FDOT

Florida Department of
Transportation

Interchange Access Request User's Guide
Safety Analysis Guidance

Florida Department of Transportation
Systems Implementation Office, Mail Station 19
605 Suwannee Street
Tallahassee, FL 32399

November 2020

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Interchange Access Request – User's Guide

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IAR Safety Guidance

1.1 Introduction

The purpose of performing safety analyses in Interchange Access Requests (IARs) is to understand the impacts of the proposed modifications on safety and crash likelihood at an existing or proposed interchange. It is important that an appropriate safety analysis methodology is selected to analyze the proposed modifications in the IAR. The safety analysis method chosen for the IAR should be in concert with the purpose and need, alternatives analysis and other aspects of the study project. The objective of the safety analysis is to examine the effects of the IAR proposed modifications on the safety performance of the interchange. As such, the safety analysis should proactively aim at reducing or correcting potential safety concerns before recommendations are constructed. The safety analysis should include the analysis of the existing conditions using historic data and future safety analysis of the proposed modifications using statistical analysis techniques for crash prediction methods. The common methods to perform the future safety analysis are:

i. the Countermeasure Crash Modification Factors (CMFs) and
ii. the Highway Safety Manual (HSM) Part C Methodology.

These methodologies are based on the guidelines set by the HSM. The HSM is published by the American Association of State Highway and Transportation Officials (AASHTO) and includes methodologies to quantitatively predict a facility's safety performance. The "Predictive Method" in the HSM provides equations (Safety Performance Functions) that statistically predict the number of crashes on rural two-lane roads, rural multilane roads, urban/suburban roads, urban/rural freeways and ramps with specific geometric features and traffic volumes for a given period of time. Crash prediction methods offer a scientific and objective approach for predicting the quantitative safety differences of project alternatives. This allows analysts and reviewers to make sound engineering decisions regarding the proposed modifications in IARs.

The HSM was published in 2010 and, according to Volume 1, is "a resource that provides safety knowledge and tools in a useful form to facilitate improved decision making based on safety performance. … The purpose of the HSM is to convey present knowledge regarding highway safety information for use by a broad array of transportation professionals." To present this information, the HSM is divided into four parts:

- Part A – Introduction, Human Factors, and Fundamentals
- Part B – Roadway Safety Management Process
- Part C – Predictive Method
- Part D – Crash Modification Factors

Per the HSM, "Part A describes the purpose and scope of the HSM and explains the relationship of the HSM to planning, design, operations, and maintenance activities. Part A also presents an overview of human factor principles for road safety and fundamentals of the processes and tools described in the HSM. … Part B presents the steps that can be used to monitor and reduce crash frequency and severity on existing roadway networks. … Part C of the HSM provides a predictive method for estimating expected average crash frequency of a network, facility, or individual site. … Part D summarizes the effects of various treatments such as geometric and operational modifications at a site. Some of the effects are quantified as CMFs. CMFs quantify the change in expected average crash frequency because of modifications to a site.” The focus of this guidance will be on HSM Parts C and D. HSM Parts A and B are not covered in this guidance. For further information regarding HSM Parts A and B, please refer to the HSM.

1.2 Purpose

The purpose of this Safety Analysis Guidance is to provide:

- Direction for performing existing and future safety analysis in IARs using appropriate data and methods.
- Information to select and appropriately apply the Countermeasure CMF and HSM Part C methodologies.
- Consistent and uniform approach for completing safety analyses for IARs throughout the state.
- Analysis examples demonstrating the application of safety analysis methods for IARs.

This guidance is divided into the following sections:

- Methodology Letter of Understanding (MLOU)
- IAR Safety Analysis Process
- Existing Safety Analysis
- Future Safety Analysis
  - Guidance on the application of the Countermeasure CMF methodology: To perform a future safety analysis using the Countermeasure CMF methodology, sources such as the Federal Highway Administration (FHWA) CMF Clearinghouse, HSM and Florida Crash Reduction Factors (CRFs) can be used. Further information regarding Countermeasure CMF methodology is discussed in **Section 1.6.1**.
  - Guidance on the application of the HSM Part C methodology: The HSM Part C methodology is a multistep process to determine the predicted number of crashes at a location, based on the facility's roadway and traffic characteristics. Tools that support the HSM Part C methodology may be used to perform the safety analysis. Commonly available tools that are used to quantify safety include HSM spreadsheets, the Enhanced Interchange Safety Analysis Tool (ISATe) and the Interactive Highway Safety Design Model (IHSDM). Further information regarding the HSM Part C methodology is discussed in **Section 1.6.2**.
- Documentation of IAR safety analysis.

The Safety Analysis Guidance for IARs should be used by FDOT staff and consultants who perform and review safety analyses for IAR documents. The focus of this guidance is to assist the analyst in selecting the appropriate safety analysis techniques for IARs. It is assumed that the analyst has a basic knowledge of safety analysis and experience with HSM methods and tools.

1.3 Methodology Letter of Understanding (MLOU)

The safety analysis discussion provided in the MLOU should follow and be consistent with the MLOU template available on the Systems Implementation Office website. The following information is required in the safety section of the MLOU:

- Safety analysis years
- Historic crash data sources

The safety analysis discussion in the MLOU should be consistent with the MLOU template.

Safety analysis should be performed using the latest five years of historic crash data available at the MLOU stage. If data is not available for the latest five years, then three years of crash data can be used to perform the safety analysis. In case less than five years of data is used, it should be explained in the MLOU. If the project is put on hold and does not progress, then the crash data must be updated to the latest five years during the next project initiation. The second item to be included in the MLOU is the sources of historic crash data to be used in the safety analysis. Further discussion on the sources of historic crash data and their use is provided in **Section 1.5**.

The MLOU shall document an understanding that an existing and quantitative safety analysis will be performed and will be consistent with the safety guidance. If a known deviation from the safety guidance is expected during the MLOU stage, it should be documented in the MLOU. Additional deviations from the safety guidance that occur after the MLOU approval should be discussed with the State Interchange Review Coordinator (SIRC) and documented in the IAR.

An example of the safety discussion needed in the MLOU is provided below.

> 7.0 Safety Analysis
> A. Detailed crash data within the study area will be analyzed and documented.
> Years: 2013-17
> Source: FDOT Safety Office
>
> Crash data will be obtained from the FDOT Safety Office for the most recent five-year period on the mainline, interchanges and major cross streets within the area of influence. The data collected shall include the number, type and location of crashes and the crash severity. Actual crash rates along the facility will be compared with the statewide average rates for similar facilities to determine if any “high crash locations” exist within the study area.
>
> The historic crash analysis will be used to inform the quantitative safety analysis of the future year alternatives utilizing Highway Safety Manual procedures. The safety analysis for the proposed conditions will document how the request will impact the facility’s safety within the project study area. The quantitative safety analysis will comply with the guidelines of the FDOT Interchange Access Request User’s Guide Safety Analysis Guidance to determine the estimated change in the expected number of crashes due to the proposed modifications of the project.

1.4 IAR Safety Analysis Process

The IAR Safety Analysis Process Flow Chart is depicted in **Figure 1**. The safety analysis methodology is determined based on the type of modifications that are being recommended.

The first step in the IAR safety analysis process is to perform the existing safety analysis. The existing safety analysis should be consistent with the guidance provided in **Section 1.5**.

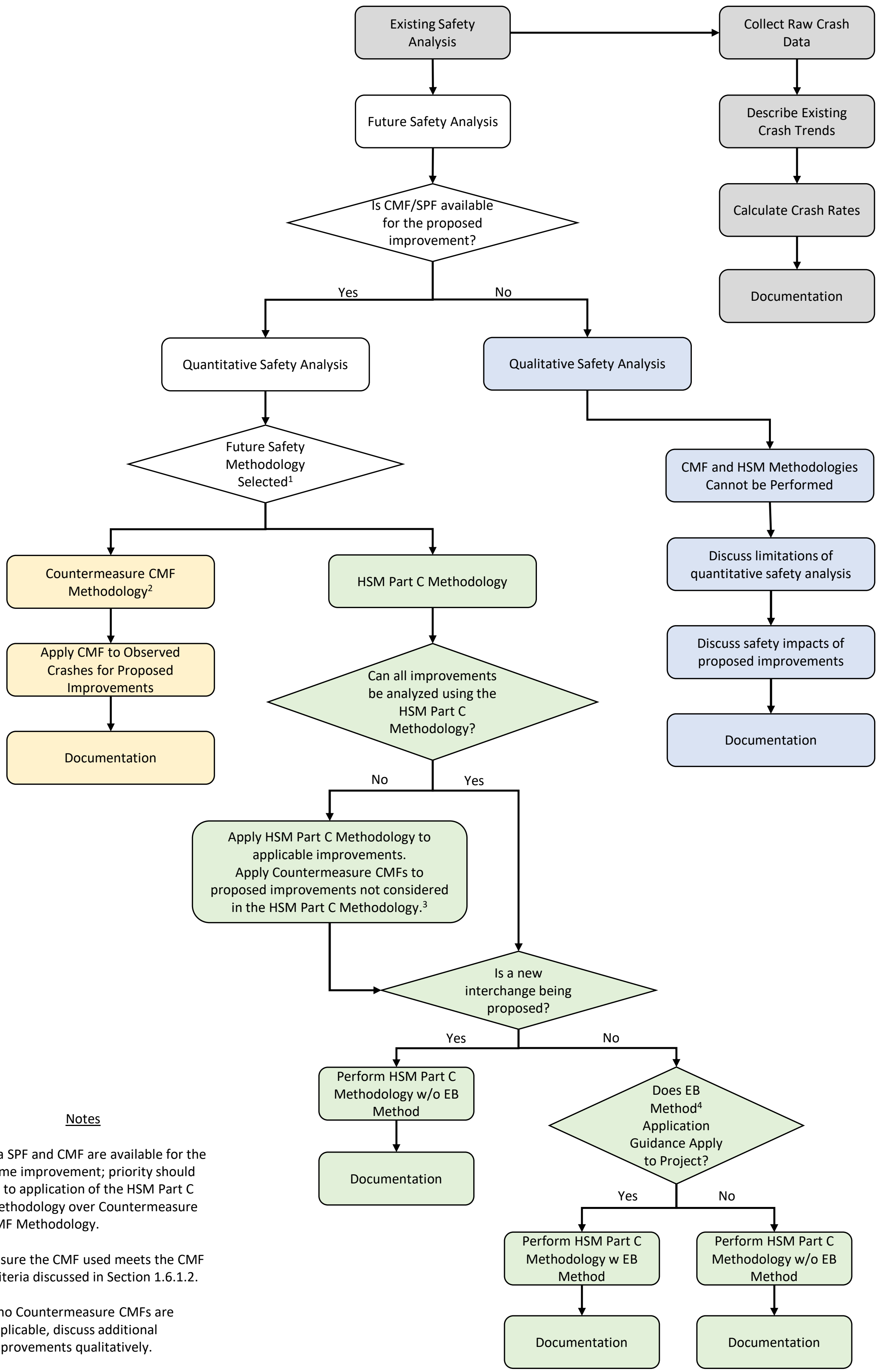
Step two is to perform the future safety analysis. To begin the future safety analysis, determine if the proposed modifications have a CMF or Safety Performance Function (SPF) that is applicable. If a CMF or SPF is available, proceed to quantitative safety analysis. If a CMF or SPF is not available, proceed with qualitative safety analysis.

Qualitative safety analysis must only be selected if the quantitative safety analysis cannot be performed using an applicable CMF or SPF. Qualitative safety analysis should include a discussion on the limitations of the quantitative safety analysis and the safety impacts of the proposed modifications. It is recommended that the discussion is supported by additional research and data, if available.

Qualitative safety analysis must only be selected if quantitative safety analysis cannot be performed.

If a CMF or SPF is available, a quantitative safety analysis should be performed. Depending on the proposed modification, the Countermeasure CMF methodology or HSM Part C methodology can be selected. If a CMF and SPF are available for the proposed modification, priority should be given to the application of the HSM Part C methodology over the Countermeasure CMF methodology.

Figure 1: IAR Safety Analysis Process Flow Chart



Notes

1. If a SPF and CMF are available for the same improvement; priority should go to application of the HSM Part C Methodology over Countermeasure CMF Methodology.
2. Ensure the CMF used meets the CMF Criteria discussed in Section 1.6.1.2.
3. If no Countermeasure CMFs are applicable, discuss additional improvements qualitatively.
4. EB Method is discussed in Section 1.6.2.1.

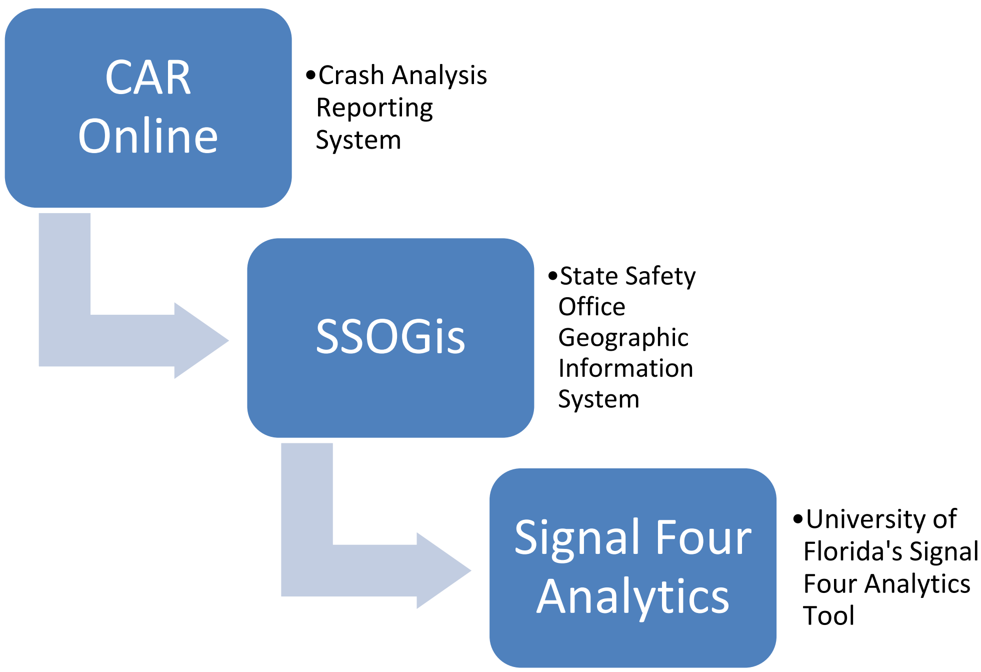
1.5 Analysis of Existing Safety Conditions

The study limits of the existing safety analysis are the same as for the operational analyses.

The existing safety analysis helps identify safety issues within the project study area in the existing year. Along with traffic operations and other relevant factors, existing safety analysis helps develop the purpose and need for the project. An existing conditions safety analysis shall be performed for all IARs by analyzing the latest five years of historic crash data within the area of influence. If data is not available for the latest five years, then three years of crash data can be used to perform the existing safety analysis. If a shorter study period is necessary due to nonavailability or discrepancies in data, it should be discussed in the IAR. The study limits of the existing safety analysis should be the same as for the operational analyses.

There are three main sources of historic crash data, as shown in **Figure 2**. These three sources should be used in the analysis, as per the hierarchical order of preference shown below.

Figure 2: Historic Crash Data Sources Hierarchy



1. **<u>Crash Analysis Reporting System (CAR Online)</u>** data can be requested from the District or State Safety Office or accessed from the FDOT mainframe. The CAR Online database includes crashes on all public roads, along with roadway and geolocation data. The data is subject to an extensive review by FDOT prior to publishing which typically results in a data entry lag. The approved CAR Online database should be the first source of crash data that is considered in the safety analysis prior to using other sources.

2. **<u>The State Safety Office Geographic Information System (SSOGis)</u>** is a publicly available crash database in the form of a web-based map, that is maintained by the FDOT Safety Office. The map can be accessed on the State Safety Office's traffic safety web portal. This database covers state highways and local roadways. SSOGis does not include the detailed crash data fields that are included in the CAR Online database, but the information provided is sufficient for safety analysis in IARs. Like the CAR Online database, the SSOGis also experiences delays in data entry due to the review process.

3. **<u>The University of Florida's Signal Four Analytics tool</u>** is an interactive, web-based geospatial crash analytical tool developed and maintained by the GeoPlan Center of the University of Florida. The tool provides up-to-date crash data for the entire state reported by law enforcement to the Department of Highway Safety and Motor Vehicles. The tool also has built in crash analysis functions to evaluate the data. It is a good source of crash data for non-state arterials. If the study interchange is on a local road, then data from Signal Four Analytics tool is required as information may not be available from CAR Online and the SSOGis. A limitation of this tool is that the locations and crash data are not subject to the same scrutiny as the CAR Online and SSOGis databases.

Crash data from multiple sources must be for the same time period.

CAR Online or the SSOGis should be used as the primary sources of historic crash data. If data is missing for a local road, Signal Four Analytics can be used to supplement the CAR Online or SSOGis data. If multiple sources of crash data are used to cover the safety analysis study area, ensure that the data collected is for the same time period. It is common for the CAR Online and SSOGis crash data to lag behind the Signal Four Analytics database. If the most recent crash data used from CAR Online or the SSOGis is 2013–17, then the Signal Four Analytics crash data should also be from 2013–17, even if the 2018–20 crash data is available. Also, do not mix data sources to meet the five years of safety data requirement. For example, do not take two years (2013–14) of crash data from CAR Online and three (2015–17) years of crash data from Signal Four Analytics.

Do not mix data sources to meet the five years of safety data requirement.

In addition to ensuring the same data collection years are used, it is important to check and validate the crash data and ensure that crashes are not double-counted when using multiple sources.

The historic crash data collected should include all roadway elements (freeway segments, merge/diverge areas, weaving segments, arterial segments and intersections) within the area of influence.

The historic crash data collected should include at a minimum:

- Crash type
  - Overturns, rear-ends, angle, sideswipes, hitting fixed objects, etc.
- Prevalence of crash types
- Crash patterns and crash contributing factors
- Crash severity
  - Fatal injury, incapacitation injuries, non-incapacitation injury, possible injury, no injury (property damage only) — commonly referred to as KABCO

Existing conditions safety analysis uses observed crash data to determine crash severity for historic crashes, crash trends, crash types and major contributing factors. The existing conditions safety analysis' purpose is to identify areas where there may be a safety concern and should include:

a. Description of Existing Crash Trends

A written description of the crashes occurring over the analysis period, broken down by location, is required.

The descriptions must provide the following:

- Number of crashes occurred (crash frequency)
- The most frequent crash type
- Common crash cause
- Severity of crashes
- Pedestrian and bicycle crashes

An example of the written description of crashes that should be provided in the IAR is provided below.

> There were 354 reported crashes along the interstate within the study area during the five-year period; 66 occurred in 2014, 94 in 2015, 109 in 2016, 55 in 2017 and 30 in 2018. Based on crash severity, of the 354 reported crashes, 250 (70.6%) were property-damage-only crashes, 99 (28.0%) were injury-type crashes and five (1.4%) were fatal crashes. There were 95 (26.8%) night/dusk/dawn crashes reported, which is lower than the statewide average for all roadways of 30 percent, and 72 (20.3%) of the total crashes occurred under wet/slippery pavement conditions, which is higher than the statewide average for all roadways of 18 percent. Among the contributing causes documented in the crash data, work zone-related (95–27%), careless driving (90–25%) and improper lane change/passing (55–16%) were among the highest. There were no pedestrian or bicycle reported crashes. Rear end (139–39%), sideswipe (109–31%) and fixed object (52–15%) crash types had the highest frequencies.

b. Crash Tables and Diagrams

Crash tables and diagrams — such as heat maps, bar charts, pie charts or other maps graphically showing the common crash types, common crash causes, severity of crashes and high crash locations along a system or at an interchange — should be created. It is not required that each of these tables and diagrams be provided. It is recommended that a sufficient number of tables and diagrams are provided to adequately present the historic safety analysis. Examples of recommended tables and diagrams are shown in **Figure 3**.

Figure 3: Crash Table and Diagram Examples

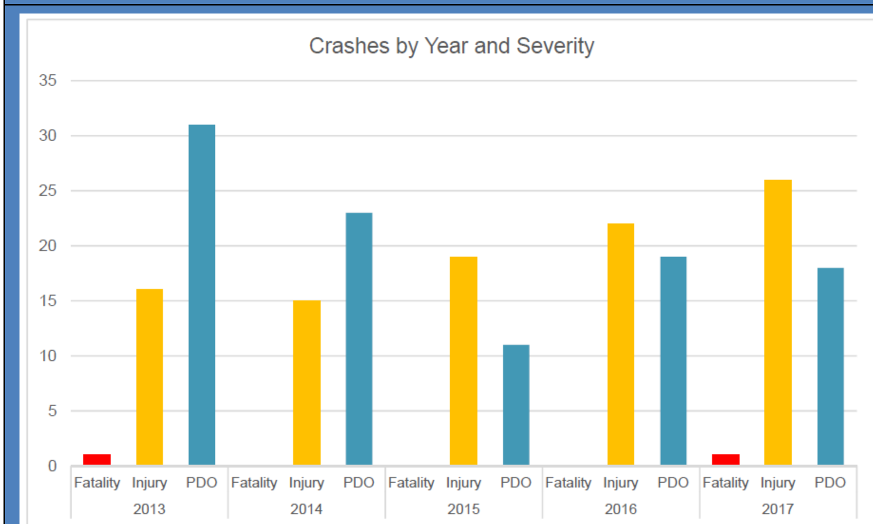
Crash Segment	Crash Type											Total
	Rear End	Head On	Sideswipe	Roll Over	Angle	Left Turn	Right Turn	Off Road	Pedestrian & Bicycle	Animal	Other	
I-75 SB Merge from SR 82	4	0	1	0	0	0	0	7	0	0	3	15
I-75 SB between SR 82 & SR 884	3	0	2	0	0	0	0	2	0	0	3	10
I-75 SB Diverge to SR 884	4	0	3	0	0	0	0	3	0	0	3	13
I-75 & SR 884 SB Off-Ramp	9	0	4	0	1	0	0	1	0	0	1	16
I-75 NB On-Ramp from WB SR 884	0	0	3	2	0	0	0	1	0	0	1	7
I-75 NB Merge from WB SR 884	2	0	4	0	0	0	0	5	0	0	3	14
I-75 NB between SR 884 & SR 82	1	0	0	0	0	0	0	2	0	0	0	3
I-75 NB Diverge to SR 82	2	0	1	0	0	0	0	2	0	0	2	7
Total	**25**	**0**	**18**	**2**	**1**	**0**	**0**	**23**	**0**	**0**	**16**	**85**
Percentage of Total	**29.4%**	**0.0%**	**21.2%**	**2.4%**	**1.2%**	**0.0%**	**0.0%**	**27.1%**	**0.0%**	**0.0%**	**18.8%**	**100%**

A table showing each crash segment broken down by crash type

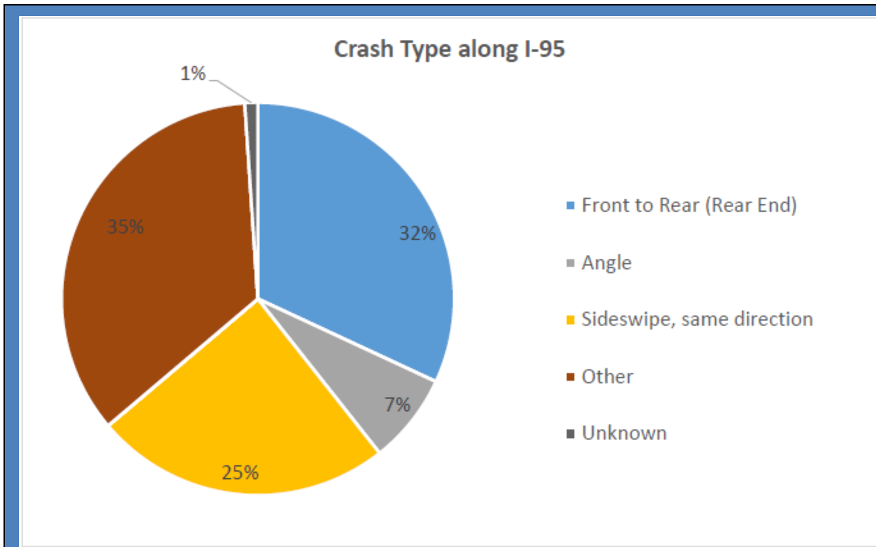
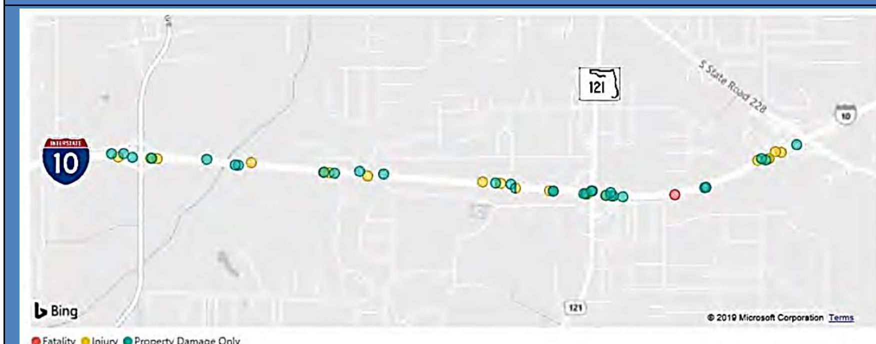
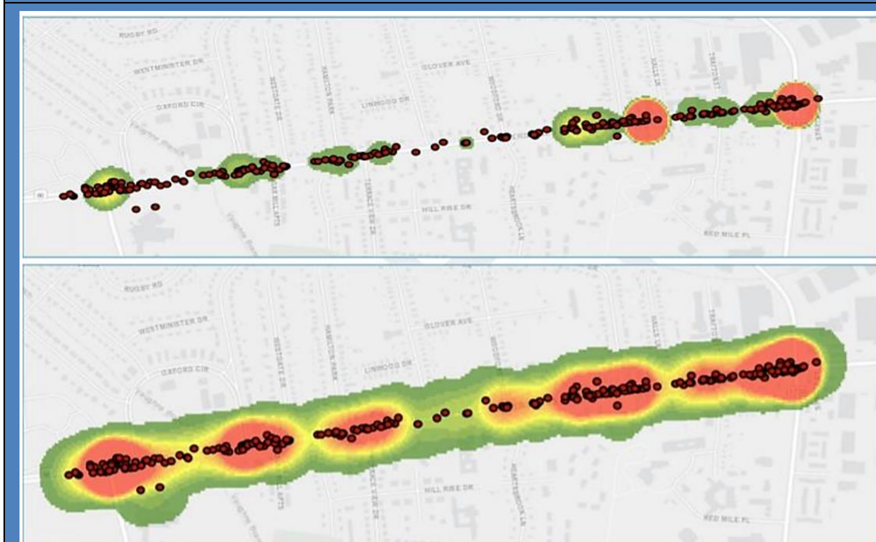
Crash Segment	Crash Frequency & Rate					
	Severity	No. of Crashes	Daily Volume*	Segment Length (miles)	No. of Crashes Per Year	Total Crash Rate
I-75 between SR 884 & SR 82	Total	**13**	93,500	0.46	2.60	0.16
	FI	3				
	PDO	10				
I-75 SB Merge from SR 82	Total	**15**	46,750	0.29	3.00	0.62
	FI	2				
	PDO	13				
I-75 SB Diverge to SR 884	Total	**13**	46,750	0.29	2.60	0.53
	FI	3				
	PDO	10				
I-75 & SR 884 SB Off-Ramp	Total	**16**	11,500	0.22	3.20	3.48
	FI	6				
	PDO	10				
I-75 NB On-Ramp from WB SR 884	Total	**7**	2,200	0.36	1.40	4.88
	FI	1				
	PDO	6				
I-75 NB Merge from WB SR 884	Total	**14**	46,750	0.29	2.80	0.58
	FI	3				
	PDO	11				
I-75 NB Diverge to SR 82	Total	**7**	46,750	0.29	1.40	0.29
	FI	3				
	PDO	4				

*Note: *Daily volume is 2018 AADT from the Florida Traffic Online (FTO) Website*

A table showing each crash segment broken down by crash frequency and crash rate



A bar chart showing yearly crashes broken down by crash severity

	A pie chart showing a corridor's crash type broken down by percentage
	A crash map showing crash locations by severity level
	A crash map showing crash frequency and heat map

c. <u>Calculation of Crash Rates</u>

Crash rates are reported as a measure of the existing safety condition as they help neutralize the number of crashes relative to traffic exposure variables. Actual crash rates are compared to statewide average crash rates for comparable facilities to determine if a crash location is a high-crash location. If a location has a higher crash rate than the statewide average, it should be noted and considered when recommending modifications. The most recent statewide average crash rates for Florida can be obtained from the FDOT Safety Office. Actual crash rates are calculated for roadway segments and intersections. The calculation of the roadway segment and intersection crash rates should be included in the existing safety analysis.

The roadway segment crash rate is calculated in crashes per million vehicle miles traveled. The roadway segment crash rate equation is:

$$Crash\ Rate = \frac{total\ number\ of\ crashes\ \times 1{,}000{,}000}{segment\ length\ \times AADT\ \times (number\ of\ years\ \times 365)}$$

Where:
Total number of crashes: total number of crashes over the existing safety analysis study period (e.g., five years)
Segment length: length of roadway in miles
AADT: Annual Average Daily Traffic (Average Daily Traffic can be used if AADT is not available)

The intersection crash rate is calculated in crashes per million entering vehicles. The intersection crash rate equation is:

$$Crash\ Rate = \frac{total\ number\ of\ crashes\ \times 1{,}000{,}000}{total\ intersection\ entering\ AADT\ \times (number\ of\ years\ \times 365)}$$

Where:
Total number of crashes: total number of crashes over the existing safety analysis study period (e.g., five years)
AADT: sum of daily traffic entering the intersection from each approach

Calculate the Freeway Crash Rate

An IAR is being performed along a 1.5-mile, six-lane urban interstate corridor. A review of the historic crash data shows 200 crashes have been reported between 2013 and 2017. The freeway segment has an AADT of 85,000. What is the segment's actual crash rate?

$$crash\ rate = \frac{total\ number\ of\ crashes\ \times 1{,}000{,}000}{segment\ length\ \times\ AADT\ \times (number\ of\ years\ \times 365)}$$

$$crash\ rate = \frac{200\ \times 1{,}000{,}000}{1.5\ \times 85{,}000 \times ((2017 - 2013) \times 365)}$$

$$crash\ rate = 1.074$$

In Florida, the statewide average crash rate for a similar urban interstate facility is 0.976. Because the actual crash rate is higher than the statewide average, this segment should be noted as a high-crash location.

d. Documentation

The safety analysis of the existing conditions should be summarized in the existing conditions section of the IAR. It should summarize crash rates, crash types, crash trends, high crash locations and other safety concerns using the methods and graphics discussed above. Existing safety analysis documentation should include a discussion about any fatal crashes and/or high-crash locations. Lastly, the discussion should include critical crashes involving pedestrians and cyclists since many of these crashes result in injury or fatality. It is not common practice in Florida to perform HSM Part C analysis for existing conditions. However, if the analyst deems it appropriate for the project, it can be performed. Any supporting data and calculations should be included in the appendix of the IAR.

