8.4 Safety

A predictive safety analysis was performed in the study area. The predictive safety analysis was performed per the guidelines in the American Association of State Highway and Transportation Officials (AASHTO) HSM and the IARUG Safety Analysis Guidance.

Predictive safety analysis was performed using a quantitative and qualitative approach. Quantitative safety analysis, using the Enhanced Interchange Safety Analysis Tool (ISATe), was performed where applicable in the study area. The quantitative safety analysis was performed for a 20-year design period from 2025 to 2045 for the No-Build and Build Alternative. For sections where the HSM Part C and CMF methodologies could not be applied, a qualitative safety analysis was performed. The following improvements were analyzed either quantitatively or qualitatively:

- Quantitative
    - Addition of two lanes on I-95 in each direction and modification of speed change lanes
    - Additional one to two lanes on I-95 C-D Road in each direction and modification of speed change lanes
    - Improvements at 8th Street interchange ramp terminals
    - Improvements at Kings Road southbound ramp terminal
    - Improvements at Union Street ramps
    - Improvements at Beaver Street ramps
    - Improvements at Union Street ramps
    - Improvements at Kings Road ramps
- Qualitative
    - Intersection improvements at Forest Street and Myrtle Avenue intersection
    - Intersection improvements at Forest Street and Park Street intersection
    - Intersection improvements at Church Street and Cleveland Street intersection
    - New intersection at Beaver Street at I-95 northbound off ramp
    - Intersection improvements (roundabout) at Beaver Street
    - Improvements at I-95 southbound and I-95 C-D road off ramp

8.4.1 Quantitative Safety Analysis

A quantitative safety analysis was performed as part of this SIMR, where applicable. To perform the analysis, the ISATe tool was used. The ISATe tool is intended to apply the HSM Part C methodology to freeway facilities, including freeway segments and interchanges in urban and rural areas. ISATe was developed as part of the National Cooperative Highway Research Program (NCHRP) Project 17-45. To perform the safety analysis in ISATe, the study area, where improvements are being recommended, was segmented into homogenous sections. Once the study area was segmented, the applicable inputs were provided to produce a predicted number of crashes for the 2025 to 2045 study period. The total number of crashes was then distributed using the KABCO injury classification scale. The KABCO distribution provided in the FDM Chapter 122 was used.

For the safety analysis, the No-Build alternative uses the existing roadway with the proposed improvements described in **Section 5.1**. The Build alternative uses the proposed improvements described in **Section 7.2**. The No-Build and Build Alternative predictive crash results were compared to determine the safety benefits of the proposed improvements. Since the Build alternative does require significant changes in the geometric configuration, the predictive safety analysis did not utilize the Empirical-Bayes Method for the No-Build or Build Alternative, as recommended in the Safety Guidance. The following quantitative safety analysis compares the No-Build and Build Alternative for the I-95 mainline, I-95 ramps, 8th Street interchange improvements, Kings Road southbound terminal intersection improvements and Union Street terminal intersection improvements. No improvements are recommended at the Kings Road northbound terminal intersection or the Bay Street, Forsyth Street, Adams Street and Monroe Street ramps as part of this SIMR, therefore a quantitative safety analysis was not performed. Improvements at Forest Street, Church Street, Beaver Street and I-95 southbound C-D Road off ramp are discussed in the qualitative safety analysis. **Appendix G** presents the input data used to perform the quantitative safety analysis and output summary for the No-Build and Build Alternatives.

I-95

A predictive safety analysis was performed for I-95 from north of I-10 to south of Martin Luther King Jr. Parkway. The addition of two general use lanes along I-95 in each direction and modifications to the length of the merge and diverge lanes were coded for the Build alternative. **Table 8-11**, presented below, shows the expected crash frequencies for the No-Build and Build Alternative.

Table 8-11: Predicted Crash Frequency along I-95 Mainline (Crashes/Year)

Alternative	K	A	B	C	PDO	Total
No-Build	0.59	3.45	10.43	18.25	51.39	84.10
Build	0.50	2.92	8.84	15.47	43.56	71.30
Change	-0.09	-0.52	-1.59	-2.78	-7.82	-12.80

The analysis indicates the additional lanes provided along I-95 should reduce the number of crashes along the I-95 mainline by 12.80 crashes/year. Additionally, the analysis indicates a reduction in crashes along I-95's ramps by 3.1 crashes/year as shown in **Table 8-12**.

Table 8-12: Predicted Crash Frequency along I-95 Ramps (Crashes/Year)

Alternative	K	A	B	C	PDO	Total
No-Build	0.06	0.33	0.99	1.74	4.89	8.00
Build	0.03	0.20	0.61	1.06	2.99	4.90
Change	-0.03	-0.13	-0.38	-0.68	-1.90	-3.10

8th Street Interchange

A predictive safety analysis was performed for I-95 at 8th Street interchange. The improvements to the I-95 northbound and southbound ramp terminals were coded in the Build alternative. **Table 8-13**, presented below, shows the expected crash frequencies for the No-Build and Build Alternative.

