified at three bottleneck locations.

- I-95 Southbound – South of the I-26 at I-95 system interchange (north of U.S. 178)
- I-95 Northbound - South of the I-26 at I-95 system interchange (north of U.S. 178)
- I-26 Westbound – West of the I-26 at I-95 system interchange (east of S.C. 210) (even with the planned 6-lane widening of I-26)

## Figure 7.1: I-26 and I-95 Mainline Bottleneck Segments in TransModeler




This impacts the ability to evaluate the proposed interchange alternatives because the full estimated volume is not represented. For this reason, interstate improvements were added to the model to allow for a more accurate and unconstrained analysis of the interchange alternatives. The flow constraints and related model adjustments are described in more detail below. They are illustrated using Alternative 2.

**Figure 7.2** shows congestion on the I-26 eastbound to I-95 southbound ramp. This congestion queues on I-26 eastbound to the S.C. 210 interchange, due to the bottleneck on I-95 southbound south of the system interchange. **Figure 7.3** shows the bottlenecks on I-95 northbound and southbound south of the system interchange. To alleviate this congestion, auxiliary lanes were added to create a 6-lane section between U.S. 178 and the system interchange.

### Figure 7.2: TransModeler Alternative 2 (No Additional Widening)

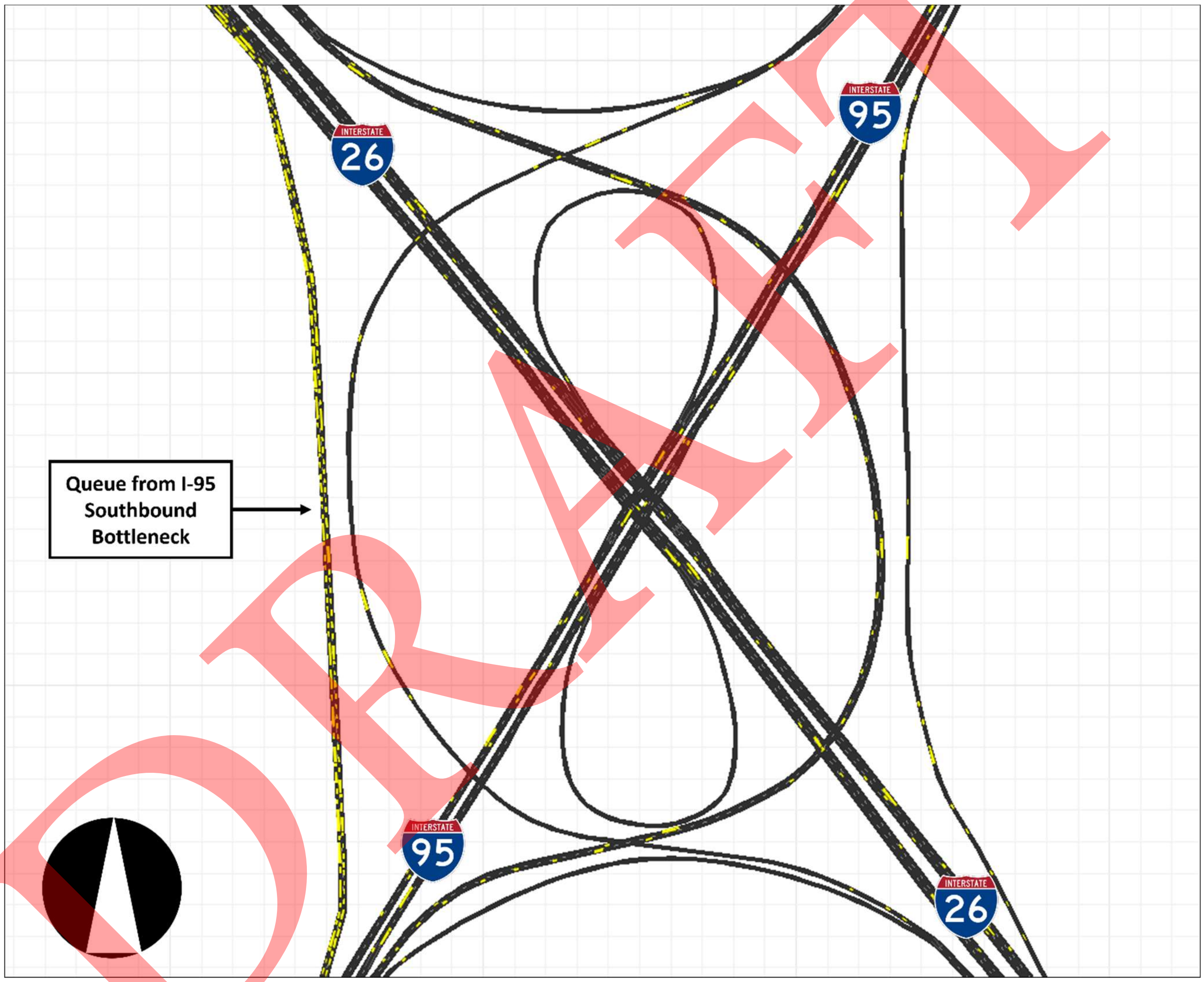


**Figure 7.3: TransModeler Alternative 2 (No Additional Widening)**

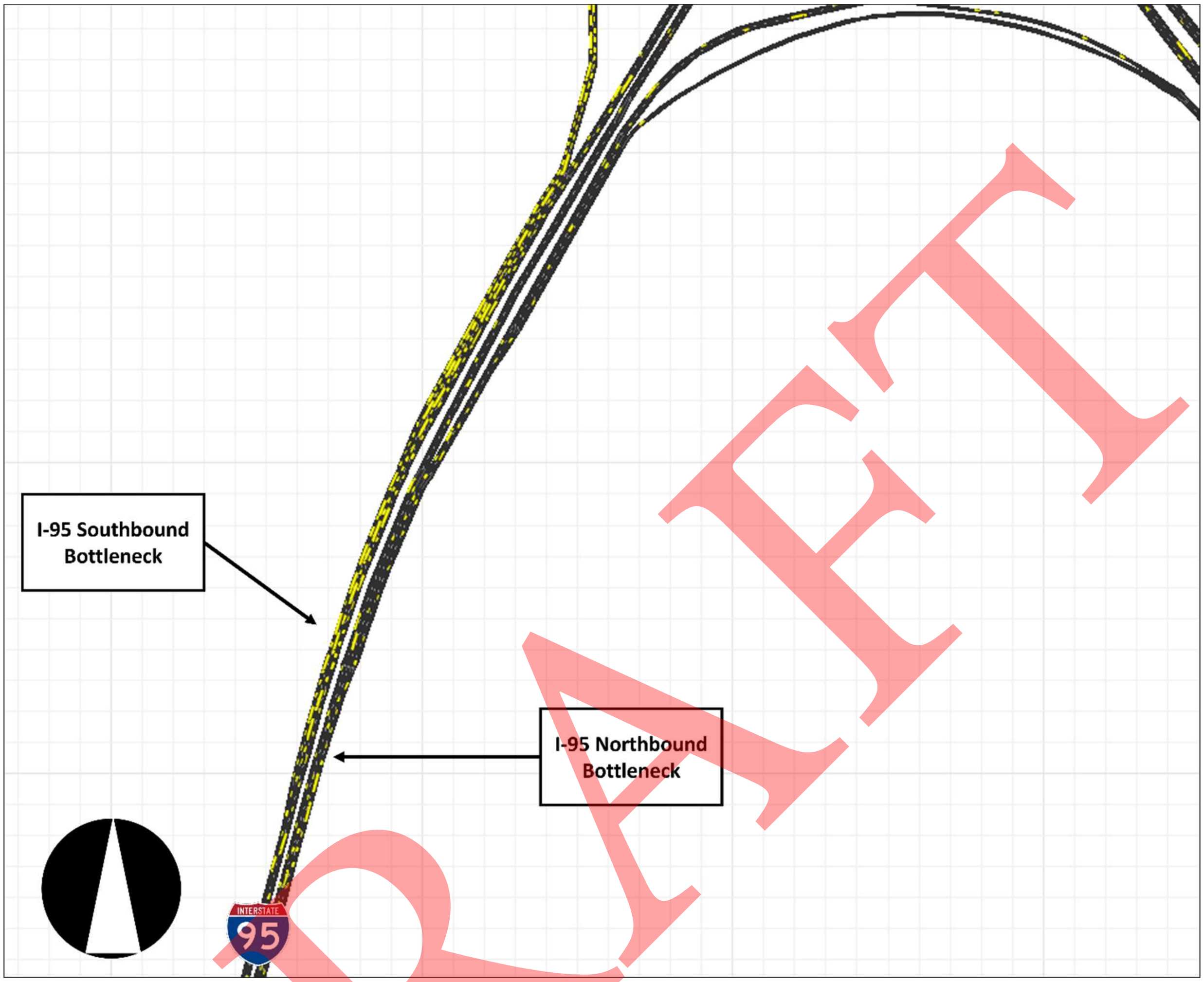


**Figure 7.4** shows that once auxiliary lanes were added to the I-95 southbound segment, the volume was able to flow more freely, which then highlighted congestion on the I-95 northbound to I-26 westbound fly-over ramp. This congestion queues on I-26 westbound from the S.C. 210 interchange, due to the bottleneck on I-26 westbound west of the system interchange. **Figure 7.5** shows the I-26 westbound bottleneck west of the system interchange. To alleviate the I-26 westbound congestion, an auxiliary lane was added in the westbound direction only to create a 7-lane section between S.C. 210 and the system interchange.

**Figure 7.4: TransModeler Alternative 2 (I-95 Additional Widening)**

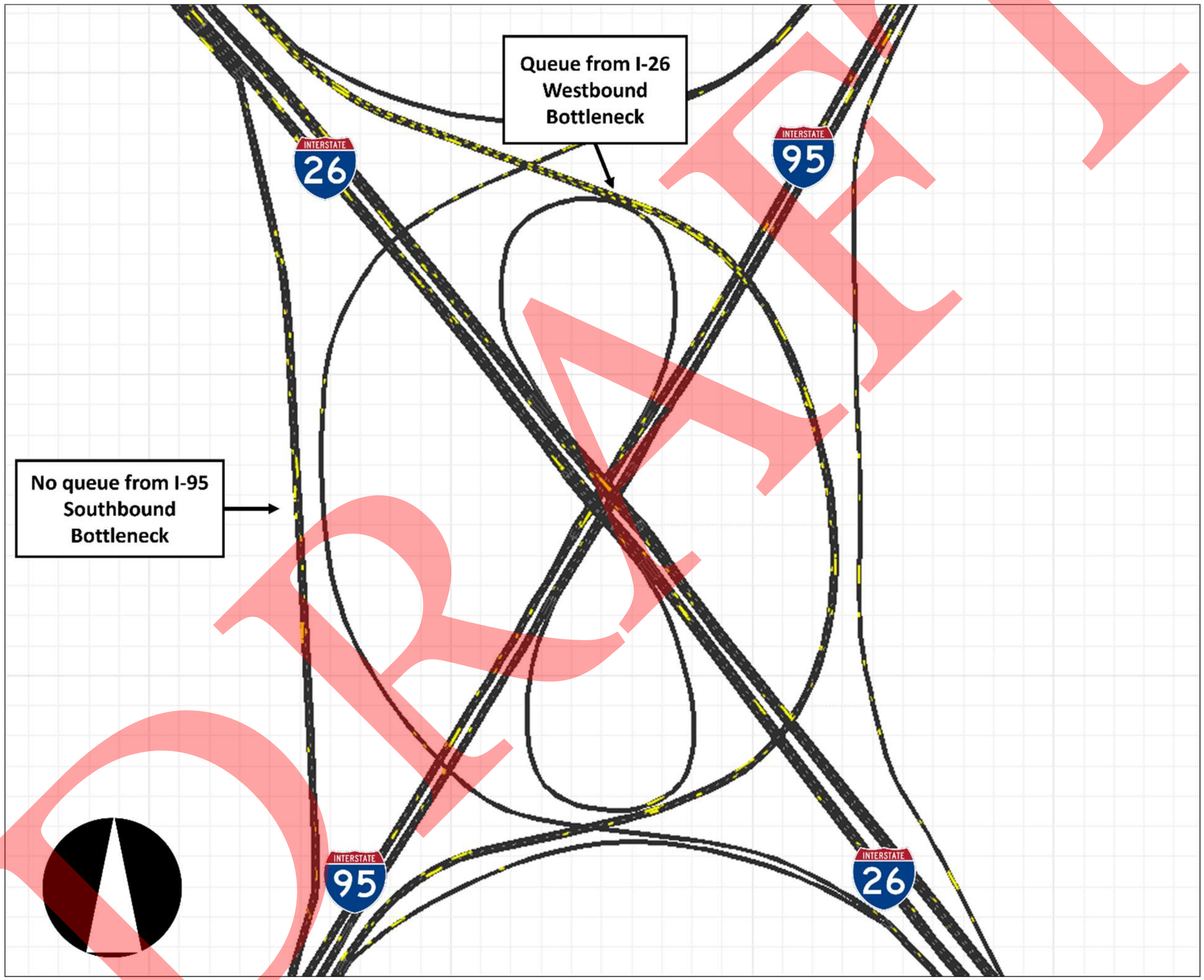


**Figure 7.5: TransModeler Alternative 2 (I-26 Additional Widening)**

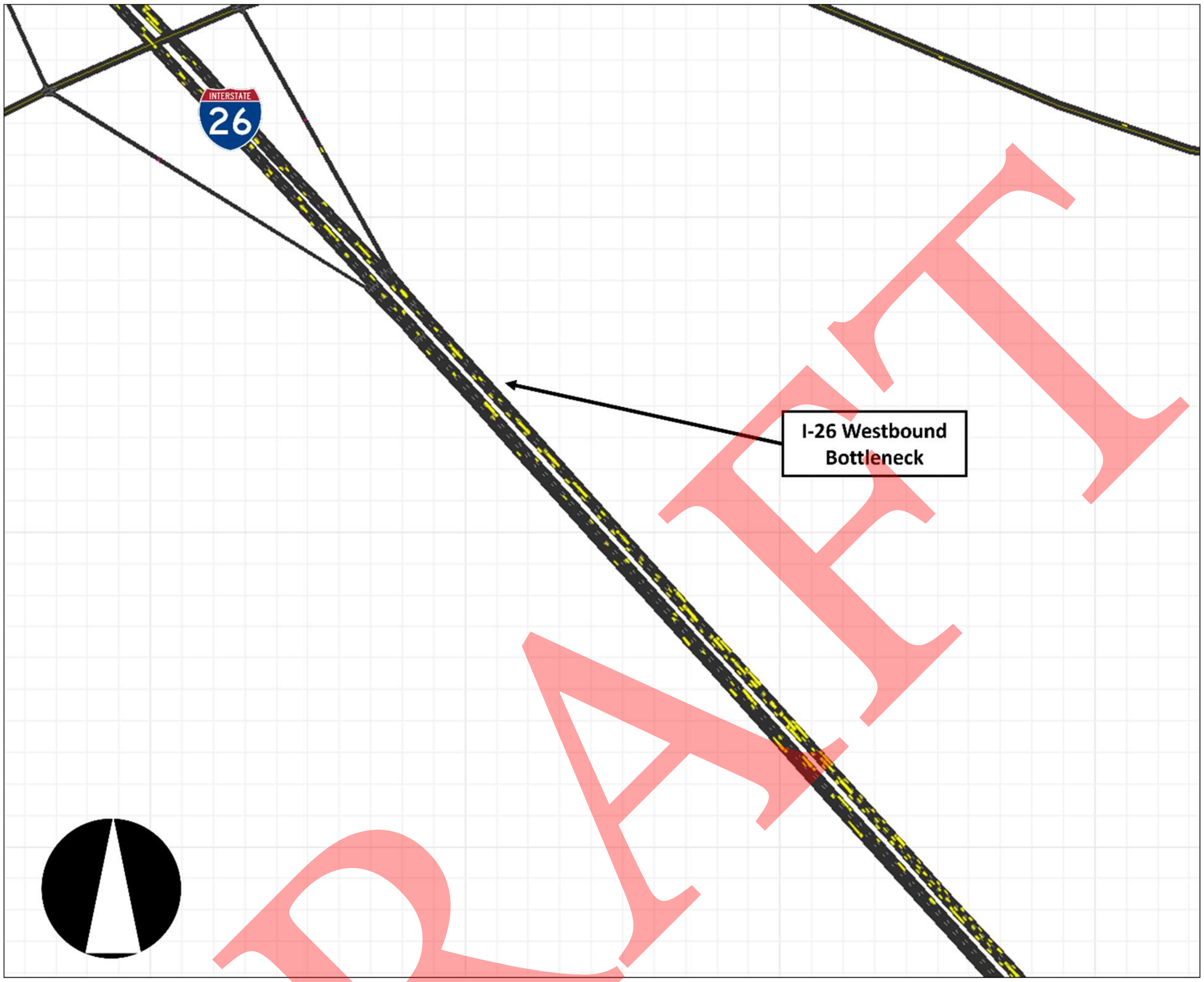
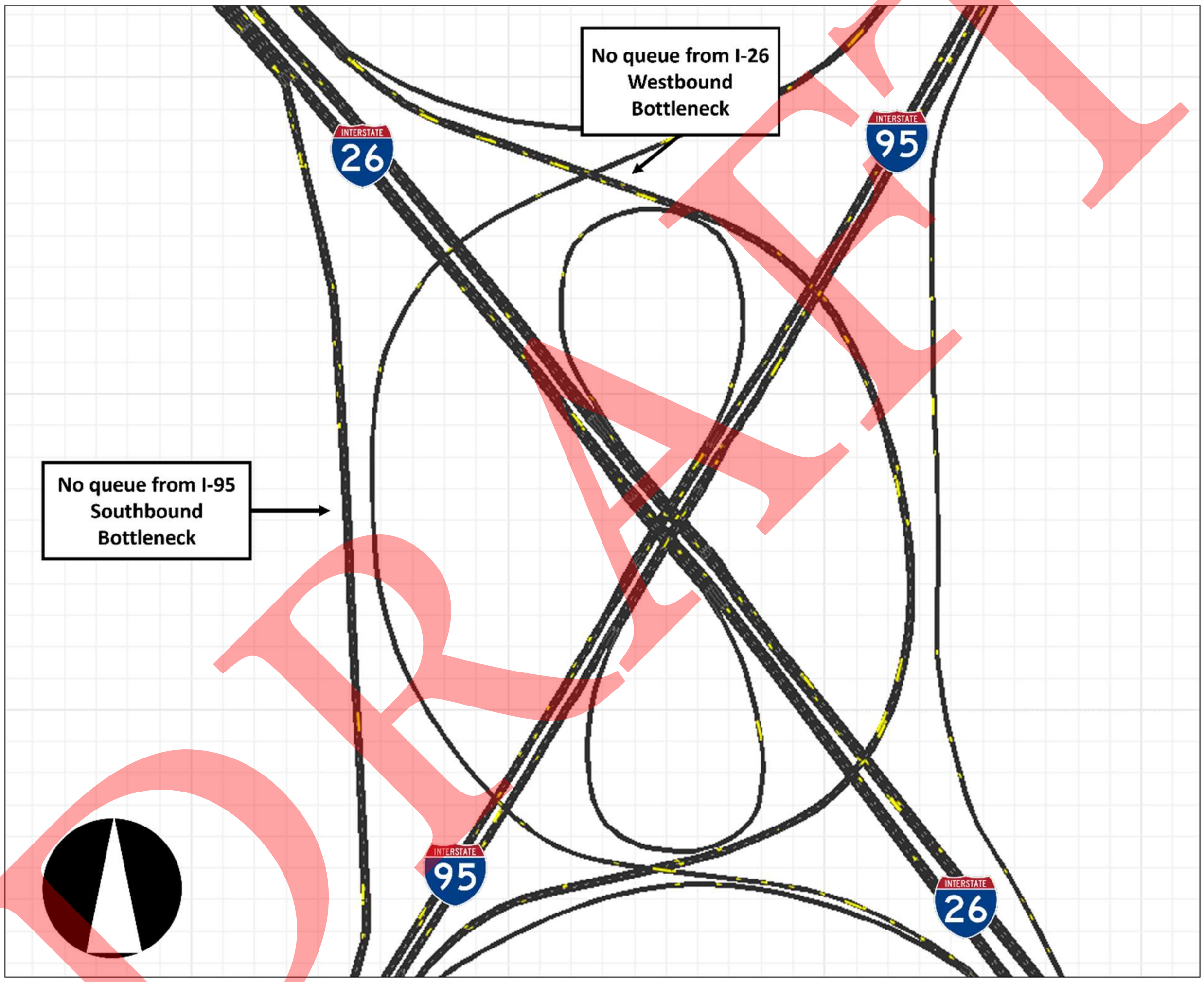


**Figure 7.6** shows that, adding auxiliary lanes to these specific segments alleviates congestion so that entering and exiting volume can flow freely through the system interchange. This ensures the model results will reflect anticipated interchange operations if no downstream queueing backs into the interchanges. These widening tests are only intended for modeling and analysis purposes – widening on I-95 to the south is not being proposed as part of this study. Instead, the objective is to identify a preferred merge treatment.

### Figure 7.6: TransModeler Alternative 2 (I-95 and I-26 Additional Widening)



## 7.1.2 TransModeler Analysis Assumptions for Initial Analysis with Additional Freeway Lanes

Based on this process, it was determined that the baseline comparison for the evaluation of alternatives would include theoretical capacity on I-95 south of the interchange (in addition to the planned future widening of I-26 to six-lanes). Therefore, the Section 7.4 TransModeler analysis of alternatives included the following assumptions as part of the analysis to determine the preferred merge treatments onto both I-95 southbound and I-26 westbound. These merge treatments movements need additional analysis due to poor LOS results from HCS (Section 6.2) as well as queuing identified in TransModeler that extends back from the key merges into the I-26 at I-95 interchange resulting in congested interchange operations and ramp queuing caused by downstream merges.

- **I-95 Southbound – Auxiliary lane from I-26 Eastbound On-Ramp to U.S. 178 Off-Ramp.** Figure 7.2 illustrates the ramp queuing issue that this modeling assumption is intended to address. Figure 7.3 illustrates that the cause of the ramp queuing is not the interchange itself but the two-lane section on I-95. By providing an extra southbound lane in the TransModeler analysis, an iterative analysis of options can occur to evaluate long term impacts and to identify an optimum design if widening does not occur. The assumed lane also allows for a test of whether the interchange operates effectively if or when the I-95 bottleneck is addressed.

- **I-95 Northbound - Auxiliary lane from U.S. 178 On-Ramp to I-26 Eastbound Off-Ramp.** The purpose of this extra lane is to test the true demand on the interchange ramps, merges and diverges with all I-95 northbound traffic being able to reach the interchange without metering of northbound flow. Figure 7.3 illustrates the northbound bottleneck on I-95 that restricts traffic volumes from reaching the I-26 at I-95 interchange. A review of the model simulations illustrates the effect of testing the model with constrained or metered traffic flow.

  – Figure 7.2 shows no congestion on the proposed flyover from I-95 northbound to I-26 westbound. The "uncongested" operations, however, actually reflect the processing of lower traffic volumes due to the I-95 northbound bottleneck.

  – Figure 7.4 illustrates ramp queuing on the same proposed flyover if the I-95 northbound bottleneck were not occurring. By testing the theoretical scenario with an extra northbound lane on I-95, the inadequacy of the I-26 westbound merge is identified. Adding the extra lane from a modeling perspective assures that the interchange is tested with the identified design volumes.

- **I-26 Westbound – Auxiliary lane from I-95 Southbound On-Ramp to S.C. 210 Off-Ramp.** As identified in the I-26 northbound discussion, queuing is shown at this merge even with the proposed widening to six lanes. By testing an additional I-26 westbound lane an iterative analysis can be conducted on shorter merges to identify the length of merge needed to best serve the interchange without overdesigning the corridor.

The TransModeler analysis will focus on identifying a preferred alternative from a traffic perspective. Chapter 8 will then include an iterative analysis of the key merge items noted above to determine a preferred merging treatment for I-95 southbound and I-26 westbound. Based on the initial TransModeler analysis (Chapter 7) and the refined merge analysis (Chapter 8), a preferred alternative will be identified for analysis as part of the IMR comparison of the No Build and preferred alternative. This final TransModeler analysis for the IMR comparison is presented in Chapter 9.

### 7.1.3 Corridor Freeway Analysis Summary with Additional Freeway Lanes

The following section presents the peak hour TransModeler corridor analysis for 2022 existing conditions, and 2030 and 2050 under No Build and Build conditions. Future year no build and build results reflect the future widening of I-26 to 6-lanes and the three widening assumptions introduced in the previous section:

Note that the widening of I-95 is included in this comparison analysis to test the interchange itself assuming that there are no restrictions on either the I-26 or I-95 approaches or departures. Applying this methodology prevents over design of the interchange, while also allowing for a fair comparison between alternatives. Chapter 8 provides a more detailed iterative TransModeler analysis with the unwidened sections of I-95 to identify a preferred interchange laneage and to identify an appropriate interchange design recognizing that no project has been identified for widening of I-95.

**Table 7.2, Table 7.3, Table 7.4,** and **Table 7.5** summarize freeway capacity analysis for the I-26 corridor in the eastbound and westbound directions, respectively, and the I-95 corridor in the northbound and southbound directions, respectively. LOS C is again used as the preferred LOS threshold with LOS D as the minimum acceptable operations. TransModeler output for the corridor freeway analysis are provided in **Appendix G**.

Table 7.2 and Table 7.3 summarize freeway capacity analysis for the I-26 corridor in the eastbound and westbound directions, respectively. The results indicate that the capacity improvement at the I-26 eastbound to I-95 southbound ramp will improve the freeway to acceptable LOS. Removing the I-26 at I-95 System weave and associated ramps on I-26 westbound will improve the freeway to acceptable LOS. Additionally, it is noted that unacceptable LOS occurs in the future year Build conditions on I-95 northbound, south of U.S. 178 and on I-95 southbound, north of U.S. 176. The U.S. 176 and U.S. 178 interchanges were included in the study due to its location to the I-26 at I-95 System interchange and remains outside of the scope of this project's improvement analysis.

It is also noted that some I-26 segments appear to degrade from 2050 No Build to the 2050 Build scenarios. This is misleading because bottlenecks within the No Build system result in not all traffic being processed through the interchange in the peak hour. For example, Segments 12-17 along I-26 eastbound have lower density and corresponding better LOS in 2050 No Build due to the bottleneck at the I-26 eastbound diverge to I-95 southbound, which allows less volume to travel along I-26 eastbound than compared to the build scenarios. The same occurs along I-26 westbound for segments 14-17. These segments have a lower density and better LOS in 2050 No Build due to another bottleneck at I-95 northbound at the system-to-system weave, which allows less volume to travel to I-26 westbound. Nevertheless, the Build scenario represents an overall improvement in operations compared with the No Build.

Table 7.4 and Table 7.5 summarize freeway capacity analysis for the I-95 corridor in the northbound and southbound directions, respectively. Removing the I-26 at I-95 System weave and associated ramps on I-95 northbound and southbound directions will improve the freeway to acceptable LOS. Additionally, it is noted that unacceptable LOS occurs in the future year Build conditions on I-26 eastbound and westbound, west of S.C. 210. The S.C. 210 interchange was included in the study due to its location to the I-26 at I-95 System interchange and remains outside of the scope of this project's improvement analysis.

It is also noted that some I-95 segments appear to degrade from 2050 No Build to the 2050 Build scenarios. As with the I-26 observations, this is due to bottlenecks in the No Build network restricting flow from being processed through the interchange resulting in lower volumes being processed. For example, Segments 12-15 along I-95 northbound have lower density and corresponding better LOS in 2050 No Build due to the previously mentioned bottleneck at I-95 northbound at the system-to-system weave, which allows less volume to travel along I-95 northbound. The same occurs along I-95 southbound for segments 12-15. These segments have a lower density and better LOS in 2050 No Build due to the previously mentioned bottleneck at the I-26 eastbound diverge to I-95 southbound, which allows less volume to travel to I-95 southbound than compared to the build scenarios.

