TxDOT 2023
Vulnerable Road User Safety Assessment

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Texas Strategic Highway Safety Plan

November 2023

Executive Summary

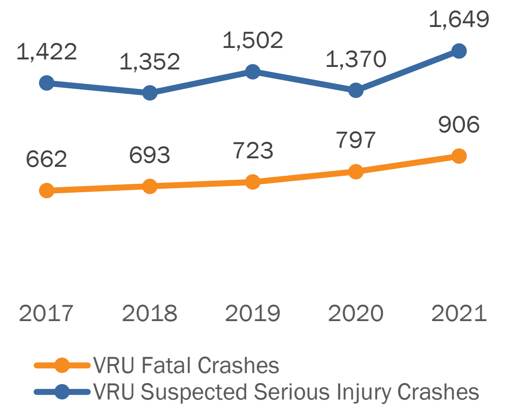

Figure 1 – Total VRU Fatal and Suspected Serious Injury Crashes

Trends in fatal and serious injury crashes are rising for vulnerable road users (VRU) across the United States. However, this trend is not evenly distributed across all states, with some states experiencing higher levels of fatalities than others. In Texas, overall fatal crashes for VRUs have been steadily increasing over the past few years with a larger increase coming between 2020 and 2021. See **Figure 1** for the total VRU fatal and suspected serious injury crashes. Suspected serious injury crash trends for VRUs have been fluctuating for the same five years, however, the overall trend line is increasing. Similar to fatal crashes, there was a large increase between 2020 and 2021. Overall, VRU fatal crashes have increased by 16%, while pedestrian fatal crashes have increased 35% from 2017 to 2021, and pedalcyclists fatal crashes haved increased by 60% from 2017 to 2021.

A collaborative and holistic approach is needed to address these trends and lower them over time, striving towards TxDOT's "Road-to-Zero" goal. The Vulnerable Road User Safety Assessment takes into account current plans such as the Pedestrian Safety Action Plan and the Statewide Bicycle Safety Analysis Summary in developing the analysis and strategies to mitigate and reduce the vulnerable road user related crashes.

A quantitative study was conducted to analyze the "why" of these vulnerable road user crashes. The goal was to determine what characteristics influence the severity of a VRU crash. This study found that *light conditions* are an important indicator of the severity of VRU crashes. Consider that 81% of all pedestrian fatalities occurred at night, even though of all the pedestrian crashes that occurred, 50% happened during the day, and 50% happened at night. The same trend holds true for fatal pedalcylist crashes, where 63% of fatal crashes occur at night, even though for the overall crash number, 72% occurred in the day, and 28% occurred at night. This study also found that *speed* is an important indicator of the severity of VRU crashes. The data showed that roadways with speed limits between 30 and 45 miles per hour accounted for 70% of all fatal and severe injury crashes for VRUs. Demographic composition was also determined to influence the likelyhood for a VRU crash to be fatal or severe. The data shows that 39% of fatal and severe crashes for pedestrian crashes and 33% of fatal and severe crashes for pedalcyclists occur in census tracts labeled by the Centers for Disease Control and Prevention as "high vulnerability" based on the Social Vulnerability Index. This index takes into account Socioecnomic Status, Household Characteristics, Racial & Ethinic Minority Status, and Housing Type & Transportation. This statistic becomes more impactful when considering that the "high vulnerability" population only accounts for 25% of the total population. Lastly, the study found that area type (i.e., urban or rural) is an important indicator of the severity of VRU crashes. The study showed that 85% of the all VRU crashes occurred in urban areas.

As part of the quantitative analysis, several different statewide maps were developed using pedestrian and pedalcyclist systemic analysis and targeted hot spot analysis. Systemic analysis maps showed potential risk segments based on risk factors while the targeted analysis maps showed the specific locations and concentrations of crashes across a statewide level. The purpose of these two types of analysis was to provide decision-makers with a tool that can help them prioritize locations for screening and implementation of countermeasures.