Existing safety analysis documentation should include discussion about fatal crashes and high-crash locations.

1.6 Future Safety Analysis

The future safety analysis helps evaluate and compare the potential safety impacts of no-build and proposed alternatives in the IAR. Future safety analysis can be performed using the three methodologies shown in **Figure 4**.

Figure 4: Future Safety Analysis Methodologies

1. Countermeasure CMF methodology

2. HSM Part C methodology

3. Qualitative methodology
   - If countermeasure CMF or HSM Part C methodologies cannot be applied to the proposed modifications

The three methodologies can be applied in isolation or in combination depending on the type of proposed modifications. There is no single method that is applicable to all project conditions. The method chosen for future safety analysis depends on multiple factors such as availability of CMFs or SPFs, type of recommended modifications etc. It is possible that not all recommended modifications can be analyzed using the Countermeasure CMF or HSM Part C methodology. Hence a combination of the three methods may be necessary in such situations. This is illustrated by the four project examples shown below.

The three methodologies can be applied in isolation or in combination depending on the proposed modifications.

Project	Modification	Future Analysis Approach
1	Diamond Interchange to DDI	Countermeasure CMF Methodology
2	Interstate Widened from Four to Six Lanes	HSM Part C Methodology
3	Diamond Interchange to DDI and Interstate Widened from Four to Six Lanes	Combination of Countermeasure CMF and HSM Part C Methodologies
4	Convert Single Point Urban Interchange to a Diverging Diamond Interchange	Qualitative Methodology

1.6.1 Countermeasure CMF Methodology

A CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure. Therefore, CMFs are applied to the existing crashes observed without treatment to compute the expected crashes due to the proposed modification. For example, a project is recommending an intersection be converted to a high-speed roundabout. The existing intersection experiences a crash frequency of 10 crashes per year. A 4-star CMF from the CMF Clearinghouse, that is applicable to the recommended modification, is selected. The CMF, with a value of 0.659, is multiplied by the existing 10 crashes per year to determine the predicted crash frequency due to the recommended modification. It is predicted the conversion to the high-speed roundabout will result in 6.59 crashes per year or a reduction of 3.41 crashes per year.

CMFs are applied to the existing crashes to compute the expected crashes after modification.

The value of a CMF indicates how effective or ineffective a proposed modification could be. If a CMF of 1.0 is applied, it implies the proposed modification will have no effect on the number of crashes. If a CMF of greater than 1.0 is applied, it implies the proposed modification will increase the number of crashes. If a CMF of less than 1.0 is applied, it implies the proposed modification will decrease the number of crashes.

Another way to represent the reduction in crashes is the Crash Reduction Factor (CRF). A CRF is an estimate of the percentage reduction in crashes due to implementation of a countermeasure. The CRF is equal to 100*(1-CMF).

There are two types of CMFs: Countermeasure CMFs and HSM Part C CMFs.

1. Countermeasure CMFs should be used when performing the Countermeasure CMF methodology for IARs. Countermeasure CMFs are used to estimate how a countermeasure will change crashes at a specific location. Countermeasure CMFs are developed using multiple sites, studies and statistical methods. An example of a Countermeasure CMF is provided below.

Recommended countermeasure: A deceleration lane on the off-ramp is being extended from 150 feet to 350 feet.

Step 1: Research CMFs

Step 2: Select applicable CMF

For this recommended modification, the following CMF from the FHWA Clearinghouse is recommended:

Countermeasure: Change length of deceleration lane from 201-300 ft. to 601-700 ft.

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.155	84.47	★★★☆☆	All	All	Not specified	CHEN, ZHOU, AND LIN, 2012	

The application process of the Countermeasure CMFs, along with examples of when to use Countermeasure CMFs, is discussed in **Sections 1.6.1.3** and **1.6.1.4**, respectively.

2. HSM Part C CMFs are used in the predictive models as adjustment factors for the SPFs. Each SPF is applicable to a set of base geometric design and traffic control features. CMFs are used to adjust the SPF estimate and determine the predicted number of crashes to account for differences between the base geometric design and actual geometric design of the site. Each SPF has unique HSM Part C CMFs that are applicable to the SPF. The predicted number of crashes is shown in general form using this equation:

$$N_{predicted} = N_{SPF} \times (CMF_1 \times CMF_2 \times CMF_n)$$

Where:
$N_{predicted}$: site-specific predicted number of crashes
N_{SPF}: predicted number of crashes with base conditions
CMF_n: crash modification factor for treatment i to adjust N_{SPF} to site-specific geometric design and traffic control features

An example of the application of the HSM Part C CMFs is provided below.

Recommended modification: An off-ramp at the study interchange is being widened from one lane to two lanes.

Step 1: Select SPF equation — HSM Equation 19-20 (for multiple vehicle crashes):

$$N_{SPF\_Ramp} = L_r \times \exp\left(a + b \times \ln(c \times AADT_r) + d(c \times AADT_r)\right)$$

Step 2: Determine initial number of crashes under base geometric design and traffic features using SPF equation in Step 1

Step 3: Calculate all HSM Part C CMFs applicable to this ramp segment SPF from HSM Chapter 19.7

Step 4: Apply CMFs to the base SPF calculation to determine the number of crashes for project location, accounting for its unique geometric design and traffic features:

$$N_{predicted} = N_{SPF\_Ramp} \times (CMF_1 \times CMF_2 \times CMF_n)$$

1.6.1.1. Countermeasure CMF Sources

Countermeasure CMFs for several treatments have been developed over the years and can be found in the following three sources. For IARs, these sources should be used when selecting a Countermeasure CMF.

- Crash Modification Factors Clearinghouse
  - The CMF Clearinghouse, available at http://www.CMFClearinghouse.org, offers transportation professionals a central, web-based repository of CMFs, as well as additional information and

resources related to CMFs. The CMFs developed for the Clearinghouse are from studies performed in several parts of the world. It is important to review the study and specifics for each CMF used from the Clearinghouse to ensure it is applicable to the IAR-proposed modifications. The CMF Clearinghouse is regularly updated with new CMFs and provides additional information on how to apply these CMFs appropriately. Research on new CMFs is continuously being performed, and they are included in the clearinghouse after a sufficient review of the associated study. CMFs and CRFs are presented in the clearinghouse.

- HSM Part D

  Part D of the HSM includes some of the highest quality and most common Countermeasure CMFs. The CMFs in Part D have gone through a literature review, inclusion process and expert panel review. Part D includes all CMFs for a broad range of roadway segment and intersection facility types. The CMFs in the HSM Part D are also available on the CMF Clearinghouse portal. The HSM Part D CMFs are not updated as often as the CMF Clearinghouse.

  > HSM Part D CMFs are available on the CMF Clearinghouse portal.

  An example of a Countermeasure CMF in the HSM Part D for converting an at-grade intersection into a grade-separated interchange is shown below. In this example, the applicable CMF from the table is 0.58 to estimate the expected crashes for all crash severities, converting the at-grade intersection to a grade-separated interchange with four-leg intersection, under signal control.

HSM Table 15-2: Potential Crash Effects of Converting an At-Grade Intersection into a Grade-Separated Interchange

Treatment	Setting (Intersection Type)	Traffic Volume	Crash Type (Severity)	CMF	Std. Error
Convert at-grade intersection into a grade-separated interchange	Setting unspecified (four-leg intersection, traffic control unspecified)	Unspecified	All crashes in the area of the intersection (all severities)	0.58	0.1
			All crashes in the area of the intersection (injury)	0.43	0.05
			All crashes in the area of the intersection (noninjury)	0.64	0.1
	Setting unspecified (three-leg intersection, traffic control unspecified)		All crashes in the area of the intersection (all severities)	0.84	0.2
	Setting unspecified (three-leg or four-leg, signalized intersection)		All crashes in the area of the intersection (all severities)	0.73	0.08
			All crashes in the area of the intersection (injury)	0.72	0.1

Source: HSM Table 15-2

- FDOT CRFs
    - Florida began producing state-specific CRFs in April 2005. In 2005, the Lehman Center for Transportation Research at Florida International University produced the "Update of Florida Crash Reduction Factors and Countermeasures to Improve the Development of District Safety Improvement Projects" final report for the state safety office. The report focused on developing CRFs using Florida crash data. In 2014, the CRFs were updated. The current Florida CRFs are available at: https://www.fdot.gov/docs/default-source/roadway/qa/tools/CRF.pdf.

1.6.1.2. CMF Selection Criteria

Many CMFs and CRFs have been developed and are available for use; however, not all CMFs and CRFs should be used. It is important when selecting a CMF or CRF that the following criteria are followed.

The CMFs in the CMF Clearinghouse include quality ratings. A five-star rating indicates a greater level of confidence on estimating safety performance. CMFs with a star rating of three or higher should be used. The use of a CMF with two or fewer stars is not recommended for the IAR safety analysis. The

CMFs with star rating of three or higher should be used in IARs analyst should refer to the CMF Clearinghouse when performing safety analysis to ensure the proper CMF and screening criteria are being applied to the project. It is important the analyst perform this check because the CMF Clearinghouse is updated on a regular basis. Consider the following project example.

Select the Appropriate CMF from the CMF Clearinghouse

Question: Which CMF from the CMF Clearinghouse should be used?

Modification: Convert a diamond Interchange to a DDI in downtown Jacksonville

Determine applicable CMFs:

Countermeasure: Convert diamond interchange to Diverging Diamond Interchange (DDI) or Double Crossover Diamond (DCD)

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.54	46	★★☆☆☆	All	All	Urban	CHILUKURI ET AL., 2011	The authors computed the CMF ... [READ MORE]

Countermeasure: Convert diamond interchange to Diverging Diamond Interchange (DDI) or Double Crossover Diamond (DCD)

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.592	40.8	★★★★☆	All	All	Urban	CLAROS ET AL., 2015	This CMF applies to the ... [READ MORE]

CMF 3852 (top) will show a greater reduction in the number of crashes due to the proposed modification, but it has a two-star rating, while CMF 9104 (bottom) has a four-star rating. Because CMF 3852's star quality rating is two, it is not recommended for use in the predictive safety analysis.

Similar to the CMF Clearinghouse, the FDOT CRFs have limitations when selecting an FDOT CRF for IAR safety analysis. It is recommended, when using the FDOT CRFs, that a CRF based on fewer than five projects should not be used in the safety analysis. Take the following project example.

FDOT CRFs based on five or more studies should be used in IARs

Select the Appropriate CMF from the FDOT CRFs Spreadsheet

Question: Should the CRF from the FDOT CRFs Spreadsheet be used?

Modifications: Add a left turn at a T-intersection

Determine applicable CRFs:

ID	Modification	Number of Projects	CRF
20	Add LT (T-intersection)	3	42

FDOT CRF 20 could be used for this modification; however, the CRF is based on only three projects. Because the CRF is based on fewer than five studies, it is not recommended that this CRF be used for the predictive safety analysis.

1.6.1.3. Application of the Countermeasure CMF Methodology

Apply CMFs to conditions that closely match the conditions from which they were developed.

The Countermeasure CMF methodology begins with research and the selection of a CMF that applies to the proposed modification. When determining if a CMF applies, the analyst must consider the CMF's project context (e.g., roadway characteristics, surrounding environment, traffic control and traffic volume). Often, there are CMFs for the same modification that have different project contexts. It is very important to apply CMFs to conditions that closely match those from which they were developed in order to ensure the reliability and accuracy of the safety performance estimates. The following example presents a situation in which the appropriate CMF must be selected based on area type.

Select the Appropriate CMF Based on Area Type

Question: How many crashes are expected after the proposed modification?

Modification: Convert a diamond interchange to a DDI in downtown Jacksonville (urban)

Historic crash data: total number of crashes in the interchange area = 30 crashes/year

Step 1: Determine applicable CMFs (the following CMFs are from the CMF Clearinghouse)

- CMF 8258 (four-star rating) – 0.67
- CMF 9104 (four-star rating) – 0.592

Step 2: Check the CMF area type:

- CMF 8258 – suburban
- CMF 9104 – urban

Step 3: Select the appropriate CMF based on area type:

- CMF 9104 – 0.592

CMF 8258 was not selected, because the proposed modification is recommended in downtown Jacksonville, which is considered an urban area. CMF 8258 was developed for a suburban area, and as a result, it may not have direct relevance to the same modifications in the urban area.

Step 4: Calculate the predicted number of crashes

- Predicted number of crashes = 30 crashes/year x 0.592 = 17.76 crashes/year

It is important to note that both the studies in the above example have a star rating higher than the minimum requirement of three stars.

In addition to project context, each CMF is developed for a specific crash type and severity. The CMF selected for the IAR's proposed modifications should be applied to the crash type and severity for which the CMF was developed.

The following examples show the application of CMFs based on crash type and crash severity.

CMF Based on Crash Type

Modification: Convert a yield signal control to a signalized control

Countermeasure: Convert from yield signal control to signalized control

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.83	17	★★★★☆	Head on,Rear end	All	Urban	JENSEN, 2010	This CMF is for intersection ... [READ MORE]

If the above CMF was selected to estimate the change in crashes, it could only be applied to the existing head-on and rear-end crash types. It would be inappropriate to apply this CMF to the total number of crashes.

Select the Appropriate CMF Based on Crash Type

Question: How many rear-end crashes are expected after the proposed modification?

Modification: Convert a diamond interchange to a DDI in suburban Tampa

Historic Crash Data:

- Total number of crashes in the interchange area = 30 crashes/year
- Number of rear-end crashes in the interchange area = 10 crashes/year

Step 1: Determine applicable CMFs (the following CMFs are from the CMF Clearinghouse)

- CMF 8258 (4-star rating) – 0.67
- CMF 8317 (4-star rating) – 0.64

Step 2: Check applicable CMF crash type

- CMF 8258 – All
- CMF 8317 – Rear-End

Step 3: Select the appropriate CMF based on crash type

- CMF 8317 – 0.64

CMF 8258 was not selected because the analyst is interested in the number of rear-end crashes reduced due to the proposed modification. CMF 8258 was developed to account for all crash types, and as a result, should not be used for the predictive analysis.

Step 4: Calculate the predicted number of crashes

- Predicted number of crashes = 10 crashes/year x 0.64 = 6.40 rear-end crashes/year

CMF Based on Crash Severity

Modification: convert an intersection into a low-speed roundabout

Countermeasure: Conversion of intersection into low-speed roundabout

Compare	CMF	CRF(%)	Quality	Crash Type	Crash Severity	Area Type	Reference	Comments
☐	0.473	52.73	★★★★☆	All	Fatal,Serious injury,Minor injury	All	QIN ET AL., 2013	- Study included three-yearbefore and ... [READ MORE]

If the above CMF was selected to estimate the reduction in crashes, it could only be applied to the existing fatal and injury crashes. The CMF cannot be applied to property damage only or the total number of crashes.

Select the Appropriate CMF Based on Crash Severity

Question: How many Property Damage Only (PDO) crashes are expected after the proposed modification?

Modification: Convert a diamond interchange to a DDI in Miami.

Historic Crash Data:

- Total number of crashes in the interchange area = 30 crashes/year
- Number of PDO crashes in the interchange area = 15 PDO crashes/year

Step 1: Determine applicable CMFs (the following CMFs are from the CMF Clearinghouse)

- CMF 9104 (4-star rating) – 0.592
- CMF 9103 (4-star rating) – 0.649

Step 2: Check applicable CMF crash severity

- CMF 9104 – All
- CMF 9103 – PDO

Step 3: Select the appropriate CMF based on crash severity

- CMF 9103 – 0.649

CMF 9104 was not selected because the analyst is interested in the number of PDO crashes reduced due to the proposed modification. CMF 9104 was developed to account for all crash severities, and as a result, should not be used for the predictive analysis.

Step 4: Calculate the predicted number of crashes

- Predicted number of crashes = 15 PDO crashes/year x 0.649 = 9.735 PDO crashes/year

It is very important to review the details of the CMF described in this section before applying it to the project. The CMF Clearinghouse and HSM Part D provide a summary of the research used to develop the CMF. The summary provided includes details on the CMF's project context and applicable crash type and severity. It is crucial that this information is reviewed to ensure the selected CMF meets the minimum star rating and closely represents the project area conditions.

When multiple CMFs are applied in a project, the recommended HSM practice is to assume that CMFs are multiplicative, if they are assumed to be independent. Engineering judgement should be used to ensure that CMFs for similar treatments are not combined to estimate cumulative effects. Because there are limitations and uncertainties in combining multiple CMFs, it is suggested that no more than three CMFs should be used. The equation for combining multiple CMFs is:

$$N = N_B \times (CMF_1 \times CMF_2 \times CMF_3)$$

Where:
N: estimated crash frequency after application of CMF
NB: crash frequency under existing conditions
CMF_n: CMF associated with applicable modification

1.6.1.4 Examples of Countermeasure CMF Methodology Application

Common examples of modifications that can be evaluated using the Countermeasure CMF methodology are:

- Convert an unsignalized ramp terminal to a roundabout ramp terminal
- Convert a conventional signalized intersection to a signalized superstreet
- Convert a conventional signalized intersection to a continuous flow intersection
- Yield to signalized right-turn movements from an off-ramp to the arterial
- Add additional left- and/or right-turn lanes at adjacent arterial intersections
- Modify an adjacent arterial intersection
- Convert an at-grade signalized intersection to a grade-separated intersection at an interchange
- Convert a diamond interchange to a diverging diamond interchange (DDI)
- Add a right-turn lane and convert the yield to a signalized right-turn from an off-ramp to the arterial
- Convert a conventional signalized intersection to an RCUT-style intersection
- Increase the storage lane
- Add a turn bay

1.6.2 HSM Part C Methodology

The HSM Part C provides a predictive method for estimating the expected average crash frequency of freeway segments, merge/diverge segments, weaving segments, ramp segments, ramp terminals, arterial segments and arterial intersections. The predictive method is based on mathematical regression models known as Safety Performance Functions (SPFs). SPFs predict the crash frequency by facility type as a function of roadway characteristics and traffic volume for the existing and proposed conditions at a specific site.

SPFs predict the crash frequency by facility type as a function of roadway characteristics and traffic volume.

1.6.2.1 HSM Part C Methodology Analysis

This section discusses the application of the HSM Part C using SPF equations. The methodology discussed in this section should be used only when SPF equations applicable to the project modifications are available. The application of SPFs should be consistent with the HSM Part C. The SPF methodology for IARs can be summarized into 10 steps, as shown in **Figure 5**.

Figure 5: HSM Part C Methodology Steps for IARs

Step 1: Define the safety area of influence

Step 2: Define the analysis period

Step 3: Determine the AADT

Step 4: Segmentation of the study area

Step 5: Select and apply appropriate SPF

Step 6: Apply HSM Part C CMFs

Step 7: Apply Empirical Bayes method (if applicable)

Step 8: Sum predicted/expected crashes for all sites and years

Step 9: Apply appropriate FDOT Design Manual (FDM) KABCO crash distribution

Step 10: Compare and evaluate results

The 10 steps are discussed in more detail below.

Step 1: Define the Safety Study Area of Influence

For IARs, it is recommended that the overall study area for the future safety analysis be the same as the project area of influence. However, the future safety analysis needs to be performed only for elements within the area of influence that are anticipated to be affected by the proposed modifications. If the proposed modifications will influence a roadway segment or intersection within the project area of influence, it should be included in the predictive safety analysis. For example, if a new interchange is proposed, then the adjacent interchanges should be included in the future safety analysis. This is because the traffic at the adjacent interchanges will most likely change due to the new interchange, resulting in a change in anticipated crashes at the existing adjacent interchanges. If a modification to an existing interchange is proposed, in most cases the adjacent interchanges are not affected and, therefore, no future safety analysis is needed at the adjacent interchanges.

Future safety analysis needs to be performed only for elements within the area of influence that are anticipated to be affected by the proposed modifications.

Step 2: Define the Analysis Period

Future predictive safety analysis should be performed between the opening year and design year.

The future predictive safety analysis should be performed between the opening year and design year of the project. The safety impacts due to the proposed project modifications should be evaluated for the entire life of the project. *There are some instances when it is not feasible to perform a safety analysis for the entire life of the project between the opening year and design year,* such as when the Empirical Bayes method is performed using ISATe tool. The ISATe tool can perform a safety analysis only up to a 24-year period. The Empirical Bayes method is used when the proposed modification does not create a major geometric modification; therefore, the analysis is performed starting from the existing year of the project. This results in total analysis years being more than 24 years and cannot be analyzed in ISATe. When this situation occurs, it is recommended to perform an analysis for all the analysis years that are possible using the tool and the limitation discussed in the IAR document. It is not recommended to extrapolate the total crashes.

It is not recommended to extrapolate the total crashes.

Step 3: Determine AADT

A major input, in the SPF equations that predicts the number of crashes, is AADT. It is important to obtain the appropriate AADT needed to perform the safety analysis for the proposed changes. Typically, AADT is not developed for all the years between the opening year and design year of an IAR. To perform the safety analysis, it is important to estimate the AADT for each year in the evaluation period. Some tools, such as ISATe and IHSDM, perform an AADT interpolation within the tool. Other tools, such as HSM spreadsheets, will require the analyst to develop AADTs for each year in the analysis period. If the Empirical Bayes method is used, AADT data is needed for each year, following the existing year and up to the design year.

It is important to estimate the AADT for each year in the evaluation period.

Step 4: Segmentation of the Study Area

The next major step in determining the predicted number of crashes is the segmentation of the study area. The segmentation should follow the recommended procedures outlined in the HSM. For IAR documents, the segmentation only needs to occur for the areas where the proposed modifications are being implemented. After the study area is segmented, the appropriate SPFs can be selected for each segment, and the data needed to implement each SPF can be collected. Segmentation can be one of the most time-consuming parts of the HSM Part C analysis, but it can provide the analyst a lot of useful data needed to perform an accurate SPF analysis.

For IARs, segmentation needs to occur for the areas where the proposed modifications are being implemented.

It is important to note that each HSM predictive model has different segmenting requirements; therefore, the analyst should refer to the appropriate HSM chapter for segmentation details. The following segmentation processes in the HSM should be followed:

- Rural two-lane, two-Way roads (Chapter 10)
- Rural multilane highways (Chapter 11)
- Urban and suburban arterials (Chapter 12)
- Freeways (Chapter 18)
- Ramps (Chapter 19)

When performing segmentation for roadway segments, the HSM recommends that segment lengths be between 0.1 and 1.0 miles

When performing the segmentation process for roadway segments (arterials, highways and freeways), the HSM recommends that segment lengths be between 0.1 and 1.0 miles. The lengths in this range should be long enough to have statistical validity and short enough to be realistically homogenous. If the roadway segment length is outside the recommended range, it should be discussed in the safety analysis. Roadway segments are segmented into these homogenous sections, which have the similar attributes provided in **Figure 6**.

Figure 6: Segmentation Attributes

- Traffic volume
- Key geometric design features
  - Number of through lanes, lane width, outside and inside shoulder width, median width, presence/type of median, ramp presence, clear zone width, etc.
- Land use type
- Traffic control features

Intersection segmentations should be considered separately, because they are treated as points. For intersections, crashes within 250 feet of the intersection are assigned to the intersection. It is important that all crashes counted within these 250 feet are not double-counted in the roadway segment. The segmentation of the ramp terminal intersections should also be considered separately in the analysis, and all crashes within the influence area of 250 feet of the ramp terminal should be assigned to the ramp terminal.

> For intersections and ramp terminals, crashes within 250 feet are assigned to the intersection or ramp terminal.

Figure 7 provides an example of the arterial segmentation process at a study interchange.

Figure 7: Segmentation Example for an Arterial

Figure 8 provides an example of the freeway segmentation process at a study interchange.

Figure 8: Segmentation Example for a Freeway

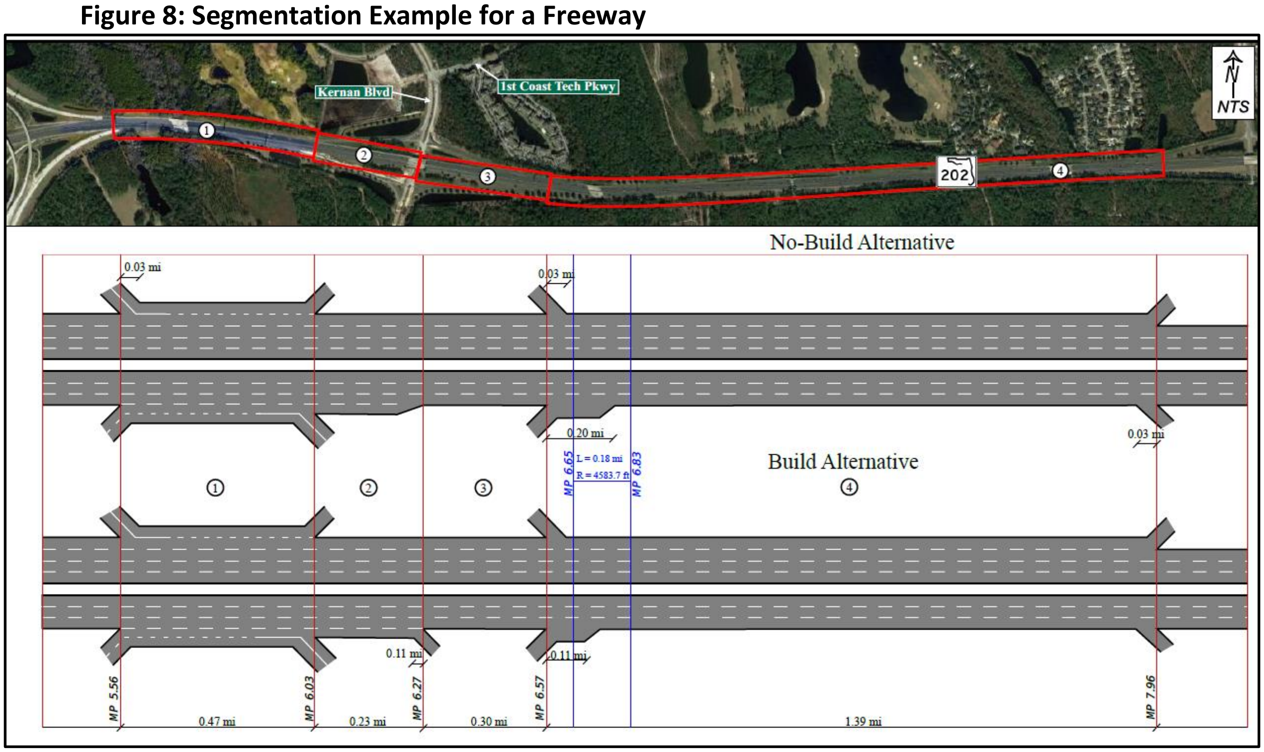
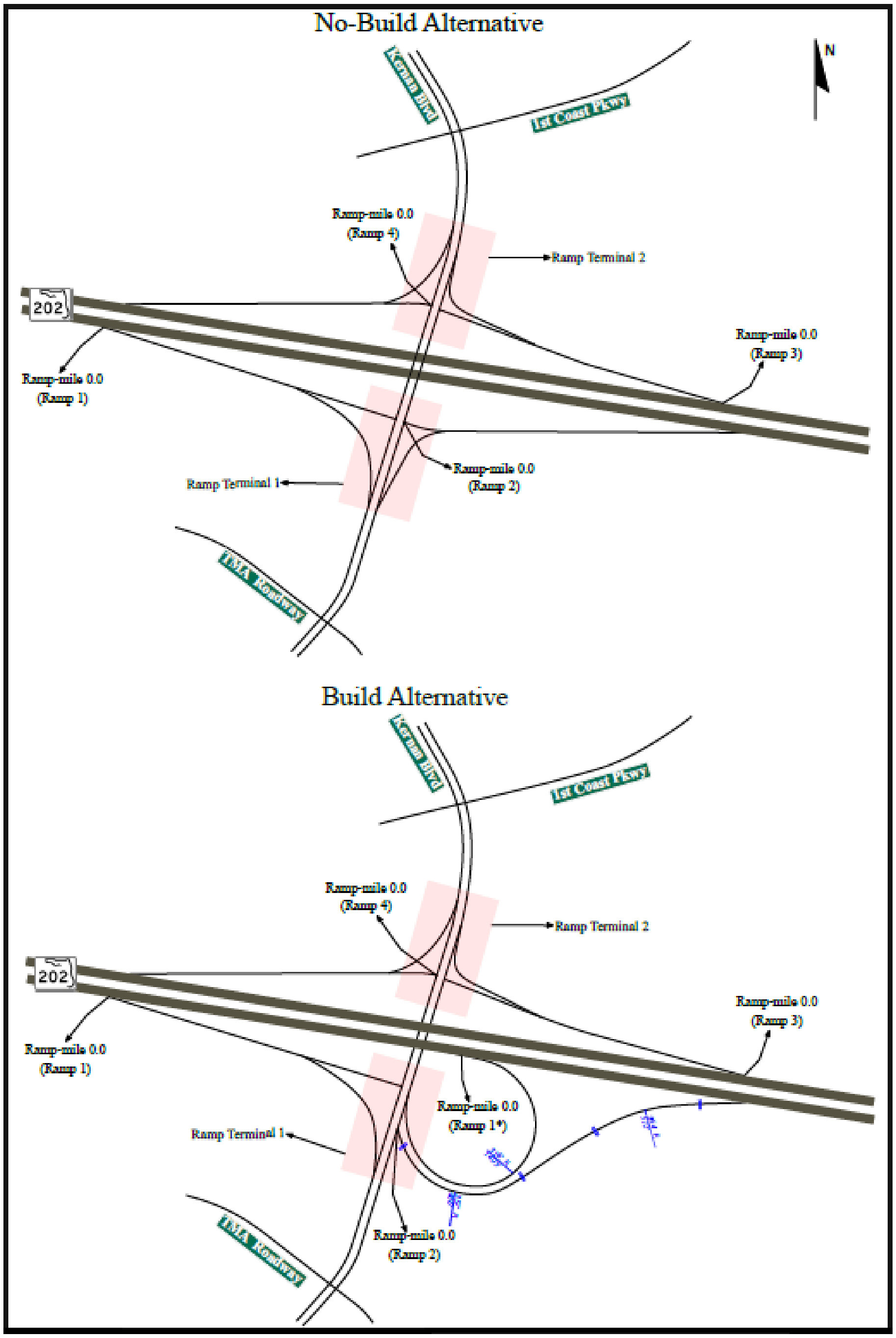


Figure 9 provides an example of the ramp segmentation process at a study interchange.