Overall, however, the Build Alternatives provide improved operations on both I-26 and I-95. In all instances with a reduced density in the No Build, the density reduction is the result of a significant bottleneck causing delays and queuing on upstream freeway and ramp approaches. Also note that for the No Build roadway sections serving restricted or reduced volumes in the peak period, it is expected that peak period congestion will be pushed from the peak hours to adjacent hours resulting in more hours of congestion per day as queues build and dissipate.

**Table 7.2: TransModeler Freeway Segment Density Results: I-26 Eastbound**

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| | | | | | 7-lanes on I-26 + 6-lanes on I-95** | | | | | | | | | | | | | | | |
| 1 | West of S.C. 210 | Basic | 18.1 | C | 18.0 | B | 18.1 | C | 18.1 | C | 18.2 | C | 65.1 | F | 27.3 | D | 28.8 | D | 26.3 | D |
| 2 | Off-Ramp to S.C. 210 | Diverge | 23.4 | C | 15.7 | B | 14.9 | B | 14.8 | B | 14.9 | B | 42.3 | E | 21.3 | C | 22.3 | C | 20.3 | C |
| 3 | Between S.C. 210 Ramps | Basic | 23.9 | C | 17.8 | B | 17.7 | B | 17.7 | B | 17.9 | B | 88.3 | F | 26.0 | C | 25.5 | C | 25.6 | C |
| 4 | On-Ramp from S.C. 210 | Merge | 23.2 | C | 14.9 | B | 14.2 | B | 14.0 | B | 14.6 | B | 90.9 | E | 20.3 | C | 20.8 | C | 20.9 | C |
| 5 | West of I-26/I-95 System Interchange | Basic | 24.6 | C | 18.9 | C | 18.3 | C | 18.4 | C | 18.3 | C | 110.6 | F | 25.6 | C | 25.4 | C | 25.7 | C |
| 6 | Off-Ramp to I-95 SB | Diverge | 36.7 | E | 26.3 | C | 12.2 | B | 11.5 | B | 11.6 | B | 29.7*** | D | 16.6 | B | 15.2 | B | 15.7 | B |
| 7 | Between Ramps | Basic | 12.3 | B | 8.6 | A | 8.3 | A | 8.5 | A | 9.0 | A | 10.6*** | A | 13.1 | B | 13.5 | B | 13.4 | B |
| 8 | I-26 at I-95 System Weave* | Weave | 11.9 | B | 11.8 | B | 5.5 | A | 5.3 | A | 5.0 | A | 14.8*** | B | 8.5 | A | 8.5 | A | 8.3 | A |
| 9 | Between Ramps | Basic | 18.9 | C | 13.8 | B | 8.4 | A | 8.6 | A | 8.5 | A | 17.2*** | B | 13.1 | B | 13.0 | B | 13.2 | B |
| 10 | On-Ramp from I-95 NB | Merge | 18.1 | B | 13.0 | B | 11.1 | B | 11.2 | B | 11.3 | B | 15.6*** | B | 16.5 | B | 16.3 | B | 16.5 | B |
| 11 | East of I-26/I-95 System Interchange | Basic | 19.7 | C | 15.0 | B | 11.5 | B | 11.0 | B | 11.7 | B | 17.8*** | B | 17.7 | B | 17.2 | B | 18.1 | C |
| 12 | Off-Ramp to U.S. 15 SB | Diverge | 18.8 | B | 11.8 | B | 11.3 | B | 11.7 | B | 11.3 | B | 13.6*** | B | 16.6 | B | 16.4 | B | 16.7 | B |
| 13 | Between Ramps | Basic | 17.0 | B | 14.2 | B | 14.5 | B | 13.8 | B | 14.1 | B | 17.2*** | B | 21.1 | C | 21.1 | C | 21.4 | C |
| 14 | Weave to/from U.S. 15 | Weave | 8.4 | A | 4.8 | A | 5.9 | A | 5.1 | A | 6.4 | A | 5.9*** | A | 8.5 | A | 9.4 | A | 9.0 | A |
| 15 | Between Ramps | Basic | 20.4 | C | 14.3 | B | 14.0 | B | 13.9 | B | 14.4 | B | 16.9*** | B | 21.6 | C | 20.7 | C | 21.0 | C |
| 16 | On-Ramp from U.S. 15 NB | Merge | 19.0 | B | 11.9 | B | 13.1 | B | 12.7 | B | 13.0 | B | 14.9*** | B | 18.6 | B | 19.2 | B | 19.9 | B |
| 17 | East of U.S. 15 | Basic | 19.8 | C | 14.9 | B | 15.0 | B | 15.4 | B | 14.8 | B | 17.9*** | B | 22.2 | C | 22.0 | C | 22.1 | C |

*In all 2030 and 2050 Build Alternatives the weave segment is removed. This segment is replaced by a diverge segment, which is the off-ramp to I-95 Northbound.*
*** See TransModeler analysis assumptions as discussed in Section 7.1.2.*
**** For 2050, the No Build has substantial queuing and restricted flow at Link 5 which is a bottleneck. For this reason, densities on downstream links are lower than the Build alternatives based on the TransModeler simulation analysis. Nevertheless, the Build alternatives all represent an improvement in I-26 eastbound flow, serves higher volumes, and maintain LOS C or better operations.*

**Table 7.3: TransModeler Freeway Segment Density Results: I-26 Westbound**

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| | | | | | 7-lanes on I-26 + 6-lanes on I-95** | | | | | | | | | | | | | | | |
| 1 | East of U.S. 15 | Basic | 19.6 | C | 15.0 | B | 15.0 | B | 14.9 | B | 14.9 | B | 22.8 | C | 22.7 | C | 22.4 | C | 22.7 | C |
| 2 | Off-Ramp to U.S. 15 NB | Diverge | 13.0 | B | 11.5 | B | 11.4 | B | 10.9 | B | 11.5 | B | 17.1 | B | 17.5 | B | 17.3 | B | 17.5 | B |
| 3 | Between Ramps | Basic | 19.2 | C | 14.7 | B | 14.8 | B | 14.9 | B | 14.8 | B | 22.6 | C | 22.4 | C | 22.2 | C | 22.7 | C |
| 4 | Weave to/from U.S. 15 | Weave | 9.4 | A | 7.2 | A | 7.0 | A | 6.9 | A | 6.7 | A | 10.8 | B | 10.8 | B | 10.2 | B | 10.7 | B |
| 5 | Between Ramps | Basic | 19.4 | C | 14.8 | B | 14.5 | B | 14.9 | B | 14.2 | B | 21.5 | C | 22.2 | C | 21.8 | C | 21.9 | C |
| 6 | On-Ramp from U.S. 15 SB | Merge | 19.3 | B | 13.4 | B | 12.3 | B | 11.9 | B | 14.1 | B | 18.9 | B | 17.9 | B | 18.0 | B | 21.0 | C |
| 7 | East of I-26/I-95 System Interchange | Basic | 19.8 | C | 15.3 | B | 15.2 | B | 15.1 | B | 15.2 | B | 22.4 | C | 22.2 | C | 22.1 | C | 22.1 | C |
| 8 | Off-Ramp to I-95 NB | Diverge | 19.9 | B | 14.2 | B | 15.3 | B | 15.3 | B | 17.0 | B | 18.4 | B | 22.1 | C | 22.3 | C | 27.3 | C |
| 9 | Between Ramps | Basic | 14.1 | B | 11.0 | B | 10.2 | A | 10.2 | A | 8.7 | A | 16.4 | B | 14.9 | B | 14.6 | B | 12.7 | B |
| 10 | I-26 at I-95 System Weave* | Weave | 27.3 | C | 29.3 | D | 7.9 | A | 8.0 | A | * | * | 34.7*** | D | 10.6 | B | 10.5 | B | * | * |
| 11 | Between Ramps | Basic | 29.0 | D | 20.6 | C | 8.6 | A | 8.6 | A | * | * | 26.8*** | D | 12.8 | B | 12.8 | B | * | * |
| 12 | On-Ramp from I-95 SB | Merge | 24.3 | C | 13.5 | B | 12.9 | B | 12.6 | B | 12.5 | B | 16.8*** | B | 18.6 | B | 18.7 | B | 18.4 | B |
| 13 | West of I-26/I-95 System Interchange (assumes theoretical westbound auxiliary lane)** | Basic | 24.2 | C | 13.5 | B | 13.7 | B | 13.8 | B | 13.8 | B | 16.8*** | B | 20.3 | C | 20.4 | C | 20.4 | C |
| 14 | Off-Ramp to S.C. 210 | Diverge | 29.1 | D | 14.7 | B | 13.7 | B | 13.1 | B | 14.7 | B | 16.8*** | B | 22.0 | C | 21.6 | C | 22.3 | C |
| 15 | Between S.C. 210 Ramps | Basic | 24.4 | C | 18.1 | C | 17.9 | B | 17.9 | B | 17.8 | B | 22.0*** | C | 27.0 | D | 26.9 | D | 26.7 | D |
| 16 | On-Ramp from S.C. 210 | Merge | 22.6 | C | 16.2 | B | 17.8 | B | 17.7 | B | 17.4 | B | 20.5*** | C | 25.3 | C | 24.9 | C | 25.5 | C |
| 17 | West of S.C. 210 | Basic | 23.9 | C | 18.2 | C | 18.3 | C | 18.3 | C | 18.4 | C | 22.5*** | C | 27.2 | D | 27.4 | D | 27.2 | D |

*In all 2030 and 2050 Build Alternatives the weave segment is removed. In Alternatives 1 and 2, this segment is replaced by a diverge segment, which is the off-ramp to I-95 Southbound.
** See TransModeler analysis assumptions as discussed in Section 7.1.2.
*** For 2050, the No Build has substantial queuing and restricted flow on the I-95 northbound loop to I-26 westbound (needs two lanes). For this reason, I-26 westbound volumes are lower as compared with the Build alternatives. Due to the lower volumes, densities on downstream links are lower than the Build alternatives west of the I-26 at I-95 interchange based on the TransModeler simulation analysis. Nevertheless, the Build alternatives all represent an improvement in I-26 westbound flow (since the densities in the No Build are limited), serves higher volumes, and maintains acceptable LOS D operations.

**Table 7.4: TransModeler Freeway Segment Density Results: I-95 Northbound**

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| | | | | | 7-lanes on I-26 + 6-lanes on I-95** | | | | | | | | | | | | | | | |
| 1 | South of U.S. 178 | Basic | 24.7 | C | 29.2 | D | 29.0 | D | 29.1 | D | 29.0 | D | 86.4 | F | 38.8 | E | 38.6 | E | 38.7 | E |
| 2 | I-26 NB Off-Ramp to U.S. 178 | Diverge | 30.1 | D | 35.3 | E | 35.2 | E | 36.6 | E | 34.6 | D | 108.0 | E | 45.5 | E | 43.5 | E | 48.2 | E |
| 3 | I-26 EB Between U.S. 178 Ramps | Basic | 23.4 | C | 27.4 | D | 27.6 | D | 27.9 | D | 27.6 | D | 92.6 | F | 35.7 | E | 35.0 | E | 35.5 | E |
| 4 | I-26 EB On-Ramp from U.S. 178 | Merge | 25.1 | C | 22.0 | C | 19.7 | B | 19.7 | B | 19.7 | B | 121.4 | E | 25.3 | C | 25.2 | C | 25.2 | C |
| 5 | South of I-26/I-95 System interchange (assumes theoretical I-95 northbound auxiliary lane)** | Basic | 25.3 | C | 22.0 | C | 19.7 | C | 19.7 | C | 19.7 | C | 121.4 | F | 25.3 | C | 25.2 | C | 25.2 | C |
| 6 | Off-Ramp to I-26 EB | Diverge | 26.0 | C | 22.0 | C | 17.1 | B | 16.9 | B | 17.1 | B | 121.4 | F | 23.6 | C | 24.0 | C | 23.6 | C |
| 7 | Between Ramps | Basic | 24.9 | C | 52.7*** | F | 12.5 | B | 12.9 | B | 12.7 | B | 86.8 | F | 13.3 | B | 13.5 | B | 13.8 | B |
| 8 | I-26 at I-95 System Weave* | Weave | 27.4 | C | 45.7*** | F | 8.9 | A | 8.8 | A | 9.0 | A | 51.0 | F | 9.6 | A | 9.9 | A | 9.4 | A |
| 9 | Between Ramps | Basic | 11.4 | B | 14.6*** | B | 12.9 | B | 12.8 | B | 12.9 | B | 11.1*** | B | 14.3 | B | 13.9 | B | 14.2 | B |
| 10 | On-Ramp from I-26 WB | Merge | 17.7 | B | 21.2*** | C | 21.2 | C | 21.2 | C | 21.1 | C | 22.4*** | C | 27.3 | C | 27.4 | C | 27.3 | C |
| 11 | North of I-26/I-95 System interchange | Basic | 17.4 | B | 20.6*** | C | 20.6 | C | 20.7 | C | 20.5 | C | 20.6*** | C | 25.3 | C | 25.3 | C | 25.2 | C |
| 12 | Off-Ramp to U.S. 176 | Diverge | 19.1 | B | 21.8*** | C | 23.0 | C | 22.9 | C | 23.3 | C | 23.0*** | C | 25.6 | C | 25.9 | C | 27.1 | C |
| 13 | Between U.S. 176 Ramps | Basic | 16.3 | B | 19.8*** | C | 19.3 | C | 19.5 | C | 18.9 | C | 19.2*** | C | 24.5 | C | 24.5 | C | 24.0 | C |
| 14 | On-Ramp from U.S. 176 | Merge | 15.6 | B | 18.3*** | B | 18.8 | B | 18.0 | B | 19.2 | B | 19.1*** | B | 23.4 | C | 23.2 | C | 23.4 | C |
| 15 | North of U.S. 176 | Basic | 16.5 | B | 19.8*** | C | 19.7 | C | 19.7 | C | 19.4 | C | 19.4*** | C | 24.2 | C | 24.2 | C | 24.2 | C |

** In all 2030 and 2050 Build Alternatives the weave segment is removed. In This segment is replaced by a merge segment, which is the on-ramp to I-26 Eastbound.*
*** See TransModeler analysis assumptions as discussed in Section 7.1.2.*
**** For 2030 and 2050, the No Build has substantial queuing and restricted flow on I-95 northbound approaching weave area in Link 8. For this reason, I-95 northbound volumes are restricted to links north of the bottleneck in the No Build scenario. Due to the lower volumes, densities on downstream links are lower than the Build alternatives north of the I-26 at I-95 interchange based on the TransModeler simulation analysis. Nevertheless, the Build alternatives all represent an improvement in I-95 northbound flow (since the densities in the No Build are limited), serves higher volumes, and maintains acceptable LOS C or better operations to the north.*

**Table 7.5: TransModeler Freeway Segment Density Results: I-95 Southbound**

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| | | | | | 7-lanes on I-26 + 6-lanes on I-95** | | | | | | | | | | | | | | | |
| 1 | North of U.S. 176 | Basic | 16.2 | B | 19.2 | C | 19.1 | C | 19.1 | C | 19.0 | B | 24.0 | C | 24.1 | C | 24.0 | C | 24.0 | C |
| 2 | Off-Ramp to U.S. 176 | Diverge | 17.7 | B | 20.9 | C | 20.5 | C | 20.4 | C | 20.8 | C | 27.6 | D | 26.1 | C | 25.9 | C | 26.3 | C |
| 3 | Between U.S. 176 Ramps | Basic | 15.9 | B | 18.6 | C | 19.0 | C | 19.0 | C | 19.0 | C | 24.1 | C | 24.0 | C | 24.2 | C | 23.9 | C |
| 4 | On-Ramp from U.S. 176 | Merge | 16.4 | B | 19.6 | B | 19.2 | B | 19.2 | B | 19.1 | B | 24.4 | C | 24.5 | C | 24.2 | C | 24.2 | C |
| 5 | North of I-26/I-95 Interchange | Basic | 17.3 | B | 20.5 | C | 20.5 | C | 20.4 | C | 20.4 | C | 25.6 | C | 25.7 | C | 25.7 | C | 25.6 | C |
| 6 | Off-Ramp to I-26 | Diverge | 16.8 | B | 19.7 | B | 19.2 | B | 18.9 | B | 18.6 | B | 26.1 | C | 24.5 | C | 24.9 | C | 24.1 | C |
| 7 | Between Ramps | Basic | 17.3 | B | 21.1 | C | 12.7 | B | 12.5 | B | 12.5 | B | 28.7 | D | 14.3 | B | 14.5 | B | 14.6 | B |
| 8 | I-26 at I-95 System Weave* | Weave | 16.4 | B | 22.4 | C | 10.4 | B | 11.5 | B | 13.5 | B | 30.5 | D | 13.9 | B | 12.6 | B | 15.3 | B |
| 9 | Between Ramps | Basic | 14.1 | B | 16.6 | B | 15.1 | B | 15.5 | B | 13.5 | B | 19.5 | C | 18.4 | C | 18.0 | B | 15.3 | B |
| 10 | On-Ramp from I-26 EB | Merge | 23.7 | C | 19.8 | B | 18.0 | B | 17.3 | B | 14.6 | B | 20.6*** | C | 21.7 | C | 21.1 | C | 18.5 | B |
| 11 | South of I-26/I-95 Interchange (assumes theoretical extra I-95 southbound auxiliary lane**) | Basic | 25.5 | C | 19.8 | C | 19.8 | C | 20.5 | C | 20.7 | C | 20.6*** | C | 24.2 | C | 25.9 | C | 24.9 | C |
| 12 | Off-Ramp to U.S. 178 | Diverge | 25.9 | C | 19.8 | B | 19.8 | B | 19.8 | B | 19.8 | B | 20.6*** | C | 24.2 | C | 24.3 | C | 24.1 | C |
| 13 | Between U.S. 178 Ramps | Basic | 24.6 | C | 28.8 | D | 30.0 | D | 29.8 | D | 29.4 | D | 31.2*** | D | 48.3 | F | 46.6 | F | 42.5 | E |
| 14 | On-Ramp from U.S. 178 | Merge | 25.3 | C | 31.8 | D | 32.1 | D | 31.8 | D | 31.4 | D | 34.4*** | D | 49.9 | E | 47.9 | E | 47.0 | E |
| 15 | South of U.S. 178 | Basic | 25.4 | C | 29.8 | D | 30.0 | D | 30.4 | D | 30.1 | D | 31.7*** | D | 37.6 | E | 37.2 | E | 37.4 | E |

*In all 2030 and 2050 Build Alternatives the weave segment is removed. In Alternatives 1 and 2, this segment is replaced by a diverge segment, which is the off-ramp to I-95 Southbound. In Alternative 3, this segment is replaced by a merge segment, which is the flyover on-ramp from I-26 Westbound.

** See TransModeler analysis assumptions as discussed in Section 7.1.2.

*** For 2030 and 2050, the No Build has substantial queuing and restricted flow on I-26 eastbound due to the existing one lane ramp from I-26 eastbound to I-95 southbound. The I-26 bottleneck and ramp constraint substantially reduces the amount of traffic able to access and merge into I-95 southbound at the Link 10 merge. For this reason, I-95 southbound volumes are restricted south of the Link 10 merge. Due to the lower volumes, densities on downstream links are lower than the Build alternatives south of the I-26 at I-95 interchange based on the TransModeler simulation analysis. Nevertheless, the Build alternatives all represent an improvement in I-26 eastbound flow. There is slightly increased congestion and higher densities on I-95 southbound because I-95 southbound serves higher peak period volumes. The increased congestion on I-95 south of the interchange is a key reason for additional analysis in Chapters 7 and 8.

## 7.2 TransModeler Capacity Analysis Criteria

The following section describes the capacity analysis for the I-26 at I-95 system interchange. In contrast to Chapter 6 which has merge, diverge, and weave analysis, the analysis in this section primarily focuses on the ramp roadway capacity and volume served results from TransModeler. Ramp roadway analysis is important because it provides far more detail into how the interchange operates today and will operate with different alternatives. HCS only looks at freeway segments and only includes the on and off-ramp lane, while this section of the report examines each interchange ramp. This additional analysis provides insightful information about No Build conditions and how each potential concept compares to each other and to the No Build.

To compare each modeled scenario, the following characteristics were collected:

- Ramp Density LOS
- Ramp Volume Served
- System Travel Times

Using engineering judgment, the basic freeway segment HCM LOS criteria was selected to evaluate the ramp segments of the system interchange. **Table 7.6** shows the HCM LOS criteria for basic freeway segments.

### Table 7.6: HCM Basic Segment LOS Criteria

| LOS | Density (pc/mi/ln) |
|---|---|
| A | < 11 |
| B | > 11 - 18 |
| C | > 18 - 26 |
| D | > 26 - 35 |
| E | > 35 - 45 |
| F | > 45 |

Based on the design criteria for rural freeways presented in SCDOT's 2021 Roadway Design Manual, HCM LOS C is the preferred minimum LOS for a rural interstate analysis. SCDOT guidance for this project is that LOS D will be used as the minimum LOS.

One indicator of congestion in TransModeler is the percent of the volume served. Percent volume served is the number of vehicles that are actually served compared to the volume input coded into the model, in this case the volumes described in Chapter 4. If the input volume cannot be served, this indicates an operational or capacity issue. To verify it was a true capacity issue, a throughput threshold of 80 percent to identify locations that specific movements were potentially restricted. No specific guidance was utilized in identifying 80 percent threshold, but it was based on the evaluation of the 2022 calibrated network data in Table 7.7 which identifies some of the lower volume ramps at or near the 80 percent traffic served. This means that any movement served less than 80 percent of the volume put into the model was inspected more closely to ensure the issue was not related to model coding. Regardless, this was a secondary quality control review and all links were thoroughly checked to verify that modeling errors were not causing backups.

Additionally, TransModeler travel times are compared to show time saved for each interchange alternative. Each travel time represents a system-to-system movement in the network and each one is measured to and from each extent of the study area.

## 7.3 I-26 at I-95 System Interchange Existing and No Build Analysis

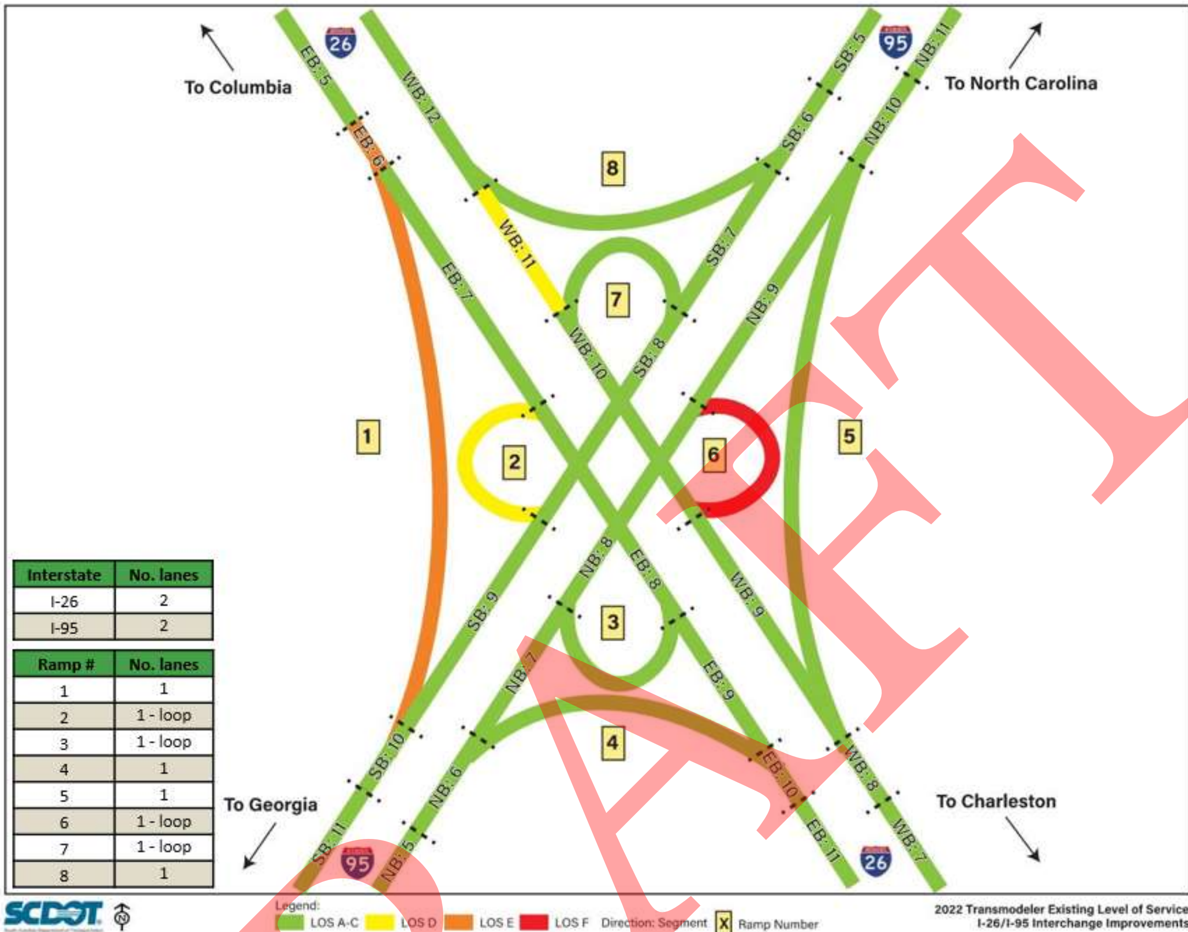
The following section describes the evaluation of the I-26 at I-95 system interchange as well as proposed alternative interchange configurations to address deficiencies. As described in Section 7.1.2, this initial analysis was conducted assuming additional lanes on I-95 to the south and I-26 to the west in order to test interchange design needs without flow restrictions impacting upstream and downstream volumes. Final TransModeler analysis of the final interchange layouts with anticipated laneage on both I-26 and I-95 are included in Chapter 9.

### 7.3.1 2022 Existing Conditions

The evaluation of existing volumes under current interchange geometry is discussed in the sections below. TransModeler output for the 2022 existing conditions analysis are provided in **Appendix H**.

**Figure 7.7** shows the existing I-26 at I-95 system interchange with numbered ramps that correspond with the TransModeler results of the 2022 existing analysis, shown in the following table. Table 7.7 shows the volume served, percent volume served, density, and LOS results for each ramp. Despite capacity issues, the results show each ramp serves at least 80 percent of the traffic demand. Based on density, five ramps perform at LOS C or better (preferred), one ramp operates at LOS D (acceptable) and two perform at an unacceptable LOS of E and F. Widening of ramps 1 and 6 are needed under existing conditions, especially for the Ramp 6 loop which has the highest density. These results do not reflect the weave issues which would only worsen the congestion findings and are looked at in the following analysis.

