## 5.5 Safety Analysis of the DDI Alternative

An analysis of the predicted number of crashes along mainline I-95 was conducted for both the RFP and the DDI concepts to assess and compare the safety conditions between the two. The study area limits for the safety analysis on I-95 are:

- I-95 between W Palmetto Park Road (northbound entrance ramp gore point) and Yamato Rod (southbound entrance ramp gore point)

The analysis was done for 2040 conditions.

### *5.5.1 Data Collection*

- The 2040 traffic volumes for all the basic freeway segments and ramps were used.
- All the required geometric design and traffic control data were obtained from the design files that were provided.

### *5.5.2 Methodology*

The analysis followed the procedures from Chapters 18 and 19 of the Highway Safety Manual (HSM) – 1st Edition Supplement 2014 by the American Association of State Highway and Transportation Officials (AASHTO). The Enhanced Interchange Safety Analysis Tool (ISATe) was used for performing the analysis. The methodology discussed in the ISATe user manual was followed in the current analysis.

### *5.5.3 Analysis*

The project was divided into freeway segments and ramps segments. All the freeway segments within the study limits were included in the freeway analysis whereas the ramps at the interchange were included in the ramp analysis. However, the ramp terminals were not included in the analysis. The RFP alternative was segmented into 24 freeway and 9 ramp segments. The DDI alternative was segmented into 21 freeway and 8 ramp segments. The results from the analysis are summarized in Table 5.4**.**

**Table 5.4: RFP and DDI Concepts - Summary of Predicted Crashes (2040)**

| Crash Severity Type | FDM Crash Distribution Factors (Freeway) | FDM Crash Distribution Factors (Ramps) | Predicted Crashes | | | |
|---|---|---|---|---|---|---|
| | | | RFP Concept | | DDI Concept | |
| | | | Freeway | Ramp | Freeway | Ramp |
| K | 0.006 | 0.004 | 0.93 | 0.03 | 0.85 | 0.02 |
| A | 0.035 | 0.032 | 5.40 | 0.25 | 4.98 | 0.15 |
| B | 0.113 | 0.107 | 17.45 | 0.83 | 16.09 | 0.51 |
| C | 0.206 | 0.210 | 31.81 | 1.64 | 29.33 | 1.01 |
| PDO | 0.641 | 0.647 | 98.97 | 5.05 | 91.28 | 3.11 |
| | **Total (Rounded)** | | **162** | | **147** | |

As presented in Table 5.4, the DDI concept is predicted to have 147 crashes within the study area whereas the RFP concept is predicted to have 162 crashes. The DDI concept is predicted to have 15 less crashes, which equates to a 9 percent crash reduction when compared to the RFP concept.

### *5.5.4 Assumptions and Limitations*

- A calibration factor of 1.00 was used for both the concepts.
- A 30-feet clear zone was assumed for both the designs.
- Freeway free flow speed of 65 mph was used for both the designs.
- The analysis did not include the ramp terminals due to the limitations of the HSM in predicting crashes at a DDI interchange ramps terminals.

### *5.5.5 Safety Research on DDIs*

The HSM and ISATe tool do not account for the unique configuration of a DDI and therefore, ISATe methods could not be used to predict the safety benefits for the ramp terminal intersections at Glades Road. Since there are no other tools that account for the DDI configuration either, the safety benefits of the DDI based on previous researches are summarized below:

The key safety benefits of the DDI configuration include:

- Reduction of conflict points (14 conflict points and 2 crossing points, compared to the 26 conflict points found in the conventional diamond interchange) and improved sight distance at the turns.
- Reduction in crash severity due to lower design speeds compared to other interchange designs.
- Traffic calming effect that reduces vehicular speed (while maintaining the capacity) due to the small geometric deflection introduced by the DDI for through traffic.
- Elimination of the wrong-way movements into ramps from the DDI interchange design.
- Crash reduction associated with the elimination of loop ramps, where applicable.

Several research papers and before-after studies support the safety benefits of the DDIs. Hummer, Joseph E., et al.[1] recommended a Crash Modification Factor (CMF) of 0.67 for conversion of a conventional Diamond Interchange to a DDI. This implies that the DDI design is estimated to reduce crashes by 33 percent compared to the conventional Diamond Interchange. The research team analyzed seven of the earliest DDIs in the US - four of which were in Missouri and the rest in Kentucky, New York, and Tennessee. The team collected over 28 site-years of "before" (conversion to DDI) data and over 19 site-years of "after" (conversion to DDI) data. The overall crash reduction was found to be 33 percent, while the reduction in injury crashes was found to be 41 percent. Additionally, the analyses indicated that DDI installation could reduce angle and turning crashes substantially. The research team recommended that agencies consider DDI strongly as replacements for conventional diamonds. The Glades Road interchange is not completely a conventional diamond due to its loop ramps. Based on the study by Elvik, Rune, et al.[2], replacing the loop ramps with straight ramps or short ramps would reduce the crashes by 45 percent and 30 percent respectively.

This CMFs from these studies can be found in the Crash Modification Factors Clearinghouse, developed by the US Department of Transportation (USDOT) Federal Highway Administration

(FHWA) and maintained by the University of North Carolina Highway Safety Research Center (UNC HSRC).

### *5.5.6 Conclusions*

The DDI configuration at Glades Road results in reduced ramp access points along the I-95 freeway. Based on the ISATe analysis results, the DDI concept is predicted to have 15 less crashes, which equates to a 9 percent crash reduction when compared to the RFP concept. The before and after comparison presented in the research study indicates that the DDIs (in comparison to the conventional Diamond Interchanges) are predicted to reduce the overall crashes by 33 percent while significantly reducing the injury crashes. Additionally, the elimination of the existing loop ramps would further improve the safety conditions for the DDI. Therefore, the DDI configuration at Glades Road is predicted to have lower than the total number of predicted crashes as well as reduce the severity of crashes.

### *5.5.7 References*

1. Hummer, Joseph E., et al. "Safety evaluation of seven of the earliest diverging diamond interchanges installed in the United States." Transportation research record 2583.1 (2016): 25-33.
2. Elvik, Rune, et al. "Traffic Control', The Handbook of Road Safety Measures." (2009): 397-541.