Table 8-13: Predicted Crash Frequency at the I-95 and 8th Street Interchange (Crashes/Year)

Ramp Terminal	Alternative	K	A	B	C	PDO	Total
Northbound Ramp Terminal	No-Build	0.06	0.38	1.14	2.00	5.63	9.21
	Build	0.05	0.27	0.82	1.44	4.05	6.63
	Change	-0.02	-0.11	-0.32	-0.56	-1.58	-2.58
Southbound Ramp Terminal	No-Build	0.05	0.27	0.82	1.43	4.03	6.60
	Build	0.04	0.25	0.76	1.32	3.72	6.09
	Change	0.00	-0.02	-0.06	-0.11	-0.31	-0.51
Total	No-Build	0.11	0.65	1.96	3.43	9.66	15.81
	Build	0.09	0.52	1.58	2.76	7.77	12.72
	Change	-0.02	-0.13	-0.38	-0.67	-1.89	-3.09

The analysis shows the improvements provided at the northbound ramp terminal should reduce the number of crashes by 2.58 crashes/year. The analysis also shows the improvements provided at the

Southbound ramp terminal should reduce the number of crashes by 0.51 crashes/year. Overall, the improvements at the I-95 and 8th Street interchange should reduce the number of crashes by 3.09 crashes/year.

Kings Road Southbound Terminal Intersection

A predictive safety analysis was performed for I-95 at Kings Road southbound terminal intersection. The conversion of the ramp from an unsignalized ramp to a signalized intersection and additional intersection improvements were coded in the Build alternative. **Table 8-14**, presented below, shows the expected crash frequencies for the No-Build and Build Alternative.

Table 8-14: Predicted Crash Frequency at Kings Road Southbound Terminal Intersection (Crashes/Year)

Ramp Terminal	Alternative	K	A	B	C	PDO	Total
Southbound Ramp Terminal	No-Build	0.00	0.02	0.07	0.12	0.35	0.57
	Build	0.01	0.04	0.12	0.21	0.58	0.95
	Change	0.00	0.02	0.05	0.08	0.23	0.38

The analysis shows the improvements provided at the southbound ramp terminal may increase the number of crashes by 0.38 crashes/year. This slight increase in crashes is most likely a result of adding a signal at the intersection instead of the free-flow movement allowed in the No-Build. The number of rear-end crashes could increase with the signal but the improvement should reduce the number of free flowing sideswipe collisions, as a result of eliminating the potential friction point. This is a safety benefit that could result in less serious collisions.

Union Street Southbound Terminal Intersection

A predictive safety analysis was performed for I-95 at Union Street southbound terminal intersection. The removal of various ramps in the Build alternative along the I-95 mainline contributed to increased ramp volume at Union Street. This volume and intersection improvements were coded in the Build alternative. **Table 8-15**, presented below, shows the expected crash frequencies for the No-Build and Build Alternative.

Table 8-15: Predicted Crash Frequency at Union Street Southbound Terminal Intersection (Crashes/Year)

Ramp Terminal	Alternative	K	A	B	C	PDO	Total
Southbound Ramp Terminal	No-Build	0.08	0.48	1.45	2.54	7.15	11.70
	Build	0.14	0.81	2.45	4.28	12.06	19.74
	Change	0.06	0.33	1.00	1.74	4.91	8.04

The analysis shows the improvements provided at the southbound ramp terminal may increase the number of crashes by 8.04 crashes/year. As a result of the removal of ramps and volume redistribution, the crashes at the Union Southbound Ramp Terminal do increase. However, because of these improvements, there is also a decrease in crashes along the I-95 mainline, ramps and other ramp terminals within the study area. The removal of ramps along I-95 results in far less friction along the I-95 mainline resulting in improved safety operations.

Church Street Southbound Terminal Intersection

A predictive safety analysis was performed for I-95 at Church Street southbound terminal intersection. This is a new intersection proposed in the Build Alternative. This intersection is not existing and is not present in the No-Build alternative**. Table 8-16**, presented below, shows the expected crash frequencies for the Build Alternative.

Table 8-16: Predicted Crash Frequency at Church Street Southbound Terminal Intersection (Crashes/Year)

Ramp Terminal	Alternative	K	A	B	C	PDO	Total
Southbound Ramp Terminal	Build	0.00	0.01	0.02	0.03	0.08	0.13

The analysis shows this new southbound terminal intersection at Church Street should result in 0.13 crashes/year.