### Figure 7.7: TransModeler 2022 Existing Conditions Ramp LOS




### Table 7.7: 2022 Existing Interchange Ramp Volume and Capacity Results

| | 2022 Demand | Number of Lanes | Volume Served | % Volume Served | Density (pcpmpl) | LOS |
|---|---|---|---|---|---|---|
| 1 | 1,365 | 1 | 1,342 | 98% | 43.0 | E |
| 2 | 714 | 1 (loop) | 694 | 97% | 29.2 | D |
| 3 | 42 | 1 (loop) | 33 | 82% | 1.2 | A |
| 4 | 242 | 1 | 222 | 92% | 6.1 | A |
| 5 | 714 | 1 | 706 | 99% | 21.6 | C |
| 6 | 1,365 | 1 (loop) | 1,331 | 98% | 62.6 | F |
| 7 | 242 | 1 (loop) | 201 | 83% | 7.4 | A |
| 8 | 42 | 1 | 33 | 88% | 0.9 | A |

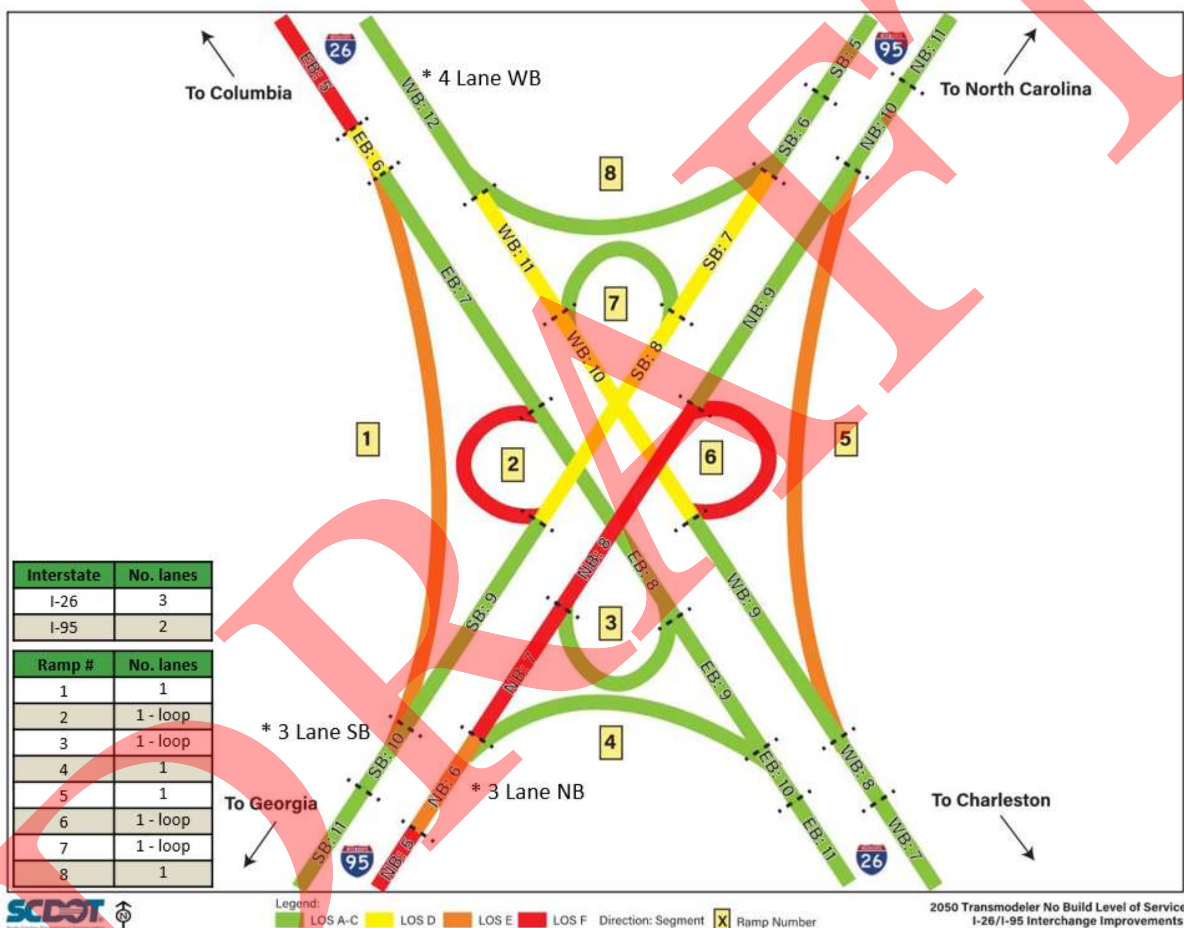
*Note: All ramps are single lane under existing conditions.*

### 7.3.2 2030 and 2050 No Build Conditions

The evaluation of future volumes under current geometry with the widening of I-26 to 3 lanes in each direction is discussed in the sections below. TransModeler output for the 2030 and 2050 No Build conditions analysis is provided in **Appendix I**.

**Figure 7.8** shows the 2050 No Build I-26 at I-95 system interchange with numbered ramps that correspond with the TransModeler results of the 2050 No Build analysis. 2030 No Build results are presented with the 2050 results in the following tables.

**Figure 7.8: TransModeler 2050 No Build Conditions Ramp LOS**




*Note: * TransModeler LOS results shown include theoretical improvements on I-95 northbound, I-95 southbound and I-26 westbound as described in Section 7.1.2.*

**Table 7.8** shows the volume served and percent volume served results for each ramp.

### Table 7.8: TransModeler No Build Interchange Ramp Volume Results

| Segment Description | | 2030 Demand | 2050 Demand | Volume Served \| % Demand Served | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2030 No Build | | 2050 No Build | |
| 1 | I-26 EB to I-95 SB | 1,570 | 2,192 | 1,516 | 97% | 1,378 | 63% |
| 2 | I-95 SB to I-26 EB | 821 | 1,152 | 782 | 95% | 1,075 | 93% |
| 3 | I-26 EB to I-95 NB | 48 | 70 | 49 | 100% | 50 | 71% |
| 4 | I-95 NB to I-26 EB | 278 | 375 | 264 | 95% | 236 | 63% |
| 5 | I-26 WB to I-95 NB | 821 | 1,154 | 791 | 96% | 1,100 | 95% |
| 6 | I-95 NB to I-26 WB | 1,570 | 2,194 | 1,507 | 96% | 1,517 | 69% |
| 7 | I-26 WB to I-95 SB | 278 | 375 | 279 | 100% | 314 | 84% |
| 8 | I-95 SB to I-26 WB | 48 | 70 | 45 | 93% | 59 | 85% |
| **Total Volume Served** | | **5,434** | **7,582** | **5,232** | **96%** | **5,729** | **76%** |

*Note:*
*All ramps are single lane in existing conditions.*
*Output with less than 80% of demand served is shown in* ***red***

Table 7.8 indicates that the ramps should perform acceptably through 2030, but Ramps 1, 3, 4, and 6 could degrade by 2050 due to deficiencies that restrict volume flow.

- Ramp 1 is only able to serve 63 percent of demand because it is over capacity as a one-lane ramp and creates a bottleneck on I-26 eastbound.
- The Ramp 1 bottleneck constricts the ability of demand to reach Ramp 3, affecting its volume served.
- Ramp 4 is only able to serve 63 percent of demand because of the bottleneck on I-95 northbound south of this ramp. Percent demand served for Ramps 3 and 4 is not an indication of a deficiency, but instead an indication that upstream flow is metered.
- Ramp 6 is only able to serve 69 percent of demand because it is over capacity as a one-lane loop ramp and creates a bottleneck on I-95 northbound. This bottleneck constricts the ability of demand to reach Ramp 4, in a manner similar to Ramp 3.
- Overall, the No Build interchange only serves 76 percent of the 2050 design hour peak volumes. This is an indicator that improvements are required to at the interchange.

**Table 7.9** shows the density and LOS results for each ramp.

### Table 7.9: TransModeler No Build Interchange Ramp Capacity Results

| Ramp Description | | Number of Lanes* | Density (pcpmpl) \| LOS | | | |
|---|---|---|---|---|---|---|
| | | | 2030 No Build | | 2050 No Build | |
| 1 | I-26 EB to I-95 SB | 1 | 48.6 | F | 43.4 | E* |
| 2 | I-95 SB to I-26 EB | 1 | 32.3 | D | 46.9 | F |
| 3 | I-26 EB to I-95 NB | 1 | 2.1 | A | 2.0 | A* |
| 4 | I-95 NB to I-26 EB | 1 | 7.3 | A | 6.7 | A* |
| 5 | I-26 WB to I-95 NB | 1 | 24.7 | C | 34.1 | D |
| 6 | I-95 NB to I-26 WB | 1 | 76.8 | F | 85.2 | F |
| 7 | I-26 WB to I-95 SB | 1 | 10.4 | A | 12.6 | B |
| 8 | I-95 SB to I-26 WB | 1 | 1.3 | A | 1.7 | A |

*Notes:*
** All ramps are single lane in existing conditions*
*** In all cases, ramp volumes increase from 2030 to 2050. Reductions in density or improvements in LOS are reflective of bottlenecks restricting flow onto some ramps and are not indicative of improved conditions.*

Table 7.9 indicates Ramps 1, 2, and 6 will exceed the LOS threshold by 2050. Ramp 1 appears to improve in LOS from 2030 to 2050 but is due to the failing merge on I-95 southbound, reducing the volume on the ramp, as shown in Table 7.9.

# 7.4 I-26 at I-95 System Interchange Alternatives Analysis

Three Build alternatives were developed, analyzed and compared as part of the initial TransModeler analysis. As described in Section 7.1.2, this initial analysis was conducted assuming additional lanes on I-95 to the south and I-26 to the west to test interchange design needs without flow restrictions impacting upstream and downstream volumes. Final TransModeler analysis of the final interchange layouts with anticipated laneage on both I-26 and I-95 are included in Chapter 9.

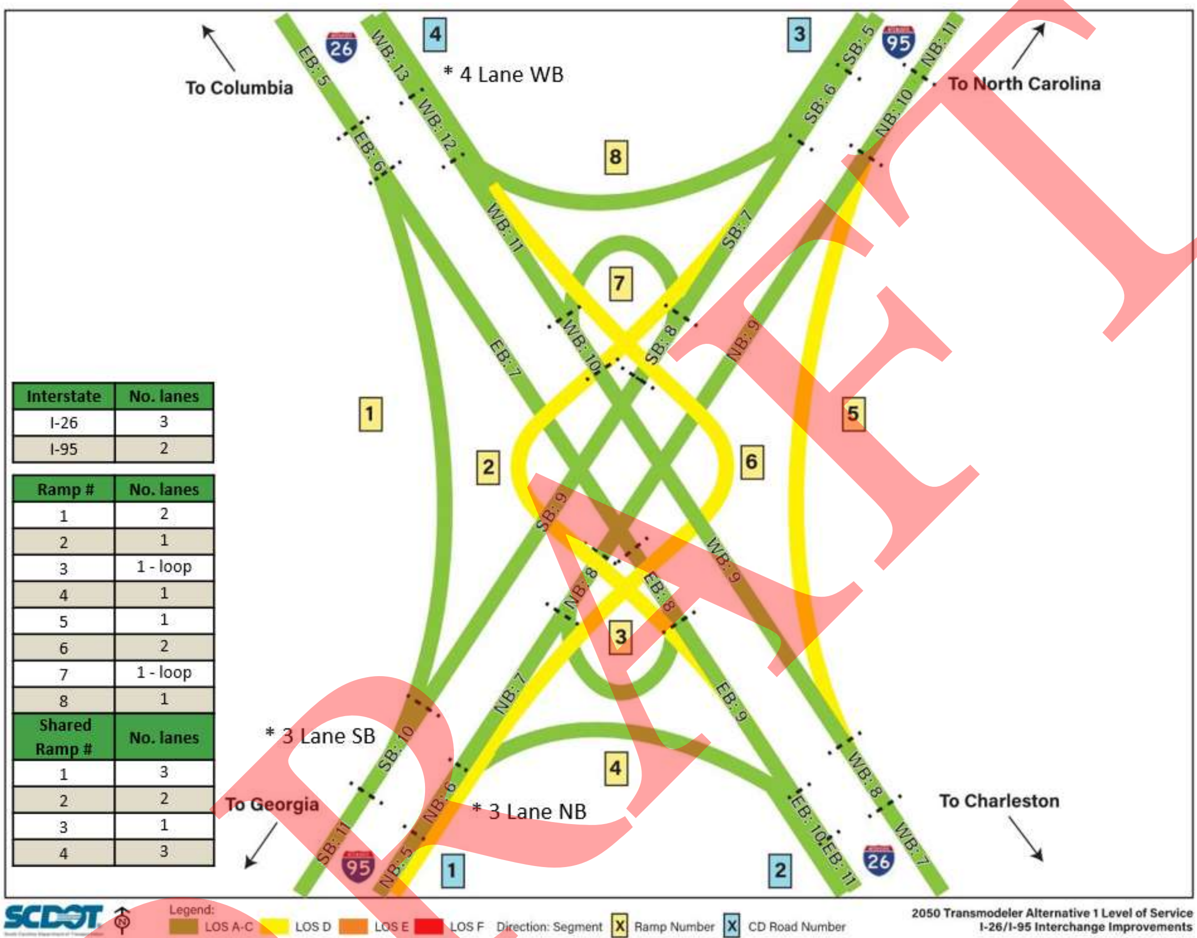
## 7.4.1 Alternative 1 Interchange

The Alternative 1 interchange is a stacked four-level flyover interchange with two loops as described in Section 5.1. Specific features include:

- Ramp 1 is widened to two lanes and maintains a similar alignment to the existing ramp.
- Ramp 5 remains a one lane ramp on a similar alignment.
- Ramp 4 remains a one lane ramp and will follow a similar alignment, but the design speed and radii are increased. The ramp will pull off I-95 northbound on a combined shared ramp segment with Ramp 6 (the old Loop 6) and then exit the shared ramp segment to I-26 eastbound.
- Ramp 8 remains a one lane ramp and will be very similar to Ramp 4 with a similar layout to the existing ramp with a higher design speed and radii. The ramp will pull off I-95 southbound on a shared ramp segment with Ramp 2 (the old Loop 2) and then exit the shared ramp segment to I-26 westbound.
- Ramps 2 and 6 (the old Loops 2 and 6) are replaced with fly-over ramps connecting to the shared ramp segments both at the exit from I-95 and the merge segments with I-26. Ramp 2 is a one lane fly-over and Ramp 6 is a two-lane fly-over.
- Loops 3 and 7 (i.e., Loops 3 and 7) will be reconstructed as improved loops in the same quadrant as currently located and will both be one lane. The loop radii and design speed will be increased to meet the design speed for the project. These loops carry the two lowest loop volumes and are diagonally opposite each other. They can both be maintained as isolated merges and diverges with the mainline with no weave segments.

TransModeler output for the 2030 and 2050 Build Alternative 1 conditions ramp output is provided in **Appendix J**. **Figure 7.9** shows the 2050 Build Alternative 1 interchange with numbered ramps and shared ramp segments that correspond with the TransModeler results of the 2050 Build Alternative 1 analyses.

### Figure 7.9: TransModeler 2050 Build Alternative 1 Ramp LOS




*Note: * TransModeler LOS results shown include theoretical improvements on I-95 northbound, I-95 southbound and I-26 westbound as described in Section 7.1.2.*

**Table 7.10** shows the volume served and percent volume served results for each ramp. It also indicates that the Alternative 1 interchange improvements allow for the ramps to serve above the 80 percent volume threshold through 2050.

### Table 7.10: TransModeler Build Alternative 1 Interchange Ramp Volume Results

| Segment Description | | 2030 Demand | 2050 Demand | Volume Served \| % Demand Served | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2030 Build Alternative 1 | | 2050 Build Alternative 1 | |
| 1 | I-26 EB to I-95 SB | 1,570 | 2,192 | 1,516 | 97% | 1,870 | 85% |
| 2 | I-95 SB to I-26 EB | 821 | 1,152 | 779 | 95% | 1,070 | 93% |
| 3 | I-26 EB to I-95 NB | 48 | 70 | 46 | 96% | 65 | 92% |
| 4 | I-95 NB to I-26 EB | 278 | 375 | 266 | 96% | 338 | 90% |
| 5 | I-26 WB to I-95 NB | 821 | 1,154 | 789 | 96% | 1,159 | 100% |
| 6 | I-95 NB to I-26 WB | 1,570 | 2,194 | 1,529 | 97% | 2,218 | 100% |
| 7 | I-26 WB to I-95 SB | 278 | 375 | 281 | 100% | 333 | 89% |
| 8 | I-95 SB to I-26 WB | 48 | 70 | 44 | 92% | 59 | 84% |
| **Total Volume Served** | | **5,434** | **7,582** | **5,250** | **97%** | **7,110** | **94%** |

*Note: Output with less than 80% of demand served is shown in* ***red***

**Table 7.11** shows the density and LOS results for each ramp. Table 7.11 indicates that the interchange ramps perform at an acceptable LOS under 2030 and 2050 Build Alternative 1 conditions with three ramps links operating at LOS D and the remaining five ramps at LOS C or better.

### Table 7.11: TransModeler Build Alternative 1 Interchange Ramp Capacity Results

| Ramp Description | | Number of Lanes | Density (pcpmpl) \| LOS | | | |
|---|---|---|---|---|---|---|
| | | | 2030 Build Alternative 1 | | 2050 Build Alternative 1 | |
| 1 | I-26 EB to I-95 SB | 2 | 20.0 | C | 25.3 | C |
| 2 | I-95 SB to I-26 EB | 1 | 20.4 | C | 28.8 | D |
| 3 | I-26 EB to I-95 NB | 1 | 1.3 | A | 1.7 | A |
| 4 | I-95 NB to I-26 EB | 1 | 7.5 | A | 9.1 | A |
| 5 | I-26 WB to I-95 NB | 1 | 21.7 | C | 33.4 | D |
| 6 | I-95 NB to I-26 WB | 2 | 20.4 | C | 29.9 | D |
| 7 | I-26 WB to I-95 SB | 1 | 8.8 | A | 10.0 | A |
| 8 | I-95 SB to I-26 WB | 1 | 1.0 | A | 1.5 | A |

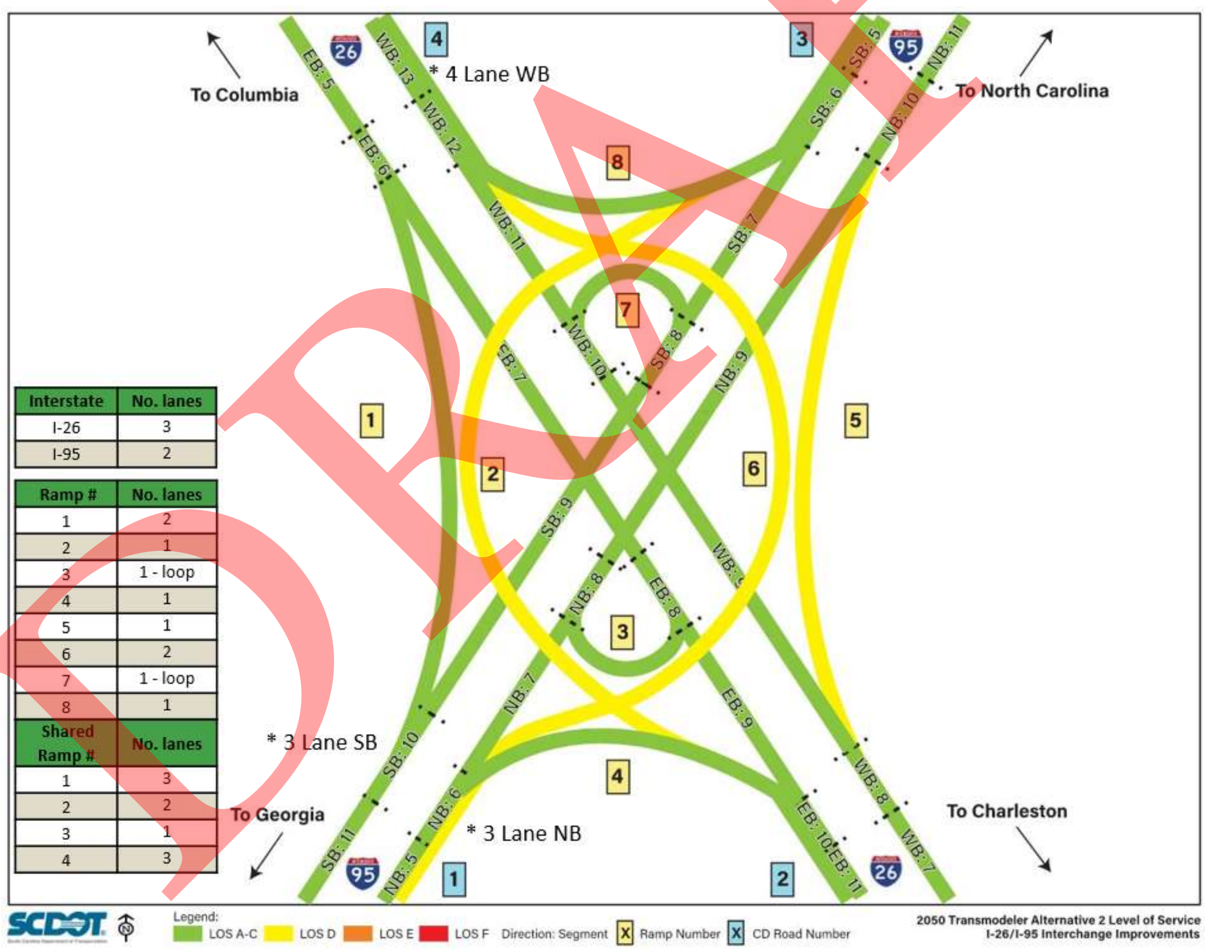
## 7.4.2 Alternative 2 Interchange

The Alternative 2 interchange operates almost identically to Alternative 1. The only difference is the flyover ramps replacing Loop 2 and Loop 6. Instead of following an alignment creating a third level and fourth level structure over the center of the interchange, the ramps are taken on a longer alignment requiring more two level structures, but no third and fourth level structure. As a result, Alternative 2 does require a bigger footprint with more impacts and ROW.

TransModeler output for the 2030 and 2050 build alternative 2 conditions ramp output is provided in **Appendix K**.

**Figure 7.10** shows the 2050 Build Alternative 2 I-26 at I-95 System interchange with numbered ramps and shared ramp segments that correspond with the TransModeler results of the 2050 Build Alternative 2 analyses.

### Figure 7.10: TransModeler 2050 Build Alternative 2 Ramp LOS




*Note: * TransModeler LOS results shown include theoretical improvements on I-95 northbound, I-95 southbound and I-26 westbound as described in Section 7.1.2.*

**Table 7.12** shows the volume served and percent volume served results for each ramp. The results indicate that the Alternative 2 interchange improvements allow for the ramps to serve above the 80 percent volume threshold through 2050.

### Table 7.12: TransModeler Build Alternative 2 Interchange Ramp Volume Results

| Segment Description | | 2030 Demand | 2050 Demand | Volume Served \| % Demand Served | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2030 Build Alternative 2 | | 2050 Build Alternative 2 | |
| 1 | I-26 EB to I-95 SB | 1,570 | 2,192 | 1,516 | 97% | 1,850 | 84% |
| 2 | I-95 SB to I-26 EB | 821 | 1,152 | 779 | 95% | 1,071 | 93% |
| 3 | I-26 EB to I-95 NB | 48 | 70 | 46 | 96% | 64 | 91% |
| 4 | I-95 NB to I-26 EB | 278 | 375 | 268 | 96% | 336 | 90% |
| 5 | I-26 WB to I-95 NB | 821 | 1,154 | 789 | 96% | 1,160 | 100% |
| 6 | I-95 NB to I-26 WB | 1,570 | 2,194 | 1,528 | 97% | 2,218 | 100% |
| 7 | I-26 WB to I-95 SB | 278 | 375 | 279 | 100% | 333 | 89% |
| 8 | I-95 SB to I-26 WB | 48 | 70 | 43 | 90% | 60 | 85% |
| **Total Volume Served** | | **5,434** | **7,582** | **5,249** | **97%** | **7,091** | **94%** |

*Note: Output with less than 80% of demand served is shown in* ***red***

**Table 7.13** shows the density and LOS results for each ramp. Three ramps operate at LOS D and 5 operate at LOS C or better.

### Table 7.13: TransModeler Build Alternative 2 Interchange Ramp Capacity Results

| Segment Description | | Number of Lanes | Density (pcpmpl) \| LOS | | | |
|---|---|---|---|---|---|---|
| | | | 2030 Build Alternative 2 | | 2050 Build Alternative 2 | |
| 1 | I-26 EB to I-95 SB | 2 | 20.4 | C | 25.2 | C |
| 2 | I-95 SB to I-26 EB | 1 | 20.3 | C | 28.9 | D |
| 3 | I-26 EB to I-95 NB | 1 | 1.4 | A | 1.9 | A |
| 4 | I-95 NB to I-26 EB | 1 | 7.0 | A | 10.0 | A |
| 5 | I-26 WB to I-95 NB | 1 | 21.8 | C | 33.7 | D |
| 6 | I-95 NB to I-26 WB | 2 | 20.1 | C | 29.4 | D |
| 7 | I-26 WB to I-95 SB | 1 | 8.1 | A | 10.0 | A |
| 8 | I-95 SB to I-26 WB | 1 | 1.2 | A | 1.5 | A |

Table 7.13 indicates that the interchange ramps perform at an acceptable LOS under 2030 and 2050 Build Alternative 2 conditions.

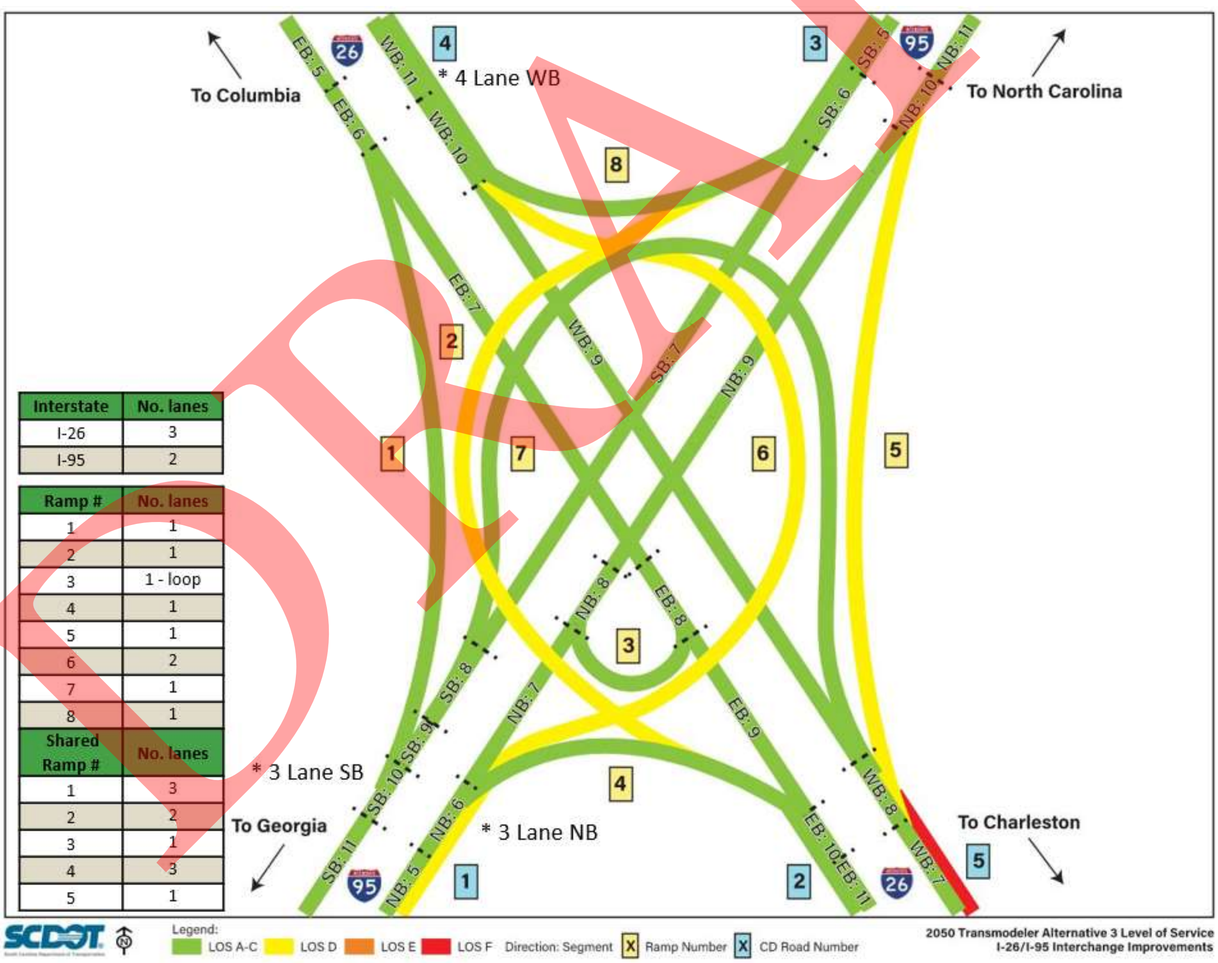
## 7.4.3 Alternative 3 Interchange

The Alternative 3 interchange is very similar to Alternative 2 except that three existing loops are converted to flyovers. Specifically, Loop 7 is converted to a flyover from I-26 westbound to I-95 southbound. In providing the flyover it introduces a need for a short shared ramp segment with Ramp 5 at the diverge from I-26 westbound. The proposed merge with I-95 southbound does not use a shared ramp segment but does shift the southbound merge further south than the existing loop reducing spacing to the heavy downstream merge of Ramp 1 with I-95 southbound.