Figure 9: Segmentation Example for Interchange Ramps



Step 5: Select and Apply the Appropriate SPF

The HSM has developed multiple SPFs based on different site conditions. In this step, the analyst should review the available SPF equations and determine which SPF equation represents the site conditions most appropriately. For example, SPF equations have been developed for varying ramp terminal configurations. If the study ramp terminal is at a four-leg diamond interchange, the four-leg terminals with diagonal ramps SPF should be applied.

When performing HSM Part C methodology analysis, it is important to note that arterial intersection SPF analysis should not be applied at the ramp terminals or vice versa. This is important, because independent SPF equations have been developed for each intersection type to account for the different operational characteristics.

Arterial intersection SPF analysis should not be applied to ramp terminals or vice versa.

It is important to review the site conditions being analyzed and ensure the appropriate SPF is used. The predicted number of crashes calculated using the SPF equations in this step are for base geometric and traffic characteristics.

Step 6: Apply the HSM Part C CMFs

To adjust the predicted number of crashes to the segment's specific geometric and traffic characteristics, HSM Part C CMFs are used to adjust the base condition's SPF crash estimate, as explained in **Section 1.6.1**. In Step 6, the CMF adjustments are applied to the base condition's predicted number of crashes. An example is provided below that shows how the HSM Part C CMFs are applied. The tools available to perform the HSM Part C safety analysis (HSM spreadsheets, ISATe or IHSDM) should include the CMFs from the HSM Part C. After determining the predicted number of crashes, the HSM recommends that regional calibration factors be applied to the predicted number of crashes to calibrate the crashes to regional conditions. FDOT has developed calibration factors for rural and urban arterial roadway segments and intersections. HSM calibration factors for Florida can be found in the FDOT Design Manual (FDM), Chapter 122. At this time, FDOT has not developed calibration factors for interstate analysis, and they should not be applied to arterials within the interchange area. The application of calibration factors to arterials outside the interchange area should be based on engineering judgment because they could have a disproportionate effect on results.

At this time, FDOT has not developed calibration factors for interstate analysis.

Determine the Predicted Number of Crashes on the Ramp Segment

Question: How many fatal injury crashes are predicted along the 2-lane urban off-ramp based on the following conditions?

Step 1: Collect the site specific conditions

- Ramp Type: Diverge
- Length of Segment: 0.2 miles
- Ramp AADT: 12,000
- Horizontal Curve: No
- Lane Width: 14 feet
- Right Shoulder Width: 12 feet
- Left Shoulder Width: 10 feet
- Right and Left Side Barrier: Not Present
- Ramp Speed Change Lane: No
- Lane Add or Drop: No

Step 2: Calculate the Base Conditions Fatal Injury SPFs

- Multiple Vehicle (MV) Fatal Injury Crashes: 0.019 crashes (calculated using HSM equation 19-20)
- Single Vehicle (SV) Fatal Injury Crashes: 0.222 (calculated using HSM equation 19-24)
- Total Fatal Injury Crashes: 0.241 crashes (sum of Multiple and Sigle Vehicle crashes)

Step 3: Calculate HSM Part C Fatal Injury CMFs using HSM equations from HSM Chapter 19.7:

CMF	Fatal Injury	
	Multiple Vehicle	Single Vehicle
Horizontal Curve	1.000	1.000
Lane Width	1.000	1.000
Right Shoulder Width	0.806	0.806
Left Shoulder Width	0.724	0.724
Right Side Barrier	1.000	1.000
Left Side Barrier	1.000	1.000
Lane Add or Drop	1.000	1.000
Ramp Speed-Change Lane	1.000	

Step 4: Apply HSM Part C CMF adjustments to calculate the site specific predicted number of crashes

$$N_{MV\_predicted} = 0.019 \times (1.000 \times 1.000 \times 0.806 \times 0.724 \times 1.000 \times 1.000 \times 1.000 \times 1.000)$$
$$N_{MV\_predicted} = 0.011 \text{ crashes}$$

$$N_{SV\_predicted} = 0.222 \times (1.000 \times 1.000 \times 0.806 \times 0.724 \times 1.000 \times 1.000 \times 1.000)$$
$$N_{SV\_predicted} = 0.130 \text{ crashes}$$

$$N_{predicted} = 0.011 + 0.130 = 0.141 \text{ crashes}$$

To calculate the property damage only (PDO) predicted number of crashes, the same process will be followed but using HSM Part C PDO CMFs from HSM Chapter 19.7. The total predicted number of crashes due to the modifications would be the sum of the Fatal Injury and PDO crashes.

Step 7: Apply the Empirical Bayes Method

The Empirical Bayes method combines the observed and predicted number of crashes to determine the expected number of crashes at the study segment. The Empirical Bayes method uses historic crash data and, therefore, can only be applied to proposed conditions that are not substantially different from the existing roadway geometry or land use context. For Interchange Operational Analysis Reports (IOARs) and Interchange Modification Reports (IMRs), the use of the Empirical Bayes method should be considered on a case-by-case basis. The Empirical Bayes method should only be used if site-by-site observed crash data is available and geometric features for the no-build and build conditions are comparable. The Empirical Bayes method should not be applied for Interchange Justification Reports (IJRs). If the Empirical Bayes method does not apply to all the considered alternatives, it should not be incorporated in the predictive safety analysis. For example, if the build alternative proposes major geometric modifications, the no-build alternative should not be analyzed using the Empirical Bayes method, because the build alternative will not be able to use the Empirical Bayes method. This is done to ensure a direct comparison of the predicted safety analysis between the alternatives.

> Empirical Bayes method can only be applied to proposed conditions that are not substantially different from the existing conditions.

> If Empirical Bayes Method does not apply to all alternatives, it should not be incorporated in the predictive safety analysis.

Some examples of projects where the Empirical Bayes method should be applied include:

- Projects in which the roadway geometrics and traffic control are not being changed
- Projects in which the roadway cross-section is modified but the basic number of through lanes remains the same (e.g., widening of lanes or shoulders, but the number of through lanes stays consistent with the existing conditions)
- Projects in which minor changes in alignment are made (e.g., flattening horizontal curves)

The Empirical Bayes method would not be applied to the following project examples:

- Projects in which a new alignment is developed or a new interchange is proposed.
- Intersections at which the basic number of legs or type of traffic control is changed as part of the project (e.g. conversion of T intersection to a 4-legged intersection, stop control to signal control).
- Widening of a roadway (e.g., adding new lanes or median)

Engineering judgment should be applied when determining if the Empirical Bayes Method is applicable to the project.

Step 8: Combine the Predicted/Expected Crashes for All Sites and Years

Once the predicted safety analysis has been performed for all applicable sites and years, combine the crashes for each segment into a total number of crashes for the alternative. This will allow for a comparison of the alternatives.

Step 9: Apply the Appropriate FDM KABCO Crash Distribution

In addition to reporting the total number of crashes, it is recommended to distribute the total number of crashes using the KABCO injury classification scale. A summary of the KABCO scale is in **Table 1**.

Table 1: KABCO Injury Classification Scale for Florida

Injury Severity	Abbreviation	Definition
Fatal Injury (within 30 days)	K	Any injury that results in death within 30 days after the crash occurred.
Incapacitating Injury	A	Disabling injuries, such as broken bones, severed limbs, etc. These injuries usually require hospitalization and transport to a medical facility
Non-Incapacitating Evident Injury	B	Non-disabling injuries, such as lacerations, scrapes, bruises, etc.
Possible Injury	C	
No Injury	O	Also known as property damage only (PDO)

Various KABCO scales have been prepared, and tools such as ISATe will use a default KABCO scale that is based on national averages. For IAR projects in which the total crashes are broken down into the KABCO scale, the HSM Crash Distribution for Florida must be used. The HSM Crash Distribution for Florida can be found in FDM Chapter 122.

When crashes are broken down into KABCO scale, HSM Crash Distribution for Florida must be used.

Step 10: Compare and Evaluate the Results
After the analysis for all alternatives is complete, compare and evaluate the final results.

An example incorporating all ten steps of the HSM Part C Methodology is provided in **Appendix A-1**.

Benefit-Cost Analysis

Safety-based benefit-cost analysis is not required in IARs.

IARs are typically initiated to resolve congestion and operational concerns. The total project cost in most cases significantly outweighs the savings due to a reduction in crashes. Therefore, safety-based benefit-cost analysis is not required in IARs.

1.6.2.2. HSM Part C Methodology Analysis Tools

The manual application of the HSM Part C methodology is a cumbersome task and can lead to more analyst errors due to the complexity of the SPF equations and the high number of required inputs. To simplify and expedite the predictive safety analysis process, the following three tools in **Figure 10** are recommended to perform the predictive safety analysis using SPFs:

Figure 10: HSM Part C Methodology Analysis Tools

1. HSM spreadsheets
2. Enhanced Interchange Safety Analysis Tool
   - ISATe
3. Interactive Highway Safety Design Model
   - IHSDM

A description of each tool and its pros and cons is provided below.

HSM Spreadsheets

Various spreadsheets have been developed throughout the country and state to implement the HSM predictive method. The spreadsheets prepared apply the HSM Part C methodology and allow for simpler calculations of the predicted number of crashes. Any HSM spreadsheets that are developed and used must be consistent with the methodology presented in the HSM Part C for predicting crashes for each facility type and checked for errors prior to their use. HSM Spreadsheets are available on the AASHTO website. The pros and cons of the HSM spreadsheets are in **Table 2**.

HSM spreadsheets that are developed and used must be consistent with the methodology in HSM Part C.

Table 2: Pros and Cons of the HSM Spreadsheets

Pros	Cons
▪ Simple data entry ▪ Quick results for a small project area ▪ Analysis for all HSM SPF equations can be performed	▪ Can perform one year of safety analysis ▪ Program does not summarize multiple roadway segments ▪ Spreadsheets can be cumbersome

Enhanced Interchange Safety Analysis Tool (ISATe)

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. As part of this project, the ISATe tool and a User Manual were developed.

ISATe cannot be used to evaluate arterial segments outside of the interchange area and ramp terminals. If modifications are being recommended along the arterial or at adjacent intersections, another tool must be used to perform the predictive safety analysis.

ISATe cannot be used to evaluate arterial segments outside the interchange area and ramp terminals.

ISATe includes algorithms and equations that are implemented in a Microsoft Excel workbook as software (using the Visual Basic for Applications programming language). To perform the safety analysis in ISATe, the study area must be segmented into homogenous sections. The study area should be broken down into three categories: freeway segments, ramp segments and ramp terminals. Please refer to chapters 18 and 19 of the HSM or Chapter 2 of the ISATe User Manual for proper segmentation guidelines. After the segmentation is complete, the analyst enters the geometric and traffic data for the study segments. The pros and cons of the ISATe analysis tool are in **Table 3**.

Table 3: Pros and Cons of ISATe

Pros	Cons
▪ Validated safety analysis tool ▪ Extrapolates AADT ▪ Analyzes multiple years of safety analysis ▪ Analyzes multiple freeway segments ▪ Summarizes freeway segments ▪ Useful for small interchange projects ▪ Empirical Bayes method incorporated in program ▪ Provides user-friendly data entry and output sheets	▪ Does not perform arterial segment or arterial intersection predictive safety analysis ▪ Can analyze a maximum of 24 consecutive years ▪ Does not perform automatic segmentation ▪ Can cause difficulties for large project areas

Interactive Highway Safety Design Model (IHSDM)

The IHSDM is an FHWA software analysis tool that applies the HSM predictive method. The standalone software package has multiple modules that allow for different variants (station or site-based analyses) for the evaluation of rural highways (two-lane and multilane), arterials (urban and suburban), freeways (segments, ramps and interchanges) and intersections.

- The station-based analysis approach allows the user to either import roadway geometry features directly from a design alignment file or manually input the stationing and features. The station-based analysis allows for the automation of the segmentation and improves the accuracy of the analysis, because alignments are directly imported without translation.
- The site-based analysis approach is more simplified. The user must manually input roadway data and must manually segment the study network.

Either analysis approach can be used, as long as the facility type is covered within the IHSDM. The output results are the same for either approach.

The analyst can select either one or a combination of the HSM Part C analysis tools

The following pros and cons of the IHSDM are in **Table 4**.

Table 4: Pros and Cons of IHSDM

Pros	Cons
▪ Extrapolates AADT ▪ Analyzes multiple years of safety analysis ▪ Analyzes multiple roadway segments ▪ Performs analysis for all HSM SPF equations ▪ Can perform automatic segmentation ▪ Useful for large study area ▪ Empirical Bayes method incorporated in program	▪ Data intensive ▪ Must code and develop complete study area to perform analysis ▪ Takes a lot of time to code the network ▪ Making changes to the analysis could be time consuming and cumbersome

Based on the project conditions and alternatives, the analyst can utilize any one or a combination of the tools listed above to perform the predictive safety analysis in IARs.

1.6.2.3. HSM Part C Methodology Limitations

The HSM provides several predictive models that are helpful in the safety analysis and comparison of various alternatives. But there are some limitations that exist in the methodology. Some of these limitations of the HSM Part C encountered in IARs include:

- It does not account for traffic variability, because the HSM analysis uses AADT volumes.
- The HSM assumes the independence of geometric and traffic control features on crash occurrences.
- It does not account for the influence of freeways with eleven or more through lanes in urban areas.
- It does not account for the influence of freeways with nine or more through lanes in rural areas.
- It does not perform a safety analysis for freeways with high-occupancy vehicle lanes, toll plazas, reversible lanes, hard shoulders, ramp metering and managed lanes.
- It does not account for a ramp or collector-distributor roads with two or more lanes in rural areas or three or more lanes in urban areas.
- It does not account for the influence of unique or innovative intersection or roadway designs (e.g., DDI, continuous flow intersection, Texas U-turns, etc.).
- It does not account for the influence of a crossroad ramp terminal with three or more left-turn lanes on a crossroad approach.
- It does not account for the influence of a crossroad ramp terminal that provides one-way travel or when the ramp terminal is a single-point urban interchange (SPUI) or roundabout.

When performing a safety analysis, if one of the above listed limitations is experienced, discuss the limitation in the IAR and refer to the process flow chart in **Section 1.4** to perform the appropriate safety analysis for the project.

1.6.2.4. Examples of HSM Part C Methodology Application

Common examples of modifications that can be evaluated using the HSM Part C methodology are provided below:

- Implement a new interchange
- Complete basic movements at an existing partial interchange
- Convert a partial cloverleaf interchange to a diamond interchange
- Convert a diamond interchange to a partial cloverleaf interchange
- Modifications to freeway segments:
  - Addition or removal of general use lanes
  - Addition or removal of speed-change lanes (merge/diverge lanes)
  - Extension or shortening of speed-change lanes
  - Addition or removal of ramp segments
  - Widening a ramp segment from one to two lanes
  - Addition or removal of an auxiliary lane that creates or eliminates a weaving section
- Convert an unsignalized intersection to a signalized intersection at a ramp terminal
- Addition or removal of left- and/or right-turn lanes from the off-ramp to the arterial
- Addition or removal of left-turn lanes from the arterial to an on-ramp
- Convert a left-turn signal phase from permissive or protected/permissive to protected
- Addition of through lanes along the arterial
- Modifications to an existing diamond or partial cloverleaf interchange geometry
- Provide a non-ramp public street leg at a ramp terminal
- Reconfigure an adjacent arterial's unsignalized and/or signalized intersection
  - Convert an unsignalized intersection to signalized
  - Convert turn lanes to shared turn/through lanes
  - Convert shared turn/through lanes to turn lanes
- Addition or removal of an adjacent arterial intersection

1.6.3 Qualitative Safety Methodology

A qualitative safety analysis must only be performed if the quantitative safety analysis cannot be performed for the project modifications using the CMFs/CRFs or HSM Part C methodology. Priority should be given to the quantitative safety assessment of project alternatives. If quantitative assessment is not feasible, then qualitative safety methodology should be applied. A qualitative safety analysis should include a detailed discussion about the limitations of the quantitative safety analysis techniques in evaluating the safety impacts of the proposed modifications. The qualitative discussion should then list the anticipated impacts on safety due to the recommended modifications. If appropriate, additional qualitative safety discussion can be provided to supplement quantitative safety analysis. A project example of qualitative discussion is in **Appendix A-2**. An excerpt from the discussion is below.

> Qualitative safety analysis should include a discussion about the limitations of the quantitative safety analysis techniques.

The I-95 at Glades Road IMR Re-Evaluation recommended that a partial cloverleaf interchange be converted to a diverging diamond interchange (DDI). This modification cannot be performed using CMFs or SPFs.

"Since no other tools can account for the DDI configuration, the safety benefits of converting a partial cloverleaf interchange to DDI was based on previous researches that 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."

1.6.4 Common Safety Analysis Questions

Interchange designs can be innovative and complex, thereby creating uncertainties when performing the safety analysis in IARs. It is also common to prepare IAR re-evaluations. The following questions are commonly asked pertaining to quantitative safety analysis.

<u>Question 1: What type of analysis can be performed if some, but not all, of the proposed modifications can be analyzed using the HSM Part C methodology?</u>

If some of the proposed modifications can be analyzed using the HSM Part C, then those segments should be analyzed using the HSM Part C methodology. For the modifications that cannot be analyzed using the HSM, ask, "Is there a CMF for the proposed modification?" If there is a CMF for the proposed modification, apply the Countermeasure CMF methodology, and document the safety benefits of the proposed modification. It is also important to document in the IAR the limitations of the HSM Part C methodology and explain why the proposed modifications could not be analyzed using SPFs. If there are no Countermeasure CMFs that can be applied to the proposed modification, discuss qualitatively the expected safety benefits of the proposed modifications. It is recommended the qualitative discussion be backed with data and research, if available. An example of similar condition is in **Appendix A-2**.

<u>Question 2: What type of safety analysis should be performed for an IAR re-evaluation?</u>

First, a quantitative safety analysis is required for all IAR re-evaluations, and it must follow the safety analysis requirements discussed in this guidance. For re-evaluations, a safety analysis must be performed only for the proposed modifications discussed in the re-evaluation. For instance, if the original approved IAR recommended the conversion of a diamond interchaynge to a DDI, and the re-evaluation recommends the addition of lanes on the ramp segments, then the safety analysis in the re-evaluation should only be performed for the addition of lanes on the ramp segments. An IAR re-evaluation must follow the guidelines for the future safety analysis. An example of safety analysis in IAR re-evaluation is in **Appendix A-3**.

Question 3: What if a quantitative safety analysis cannot be applied?

It is recommended to follow the safety analysis process flow chart when performing a quantitative safety analysis. If none of the proposed modifications can be analyzed using the Countermeasure CMF or HSM Part C methodologies, then document in the IAR and the limitations of the quantitative safety analysis and explain why the proposed modifications could not be analyzed using CMFs or SPFs. Then, as depicted in the process follow chart, provide a qualitative discussion of the expected safety benefits of the proposed modifications. It is recommended the qualitative discussion be backed with data and research, if available. Consider the following example:

> A single-point urban interchange (SPUI) was evaluated to replace a diamond interchange. The following approach was followed to perform the future safety analysis:
>
> SPF and CMFs were reviewed to ensure that the modifications could not be quantitatively analyzed. No SPF or CMFs were discovered to perform a quantitative safety analysis for the proposed modification of converting a diamond interchange to a SPUI. Because there are no SPFs or CMFs applicable, a literature review was conducted. The findings from the literature review were discussed qualitatively in the IAR document. The qualitative discussion included the expected safety benefits of the proposed modification, and information from the literature review to support the conclusions were provided.

Question 4: What if the Countermeasure CMF and HSM Part C methodologies are applicable to the proposed modification?

Some modifications could be analyzed using the Countermeasure CMF and HSM Part C methodologies. For example, Countermeasure CMFs are available for increasing the number of lanes from four to six in the CMF Clearinghouse. The same modification can be analyzed using SPFs from the HSM Part C methodology. It is important that Countermeasure CMFs and SPFs not be applied to the same modification. It is recommended that SPFs should be used over the CMFs in this situation, because they are developed based on the high level of research and undergo an extensive review process.

1.7 Documentation

Sufficient documentation must be provided for each step of the IAR safety analysis.

For existing safety analysis documentation, refer to the guidance in **Section 1.5**.

The future safety analysis documentation required in the IAR is determined by the method used to perform the analysis (Countermeasure CMF, HSM Part C or qualitative safety analysis). The safety analysis for proposed modifications should document how the IAR proposal would improve the identified safety problems.

1.7.1 Qualitative Safety Analysis

A qualitative safety analysis should include a discussion on the limitations of the quantitative safety analysis and the anticipated safety impacts of the proposed modifications. It is recommended that the discussion provided is supported by additional research and data, if available. Any supporting data should be included in the appendix of the IAR.

1.7.2 Countermeasure CMF Methodology

If the Countermeasure CMF methodology is applied, the documentation should discuss each applicable CMF to every proposed modification. The documentation for the selected CMFs should include:

- CMFs considered and selected for each proposed modification
- CMF characteristics (e.g., base conditions and CMF criteria)
- Summary and values of CMFs
- Justification for selected CMFs
- Source of the selected CMFs

The documentation should summarize the selected CMF and the results of applying the CMF to the proposed alternatives. The text should describe the interpretation of the results, any caveats and recommendations based on the analysis. All supporting data and calculations should be included in the appendix.

1.7.3 HSM Part C Methodology

If the HSM Part C methodology is applied to the no-build and build alternatives, the discussion should summarize the analysis, the results and the interpretation and conclusions based on the analysis. A discussion for each alternative evaluated should include:

- Discussion of the modifications analyzed, years analyzed and tool used in the analysis (e.g., HSM spreadsheets, ISATe or IHSDM)
- Explanation of assumptions needed to perform the analysis, the rationale for the assumptions and the potential implications to the results
- Discussion of the segmentation process for the reviewer to verify the approach
- Presentation, explanation and comparison of the results of the analysis for all alternatives. The results of the analysis will likely be presented as a mix of tables and text showing the predicted/expected crashes. The results should show how the individual components (e.g., ramp terminal intersections, freeway segments, ramp segments, etc.) will perform due to the

recommended modifications. The documentation should compare the results of the analysis for each alternative and present the safety outcomes associated with the estimated future crash conditions. The alternatives analyzed for the safety analysis should be consistent with the alternatives for which operational analysis was performed.

Any supporting data and calculations, such as safety analysis tool input and output data sheets, should be included in the appendix of the IAR.

1.7.4 Safety Analysis Types and Work Estimate

When preparing the IAR safety analysis, it is important to consider the tasks that will have to be performed and the time needed to perform these tasks. **Table 5** provides a brief summary of the safety analysis tasks required under each methodology and the approximate time required to complete them.

Table 5: Safety Analysis Types and Work Estimate

Analysis Type	Safety Analysis Process							Time Estimate
HSM Part C Methodology	Calculation of Crash Rates	Crash Diagrams	Description of Existing Crash Trends	Safety Performance Functions	Empirical Bayes Method (if applicable)	Crash Reduction Estimation (CMFs/CRFs)	Documentation	80 - 160 Hours* (Including Existing Conditions)
Countermeasure CMF Methodology	Calculation of Crash Rates	Crash Diagrams	Description of Existing Crash Trends	→	→	Crash Reduction Estimation (CMFs/CRFs)	Documentation	30 - 60 Hours (Including Existing Conditions)
Existing Conditions	Calculation of Crash Rates	Crash Diagrams	Description of Existing Crash Trends	→	→	→	Documentation	20-40 Hours

*Hours will vary based on multiple factors such as analysis area, application of Empirical Bayes Method, etc.

Appendix A
Example Safety Studies

Appendix A-1 Example Safety Studies – JTB at Kernan Boulevard IMR

The total and denied delay per vehicle was documented at over 13 minutes during the AM peak hour and nearly 10 minutes during the PM peak hour. With the expected increase in traffic demand in the future within the study area limits, these delays can be expected to drastically increase as the facility reaches its capacity.

The Existing Year (2019) analyses output reports are provided in **Appendix D**.

3.6 Existing Crash Data

Crash data for the area of influence for the most recent five years (2015 to 2019) was obtained from Signal Four Analytics crash database. A crash data analysis was performed to quantify the frequency and severity of crashes along SR 202 and Kernan Boulevard within the project study area. A detailed summary of the crash data is provided below. Historical crash data is provided in **Appendix E**.

3.6.1 Crash Severity:

A safety analysis was conducted for SR 202 between I-295 and Hodges Boulevard ramps and for Kernan Boulevard between Betty Holzendorf Drive and south of the Kernan Boulevard and eastbound SR 202 ramp terminal intersection. Over the five-year span, this area experienced a total of 575 crashes of which 422 are Property Damage Only (PDO) crashes (73.4 percent), 151 are injury crashes (26.3 percent), and two are fatal crashes (0.3 percent). Both fatal crashes occurred along eastbound SR 202. Out of the two fatal crashes, one involved a driver under the influence of alcohol and the other was an off-road crash. **Table 3-11** summarizes the crash data for the study area by severity.

Table 3-11: Study Area Crash Data Summary

Year	PDO Crashes*	Injury Crashes	Fatal Crashes	Total Crashes
2015	73	30	1	104
2016	76	23	0	99
2017	78	30	0	108
2018	100	36	0	136
2019	95	32	1	128
Total	**422**	**151**	**2**	**575**
Percentage	**73.4%**	**26.3%**	**0.3%**	**100.0%**

*Property Damage Only

3.6.2 Crash Location:

Out of the 575 crashes, a total of 261 crashes (approximately 45 percent) occurred along eastbound SR 202. This can be attributed to the weaving segment located between the I-295 northbound on-ramp and the eastbound SR 202 off-ramp to Kernan Boulevard. This weaving segment is highly congested during the PM peak hour. The summary of crashes by location is shown in **Figure 3-6**.

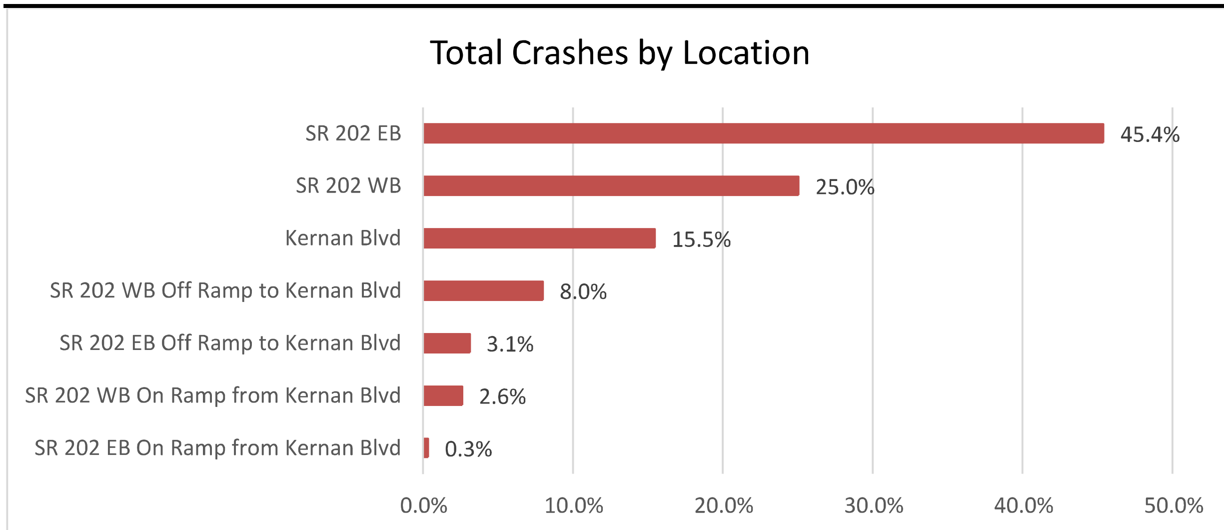


Figure 3-6. Summary of Total Crashes by Location

3.6.3 Crash Types

Crash types within the study area were evaluated to determine the most predominant crash type and its causes. **Table 3-12** summarizes all the crash types observed within the study area. Most of the incidents, approximately 57 percent, were rear-end collisions. The high number of rear-end crashes can be attributed to the congestion and stop-and-go conditions experienced by the study area during the peak hours.

Table 3-12: Summary of Crash Types

Crash Type	2015	2016	2017	2018	2019	Total	Percentage
Rear End	55	60	66	66	81	328	57.1%
Off Road	21	17	13	17	19	87	15.1%
Sideswipe	7	10	11	13	13	54	9.4%
Other	10	4	10	17	7	48	8.3%
Unknown	3	1	1	17	1	23	4.0%
Left Turn	2	3	1	3	3	12	2.1%
Rollover	2	4	3	1	0	10	1.7%
Angle	3	0	2	2	2	9	1.6%
Animal	0	0	1	0	2	3	0.5%
Head On	1	0	0	0	0	1	0.2%
Total	104	99	108	136	128	575	100.0%

3.6.4 Kernan Boulevard Crashes Severity

Kernan Boulevard experienced a total of 89 crashes, of which 64 were PDO (approximately 72 percent) and 25 were injury crashes (approximately 28 percent). A summary of crash severity on Kernan Boulevard is shown in **Table 3-13**.