Summary of Quantitative Safety Analysis

A quantitative safety analysis was performed for all applicable segments/intersections within the study area. **Table 8-17** summarizes the quantitative safety analysis for all segments/intersections analyzed. Overall, the Build alternative reduces crashes within the study area by 10.44 crashes/year. The reduction in crashes is most prominent along the I-95 mainline, I-95 ramps and at the 8th Street interchange ramp terminals. Additional improvements that could not be analyzed using quantitative safety analysis are discussed qualitatively in **Section 8.4.2**. These additional improvements should provide additional safety benefits.

Table 8-17: Predicted Crash Frequency (Crashes/Year) Comparison – No-Build vs. Build

I-95 Segment/Interchange	Alternative	K	A	B	C	PDO	Total
I-95 Mainline	No-Build	0.59	3.45	10.43	18.25	51.39	84.10
	Build	0.50	2.92	8.84	15.47	43.56	71.30
	Change	**-0.09**	**-0.52**	**-1.59**	**-2.78**	**-7.82**	**-12.80**
I-95 Ramps	No-Build	0.06	0.33	0.99	1.74	4.89	8.00
	Build	0.03	0.20	0.61	1.06	2.99	4.90
	Change	**-0.02**	**-0.13**	**-0.38**	**-0.67**	**-1.89**	**-3.10**
8Th Street Interchange	No-Build	0.11	0.65	1.96	3.43	9.66	15.81
	Build	0.09	0.52	1.58	2.76	7.77	12.72
	Change	**-0.02**	**-0.13**	**-0.38**	**-0.67**	**-1.89**	**-3.09**
Kings Road Southbound Terminal Intersection	No-Build	0.00	0.02	0.07	0.12	0.35	0.57
	Build	0.01	0.04	0.12	0.21	0.58	0.95
	Change	**0.00**	**0.02**	**0.05**	**0.08**	**0.23**	**0.38**
Union Street Southbound Terminal Intersection	No-Build	0.08	0.48	1.45	2.54	7.15	11.70
	Build	0.14	0.81	2.45	4.28	12.06	19.74
	Change	**0.06**	**0.33**	**1.00**	**1.74**	**4.91**	**8.04**
Church Street Southbound Terminal Intersection	No-Build	-	-	-	-	-	-
	Build	0.00	0.01	0.02	0.03	0.08	0.13
	Change	**0.00**	**0.01**	**0.02**	**0.03**	**0.08**	**0.13**
Overall	No-Build	0.84	4.93	14.9	26.08	73.44	120.18
	Build	0.77	4.5	13.62	23.81	67.04	109.74
	Change	-0.07	-0.43	-1.28	-2.27	-6.4	-10.44

8.4.2 Qualitative Safety Analysis

The HSM Part C methodology and CMF methodology cannot always account for unique configurations and as a result, quantitative predictive safety analysis cannot be performed. However, to still account for the proposed improvements that cannot be analyzed using HSM Part C or with CMFs, a qualitative safety analysis has been performed for these applicable improvements.

I-95 at Forest Street Interchange

Improvements at the northbound ramp terminal (Forest Street at Myrtle Avenue intersection) are proposed to eliminate the southbound through and left turn movements on Myrtle Avenue. Myrtle Avenue is a public road with no connections to I-95. The elimination of these movements would create fewer conflict points at the intersection and improved intersection operations.

Northbound dual left turn lanes, a southbound exclusive left turn lane and an eastbound exclusive right turn lane are proposed at the intersection of Forest Street and Park Street. The addition of the eastbound

exclusive right turn lane would eliminate a shared right-through movement on the intersection leg. This would reduce potential rear end crashes.

I-95 at Church Street and Cleveland Street Intersection

The southbound off ramp at I-95 and Church Street (Church Street at Cleveland Street intersection) is proposed to be removed. Vehicles wanting to exit at Church Street would need to utilize the Union Street exit and proposed roundabout at Beaver Street.

The removal of a mainline ramp will eliminate the weaving segment on I-95 southbound between Kings Road and Church Street and potential queues that may otherwise have back up onto the mainline. It should also improve operations at the Church Street at Cleveland Street intersection and reduce crash severity due to the reduction of conflict points.

I-95 Northbound at Beaver Street New Terminal Intersection

It is proposed to modify the Beaver Street northbound off ramp to create a new terminal intersection at Beaver Street. Similar to the existing conditions, the off ramp would still have an exit onto Union Street; however, a new loop portion would be constructed to intersect with Beaver Street. The loop would replace a portion of Lee Street. The removal of this Lee Street roadway portion would reduce crash types such as head on and sideswipe since the new loop is one-directional. Lee Street is currently two-directional. It would also eliminate current crashes at Union and Lee Street.