TransModeler output for the 2030 and 2050 build alternative 3 conditions ramp output is provided in **Appendix L.**

**Figure 7.11** shows the 2050 Build Alternative 3 I-26 at I-95 System interchange with numbered ramps and shared ramp segments that correspond with the TransModeler results of the 2050 Build Alternative 3 analyses.

### Figure 7.11: TransModeler 2050 Build Alternative 3 Ramp LOS




| Interstate | No. lanes |
|---|---|
| I-26 | 3 |
| I-95 | 2 |

| Ramp # | No. lanes |
|---|---|
| 1 | 1 |
| 2 | 1 |
| 3 | 1 - loop |
| 4 | 1 |
| 5 | 1 |
| 6 | 2 |
| 7 | 1 |
| 8 | 1 |

| Shared Ramp # | No. lanes |
|---|---|
| 1 | 3 |
| 2 | 2 |
| 3 | 1 |
| 4 | 3 |
| 5 | 1 |

*Note: * TransModeler LOS results shown include theoretical improvements on I-95 northbound, I-95 southbound and I-26 westbound as described in Section 7.1.2.*

**Table 7.14** shows the volume served and percent volume served results for each ramp. In both 2030 and 2050, the Alternative 3 interchange improvements allow for the ramps to serve above the 80 percent volume threshold through 2050.

### Table 7.14: TransModeler Build Alternative 3 Interchange Ramp Volume Results

| Segment Description | | 2030 Demand | 2050 Demand | Volume Served \| % Demand Served | | | |
|---|---|---|---|---|---|---|---|
| | | | | 2030 Build Alternative 3 | | 2050 Build Alternative 3 | |
| 1 | I-26 EB to I-95 SB | 1,570 | 2,192 | 1,512 | 96% | 1,881 | 86% |
| 2 | I-95 SB to I-26 EB | 821 | 1,152 | 780 | 95% | 1,068 | 93% |
| 3 | I-26 EB to I-95 NB | 48 | 70 | 47 | 98% | 67 | 96% |
| 4 | I-95 NB to I-26 EB | 278 | 375 | 269 | 97% | 336 | 90% |
| 5 | I-26 WB to I-95 NB | 821 | 1,154 | 790 | 96% | 1,157 | 100% |
| 6 | I-95 NB to I-26 WB | 1,570 | 2,194 | 1,531 | 97% | 2,211 | 100% |
| 7 | I-26 WB to I-95 SB | 278 | 375 | 280 | 100% | 328 | 87% |
| 8 | I-95 SB to I-26 WB | 48 | 70 | 43 | 90% | 59 | 84% |
| **Total Volume Served** | | **5,434** | **7,582** | **5,252** | **97%** | **7,107** | **94%** |

*Note: Output with less than 80% of demand served is shown in* ***red***

**Table 7.15** shows the density and LOS results for each ramp. It indicates that the interchange ramps perform at an acceptable LOS under 2030 and 2050 Build Alternative 3 conditions. The ramps operate at the same LOS as Alternatives 1 and 2.

### Table 7.15: TransModeler Build Alternative 3 Interchange Ramp Capacity Results

| Segment Description | | Number of Lanes | Density (pcpmpl) \| LOS | | | |
|---|---|---|---|---|---|---|
| | | | 2030 Build Alternative 3 | | 2050 Build Alternative 3 | |
| 1 | I-26 EB to I-95 SB | 2 | 20.9 | C | 25.7 | C |
| 2 | I-95 SB to I-26 EB | 1 | 20.5 | C | 29.1 | D |
| 3 | I-26 EB to I-95 NB | 1 | 1.4 | A | 1.9 | A |
| 4 | I-95 NB to I-26 EB | 1 | 7.5 | A | 9.3 | A |
| 5 | I-26 WB to I-95 NB | 1 | 22.5 | C | 33.7 | D |
| 6 | I-95 NB to I-26 WB | 2 | 20.1 | C | 34.6 | D |
| 7 | I-26 WB to I-95 SB | 1 | 9.4 | A | 11.0 | B |
| 8 | I-95 SB to I-26 WB | 1 | 1.1 | A | 1.6 | A |

### 7.4.4 Shared Ramp Diverge & Merge Segment Analysis

The proposed design alternatives for the proposed flyovers reflect a "single exit" and "single entrance" design type. This design approach combines traffic bound for two separate ramps into a single ramp exit from the mainline followed by a separate split to the two destinations. In other locations, this treatment may include a full collector distributor roadway, but the proposed alternatives do not strictly provide CD sections because the shared ramp does not allow for a parallel route through the entire interchange. Instead, the proposed alternatives include the following shared ramp sections:

Shared ramp sections at exits:

- I-95 northbound has a single exit point to I-26 which then separates as a proposed two-lane flyover to I-26 westbound and a single lane ramp to I-26 eastbound. (Alternatives 1, 2 and 3)
- I-95 southbound has a single exit point to a single lane flyover to I-26 eastbound and a single lane ramp to I-26 westbound. (Alternatives 1, 2 and 3)
- I-95 westbound also has an option with a shared ramp section for the exits to I-95 southbound (a single lane flyover) and I-95 southbound (a single lane ramp). (Alternative 3 only)

Shared ramp sections at merges:

- I-26 westbound includes a shared section of ramp when the two-lane I-95 northbound flyover and the I-95 southbound exit ramp merge together before merging with the I-26 westbound mainline traffic (Alternatives 1, 2 and 3)
- I-26 eastbound includes a shared section of ramp when the one-lane I-95 southbound flyover merges with the I-95 northbound ramp to I-26 eastbound (Alternatives 1, 2 and 3)
- With Alternative 3, the flyover from I-26 westbound is not proposed as a shared ramp and instead merges directly onto I-95 southbound in a separate merge from the I-26 eastbound to I-95 southbound merge.

Each alternative interchange design incorporates short sections of shared ramps that combine entering and exiting ramp volumes. These shared ramp segments are short and require a separate capacity analysis. **Table 7.16** shows the capacity analysis of the shared ramps for each alternative based on the density of the combined segment. TransModeler output for the 2030 and 2050 build alternatives shared ramp segment analysis is provided in **Appendix M**.

Table 7.16 indicates that the four shared ramp segments in common to all three alternatives operate similarly and function at LOS D or better. Alternative 3, however, is the only alternative with shared ramp Segment 5. Segment 5 is forecast to operate at LOS E in 2030 and LOS F in 2050. As currently designed, Alternative 3 does not meet the required acceptable LOS. Note that the shared ramp segment could be widened and would likely function at LOS D or better, but this would require additional construction on the I-26 approach resulting in increased costs and impacts.

**Table 7.16: TransModeler Interchange Shared Ramp Capacity Results**

| Shared Ramp Description | | Number of Lanes | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I-95 NB to I-26 | 3 | 19.5 | C | 21.0 | C | 20.7 | C | 30.3 | D | 30.1 | D | 29.0 | D |
| 2 | I-95 to I-26 EB | 2 | 12.9 | B | 12.8 | B | 12.7 | B | 16.3 | B | 17.9 | B | 17.1 | B |
| 3 | I-95 SB to I-26 | 1 | 22.3 | C | 19.1 | C | 19.0 | C | 29.5 | D | 30.1 | D | 26.6 | D |
| 4 | I-95 to I-26 WB | 3 | 14.0 | B | 13.7 | B | 13.6 | B | 20.7 | C | 21.4 | C | 21.4 | C |
| 5 | I-26 WB to I-95 | 1 | - | - | - | - | 43.2 | E | - | - | - | - | 64.4 | F |

## 7.4.5 Interchange Travel Times

Each interchange alternative significantly reduces congestion, which impacts overall service and results in shorter travel times. **Table 7.17** shows travel times for each system-to-system movement in the network, associated with an interchange ramp. **Table 7.18** shows the associated average speeds. TransModeler output for the 2030 and 2050 build alternatives travel time analysis is provided in **Appendix N.**

Table 7.17 indicates that travel times will continue to increase from 2022 to 2030 and 2050 if no interchange improvements are made. Travel times will decrease with the alternative interchange improvements. Compared to 2030 and 2050 No Build conditions, the Alternative 1 interchange improvements will result in a network-wide travel time savings of more than 3 minutes by 2030 and 2 hours by 2050. The Alternative 2 interchange improvements will result in a network-wide travel time savings of almost 3 minutes by 2030 and 2 hours by 2050. The Alternative 3 interchange improvements will result in a network-wide travel time savings of 1 minute and 36 seconds by 2030 and 2 hours by 2050.

### Table 7.17: TransModeler Alternative Travel Time Results

| Travel Time Segment Start | Travel Time Segment End | Associated Ramp | 2022 Existing | 2030 No Build | 2030 Build Alternative 1 | Time Diff | 2030 Build Alternative 2 | Time Diff | 2030 Build Alternative 3 | Time Diff | 2050 No Build | 2050 Build Alternative 1 | Time Diff | 2050 Build Alternative 2 | Time Diff | 2050 Build Alternative 3 | Time Diff |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Travel Time (mm:ss) | | | | | | | | | | | | | | |
| | | | | 7-lanes on I-26 + 6-lanes on I-95 | | | | | | | | | | | | | |
| I-26 Eastbound, West of S.C. 210 | I-26 Eastbound, East of U.S. 15 | - | 08:15 | 08:12 | 08:05 | -00:07 | 08:05 | -00:06 | 08:05 | -00:07 | 08:20 | -18:09 | 08:43 | -17:45 | 08:17 | -18:12 | 08:15 |
| | I-95 Northbound, North of U.S. 176 | 3 | 10:15 | 10:21 | 10:11 | -00:10 | 10:11 | -00:10 | 10:11 | -00:10 | 10:25 | -16:04 | 10:49 | -15:40 | 10:21 | -16:08 | 10:15 |
| | I-95 Southbound, South of U.S. 178 | 1 | 09:24 | 09:24 | 09:10 | -00:14 | 09:11 | -00:13 | 09:14 | -00:10 | 09:39 | -15:47 | 09:58 | -15:28 | 09:35 | -15:51 | 09:24 |
| I-26 Westbound, East of U.S. 15 | I-26 Westbound, West of S.C. 210 | - | 08:15 | 08:08 | 08:02 | -00:06 | 08:02 | -00:06 | 08:04 | -00:04 | 08:13 | -01:42 | 08:14 | -01:41 | 08:16 | -01:39 | 08:15 |
| | I-95 Northbound, North of U.S. 176 | 5 | 08:19 | 08:21 | 08:14 | -00:07 | 08:14 | -00:07 | 08:27 | 00:06 | 08:23 | -01:32 | 08:24 | -01:31 | 08:39 | -01:16 | 08:19 |
| | I-95 Southbound, South of U.S. 178 | 7 | 08:08 | 08:09 | 08:03 | -00:07 | 08:03 | -00:07 | 08:51 | 00:42 | 08:26 | -01:22 | 08:21 | -01:27 | 09:12 | -00:35 | 08:08 |
| I-95 Northbound, South of U.S. 178 | I-26 Eastbound, East of U.S. 15 | 4 | 07:24 | 07:40 | 07:32 | -00:08 | 07:32 | -00:08 | 07:32 | -00:08 | 07:45 | -17:28 | 07:45 | -17:28 | 07:45 | -17:27 | 07:24 |
| | I-26 Westbound, West of S.C. 210 | 6 | 10:01 | 10:28 | 09:32 | -00:56 | 09:48 | -00:40 | 09:47 | -00:40 | 10:03 | -18:28 | 10:05 | -18:26 | 10:03 | -18:27 | 10:01 |
| | I-95 Northbound, North of U.S. 176 | - | 08:59 | 09:33 | 08:38 | -00:54 | 08:38 | -00:55 | 08:38 | -00:55 | 08:48 | -16:38 | 08:49 | -16:38 | 08:48 | -16:39 | 08:59 |
| I-95 Southbound, North of U.S. 176 | I-26 Eastbound, East of U.S. 15 | 2 | 09:33 | 09:35 | 09:07 | -00:28 | 09:26 | -00:09 | 09:26 | -00:09 | 09:36 | -00:09 | 09:35 | -00:10 | 09:37 | -00:08 | 09:33 |
| | I-26 Westbound, West of S.C. 210 | 8 | 10:16 | 10:13 | 10:18 | 00:05 | 10:15 | 00:02 | 10:15 | 00:02 | 10:25 | 00:06 | 10:26 | 00:07 | 10:25 | 00:06 | 10:16 |
| | I-95 Southbound, South of U.S. 178 | - | 09:38 | 09:43 | 09:40 | -00:03 | 09:40 | -00:03 | 09:39 | -00:04 | 10:02 | -15:25 | 09:56 | -15:30 | 09:56 | -15:30 | 09:38 |
| **Time saved compared to No Build** | | | | | **-0:03:14** | | **-0:02:42** | | **-0:01:36** | | | **-2:02:35** | | **-2:01:36** | | **-2:01:45** | |

### Table 7.18: TransModeler Alternative Average Speed Results

| Travel Time Segment Start | Travel Time Segment End | Associated Ramp | 2022 Existing | 2030 No Build | 2030 Build Alternative 1 | 2030 Build Alternative 2 | 2030 Build Alternative 3 | 2050 No Build | 2050 Build Alternative 1 | 2050 Build Alternative 2 | 2050 Build Alternative 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Average Speed (mph) | | | | | | | | |
| I-26 Eastbound, West of S.C. 210 | I-26 Eastbound, East of U.S. 15 | - | 68 | 68 | 69 | 69 | 69 | 39 | 67 | 66 | 67 |
| | I-95 Northbound, North of U.S. 176 | 3 | 68 | 67 | 68 | 69 | 68 | 44 | 67 | 66 | 67 |
| | I-95 Southbound, South of U.S. 178 | 1 | 66 | 66 | 67 | 68 | 67 | 40 | 65 | 65 | 64 |
| I-26 Westbound, East of U.S. 15 | I-26 Westbound, West of S.C. 210 | - | 68 | 69 | 70 | 70 | 70 | 61 | 68 | 68 | 68 |
| | I-95 Northbound, North of U.S. 176 | 5 | 67 | 67 | 67 | 69 | 66 | 60 | 68 | 68 | 65 |
| | I-95 Southbound, South of U.S. 178 | 7 | 67 | 67 | 67 | 68 | 63 | 59 | 65 | 66 | 61 |
| I-95 Northbound, South of U.S. 178 | I-26 Eastbound, East of U.S. 15 | 4 | 68 | 67 | 66 | 65 | 66 | 39 | 63 | 63 | 64 |
| | I-26 Westbound, West of S.C. 210 | 6 | 66 | 66 | 66 | 66 | 66 | 43 | 65 | 64 | 64 |
| | I-95 Northbound, North of U.S. 176 | - | 69 | 67 | 68 | 69 | 68 | 43 | 67 | 67 | 67 |
| I-95 Southbound, North of U.S. 176 | I-26 Eastbound, East of U.S. 15 | 2 | 67 | 67 | 67 | 66 | 66 | 66 | 65 | 65 | 65 |
| | I-26 Westbound, West of S.C. 210 | 8 | 68 | 69 | 68 | 68 | 68 | 68 | 67 | 67 | 67 |
| | I-95 Southbound, South of U.S. 178 | - | 69 | 68 | 68 | 68 | 68 | 67 | 66 | 67 | 67 |
| | | **Average Speed** | **67** | **67** | **67** | **68** | **67** | **52** | **66** | **66** | **65** |

## 7.4.6 Initial TransModeler Interchange Alternatives Capacity Analysis Summary

**Table 7.19** and **Table 7.20** show the TransModeler volumes served and density/LOS at each ramp of the I-26 at I-95 System interchange for all existing and future conditions.

The TransModeler results indicate that existing interchange conditions will continue degrading by 2030 and 2050 under projected volumes, potentially impacting the operation of I-95 by 2030 and I-26 by 2050. Each of the alternatives showed improvements in ramp volumes served, ramp density/LOS, travel times, and average speeds, compared to the No Build analyses. All three alternatives had similar ramp volume served and LOS results. Alternative 1 and 2 showed better operations on the shared ramp segments also. Additional year of failure analysis is documented in the next section for the I-26 and I-95 corridors.

## Table 7.19: TransModeler Comparison of Build Alternative Interchange Ramp Volume Results

| Segment Description | | 2030 Demand | 2050 Demand | Volume Served \| % Demand Served | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build: | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| 1 | I-26 EB to I-95 SB | 1,570 | 2,192 | 1,516 | 97% | 1,516 | 97% | 1,512 | 96% | 1,378 | 63% | 1,870 | 85% | 1,850 | 84% | 1,881 | 86% |
| 2 | I-95 SB to I-26 EB | 821 | 1,152 | 779 | 95% | 779 | 95% | 780 | 95% | 1,075 | 93% | 1,070 | 93% | 1,071 | 93% | 1,068 | 93% |
| 3* | I-26 EB to I-95 NB | 48 | 70 | 46 | 96% | 46 | 96% | 47 | 98% | 50 | 71% | 65 | 92% | 64 | 91% | 67 | 96% |
| 4 | I-95 NB to I-26 EB | 278 | 375 | 266 | 96% | 268 | 96% | 269 | 97% | 236 | 63% | 338 | 90% | 336 | 90% | 336 | 90% |
| 5 | I-26 WB to I-95 NB | 821 | 1,154 | 789 | 96% | 789 | 96% | 790 | 96% | 1,100 | 95% | 1,159 | 100% | 1,160 | 100% | 1,157 | 100% |
| 6 | I-95 NB to I-26 WB | 1,570 | 2,194 | 1,529 | 97% | 1,528 | 97% | 1,531 | 97% | 1,517 | 69% | 2,218 | 100% | 2,218 | 100% | 2,211 | 100% |
| 7* | I-26 WB to I-95 SB | 278 | 375 | 281 | 100% | 279 | 100% | 280 | 100% | 314 | 84% | 333 | 89% | 333 | 89% | 328 | 87% |
| 8 | I-95 SB to I-26 WB | 48 | 70 | 44 | 92% | 43 | 90% | 43 | 90% | 59 | 85% | 59 | 84% | 60 | 85% | 59 | 84% |
| **Total Volume Served** | | **5,434** | **7,582** | **5,250** | **97%** | **5,249** | **97%** | **5,252** | **97%** | **5,729** | **76%** | **7,110** | **94%** | **7,091** | **94%** | **7,107** | **94%** |

*Ramps 7 and 3 are loops in Alternative 1 and 2. Alternative 7 replaces the loop with a fly-over ramp.*

## Table 7.20: TransModeler Comparison of Build Alternative Interchange Ramp Capacity Results

| Segment Description | | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2022 Existing | | 2030 No Build | | 2030 Build Alternative 1 | | 2030 Build Alternative 2 | | 2030 Build Alternative 3 | | 2050 No Build | | 2050 Build Alternative 1 | | 2050 Build Alternative 2 | | 2050 Build Alternative 3 | |
| 1 | I-26 EB to I-95 SB | 43.0 | E | 48.5 | F | 20.0 | C | 20.4 | C | 20.9 | C | 43.5 | E | 25.3 | C | 25.2 | C | 25.7 | C |
| 2 | I-95 SB to I-26 EB | 29.2 | D | 33.0 | D | 20.4 | C | 20.3 | C | 20.5 | C | 47.0 | F | 28.8 | D | 28.9 | D | 29.1 | D |
| 3* | I-26 EB to I-95 NB | 1.2 | A | 2.0 | A | 1.3 | A | 1.4 | A | 1.4 | A | 2.0 | A | 1.7 | A | 1.9 | A | 1.9 | A |
| 4 | I-95 NB to I-26 EB | 6.1 | A | 7.6 | A | 7.5 | A | 7.0 | A | 7.5 | A | 6.5 | A | 9.1 | A | 10.0 | A | 9.3 | A |
| 5 | I-26 WB to I-95 NB | 21.6 | C | 24.9 | C | 21.7 | C | 21.8 | C | 22.5 | C | 36.6 | E | 33.4 | D | 33.7 | D | 33.7 | D |
| 6 | I-95 NB to I-26 WB | 62.6 | F | 77.0 | F | 20.4 | C | 20.1 | C | 20.1 | C | 85.7 | F | 29.9 | D | 29.4 | D | 34.6 | D |
| 7* | I-26 WB to I-95 SB | 7.4 | A | 10.8 | A | 8.8 | A | 8.1 | A | 9.4 | A | 13.0 | B | 10.0 | A | 10.0 | A | 11.0 | B |
| 8 | I-95 SB to I-26 WB | 0.9 | A | 1.2 | A | 1.0 | A | 1.2 | A | 1.1 | A | 1.5 | A | 1.5 | A | 1.5 | A | 1.6 | A |

*Ramps 7 and 3 are loops in Alternative 1 and 2. Alternative 7 replaces the loop with a fly-over ramp.*

# 8. REFINED TRANSMODELER ANALYSIS OF KEY MERGES

Chapters 6 and 7 provided a comparative analysis of the No Build and proposed Build alternatives using HCS and TransModeler. The purpose of Chapter 8 is to test and identify improvements to the proposed design that could be applied to improve traffic operations. As identified in both Chapters 6 and 7, two key capacity issues requiring additional analysis are:

- The merge of southbound I-95 with the ramp carrying traffic from I-26 eastbound to I-95 southbound. This issue is especially critical given that no widening is currently planned on I-95 south of I-26.
- Similarly, an operational issue on the I-26 westbound merge with the proposed flyovers carrying traffic from I-95 northbound to I-26 westbound. The planned widening of I-26 helps relieve this issue, but some operational and queuing effects are noted that impact flow through the project interchange.

Note that the Chapter 6 and 7 analyses were preliminary analyses used to develop and refine the preferred design. For both chapters, assumptions were made analyzing flows on all ramps by including extra capacity on I-95 to the south and I-26 to the west. This assumption maximized traffic volumes through the I-26 at I-95 interchange.

## 8.1 I-26 and I-95 Corridor Year of Failure Analysis

Preliminary unconstrained analysis identified two segments where congestion impacted ramp flow: I-95 southbound south of the interchange and I-26 westbound west of the interchange. In both cases, the highest volume ramps in the corridor must merge into interstate mainline lanes despite higher volumes on the ramps. As a result, while the interchange has adequate capacity, queuing from the downstream interstate queues backs to the interchange.

TransModeler was used to evaluate a year of failure to determine when mitigation might be needed and different options for mitigation. Alternative 1, without additional widening to I-95, was used in each evaluation to allow for free-flowing ramp operations but would apply similarly for all three Build alternatives.

The analysis began with estimating origin-destination matrices for 2040 by averaging the 2030 and 2050 matrices. These volumes were used to evaluate the critical segments in 2040 and 2045. **Table 8.1** shows the capacity results for 2030, 2040, and 2045. TransModeler output for the year of failure analysis is provided in **Appendix O.**

**Table 8.1: TransModeler I-95 Southbound and I-26 Westbound Freeway Segment Year of Failure Results**

| Basic Segment Location | Density (pcpmpl) \| LOS | | | | | |
|---|---|---|---|---|---|---|
| | 2030 Build Alternative 1 | | 2040 Build Alternative 1 | | 2045 Build Alternative 1 | |
| **I-95 Southbound** South of I-26 and I-95 System Interchange | 36.14 | E | 50.53 | F | 52.03 | F |
| **I-26 Westbound** West of the I-26 and I-95 System Interchange | 14.01 | B | 24.16 | C | 56.03 | F |

*Thresholds for LOS D and E are densities >29 pc/mi/ln and >35 pc/mi/ln. LOS F occurs with V/C > 1.0.*

Table 8.1 suggests the I-95 southbound basic segment reaches LOS E by 2030. When the I-95 southbound segment reaches LOS E in 2030, the I-26 eastbound to I-95 southbound ramp will queue back to I-26 eastbound. The I-26 westbound basic segment exceeds LOS D between 2040 and 2045.

## 8.2 Merge Length Analysis for I-26 Westbound

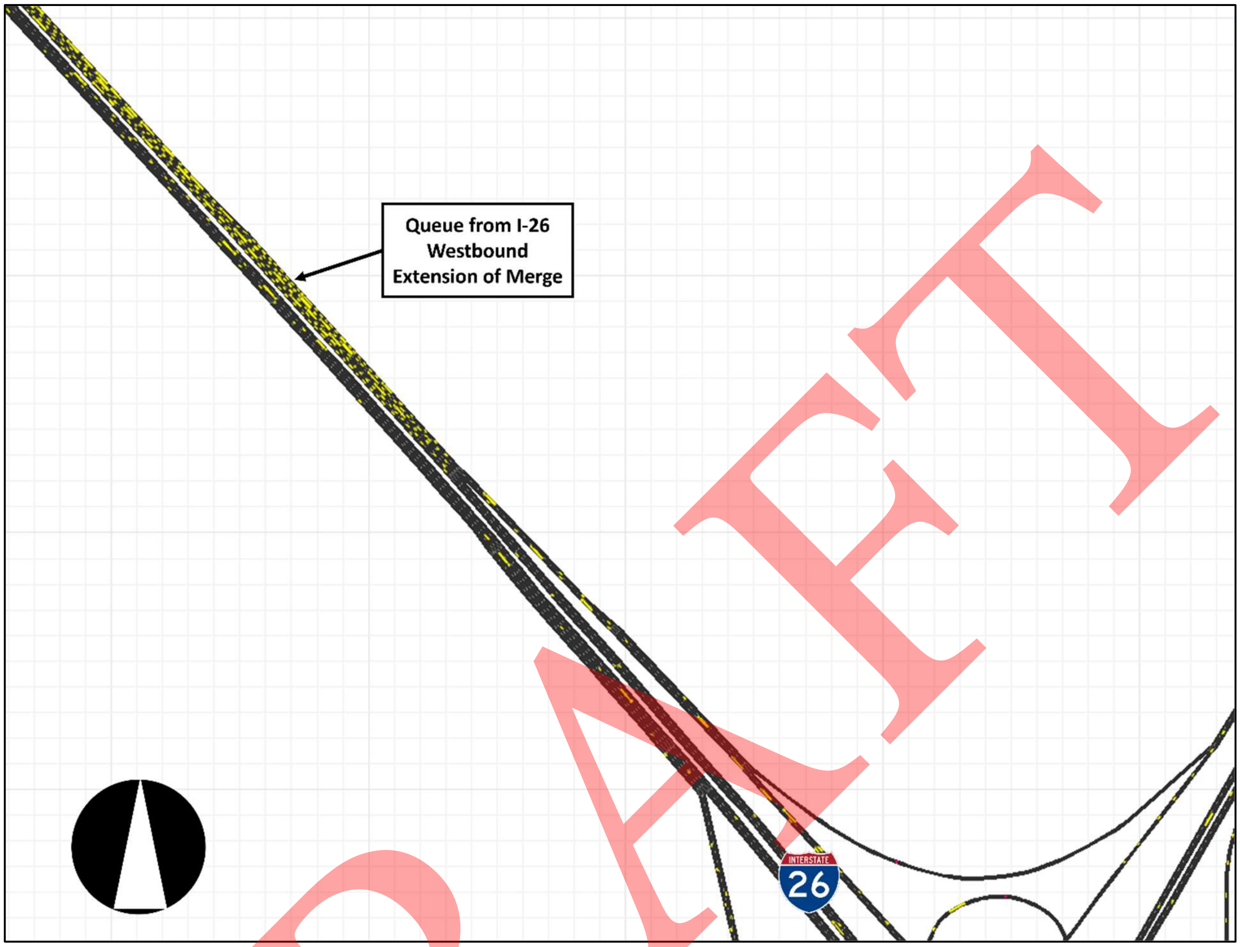
As a follow-on analysis to the freeway year of failure analysis, a second analysis was developed examining the length of a merge lane required to prevent queuing into the I-26 at I-95 interchange. The I-26 westbound merge congestion begins where the two-lane flyover Ramp 6 (which replaces loop Ramp 6) merges onto I-26 westbound. Using 2050 data, a temporary extension of merge areas was analyzed to determine what length of merge can keep congestion queues off the interchange ramps without needing a full auxiliary lane carried the to the S.C. 210 interchange. Visual queue lengths were the basis of this analysis and simulations were stopped just before the peak hour ended.