Table 3-13: Kernan Boulevard Crash Data Summary

Year	PDO Crashes*	Injury Crashes	Fatal Crashes	Total Crashes
2015	14	3	0	17
2016	7	7	0	14
2017	15	5	0	20
2018	13	7	0	20
2019	15	3	0	18
Grand Total	**64**	**25**	**0**	**89**
Percentage	**71.9%**	**28.1%**	**0.0%**	**100.0%**

*Property Damage Only

3.6.5 Kernan Boulevard Crash Types

Most of the incidents, approximately 53 percent, were rear-end collisions. The high number of rear-end crashes can be attributed to congestion and stop-and-go conditions experienced along Kernan Boulevard during the peak hours. **Table 3-14** provides a summary of crash types along Kernan Boulevard.

Table 3-14: Summary of Kernan Boulevard Crash Types

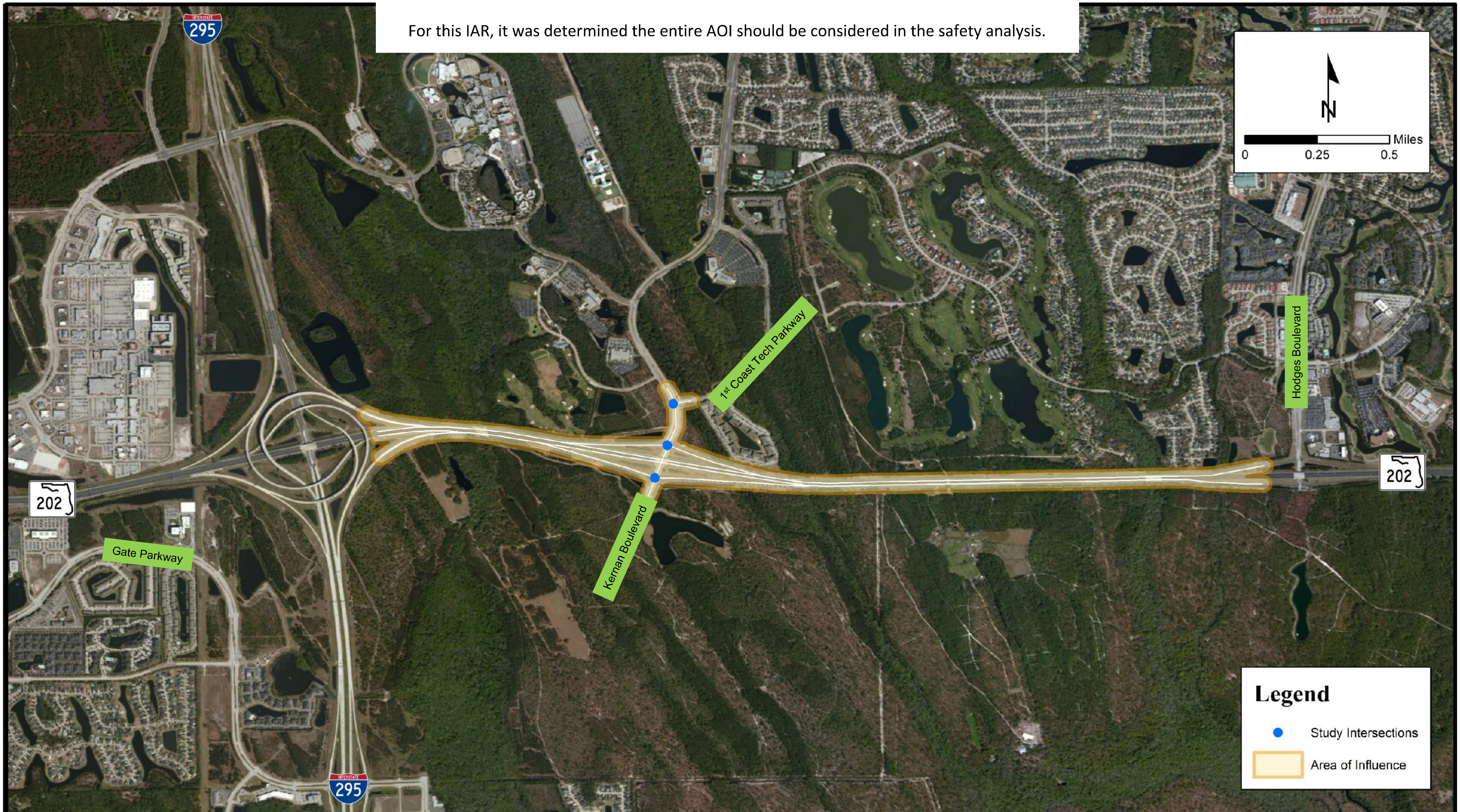
Crash Type	2015	2016	2017	2018	2019	Total	Percentage
Rear End	7	8	12	11	9	47	52.8%
Off Road	3	2	2	0	3	10	11.2%
Left Turn	2	2	0	1	3	8	9.0%
Other	2	0	3	1	0	6	6.8%
Unknown	1	0	0	4	0	5	5.6%
Sideswipe	0	0	1	2	2	5	5.6%
Angle	2	0	1	1	1	5	5.6%
Rollover	0	2	0	0	0	2	2.3%
Animal	0	0	1	0	0	1	1.1%
Total	17	14	20	20	18	89	100.0%

3.7 Environmental Constraints

A National Environmental Policy Act (NEPA) evaluation has been conducted by FDOT District Two for this project (2020). The roadway improvements proposed for this project are within the right-of-way limits. Details of the existing environmental constraints and an extensive examination of the natural, social and physical impacts associated with the Build Alternative are documented through the NEPA evaluation

HSM Part C Methodology - Step 1: Define the Safety Area of Influence

For this IAR, it was determined the entire AOI should be considered in the safety analysis.



FDOT	SR 202 at Kernan Boulevard Interchange Improvements (Interchange Modification Report)	**Project Location and Area Influence Map**	Figure 1-1 Page 3

HSM Part C Methodology - Step 2: Define the Analysis Period

For this IAR, Opening Year 2025 and Design Year 2045 were considered.

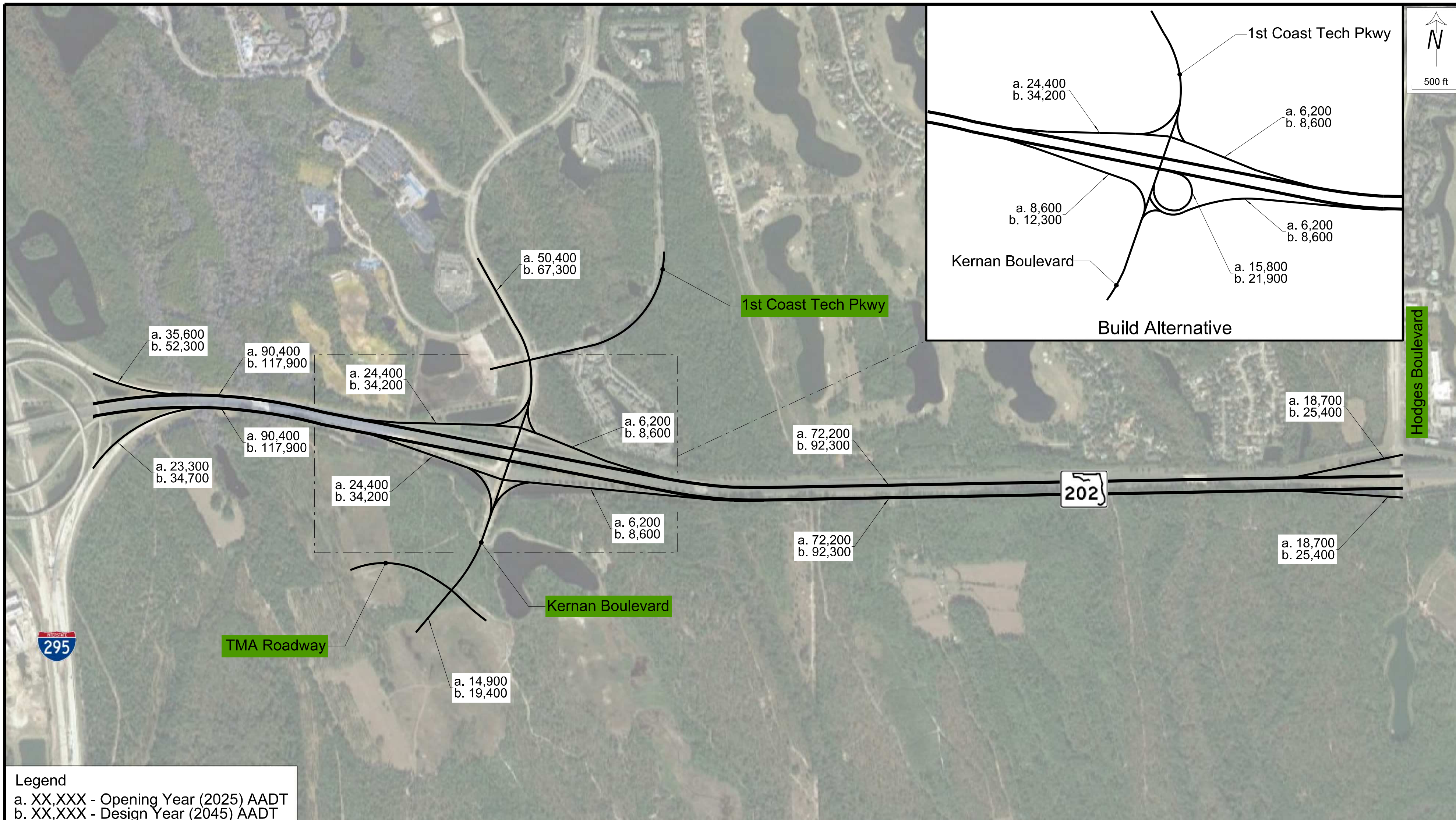
7.2 Predictive Safety Analysis

Predictive safety analysis was performed per Chapter 18 of the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM) Supplement utilizing the Enhanced Interchange Safety Analysis Tool (ISATe) to obtain an estimate of the predicted average crash frequency during the Opening Year (2025) and the Design Year (2045) associated with the two alternatives: the No-Build Alternative and the Build Alternative. The No-Build Alternative uses the existing roadway with the improvements described in **Section 5**. The Build Alternative installs a new loop ramp access for the eastbound SR 202 to northbound Kernan Boulevard traffic as well as other improvements described in **Section 5**.

Since the Build Alternative requires significant changes in the geometric design, the Predictive Method for Freeways using the Empirical-Bayes Method was not applied for all alternatives to have consistent results.

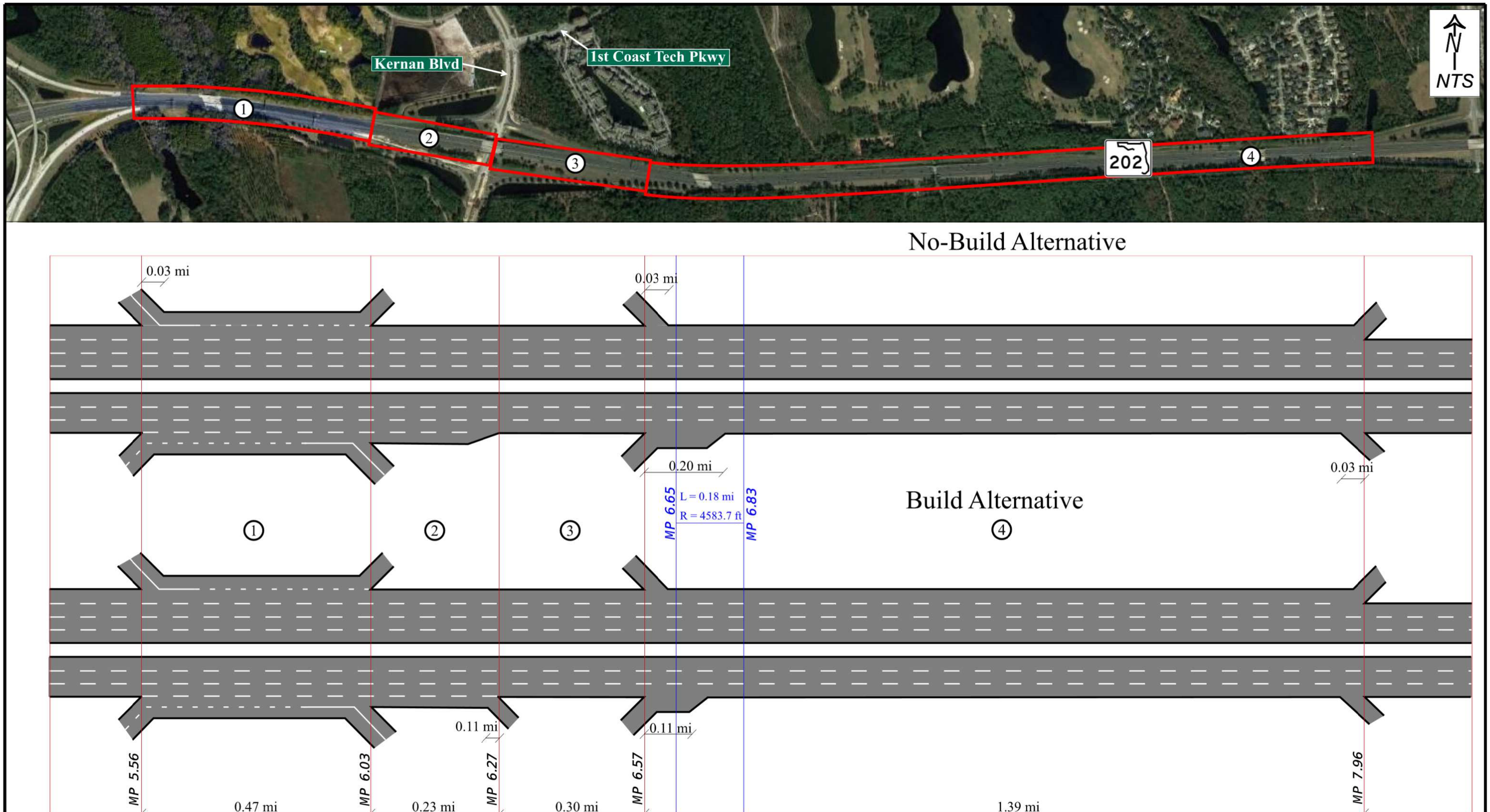
A summary of the predicted average crash frequency obtained by HSM analysis is presented in **Table 7-15**. **Appendix K** presents the input data used to perform the analysis and the output summary for the alternatives evaluated.

HSM Part C Methodology - Step 3: Determine AADT



FDOT	SR 202 at Kernan Boulevard Interchange Improvements (Interchange Modification Report)	**Opening Year (2025) & Design Year (2045) Annual Average Daily Traffic (AADT)**	Figure 6-1

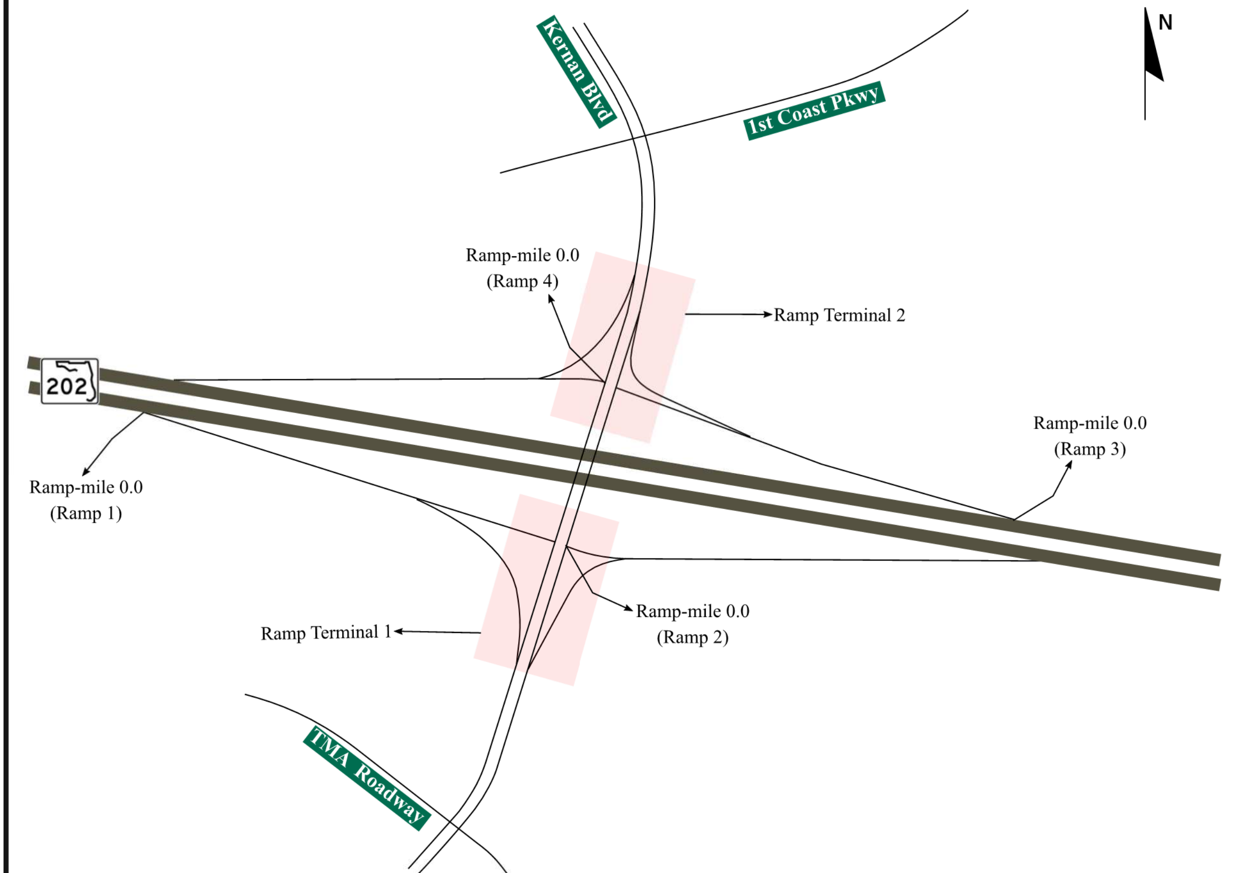
HSM Part C Methodology - Step 4: Segmentation of the Study Area



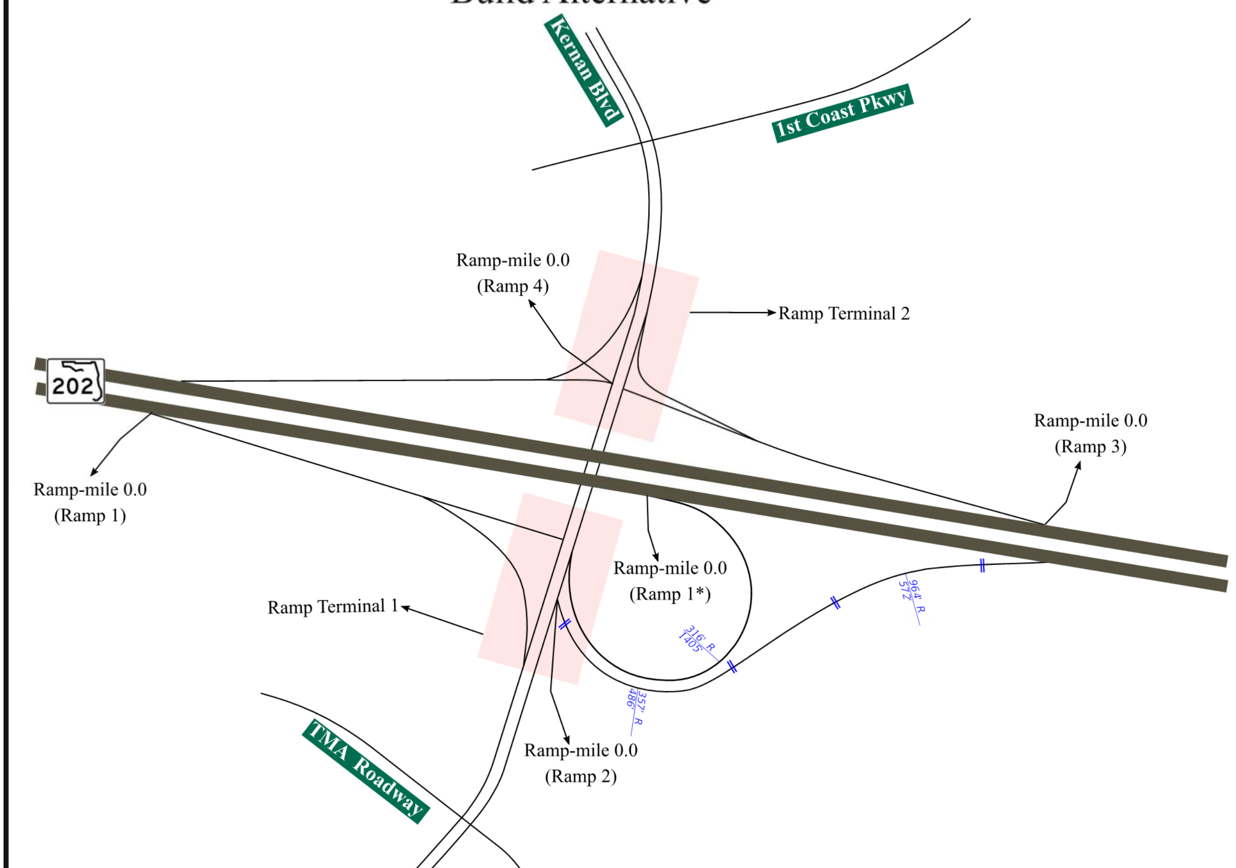
SR 202 at Kernan Blvd Interchange Modification Report	Segmentation Along SR 202 Mainline	Figure A1
		Page 1

FDOT	SR 202 at Kernan Blvd Interchange Modification Report	**Segmentation Along Kernan Blvd**	Figure A2
			Page 2

No-Build Alternative



Build Alternative



SR 202 at Kernan Blvd Interchange Modification Report	Segmentation Along SR 202 & Kernan Blvd Ramps	Figure A3
		Page 3

Segments Data

No-Build Alternative

Segment No.	Begin MP	End MP	2025 No. of Lanes	2045 No. of Lanes	Length (mi)	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Lane Width (ft)	Outside Shoulder Width (ft)	Inside Shoulder Width (ft)	Median Width (ft)	Outside Rumble Strip Incr. MP (mi)	Outside Rumble Strip Dcr. MP (mi)	Inside Rumble Strip Incr. MP (mi)	Inside Rumble Strip Dcr. MP (mi)	Median Barrier Length (mi)	Median Barrier Offset (ft)	Median Barrier Width (ft)	Clear Zone Width (ft)	Roadside Barrier Length (mi)	Roadside Barrier Offset (ft)
1	5.56	6.03	8	8	0.47	5729.6	0.46	0.26	12.0	10.0	7.0	17.0	0.47	0.47	N/A	N/A	Full	7.0	2.0	15.0	0.07, 0.13	10.0
2	6.03	6.27	8	8	0.23	N/A	N/A	N/A	12.0	10.0	7.0	17.0	0.23	0.23	N/A	N/A	Full	7.0	2.0	10.0	0.2	10.0
3	6.27	6.57	7	7	0.30	N/A	N/A	N/A	12.0	10.0	7.0	17.0	0.30	0.30	N/A	N/A	Full	7.0	2.0	10.0	0.27, 0.30	10.0
4	6.57	7.96	7	7	1.39	4583.7	0.18	0.18	12.0	10.0	7.0	17.0	1.39	1.39	N/A	N/A	Full	7.0	2.0	25.0	0.16, 0.57	10.0

Segment No.	Ramp Entrance in Seg.	$X_{b,ent}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Entrance Side	Ramp Exit in Seg.	$X_{b,ext}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Exit Side	Type B Weave	Length of Weave (mi)	Length of Weave in Seg. (mi)
1	Lane Add	0.00	N/A	N/A	Right	Lane Drop	0.00	N/A	N/A	Right	No	N/A	N/A
2	No	0.47	N/A	N/A	Right	No	999.00	N/A	N/A	Right	No	N/A	N/A
3	No	999.00	N/A	N/A	Right	No	999.00	N/A	N/A	Right	No	N/A	N/A
4	S-C Lane	0.00	0.2	0.2	Right	SC	0.00	0.03	0.03	Right	No	N/A	N/A

Segment No.	Ramp Entrance in Seg.	$X_{e,ent}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Entrance Side	Ramp Exit in Seg.	$X_{e,ext}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Exit Side	Type B Weave	Length of Weave (mi)	Length of Weave in Seg. (mi)
1	Lane Add	0.00	N/A	N/A	Right	Lane Drop	0.00	N/A	N/A	Right	Yes	0.47	0.47
2	No	999.00	N/A	N/A	Right	No	0.47	N/A	N/A	Right	No	N/A	N/A
3	No	999.00	N/A	N/A	N/A	No	999.00	N/A	N/A	Right	No	N/A	N/A
4	Lane Add	0.00	N/A	N/A	Right	SC	0.00	0.03	0.03	Right	No	N/A	N/A

Segment No.	P_{FW}	2025 AADT	2025 $AADT_{b,ent}$	2025 $AADT_{b,ext}$	2025 $AADT_{e,ent}$	2025 $AADT_{e,ext}$	2045 AADT	2045 $AADT_{b,ent}$	2045 $AADT_{b,ext}$	2045 $AADT_{e,ent}$	2045 $AADT_{e,ext}$
1	Comp.	180,800	23,300	24,400	24,400	35,600	235,800	34,700	34,300	34,300	52,300
2	Comp.	132,000	23,300	18,700	18,700	35,600	167,400	34,700	25,400	25,400	52,300
3	Comp.	132,000	23,300	18,700	18,700	35,600	167,400	34,700	25,400	25,400	52,300
4	Comp.	144,400	6,200	18,700	18,700	6,200	184,600	8,600	25,400	25,400	8,600

Build Alternative

Segment No.	Begin MP	End MP	2025 No. of Lanes	2045 No. of Lanes	Length (mi)	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Lane Width (ft)	Outside Shoulder Width (ft)	Inside Shoulder Width (ft)	Median Width (ft)	Outside Rumble Strip Incr. MP (mi)	Outside Rumble Strip Dcr. MP (mi)	Inside Rumble Strip Incr. MP (mi)	Inside Rumble Strip Dcr. MP (mi)	Median Barrier Length (mi)	Median Barrier Offset (ft)	Median Barrier Width (ft)	Clear Zone Width (ft)	Roadside Barrier Length (mi)	Roadside Barrier Offset (ft)
1	5.56	6.03	8	8	0.47	5729.6	0.46	0.26	12.0	10.0	7.0	17.0	0.47	0.47	N/A	N/A	Full	7.0	2.0	15.0	0.07, 0.13	10.0
2	6.03	6.31	8	8	0.28	N/A	N/A	N/A	12.0	10.0	7.0	17.0	0.28	0.28	N/A	N/A	Full	7.0	2.0	10.0	0.18, 0.16	10.0
3	6.31	6.57	7	7	0.26	N/A	N/A	N/A	12.0	10.0	7.0	17.0	0.26	0.26	N/A	N/A	Full	7.0	2.0	10.0	0.26, 0.11	10.0
4	6.57	7.96	7	7	1.39	4583.7	0.18	0.18	12.0	10.0	7.0	17.0	1.39	1.39	N/A	N/A	Full	7.0	2.0	25.0	0.16, 0.57	10.0

Segment No.	Ramp Entrance in Seg.	$X_{b,ent}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Entrance Side	Ramp Exit in Seg.	$X_{b,ext}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Exit Side	Type B Weave	Length of Weave (mi)	Length of Weave in Seg. (mi)
1	Lane Add	0.00	N/A	N/A	Right	Lane Drop	0.00	N/A	N/A	Right	No	N/A	N/A
2	No	0.47	N/A	N/A	Right	Lane Drop	0.00	N/A	N/A	Right	No	N/A	N/A
3	No	999.00	N/A	N/A	Right	No	999.00	N/A	N/A	Right	No	N/A	N/A
4	S-C Lane	0.00	0.2	0.2	Right	SC	0.00	0.03	0.03	Right	No	N/A	N/A

Segment No.	Ramp Entrance in Seg.	$X_{e,ent}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Entrance Side	Ramp Exit in Seg.	$X_{e,ext}$ (mi)	Length of Ramp (mi)	Length of Ramp in Seg. (mi)	Exit Side	Type B Weave	Length of Weave (mi)	Length of Weave in Seg. (mi)
1	Lane Add	0.00	N/A	N/A	Right	Lane Drop	0.00	N/A	N/A	Right	Yes	0.47	0.47
2	No	999.00	N/A	N/A	Right	No	0.47	N/A	N/A	Right	No	N/A	N/A
3	No	999.00	N/A	N/A	N/A	No	999.00	N/A	N/A	Right	No	N/A	N/A
4	Lane Add	0.00	N/A	N/A	Right	SC	0.00	0.03	0.03	Right	No	N/A	N/A

Segment No.	P_{FW}	2025 AADT	2025 $AADT_{b,ent}$	2025 $AADT_{b,ext}$	2025 $AADT_{e,ent}$	2025 $AADT_{e,ext}$	2045 AADT	2045 $AADT_{b,ent}$	2045 $AADT_{b,ext}$	2045 $AADT_{e,ent}$	2045 $AADT_{e,ext}$
1	Comp.	180,800	23,300	8,600	24,400	35,600	235,800	34,700	12,800	34,300	52,300
2	Comp.	142,800	23,300	15,800	18,700	35,600	189,300	34,700	21,900	25,400	52,300
3	Comp.	132,000	23,300	18,700	18,700	35,600	167,400	34,700	25,400	25,400	52,300
4	Comp.	144,400	6,200	18,700	18,700	6,200	184,600	8,600	25,400	25,400	8,600

Segments Data (Ramps)