Beaver Street Roundabout

A single-lane roundabout is proposed at Beaver Street, which connects the I-95 southbound Union Street off ramp to Church Street. The roundabout would also provide a direct connection to I-95 northbound. Federal Highway Administration (FHWA) sites a reduction in speed along roundabout corridors as one of the many benefits. The conversion of the current intersection to a roundabout also significantly reduces the possibility of an angle crash and can reduce queuing, which could potentially spill back onto the I-95 off ramp.

I-95 Southbound at I-95 C-D Road Off Ramp

The I-95 C-D road is proposed to have one to two additional lanes in the Build alternative. This improvement cannot be accounted for using the HSM Part C methodology or CMF methodology. Since

there are no other ways to quantify this improvement, a qualitative discussion has been provided. By adding lanes to the C-D road, capacity is increased, and it is anticipated that queues on I-95 would be reduced. The entrance to the C-D road southbound is also proposed to be moved further north on I-95 (approximately over ½ a mile earlier exit). This would remove potential weaving conflicts from vehicles trying to access the I-95 Southbound Union Street exit, as vehicles accessing the I-95 Southbound C-D road would already be removed from the mainline traffic.

I-95 C-D Roadway System

The C-D road system improvements cannot be analyzed using the HSM Part C methodology or CMF methodology due to the complex geometry. In the southbound direction, traffic volumes increase on the C-D road which could potentially increase crashes, but by adding lanes to the C-D road, capacity is increased which should reduce congestion and lane changes on the C-D road. Also, the elimination of some access points on the C-D road should eliminate weave and lane change movements, thereby reducing crashes. In the northbound direction, traffic volumes remain the same under the Build Alternative, and safety should get better due to the recommended improvements. The entrance to the C-D road southbound is also proposed to be moved further north on I-95 (approximately over ½ a mile earlier exit). This would remove potential weaving conflicts from vehicles trying to access the I-95 Southbound Union Street exit, as vehicles accessing the I-95 Southbound C-D road would already be removed from the mainline traffic.

8.5 Project Cost

The anticipated cost of this project based on the FDOT Long Range Estimating (LRE) System is provided in **Appendix H**.

8.6 Conceptual Signing Plan

A conceptual signing plan was prepared for the preferred alternative in accordance with the IARUG requirements. **Appendix I** presents the conceptual signing plan for proposed modifications within the AOI. No modifications are proposed at I-10 and Martin Luther King Jr. Parkway interchanges as part of this SIMR.

8.7 Design Exceptions and Variations

Implementation of the proposed improvements will require the following design exceptions and variations:

1. Shoulder Width Variation
    a. The southbound I-95 ramp from the non-truss bridge section to southbound I-95 has 2.5' shoulders. The existing ramp structure currently operates as a single lane ramp.
    b. Northbound outside mainline section south of the R/R crossing has 6' shoulders to minimize the r/w impacts to Historic Allen Chapel AME Church
    c. All existing bridge shoulders are 10'

8.8 Recommendation

The No-Build Alternative will not accommodate the travel demand along I-95 and at the study interchanges. In the Design Year 2045, significant operational deficiencies will exist with the No-Build Alternative. Multiple segments along I-95 northbound and southbound operate at densities greater than 45 vhpmpl and estimated LOS F in both AM And PM peak hours. Multiple segments along I-95 northbound C-D road also experience higher densities and lower speed. Five of the 12 study intersections will operate at unacceptable delay (greater than 80 seconds per vehicle) under the No-Build Alternative. Vissim operational analysis results show latent demand at the end of AM and PM peak periods. These operational deficiencies are associated with high traffic demand and insufficient capacity.

The Build Alternative for this study performs substantially better than the No-Build alternative for all future years. The proposed improvements provide additional capacity along the I-95 mainline and I-95 C-D road while improving traffic flow with ramp modifications and removals at interchanges. In the Design Year 2045, significant operational benefits result from the Build Alternative. Overall, the total delay along the network will decrease by 83 percent and 67 percent in AM and PM peak respectively. The average speed in the network will increase by 91 percent and 60 percent in AM and PM peak respectively, and the total travel time will decrease by 44 percent and 34 percent in AM and PM peak respectively. The five study intersections that were operating with unacceptable delay in 2045 No-Build Alternative improve to only one intersection performing at an unacceptable in the PM peak hour. This intersection (8th Street at Illinois Street) is not a terminal intersection and will not impact I-95 operations. These improvements will help process traffic traveling along I-95 and to and from the study interchanges.

A predicted quantitative safety analysis was also performed where applicable to determine if the Build Alternative addressed the existing safety concerns. Based on the proposed improvements, combined crashes for mainline, ramps and intersections are expected to reduce by 10.4 crashes per year under the Build Alternative.

Considering all the analysis findings described in this SIMR, the Build Alternative is recommended for approval in this study.