A series of model runs were completed showing queuing issues on the westbound merge. For I-26 westbound, an iterative lengthening of the 4-lane merge area determined that an additional 4,000 feet is needed to keep the congestion from queuing onto the I-95 northbound to I-26 westbound ramp. **Figure 8.1** shows the queue not spilling back to the I-95 northbound to I-26 westbound ramp.

Key findings of this analysis for the westbound merge include:

- A 4,000-foot westbound merge of the two-lane ramp would be needed to minimize potential of queuing back into the interchange area or ramp in 2050.
- This analysis was done assuming that all ramp traffic from I-95 northbound would be processed on the flyover Ramp 6. To do this, the TransModeler network assumed an additional I-95 northbound lane. Since an additional lane on I-95 is not planned, the traffic demand may be metered during the highest periods of congestion, reducing the ramp movement and subsequent merge movement that was analyzed to determine the 4,000-foot merge length.

**Figure 8.1: TransModeler 2050 Build Alternative 1 - I-26 Westbound Widening**



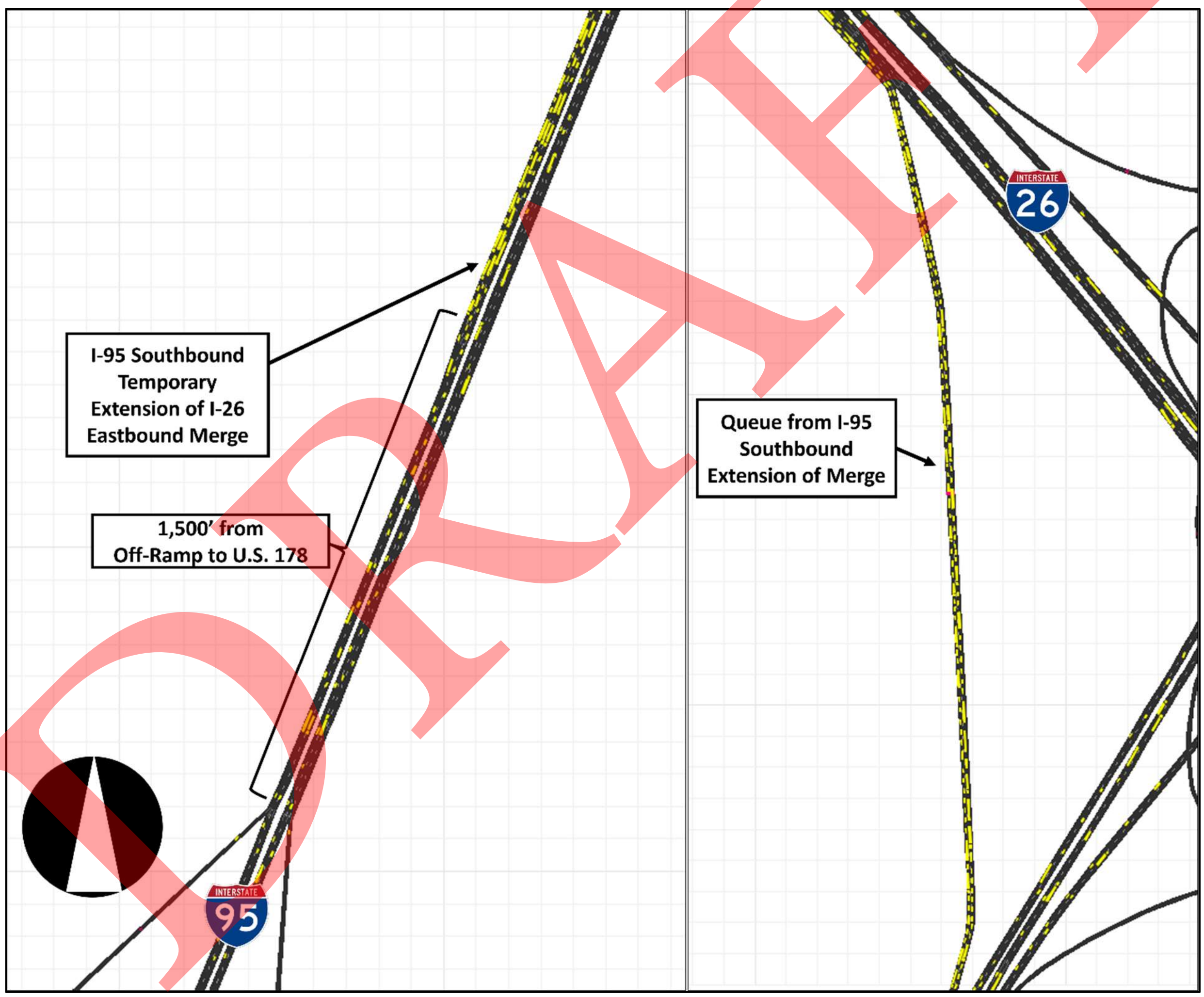

## 8.3 Merge Length Analysis for I-95 Southbound

An additional merge length analysis was also completed for I-95 southbound that further examines the segment of I-95 southbound south of the system interchange in 2030 and 2050 to determine mitigation of the merge area. The analysis focused on the length of a merge lane required to prevent queuing into the I-26 at I-95 interchange caused by a two-lane section on I-95 having inadequate capacity. Using 2050 data, a temporary extension of merge areas was analyzed to determine what length of merge can keep congestion queues off the interchange ramps without needing a full auxiliary lane carried the full two and one-half miles to the U.S. 178 interchange. Visual queue lengths were the basis of this analysis and simulations were stopped just before the peak hour ended.

### 8.3.1 Initial Testing of Extended Merge

**Figure 8.2** shows the extension of the merge area just north of U.S. 178 and the resulting queue on the ramp. For I-95 southbound, an iterative lengthening of the three-lane merge area determined that the congestion would continue queuing onto the I-26 eastbound to I-95 southbound ramp even if this merge is extended to provide three southbound lanes over two miles to within 1,500 feet from the off-ramp to U.S. 178. Figure 8.2 shows the queue spilling back onto the I-26 eastbound to I-95 southbound ramp and further into the I-26 eastbound mainline. In general, the findings were that simply extending the merge lane would not address the congestion issue related to inadequate capacity on I-95 south of the I-26 at I-95 interchange.

**Figure 8.2: TransModeler 2050 Build Alternative 1 - I-95 Southbound Widening**



## 8.3.2 Alternative Merge Treatments for I-95 Southbound based on ITE Interchange Design Handbook Guidance

Based on the previous analysis in Section 8.3.1 simply extending the merge lane at the I-95 southbound merge would not eliminate queuing back into the I-26 at I-95 interchange even with the proposed Build alternative improvements. The key issue is that 2050 volumes are expected to exceed the volume of a two-lane freeway section on I-95 south of the interchange. This analysis also indicated that congestion would persist with improvements to the merge area in 2050.

Further analysis for 2030 and 2050 was used to examine alternative merging solutions to mitigate congestion in the merge area to ideally allow for free-flowing ramp operations. Alternative 1 was used in each evaluation to allow for free-flowing ramp operations but would apply similarly for all three Build alternatives.

All merges were assumed to be for a two-lane ramp merging into a two-lane freeway. The section starts with four lanes and the ramp lanes are dropped from the right side. It is assumed that the rightmost lane is merged over approximately half the total merge distance resulting in a three-lane section. The next ramp lane is similarly merged into the two interstate lanes in the second half of the merge.

As noted, two merge lengths were tested on I-95 southbound. The shorter merge section of 2,500 feet was provided in the initial interchange concept based on minimum geometric requirements from the AASHTO Policy on Geometric Design of Highways and Streets for a two-lane merge comparing gap acceptance length and acceleration length.

After consultation with SCDOT staff, reference was made to the Institute of Transportation Engineers *Freeway and Interchange Geometric Design Handbook* as an alternate guideline. Chapter 6 of this document includes a section on auxiliary lanes with the following guidance which is applicable to our current situation.

> *When interchanges are widely spaced, it might not be feasible or necessary to extend the auxiliary lane from one interchange to the next. In such cases, an auxiliary lane added at a two-lane entrance should be carried along the freeway for an effective distance beyond the merging point, or an auxiliary lane introduced on a two-lane exit should be carried along the freeway for an effective distance in advance of the exit and extended onto the ramp. Experience indicates that distances of about 2,500 feet are needed to produce the necessary operational effect and develop the full capacity of two-lane entrances and exits on high-type facilities.*

The key element is that once a distance of 2,500 feet is reached for a lane merge, the operational effects and capacity benefits are effectively achieved, and additional extension provide minimal benefit. After consultation with SCDOT, it was confirmed that the 2,500-foot guidance was for each lane to dropped in the merge. Based on the feedback and consideration of the ITE guidance, a 5,000-foot merge was tested and compared with a 2,500-foot merge.

Based on these assumptions, four scenarios were analyzed for both 2030 and 2050 analyses:

1. Build Alternative 1 concept with no I-95 widening
    a. Southbound merge section of 2,500 feet (reflects the initial concept design for the interchange Alternative 1)

2. Build Alternative 1 with no I-95 widening
    a. Increase southbound merge section to 5,000 feet (reflects the proposed ITE method for maximizing the effective merging distance)

3. Build Alternative 1 with I-95 widened to 3-lanes southbound (tests ultimate future layout)
    a. Southbound merge section of 2,500 feet

4. Build Alternative 1 with I-95 widened to 3-lanes southbound (tests ultimate future layout)
    a. Increase southbound merge section to 5,000 feet

Option 1 represents the base condition with a 2,500-foot merge for the key merge area. This option was utilized to compare the mitigations described in Options 2, 3, and 4. I-95 southbound operational improvements were compared using freeway density, LOS, and travel times. Focusing only on the I-95 southbound operations, freeway density and LOS was analyzed for the I-95 southbound segments south of the I-26 and I-95 system interchange and shown in **Table 8.2**. Additionally, travel time was analyzed for segments ending at I-95 southbound, south of U.S. 178 and shown in **Table 8.3**. TransModeler output for the I-95 southbound south of the system interchange analysis is provided in **Appendix P.**

### Table 8.2: TransModeler I-95 Southbound Freeway Segment Density Results

| Segment Number | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2030 No Build – No Widening | | 1. 2030 Build Alternative 1 - No I-95 Widening with 2,500 ft merge | | 2. 2030 Build Alternative 1 - No I-95 Widening + Extended 5,000 ft Merge | | 3. 2030 Build Alternative 1 - I-95 Widening with 2,500 ft merge | | 4. 2030 Build Alternative 1 - I-95 Widening + Extended 5,000 ft Merge | | 2050 No Build | | 1. 2050 Build Alternative 1 - No I-95 Widening + with 2,500 ft merge | | 2. 2050 Build Alternative 1 - No I-95 Widening + Extended 5,000 ft merge | | 3. 2050 Build Alternative 1 - I-95 Widening with 2,500 ft merge | | 4. 2050 Build Alternative 1 - I-95 Widening + Extended 5,000 ft merge | |
| 1 | North of U.S. 176 | Basic | 19.2 | C | 19.1 | C | 19.1 | C | 12.6 | B | 12.6 | B | 24.1 | C | 24.1 | C | 24.1 | C | 15.7 | B | 15.8 | B |
| 24.1 | Off-Ramp to U.S. 176 | Diverge | 22.3 | C | 21.5 | C | 21.2 | C | 13.1 | B | 13.1 | B | 26.6 | D | 26.5 | C | 27.2 | C | 17.0 | B | 16.7 | B |
| 26.5 | Between U.S. 176 Ramps | Basic | 18.9 | C | 19.0 | C | 18.8 | C | 12.5 | B | 12.4 | B | 24.1 | C | 24.1 | C | 24.0 | C | 15.5 | B | 15.5 | B |
| 24.1 | On-Ramp from U.S. 176 | Merge | 19.5 | B | 19.5 | B | 19.4 | B | 12.0 | B | 12.4 | B | 24.3 | C | 23.9 | C | 24.3 | C | 14.9 | B | 14.7 | B |
| 23.9 | North of I-26/I-95 Interchange | Basic | 20.5 | C | 20.5 | C | 20.4 | C | 13.4 | B | 13.4 | B | 25.7 | C | 25.7 | C | 25.7 | C | 16.7 | B | 16.8 | B |
| 25.7 | Off-Ramp to I-26 | Diverge | 21.2 | C | 18.6 | B | 19.6 | B | 13.5 | B | 13.6 | B | 26.6 | C | 24.1 | C | 23.7 | C | 17.5 | B | 17.1 | B |
| 24.1 | Between Ramps | Basic | 21.1 | C | 12.9 | B | 12.1 | B | 8.2 | A | 8.3 | A | 28.9 | D | 15.1 | B | 15.1 | B | 9.5 | A | 9.8 | A |
| 15.1 | Loop On-Ramp from I-26 WB | Merge | 19.3 | B | 11.4 | B | 10.8 | B | 6.6 | A | 6.8 | A | 30.0 | D | 13.1 | B | 13.6 | B | 8.7 | A | 8.0 | A |
| 13.1 | Between Ramps | Basic | 16.3 | B | 15.4 | B | 16.2 | B | 9.9 | A | 10.1 | A | 20.1 | C | 22.0 | C | 24.0 | C | 12.1 | B | 12.0 | B |
| 22.0 | On-Ramp from I-26 EB | Critical Merge under Study | 28.7 | D | 25.4 | C | 18.6 | B | 18.9 | B | 15.7 | B | 30.2 | D | 109.3 | F | 93.8 | F | 23.1 | C | 18.9 | B |
| 109.3 | South of I-26/I-95 Interchange | Basic | 30.6 | D | 36.1 | E | 20.0 | C | 19.7 | C | 14.6 | B | 32.6 | D | 115.4 | F | 51.4 | F | 24.5 | C | 17.8 | B |
| 115.4 | Off-Ramp to U.S. 178 | Diverge | 31.3 | D | 29.8 | D | 20.0 | B | 19.1 | B | 14.6 | B | 32.4 | D | 29.8 | D | 29.7 | D | 22.2 | C | 22.7 | C |
| 115.4 | Between U 178 Ramps | Basic | 29.8 | D | 29.7 | D | 30.0 | D | 18.4 | C | 18.9 | C | 32.1 | D | 28.8 | D | 29.4 | D | 23.5 | C | 22.9 | C |
| 14 | On-Ramp from U.S. 178 | Merge | 30.8 | D | 32.0 | D | 32.4 | D | 18.4 | B | 18.8 | B | 33.5 | D | 30.7 | D | 30.8 | D | 21.0 | C | 22.2 | C |
| 15 | South of U.S. 178 | Basic | 30.0 | D | 29.7 | D | 29.9 | D | 19.4 | C | 19.7 | C | 31.7 | D | 29.9 | D | 29.7 | D | 24.0 | C | 23.8 | C |

### Table 8.3: TransModeler I-95 Southbound Travel Time Results

| Travel Time Segment | | Travel Time (mm:ss) \ Average Speed (mph) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start | End | 1. 2030 Build Alternative 1 - No I-95 Widening with 2,500 ft merge | 2. 2030 Build Alternative 1 - No I-95 Widening + Extended 5,000 ft Merge | Time Diff | 3. 2030 Build Alternative 1 - I-95 Widening with 2,500 ft merge | Time Diff | 4. 2030 Build Alternative 1 - I-95 Widening + Extended 5,000 ft Merge | Time Diff | 1. 2050 Build Alternative 1 - No I-95 Widening with 2,500 ft merge | 2. 2050 Build Alternative 1 - No I-95 Widening + Extended 5,000 ft Merge | Time Diff | 3. 2050 Build Alternative 1 - I-95 Widening with 2,500 ft merge | Time Diff | 4. 2050 Build Alternative 1 - I-95 Widening + Extended 5,000 ft Merge | Time Diff |
| I-26 Eastbound, West of S.C. 210 | I-95 Southbound, South of U.S. 178 | 09:16 | 09:03 | -00:13 | 09:06 | -00:10 | 09:05 | -00:11 | 24:14 | 17:37 | -06:37 | 09:18 | -14:56 | 09:16 | -14:57 |
| Average Speed (mph) | | 66 | 67 | - | 68 | - | 68 | - | 45 | 52 | - | 66 | - | 66 | - |

Using these model results, a matrix comparison was prepared of the key findings and results of this comparison as shown in **Table 8.4** and **Table 8.5**.

### Table 8.4: TransModeler I-95 Southbound LOS Comparison

| Movement | 2030 LOS from TransModeler | | 2050 LOS from TransModeler | |
|---|---|---|---|---|
| I-26 EB to I-95 SB | Ramp from I-26 EB to I-95 SB | I-95 SB merge | Ramp from I-26 EB to I-95 SB | I-95 SB merge |
| | Maintain 2 SB lanes on I-95 | | | |
| 2,500-foot merge | C | E | E | F |
| 5,000-foot merge | B | C | E | F |
| | Widen to 3 SB lanes on I-95 | | | |
| 2,500-foot merge | A | A | A | B |
| 5,000-foot merge | A | A | A | B |

### Table 8.5: TransModeler I-26 Eastbound to I-95 Southbound Movement: Travel Time & Speed Comparison

| Movement | Travel Time EB to SB | | Delay per Vehicle over Uncongested Travel Time of 09:00 (in min:sec) | | Travel Speed EB to SB | |
|---|---|---|---|---|---|---|
| I26 EB to I-95 SB | 2030 | 2050 | 2030 | 2050 | 2030 | 2050 |
| | Maintain 2 SB lanes on I-95 | | | | | |
| 2,500-foot merge | 09:16 | 24:14 | 0:16 | 15:14 | 66 mph | 45 mph |
| 5,000-foot merge | 09:03 | 17:37 | 0:03 | 8:37 | 67 mph | 52 mph |
| | Widen to 3 SB lanes on I-95 | | | | | |
| 2,500-foot merge | 09:06 | 09:18 | 0:06 | 0:18 | 68 mph | 66 mph |
| 5,000-foot merge | 09:05 | 09:16 | 0:05 | 0:16 | 68 mph | 66 mph |

## 8.3.3 Level of Service

- 2030: With a 2,500-foot merge, LOS E will be observed on I-95 immediately south of the ramp merge. Lengthening the merge to 5,000 feet improves 2030 operations to LOS C.
- 2050: Increasing volumes on I-95 will result in LOS F operations at the merge regardless of whether a 2,500-foot merge or 5,000-foot merge. This is consistent with the iterative merge analysis that showed queuing even if the merge were extended more than two miles.

- Widening I-95 to a six lane section results in LOS C and B operations in 2050 with a 2,500-foot or 5,000-foot merge, respectively.

### 8.3.4 Travel Times and Travel Speeds

- Baseline for Uncongested Operations: Relative free flow (LOS A and B) are anticipated for all scenarios with three southbound lanes on I-95. Using this as a base for comparison, uncongested conditions are assumed to be occurring with a travel time of 9 minutes corresponding to a travel speed of 68 mph.

- 2030: With a 2,500-foot merge, queuing and congestion will slightly increase travel times and decrease travel speed to 66 mph (a reduction of 2 mph). In comparison, a 5,000-foot merge maintains relatively uncongested travel times through the southbound merge.

- 2050: With either a 2,500 foot or a 5,000-foot merge, congested conditions will increase travel time and reduce travel speed substantially on both the ramp from I-26 eastbound to I-95 southbound as well as on I-95 southbound if I-95 is not widened. Nevertheless, a 5,000-foot merge still provides substantial benefit compared with the 2,500-foot merge in terms of travel time saving and operational speeds:
  - With a 5,000-foot merge, travel time (17 minutes 37 seconds) is almost twice as long as uncongested conditions (approx. 9 minutes 0 seconds). In comparison, the 2,500-foot merge travel time (24 minutes 14 seconds) is near three times the uncongested travel time.
  - Looked at in terms of delay, the 5,000-foot merge has 8 minutes 37 seconds of delay per vehicle which is near half the 15 minutes 14 seconds of delay with a 2,500-foot merge.
  - Average travel speeds with the 5,000-foot merge ramp is 52 mph compared with 45 mph with a 2,500 foot ramp. If I-95 were to be widened in the future, 66 mph flow is anticipated with either merge treatment.

Based on this analysis (especially the travel time, delay and speed analysis), it is recommended that a 5,000-foot merge section be utilized for the two-lane ramp merging onto I-95 southbound. With the 5,000-foot merge, peak hour delays on the eastbound to southbound movement will be approximately half that which occurs with a 2,500-foot merge.

# 9. FINAL TRANSMODELER COMPARISON OF NO BUILD & PREFERRED ALTERNATIVE

## 9.1 Selection of Preferred Interchange Alternative & Design Enhancements

Based on the initial analysis comparison of alternatives in Chapter 6 and the more detailed findings and refinements in Chapter 8, the following conclusions were reached for the comparison of alternatives.

- From a traffic perspective, Alternatives 1 and 2 operate almost identically since the traffic volumes and recommended laneage are the same at all merge and diverge points.
- Alternative 3 operates similarly to Alternatives 1 and 2 but does exhibit some operational deficiencies. Specifically, the replacement with a flyover introduces two traffic capacity issues:
  - The merge from the flyover onto I-95 southbound occurs further south than the loop merge that is being replaced. Due to the shift southward, there is a shorter distance to the critical four lane merging section of the I-26 eastbound to I-95 southbound merge. The reduced spacing causes disruptions in flow at both merge areas.
  - With the third flyover, the I-26 westbound shared ramp requires a combined exit of both the I-95 northbound and I-95 southbound traffic. This ramp exit then divides approximately 800 to 1000 feet downstream. The combination of these two movements into a single lane shared ramp results in a poor LOS on the combined ramp segment.

Based on this review, both Alternative 1 and 2 meet the traffic operational requirements for the project and provide essentially the same level of traffic operations and are equally acceptable as a preferred alternative from a traffic perspective.  After additional analysis examining multiple planning, impact, design and cost characteristics (in addition to the traffic analysis), Alternative 2 was identified as the Preferred Alternative for the project.

In addition to the identification of the highest functioning interchange alternatives from a traffic perspective, Chapter 8 examined some key operational requirements of the proposed alternatives. The two key elements are:

- On I-95 southbound, no widening of I-95 is currently planned. As a result, there are capacity issues noted for the high-volume merge of the I-26 eastbound to I-95 southbound ramp with I-95 southbound south of the interchange.

- After a series of iterative runs and examination of alternatives, it is recommended that this merge area be extended to 5,000 feet (approximately 1 mile) with a four-lane section carried for 2,500 feet followed by a three-lane section of an additional 2,500 feet.
- Even with this configuration some queuing is anticipated in the southbound direction from the ultimate merge back into two lanes. This queue is expected to back into the interchange during the peak analysis period (based on TransModeler), but additional length on the merge does not substantially improve traffic flows.
- In order to eliminate queuing at this merge in 2050, I-95 widening to a three-lane section would be required. If this were to happen in the future, the proposed 5,000-foot weave would provide adequate capacity for operations without anticipated queuing.

- On I-26 westbound, there is also a high-volume merge from proposed two-lane I-95 northbound to I-26 westbound flyover located west of the interchange. Even with the planned six-lane widening of I-26, the merge area westbound was determined to require a 4,000-foot merge. Ideally, the merge would be 5 lanes for the first 1,500 feet and four lanes for the next 2,500 feet before merging into the planned three mainline lanes on westbound I-26.

As part of the Interchange Modification Report requirements, this section examines the No Build scenario and the preferred alternative scenario in both the 2030 opening year and the 2050 design year. For the preferred alternative, the Alternative 2 TransModeler simulation model is used as a base with modifications to include the longer merge distance on I-95 southbound and I-26 westbound. Note that although the Alternative 2 model is being used as a base, the results are intended to reflect either Alternative 1 or 2 for traffic analysis.

## 9.2 Final Comparison of No Build and Preferred Alternative with TransModeler

The final step in the traffic analysis was to test operations for the No Build scenarios with the preferred alternative as revised based upon the Chapter 8 analysis of key merges – specifically the provision of a 5,000-foot merge onto I-95 southbound and a 4,000-foot westbound merge onto I-26.

The analysis methods will be the same as originally applied in the Section 7.1.3 TransModeler analysis and the Section 7.4 comparison of Build alternatives. The analysis findings in this new section are different and show higher levels of congestion for the preferred alternative. The key reason is that Section 7.1.3 analysis assumed widening of I-95 (and westbound auxiliary lanes on I-26) to maximize flows entering and exiting the interchange on all approaches and departures. This was necessary at that stage to verify the overall design requirements and still allowed for comparison of alternatives.

The updated analysis in this section assumes no widening on I-95 (four mainline lanes – two northbound and two southbound) as well as the lengthened merge areas on I-26 westbound and I-95 southbound. As a result, there are locations with poor LOS and reduced speeds (primarily due to congestion at the I-26 westbound merge area and the I-95 southbound merge area). Due to the future congestion issues with the preferred alternative operations in 2050, an interim year analysis of both of these key merges is also addressed. TransModeler output for the 2030 and 2050 No Build and Build preferred alternative conditions output is provided in **Appendix Q.**

The updated TransModeler analysis provides a comparison of five scenarios:

- 2022 Existing
- 2030 No Build and 2030 Build Preferred Alternative
- 2050 No Build and 2050 Build Preferred Alternative

### 9.2.1 Freeway Operations and Key Merge, Diverge and Weave Operations

The following section describes the evaluation of the I-26 at I-95 system interchange as well as proposed alternative interchange configurations to address deficiencies. The analysis examined traffic flows in the four key directions along I-26 and I-95. Key findings from each table include:

***Eastbound on I-26***

As shown in **Table 9.1**, there is congestion anticipated in 2050 on the three-lane approach to the I-26 at I-95 interchange and on the ramp to I-95 southbound. Specific observations include:

- The three-lane freeway approach (Link 5 EB) to the ramp is projected to operate at LOS F in both the 2050 No Build and Build scenarios. That said, the preferred alternative congestion is substantially lower with a density (46.6 pcpmpl) less than half of the No Build density (110.2 pcpmpl).
- The diverge section (Link 6 EB) just past the freeway section is showing as LOS F with the preferred alternative compared to LOS E with the No Build. Key issues in both the No Build and Build operations are:
  - For the No Build, the existing one lane ramp to I-95 southbound (at the Link 6 EB diverge) is not able to process the full volume of demand. As a result, substantial volumes of traffic is queuing back onto I-26 (Link 5 EB). Once I-26 is congested it hits a bottleneck which meters eastbound traffic from

reaching the diverge at Link 6. Diverging traffic is able to travel at a lower density on the ramp to southbound I-95 once the bottleneck is passed.