No-Build Alternative

Segment No.	Begin Ramp Mile	End Ramp Mile	2025 No. of Lanes	2045 No. of Lanes	Length (mi)	Segment Type	Control Type	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Ramp-mile of beginning of Curve (mi)	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Ramp-mile of beginning of Curve (mi)	Lane Width (ft)	Right Shoulder Width (ft)	Left Shoulder Width (ft)	Lane Add/Drop by Taper	Length of Taper in Seg. (mi)	Right Barrier Length (mi)	Right Barrier Offset (ft)	Left Barrier Length (mi)	Left Barrier Offset (ft)	Segment No.	Ramp Entrance in Seg.	Length of entrance s-c in Seg. (mi)	Ramp Exit in Seg.	Length of exit s-c in Seg. (mi)	Weave Section in CD Road Segment	Length of Weave Section (mi)	Length of Weave Section in Seg. (mi)	2025 AADT	2045 AADT
1	0.00	0.33	1	1	0.33	Exit	Stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.25	20.0	0.00	0.0	1	No	N/A	No	N/A	N/A	N/A	N/A	24,400	34,200
2	0.00	0.14	2	2	0.14	Entrance	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.14	25.0	0.00	0.0	2	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
3	0.14	0.27	1	1	0.13	Entrance	None	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.26	25.0	0.00	0.0	3	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
4	0.00	0.26	1	1	0.26	Exit	Stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.03	25.0	0.00	0.0	4	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
5	0.00	0.29	1	1	0.29	Entrance	Stop	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.20	25.0	0.00	0.0	5	No	N/A	No	N/A	N/A	N/A	N/A	24,400	34,200

Build Alternative

Segment No.	Begin Ramp Mile	End Ramp Mile	2025 No. of Lanes	2045 No. of Lanes	Length (mi)	Segment Type	Control Type	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Ramp-mile of beginning of Curve (mi)	Curve Radius (ft)	Curve Length (mi)	Curve Length in Seg. (mi)	Ramp-mile of beginning of Curve (mi)	Lane Width (ft)	Right Shoulder Width (ft)	Left Shoulder Width (ft)	Lane Add/Drop by Taper	Length of Taper in Seg. (mi)	Right Barrier Length (mi)	Right Barrier Offset (ft)	Left Barrier Length (mi)	Left Barrier Offset (ft)	Segment No.	Ramp Entrance in Seg.	Length of entrance s-c in Seg. (mi)	Ramp Exit in Seg.	Length of exit s-c in Seg. (mi)	Weave Section in CD Road Segment	Length of Weave Section (mi)	Length of Weave Section in Seg. (mi)	2025 AADT	2045 AADT
1	0.00	0.33	2	2	0.33	Exit	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.25	20.0	0.00	0.0	1	No	N/A	No	N/A	N/A	N/A	N/A	8,600	12,300
2	0.00	0.38	1	1	0.38	Exit	None	316.0	0.27	0.27	0.11	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.38	7.0	0.02	11.0	2	No	N/A	No	N/A	N/A	N/A	N/A	15,800	21,900
3	0.00	0.14	2	2	0.14	Entrance	Signal	357.0	0.09	0.09	0.00	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.40	25.0	0.00	0.0	3	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
4	0.14	0.46	1	1	0.32	Entrance	Signal	357.0	0.09	0.00	0.00	964.00	0.11	0.11	0.22	12.0	7.0	4.0	No	N/A	0.40	25.0	0.00	0.0	4	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
5	0.00	0.26	1	1	0.26	Exit	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.03	25.0	0.00	0.0	5	No	N/A	No	N/A	N/A	N/A	N/A	6,200	8,600
6	0.00	0.29	2	2	0.29	Entrance	Signal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	12.0	7.0	4.0	No	N/A	0.20	19.0	0.00	0.0	6	No	N/A	No	N/A	N/A	N/A	N/A	24,400	34,200

Segments Data (Ramp Terminals)

No-Build Alternative

Ramp Terminal No.	Ramp Terminal Config.	Control Type	Public Street Leg	Exit Ramp Skew Angle (Degrees)	Distance to Public Street Intersection	Distance to Adjacent Ramp Terminal	Left Turn Protected (Inside Approach)	Left Turn Protected (Outside Approach)	Exit Ramp Right Turn Control	Median Width (ft)	Crossroad Number of Lanes (Total)	Crossroad Number of Lanes (Inside Approach)	Crossroad Number of Lanes (Outside Approach)	Number of Lanes (Exit Ramp)	Crossroad Right Turn Channelization (Inside Approach)	Crossroad Right Turn Channelization (Outside Approach)	Right Turn Channelization (Exit Ramp)	Inside Approach Left Turn Bay	Inside Approach Left Turn Bay Width (ft)	Outside Approach Left Turn Bay	Outside Approach Left Turn Bay Width (ft)	Inside Approach Right Turn Bay	Outside Approach Right Turn Bay	Number of Driveways on the Outisde Leg	Number of Public Street Approaches on the Outisde Leg	2025 AADT (Inside Leg)	2025 AADT (Outside Leg)	2025 AADT (Exit Ramp)	2025 AADT (Entrance Ramp)	2045AADT (Inside Leg)	2045 AADT (Outside Leg)	2045 AADT (Exit Ramp)	2045 AADT (Entrance Ramp)
1	D4	Signal	No	0.0	0.14	0.14	Yes	N/A	Signal	36.0	4	2	2	2	No	Yes	Yes	Yes	24.0	No	N/A	N/A	Yes	N/A	0	43,400	37,200	24,400	6,200	60,700	52,500	34,200	8,600
2	D4	Signal	No	0.0	0.17	0.14	No	N/A	Signal	36.0	4	2	2	1	No	Yes	Yes	Yes	12.0	No	N/A	N/A	Yes	N/A	0	43,400	53,400	6,200	24,400	60,700	71,700	8,600	34,200

Build Alternative

Ramp Terminal No.	Ramp Terminal Config.	Control Type	Public Street Leg	Exit Ramp Skew Angle (Degrees)	Distance to Public Street Intersection Outside (mi)	Distance to Adjacent Ramp Terminal	Left Turn Protected (Inside Approach)	Left Turn Protected (Outside Approach)	Exit Ramp Right Turn Control	Median Width (ft)	Crossroad Number of Lanes (Total)	Crossroad Number of Lanes (Inside Approach)	Crossroad Number of Lanes (Outside Approach)	Number of Lanes (Exit Ramp)	Crossroad Right Turn Channelization (Inside Approach)	Crossroad Right Turn Channelization (Outside Approach)	Right Turn Channelization (Exit Ramp)	Inside Approach Left Turn Bay	Inside Approach Left Turn Bay Width (ft)	Outside Approach Left Turn Bay	Outside Approach Left Turn Bay Width (ft)	Inside Approach Right Turn Bay	Outside Approach Right Turn Bay	Number of Driveways on the Outisde Leg	Number of Public Street Approaches on the Outisde Leg	2025 AADT (Inside Leg)	2025 AADT (Outside Leg)	2025 AADT (Exit Ramp)	2025 AADT (Entrance Ramp)	2045AADT (Inside Leg)	2045 AADT (Outside Leg)	2045 AADT (Exit Ramp)	2045 AADT (Entrance Ramp)
1	B4	Signal	No	30.0	0.14	0.14	Yes	N/A	Signal	36.0	4	2	2	2	No	Yes	Yes	Yes	24.0	No	N/A	N/A	Yes	N/A	0	43,400	37,200	8,600	6,200	60,700	52,500	12,300	8,600
2	D4	Signal	No	0.0	0.17	0.14	Yes	N/A	Signal	36.0	4	2	2	1	No	Yes	Yes	Yes	24.0	No	N/A	N/A	Yes	N/A	0	43,400	53,400	6,200	24,400	60,700	71,700	8,600	34,200

Segments Data (Arterials)

No-Build and Build Alternative

Segment No.	Roadway Type	Length (mi)	2025 AADT	2045 AADT	On-Street Parking	Proportion of Curb Length with Parking	Median Width	Lighting	Auto Speed Enforcement	Major Commercial Driveway	Minor Commercial Driveway	Major Industrial/Institutuional Driveway	Minor Industrial/Institutuional Driveway	Major Residential Driveway	Minor Residential Driveway	Other Driveways	Speed Category	Roadside Fixed Object Density (Fixed Objects/mi)	Offset to Roadside Fixed Objects	Calibration Factor
1	4D	0.14	37,200	52,500	None	N/A	36	Present	Not Present	0	0	0	0	0	0	0	Greater than 30 mph	104.6	30.0	1.0
2	4D	0.09	43,400	60,700	None	N/A	36	Present	Not Present	0	0	0	0	0	0	0	Greater than 30 mph	122.0	26.0	1.0
3	4D	0.16	53,400	71,700	None	N/A	36	Present	Not Present	0	0	0	0	0	0	0	Greater than 30 mph	124.9	30.0	1.0
4	4D	0.11	50,600	67,300	None	N/A	36	Present	Not Present	0	0	0	0	0	0	0	Greater than 30 mph	214.4	29.3	1.0

Segments Data (Intersections)

No-Build and Build Alternative

Intersection No.	Intersection Type	2025 $AADT_{major}$	2025 $AADT_{minor}$	2045 $AADT_{major}$	2045 $AADT_{minor}$	Intersection Lighting	Calibration Factor	Unsig. Major Approaches with LT Lane	Unsig. Major Approaches with RT Lane	Sig. Major Approaches with LT Lane	Sig. Major Approaches with RT Lane	No. of Approaches with LT Signal Phasing	LT Phasing Leg 1	LT Phasing Leg 2	LT Phasing Leg 3	LT Phasing Leg 4	No. of approaches with prohibited RTOR	Intersection Red Light Cameras	Sig. Intersection Ped Crossing Volume/Day	Max. Lanes Crossed by Peds	No. of Bus Stops with 1000 ft.	Schools within 1000 ft.	No. of Alcohol Establishments within 1000 ft.
1	4SG	37,200	19,200	52,500	23,600	Present	1.0	0	0	2	1	4	Protected	Protected	Protected	Protected	0	Not Present	N/A	5	0	Not Present	0
2	4SG	53,400	4,400	71,700	6,600	Present	1.0	0	0	2	2	4	Protected/Permissive	Protected/Permissive	Protected/Permissive	Protected/Permissive	0	Not Present	N/A	4	0	Not Present	0

HSM Part C Methodology - Steps 5-6

For this IAR, Safety Analysis was performed using HSM Spreadsheets and ISATe.

Enhanced Interchange Safety Analysis Tool					
General Information					
Project description:	SR 202 at Kernan Blvd IMR, Existing Year 2019				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2019				
Last year of analysis:	2019				
Crash Data Description					
Freeway segments	No crash data				
Ramp segments	No crash data				
Ramp terminals	No crash data				
Program Control					

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Perform Calculations | Print Results (optional) | Print Site Summary (optional)

3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Input Worksheet for Freeway Segments

Item	Year	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period
(View results in Column AV) (View results in Advisory Messages)							
Basic Roadway Data							
Number of through lanes (n):		8	8	7	7		
Freeway segment description:		MP. 5.56-6.03	MP. 6.03-6.27	MP. 6.27-6.57	MP. 6.57-7.96		
Segment length (L), mi:		0.47	0.23	0.3	1.39		
Alignment Data							
Horizontal Curve Data ← See note							
1 Horizontal curve in segment?:		Both Dir.	No	No	Both Dir.		
Curve radius (R_1), ft:		5730			4584		
Length of curve (L_{c1}), mi:		0.46			0.18		
Length of curve in segment ($L_{c1,seg}$), mi:		0.26			0.18		
2 Horizontal curve in segment?:		No			No		
Curve radius (R_2), ft:							
Length of curve (L_{c2}), mi:							
Length of curve in segment ($L_{c2,seg}$), mi:							
3 Horizontal curve in segment?:							
Curve radius (R_3), ft:							
Length of curve (L_{c3}), mi:							
Length of curve in segment ($L_{c3,seg}$), mi:							
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12		
Outside shoulder width (W_s), ft:		10	10	10	10		
Inside shoulder width (W_{is}), ft:		7	7	7	7		
Median width (W_m), ft:		17	17	17	17		
Rumble strips on outside shoulders?:		Yes	Yes	Yes	Yes		
Length of rumble strips for travel in increasing milepost direction, mi:		0.47	0.23	0.3	1.39		
Length of rumble strips for travel in decreasing milepost direction, mi:		0.47	0.23	0.3	1.39		
Rumble strips on inside shoulders?:		No	No	No	No		
Length of rumble strips for travel in increasing milepost direction, mi:							
Length of rumble strips for travel in decreasing milepost direction, mi:							
Presence of barrier in median:		Center	Center	Center	Center		
1 Length of barrier ($L_{ib,1}$), mi:		0.47	0.23	0.3	1.39		
Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:		7	7	7	7		
2 Length of barrier ($L_{ib,2}$), mi:		0.47	0.23	0.3	1.39		
Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:		7	7	7	7		
3 Length of barrier ($L_{ib,3}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:							
4 Length of barrier ($L_{ib,4}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:							
5 Length of barrier ($L_{ib,5}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:							
Median barrier width (W_{ib}), ft:		2	2	2	2		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:							
Roadside Data							
Clear zone width (W_{hc}), ft:		15	10	10	25		
Presence of barrier on roadside:		Some	Some	Some	Some		
1 Length of barrier ($L_{ob,1}$), mi:		0.07	0.2	0.27	0.16		
Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		10	10	10	10		
2 Length of barrier ($L_{ob,2}$), mi:		0.13		0.3	0.57		
Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:		10		10	10		
3 Length of barrier ($L_{ob,3}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:							
4 Length of barrier ($L_{ob,4}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:							
5 Length of barrier ($L_{ob,5}$), mi:							
Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:							
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:							
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:							
Ramp Access Data							
Travel in Increasing Milepost Direction							
Entrance Ramp: Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	S-C Lane		
Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			0.47	999			
Length of ramp entrance ($L_{en,inc}$), mi:					0.2		
Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:					0.2		
Entrance side?:					Right		
Exit Ramp: Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			999	999			
Length of ramp exit ($L_{ex,inc}$), mi:					0.03		
Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:					0.03		
Exit side?:					Right		
Weave: Type B weave in segment?:		No	No	No	No		
Length of weaving section ($L_{wev,inc}$), mi:							
Length of weaving section in segment ($L_{wev,seg,inc}$), mi:							
Travel in Decreasing Milepost Direction							
Entrance Ramp: Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	Lane Add		
Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			999	999			
Length of ramp entrance ($L_{en,dec}$), mi:							
Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:							
Entrance side?:							
Exit Ramp: Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			0.47	999			
Length of ramp exit ($L_{ex,dec}$), mi:					0.03		
Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:					0.03		
Exit side?:					Right		
Weave: Type B weave in segment?:		Yes	No	No	No		
Length of weaving section ($L_{wev,dec}$), mi:		0.47					
Length of weaving section in segment ($L_{wev,seg,dec}$), mi:		0.47					
Traffic Data	Year						
Proportion of AADT during high-volume hours (P_{hv}):							
Freeway Segment Data	2019	143400	114400	114400	121200		
Entrance Ramp Data for Travel in Increasing Milepost Dir.	Year						
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:	2019	20800	20800		3400		
Exit Ramp Data for Travel in Increasing Milepost Direction	Year						
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2019	14500			17200		
Entrance Ramp Data for Travel in Decreasing Milepost Dir.	Year						
Exit Ramp Data for Travel in Decreasing Milepost Direction	Year						
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2019	31900	31900		3400		

Input Worksheet for Ramp Segments

		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column CJ)	(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data							
Number of through lanes (n):		1	1	1	1		
		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column CJ)	(View results in Advisory Messages)						
Basic Roadway Data							
Number of through lanes (n):		1	1	1	1		
Ramp segment description:		EB. Off Ramp	EB. On Ramp	WB. Off Ramp	WB. On Ramp		
Segment length (L), mi:		0.33	0.41	0.26	0.29		
Average traffic speed on the freeway (V_{frwy}), mi/h:		65	65	65	65		
Segment type (ramp or collector-distributor road):		Exit	Entrance	Exit	Entrance		
Type of control at crossroad ramp terminal:		Stop	Stop	Stop	Stop		
Alignment Data							
Horizontal Curve Data	See notes						
1	Horizontal curve?:	No	No	No	No		
	Curve radius (R_1), ft:						
	Length of curve (L_{c1}), mi:						
	Length of curve in segment ($L_{c1,seg}$), mi:						
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:						
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12		
Right shoulder width (W_{rs}), ft:		7	7	7	7		
Left shoulder width (W_{ls}), ft:		4	4	4	4		
Presence of lane add or lane drop by taper:		No	No	No	No		
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						
Roadside Data							
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	Yes	Yes		
1	Length of barrier ($L_{rb,1}$), mi:	0.25	0.4	0.03	0.2		
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	20	25	25	25		
2	Length of barrier ($L_{rb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						
Presence of barrier on <u>left</u> side of roadway:		No	No	No	No		
1	Length of barrier ($L_{lb,1}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:						
2	Length of barrier ($L_{lb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:						
Ramp Access Data	See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No		
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No		
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:	14500	3400	3400	14500		

Input Worksheet for Crossroad Ramp Terminals								
			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
(View results in Column T)		(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Intersection Data								
Ramp terminal configuration:			D4	D4				
Ramp terminal description:			South Ramp T	North Ramp Term.				
Ramp terminal traffic control type:			One stop	One stop				
Is a non-ramp public street leg present at the terminal (I_{ps})?:								
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:			0	0				
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			999	0.17				
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.09	0.09				
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:						
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Yield	Stop				
Cross Section Data								
Crossroad median width (W_m), ft:			36	36				
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	4	4				
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):						
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):			0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	1	1				
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:						
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:						
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes				
		Width of lane or bay ($W_{b,in}$), ft:	12	12				
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	Yes	Yes				
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):								
Number of public street approaches on the outside crossroad leg (n_{ps}):								
Traffic Data		**Year**						
Inside Crossroad Leg Data		2019	17900	17900				
Outside Crossroad Leg Data		2019	0	30500				
Exit Ramp Data		2019	14500	3400				
Entrance Ramp Data		2019	3400	14500				
Average daily traffic ($AADT_{en}$) by year, veh/d:		2020						

Output Summary							
General Information							
Project description:	SR 202 at Kernan Blvd IMR, Existing Year 2019						
Analyst:	Arcadis	Date:	7/10/2020		Area type:		Urban
First year of analysis:	2019						
Last year of analysis:	2019						
Crash Data Description							
Freeway segments	Segment crash data available?		No		First year of crash data:		
	Project-level crash data available?		No		Last year of crash data:		
Ramp segments	Segment crash data available?		No		First year of crash data:		
	Project-level crash data available?		No		Last year of crash data:		
Ramp terminals	Segment crash data available?		No		First year of crash data:		
	Project-level crash data available?		No		Last year of crash data:		
Estimated Crash Statistics							
Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		126.9	0.6	2.0	12.0	38.1	74.2
Estimated average crash freq. during Study Period, crashes/yr:		126.9	0.6	2.0	12.0	38.1	74.2
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	4	96.4	0.5	1.3	7.5	20.1	67.1
Ramp segments, crashes:	4	2.8	0.0	0.1	0.5	0.7	1.5
Crossroad ramp terminals, crashes:	2	27.6	0.1	0.6	4.0	17.3	5.6
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during	2019	126.9	0.6	2.0	12.0	38.1	74.2
Distribution of Crashes for Entire Facility							
Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.7	0.0	0.0	0.1	0.4	0.2
	Right-angle crashes:	13.7	0.1	0.3	2.0	8.4	3.0
	Rear-end crashes:	59.8	0.3	0.9	5.6	17.4	35.7
	Sideswipe crashes:	17.9	0.1	0.2	1.1	3.1	13.5
	Other multiple-vehicle crashes:	2.3	0.0	0.0	0.2	0.8	1.3
	Total multiple-vehicle crashes:	94.5	0.4	1.5	9.0	30.0	53.6
Single vehicle	Crashes with animal:	0.4	0.0	0.0	0.0	0.0	0.4
	Crashes with fixed object:	23.6	0.1	0.4	2.2	6.0	14.9
	Crashes with other object:	3.1	0.0	0.0	0.1	0.3	2.6
	Crashes with parked vehicle:	0.5	0.0	0.0	0.0	0.1	0.4
	Other single-vehicle crashes	4.8	0.0	0.1	0.6	1.8	2.2
	Total single-vehicle crashes:	32.4	0.2	0.5	3.0	8.1	20.6
Total crashes:		126.9	0.6	2.0	12.0	38.1	74.2

Output Worksheet for Freeway Segments					Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
MV = multiple-vehicle model; SV = single-vehicle model	ENR = ramp entrance model; EXR = ramp exit model									
	Applicable Models (*y*)				Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Crash Modification Factors										
Fatal-and-Injury Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.010	1.000	1.000	1.003		
		SV			1.040	1.000	1.000	1.015		
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	0.983	0.983	0.983	0.983		
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.151	1.151	1.151	1.151		
		SV			0.954	0.954	0.954	0.954		
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.191	1.191	1.191	1.191		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.958	0.906	0.906	0.918		
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			1.074	1.093	1.091	1.041		
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.041	1.083	1.181	1.050		
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV									
			Year:	2019	1.417	1.000	1.000	1.069		
Ramp entrance ($CMF_{12,sc,nEN,at,fi}$):			ENR							
			Year:	2019	1.000	1.000	1.000	1.494		
Ramp exit ($CMF_{13,sc,nEX,at,fi}$):				EXR	1.000	1.000	1.000	1.472		
High volume ($CMF_{6,w,ac,y,fi}$):	MV		ENR	EXR	1.207	1.101	1.166	1.192		
		SV			0.964	0.982	0.971	0.967		
Property-Damage-Only Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,pdo}$):	MV		ENR	EXR	1.019	1.000	1.000	1.007		
		SV			1.035	1.000	1.000	1.013		
Lane width ($CMF_{2,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,pdo}$):	MV	SV	ENR	EXR	0.985	0.985	0.985	0.985		
Median width ($CMF_{4,w,ac,y,pdo}$):	MV		ENR	EXR	1.145	1.145	1.145	1.145		
		SV			1.144	1.144	1.144	1.144		
Median barrier ($CMF_{5,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.253	1.253	1.253	1.253		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside clearance ($CMF_{10,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside barrier ($CMF_{11,fs,ac,sv,pdo}$):		SV			1.054	1.110	1.240	1.066		
Lane change ($CMF_{7,fs,ac,mv,pdo}$):	MV									
			Year:	2019	1.312	1.000	1.000	1.063		
Ramp entrance ($CMF_{12,sc,nEN,at,pdo}$):			ENR		1.000	1.000	1.000	1.134		
Ramp exit ($CMF_{13,sc,nEX,at,pdo}$):				EXR	1.000	1.000	1.000	1.000		
High volume ($CMF_{6,w,ac,y,pdo}$):	MV		ENR	EXR	1.165	1.081	1.132	1.153		
		SV			0.720	0.845	0.765	0.736		
Predicted Average Crash Frequency										
Fatal-and-Injury Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,fi}$):										
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2019	6.444	1.436	2.030	10.191		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,fi}$):										
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2019	1.913	0.793	1.076	4.072		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,fi}$):										
Observed crash count ($N^*_{o,sc,EN,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2019	0.000	0.000	0.000	0.988		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,fi}$):										
Observed crash count ($N^*_{o,sc,EX,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2019	0.000	0.000	0.000	0.398		
Property-Damage-Only Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,mv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2019	14.143	3.105	4.678	23.934		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,sv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2019	3.993	1.915	2.578	9.539		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EN,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2019	0.000	0.000	0.000	2.469		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EX,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2019	0.000	0.000	0.000	0.747		

Output Worksheet for Ramp Segments								
MV = multiple-vehicle model SV = single-vehicle model			Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,fi}$):	MV		1.000	1.000	1.000	1.000		
		SV	1.000	1.000	1.000	1.000		
Lane width ($CMF_{2,w,x,y,fi}$):	MV	SV	1.096	1.096	1.096	1.096		
Right shoulder width ($CMF_{3,w,x,y,fi}$):	MV	SV	1.055	1.055	1.055	1.055		
Left shoulder width ($CMF_{4,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000		
Right side barrier ($CMF_{5,w,x,y,fi}$):	MV	SV	1.012	1.011	1.001	1.008		
Left side barrier ($CMF_{6,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000		
Weaving section ($CMF_{9,cds,ac,at,fi}$):	MV	SV						
	Year:	2019	1.000	1.000	1.000	1.000		
Ramp speed-change lane ($CMF_{8,w,x,mv,fi}$):	MV		1.000	1.000	1.000	1.000		
Lane add or drop ($CMF_{7,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000		
Property-Damage-Only Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,pdo}$):	MV		1.000	1.000	1.000	1.000		
		SV	1.000	1.000	1.000	1.000		
Lane width ($CMF_{2,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000		
Right shoulder width ($CMF_{3,w,x,y,pdo}$):	MV	SV	1.026	1.026	1.026	1.026		
Left shoulder width ($CMF_{4,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000		
Right side barrier ($CMF_{5,w,x,y,pdo}$):	MV	SV	1.011	1.011	1.001	1.007		
Left side barrier ($CMF_{6,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000		
Weaving section ($CMF_{9,cds,ac,at,pdo}$):	MV	SV						
	Year:	2019	1.000	1.000	1.000	1.000		
Ramp speed-change lane ($CMF_{8,w,x,mv,pdo}$):	MV		1.000	1.000	1.000	1.000		
Lane add or drop ($CMF_{7,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000		
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,fi}$):								
Observed crash count ($N^*_{o,w,x,mv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2019	0.030	0.035	0.005	0.114		
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,fi}$):								
Observed crash count ($N^*_{o,w,x,sv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2019	0.509	0.162	0.140	0.323		
Property-Damage-Only Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,pdo}$):								
Observed crash count ($N^*_{o,w,x,mv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2019	0.077	0.043	0.010	0.189		
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,pdo}$):								
Observed crash count ($N^*_{o,w,x,sv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2019	0.479	0.178	0.137	0.341		

Output Worksheet for Crossroad Ramp Terminals

Signal = signalized intersection model Unsig = unsignalized intersection model	Applicable Models		Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,fi}$):	Signal							
Segment length ($CMF_{14,w,x,at,fi}$):	Signal	Unsig	0.859	0.791				
Protected left-turn operation ($CMF_{16,w,SG,at,fi}$):	Signal							
	Year:	2019						
Channelized right turn on crossroad ($CMF_{17,w,SG,at,fi}$):	Signal							
	Year:	2019						
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,fi}$):	Signal							
	Year:	2019						
Access point frequency ($CMF_{13,w,x,at,fi}$):	Signal	Unsig						
	Year:	2019	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,fi}$):	Signal	Unsig						
	Year:	2019	0.795	0.889				
Crossroad right-turn lane ($CMF_{12,w,x,at,fi}$):	Signal	Unsig						
	Year:	2019	1.000	0.940				
Median width ($CMF_{15,w,x,at,fi}$):	Signal	Unsig						
	Year:	2019	1.258	1.410				
Exit ramp capacity ($CMF_{10,w,x,at,fi}$):	Signal	Unsig						
	Year:	2019	32.899	1.092				
Skew angle ($CMF_{20,w,ST,at,fi}$):		Unsig						
	Year:	2019	1.000	1.000				
All-way stop control (CMF_{awsc}):		Unsig						
Property-Damage-Only Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,pdo}$):	Signal							
Segment length ($CMF_{14,w,x,at,pdo}$):	Signal							
Protected left-turn operation ($CMF_{16,w,SG,at,pdo}$):	Signal							
	Year:	2019						
Channelized right turn on crossroad ($CMF_{17,w,SG,at,pdo}$):	Signal							
	Year:	2019						
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,pdo}$):	Signal							
	Year:	2019						
Access point frequency ($CMF_{13,w,x,at,pdo}$):	Signal							
	Year:	2019						
Crossroad left-turn lane ($CMF_{11,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2019	0.790	0.887				
Crossroad right-turn lane ($CMF_{12,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2019	1.000	0.857				
Median width ($CMF_{15,w,x,at,pdo}$):	Signal							
	Year:	2019						
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,fi}$):								
Observed crash count ($N^*_{o,w,x,at,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,fi,r}$), crashes/yr:								
Predicted average crash frequency		2019	20.040	1.967				
Property-Damage-Only Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,pdo}$):								
Observed crash count ($N^*_{o,w,x,at,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2019	1.746	3.894				

Enhanced Interchange Safety Analysis Tool					
General Information					
Project description:	SR 202 at Kernan Blvd IMR, Opening Year 2025 No-Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2025				
Last year of analysis:	2025				
Crash Data Description					
Freeway segments	No crash data				
Ramp segments	No crash data				
Ramp terminals	No crash data				
Program Control					

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Print Results (optional)

Print Site Summary (optional)

3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Input Worksheet for Freeway Segments

		Year	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column AV)	(View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data								
Number of through lanes (n):			8	8	7	7		
Freeway segment description:			MP. 5.56-6.03	MP. 6.03-6.27	MP. 6.27-6.57	MP. 6.57-7.96		
Segment length (L), mi:			0.47	0.23	0.3	1.39		
Alignment Data								
Horizontal Curve Data	See note							
1	Horizontal curve in segment?:		Both Dir.	No	No	Both Dir.		
	Curve radius (R_1), ft:		5730			4584		
	Length of curve (L_{c1}), mi:		0.46			0.18		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.26			0.18		
2	Horizontal curve in segment?:		No			No		
	Curve radius (R_2), ft:							
	Length of curve (L_{c2}), mi:							
	Length of curve in segment ($L_{c2,seg}$), mi:							
Cross Section Data								
Lane width (W_l), ft:			12	12	12	12		
Outside shoulder width (W_s), ft:			10	10	10	10		
Inside shoulder width (W_{is}), ft:			7	7	7	7		
Median width (W_m), ft:			17	17	17	17		
Rumble strips on outside shoulders?:			Yes	Yes	Yes	Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:		0.47	0.23	0.3	1.39		
	Length of rumble strips for travel in decreasing milepost direction, mi:		0.47	0.23	0.3	1.39		
Rumble strips on inside shoulders?:			No	No	No	No		
	Length of rumble strips for travel in increasing milepost direction, mi:							
	Length of rumble strips for travel in decreasing milepost direction, mi:							
Presence of barrier in median:			Center	Center	Center	Center		
1	Length of barrier ($L_{ib,1}$), mi:		0.47	0.23	0.3	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:		7	7	7	7		
2	Length of barrier ($L_{ib,2}$), mi:		0.47	0.23	0.3	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:		7	7	7	7		
3	Length of barrier ($L_{ib,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:							
Median barrier width (W_{ib}), ft:			2	2	2	2		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:								
Roadside Data								
Clear zone width (W_{hc}), ft:			15	10	10	25		
Presence of barrier on roadside:			Some	Some	Some	Some		
1	Length of barrier ($L_{ob,1}$), mi:		0.07	0.2	0.27	0.16		
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		10	10	10	10		
2	Length of barrier ($L_{ob,2}$), mi:		0.13		0.3	0.57		
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:		10		10	10		
3	Length of barrier ($L_{ob,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:							
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:								
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:								
Ramp Access Data								
Travel in Increasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	S-C Lane		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			0.47	999			
	Length of ramp entrance ($L_{en,inc}$), mi:					0.2		
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:					0.2		
	Entrance side?:					Right		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			999	999			
	Length of ramp exit ($L_{ex,inc}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		No	No	No	No		
	Length of weaving section ($L_{wev,inc}$), mi:							
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:							
Travel in Decreasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	Lane Add		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			999	999			
	Length of ramp entrance ($L_{en,dec}$), mi:							
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:							
	Entrance side?:							
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			0.47	999			
	Length of ramp exit ($L_{ex,dec}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		Yes	No	No	No		
	Length of weaving section ($L_{wev,dec}$), mi:		0.47					
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:		0.47					
Traffic Data		**Year**						
Proportion of AADT during high-volume hours (P_{hv}):								
Freeway Segment Data		2025	180800	132000	132000	144400		
Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2025	23300	23300		6200		
Exit Ramp Data for Travel in Increasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:		2025	24400			18700		
Entrance Ramp Data for Travel in Decreasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:		2025	24400			18700		
Exit Ramp Data for Travel in Decreasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:		2025	35600	35600		6200		