- In the 2050 Build scenario, the simulation is showing impacts of queuing and congestion backing onto the widened two-lane ramp from the merge with I-95 southbound. This downstream queuing represents a shift in the bottleneck point from the southern merge point on the ramp. As a result, the two-lane ramp is processing higher volumes, but the density is increased (and LOS worsened) on the ramp.
- Operations with the proposed alternative is preferred to the No Build since the two-lane ramp processes higher volumes and queuing on I-26 eastbound is reduced (and shifted to the two-lane ramp).

- As noted, the southbound merge area is a key constraint affecting Link 6 and likely Link 5. Therefore, more detailed analysis of the southbound merge is presented in Section 9.2.5 to examine the interim operations between 2030 and 2050.
- The preferred alternative eliminates the weave section. The TransModeler analysis underestimates congestion at most links east of Links 5 and 6 as through traffic is metered downstream of Links 5 and 6.

### ***Westbound on I-26***

As shown in **Table 9.2**, there is congestion noted for the 2050 preferred alternative. Key observations are:

- For the preferred alternative, eastbound operations are at LOS B and C until the merge of the I-95 northbound to I-26 westbound ramp. This high-volume ramp (Link 12 WB) operates at LOS E due primarily to the merging section at the freeway (Link 13 WB which is split into two segments) that operates at LOS F in 2050. Similar to the I-95 southbound merge, more detailed analysis of the I-26 westbound merge is included in Section 9.2.5.
- The preferred alternative eliminates the westbound weave section due to the removal of the high-volume ramp in the northeast quadrant. The removal of the weave decreases density, improves LOS, and improves operations overall. Note that in the No Build scenario, the weave meters flow merging onto I-26 westbound since it cannot process the demand volumes (i.e., the one lane loop is replaced by a two-lane flyover in order to serve the demand). As a result, the westbound operations are artificially reflecting LOS C westbound operations downstream of the weave.

## Northbound on I-95

As shown in **Table 9.3**, LOS C is maintained on I-95 northbound with the preferred alternative. Key observations are:

- The preferred alternative eliminates the northbound weave section. The removal of the northeast quadrant loop and the existing weave addresses one of the key congestion bottlenecks within the existing interchange with LOS F operations in 2030 (Link 8 NB) and queuing back to the nearest upstream segment (Link 7 NB). By 2050, the queuing for the weave and single lane loop ramp extends south to the U.S. 178 interchange.
- In both the No Build and preferred alternative, I-95 is assumed to remain two lanes northbound. In both cases, the two-lane I-95 section is unable to serve the 2050 northbound traffic with LOS F in the No Build and LOS E with the preferred alternative on Links 1 NB through 3 NB. The difference is due to residual effects of the weaving section's failed operations in the No Build.

## Southbound on I-95

As shown in **Table 9.4** (and discussed in detail), the merge of the I-26 eastbound to I-95 southbound ramp with the I-95 southbound traffic is a key bottleneck. Key observation of how this affects southbound flow include:

- The merge to the southbound I-95 operates at a LOS F by 2050. For this analysis the merge has been divided into each lane drop to illustrate the increasing congestion as the available lanes are reduced. More detailed analysis is shown in Section 9.2.5 to look at interim years.
- The southbound merge appears to operate at LOS D in the No Build condition. The primary reason, however, is that the high-volume ramp from I-26 eastbound to I-95 southbound is only one lane in the No Build resulting in queuing from the ramp back onto I-26 eastbound and reduced volumes being processed.
- The preferred alternative also eliminates the southbound weave section improving operations and reducing conflicts.

### Table 9.1: TransModeler Freeway Segment Density Results: I-26 Eastbound

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Preferred Alt | | 2050 No Build | | 2050 Build Preferred Alt | |
| 1 | West of S.C. 210 | Basic | 23.9 | C | 18.0 | C | 18.1 | C | 61.9 | F | 26.3 | D |
| 2 | Off-Ramp to S.C. 210 | Diverge | 23.4 | C | 15.2 | B | 13.9 | B | 39.9 | E | 20.9 | C |
| 3 | Between S.C. 210 Ramps | Basic | 23.9 | C | 17.9 | B | 18.0 | C | 85.1 | F | 25.6 | C |
| 4 | On-Ramp from S.C. 210 | Merge | 23.2 | C | 14.7 | B | 14.2 | B | 87.6 | E | 21.4 | C |
| 5 | West of I-26/I-95 System Interchange | Basic | 24.6 | C | 19.0 | C | 18.3 | C | 110.2 | F | 46.6 | F |
| 6 | Off-Ramp to I-95 SB | Diverge | 36.7 | E | 27.0 | C | 12.2 | B | 30.5** | F*** | 58.9 | F |
| 7 | Between Ramps | Basic | 12.3 | B | 9.2 | A | 8.6 | A | 11.0 | B | 13.1 | B |
| 8 | I-26 at I-95 System Weave* (No Build)<br>Off ramp to Loop (Preferred Alt) | Weave<br>Diverge | 11.9 | B | 10.4 | B | 4.6 | A | 15.8 | B | 7.9 | A |
| 9 | Between Ramps | Basic | 18.9 | C | 13.1 | B | 8.4 | A | 17.5 | B | 11.3 | B |
| 10 | On-Ramp from I-95 NB | Merge | 18.1 | B | 13.3 | B | 11.6 | B | 15.7 | B | 15.9 | B |
| 11 | East of I-26/I-95 System Interchange | Basic | 19.7 | C | 15.0 | B | 11.5 | B | 17.9 | B | 16.6 | B |
| 12 | Off-Ramp to U.S. 15 SB | Diverge | 18.8 | B | 11.2 | B | 11.4 | B | 13.8 | B | 15.6 | B |
| 13 | Between Ramps | Basic | 17.0 | B | 14.2 | B | 14.1 | B | 17.3 | B | 20.0 | C |
| 14 | Weave to/from U.S. 15 | Weave | 8.4 | A | 4.4 | A | 6.1 | A | 5.6 | A | 9.3 | A |
| 15 | Between Ramps | Basic | 20.4 | C | 15.2 | B | 14.9 | B | 17.6 | B | 20.5 | C |
| 16 | On-Ramp from U.S. 15 NB | Merge | 19.0 | B | 12.0 | B | 13.2 | B | 14.4 | B | 17.9 | B |
| 17 | East of U.S. 15 | Basic | 19.8 | C | 14.2 | B | 14.3 | B | 18.2 | C | 19.8 | C |

**In all 2030 and 2050 Build Alternatives the weave segment is removed. This segment is replaced by a diverge segment, which is the off-ramp to I-95 Northbound.*

*** For 2050, the No Build has substantial queuing and restricted flow at Link 6 which is a bottleneck due to the ramp from I-26 eastbound to I-95 southbound having inadequate capacity (one lane compared with two lanes in the Build). As a result, queuing and delays occur on I-26 upstream of the ramp with increased densities and poor LOS. Densities on downstream links are lower than the Build alternatives based on the lower volumes being served.*

**** Although density reflect better LOS, the capacity of the one lane exit is exceeded in the No Build resulting in substantial delays and queuing.*

### Table 9.2: TransModeler Freeway Segment Density Results: I-26 Westbound

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Preferred Alt | | 2050 No Build | | 2050 Build Preferred Alt | |
| 1 | East of U.S. 15 | Basic | 19.6 | C | 15.1 | B | 15.0 | B | 22.7 | C | 22.6 | C |
| 2 | Off-Ramp to U.S. 15 NB | Diverge | 13.0 | B | 11.2 | B | 11.2 | B | 17.7 | B | 17.1 | B |
| 3 | Between Ramps | Basic | 19.2 | C | 14.5 | B | 14.8 | B | 22.3 | C | 22.8 | C |
| 4 | Weave to/from U.S. 15 | Weave | 9.4 | A | 6.9 | A | 5.8 | A | 11.2 | B | 11.5 | B |
| 5 | Between Ramps | Basic | 19.4 | C | 15.3 | B | 15.0 | B | 21.4 | C | 21.8 | C |
| 6 | On-Ramp from U.S. 15 SB | Merge | 19.3 | B | 13.2 | B | 12.2 | B | 19.9 | B | 18.3 | B |
| 7 | East of I-26/I-95 System Interchange | Basic | 19.8 | C | 15.4 | B | 15.0 | B | 23.8 | C | 22.5 | C |
| 8 | Off-Ramp to I-95 NB | Diverge | 19.9 | B | 14.0 | B | 15.4 | B | 20.8 | C | 22.8 | C |
| 9 | Between Ramps | Basic | 14.1 | B | 10.8 | A | 10.3 | A | 16.4 | B | 14.8 | B |
| 10 | I-26 at I-95 System Weave* (No Build) Off ramp to Loop (Preferred Alt) | Weave | 27.3** | C | 29.0 | D | 7.8 | A | 33.7** | D | 10.8 | B |
| 11 | Between Ramps | Basic | 29.0 | D | 21.3 | C | 8.6 | A | 25.8 | C | 12.8 | B |
| 12 | On-Ramp from I-95 SB | Merge | 24.3 | C | 17.0 | B | 14.0 | B | 20.8 | C | 47.4 | F |
| 13 | West of I-26/I-95 System Interchange | Basic – 4 Lanes | 24.2 | C | 18.5 | C | 13.8 | B | 23.3 | C | 78.6 | F |
| | | Basic – 3 Lanes | | | | | 19.0 | C | | | 99.7 | F |
| 14 | Off-Ramp to S.C. 210 | Diverge | 29.1 | D | 16.5 | B | 18.1 | B | 22.5 | C | 30.0 | D |
| 15 | Between S.C. 210 Ramps | Basic | 24.4 | C | 17.7 | B | 18.6 | C | 23.3 | C | 25.5 | C |
| 16 | On-Ramp from S.C. 210 | Merge | 22.6 | C | 13.8 | B | 13.8 | B | 17.3 | B | 19.0 | B |
| 17 | West of S.C. 210 | Basic | 23.9 | C | 18.2 | C | 18.2 | C | 22.4 | C | 22.4 | C |

*In all 2030 and 2050 Build Alternatives the weave segment is removed. This segment is replaced by a diverge segment for the off-ramp to I-95 Northbound.

** For 2050, I-26 westbound flow is less congested based on the TransModeler simulation because the loop serving I-95 northbound to I-26 westbound is only one lane severely limiting the volumes that can access I-26 westbound. Densities on downstream links are lower than the Build alternatives based on the lower volumes being served.

**Table 9.3: TransModeler Freeway Segment Density Results: I-95 Northbound**

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Preferred Alt | | 2050 No Build | | 2050 Build Preferred Alt | |
| 1 | South of U.S. 178 | Basic | 24.7 | C | 29.3 | D | 29.2 | D | 87.0 | F | 38.6 | E |
| 2 | I-26 NB Off-Ramp to U.S. 178 | Diverge | 30.1 | D | 37.9 | E | 34.5 | D | 106.5 | F | 41.4 | E |
| 3 | I-26 EB Between U.S. 178 Ramps | Basic | 23.4 | C | 27.3 | D | 27.6 | D | 93.1 | F | 35.9 | E |
| 4 | I-26 EB On-Ramp from U.S. 178 | Merge | 25.1 | C | 21.6 | C | 19.8 | B | 121.8 | F | 25.2 | C |
| 5 | South of I-26/I-95 System interchange | Basic | 25.3 | C | 21.6 | C | 19.8 | C | 121.8 | F | 25.2 | C |
| 6 | Off-Ramp to I-26 EB | Diverge | 26.0 | C | 21.6 | C | 17.0 | B | 121.8 | F | 23.4 | C |
| 7 | Between Ramps | Basic | 24.9 | C | 66.0 | F | 12.4 | B | 87.0 | F | 13.7 | B |
| 8 | I-26 at I-95 System Weave* | Weave | 27.4 | C | 48.6 | F | 8.2 | A | 51.3** | F | 9.4 | A |
| 9 | Between Ramps | Basic | 11.4 | B | 14.9 | B | 12.9 | B | 11.0 | A | 14.1 | B |
| 10 | On-Ramp from I-26 WB | Merge | 17.7 | B | 21.1 | C | 21.1 | C | 22.6 | C | 27.3 | C |
| 11 | North of I-26/I-95 System interchange | Basic | 17.4 | B | 20.5** | C | 20.6 | C | 20.5 | C | 25.3 | C |
| 12 | Off-Ramp to U.S. 176 | Diverge | 19.1 | B | 21.7** | C | 21.8 | C | 23.4 | C | 25.4 | C |
| 13 | Between U.S. 176 Ramps | Basic | 16.3 | B | 19.5** | C | 19.5 | C | 19.2 | C | 24.2 | C |
| 14 | On-Ramp from U.S. 176 | Merge | 15.6 | B | 17.8** | B | 18.9 | B | 18.4 | B | 22.1 | C |
| 15 | North of U.S. 176 | Basic | 16.5 | B | 19.8** | C | 19.5 | C | 19.6 | C | 24.4 | C |

**In all 2030 and 2050 Build Alternatives the weave segment is removed. This segment is replaced by a diverge segment, which is the off-ramp to I-95 Northbound*

*** For 2050, I-95 northbound flow has very high levels of congestion and delays due to inadequate capacity on the one lane loop serving I-95 northbound to I-26 westbound. This queue extends south of the interchange for a substantial distance. Densities on downstream links (to the north) are lower than the Build alternatives based on the lower volumes being served.*

### Table 9.4: TransModeler Freeway Segment Density Results: I-95 Southbound

| Segment No. | Segment Description | Segment Type | Density (pcpmpl) \| LOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Preferred Alt | | 2050 No Build | | 2050 Build Preferred Alt | |
| 1 | North of U.S. 176 | Basic | 16.2 | B | 19.1 | C | 19.0 | C | 24.1 | C | 24.1 | C |
| 2 | Off-Ramp to U.S. 176 | Diverge | 17.7 | B | 23.5 | C | 22.4 | C | 25.3 | C | 25.2 | C |
| 3 | Between U.S. 176 Ramps | Basic | 15.9 | B | 19.0 | C | 18.9 | C | 24.0 | C | 24.3 | C |
| 4 | On-Ramp from U.S. 176 | Merge | 16.4 | B | 19.6 | B | 19.7 | B | 24.8 | C | 23.7 | C |
| 5 | North of I-26/I-95 Interchange | Basic | 17.3 | B | 20.5 | C | 20.5 | C | 25.6 | C | 25.6 | C |
| 6 | Off-Ramp to I-26 | Diverge | 16.8 | B | 20.5 | C | 18.6 | B | 24.7 | C | 24.6 | C |
| 7 | Between Ramps | Basic | 17.3 | B | 22.1 | C | 12.2 | B | 29.3 | D | 14.6 | B |
| 8 | I-26 at I-95 System Weave (No Build)*<br>Between Ramps (Preferred Alt) | Weave | 16.4 | B | 19.5 | B | 11.2 | B | 29.7 | D | 14.1 | B |
| 9 | Between Ramps | Basic | 14.1 | B | 15.9** | B | 16.3 | B | 19.8 | C | 23.2 | C |
| 10 | On-Ramp from I-26 EB | Merge | 23.7 | C | 29.0 | D | 20.3 | C | 30.2** | D | 110.5 | F |
| 11 | South of I-26/I-95 Interchange | Basic – 4 Lanes | 25.5 | C | 30.9 | D | 20.2 | C | 32.6 | D | 125.0 | F |
| | | Basic – 3 Lanes | | | | | 30.5 | D | | | 33.4*** | F |
| 12 | Off-Ramp to U.S. 178 | Diverge | 25.9 | C | 30.4 | D | 19.9 | B | 32.6 | D | 104.2 | F |
| 13 | Between U.S. 178 Ramps | Basic | 24.6 | C | 29.9 | D | 30.4 | D | 31.9 | D | 28.4 | D |
| 14 | On-Ramp from U.S. 178 | Merge | 25.3 | C | 31.4 | D | 31.3 | D | 32.7 | D | 30.5 | D |
| 15 | South of U.S. 178 | Basic | 25.4 | C | 29.7 | D | 30.2 | D | 31.9 | D | 29.5 | D |

**In all 2030 and 2050 Build Alternatives the weave segment is removed. This segment is replaced by a diverge segment, which is the off-ramp to I-95 Northbound.*

*** For 2050, I-95 southbound flow has high levels of congestion and delays due to inadequate capacity on the two lane I-95. In the No Build, however, these delays are less apparent because the on-ramp from I-26 eastbound (Link 10) is a single lane restricting traffic flow from ramp merging onto I-95 southbound. A high level of delays on I-26 eastbound results in the No Build.*

**** Although density reflects better LOS, the capacity of the segment is exceeded in the No Build resulting in substantial delays and queuing.*

## 9.2.2 Ramp Operations

In addition to the merges, diverges and weaves along the two interstate corridors, the TransModeler analysis was completed for specific ramp movements as shown in **Table 9.5**. The preferred alternative operates better than the No Build due to a combination of ramp widenings and the elimination of high-volume loop ramps. The preferred alternative operates at LOS C or better for all ramps in 2030 with an acceptable LOS D on three ramps in 2050. In contrast, the No Build has two ramps operating at LOS F in 2030 and four ramps operating at LOS E or F in 2050. In some cases, ramp volumes are also constrained in the No Build resulting in congestion impacts to adjacent segments.

There is one exception (Ramp 1) where the 2050 No Build LOS is better than the 2050 preferred alternative scenario (LOS E). This discrepancy is a result of merging and diverging issues discussed in Section 9.2.1 affecting flows due to metering as well as queuing. A comparison of the No Build and preferred alternative simulations at Ramp 1 indicates:

- In the No Build, the ramp from I-26 eastbound to I-95 southbound is a single lane. Since one lane is inadequate to serve the demand, the eastbound diverge from I-26 serves as a bottleneck creating a queue back onto I-26 eastbound. Downstream of this bottleneck (i.e. on the ramp), a reduced volume of traffic is served, speed increases, and density is reduced. The lower density and better LOS on this one-lane ramp compared to the Build reflects congestion on I-26 restricting flow that reaches the ramp.
- In the Build scenario with the preferred alternative, the Segment 1 ramp is widened to two lanes. With the two lane section, the bottleneck at the I-26 eastbound diverge is removed. Despite the widened section, the TransModeler results show a LOS F on the ramp in 2050 with a high density. The reason for this is that the ramp is operating upstream of a bottleneck at the I-95 southbound merge. As a result, more traffic enters onto the ramp than can be processed at the southern end of merge with I-95.

In addition to the basic ramp sections, the proposed preferred alternative has four shared ramp segments at the exit and entrances of the two proposed flyovers. Since these segments have combined ramp volumes, the laneage can be more than the ramps being separated or merged together. **Table 9.6** illustrates operations on these shared ramps. All shared ramp sections will operate at LOS D or better in 2050. No comparison with the No Build is applicable since shared ramps are not included in the existing interchange layout.

### Table 9.5: TransModeler No Build & Preferred Alternative Ramp Capacity

| Ramp Description | | # Lanes | Density (pcpmpl) \| LOS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2022 Existing | | 2030 No Build | | 2030 Build Preferred Alt | | 2050 No Build | | 2050 Build Preferred Alt | |
| 1 | I-26 EB to I-95 SB | 1 lane Ramp - NB<br>2 lane Ramp - Pref Alt | 43.0 | E | 48.7 | F | 20.4 | C | 44.1** | F | 121.3*** | F |
| 2 | I-95 SB to I-26 EB | 1 lane Loop - NB<br>1 lane Flyover – Pref Alt | 29.2 | D | 33.4 | D | 20.4 | C | 47.1 | F | 28.6 | D |
| 3* | I-26 EB to I-95 NB | 1 lane Loop | 1.2 | A | 2.1 | A | 1.3 | A | 2.1 | A | 1.4 | A |
| 4 | I-95 NB to I-26 EB | 1 lane Ramp | 6.1 | A | 7.2 | A | 7.6 | A | 6.6 | A | 9.3 | A |
| 5 | I-26 WB to I-95 NB | 1 lane Ramp | 21.6 | C | 24.6 | C | 21.7 | C | 36.7 | E | 33.2 | D |
| 6 | I-95 NB to I-26 WB | 1 lane Loop – NB<br>2 lane Flyover – Pref Alt | 62.6 | F | 75.8 | F | 20.1 | C | 87.5 | F | 29.3 | D |
| 7* | I-26 WB to I-95 SB | 1 lane Loop | 7.4 | A | 10.6 | A | 8.0 | A | 12.6 | B | 11.1 | B |
| 8 | I-95 SB to I-26 WB | 1 lane Ramp | 0.9 | A | 1.1 | A | 1.1 | A | 1.5 | A | 1.3 | A |

** Ramps 7 and 3 are loops in Alternative 1 and 2. Alternative 3 replaces Loop 7 with a fly-over ramp.*
*** The 2050 No Build analysis of Ramp 1 reflects an upstream bottleneck on I-26 restricting flow onto the existing one lane ramp. The metering results in fewer vehicles and lower densities being served by the ramp and queuing back onto I-26 eastbound.*
****The 2050 Build analysis of Ramp 1 reflects a downstream bottleneck occurring at the merge of Ramp 1 with I-95 southbound due to inadequate capacity on I-95. The queuing from this bottleneck backs onto Ramp 1 resulting in restricted flow, queuing, and increased density.*

### Table 9.6: TransModeler Shared Ramp Capacity

| Shared Ramp Description | | Number of Lanes | 2030 Build Preferred Alt | | 2050 Build Preferred Alt | |
|---|---|---|---|---|---|---|
| 1 | I-95 NB to I-26 | 3 | 19.9 | C | 29.4 | D |
| 2 | I-95 to I-26 EB | 2 | 12.8 | B | 18.6 | C |
| 3 | I-95 SB to I-26 | 1 | 19.9 | C | 30.6 | D |
| 4 | I-95 to I-26 WB | 3 | 13.6 | B | 22.3 | D* |

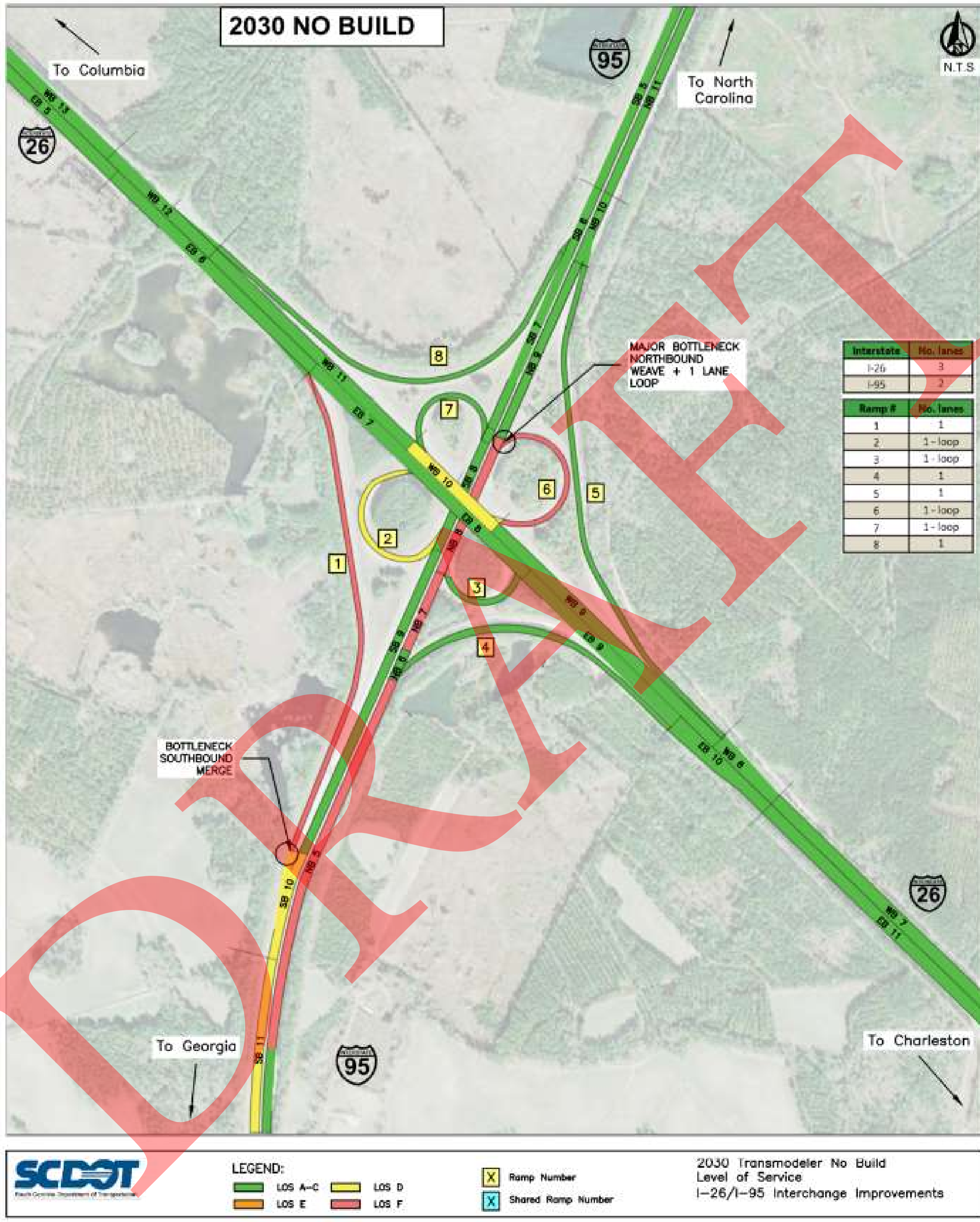
** Although density would indicate LOS C, high concentration of volume on flyover Ramp 6 controls flow and LOS.*

## 9.2.3 Summary of TransModeler LOS Results

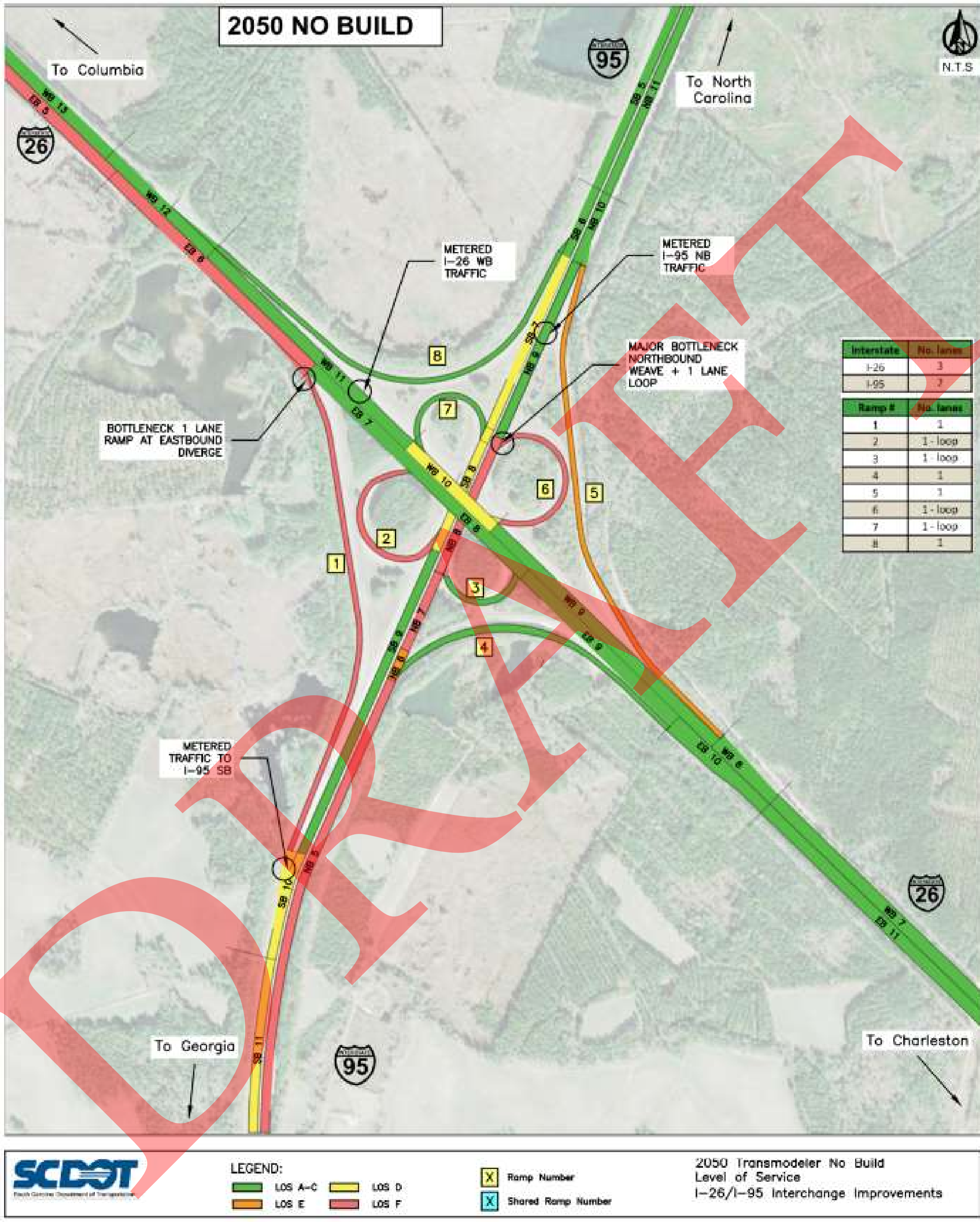
Utilizing the data from Table 9.1 through Table 9.6, a colored illustration of the interchange was developed for both the No Build and the Preferred Alternative in 2030 and 2050. These illustrations utilize the color coding first introduced in Section 6.1 to represent LOS A (low levels of congestion – green) to LOS F (very high congestion and unstable flow – red). Key bottlenecks in each scenario are also identified. The scenarios and corresponding figures are:

- 2030 No Build (**Figure 9.1**)
- 2050 No Build (**Figure 9.2**)
- 2030 Build Preferred Alternative (**Figure 9.3**)
- 2050 Build Preferred Alternative (**Figure 9.4**)

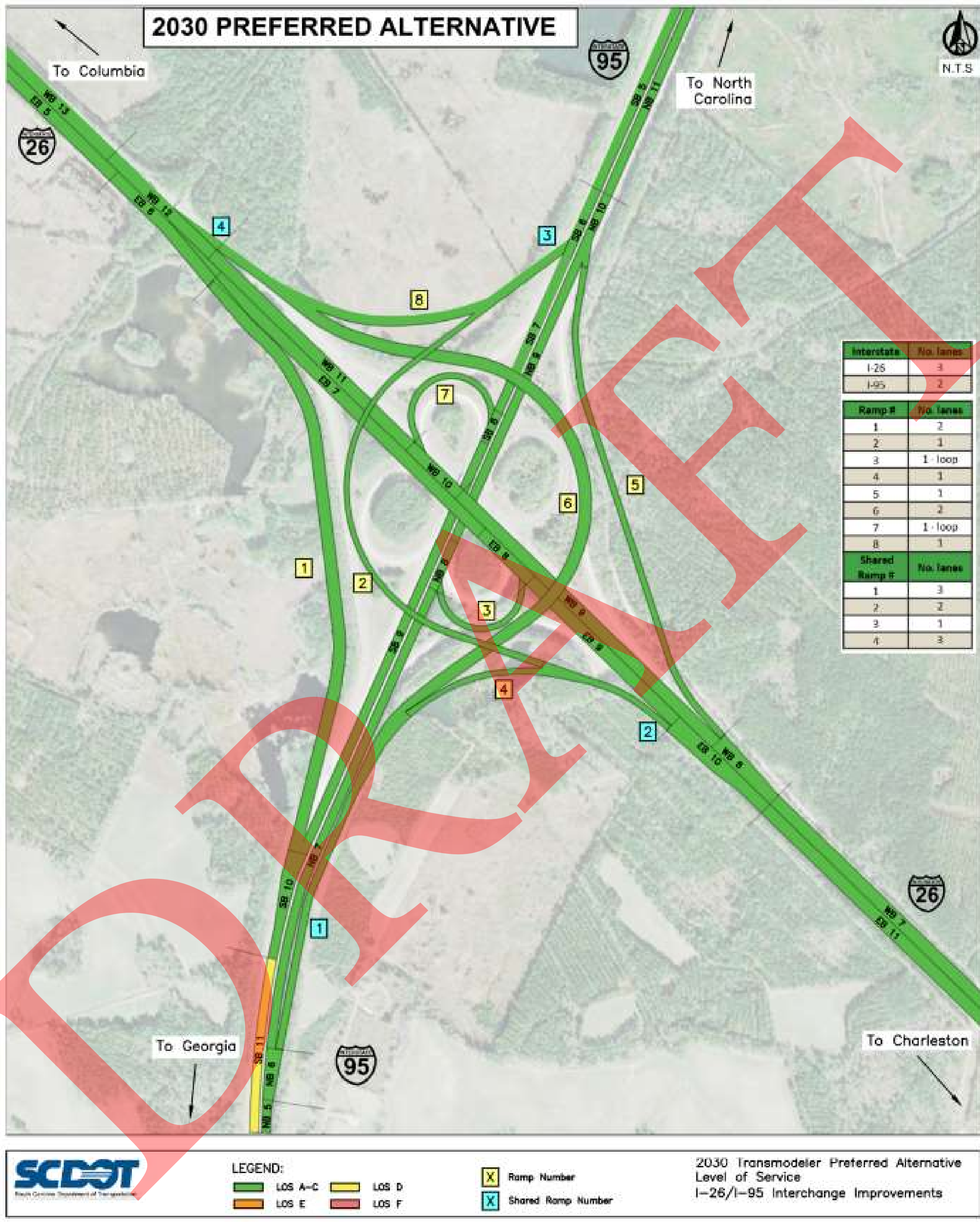
## Figure 9.1: TransModeler LOS Results 2030 No Build



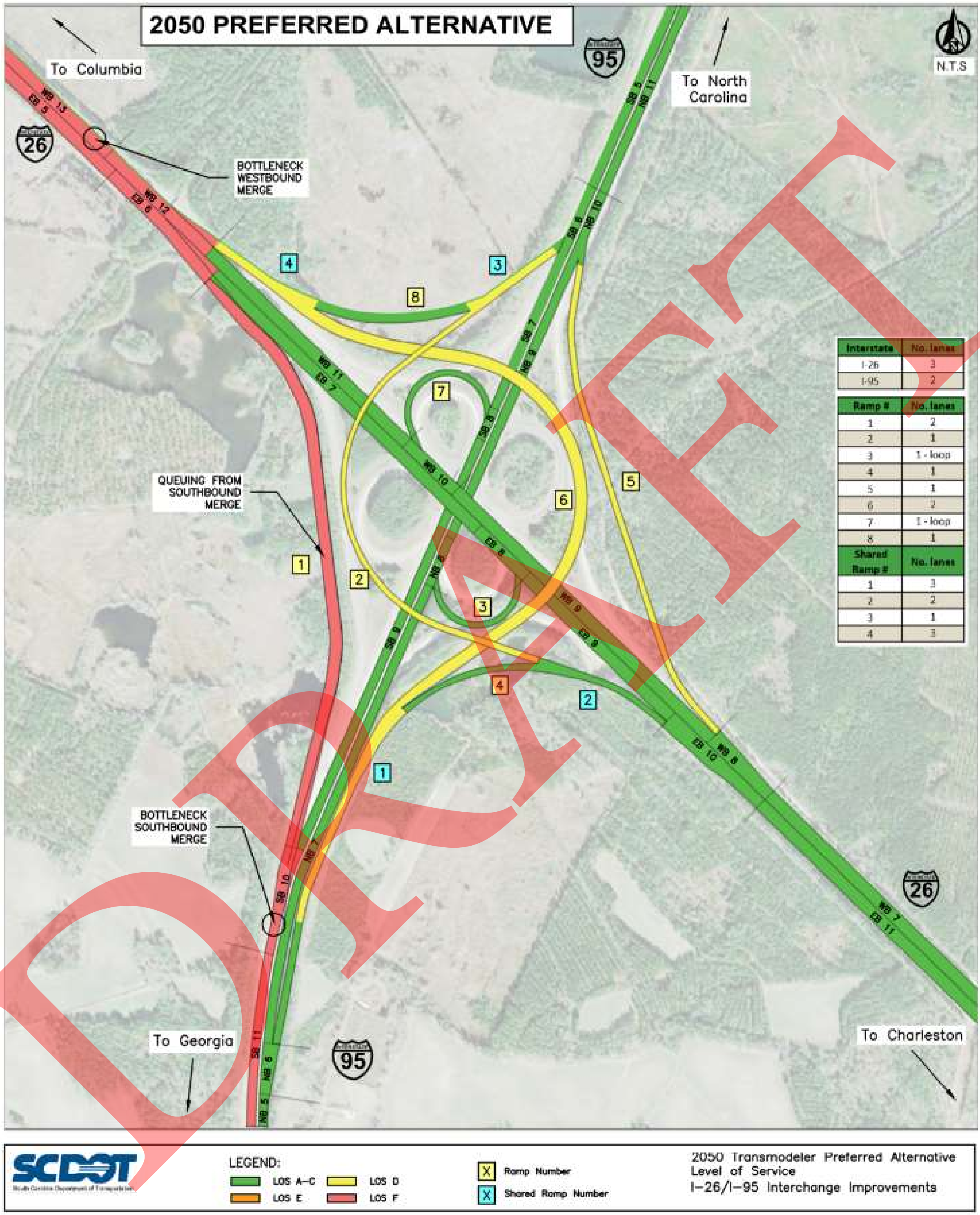
## Figure 9.2: TransModeler LOS Results 2050 No Build



## Figure 9.3: TransModeler LOS Results 2030 Build Preferred Alternative



## Figure 9.4: TransModeler LOS Results 2050 Build Preferred Alternative



### 9.2.4 Travel Times & Average Travel Speed through Corridor

In order to examine overall flow through the network, travel times and speed for 12 movements through the entire network were examined. The length of each movement varied but in general ranged from 6 to 8 miles. This measure can give insights into overall operations instead of focusing on just a single segment or merge/diverge point. At the same time, it also reflects the impacts that a single merge or diverge point may have on other segments either due to heavy queuing or metered flows allowing for improved operations once a bottleneck is passed.

**Table 9.7** illustrates the travel times through the corridor for both the No Build and Build scenarios as well as the time saved with the preferred alternative in place. **Table 9.8** illustrates the average travel speed on the same 12 travel paths, averaging the travel time of the distance traveled. Key observations include:

- Starting from west of SC 210, eastbound traffic can save between 6 and 7 minutes compared with the No Build depending upon their path. The most savings are noticed by vehicles travelling to I-95 to the north or I-26 east, primarily as a result of queuing near the weave section and blockage of the loop to the north due to I-95 northbound queues. The move to I-95 southbound has the lowest time savings, likely due to the queuing issues at the I-95 southbound merge.
- Starting from I-26 east of U.S. 15, westbound traffic experiences an increase in travel time in each direction. This is due to traffic on the northeast quadrant loop being metered in the No Build resulting in lower volumes on I-26 itself.
- Starting from south of U.S. 178, I-95 northbound traffic has the most reduction in travel times through the corridor with between 17 and 20 minutes of travel time savings in all directions. The key reason is the replacement of the northeast quadrant loop with a two-lane flyover. In addition to directly impacting the move to I-26 westbound, the replacement of the loop and elimination of the weave reduces queuing on I-95 northbound that spills back to the south impacting both the I-95 through movement and the ramp to the east on I-26.
- Starting from I-95 north of U.S. 176, I-95 southbound traffic also has limited travel time benefit and, in some cases, have longer travel times by up to 2 minutes. For the through movement on I-95, the additional time is due to congestion at the I-95 southbound merge. In the No Build, the one lane ramp from I-26 eastbound to I-95 southbound causes delays at the exit point to the ramp on I-26, but the metered flows improve operations at the southbound merge point. For the traffic bound to I-26 westbound, the slightly longer travel time is due to the I-26 westbound merge. In the No Build, this merge is less critical since the loop in the northeast quadrant is limited in the volume of traffic it can carry and meters flow to the west.

- The results of the average travel speed summary in Table 9.8 reflects these same trends. Traffic originating from the south on I-95 have the highest increase in average travel speeds with an increase of between 14 mph to 27 mph on the three trip destinations. Similarly, travel originating from the west on I-26 also have an increase of average travel speed from between 6 mph to 18 mph. For traffic from the east on I-26 and north on I-95, the preferred alternative speeds are slower by 0 mph to 7 mph. As explained, the key reason is that these trip patterns avoid the highest delays and queuing and have a hidden benefit of metered traffic not being able to access their preferred path.

## Table 9.7: TransModeler No Build & Preferred Alternative Travel Time Results

| Travel Time Segment | | Travel Time (mm:ss) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Start | End | 2022 Existing | 2030 No Build | 2030 Build Preferred Alt | Time Diff | 2050 No Build | 2050 Build Preferred Alt | Time Diff |
| I-26 Eastbound, West of S.C. 210 | I-26 Eastbound, East of U.S. 15 | 08:15 | 08:12 | 08:05 | -00:07 | 23:49 | 10:45 | -13:04 |
| | I-95 Northbound, North of U.S. 176 | 10:56 | 11:05 | 10:50 | -00:15 | 26:43 | 13:30 | -13:13 |
| | I-95 Southbound, South of U.S. 178 | 09:24 | 09:30 | 09:09 | -00:20 | 25:02 | 17:49 | -07:13 |
| I-26 Westbound, East of U.S. 15 | I-26 Westbound, West of S.C. 210 | 08:15 | 08:12 | 06:37 | -01:34 | 08:30 | 09:39 | 01:09 |
| | I-95 Northbound, North of U.S. 176 | 08:59 | 09:02 | 08:52 | -00:10 | 09:16 | 09:04 | -00:12 |
| | I-95 Southbound, South of U.S. 178 | 08:08 | 08:14 | 08:01 | -00:13 | 08:29* | 10:22 | 01:53 |
| I-95 Northbound, South of U.S. 178 | I-26 Eastbound, East of U.S. 15 | 07:24 | 07:36 | 07:33 | -00:04 | 25:40 | 07:43 | -17:57 |
| | I-26 Westbound, West of S.C. 210 | 10:01 | 10:35 | 08:24 | -02:12 | 29:09 | 11:30 | -17:39 |
| | I-95 Northbound, North of U.S. 176 | 09:40 | 10:19 | 09:17 | -01:01 | 28:39 | 09:28 | -19:11 |
| I-95 Southbound, North of U.S. 176 | I-26 Eastbound, East of U.S. 15 | 09:33 | 09:34 | 09:18 | -00:15 | 09:44 | 09:36 | -00:09 |
| | I-26 Westbound, West of S.C. 210 | 10:16 | 10:17 | 08:43 | -01:34 | 10:27* | 11:53 | 01:26 |
| | I-95 Southbound, South of U.S. 178 | 09:38 | 09:47 | 09:39 | -00:08 | 09:54* | 11:57 | 02:03 |
| **Total Time & Time saved compared to No Build** | | **1:50:30** | **1:52:23** | **1:44:29** | **0:07:54** | **3:35:23** | **2:13:15** | **-1:22:08** |

** Lower volumes served in No Build due to upstream metering caused by congestion.*

## Table 9.8: TransModeler No Build & Preferred Alternative Average Speed Results

| Travel Time Segment | | Average Speed (mph) | | | | | |
|---|---|---|---|---|---|---|---|
| Start | End | Associated Ramp | 2022 Existing | 2030 No Build | 2030 Build Preferred Alt | 2050 No Build | 2050 Build Preferred Alt |
| I-26 Eastbound, West of S.C. 210 | I-26 Eastbound, East of U.S. 15 | - | 68 | 68 | 69 | 40 | 58 |
| | I-95 Northbound, North of U.S. 176 | 3 | 68 | 67 | 68 | 45 | 60 |
| | I-95 Southbound, South of U.S. 178 | 1 | 66 | 66 | 66 | 40 | 46 |
| I-26 Westbound, East of U.S. 15 | I-26 Westbound, West of S.C. 210 | - | 68 | 69 | 70 | 66* | 60 |
| | I-95 Northbound, North of U.S. 176 | 5 | 67 | 67 | 67 | 65* | 66 |
| | I-95 Southbound, South of U.S. 178 | 7 | 67 | 66 | 67 | 64* | 58 |
| I-95 Northbound, South of U.S. 178 | I-26 Eastbound, East of U.S. 15 | 4 | 68 | 67 | 66 | 38 | 65 |
| | I-26 Westbound, West of S.C. 210 | 6 | 66 | 65 | 65 | 42 | 56 |
| | I-95 Northbound, North of U.S. 176 | - | 68 | 66 | 68 | 48 | 67 |
| I-95 Southbound, North of U.S. 176 | I-26 Eastbound, East of U.S. 15 | 2 | 67 | 67 | 66 | 66* | 65 |
| | I-26 Westbound, West of S.C. 210 | 8 | 68 | 68 | 67 | 67* | 60 |
| | I-95 Southbound, South of U.S. 178 | - | 69 | 68 | 68 | 67* | 62 |
| | **Average Speed** | | **67** | **67** | **67** | **54*** | **60** |

** Lower volumes served in No Build due to upstream metering caused by congestion.*

## 9.2.5 Interim Year Analysis of the I-95 Southbound and I-26 Westbound Merges

As noted, the I-95 southbound merge and the I-26 westbound merge points are the two key congestion points and are both anticipated to operate at LOS F in the 2050 design year. This analysis is intended to illustrate the operations for not just 2030 and 2050, but also for each five-year increment (2035, 2040 and 2045). The analysis focuses on the preferred alternative.

Additional traffic analysis was conducted to examine operations for interim years at these key merge points between 2030 and 2050.

***I-26 Westbound Merge***

For the I-26 westbound merge, the proposed two-lane flyover from I-95 northbound must merge with the future three westbound I-26 lanes. As documented, a 4,000-foot merge is proposed – 1,500 feet to merge in the first lane and 2,500 feet for the second lane (effectively merging five lanes into three lanes). A key assumption in this analysis is that I-26 is widened to six lanes from the current four lane section.

**Table 9.9** provides a comparison of operations on multiple segments of both the ramp and I-26 through the I-26 westbound merge. As indicated in previous summaries, the merge is forecast to operate at LOS C in 2030 and at LOS F in 2050. Examining the interim years provides some key insights:

- The ramp from eastbound I-95 carries higher volumes than the I-95 southbound flow approaching the merge. This reflects the observation that the movement between I-26 to the west (Columbia) to/from I-95 to the south (Georgia) is the highest demand volume in the interchange area.
- Congestion is observed in 2045 and 2050. Specifically:
  - The operations of the merge area are relatively uncongested through 2040 (LOS C and 65 mph).
  - By 2045, however, the final three lane bottleneck operates at LOS F with speeds reduced to 25 mph. Congested operations, however, are focused on this segment and have not resulted in backup into the upstream segments.
  - By 2050, congested operations are noted in both the five lane (LOS E and 36 mph) and four lane (LOS F and 26 mph) merge segments. LOS D is observed on the ramp with minimal queuing. This matches the previous analysis where a 4,000-foot merge was deemed the minimum applicable merge length to prevent queuing back onto the flyover.

- As noted, this section is planned for widening from four to six lanes by 2030. This is the primary reason congestion is less at this location than the I-95 southbound merge (which has similar volumes). Widening beyond six lanes is not currently anticipated for I-26.
- Provision of an auxiliary lane to the SC 210 interchange would reduce potential for queuing back into the interchange. At the same time, it would not provide a true solution – ultimately the three-lane section would be reached. Since SC 210 does not have a substantial volume of traffic exiting, it does not seem efficient to provide an auxiliary lane.

As demonstrated, the westbound merge is anticipated to operate at LOS F in 2050 and will see substantial congestion by 2045. The solution to this issue, however, is not achievable by improvements to the interchange ramps or layout. Nevertheless, the improvements provided by the preferred alternative are still recommended as needed to improve overall flow, including travel onto I-26 westbound from I-95 northbound. As noted, the movement between I-26 to the west (Columbia) and I-95 to the south (Georgia) is the highest volume movement at this interchange, higher than the through movements on both I-26 and I-95. TransModeler output for the I-26 westbound merge with the Build preferred alternative year of failure analysis is provided in **Appendix R.**

### ***I-95 Southbound Merge***

For the I-95 southbound merge, the proposed two-lane widened ramp must merge with the two I-95 southbound merge lanes. As documented, a 5,000-foot merge is proposed – 2,500 feet to merge in the first lane and 2,500 feet for the second lane (effectively merging four lanes into two lanes). As noted, however, the four lane I-95 does not provide adequate capacity in 2050 (south of the I-26 interchange) and there are no widening projects currently planned for I-95.

**Table 9.10** provides a comparison of operations on multiple segments of both the ramp and I-95 through the I-95 southbound merge. As indicated in previous summaries, the merge is forecast to operate acceptably in 2030 and at LOS F in 2050. Examining the interim years provides some key insights:

- The ramp carries higher volumes than I-95 approaching the merge.
- The ramp from I-26 eastbound degrades sooner with LOS D in 2040 quickly degrading to LOS F by 2045. A key measure is the travel speed on the ramp which decreases from 41 mph to 10 mph between 2030 and 2035. Note that the congestion and slowdowns are a result of spillback from the merge – if the ramp were in isolation it would operate at LOS D.

## Table 9.9: TransModeler Preferred Alternative I-26 Westbound Merge Year of Failure Analysis

| Segment Description | Segment Type | # of Lanes | Density (pcpmpl) \| LOS \| Speed (mph) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2030 Build Preferred Alternative | | | 2035 Build Preferred Alternative | | | 2040 Build Preferred Alternative | | | 2045 Build Preferred Alternative | | | 2050 Build Preferred Alternative | | |
| I-95 to I-26 Westbound | Ramp | 2 | 20.1 | C | 49 | 22.1 | C | 49 | 23.7 | C | 48 | 25.0 | C | 48 | 29.3 | D | 48 |
| Between Ramps | Basic | 3 | 8.6 | A | 71 | 9.7 | A | 71 | 10.7 | A | 70 | 11.7 | B | 71 | 12.8 | B | 70 |
| On-Ramp from I-95 NB + SB | Merge | 5 | 14.0 | B | 67 | 14.9 | B | 66 | 16.9 | B | 65 | 18.5 | B | 65 | 47.4 | E | 36 |
| West of I-26/I-95 System Interchange | Basic | 4 | 13.8 | B | 69 | 15.6 | B | 68 | 17.0 | B | 68 | 18.5 | B | 67 | 78.6 | F | 26 |
| | | 3 | 19.0 | C | 67 | 21.4 | C | 66 | 24.0 | C | 65 | 68.0 | F | 25 | 99.7 | F | 16 |

## Table 9.10: TransModeler Preferred Alternative I-95 Southbound Merge Year of Failure Analysis

| Segment Description | Segment Type | # of Lanes | Density (pcpmpl) \| LOS \| Speed (mph) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2030 Build Preferred Alternative | | | 2035 Build Preferred Alternative | | | 2040 Build Preferred Alternative | | | 2045 Build Preferred Alternative | | | 2050 Build Preferred Alternative | | |
| I-26 Eastbound to I-95 Southbound | Ramp | 2 | 20.4 | C | 48 | 22.2 | C | 47 | 29.0 | D | 41 | 101.6 | F | 10 | 121.3 | F | 7 |
| North of I-26 EB Merge | Basic | 2 | 16.3 | C | 68 | 15.2 | B | 68 | 19.1 | C | 66 | 22.3 | C | 57 | 23.2 | C | 54 |
| On-Ramp from I-26 Eastbound | Merge | 4 | 20.3 | C | 62 | 22.4 | C | 61 | 53.2 | E | 32 | 99.7 | F | 12 | 110.5 | F | 10 |
| South of I-26/I-95 Interchange | Basic | 3 | 20.2 | C | 67 | 21.8 | C | 65 | 76.5 | F | 17 | 119.4 | F | 11 | 125.0 | F | 11 |
| | | 2 | 30.5 | D | 66 | 33.0 | D | 66 | 33.2 | D | 62 | 33.3 | D | 61 | 33.4 | D | 61 |

- The I-95 southbound mainline section approaching the merge is anticipated to operate at LOS C into 2050. Nevertheless, the impact of the queue congestion is reflected primarily by a decrease in speed of 66 mph in 2040 (still relatively uncongested) to 57 mph in 2045 and 54 mph in 2050.
- The key impacts and degraded flow are observed in the merge section. For this analysis, TransModeler was used to examine operations in both the initial four lane merge (where the two-ramp lane and two I-95 lanes come together), the following three lane segment and then the final two-lane segment. Note that all traffic on I-95 and the ramp are impacted in these segments.
  - The first portion of the merge section is the four-lane segment which ultimately merges down to three lanes. In 2035, this section is still operating acceptably (LOS C and 61 mph), but it degrades by 2040 (LOS E and 32 mph). In 2045, the density increases substantially from 2040 and speeds reach 12 mph. The 2050 results are similar to 2045 at the merge which is indicative that the merge area is saturated, and queues are extending further back.
  - The key bottleneck is observed in the three-lane segment (more precisely, the bottleneck is at the point where the two-lane segment is reached so the delay is observed in the three-lane segment). This section is expected to degrade rapidly between 2035 (LOS C and 65 mph) to 2040 (LOS F and 17 mph). Flow continues to degrade, with density increasing between 2040 and 2045 (reflective of more stop and go operations) and decreasing in speed to 11 mph.
  - South of the merge section, the analysis shows LOS D through 2050. This is misleading in that the merge point is a bottleneck. As traffic queues north of the bottleneck, the flows south of the bottleneck are metered resulting in the LOS D operations.

As demonstrated, the southbound merge is anticipated to operate at LOS F in 2050 and will see substantial congestion by 2040. The solution to this issue, however, is not achievable by improvements to the interchange ramps or layout. Instead, it is recommended that widening of I-95 south of the I-26 interchange be considered as part of future projects. Nevertheless, the improvements provided by the preferred alternative are still recommended as needed to improve overall flow, including travel onto I-95 southbound from I-26 west of I-95. As noted, the movement between I-26 to the west (Columbia) and I-95 to the south (Georgia) is the highest volume movement at this interchange, higher than the through movements on both I-26 and I-95. TransModeler I-95 southbound merge output for the Build preferred alternative year of failure analysis is provided in **Appendix R.**

# 10. INTERCHANGE MODIFICATION REPORT

## 10.1 Design Exceptions & Operational Deficiencies

No formal design exceptions are being requested or planned for the proposed I-26 at I-95 interchange improvements project.

In terms of the preferred design level of service and operations, there are some features that operate at an acceptable but not a preferred level of service. In general, the preferred 2050 level of service for this project is LOS C, although LOS D is deemed acceptable. LOS D operations are identified in 2050 at the following ramps:

- The proposed two-lane flyover from I-95 northbound to I-26 westbound will operate at LOS D in 2050. Widening to three lanes would introduce multiple issues in terms of lane balance and driver expectations.
- The relocated and widened two-lane ramp from I-26 eastbound to I-95 southbound will operate at LOS D in 2050. Similar to the opposing flyover, widening this section to three lanes would introduce multiple issues related to lane balance and driver expectations.
- The relocated one lane ramp from I-26 westbound to I-95 northbound operates at LOS D in 2050 (two-lanes required for LOS C or better).
- The proposed one lane flyover from I-95 southbound to I-26 eastbound operates at LOS D in 2050 (two lanes required for LOS C or better).