Input Worksheet for Ramp Segments

(View results in Column CJ) (View results in Advisory Messages)		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period
Basic Roadway Data							
Number of through lanes (n):		1	2	1	1	1	
Ramp segment description:		EB. Off Ramp	EB. On Ramp	EB. On Ramp	WB. Off Ram	WB. On Ramp	
Segment length (L), mi:		0.33	0.14	0.27	0.26	0.29	
Average traffic speed on the freeway (V_{frwy}), mi/h:		65	65	65	65	65	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	Entrance	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	Signal	
Alignment Data							
Horizontal Curve Data	See notes						
1	Horizontal curve?:	No	No	No	No	No	
	Curve radius (R_1), ft:						
	Length of curve (L_{c1}), mi:						
	Length of curve in segment ($L_{c1,seg}$), mi:						
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:						
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12	12	
Right shoulder width (W_{rs}), ft:		7	7	7	7	7	
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						
Roadside Data							
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	Yes	Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.25	0.14	0.26	0.03	0.2	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	20	25	25	25	25	
2	Length of barrier ($L_{rb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						
Presence of barrier on <u>left</u> side of roadway:		No	No	No	No	No	
1	Length of barrier ($L_{lb,1}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:						
Ramp Access Data	See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:						
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data	**Year**						
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2025	24400	6200	6200	6200	24400	

Input Worksheet for Crossroad Ramp Terminals

			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
(View results in Column T)		(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Intersection Data								
Ramp terminal configuration:			D4	D4				
Ramp terminal description:			South Ramp T	North Ramp Term.				
Ramp terminal traffic control type:			Signal	Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:								
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:								
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.14	0.17				
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.14	0.14				
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:	Yes	No				
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Signal	Signal				
Cross Section Data								
Crossroad median width (W_m), ft:			36	36				
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	4	4				
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	2	2				
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	2	2	0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2	1				
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:	Yes	Yes				
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:	Yes	Yes				
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes				
		Width of lane or bay ($W_{b,in}$), ft:	24	12				
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	Yes	Yes				
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):								
Number of public street approaches on the outside crossroad leg (n_{ps}):								
Traffic Data		**Year**						
Inside Crossroad Leg Data		2025	43400	43400				
Outside Crossroad Leg Data		2025	37200	53400				
Exit Ramp Data		2025	24400	6200				
Entrance Ramp Data		2025	6200	24400				

Output Summary

General Information

Project description:	SR 202 at Kernan Blvd IMR, Opening Year 2025 No-Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2025				
Last year of analysis:	2025				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
General Information				
Project description:				
Analyst:	Date:		Area type:	
First year of analysis:	2025			
Last year of analysis:	2025			

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility		Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:		189.0	0.6	2.3	14.1	50.8	121.1
Estimated average crash freq. during Study Period, crashes/yr:		189.0	0.6	2.3	14.1	50.8	121.1
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	4	130.9	0.5	1.5	9.0	27.8	92.1
Ramp segments, crashes:	5	4.5	0.1	0.2	0.8	1.1	2.3
Crossroad ramp terminals, crashes:	2	53.7	0.0	0.7	4.4	21.9	26.7
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during	2025	189.0	0.6	2.3	14.1	50.8	121.1

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.9	0.0	0.0	0.1	0.4	0.3
	Right-angle crashes:	15.1	0.0	0.2	1.3	6.3	7.2
	Rear-end crashes:	104.0	0.3	1.3	8.0	29.7	64.7
	Sideswipe crashes:	30.0	0.1	0.2	1.4	4.8	23.5
	Other multiple-vehicle crashes:	3.5	0.0	0.0	0.3	0.9	2.3
	Total multiple-vehicle crashes:	153.5	0.5	1.8	11.1	42.1	98.0

Output Worksheet for Freeway Segments										
MV = multiple-vehicle model SV = single-vehicle model	ENR = ramp entrance model EXR = ramp exit model				Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models (*y*)				**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors										
Fatal-and-Injury Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.010	1.000	1.000	1.003		
		SV			1.040	1.000	1.000	1.015		
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	0.983	0.983	0.983	0.983		
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.151	1.151	1.151	1.151		
		SV			0.954	0.954	0.954	0.954		
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.191	1.191	1.191	1.191		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.958	0.906	0.906	0.918		
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			1.074	1.093	1.091	1.041		
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.041	1.083	1.181	1.050		
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV									
			Year:	2025	1.400	1.000	1.000	1.062		
Ramp entrance ($CMF_{12,sc,nEN,at,fi}$):			ENR							
			Year:	2025	1.000	1.000	1.000	1.682		
Ramp exit ($CMF_{13,sc,nEX,at,fi}$):				EXR	1.000	1.000	1.000	1.472		
High volume ($CMF_{6,w,ac,y,fi}$):	MV		ENR	EXR	1.296	1.170	1.229	1.264		
		SV			0.951	0.970	0.961	0.956		
Property-Damage-Only Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,pdo}$):	MV		ENR	EXR	1.019	1.000	1.000	1.007		
		SV			1.035	1.000	1.000	1.013		
Lane width ($CMF_{2,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,pdo}$):	MV	SV	ENR	EXR	0.985	0.985	0.985	0.985		
Median width ($CMF_{4,w,ac,y,pdo}$):	MV		ENR	EXR	1.145	1.145	1.145	1.145		
		SV			1.144	1.144	1.144	1.144		
Median barrier ($CMF_{5,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.253	1.253	1.253	1.253		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside clearance ($CMF_{10,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside barrier ($CMF_{11,fs,ac,sv,pdo}$):		SV			1.054	1.110	1.240	1.066		
Lane change ($CMF_{7,fs,ac,mv,pdo}$):	MV									
			Year:	2025	1.297	1.000	1.000	1.056		
Ramp entrance ($CMF_{12,sc,nEN,at,pdo}$):			ENR		1.000	1.000	1.000	1.134		
Ramp exit ($CMF_{13,sc,nEX,at,pdo}$):				EXR	1.000	1.000	1.000	1.000		
High volume ($CMF_{6,w,ac,y,pdo}$):	MV		ENR	EXR	1.233	1.135	1.181	1.209		
		SV			0.636	0.760	0.698	0.664		
Predicted Average Crash Frequency										
Fatal-and-Injury Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,fi}$):										
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	9.661	1.889	2.650	13.944		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,fi}$):										
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,fs,n,sv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	2.192	0.859	1.168	4.509		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,fi}$):										
Observed crash count ($N^*_{o,sc,EN,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,sc,EN,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	1.449		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,fi}$):										
Observed crash count ($N^*_{o,sc,EX,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,sc,EX,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	0.494		
Property-Damage-Only Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,mv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	23.198	4.302	6.440	35.011		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,sv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,fs,n,sv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	4.320	1.953	2.666	10.036		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EN,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,sc,EN,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	3.202		
				2048						
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EX,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{a,sc,EX,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	0.922		

Output Worksheet for Ramp Segments								
MV = multiple-vehicle model SV = single-vehicle model	Applicable Models		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	
		SV	1.000	1.000	1.000	1.000	1.000	
Lane width ($CMF_{2,w,x,y,fi}$):	MV	SV	1.096	1.096	1.096	1.096	1.096	
Right shoulder width ($CMF_{3,w,x,y,fi}$):	MV	SV	1.055	1.055	1.055	1.055	1.055	
Left shoulder width ($CMF_{4,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right side barrier ($CMF_{5,w,x,y,fi}$):	MV	SV	1.012	1.012	1.011	1.001	1.008	
Left side barrier ($CMF_{6,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Weaving section ($CMF_{9,cds,ac,at,fi}$):	MV	SV						
	Year:	2025	1.000	1.000	1.000	1.000	1.000	
Ramp speed-change lane ($CMF_{8,w,x,mv,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	
Lane add or drop ($CMF_{7,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Property-Damage-Only Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	
		SV	1.000	1.000	1.000	1.000	1.000	
Lane width ($CMF_{2,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right shoulder width ($CMF_{3,w,x,y,pdo}$):	MV	SV	1.026	1.026	1.026	1.026	1.026	
Left shoulder width ($CMF_{4,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right side barrier ($CMF_{5,w,x,y,pdo}$):	MV	SV	1.011	1.011	1.010	1.001	1.007	
Left side barrier ($CMF_{6,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Weaving section ($CMF_{9,cds,ac,at,pdo}$):	MV	SV						
	Year:	2025	1.000	1.000	1.000	1.000	1.000	
Ramp speed-change lane ($CMF_{8,w,x,mv,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	
Lane add or drop ($CMF_{7,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,fi}$):								
Observed crash count ($N^*_{o,w,x,mv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.079	0.032	0.038	0.008	0.298	
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,fi}$):								
Observed crash count ($N^*_{o,w,x,sv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.739	0.082	0.164	0.215	0.469	
Property-Damage-Only Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,pdo}$):								
Observed crash count ($N^*_{o,w,x,mv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.148	0.073	0.061	0.021	0.364	
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,pdo}$):								
Observed crash count ($N^*_{o,w,x,sv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.685	0.126	0.177	0.208	0.487	
		2048						

Output Worksheet for Crossroad Ramp Terminals							
Signal = signalized intersection model Unsig = unsignalized intersection model			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5
	Applicable Models		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors							
Fatal-and-Injury Crash CMFs							
Non-ramp public street leg ($CMF_{19,w,SG,at,fi}$):	Signal		1.000	1.000			
Segment length ($CMF_{14,w,x,at,fi}$):	Signal	Unsig	0.772	0.791			
Protected left-turn operation ($CMF_{16,w,SG,at,fi}$):	Signal						
	Year:	2025	0.626	1.000			
Channelized right turn on crossroad ($CMF_{17,w,SG,at,fi}$):	Signal						
	Year:	2025	1.199	1.249			
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,fi}$):	Signal						
	Year:	2025	1.372	1.083			
Access point frequency ($CMF_{13,w,x,at,fi}$):	Signal	Unsig					
Crossroad left-turn lane ($CMF_{11,w,x,at,fi}$):	Signal	Unsig					
	Year:	2025	0.863	0.881			
Crossroad right-turn lane ($CMF_{12,w,x,at,fi}$):	Signal	Unsig					
	Year:	2025	0.920	0.899			
Median width ($CMF_{15,w,x,at,fi}$):	Signal	Unsig					
	Year:	2025	0.994	0.880			
Exit ramp capacity ($CMF_{10,w,x,at,fi}$):	Signal	Unsig					
	Year:	2025	1.900	1.063			
Skew angle ($CMF_{20,w,ST,at,fi}$):		Unsig					
	Year:	2025					
All-way stop control (CMF_{awsc}):		Unsig					
Property-Damage-Only Crash CMFs							
Non-ramp public street leg ($CMF_{19,w,SG,at,pdo}$):	Signal		1.000	1.000			
Segment length ($CMF_{14,w,x,at,pdo}$):	Signal		0.771	0.790			
Protected left-turn operation ($CMF_{16,w,SG,at,pdo}$):	Signal						
	Year:	2025	0.739	1.000			
Channelized right turn on crossroad ($CMF_{17,w,SG,at,pdo}$):	Signal						
	Year:	2025	1.198	1.248			
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,pdo}$):	Signal						
	Year:	2025	1.697	1.154			
Access point frequency ($CMF_{13,w,x,at,pdo}$):	Signal						
	Year:	2025	1.000	1.000			
Crossroad left-turn lane ($CMF_{11,w,x,at,pdo}$):	Signal	Unsig					
	Year:	2025	0.875	0.891			
Crossroad right-turn lane ($CMF_{12,w,x,at,pdo}$):	Signal	Unsig					
	Year:	2025	0.980	0.975			
Median width ($CMF_{15,w,x,at,pdo}$):	Signal						
	Year:	2025	0.690	0.509			
Predicted Average Crash Frequency							
Fatal-and-Injury Crash Frequency							
Ramp Terminal Crash Analysis		**Year**					
Overdispersion parameter ($k_{w,x,at,fi}$):							
Observed crash count ($N^*_{o,w,x,at,fi}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,w,x,at,fi,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,w,x,at,fi,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,fi,r}$), crashes/yr:							
Predicted average crash frequency		2025	14.755	12.186			
Property-Damage-Only Crash Frequency							
Ramp Terminal Crash Analysis		**Year**					
Overdispersion parameter ($k_{w,x,at,pdo}$):							
Observed crash count ($N^*_{o,w,x,at,pdo}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,w,x,at,pdo,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,w,x,at,pdo,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,pdo,r}$), crashes/yr:							
Predicted average crash frequency		2025	14.354	12.364			

Enhanced Interchange Safety Analysis Tool					
General Information					
Project description:	SR 202 at Kernan Blvd IMR, Design Year 2045 No-Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				
Crash Data Description					
Freeway segments	No crash data				
Ramp segments	No crash data				
Ramp terminals	No crash data				
Program Control					

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Print Results (optional) | Print Site Summary (optional)

3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Input Worksheet for Freeway Segments

			Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column AV)	(View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data								
Number of through lanes (n):			8	8	7	7		
Freeway segment description:			MP. 5.56-6.03	MP. 6.03-6.27	MP. 6.27-6.57	MP. 6.57-7.96		
Segment length (L), mi:			0.47	0.23	0.3	1.39		
Alignment Data								
Horizontal Curve Data	See note							
1	Horizontal curve in segment?:		Both Dir.	No	No	Both Dir.		
	Curve radius (R_1), ft:		5730			4584		
	Length of curve (L_{c1}), mi:		0.46			0.18		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.26			0.18		
2	Horizontal curve in segment?:		No			No		
	Curve radius (R_2), ft:							
	Length of curve (L_{c2}), mi:							
	Length of curve in segment ($L_{c2,seg}$), mi:							
Cross Section Data								
Lane width (W_l), ft:			12	12	12	12		
Outside shoulder width (W_s), ft:			10	10	10	10		
Inside shoulder width (W_{is}), ft:			7	7	7	7		
Median width (W_m), ft:			17	17	17	17		
Rumble strips on outside shoulders?:			Yes	Yes	Yes	Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:		0.47	0.23	0.3	1.39		
	Length of rumble strips for travel in decreasing milepost direction, mi:		0.47	0.23	0.3	1.39		
Rumble strips on inside shoulders?:			No	No	No	No		
	Length of rumble strips for travel in increasing milepost direction, mi:							
	Length of rumble strips for travel in decreasing milepost direction, mi:							
Presence of barrier in median:			Center	Center	Center	Center		
1	Length of barrier ($L_{ib,1}$), mi:		0.47	0.23	0.3	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:		7	7	7	7		
2	Length of barrier ($L_{ib,2}$), mi:		0.47	0.23	0.3	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:		7	7	7	7		
3	Length of barrier ($L_{ib,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:							
Median barrier width (W_{ib}), ft:			2	2	2	2		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:								
Roadside Data								
Clear zone width (W_{hc}), ft:			15	10	10	25		
Presence of barrier on roadside:			Some	Some	Some	Some		
1	Length of barrier ($L_{ob,1}$), mi:		0.07	0.2	0.27	0.16		
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		10	10	10	10		
2	Length of barrier ($L_{ob,2}$), mi:		0.13		0.3	0.57		
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:		10		10	10		
3	Length of barrier ($L_{ob,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:							
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:								
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:								
Ramp Access Data								
Travel in Increasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	S-C Lane		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			0.47	999			
	Length of ramp entrance ($L_{en,inc}$), mi:					0.2		
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:					0.2		
	Entrance side?:					Right		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			999	999			
	Length of ramp exit ($L_{ex,inc}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		No	No	No	No		
	Length of weaving section ($L_{wev,inc}$), mi:							
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:							
Travel in Decreasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	Lane Add		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			999	999			
	Length of ramp entrance ($L_{en,dec}$), mi:							
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:							
	Entrance side?:							
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			0.47	999			
	Length of ramp exit ($L_{ex,dec}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		Yes	No	No	No		
	Length of weaving section ($L_{wev,dec}$), mi:		0.47					
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:		0.47					
Traffic Data		**Year**						
Proportion of AADT during high-volume hours (P_{hv}):								
Freeway Segment Data		2045	235800	167400	167400	184600		
Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045	34700	34700		8600		
Exit Ramp Data for Travel in Increasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:		2045	34200			25400		
Entrance Ramp Data for Travel in Decreasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:		2045	34200			25400		
Exit Ramp Data for Travel in Decreasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:		2045	52300	52300		8600		

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column CJ) (View results in Advisory Messages)		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data							
Number of through lanes (n):		1	2	1	1	1	
Ramp segment description:		EB. Off Ramp	EB. On Ramp	EB. On Ramp	WB. Off Ramp	WB. On Ramp	
Segment length (L), mi:		0.33	0.14	0.27	0.26	0.29	
Average traffic speed on the freeway (V_{frwy}), mi/h:		65	65	65	65	65	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	Entrance	
Type of control at crossroad ramp terminal:		Stop	Stop	Stop	Stop	Stop	
Alignment Data							
Horizontal Curve Data	See notes						
1	Horizontal curve?:	No	No	No	No	No	
	Curve radius (R_1), ft:						
	Length of curve (L_{c1}), mi:						
	Length of curve in segment ($L_{c1,seg}$), mi:						
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:						
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12	12	
Right shoulder width (W_{rs}), ft:		7	7	7	7	7	
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						
Roadside Data							
Presence of barrier on right side of roadway:		Yes	Yes	Yes	Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.25	0.14	0.26	0.03	0.2	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	20	25	25	25	25	
2	Length of barrier ($L_{rb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						
Presence of barrier on left side of roadway:		No	No	No	No	No	
1	Length of barrier ($L_{lb,1}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:						
Ramp Access Data	See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:						
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data	**Year**						
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	34200	8600	8600	8600	34200	

Input Worksheet for Crossroad Ramp Terminals

			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
	(View results in Column T)	(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Intersection Data								
Ramp terminal configuration:			D4	D4				
Ramp terminal description:			South Ramp T	North Ramp Term.				
Ramp terminal traffic control type:			Signal	Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:								
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:								
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.14	0.17				
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.14	0.14				
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:	Yes	No				
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Signal	Signal				
Cross Section Data								
Crossroad median width (W_m), ft:			36	36				
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	4	4				
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	2	2				
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	2	2	0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2	1				
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:	Yes	Yes				
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:	Yes	Yes				
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes				
		Width of lane or bay ($W_{b,in}$), ft:	24	12				
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	Yes	Yes				
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):								
Number of public street approaches on the outside crossroad leg (n_{ps}):								
Traffic Data		**Year**						
Inside Crossroad Leg Data		2045	60700	60700				
Outside Crossroad Leg Data		2045	52500	71700				
Exit Ramp Data		2045	34200	8600				
Entrance Ramp Data		2045	8600	34200				

Output Summary

General Information

Project description:	SR 202 at Kernan Blvd IMR, Design Year 2045 No-Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	289.6	0.8	3.4	20.4	82.6	182.4
Estimated average crash freq. during Study Period, crashes/yr:	289.6	0.8	3.4	20.4	82.6	182.4

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	4	199.9	0.7	1.9	11.6	41.8	143.8
Ramp segments, crashes:	5	6.3	0.1	0.2	1.2	1.7	3.1
Crossroad ramp terminals, crashes:	2	83.5	0.0	1.2	7.6	39.1	35.5

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during	2045	289.6	0.8	3.4	20.4	82.6	182.4

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	1.4	0.0	0.0	0.2	0.7	0.5
	Right-angle crashes:	23.9	0.0	0.4	2.3	11.2	10.0
	Rear-end crashes:	168.1	0.5	2.0	12.1	50.1	103.5
	Sideswipe crashes:	48.3	0.1	0.3	2.1	7.8	38.0
	Other multiple-vehicle crashes:	5.7	0.0	0.1	0.4	1.5	3.7
	Total multiple-vehicle crashes:	247.4	0.6	2.8	17.0	71.2	155.8
Single vehicle	Crashes with animal:	0.5	0.0	0.0	0.0	0.0	0.5
	Crashes with fixed object:	30.5	0.1	0.4	2.4	8.0	19.6
	Crashes with other object:	3.9	0.0	0.0	0.1	0.5	3.3
	Crashes with parked vehicle:	0.7	0.0	0.0	0.1	0.2	0.4
	Other single-vehicle crashes	6.6	0.0	0.1	0.8	2.7	2.9
	Total single-vehicle crashes:	42.3	0.2	0.6	3.4	11.4	26.7
	Total crashes:	289.6	0.8	3.4	20.4	82.6	182.4

Output Worksheet for Freeway Segments										
MV = multiple-vehicle model SV = single-vehicle model	ENR = ramp entrance model EXR = ramp exit model				Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models (*y*)				**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors										
Fatal-and-Injury Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.010	1.000	1.000	1.003		
		SV			1.040	1.000	1.000	1.015		
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	0.983	0.983	0.983	0.983		
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.151	1.151	1.151	1.151		
		SV			0.954	0.954	0.954	0.954		
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.191	1.191	1.191	1.191		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.958	0.906	0.906	0.918		
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			1.074	1.093	1.091	1.041		
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.041	1.083	1.181	1.050		
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV									
			Year:	2045	1.384	1.000	1.000	1.056		
Ramp entrance ($CMF_{12,sc,nEN,at,fi}$):			ENR							
			Year:	2045	1.000	1.000	1.000	1.795		
Ramp exit ($CMF_{13,sc,nEX,at,fi}$):				EXR	1.000	1.000	1.000	1.472		
High volume ($CMF_{6,w,ac,y,fi}$):	MV		ENR	EXR	1.365	1.269	1.314	1.341		
		SV			0.942	0.955	0.949	0.945		
Property-Damage-Only Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,pdo}$):	MV		ENR	EXR	1.019	1.000	1.000	1.007		
		SV			1.035	1.000	1.000	1.013		
Lane width ($CMF_{2,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,pdo}$):	MV	SV	ENR	EXR	0.985	0.985	0.985	0.985		
Median width ($CMF_{4,w,ac,y,pdo}$):	MV		ENR	EXR	1.145	1.145	1.145	1.145		
		SV			1.144	1.144	1.144	1.144		
Median barrier ($CMF_{5,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.253	1.253	1.253	1.253		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside clearance ($CMF_{10,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside barrier ($CMF_{11,fs,ac,sv,pdo}$):		SV			1.054	1.110	1.240	1.066		
Lane change ($CMF_{7,fs,ac,mv,pdo}$):	MV									
			Year:	2045	1.282	1.000	1.000	1.051		
Ramp entrance ($CMF_{12,sc,nEN,at,pdo}$):			ENR		1.000	1.000	1.000	1.134		
Ramp exit ($CMF_{13,sc,nEX,at,pdo}$):				EXR	1.000	1.000	1.000	1.000		
High volume ($CMF_{6,w,ac,y,pdo}$):	MV		ENR	EXR	1.286	1.213	1.247	1.268		
		SV			0.581	0.659	0.621	0.599		
Predicted Average Crash Frequency										
Fatal-and-Injury Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,fi}$):										
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2045	14.942	2.920	4.039	21.232		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,fi}$):										
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2045	2.576	0.986	1.345	5.225		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,fi}$):										
Observed crash count ($N^*_{o,sc,EN,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2045	0.000	0.000	0.000	2.187		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,fi}$):										
Observed crash count ($N^*_{o,sc,EX,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2045	0.000	0.000	0.000	0.654		
Property-Damage-Only Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,mv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2045	39.995	7.278	10.769	58.799		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,sv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2045	4.980	2.087	2.920	11.230		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EN,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2045	0.000	0.000	0.000	4.526		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EX,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2045	0.000	0.000	0.000	1.216		

Output Worksheet for Ramp Segments								
MV = multiple-vehicle model SV = single-vehicle model			Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	
		SV	1.000	1.000	1.000	1.000	1.000	
Lane width ($CMF_{2,w,x,y,fi}$):	MV	SV	1.096	1.096	1.096	1.096	1.096	
Right shoulder width ($CMF_{3,w,x,y,fi}$):	MV	SV	1.055	1.055	1.055	1.055	1.055	
Left shoulder width ($CMF_{4,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right side barrier ($CMF_{5,w,x,y,fi}$):	MV	SV	1.012	1.012	1.011	1.001	1.008	
Left side barrier ($CMF_{6,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Weaving section ($CMF_{9,cds,ac,at,fi}$):	MV	SV						
	Year:	2045	1.000	1.000	1.000	1.000	1.000	
Ramp speed-change lane ($CMF_{8,w,x,mv,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	
Lane add or drop ($CMF_{7,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Property-Damage-Only Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	
		SV	1.000	1.000	1.000	1.000	1.000	
Lane width ($CMF_{2,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right shoulder width ($CMF_{3,w,x,y,pdo}$):	MV	SV	1.026	1.026	1.026	1.026	1.026	
Left shoulder width ($CMF_{4,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Right side barrier ($CMF_{5,w,x,y,pdo}$):	MV	SV	1.011	1.011	1.010	1.001	1.007	
Left side barrier ($CMF_{6,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Weaving section ($CMF_{9,cds,ac,at,pdo}$):	MV	SV						
	Year:	2045	1.000	1.000	1.000	1.000	1.000	
Ramp speed-change lane ($CMF_{8,w,x,mv,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	
Lane add or drop ($CMF_{7,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,fi}$):								
Observed crash count ($N^*_{o,w,x,mv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.186	0.045	0.053	0.012	0.706	
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,fi}$):								
Observed crash count ($N^*_{o,w,x,sv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.942	0.104	0.207	0.272	0.598	
Property-Damage-Only Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,pdo}$):								
Observed crash count ($N^*_{o,w,x,mv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.226	0.110	0.092	0.031	0.556	
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,pdo}$):								
Observed crash count ($N^*_{o,w,x,sv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.864	0.158	0.222	0.260	0.615	

Output Worksheet for Crossroad Ramp Terminals								
Signal = signalized intersection model Unsig = unsignalized intersection model	Applicable Models		Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,fi}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,fi}$):	Signal	Unsig	0.772	0.791				
Protected left-turn operation ($CMF_{16,w,SG,at,fi}$):	Signal							
Channelized right turn on crossroad ($CMF_{17,w,SG,at,fi}$):	Signal							
	Year:	2045	1.200	1.243				
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,fi}$):	Signal							
	Year:	2045	1.372	1.083				
Access point frequency ($CMF_{13,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.864	0.879				
Crossroad right-turn lane ($CMF_{12,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.919	0.902				
Median width ($CMF_{15,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.865	0.777				
Exit ramp capacity ($CMF_{10,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	2.934	1.106				
Skew angle ($CMF_{20,w,ST,at,fi}$):		Unsig						
	Year:	2045						
All-way stop control (CMF_{awsc}):		Unsig						
Property-Damage-Only Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,pdo}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,pdo}$):	Signal		0.771	0.790				
Protected left-turn operation ($CMF_{16,w,SG,at,pdo}$):	Signal							
	Year:	2045	0.739	1.000				
Channelized right turn on crossroad ($CMF_{17,w,SG,at,pdo}$):	Signal							
	Year:	2045	1.199	1.242				
		2068						
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,pdo}$):	Signal							
	Year:	2045	1.696	1.156				
		2068						
Access point frequency ($CMF_{13,w,x,at,pdo}$):	Signal							
	Year:	2045	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2045	0.875	0.889				
Crossroad right-turn lane ($CMF_{12,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2045	0.980	0.975				
		2068						
Median width ($CMF_{15,w,x,at,pdo}$):	Signal							
	Year:	2045	0.546	0.447				
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,fi}$):								
Observed crash count ($N^*_{o,w,x,at,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	31.062	16.920				
Property-Damage-Only Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,pdo}$):								
Observed crash count ($N^*_{o,w,x,at,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	18.381	17.103				

Enhanced Interchange Safety Analysis Tool							
General Information							
Project description:	SR 202 at Kernan Blvd IMR, Opening Year 2025 Build						
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban		
First year of analysis:	2025						
Last year of analysis:	2025						
Crash Data Description							
Freeway segments	No crash data						
Ramp segments	No crash data						
Ramp terminals	No crash data						
Program Control							

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Print Results (optional) | Print Site Summary (optional)

3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Input Worksheet for Freeway Segments

			Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	
(View results in Column AV) (View results in Advisory Messages)			**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	
Basic Roadway Data									
Number of through lanes (n):			8	8	7	7			0
Freeway segment description:			MP. 5.56-6.03	MP. 6.03-6.31	MP. 6.31-6.57	MP. 6.57-7.96			
Segment length (L), mi:			0.47	0.28	0.26	1.39			0
Alignment Data									
Horizontal Curve Data		See note							
	1	Horizontal curve in segment?:	Both Dir.	No	No	Both Dir.			0
		Curve radius (R_1), ft:	5730			4584			0
		Length of curve (L_{c1}), mi:	0.46			0.18			0
		Length of curve in segment ($L_{c1,seg}$), mi:	0.26			0.18			0
	2	Horizontal curve in segment?:	No			No			0
		Curve radius (R_2), ft:							0
		Length of curve (L_{c2}), mi:							0
		Length of curve in segment ($L_{c2,seg}$), mi:							0
Cross Section Data									
Lane width (W_l), ft:			12	12	12	12			0
Outside shoulder width (W_s), ft:			10	10	10	10			0
Inside shoulder width (W_{is}), ft:			7	7	7	7			0
Median width (W_m), ft:			17	17	17	17			0
Rumble strips on outside shoulders?:			Yes	Yes	Yes	Yes			0
		Length of rumble strips for travel in increasing milepost direction, mi:	0.47	0.28	0.26	1.39			0
		Length of rumble strips for travel in decreasing milepost direction, mi:	0.47	0.28	0.26	1.39			0
Rumble strips on inside shoulders?:			No	No	No	No			0
		Length of rumble strips for travel in increasing milepost direction, mi:							0
		Length of rumble strips for travel in decreasing milepost direction, mi:							0
Presence of barrier in median:			Center	Center	Center	Center			0
	1	Length of barrier ($L_{ib,1}$), mi:	0.47	0.28	0.26	1.39			0
		Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	7	7	7	7			0
	2	Length of barrier ($L_{ib,2}$), mi:	0.47	0.28	0.26	1.39			0
		Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:	7	7	7	7			0
	3	Length of barrier ($L_{ib,3}$), mi:							0
		Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:							0
Median barrier width (W_{ib}), ft:			2	2	2	2			0
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:									0
Roadside Data									
Clear zone width (W_{hc}), ft:			15	10	10	25			0
Presence of barrier on roadside:			Some	Some	Some	Some			0
	1	Length of barrier ($L_{ob,1}$), mi:	0.07	0.18	0.26	0.16			0
		Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:	10	10	10	10			0
	2	Length of barrier ($L_{ob,2}$), mi:	0.13	0.16	0.11	0.57			0
		Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:	10	10	10	10			0
	3	Length of barrier ($L_{ob,3}$), mi:							0
		Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:							0
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:									0
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:									0
Ramp Access Data									
Travel in Increasing Milepost Direction									
Entrance Ramp		Ramp entrance in segment? (If yes, indicate type.):	Lane Add	No	No	S-C Lane			0
		Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:		0.47	999				0
		Length of ramp entrance ($L_{en,inc}$), mi:				0.2			0
		Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:				0.2			0
		Entrance side?:				Right			0
Exit Ramp		Ramp exit in segment? (If yes, indicate type.):	Lane Drop	Lane Drop	No	S-C Lane			0
		Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			999				0
		Length of ramp exit ($L_{ex,inc}$), mi:				0.03			0
		Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:				0.03			0
		Exit side?:				Right			0
Weave		Type B weave in segment?:	No	No	No	No			0
		Length of weaving section ($L_{wev,inc}$), mi:							0
		Length of weaving section in segment ($L_{wev,seg,inc}$), mi:							0
Travel in Decreasing Milepost Direction									
Entrance Ramp		Ramp entrance in segment? (If yes, indicate type.):	Lane Add	No	No	Lane Add			0
		Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:		999	999				0
		Length of ramp entrance ($L_{en,dec}$), mi:							0
		Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:							0
		Entrance side?:							0
Exit Ramp		Ramp exit in segment? (If yes, indicate type.):	Lane Drop	No	No	S-C Lane			0
		Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:		0.47	999				0
		Length of ramp exit ($L_{ex,dec}$), mi:				0.03			0
		Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:				0.03			0
		Exit side?:				Right			0
Weave		Type B weave in segment?:	Yes	No	No	No			0
		Length of weaving section ($L_{wev,dec}$), mi:	0.47						0
		Length of weaving section in segment ($L_{wev,seg,dec}$), mi:	0.47						0
Traffic Data		Year							
Proportion of AADT during high-volume hours (P_{hv}):									
Freeway Segment Data		2025	180800	147800	132000	144400			
Entrance Ramp Data for Travel in Increasing Milepost Dir.		Year							
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2025	23300	23300		6200			
Exit Ramp Data for Travel in Increasing Milepost Direction		Year							
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:		2025	8600	15800		18700			
Entrance Ramp Data for Travel in Decreasing Milepost Dir.		Year							
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:		2025	24400			18700			
Exit Ramp Data for Travel in Decreasing Milepost Direction		Year							
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:		2025	35600	35600		6200			

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column CJ)	(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data							
Number of through lanes (n):		2	1	2	1	1	2
Ramp segment description:		EB. Off Ramp	EB. Off Ramp	EB. On Ramp	EB. On Ramp	WB. Off Ramp	WB. On Ramp
Segment length (L), mi:		0.33	0.38	0.14	0.46	0.26	0.29
Average traffic speed on the freeway (V_{frwy}), mi/h:		65	65	65	65	65	65
Segment type (ramp or collector-distributor road):		Exit	Exit	Entrance	Entrance	Exit	Entrance
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	Signal	Signal
Alignment Data							
Horizontal Curve Data	←See notes →						
1	Horizontal curve?:	No	In Seg.	In Seg.	Off Seg.	No	No
	Curve radius (R_1), ft:		316	357	357		
	Length of curve (L_{c1}), mi:		0.27	0.09	0.09		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.27	0.09			
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.11	0	0		
2	Horizontal curve?:		No	No	In Seg.		
	Curve radius (R_2), ft:				964		
	Length of curve (L_{c2}), mi:				0.11		
	Length of curve in segment ($L_{c2,seg}$), mi:				0.11		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:				0.22		
3	Horizontal curve?:				No		
	Curve radius (R_3), ft:						
	Length of curve (L_{c3}), mi:						
	Length of curve in segment ($L_{c3,seg}$), mi:						
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:						
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12	12	12
Right shoulder width (W_{rs}), ft:		7	7	7	7	7	7
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	4
Presence of lane add or lane drop by taper:		No	No	No	No	No	No
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						
Roadside Data							
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{rb,1}$), mi:	0.25	0.32	0.14	0.32	0.03	0.2
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	20	7	25	25	25	19
2	Length of barrier ($L_{rb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						
Presence of barrier on <u>left</u> side of roadway:		No	Yes	No	No	No	No
1	Length of barrier ($L_{lb,1}$), mi:		0.02				
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		11				
2	Length of barrier ($L_{lb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:						
Ramp Access Data	←See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:						
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data	**Year**						
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2025	8600	15800	6200	6200	6200	24400

Input Worksheet for Crossroad Ramp Terminals

			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
(View results in Column T)		(View results in Advisory Messages)	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Intersection Data								
Ramp terminal configuration:			B4	D4				
Ramp terminal description:			South Ramp T	North Ramp Term.				
Ramp terminal traffic control type:			Signal	Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:								
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:								
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.14	0.17				
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.14	0.14				
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:	Yes	Yes				
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Signal	Signal				
Cross Section Data								
Crossroad median width (W_m), ft:			36	36				
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	4	4				
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	2	2				
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	2	2	0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2	1				
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:	Yes	Yes				
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:		Yes				
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes				
		Width of lane or bay ($W_{b,in}$), ft:	24	24				
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	Yes	Yes				
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):								
Number of public street approaches on the outside crossroad leg (n_{ps}):								
Traffic Data		**Year**						
Inside Crossroad Leg Data		2025	43400	43400				
Outside Crossroad Leg Data		2025	37200	53400				
Exit Ramp Data		2025	8600	6200				
Entrance Ramp Data		2025	6200	24400				

Output Summary								
General Information								
Project description:	SR 202 at Kernan Blvd IMR, Opening Year 2025 Build							
Analyst:	Arcadis	Date:	7/10/2020		Area type:		Urban	
First year of analysis:	2025							
Last year of analysis:	2025							
Crash Data Description								
Freeway segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp terminals	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Estimated Crash Statistics								
Crashes for Entire Facility			**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:			169.4	0.7	2.2	12.4	39.6	114.5
Estimated average crash freq. during Study Period, crashes/yr:			169.4	0.7	2.2	12.4	39.6	114.5
Crashes by Facility Component		**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:		4	134.1	0.6	1.5	9.1	28.6	94.4
Ramp segments, crashes:		6	12.1	0.1	0.4	1.8	3.0	6.8
Crossroad ramp terminals, crashes:		2	23.2	0.0	0.2	1.5	8.1	13.4
Crashes for Entire Facility by Year		**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during		2025	169.4	0.7	2.2	12.4	39.6	114.5

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.6	0.0	0.0	0.1	0.3	0.3
	Right-angle crashes:	7.8	0.0	0.1	0.6	2.8	4.3
	Rear-end crashes:	88.8	0.3	1.0	6.3	21.8	59.3
	Sideswipe crashes:	28.3	0.1	0.2	1.4	4.3	22.3
	Other multiple-vehicle crashes:	3.3	0.0	0.0	0.3	0.8	2.2
	Total multiple-vehicle crashes:	128.7	0.4	1.4	8.6	29.9	88.3
Single vehicle	Crashes with animal:	0.5	0.0	0.0	0.0	0.0	0.5
	Crashes with fixed object:	29.8	0.2	0.5	2.7	6.9	19.5
	Crashes with other object:	3.5	0.0	0.0	0.1	0.4	2.9
	Crashes with parked vehicle:	0.6	0.0	0.0	0.1	0.1	0.4
	Other single-vehicle crashes	6.2	0.1	0.2	0.9	2.2	2.9
	Total single-vehicle crashes:	40.7	0.3	0.7	3.8	9.7	26.2
	Total crashes:	169.4	0.7	2.2	12.4	39.6	114.5

Output Worksheet for Freeway Segments										
MV = multiple-vehicle model SV = single-vehicle model	ENR = ramp entrance model EXR = ramp exit model				Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models (y)				**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors										
Fatal-and-Injury Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.010	1.000	1.000	1.003		
		SV			1.040	1.000	1.000	1.015		
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	0.983	0.983	0.983	0.983		
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.151	1.151	1.151	1.151		
		SV			0.954	0.954	0.954	0.954		
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.191	1.191	1.191	1.191		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.958	0.906	0.906	0.918		
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			1.074	1.092	1.092	1.041		
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.041	1.116	1.136	1.050		
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV									
			Year:	2025	1.413	1.065	1.000	1.062		
Ramp entrance ($CMF_{12,sc,nEN,at,fi}$):			ENR							
			Year:	2025	1.000	1.000	1.000	1.682		
Ramp exit ($CMF_{13,sc,nEX,at,fi}$):				EXR	1.000	1.000	1.000	1.472		
High volume ($CMF_{6,w,ac,y,fi}$):	MV		ENR	EXR	1.296	1.220	1.229	1.264		
		SV			0.951	0.962	0.961	0.956		
Property-Damage-Only Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,pdo}$):	MV		ENR	EXR	1.019	1.000	1.000	1.007		
		SV			1.035	1.000	1.000	1.013		
Lane width ($CMF_{2,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,pdo}$):	MV	SV	ENR	EXR	0.985	0.985	0.985	0.985		
Median width ($CMF_{4,w,ac,y,pdo}$):	MV		ENR	EXR	1.145	1.145	1.145	1.145		
		SV			1.144	1.144	1.144	1.144		
Median barrier ($CMF_{5,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.253	1.253	1.253	1.253		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside clearance ($CMF_{10,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside barrier ($CMF_{11,fs,ac,sv,pdo}$):		SV			1.054	1.153	1.180	1.066		
Lane change ($CMF_{7,fs,ac,mv,pdo}$):	MV									
			Year:	2025	1.309	1.060	1.000	1.056		
Ramp entrance ($CMF_{12,sc,nEN,at,pdo}$):			ENR		1.000	1.000	1.000	1.134		
Ramp exit ($CMF_{13,sc,nEX,at,pdo}$):				EXR	1.000	1.000	1.000	1.000		
High volume ($CMF_{6,w,ac,y,pdo}$):	MV		ENR	EXR	1.233	1.175	1.181	1.209		
		SV			0.636	0.706	0.698	0.664		
Predicted Average Crash Frequency										
Fatal-and-Injury Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,fi}$):										
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	9.747	3.023	2.296	13.944		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,fi}$):										
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	2.192	1.150	0.974	4.509		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,fi}$):										
Observed crash count ($N^*_{o,sc,EN,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	1.449		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,fi}$):										
Observed crash count ($N^*_{o,sc,EX,at,fi}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,fi,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,fi,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,fi,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	0.494		
Property-Damage-Only Crash Frequency										
Freeway Segment Multiple-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,mv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,mv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,mv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	23.407	7.143	5.581	35.011		
Freeway Segment Single-Vehicle Crash Analysis				**Year**						
Overdispersion parameter ($k_{fs,n,sv,pdo}$):										
Observed crash count ($N^*_{o,fs,n,sv,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,fs,n,sv,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	4.320	2.536	2.198	10.036		
Ramp Entrance Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EN,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EN,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EN,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	3.202		
Ramp Exit Crash Analysis				**Year**						
Overdispersion parameter ($k_{sc,EX,at,pdo}$):										
Observed crash count ($N^*_{o,sc,EX,at,pdo}$), crashes:										
Reference year (r):										
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,pdo,r}$), crashes/yr:										
Equivalent years associated with crash count ($C_{b,sc,EX,at,pdo,r}$), yr:										
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,pdo,r}$), crashes/yr:										
Predicted average crash frequency				2025	0.000	0.000	0.000	0.922		

Output Worksheet for Ramp Segments

MV = multiple-vehicle model SV = single-vehicle model	Applicable Models		Segment 1 **Study Period**	Segment 2 **Study Period**	Segment 3 **Study Period**	Segment 4 **Study Period**	Segment 5 **Study Period**	Segment 6 **Study Period**
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,fi}$):	MV		1.000	1.989	1.059	1.039	1.000	1.000
		SV	1.000	4.054	1.183	1.120	1.000	1.000
Lane width ($CMF_{2,w,x,y,fi}$):	MV	SV	1.096	1.096	1.096	1.096	1.096	1.096
Right shoulder width ($CMF_{3,w,x,y,fi}$):	MV	SV	1.055	1.055	1.055	1.055	1.055	1.055
Left shoulder width ($CMF_{4,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right side barrier ($CMF_{5,w,x,y,fi}$):	MV	SV	1.012	1.272	1.012	1.008	1.001	1.012
Left side barrier ($CMF_{6,w,x,y,fi}$):	MV	SV	1.000	1.002	1.000	1.000	1.000	1.000
Weaving section ($CMF_{9,cds,ac,at,fi}$):	MV	SV						
	Year:	2025	1.000	1.000	1.000	1.000	1.000	1.000
Ramp speed-change lane ($CMF_{8,w,x,mv,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	1.000
Lane add or drop ($CMF_{7,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Property-Damage-Only Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,pdo}$):	MV		1.000	1.692	1.042	1.027	1.000	1.000
		SV	1.000	4.981	1.239	1.156	1.000	1.000
Lane width ($CMF_{2,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right shoulder width ($CMF_{3,w,x,y,pdo}$):	MV	SV	1.026	1.026	1.026	1.026	1.026	1.026
Left shoulder width ($CMF_{4,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right side barrier ($CMF_{5,w,x,y,pdo}$):	MV	SV	1.011	1.247	1.011	1.007	1.001	1.011
Left side barrier ($CMF_{6,w,x,y,pdo}$):	MV	SV	1.000	1.001	1.000	1.000	1.000	1.000
Weaving section ($CMF_{9,cds,ac,at,pdo}$):	MV	SV						
	Year:	2025	1.000	1.000	1.000	1.000	1.000	1.000
Ramp speed-change lane ($CMF_{8,w,x,mv,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	1.000
Lane add or drop ($CMF_{7,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,fi}$):								
Observed crash count ($N^*_{o,w,x,mv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.024	0.099	0.034	0.067	0.008	0.485
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,fi}$):								
Observed crash count ($N^*_{o,w,x,sv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.338	3.179	0.097	0.312	0.215	0.456
Property-Damage-Only Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,pdo}$):								
Observed crash count ($N^*_{o,w,x,mv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.092	0.206	0.076	0.106	0.021	0.842
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,pdo}$):								
Observed crash count ($N^*_{o,w,x,sv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2025	0.458	3.596	0.156	0.348	0.208	0.670

Output Worksheet for Crossroad Ramp Terminals								
Signal = signalized intersection model Unsig = unsignalized intersection model	Applicable Models		Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,fi}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,fi}$):	Signal	Unsig	0.772	0.791				
Protected left-turn operation ($CMF_{16,w,SG,at,fi}$):	Signal							
	Year:	2025	0.564	0.608				
		2048						
Channelized right turn on crossroad ($CMF_{17,w,SG,at,fi}$):	Signal							
	Year:	2025	1.231	1.249				
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,fi}$):	Signal							
	Year:	2025	1.000	1.083				
		2048						
Access point frequency ($CMF_{13,w,x,at,fi}$):	Signal	Unsig						
	Year:	2025	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,fi}$):	Signal	Unsig						
	Year:	2025	0.841	0.881				
Crossroad right-turn lane ($CMF_{12,w,x,at,fi}$):	Signal	Unsig						
	Year:	2025	0.906	0.899				
Median width ($CMF_{15,w,x,at,fi}$):	Signal	Unsig						
	Year:	2025	0.993	0.892				
Exit ramp capacity ($CMF_{10,w,x,at,fi}$):	Signal	Unsig						
	Year:	2025	1.070	1.063				
Skew angle ($CMF_{20,w,ST,at,fi}$):		Unsig						
	Year:	2025						
All-way stop control (CMF_{awsc}):		Unsig						
Property-Damage-Only Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,pdo}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,pdo}$):	Signal		0.771	0.790				
Protected left-turn operation ($CMF_{16,w,SG,at,pdo}$):	Signal							
	Year:	2025	0.696	0.727				
Channelized right turn on crossroad ($CMF_{17,w,SG,at,pdo}$):	Signal							
	Year:	2025	1.231	1.248				
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,pdo}$):	Signal							
	Year:	2025	1.000	1.154				
Access point frequency ($CMF_{13,w,x,at,pdo}$):	Signal							
	Year:	2025	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2025	0.854	0.891				
Crossroad right-turn lane ($CMF_{12,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2025	0.977	0.975				
Median width ($CMF_{15,w,x,at,pdo}$):	Signal							
	Year:	2025	0.644	0.564				
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,fi}$):								
Observed crash count ($N^*_{o,w,x,at,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,fi,r}$), crashes/yr:								
Predicted average crash frequency		2025	2.307	7.507				
		2048						
Property-Damage-Only Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,pdo}$):								
Observed crash count ($N^*_{o,w,x,at,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2025	3.406	9.950				

Enhanced Interchange Safety Analysis Tool					
General Information					
Project description:	SR 202 at Kernan Blvd IMR, Design Year 2045 Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				
Crash Data Description					
Freeway segments	No crash data				
Ramp segments	No crash data				
Ramp terminals	No crash data				

Program Control

1. Enter data in the Main, Input Freeway Segments, Input Ramp Segments, Input Ramp Terminals worksheets.
2. Click Perform Calculations button to start calculation process.

Print Results (optional) | Print Site Summary (optional)

3. Review results in the Output Summary worksheet. Optionally, click the Print buttons to print the summary worksheets.
4. Optionally, detailed results can be reviewed in the Output Freeway Segments, Output Ramp Segments, Output Ramp Terminals worksheets.

Input Worksheet for Freeway Segments

		Year	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
(View results in Column AV)	(View results in Advisory Messages)		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data								
Number of through lanes (n):			8	8	7	7		
Freeway segment description:			MP. 5.56-6.03	MP. 6.03-6.31	MP. 6.31-6.57	MP. 6.57-7.96		
Segment length (L), mi:			0.47	0.28	0.26	1.39		
Alignment Data								
Horizontal Curve Data	See note							
1	Horizontal curve in segment?:		Both Dir.	No	No	Both Dir.		
	Curve radius (R_1), ft:		5730			4584		
	Length of curve (L_{c1}), mi:		0.46			0.18		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.26			0.18		
2	Horizontal curve in segment?:		No			No		
	Curve radius (R_2), ft:							
	Length of curve (L_{c2}), mi:							
	Length of curve in segment ($L_{c2,seg}$), mi:							
Cross Section Data								
Lane width (W_l), ft:			12	12	12	12		
Outside shoulder width (W_s), ft:			10	10	10	10		
Inside shoulder width (W_{is}), ft:			7	7	7	7		
Median width (W_m), ft:			17	17	17	17		
Rumble strips on outside shoulders?:			Yes	Yes	Yes	Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:		0.47	0.28	0.26	1.39		
	Length of rumble strips for travel in decreasing milepost direction, mi:		0.47	0.28	0.26	1.39		
Rumble strips on inside shoulders?:			No	No	No	No		
	Length of rumble strips for travel in increasing milepost direction, mi:							
	Length of rumble strips for travel in decreasing milepost direction, mi:							
Presence of barrier in median:			Center	Center	Center	Center		
1	Length of barrier ($L_{ib,1}$), mi:		0.47	0.28	0.26	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:		7	7	7	7		
2	Length of barrier ($L_{ib,2}$), mi:		0.47	0.28	0.26	1.39		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:		7	7	7	7		
3	Length of barrier ($L_{ib,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:							
Median barrier width (W_{ib}), ft:			2	2	2	2		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:								
Roadside Data								
Clear zone width (W_{hc}), ft:			15	10	10	25		
Presence of barrier on roadside:			Some	Some	Some	Some		
1	Length of barrier ($L_{ob,1}$), mi:		0.07	0.18	0.26	0.16		
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		10	10	10	10		
2	Length of barrier ($L_{ob,2}$), mi:		0.13	0.16	0.11	0.57		
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:		10	10	10	10		
3	Length of barrier ($L_{ob,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:							
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:								
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:								
Ramp Access Data								
Travel in Increasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	S-C Lane		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			0.47	999			
	Length of ramp entrance ($L_{en,inc}$), mi:					0.2		
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:					0.2		
	Entrance side?:					Right		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	Lane Drop	No	S-C Lane		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:				999			
	Length of ramp exit ($L_{ex,inc}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		No	No	No	No		
	Length of weaving section ($L_{wev,inc}$), mi:							
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:							
Travel in Decreasing Milepost Direction								
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No	Lane Add		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			999	999			
	Length of ramp entrance ($L_{en,dec}$), mi:							
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:							
	Entrance side?:							
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	S-C Lane		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			0.47	999			
	Length of ramp exit ($L_{ex,dec}$), mi:					0.03		
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:					0.03		
	Exit side?:					Right		
Weave	Type B weave in segment?:		Yes	No	No	No		
	Length of weaving section ($L_{wev,dec}$), mi:		0.47					
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:		0.47					
Traffic Data		**Year**						
Proportion of AADT during high-volume hours (P_{hv}):								
Freeway Segment Data		2045	235800	189300	167400	184600		
Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045	34700	34700		8600		
Exit Ramp Data for Travel in Increasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:		2045	12300	21900		25400		
Entrance Ramp Data for Travel in Decreasing Milepost Dir.		**Year**						
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:		2045	34200			25400		
Exit Ramp Data for Travel in Decreasing Milepost Direction		**Year**						
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:		2045	52300	52300		8600		

Input Worksheet for Ramp Segments

(View results in Column CJ) (View results in Advisory Messages)		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period
Basic Roadway Data							
Number of through lanes (n):		2	1	2	1	1	2
Ramp segment description:		EB. Off Ramp	EB. Off Ramp	EB. On Ramp	EB. On Ramp	WB. Off Ramp	WB. On Ramp
Segment length (L), mi:		0.33	0.38	0.14	0.46	0.26	0.29
Average traffic speed on the freeway (V_{frwy}), mi/h:		65	65	65	65	65	65
Segment type (ramp or collector-distributor road):		Exit	Exit	Entrance	Entrance	Exit	Entrance
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	Signal	Signal
Alignment Data							
Horizontal Curve Data	See notes						
1	Horizontal curve?:	No	In Seg.	In Seg.	Off Seg.	No	No
	Curve radius (R_1), ft:		316	357	357		
	Length of curve (L_{c1}), mi:		0.27	0.09	0.09		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.27	0.09			
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.11	0	0		
2	Horizontal curve?:		No	No	In Seg.		
	Curve radius (R_2), ft:				964		
	Length of curve (L_{c2}), mi:				0.11		
	Length of curve in segment ($L_{c2,seg}$), mi:				0.11		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:				0.22		
3	Horizontal curve?:				No		
	Curve radius (R_3), ft:						
	Length of curve (L_{c3}), mi:						
	Length of curve in segment ($L_{c3,seg}$), mi:						
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:						
Cross Section Data							
Lane width (W_l), ft:		12	12	12	12	12	12
Right shoulder width (W_{rs}), ft:		7	7	7	7	7	7
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	4
Presence of lane add or lane drop by taper:		No	No	No	No	No	No
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						
Roadside Data							
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{rb,1}$), mi:	0.25	0.23	0.14	0.32	0.03	0.2
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	20	7	25	25	25	19
2	Length of barrier ($L_{rb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						
Presence of barrier on <u>left</u> side of roadway:		No	Yes	No	No	No	No
1	Length of barrier ($L_{lb,1}$), mi:		0.02				
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		11				
2	Length of barrier ($L_{lb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:						
Ramp Access Data	See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:						
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data	**Year**						
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	12300	21900	8600	8600	8600	34200

Input Worksheet for Crossroad Ramp Terminals

			Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
	(View results in Column T)	(View results in Advisory Messages)						
Basic Intersection Data								
Ramp terminal configuration:			B4	D4				
Ramp terminal description:			South Ramp T	North Ramp Term.				
Ramp terminal traffic control type:			Signal	Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:								
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:								
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.14	0.17				
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.14	0.14				
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:	Yes	Yes				
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Signal	Signal				
Cross Section Data								
Crossroad median width (W_m), ft:			36	36				
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	4	4				
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	2	2				
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	2	2	0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2	2				
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:	Yes	Yes				
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:		Yes				
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes				
		Width of lane or bay ($W_{b,in}$), ft:	24	24				
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	Yes	Yes				
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):								
Number of public street approaches on the outside crossroad leg (n_{ps}):								
Traffic Data		**Year**						
Inside Crossroad Leg Data		2045	60700	60700				
Outside Crossroad Leg Data		2045	52500	71700				
		2068						
Exit Ramp Data		2045	12300	8600				
Entrance Ramp Data		2045	8600	34200				

Output Summary

General Information

Project description:	SR 202 at Kernan Blvd IMR, Design Year 2045 Build				
Analyst:	Arcadis	Date:	7/10/2020	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility		Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:		252.6	0.9	2.8	16.3	57.9	174.6
Estimated average crash freq. during Study Period, crashes/yr:		252.6	0.9	2.8	16.3	57.9	174.6
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	4	205.3	0.7	2.0	11.9	43.0	147.7
Ramp segments, crashes:	6	15.7	0.2	0.5	2.4	3.9	8.6
Crossroad ramp terminals, crashes:	2	31.6	0.0	0.3	2.0	11.0	18.3
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during	2045	252.6	0.9	2.8	16.3	57.9	174.6

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.9	0.0	0.0	0.1	0.4	0.4
	Right-angle crashes:	11.2	0.0	0.1	0.8	3.9	6.3
	Rear-end crashes:	141.6	0.5	1.5	8.8	33.6	97.4
	Sideswipe crashes:	45.9	0.1	0.3	1.9	6.8	36.8
	Other multiple-vehicle crashes:	5.3	0.0	0.1	0.4	1.3	3.6
	Total multiple-vehicle crashes:	205.0	0.6	2.0	12.0	46.0	144.4
Single vehicle	Crashes with animal:	0.6	0.0	0.0	0.0	0.0	0.5
	Crashes with fixed object:	35.0	0.2	0.6	3.1	8.5	22.6
	Crashes with other object:	4.0	0.0	0.0	0.2	0.5	3.4
	Crashes with parked vehicle:	0.7	0.0	0.0	0.1	0.2	0.5
	Other single-vehicle crashes	7.3	0.1	0.2	1.0	2.7	3.3
	Total single-vehicle crashes:	47.6	0.3	0.8	4.4	11.8	30.3
	Total crashes:	252.6	0.9	2.8	16.3	57.9	174.6

Output Worksheet for Freeway Segments

MV = multiple-vehicle model
SV = single-vehicle model
ENR = ramp entrance model
EXR = ramp exit model

	Applicable Models (*y*)				Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period
Crash Modification Factors										
Fatal-and-Injury Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,fi}$):	MV		ENR	EXR	1.010	1.000	1.000	1.003		
		SV			1.040	1.000	1.000	1.015		
Lane width ($CMF_{2,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,fi}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,fi}$):	MV	SV	ENR	EXR	0.983	0.983	0.983	0.983		
Median width ($CMF_{4,w,ac,y,fi}$):	MV		ENR	EXR	1.151	1.151	1.151	1.151		
		SV			0.954	0.954	0.954	0.954		
Median barrier ($CMF_{5,w,ac,y,fi}$):	MV	SV	ENR	EXR	1.191	1.191	1.191	1.191		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,fi}$):		SV			0.958	0.906	0.906	0.918		
Outside clearance ($CMF_{10,fs,ac,sv,fi}$):		SV			1.074	1.092	1.092	1.041		
Outside barrier ($CMF_{11,fs,ac,sv,fi}$):		SV			1.041	1.116	1.136	1.050		
Lane change ($CMF_{7,fs,ac,mv,fi}$):	MV									
			Year:	2045	1.395	1.060	1.000	1.056		
Ramp entrance ($CMF_{12,sc,nEN,at,fi}$):			ENR							
			Year:	2045	1.000	1.000	1.000	1.795		
Ramp exit ($CMF_{13,sc,nEX,at,fi}$):				EXR	1.000	1.000	1.000	1.472		
High volume ($CMF_{6,w,ac,y,fi}$):	MV		ENR	EXR	1.365	1.311	1.314	1.341		
		SV			0.942	0.949	0.949	0.945		
Property-Damage-Only Crash CMFs										
Horizontal curve ($CMF_{1,w,ac,y,pdo}$):	MV		ENR	EXR	1.019	1.000	1.000	1.007		
		SV			1.035	1.000	1.000	1.013		
Lane width ($CMF_{2,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.000	1.000	1.000	1.000		
Outside shoulder width ($CMF_{8,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Inside shoulder width ($CMF_{3,w,ac,y,pdo}$):	MV	SV	ENR	EXR	0.985	0.985	0.985	0.985		
Median width ($CMF_{4,w,ac,y,pdo}$):	MV		ENR	EXR	1.145	1.145	1.145	1.145		
		SV			1.144	1.144	1.144	1.144		
Median barrier ($CMF_{5,w,ac,y,pdo}$):	MV	SV	ENR	EXR	1.253	1.253	1.253	1.253		
Shoulder rumble strip ($CMF_{9,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside clearance ($CMF_{10,fs,ac,sv,pdo}$):		SV			1.000	1.000	1.000	1.000		
Outside barrier ($CMF_{11,fs,ac,sv,pdo}$):		SV			1.054	1.153	1.180	1.066		
Lane change ($CMF_{7,fs,ac,mv,pdo}$):	MV									
			Year:	2045	1.293	1.054	1.000	1.051		
Ramp entrance ($CMF_{12,sc,nEN,at,pdo}$):			ENR		1.000	1.000	1.000	1.134		
Ramp exit ($CMF_{13,sc,nEX,at,pdo}$):				EXR	1.000	1.000	1.000	1.000		
High volume ($CMF_{6,w,ac,y,pdo}$):	MV		ENR	EXR	1.286	1.245	1.247	1.268		
		SV			0.581	0.623	0.621	0.599		