It is also noted that capacity constraints with LOS F operations in 2050 are anticipated on both I-26 and I-95 if the existing four lane sections on each facility is not widened before 2050.

- I-26 has already been identified for widening as part of SCDOT's 2021-2027 Statewide Transportation Improvement Program (STIP). Therefore, both the No Build and Build analyses assume a future six-lane section is provided on I-26 through the study area. Even with the six-lane section on I-26, the westbound merge area is expected operate at LOS F in 2050. To minimize queuing impacts, a 4,000-foot merge area has been identified for this two-lane merge.
- I-95 is anticipated to operate over capacity with queuing and stop and go operations in the 2050 PM peak period, if the existing four lane section is not widened. No widening of I-95 is currently planned or scheduled in the current plans. For this analysis, the following findings and assumptions for I-95 include:
  - Southbound on I-95, analysis was conducted to provide a design that would minimize the frequency and extent of queuing on I-95. As a result, a 5,000-foot merge south of the proposed interchange was identified in Chapter 8.

Nevertheless, queuing is still anticipated in the southbound direction due to the two-lane limitation on I-95.

- Northbound on I-95, I-95 will bottleneck resulting in metering of new traffic entering into the interchange from the south. For this analysis, the TransModeler network was theoretically assumed to be three lanes to confirm that the simulation analysis included the forecasted traffic volumes.
- Although widening of I-95 is not in the current plan for implementation by 2050, testing was performed for operations in 2050 if I-95 was widened south of the I-26 at I-95 interchange. The proposed interchange design (including the proposed I-95 southbound merge configuration) would operate at an acceptable LOS in 2050. Note, however, that widening of I-95 to the south is a future corridor level improvement and not just needed in the immediate vicinity of the I-26 at I-95 interchange.

- Despite the 2050 scenario having operational deficiencies for some movements, the analysis confirms that all Build Alternatives considered improve operations as compared with the No Build. Key improvements include widening of two key ramps, elimination of four weave sections impacting I-26 and I-95 in all four directions, and improvement of major merge, particularly on I-95 south of the interchange and I-26 west of the interchange.

## 10.2 FHWA Policy Points

FHWA policy requires that all requests for new or revised access to an interstate facility must provide sufficient supporting information to allow FHWA to independently evaluate the request. The FHWA decision to approve a request requires documentation of two key policy points. Note that Policy Point 1 is divided into three key issues: Operations & Safety, Adjacent Interchanges, and Crossroads. Policy Point 2 focuses on partial access interchanges which would not apply to the proposed interchange configuration. The policy points are addressed in **Table 10.1**.

**Table 10.1: Responses to FHWA Policy Points**

***Policy Point 1 – Operations & Safety***

***"An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, and ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections."***

The proposed revisions and modifications to the existing I-26 at I-95 interchange will have an overall positive impact on both traffic safety and the operations of I-26, I-95 and the I-26 at I-95 interchange overall. Key improvements in the preferred alternative include:

***Widening of Key Ramps***

The two highest volume movements within the interchange are between I-26 to the west toward Columbia and I-95 to the south toward Georgia with approximately 4,400 vph (both directions combined) in the 2050 peak period. This movement is currently served by a single lane ramp in the eastbound to southbound direction and a single lane loop ramp in the returning direction. The preferred alternative replaces the existing ramps with a two-lane ramp in the eastbound to southbound direction and a two-lane flyover for northbound to westbound traffic. In addition, the diverge and merge areas for these widened ramps are converted to two lanes at each of the ramp tie-ins to I-26 and I-95. These changes improve traffic operations and level of service to an acceptable LOS D (from LOS F) and increase design speeds (particularly related to elimination of the existing loop in the northeast quadrant).

***Elimination of Weaves on I-26 and I-95***

The current interchange configuration is a full cloverleaf with loops in all four quadrants. This type of interchange allows for free flow for all turning movements (no stops or signals) as is required for an interstate-to-interstate system interchange. By 2050, however, the weave areas between loop ramps will degrade resulting in queuing and delays on the freeway segments. The issue affects each of the weave areas in the main interchange, in particular the weave along I-95 northbound which operates at LOS F in 2030. Also note that the four weave areas were all identified as part of the crash and safety analysis as having a high frequency of crashes in Table 3.10. The elimination of the four weaves improves operations and safety for both ramp traffic and through vehicles on I-26 and I-95.

***Improvement of Major Merge Areas***

Two major weave areas are proposed to be widening from a single lane merge to dual lane merges on I-26 westbound and I-95 southbound. The capacity improvements are key to improving flow in the future, but it is still anticipated that there will be queuing and operational issues by 2050, in particular for the I-95 southbound merge. In addition to the 2030 and 2050 analysis, interim year operations were examined in 5-year increments. The primary reason for the operational issues at the merge is the future need to widen I-95 south of I-26.

To minimize the future impact of these flow issues, the merge areas have been lengthened in accordance with recommendations from the Institute of Transportation Engineers (ITE) *Freeway and Interchange Geometric Design Handbook* as discussed in Section 8.3.2. Even with these caveats, the proposed ramp improvements substantially improve traffic operations as compared with the No Build interchange.

Safety is improved at the major merge areas being improved. The I-95 southbound merge is the highest frequency crash location in the study area as shown in Table 3.10 primarily due to rear end crashes likely resulting from queues at the merge congestion point onto I-95. The I-26 westbound merge improvements is also identified as a crash hot spot in Figure 3.2.

***Other Safety Recommendations***

As part of the safety analysis in Chapter 3, three safety recommendations were identified and detailed in Section 3.7. These included elimination of the weave areas as well as improvements at high volume merge areas (especially at the I-95 southbound merge due to capacity constraints on I-95) that are noted above.

In addition, the analysis of fatal crashes indicated that multiple fatal crashes on I-26 in the study area (8 of 11 fatal crashes) ultimately involved a vehicle impacting a tree off the edge of the road. To minimize this, the proposed design should consider the elimination of trees in the clear zones on both the outer and inner (i.e., the median) sides of I-26 in both directions.

***Policy Point 1(continued) – Adjacent Interchanges***

***"The analysis should, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (Title 23, Code of Federal Regulations (CFR), paragraphs 625.2(a), 655.603(d) and 771.111(f))."***

The study area and network limits examined in this analysis include four interchanges on each approach to the system interchange. Despite the interchange being located in a rural area, the adjacent interchanges were included in recognition of the key regional importance and high volumes along both I-26 and I-95. Each of these interchanges are spaced more than two miles from I-26 at I-95 interchange as noted below. The four interchanges are detailed in Section 1.3.3 and include:

- I-95 at U.S. 176 Old State Road (Exit 90): 4 miles to the north
- I-95 U.S. 178 Charleston Highway (Exit 82): 2.9 miles to the south
- I-26 at S.C. 210 Vance Road (Exit 165): 3.2 miles to the west
- I-26 at U.S. 15 (Exit 172): 2.4 miles to the east

The HCS analysis in Section 6.2 included freeway operations analysis for each of the four interchanges. As part of the traffic forecasting, however, all four interchanges were identified as serving relatively low volume facilities (maximum 2021 AADT of 3,000 vpd was noted) and low historical and forecasted annual growth rates.

Based on the analysis, it was concluded that the adjacent interchanges are not adversely impacted by the proposed improvements at the I-26 at I-95 interchange. Key observations included:

- The freeway operations analysis indicated that ramp operations were not critical in either 2030 or 2050.

- It was noted that I-95 requires future widening south of I-26 (LOS F in 2050) which would address any merge or diverge improvement needs. Similarly, some LOS E operations were noted on I-26 west of I-95 in 2050 even with a six-lane segment. To address potential modeling issues associated with downstream bottlenecks impacting flows into the key interchange with the TransModeler network, theoretical widening assumptions were applied as detailed in Chapter 8.

Since the operations at the four interchanges do not require future capacity improvements and are spaced more than two miles on all approaches to the I-26 at I-95 interchange, the specific operations are not critical to this IMR. All four adjacent interchanges were included in the TransModeler simulation models to provide proper flow patterns into the interchange.

***Policy Point 1(continued) – Crossroads& Local Street Network***

***"The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, should be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d))."***

The local road network at each of the four adjacent interchanges was examined as part of the traffic forecasting process discussed in Chapter 4 and detailed in Appendix D. Key observations included:

- All four interchanges have low AADT volumes based on 2021 AADT data (3,000 vpd or less).
- Growth rates are low at the three diamond interchanges (SC 210, U.S. 176 and U.S. 178) which is reflective by the historical trends noted in both historical AADT volumes and land use patterns for Orangeburg County. In addition, at each of the three diamond interchanges, no traffic signals are currently in place and are not anticipated in the future based on the forecast traffic growth rates and volumes.
- For the existing full cloverleaf interchange at U.S. 15, a higher growth rate was noted likely reflected of the regional nature of the highway flow. Nevertheless, the increase in volumes was minimal due to the low existing volumes. The HCS freeway operations capacity analysis confirmed the adequacy of the weaves (LOS C in 2050) on I-26.

Based on these observations, a formal capacity analysis of the local road network and intersection operations was not conducted since it would not impact traffic flows or design requirements at the I-26 at I-95 interchange. The adjacent interchanges were included in the TransModeler network, however, to better reflect flows loading into the study interchange.

| ***Policy Point 1 (continued) – Conceptual Signing Plan*** |
|---|
| ***"Requests for a proposed change in access should include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute, and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request should also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d))."*** <br><br> A conceptual signing plan is provided for the proposed interchange layout and is attached in Appendix S. The conceptual plan focuses on guide signs on the approaches to the interchange as well as guide signs at various ramp exits and splits. |

| ***Policy Point 2 – Provision of All Movements & Public Road Access*** |
|---|
| ***"The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access, such as managed lanes (e.g., transit or high occupancy vehicle and high occupancy toll lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a)(2), and 655.603(d)). In rare instances where all basic movements are not provided by the proposed design, the report should include a full-interchange option with a comparison of the operational and safety analyses to the partial-interchange option. The report should also include the mitigation proposed to compensate for the missing movements, including wayfinding signage, impacts on local intersections, mitigation of driver expectation leading to wrong-way movements on ramps, etc. The report should describe whether future provision of a full interchange is precluded by the proposed design."*** <br><br> The I-26 at I-95 interchange is a system interchange with all movements currently provided in a full cloverleaf configuration. The preferred alternative (Alternative 2) maintains and improves all movements including the provision of flyover ramps to replace some loop ramps. All new ramps (including two loops) will be reconstructed and will meet or exceed current design standards. Each of these movements are between I-26 and I-95 which are both public roads serving key national, regional, state and local network connections. |

# 11. CONCLUSIONS

The South Carolina Department of Transportation (SCDOT) proposes to improve the I-26 at I-95 System interchange in Orangeburg County, South Carolina. This project will be a full interchange improvement to address the operational deficiencies of the current full cloverleaf configuration. Key elements include removal of the four existing weaving sections (two on I-26 and two on I-95), provision of directional ramps for key movements, and improving overall operations. The interchange currently experiences congestion issues that are expected to worsen with proposed traffic growth.

This Interchange Modification Report (IMR) summarizes the traffic operations and safety analyses performed for the proposed interchange alternatives. After extensive analysis, it summarizes the traffic recommendations for the project including the identification of either Alternative 1 or 2 as the preferred alternative from a traffic analysis perspective. After additional planning analysis related to the environmental impacts, design requirements, and construction costs, Alternative 2 was selected as the Preferred Alternative. The report also includes responses answering the two key policy points from FHWA for modifying access to an existing interstate interchange.

## 11.1 Crash & Safety Analysis

Crash analysis of the study area is summarized in Chapter 3. The analysis shows that the total crash rate and the injury crash on both I-26 and I-95 are below the statewide average for similar rural interstate facilities. On I-26, however, it was noted that both the serious injury and fatal crash rate exceed the statewide average crash rates.

In addition to each corridor, the crash patterns at the existing I-26 at I-95 interchange were examined and five high frequency crash locations were noted including (in order of highest frequency):

- I-95 merge of ramp serving I-26 eastbound to I-95 southbound with the I-95 southbound mainline traffic – 55 crashes
- I-26 westbound weave – 46 crashes
- I-95 northbound weave – 41 crashes
- I-26 eastbound weave – 32 crashes
- I-95 southbound weave – 30 crashes

Examining each of these locations, some patterns were noted:

- The highest frequency of crashes occurs at the I-95 southbound merge with 65 percent of crashes being rear end crashes. Review of the crashes indicates that capacity constraint at the merge area as well as on I-95 likely result in stop and go conditions on I-95 that is not typical operations for a rural interstate.

- Similarly, the crash types in the I-95 weaves were primarily rear end crashes (70 to 80 percent) that is indicative of speed reduction and queuing related to capacity constraints.
- On I-26, the crash types were primarily a combination of angle and sideswipe crashes (50 to 60 percent) which is more typical for weave areas.

Examination of the fatal crashes on I-26 indicated a high percentage of fatal crashes ultimately involving impact of a vehicle with a tree. Review of aerials show a narrower clear zone on I-26 than I-95. In addition, trees are on both sides of I-26 including the median (although trees have been removed from some sections of the median).

The analysis also indicated that although Friday, Saturday and Sunday carry an average of 24 percent higher daily traffic volumes, each of these days has an average 130 percent higher frequency of crashes.

## 11.2 Traffic Forecast

Traffic forecasts were developed for the project based on multiple sources of data and analysis steps. Baseline traffic data were analyzed, and growth factors were applied to identify 2030 and 2050 traffic volumes for I-26, I-95 and study area interchanges. Some key elements of the analysis included:

- In determining the k percentages for I-26 and I-95, a review of the highest hourly volume data was conducted, focused on identifying the “knee of the curve”.
  - On I-26, a k-factor of 10.5 percent was selected reflecting the $78^{th}$ Highest Hourly Volume (HHV).
  - On I-95, a k-factor of 10.5 percent was also selected reflecting the $98^{th}$ HHV on I-95 (although the I-95 HHV is likely closer to the $150^{th}$ HHV if all holiday data for 2019 were available).
- Based on these observations, this forecast has been developed assuming a single mid-day peak period (approximately 3 PM to 4 PM) with peak flows in both directions on I-95 and I-26.
- Although there is variation in actual counts, the design period reasonably approximates a typical Friday afternoon in the spring for both I-26 and I-95.

The estimated peak hour volumes developed for this study are presented in Figure 4.2 (2022 Base Year), Figure 4.3 (2030), and Figure 4.4 (2050). The details of the traffic forecasting assumptions and methodologies is detailed in the Appendix D Traffic Forecast Technical Memorandum.

# 11.3 Capacity Analysis & Alternative Comparison

## 11.3.1 No Build

The future traffic conditions were evaluated for the proposed opening year of 2030 and design year of 2050. Given the high volumes and variability of traffic flows on both I-26 and I-95, it was determined in cooperation with SCDOT that although the preferred level of service (LOS) for operations on a rural interstate is typically LOS C, LOS D would be considered acceptable for the peak period of analysis at the I-26 at I-95 interchange. Both Highway Capacity Software (HCS) and TransModeler microsimulation software was used in analyzing traffic flows. The HCS analysis is summarized in Chapter 6 and the TransModeler analysis is in Chapter 7.

Another key factor in the future No Build and subsequent Alternative analyses is that I-26 has been identified and funding is being assigned for the widening of I-26 from four to six lanes through the study area. No widening or improvement project has been identified for I-95, so the future assumed typical section on I-95 remains two lanes in each direction for the 2030 and 2050 analyses. Note that the highest volume roadways at the interchange is on I-26 west of the interchange and on I-95 south of the interchange. Similarly, the heaviest volume of flow is between I-26 on the west (to/from Columbia) and I-95 to the south (to/from Georgia).

The analysis of the existing interchange was performed for future operations (2030 and 2050). Key observations of the No Build interchange include:

- The loop movement from I-95 northbound to I-26 westbound (as well as the ramp serving the reverse movement) will require widening to two-lane segments. With the widening LOS D operations would be anticipated.
- The loop movement from I-95 southbound to I-26 eastbound (and the reverse movement) requires two lanes each to reach LOS C, but it was determined that leaving these movements a single lane would allow for acceptable LOS D operations.
- I-95 southbound has substantial capacity constraints with LOS F anticipated in the peak periods. In the southbound direction, the capacity constraint results in queuing extending back into and through the study interchange (resulting in queues on I-26 eastbound). On I-95 northbound LOS F condition with queuing and operational issues, occur on I-95 mainline north to the northbound loop to I-26 westbound.
- The weave areas on both I-26 and I-95 are key constraints in traffic flow both in terms of capacity as well as safety and crashes. Removing the weave areas from both I-26 and I-95 are recommended. Nevertheless, loops can be effectively utilized as part of concept alternatives, especially the lowest volume

loops in the northwest quadrant (I-26 westbound to I-95 southbound) and the southeast quadrant (I-26 eastbound to I-95 northbound).

### 11.3.2 Comparison of Build Alternatives

Three Build Alternatives were examined using the same software and assumptions as the No Build in 2030 and 2050. Overall, the three alternatives have the following similarities and differences:

- The two highest volume loops are eliminated in all alternatives. The two replaced loops are the northeast quadrant (serving I-95 northbound to I-26 westbound traffic flows) and the southeast quadrant (serving I-95 southbound to I-26 eastbound). Each of these loops is replaced by higher speed flyover movements.
  - The removal of these two loops located in opposite (diagonal) quadrants effectively eliminates all four of the critical weave movements on both I-26 and I-95.
  - Alternative 3 removes a third loop in the northwest quadrant serving I-26 westbound to I-95 southbound and replaces it with a third flyover.
- Two-lane ramps are provided for the I-95 northbound to I-26 westbound movement as well as the return movement for all alternatives. The two-lane ramps are required for multiple reasons including the initial freeway diverge, the ramp movement itself, and the merge back into the final freeway link. In both cases, the two-lane ramp sections have adequate capacity, but the 2050 merges with I-95 and I-26 are anticipated to have LOS F and queuing issues. Since LOS F is anticipated in 2050, additional capacity analysis was focused on these two-lane merges in subsequent steps.
- In all alternatives, the six remaining ramps are single lane ramps. Of these ramps, LOS C is expected at the four lowest volume ramps, while LOS D is expected on the one lane ramps between I-26 westbound to I-95 northbound (and the opposite direction).
- Each alternative has short shared ramp segments where two ramps exit from I-95, split into two ramps, continue as a new flyover, and then merge with another ramp before merging into I-26. These shared ramp segments all function at LOS D or better as currently designed. Alternative 3, however, has a fifth shared ramp segment which operates at an unacceptable LOS E in 2030 and LOS F in 2050.

### 11.3.3 Capacity Constraints on I-95 and I-26 merges

As previously noted, the future analyses assume a widening of I-26 from four to six lanes will be in place by 2030, but no widening is currently planned for I-95. A series of analyses were examined to identify options for providing a merge solution that minimizes potential for queuing to impact operations within the study interchange. This analysis is presented in Chapter 8. Key observations included:

- A 5,000-foot southbound merge onto I-95 (2 + 2 lanes = 4 lanes) is recommended to minimize queuing back into the proposed interchange. The merge would be evenly divided into two 2,500-foot merges for each merge lane. This recommendation is despite the observation that there is queuing on I-95 southbound and the merging ramp in 2050 with LOS F operations. Key reasons are:
  - The LOS restriction and queuing in 2050 is not due to deficiencies in the proposed interchange. Instead, the future traffic volumes on I-95 south of I-26 are projected to exceed the capacity of a four-lane freeway (two mainline lanes in each direction). Widening of I-95 is not the primary purpose of this project and is not currently planned for the corridor. If I-95 were to be widened, the proposed design for the I-26 at I-95 interchange would provide acceptable LOS at the the I-95 southbound merge.
  - The 5,000-foot merge provides acceptable operations with LOC C at the merge in 2030 based on TransModeler analysis. A 2,500-foot merge is anticipated to operate at an unacceptable LOS E in 2030.
  - By 2050 congested operations (LOS F and queuing on I-95 southbound and the merging ramp from I-26) are noted with both a 2,500 foot and a 5,000-foot merge. During the 2050 peak period analysis, however, the 2,500-foot merge has twice the delay per vehicle compared to the same period with the 5,000-foot merge.
  - A 5,000-foot merge is also applicable based on the Institute of Transportation Engineers (ITE) *Freeway and Interchange Geometric Design Handbook*. The guidance addresses the design of a two-lane entrance when the preferred approach would be the provision of an auxiliary lane or addition of a new lane, but other constraints do not allow for that treatment. The key element is that once a distance of 2,500 feet is reached for a single lane merge, the operational effects and capacity benefits are effectively achieved, and additional extensions provide minimal benefit. More discussion is provided in Section 8.3.2.

A similar merge issue was noted on I-26 westbound where the two-lane flyover Ramp 6 (which replaces loop Ramp 6) merges onto I-26 westbound. In this case, however, I-26 has three lanes westbound which helps disperse the traffic at the merge. Regardless, a series of model runs were completed and indicated:

- A 4,000-foot westbound merge of the two-lane ramp would be needed to minimize potential of queuing back into the interchange area or ramp in 2050.
- This analysis was done assuming that all ramp traffic from I-95 northbound would be processed on the flyover Ramp 6. To do this, the TransModeler network assumed an additional I-95 northbound lane. Since an additional lane on I-95 is not planned, the traffic demand may be metered during the highest periods of congestion, reducing the ramp movement and subsequent merge movement that was analyzed to determine the 4,000-foot merge length.

Note that the I-26 westbound merge is less critical than the I-95 southbound merge (despite a freeway volume that is 10 percent lower on I-95 than I-26). The key reason is that the planned three lane I-26 freeway segment provides more capacity than the existing two-lane I-95 freeway segment.

### 11.3.4 Summary of Initial Capacity Analysis

Based on the initial review of the initial design for Alternatives 1, 2 and 3 the following observations are made:

- All three alternatives operate substantially better than the existing interchange under 2030 and 2050 conditions.
  - The primary improvement is the removal of four weave segments impacting I-95 and I-26 in both directions. In addition to capacity constraints, the elimination of weave segments will also provide safety benefits since the four weave segments are currently the second through fifth highest frequency crash segments in the study area.
  - The other key improvement is the provision of two lanes on the I-26 eastbound to I-95 southbound ramp (Ramp 1 in the report) and the I-95 northbound to I-26 westbound flyover (Ramp 6) replacing the loop in the northeast quadrant.
- Alternatives 1 and 2 effectively operate the same from traffic operations perspective. Both can successfully meet LOS D or better operations in 2050. There is a slight difference in travel times, but this is related to the longer length (albeit partially offset by a higher design speed) on the flyovers in Alternative 2. Nevertheless, from a traffic capacity perspective, there is no key difference.

- Alternative 3 does not meet the LOS D operational goal of the entire interchange through 2030 or 2050. Specifically, the third flyover requires incorporation of a fifth shared ramp segment combining two ramps from I-26 westbound. As currently designed, this single lane shared ramp segment does not provide LOS D operations.

## 11.4 Refined Analysis of No Build Versus the Preferred Alternative

Based upon this analysis and comparison, key decisions were able to be made regarding the preferred traffic alternative for the proposed interchange. The comparison analysis was completed in Chapter 8. An illustration summarizing the TransModeler LOS analysis for both the No Build and Build preferred alternative are shown in Figure 9.1 through Figure 9.4. Overall, the key conclusions were:

- The preferred alternative from a traffic capacity perspective is either Alternative 1 or 2. Design details such as the design speed, grade and other elements could differ based on final design approved for the project.

- The preferred alternative would include a 5,000-foot merge on I-95 southbound mainline merge with the two-lane ramp from I-26 eastbound. Although this treatment still operates at LOS F in 2050, it improves operations and minimizes queuing as compared with a shorter merge and is supported for application of ITE guidance for two-lane merges.

- The preferred alternative will also include a 4,000-foot merge on I-26 westbound with the merge of the proposed I-95 northbound to I-26 westbound flyover. This merge also is anticipated to operate at LOS F in 2050. Nevertheless, the provision of a 4,000-foot merge is sufficient to prevent queuing back onto the proposed flyover ramp.

## 11.5 Design & Operational Exceptions

This document is the Interchange Modification Report (IMR) required by FHWA for modifications or changes to existing interchanges on the interstate network. In addition to the capacity analysis, the IMR requires some additional elements be provided in reviewing the document for approval. These elements include:

- FHWA policy requires that all requests for new or revised access to an interstate facility must provide sufficient supporting information to allow FHWA to independently evaluate the request. The FHWA decision to approve a request requires documentation of two key policy points as discussed in Section 10.2. Table 10.1 addresses each of the Policy Points.

- Design exceptions are typically identified as part of the IMR. For this project, however, there are no anticipated design exceptions.
- There are some operational exceptions, however, to the identified congestion threshold of minimum acceptable LOS D operations in 2050. Detailed analysis of the two-lane merges is included in Section 8.3.2 and addressed as part of this summary. Specifically:
  - The existing four lane I-95 south of I-26 will be over capacity and operate at LOS F in the 2050 design year. No widening or capacity improvements are currently identified for the I-95 corridor in SCDOT's 2021-2027 Statewide Transportation Improvement Program (STIP). Improvement of the I-95 mainline is beyond the intent of the current I-26 at I-95 interchange improvements.
  - The proposed 5,000-foot southbound merge of I-95 and the two-lane ramp from I-26 eastbound will operate at LOS F in 2050. Queuing will extend onto the ramp and I-95 southbound approaches to the merge.
  - The proposed 4,000-foot westbound merge of I-26 and the proposed two-lane flyover from I-95 northbound will operate at LOS F in 2050 (even with the assumed widening of I-26 to six lanes in the No Build). Queuing is expected in the merging section but is not anticipated to back up onto the flyover ramp in 2050.
  - Additional traffic analysis was conducted in Section 9.2.5 to examine operations for interim years at these two key merge points between 2030 and 2050. Key findings for the I-26 westbound merge were:
    - The operations of the merge area are relatively uncongested through 2040 (LOS C and 65 mph). By 2045, however, the final three lane bottleneck operates at LOS F with speeds reduced to 25 mph. Congested operations, however, are focused on this segment and have not resulted in backup into the upstream segments.
    - By 2050, congested operations are noted in both the five lane (LOS E and 36 mph) and four lane (LOS F and 26 mph) merge segments. LOS D is observed on the ramp with minimal queuing. This matches the previous analysis where a 4,000-foot merge was deemed the minimum applicable merge length to prevent queuing back onto the flyover.
  - The I-95 southbound merge interim year analysis that the southbound merge is anticipated to operate at LOS F in 2050 and will see substantial congestion by 2040. Observations include:

- The ramp from I-26 eastbound degrades sooner with LOS D in 2040 quickly degrading to LOS F by 2045. A key measure is the travel speed on the ramp which decreases from 41 mph to 10 mph between 2030 and 2035.
- The key impacts and degraded flow are observed in the merge section. The key bottleneck is observed in the three-lane segment of the merge (more precisely, the bottleneck is at the point where the two-lane segment is reached so the delay is observed in the three-lane segment). This section is expected to degrade rapidly between 2035 (LOS C and 65 mph) to 2040 (LOS F and 17 mph). Flow continues to degrade, with density increasing between 2040 and 2045 (reflective of more stop and go operations) and decreasing in speed to 11 mph.
- As demonstrated, the southbound merge is anticipated to operate at LOS F in 2050 and will see substantial congestion by 2040. The solution to this issue, however, is not achievable by improvements to the interchange ramps or layout. Instead, it is recommended that widening of I-95 south of the I-26 interchange be considered as part of future projects.