	Year	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
Predicted Average Crash Frequency							
Fatal-and-Injury Crash Frequency							
Freeway Segment Multiple-Vehicle Crash Analysis	**Year**						
Overdispersion parameter ($k_{fs,n,mv,fi}$):							
Observed crash count ($N^*_{o,fs,n,mv,fi}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,fi,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,fs,n,mv,fi,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,fi,r}$), crashes/yr:							
Predicted average crash frequency	2045	15.061	4.673	3.500	21.232		
Freeway Segment Single-Vehicle Crash Analysis	**Year**						
Overdispersion parameter ($k_{fs,n,sv,fi}$):							
Observed crash count ($N^*_{o,fs,n,sv,fi}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,fi,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,fs,n,sv,fi,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,fi,r}$), crashes/yr:							
Predicted average crash frequency	2045	2.576	1.331	1.121	5.225		
Ramp Entrance Crash Analysis	**Year**						
Overdispersion parameter ($k_{sc,EN,at,fi}$):							
Observed crash count ($N^*_{o,sc,EN,at,fi}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,fi,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,sc,EN,at,fi,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,fi,r}$), crashes/yr:							
Predicted average crash frequency	2045	0.000	0.000	0.000	2.187		
Ramp Exit Crash Analysis	**Year**						
Overdispersion parameter ($k_{sc,EX,at,fi}$):							
Observed crash count ($N^*_{o,sc,EX,at,fi}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,fi,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,sc,EX,at,fi,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,fi,r}$), crashes/yr:							
Predicted average crash frequency	2045	0.000	0.000	0.000	0.654		
Property-Damage-Only Crash Frequency							
Freeway Segment Multiple-Vehicle Crash Analysis	**Year**						
Overdispersion parameter ($k_{fs,n,mv,pdo}$):							
Observed crash count ($N^*_{o,fs,n,mv,pdo}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,fs,n,mv,pdo,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,fs,n,mv,pdo,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,mv,pdo,r}$), crashes/yr:							
Predicted average crash frequency	2045	40.317	12.160	9.333	58.799		
Freeway Segment Single-Vehicle Crash Analysis	**Year**						
Overdispersion parameter ($k_{fs,n,sv,pdo}$):							
Observed crash count ($N^*_{o,fs,n,sv,pdo}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,fs,n,sv,pdo,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,fs,n,sv,pdo,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,fs,n,sv,pdo,r}$), crashes/yr:							
Predicted average crash frequency	2045	4.980	2.780	2.407	11.230		
Ramp Entrance Crash Analysis	**Year**						
Overdispersion parameter ($k_{sc,EN,at,pdo}$):							
Observed crash count ($N^*_{o,sc,EN,at,pdo}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,sc,EN,at,pdo,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,sc,EN,at,pdo,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EN,at,pdo,r}$), crashes/yr:							
Predicted average crash frequency	2045	0.000	0.000	0.000	4.526		
Ramp Exit Crash Analysis	**Year**						
Overdispersion parameter ($k_{sc,EX,at,pdo}$):							
Observed crash count ($N^*_{o,sc,EX,at,pdo}$), crashes:							
Reference year (r):							
Predicted average crash freq. for reference year ($N_{p,sc,EX,at,pdo,r}$), crashes/yr:							
Equivalent years associated with crash count ($C_{b,sc,EX,at,pdo,r}$), yr:							
Expected average crash freq. for reference year given N^*_o ($N_{e,sc,EX,at,pdo,r}$), crashes/yr:							
Predicted average crash frequency	2045	0.000	0.000	0.000	1.216		

Output Worksheet for Ramp Segments								
MV = multiple-vehicle model SV = single-vehicle model			Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6
	Applicable Models		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,fi}$):	MV		1.000	1.989	1.059	1.039	1.000	1.000
		SV	1.000	4.054	1.183	1.120	1.000	1.000
Lane width ($CMF_{2,w,x,y,fi}$):	MV	SV	1.096	1.096	1.096	1.096	1.096	1.096
Right shoulder width ($CMF_{3,w,x,y,fi}$):	MV	SV	1.055	1.055	1.055	1.055	1.055	1.055
Left shoulder width ($CMF_{4,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right side barrier ($CMF_{5,w,x,y,fi}$):	MV	SV	1.012	1.196	1.012	1.008	1.001	1.012
Left side barrier ($CMF_{6,w,x,y,fi}$):	MV	SV	1.000	1.002	1.000	1.000	1.000	1.000
Weaving section ($CMF_{9,cds,ac,at,fi}$):	MV	SV						
	Year:	2045	1.000	1.000	1.000	1.000	1.000	1.000
Ramp speed-change lane ($CMF_{8,w,x,mv,fi}$):	MV		1.000	1.000	1.000	1.000	1.000	1.000
Lane add or drop ($CMF_{7,w,x,y,fi}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Property-Damage-Only Crash CMFs								
Horizontal curve ($CMF_{1,w,x,y,pdo}$):	MV		1.000	1.692	1.042	1.027	1.000	1.000
		SV	1.000	4.981	1.239	1.156	1.000	1.000
Lane width ($CMF_{2,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right shoulder width ($CMF_{3,w,x,y,pdo}$):	MV	SV	1.026	1.026	1.026	1.026	1.026	1.026
Left shoulder width ($CMF_{4,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Right side barrier ($CMF_{5,w,x,y,pdo}$):	MV	SV	1.011	1.178	1.011	1.007	1.001	1.011
Left side barrier ($CMF_{6,w,x,y,pdo}$):	MV	SV	1.000	1.001	1.000	1.000	1.000	1.000
Weaving section ($CMF_{9,cds,ac,at,pdo}$):	MV	SV						
	Year:	2045	1.000	1.000	1.000	1.000	1.000	1.000
Ramp speed-change lane ($CMF_{8,w,x,mv,pdo}$):	MV		1.000	1.000	1.000	1.000	1.000	1.000
Lane add or drop ($CMF_{7,w,x,y,pdo}$):	MV	SV	1.000	1.000	1.000	1.000	1.000	1.000
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,fi}$):								
Observed crash count ($N^*_{o,w,x,mv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.038	0.169	0.048	0.094	0.012	1.148
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,fi}$):								
Observed crash count ($N^*_{o,w,x,sv,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.437	3.777	0.123	0.394	0.272	0.581
Property-Damage-Only Crash Frequency								
Multiple-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,mv,pdo}$):								
Observed crash count ($N^*_{o,w,x,mv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,mv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,mv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,mv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.145	0.294	0.114	0.160	0.031	1.287
Single-Vehicle Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,sv,pdo}$):								
Observed crash count ($N^*_{o,w,x,sv,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,sv,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,sv,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,sv,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	0.585	4.253	0.195	0.436	0.260	0.846

Output Worksheet for Crossroad Ramp Terminals								
Signal = signalized intersection model Unsig = unsignalized intersection model			Terminal 1	Terminal 2	Terminal 3	Terminal 4	Terminal 5	Terminal 6
	Applicable Models		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Crash Modification Factors								
Fatal-and-Injury Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,fi}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,fi}$):	Signal	Unsig	0.772	0.791				
Protected left-turn operation ($CMF_{16,w,SG,at,fi}$):	Signal							
	Year:	2045	0.564	0.610				
Channelized right turn on crossroad ($CMF_{17,w,SG,at,fi}$):	Signal							
	Year:	2045	1.232	1.243				
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,fi}$):	Signal							
	Year:	2045	1.000	1.083				
Access point frequency ($CMF_{13,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.842	0.879				
Crossroad right-turn lane ($CMF_{12,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.906	0.902				
Median width ($CMF_{15,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	0.844	0.820				
Exit ramp capacity ($CMF_{10,w,x,at,fi}$):	Signal	Unsig						
	Year:	2045	1.117	1.038				
Skew angle ($CMF_{20,w,ST,at,fi}$):		Unsig						
	Year:	2045						
All-way stop control (CMF_{awsc}):		Unsig						
Property-Damage-Only Crash CMFs								
Non-ramp public street leg ($CMF_{19,w,SG,at,pdo}$):	Signal		1.000	1.000				
Segment length ($CMF_{14,w,x,at,pdo}$):	Signal		0.771	0.790				
Protected left-turn operation ($CMF_{16,w,SG,at,pdo}$):	Signal							
	Year:	2045	0.696	0.728				
Channelized right turn on crossroad ($CMF_{17,w,SG,at,pdo}$):	Signal							
	Year:	2045	1.232	1.242				
Channelized right turn on exit ramp ($CMF_{18,w,SG,at,pdo}$):	Signal							
	Year:	2045	1.000	1.156				
Access point frequency ($CMF_{13,w,x,at,pdo}$):	Signal							
	Year:	2045	1.000	1.000				
Crossroad left-turn lane ($CMF_{11,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2045	0.855	0.889				
Crossroad right-turn lane ($CMF_{12,w,x,at,pdo}$):	Signal	Unsig						
	Year:	2045	0.977	0.975				
Median width ($CMF_{15,w,x,at,pdo}$):	Signal							
	Year:	2045	0.484	0.498				
Predicted Average Crash Frequency								
Fatal-and-Injury Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,fi}$):								
Observed crash count ($N^*_{o,w,x,at,fi}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,fi,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,fi,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,fi,r}$), crashes/yr:								
Predicted average crash frequency		2045	3.068	10.224				
Property-Damage-Only Crash Frequency								
Ramp Terminal Crash Analysis		**Year**						
Overdispersion parameter ($k_{w,x,at,pdo}$):								
Observed crash count ($N^*_{o,w,x,at,pdo}$), crashes:								
Reference year (r):								
Predicted average crash freq. for reference year ($N_{p,w,x,at,pdo,r}$), crashes/yr:								
Equivalent years associated with crash count ($C_{b,w,x,at,pdo,r}$), yr:								
Expected average crash freq. for reference year given N^*_o ($N_{a,w,x,at,pdo,r}$), crashes/yr:								
Predicted average crash frequency		2045	4.419	13.868				

HSM Part C Methodology - Step 7: Apply EB Method (if applicable)

For this IAR, the EB Method was not applied

7.2 Predictive Safety Analysis

Predictive safety analysis was performed per Chapter 18 of the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM) Supplement utilizing the Enhanced Interchange Safety Analysis Tool (ISATe) to obtain an estimate of the predicted average crash frequency during the Opening Year (2025) and the Design Year (2045) associated with the two alternatives: the No-Build Alternative and the Build Alternative. The No-Build Alternative uses the existing roadway with the improvements described in **Section 5**. The Build Alternative installs a new loop ramp access for the eastbound SR 202 to northbound Kernan Boulevard traffic as well as other improvements described in **Section 5**.

Since the Build Alternative requires significant changes in the geometric design, the Predictive Method for Freeways using the Empirical-Bayes Method was not applied for all alternatives to have consistent results.

A summary of the predicted average crash frequency obtained by HSM analysis is presented in **Table 7-15**. **Appendix K** presents the input data used to perform the analysis and the output summary for the alternatives evaluated.

HSM Part C Methodology - Step 8: Sum Predicted/Expected Crashes for All Sites and Years

Mainline

			FI				PDO			
			MV	SV	Ramp Ent.	Ramp Ext.	MV	SV	Ramp Ent.	Ramp Ext.
Seg 1. (I-295 to Kernan Blvd)	2019	Existing	6.444	1.913	0.000	0.000	14.143	3.993	0.000	0.000
	2025	No-Build	9.661	2.192	0.000	0.000	23.198	4.320	0.000	0.000
		Build	9.747	2.192	0.000	0.000	23.407	4.320	0.000	0.000
		Percent Change	0.9%	0.0%	0.0%	0.0%	0.9%	0.0%	0.0%	0.0%
	2045	No-Build	14.942	2.576	0.000	0.000	39.995	4.980	0.000	0.000
		Build	15.061	2.576	0.000	0.000	40.317	4.980	0.000	0.000
		Percent Change	0.8%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%
Seg 2. (Between Kernan Blvd Ramps)	2019	Existing	1.436	0.793	0.000	0.000	3.105	1.915	0.000	0.000
	2025	No-Build	1.889	0.859	0.000	0.000	4.302	1.953	0.000	0.000
		Build	3.023	1.150	0.000	0.000	7.143	2.536	0.000	0.000
		Percent Change	60.0%	33.8%	0.0%	0.0%	66.0%	29.8%	0.0%	0.0%
	2045	No-Build	2.920	0.986	0.000	0.000	7.278	2.087	0.000	0.000
		Build	4.673	1.331	0.000	0.000	12.160	2.780	0.000	0.000
		Percent Change	60.0%	34.9%	0.0%	0.0%	67.1%	33.2%	0.0%	0.0%
Seg 3. (Between Kernan Blvd Ramps)	2019	Existing	2.030	1.076	0.000	0.000	4.678	2.578	0.000	0.000
	2025	No-Build	2.650	1.168	0.000	0.000	6.440	2.666	0.000	0.000
		Build	2.296	0.974	0.000	0.000	5.581	2.198	0.000	0.000
		Percent Change	-13.3%	-16.6%	0.0%	0.0%	-13.3%	-17.5%	0.0%	0.0%
	2045	No-Build	4.039	1.345	0.000	0.000	10.769	2.920	0.000	0.000
		Build	3.500	1.121	0.000	0.000	9.333	2.407	0.000	0.000
		Percent Change	-13.3%	-16.6%	0.0%	0.0%	-13.3%	-17.5%	0.0%	0.0%
Seg 4. (Kernan Blvd to Hodges Blvd)	2019	Existing	10.191	4.072	0.988	0.398	23.934	9.539	2.469	0.747
	2025	No-Build	13.944	4.509	1.449	0.494	35.011	10.036	3.202	0.922
		Build	13.944	4.509	1.449	0.494	35.011	10.036	3.202	0.922
		Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2045	No-Build	21.232	5.225	2.187	0.654	58.799	11.230	4.526	1.216
		Build	21.232	5.225	2.187	0.654	58.799	11.230	4.526	1.216
		Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

No change in Crashes/Year
Increase in Crashes/Year
Decrease in Crashes/Year

Ramps

			FI		PDO	
			MV	SV	MV	SV
Seg 1. (EB Off Ramp)	2019	Existing	0.030	0.509	0.077	0.479
	2025	No-Build	0.079	0.739	0.148	0.685
		Build	0.024	0.338	0.092	0.458
		Percent Change	56.9%	375.9%	101.7%	491.9%
	2045	No-Build	0.186	0.942	0.226	0.864
		Build	0.038	0.437	0.145	0.585
		Percent Change	11.3%	347.4%	93.7%	459.7%
Seg 1*. (Loop Ramp)	2019	Existing	-	-	-	-
	2025	No-Build	-	-	-	-
		Build	0.099	3.179	0.206	3.596
		Percent Change	-	-	-	-
	2045	No-Build	-	-	-	-
		Build	0.169	3.777	0.294	4.253
		Percent Change	-	-	-	-
Seg 2. (EB On Ramp)	2019	Existing	0.035	0.162	0.043	0.178
	2025	No-Build	0.032	0.082	0.073	0.126
		Build	0.034	0.097	0.076	0.156
		Percent Change	5.9%	18.3%	4.2%	23.9%
	2045	No-Build	0.045	0.104	0.110	0.158
		Build	0.048	0.123	0.114	0.195
		Percent Change	5.9%	18.3%	4.2%	23.9%
Seg 2*. (EB On Ramp, 2nd part)	2019	Existing	-	-	-	-
	2025	No-Build	0.038	0.164	0.061	0.177
		Build	0.067	0.312	0.106	0.348
		Percent Change	76.4%	90.2%	74.5%	96.5%
	2045	No-Build	0.053	0.207	0.092	0.222
		Build	0.094	0.394	0.160	0.436
		Percent Change	76.4%	90.2%	74.5%	96.5%
Seg 3. (WB Off Ramp)	2019	Existing	0.005	0.140	0.010	0.137
	2025	No-Build	0.008	0.215	0.021	0.208
		Build	0.008	0.215	0.021	0.208
		Percent Change	0.0%	0.0%	0.0%	0.0%
	2045	No-Build	0.012	0.272	0.031	0.260
		Build	0.012	0.272	0.031	0.260
		Percent Change	0.0%	0.0%	0.0%	0.0%
Seg 4. (WB On Ramp)	2019	Existing	0.114	0.323	0.189	0.341
	2025	No-Build	0.298	0.469	0.364	0.487
		Build	0.485	0.456	0.842	0.670
		Percent Change	62.6%	-2.9%	131.6%	37.5%
	2045	No-Build	0.706	0.598	0.556	0.615
		Build	1.148	0.581	1.287	0.846
		Percent Change	62.6%	-2.9%	131.6%	37.5%

No change in Crashes/Year
Increase in Crashes/Year
Decrease in Crashes/Year

Ramp Terminals

			FI	PDO
Terminal 1 (EB Off Ramp)	2019	Existing	20.040	1.746
	2025	No-Build	14.755	14.354
		Build	2.307	3.406
		Percent Change	-84.4%	-76.3%
	2045	No-Build	31.062	18.381
		Build	3.068	4.419
		Percent Change	-90.1%	-76.0%
Terminal 2 (WB Off Ramp)	2019	Existing	1.967	3.894
	2025	No-Build	12.186	12.364
		Build	7.507	9.950
		Percent Change	-38.4%	-19.5%
	2045	No-Build	16.920	17.103
		Build	10.224	13.868
		Percent Change	-39.6%	-18.9%

(white)	No change in Crashes/Year
(red)	Increase in Crashes/Year
(green)	Decrease in Crashes/Year

HSM Part C Methodology - Step 9: Apply Appropriate FDM KABCO Crash Distribution

			Severity					Total
			K	A	B	C	PDO	
Mainline	2019	Existing	0.463	1.252	7.546	20.080	67.100	96.442
	2025	No-Build	0.546	1.493	8.958	27.818	92.051	130.866
		Build	0.557	1.524	9.145	28.552	94.357	134.136
		Percent Change	2.1%	2.1%	2.1%	2.6%	2.5%	2.5%
	2045	No-Build	0.702	1.945	11.625	41.833	143.799	199.904
		Build	0.718	1.989	11.888	42.964	147.748	205.307
		Percent Change	2.2%	2.2%	2.3%	2.7%	2.7%	2.7%
Ramps	2019	Existing	0.032	0.097	0.491	0.697	1.454	2.770
	2025	No-Build	0.051	0.154	0.784	1.137	2.349	4.475
		Build	0.134	0.407	1.816	2.959	6.780	12.096
		Percent Change	165.0%	165.0%	131.7%	160.1%	188.6%	170.3%
	2045	No-Build	0.073	0.223	1.156	1.674	3.134	6.261
		Build	0.178	0.541	2.429	3.946	8.607	15.702
		Percent Change	142.9%	142.9%	110.1%	135.7%	174.6%	150.8%
Ramp Terminal	2019	Existing	0.117	0.613	3.958	17.319	5.640	27.647
	2025	No-Build	0.028	0.696	4.354	21.864	26.718	53.659
		Build	0.009	0.225	1.475	8.105	13.356	23.170
		Percent Change	-67.7%	-67.7%	-66.1%	-62.9%	-50.0%	-56.8%
	2045	No-Build	0.048	1.209	7.634	39.090	35.484	83.466
		Build	0.012	0.305	1.998	10.978	18.286	31.579
		Percent Change	-74.8%	-74.8%	-73.8%	-71.9%	-48.5%	-62.2%
Arterials	2019	Existing	0.031	0.180	0.555	0.914	3.646	5.326
	2025	No-Build	0.101	0.583	1.799	2.965	12.299	17.747
		Build	0.101	0.583	1.799	2.965	12.299	17.747
		Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	2045	No-Build	0.137	0.790	2.438	4.018	16.678	24.060
		Build	0.137	0.790	2.438	4.018	16.678	24.060
		Percent Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	2019	Existing	0.643	2.141	12.550	39.011	77.840	132.185
	2025	No-Build	0.725	2.926	15.894	53.784	133.417	206.747
		Build	0.801	2.739	14.235	42.581	126.792	187.148
		Percent Change	10.5%	-6.4%	-10.4%	-20.8%	-5.0%	-9.5%
	2045	No-Build	0.961	4.167	22.853	86.615	199.095	313.691
		Build	1.046	3.624	18.753	61.906	191.319	276.648
		Percent Change	8.8%	-13.0%	-17.9%	-28.5%	-3.9%	-11.8%

No change in Crashes/Year
Increase in Crashes/Year
Decrease in Crashes/Year

7.2 Predictive Safety Analysis

Predictive safety analysis was performed per Chapter 18 of the American Association of State Highway and Transportation Officials (AASHTO) Highway Safety Manual (HSM) Supplement utilizing the Enhanced Interchange Safety Analysis Tool (ISATe) to obtain an estimate of the predicted average crash frequency during the Opening Year (2025) and the Design Year (2045) associated with the two alternatives: the No-Build Alternative and the Build Alternative. The No-Build Alternative uses the existing roadway with the improvements described in **Section 5**. The Build Alternative installs a new loop ramp access for the eastbound SR 202 to northbound Kernan Boulevard traffic as well as other improvements described in **Section 5**.

Since the Build Alternative requires significant changes in the geometric design, the Predictive Method for Freeways using the Empirical-Bayes Method was not applied for all alternatives to have consistent results.

A summary of the predicted average crash frequency obtained by HSM analysis is presented in **Table 7-15**. **Appendix K** presents the input data used to perform the analysis and the output summary for the alternatives evaluated.

Table 7-15: Predicted Average Crash Frequency (Crashes/Year)

			Severity					Total
			K	A	B	C	PDO	
Mainline	2019	Existing	0.463	1.252	7.546	20.080	67.100	96.442
	2025	No-Build	0.546	1.493	8.958	27.818	92.051	130.866
		Build	0.557	1.524	9.145	28.552	94.357	134.136
	2045	No-Build	0.702	1.945	11.625	41.833	143.799	199.904
		Build	0.718	1.989	11.888	42.964	147.748	205.307
Ramps	2019	Existing	0.032	0.097	0.491	0.697	1.454	2.770
	2025	No-Build	0.051	0.154	0.784	1.137	2.349	4.475
		Build	0.134	0.407	1.816	2.959	6.780	12.096
	2045	No-Build	0.073	0.223	1.156	1.674	3.134	6.261
		Build	0.178	0.541	2.429	3.946	8.607	15.702
Ramp Terminal	2019	Existing	0.117	0.613	3.958	17.319	5.640	27.647
	2025	No-Build	0.028	0.696	4.354	21.864	26.718	53.659
		Build	0.009	0.225	1.475	8.105	13.356	23.170
	2045	No-Build	0.048	1.209	7.634	39.090	35.484	83.466
		Build	0.012	0.305	1.998	10.978	18.286	31.579
Arterials	2019	Existing	0.031	0.180	0.555	0.914	3.646	5.326
	2025	No-Build	0.101	0.583	1.799	2.965	12.299	17.747
		Build	0.101	0.583	1.799	2.965	12.299	17.747
	2045	No-Build	0.137	0.790	2.438	4.018	16.678	24.060
		Build	0.137	0.790	2.438	4.018	16.678	24.060
Total	2019	Existing	0.643	2.141	12.550	39.011	77.840	132.185
	2025	No-Build	0.725	2.926	15.894	53.784	133.417	206.747
		Build	0.801	2.739	14.235	42.581	126.792	187.148
		Percent Change	**10.5%**	**-6.4%**	**-10.4%**	**-20.8%**	**-5.0%**	**-9.5%**
	2045	No-Build	0.961	4.167	22.853	86.615	199.095	313.691
		Build	1.046	3.624	18.753	61.906	191.319	276.648
		Percent Change	**8.8%**	**-13.0%**	**-17.9%**	**-28.5%**	**-3.9%**	**-11.8%**

The analysis shows the total predicted average crash frequency along the SR 202 mainline is approximately 131 crashes per year in Opening Year (2025) and approximately 200 crashes per year in

Design Year (2045) if no improvements are made. The additional loop ramp with the Build Alternative increases crashes along SR 202 to approximately 134 crashes per year in Opening Year (2025) and approximately 205 crashes per year in Design Year (2045). The increase in predicted crash frequency is attributed to the additional traffic volume in the segment upstream of the eastbound SR 202 to northbound Kernan Boulevard off-ramp.

Similarly, the analysis shows the total predicted average crash frequency along the SR 202 at Kernan Boulevard interchange ramps to be approximately four crashes per year in Opening Year (2025) and approximately six crashes per year in Design Year (2045) if no improvements are made. However, the Build Alternative shows approximately 12 crashes per year and approximately 16 crashes per year for Opening (2025) and Design (2045) Years, respectively. This increase in predicted crash frequency can be attributed to the new ramp configuration. Although crashes are reduced along the eastbound SR 202 to southbound Kernan Boulevard off-ramp with the Build Alternative, the addition of the proposed loop ramp increases the total length of roadway considered when compared to the No-Build Alternative. In addition to the increased length of roadway, the new configuration introduces curves not present with the No-Build ramp configuration. This combination of roadway characteristics with the Build Alternative increases the predicted crash frequency by approximately 150 percent for both Opening (2025) and Design (2045) Years.

The No-Build Alternative analysis shows a total predicted average crash frequency at the ramp terminal intersections of SR 202 with Kernan Boulevard as approximately 54 crashes per year and approximately 83 crashes per year for Opening (2025) and Design (2045) Years, respectively. With the improvements proposed with the Build Alternative, the predicted average crash frequency reduces to approximately 23 crashes per year for Opening Year (2025) and approximately 32 crashes per year for Design Year (2045). The proposed improvements provide a crash reduction of over 50 percent for both years.

The arterial segments along Kernan Boulevard between TMA Roadway and the eastbound SR 202 ramp terminal intersection as well as Kernan Boulevard between the westbound SR 202 ramp terminal intersection and First Coast Technology Parkway do not have any proposed improvements with the Build Alternative. Due to no changes in roadway characteristics between the No-Build and Build Alternatives, the predicted average crash frequencies for both Opening Year (2025) and Design Year (2045) do not vary.

Thus, for the entire facility evaluated, the total average crash frequency is predicted to be approximately 207 crashes per year in Opening Year (2025) and approximately 314 crashes per year in Design Year (2045) if no improvements are made to the corridor. The entire facility evaluated with the proposed improvements is predicted to experience approximately 187 crashes per year in Opening Year (2025) and approximately 277 crashes per year in Design Year (2045). **The improvements are predicted to reduce crashes by approximately 10 percent for both years**.

The Build Alternative shows safety improvement within the study area when compared to the No-Build Alternative. A detailed segment by segment comparison between the analyzed alternatives is presented in **Appendix K**.

Appendix A-2 Example Safety Studies – I-95 at Glades Road IMR Re-Evaluation

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.

Appendix A-3 Example Safety Studies – I-75 at SR 884 IMR Re-Evaluation

6.5 Safety Comparison

Table 10 summarizes the expected crashes for the study alternatives. **Appendix E** contains the safety performance analysis worksheets and crash data utilized for this study.

Due to the geometric configuration of the No-Build and Build alternatives, and as noted in **Table 10**, the application of HSM methodologies is limited in that there is not a distinct difference in the estimated crash frequencies per year between the two (2) alternatives. Based on the safety analysis, there is a slight increase in expected number of crashes in the Build alternative compared to the No Build alternative for the ramp segments. However, there is a slight reduction in expected number of crashes in the Build alternative compared to the No Build alternative for the freeway segment. Based on estimated average crash frequency during the study period (2018-2038) for the No Build and Build alternatives, the Build alternative is expected to have slightly more crashes per year (0.19) compared to the No Build alternative.

Table 10: Expected Number of Crashes for Years 2018 through 2038

Crash Segment Type	Crash Segment	No Build	Build	Difference (Build minus No Build)
Ramp	NB On-Ramp & SB Off-Ramp at I-75/SR 884 NB Off-Ramp at I-75/SR 82	36.81	46.43	9.62
Freeway	I-75 between SR 884 and SR 82	321.28	315.68	-5.60
Estimated Number of Crashes during Study Period		**358.09**	**362.11**	**4.02**
Estimated Average Crash Frequency during Study Period (crashes/year)		**17.05**	**17.24**	**0.19**

Even though the expected number of crashes and expected crash frequencies resulting from the HSM analysis are similar between the two alternatives, the proposed improvements from the Build Alternative provide for a safer operation because of the following:

- Under the No Build alternative, a merge condition is present on the I-75 NB on-ramp before the freeway-ramp gore point, whereas the Build alternative will provide an additional 1,650 feet distance for the outside ramp lane to merge with the inside lane. The enhanced merge condition under the Build alternative is anticipated to provide safer operations with more distance and smooth merging.
- The lane balance provided under the Build alternative because of choice lane at the I-75 exit ramps (NB off-ramp to SR 82 and SB off-ramp to SR 884) will provide safer operations as evidenced by the freeway operational results. The freeway operational results show that the demand on I-75

segment between SR 884 and SR 82 will exceed capacity resulting in LOS F under the No Build alternative, which may contribute to a higher number of crashes compared to the Build alternative.

- The Build condition does not need a lane change from the freeway to ramp and this condition is anticipated to reduce the sideswipe crashes.