The findings of the quantitative study were shared with all the Metropolitan Planning Organizations (MPOs) in Texas, in hopes that the information could support the MPOs efforts to reduce fatalities and use off-system safety funds. These meetings included potential regional implementation strategies for VRU safety, ongoing VRU-related crash mitigation measures within the MPOs, observed challenges, and suggestions for enhancing the assessment process. The main feedback received from the MPOs regarding VRUs revolved around six main themes: behavior-related issues, education and awareness, infrastructure deficiencies, funding constraints, perception and prioritization, and collaboration and coordination.

Select strategies were chosen to directly counter the impact that light conditions, speed, and demographics have on the severity of VRU crashes in addition to a whole host of other strategies tied to planning, design, infrastructure, behavior, funding, and more. Adding safety lighting along segments and at intersections can directly impact VRU safety positively. Solar powered lighting can be a lower cost option than alternatives and does not require conduit, trenching, or boring across roadways in order to connect the light back to the electrical service. This can be an effective option for treating intersection or safety lighting, especially in rural areas. Speed management is an important consideration to help reduce the severity of VRU related crashes. Speed management can be accomplished through many methods such as traffic calming (e.g., roundabouts, median islands, etc.), reduced speed limits, or increased visibility for VRU roadway features (i.e., rectangular rapid flashing beacon at a crosswalk, advance "Stop Here For Pedestrians" signs at crosswalks, or pedestrian refuge island). The priority areas based on the quantitative analysis are urban areas and high vulnerability tracts within those areas.

The main goals of the Vulnerable Road User Safety Assessment were to identify the key indicators related to VRU crash severity, coordinate with stakeholders to get feedback on VRU related issues and gain an understanding of the ongoing work of organizations like MPOs, and develop a list of strategies in order to help reduce crashes on the road.

Table of Contents

List of Figures

List of Tables

1. Introduction

The Vulnerable Road User Safety Assessment requirement stems from 23 U.S.C. 148(l), a provision in the United States Code. This provision was amended by the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. 117-58). The IIJA, enacted by the U.S. Congress, requires that all states develop a Vulnerable Road User Safety Assessment as part of their Strategic Highway Safety Plan (SHSP).

The findings and recommendations presented in this Vulnerable Road User (VRU) report are intricately connected to the objectives and strategies set forth in the Texas Strategic Highway Safety Plan (SHSP). While the SHSP provides a comprehensive framework for enhancing road safety across Texas, this VRU report delves deeply into the safety concerns of vulnerable road users, including pedestrians and pedalcyclists. By offering a focused analysis of VRU-related incidents, risk factors, and safety trends, this report contributes valuable data that enriches the information pool underpinning the SHSP. The strategies and solutions proposed here align with the overarching goals of the SHSP, reinforcing its multi-faceted approach to road safety by addressing a specific subset of road users. As such, the insights and recommendations of this VRU report play an essential role in advancing the broader mission of the SHSP—to create safer roadways for all and reduce the occurrence of accidents, injuries, and fatalities. The most recent SHSP was released in July 2022. This assessment as well as the SHSP will be updated every five years.

The inclusion of this requirement in the IIJA reflects a growing concern over the rising number of roadway fatalities and injuries involving vulnerable road users in recent years. To address this issue, the legislation calls for a comprehensive assessment of each state's safety performance regarding vulnerable road users and the development of plans to enhance their safety.

1.1 Definition

A **vulnerable road user (VRU)** is a non-motorist with a fatality analysis report system (FARS) person attribute code for pedestrian, bicyclist, other cyclist, or a person in a wheelchair, on a skateboard, or other similar mode. A growing number of roadway fatalities in Texas have been VRUs. This trend is similar nationwide. VRUs are particularly more susceptible to fatal and serious injury crashes when they are involved in a crash with a motor vehicle due to more exposure and limited protection in comparison to motor vehicles. For a full list of acronyms see **Appendix A – Acronyms**.

1.2 Purpose

The purpose of the Texas VRU Safety Assessment is to help provide a high-level overview of the causes, locations, and trends in fatal and serious injury crashes related to VRUs and to help reduce those crashes to meet Texas's overall goals associated with Road-to-Zero (RTZ). In 2019, Texas adopted the vision of Road-to-Zero. This initiative's goal is to eliminate fatalities on our roadways by 2050.

The assessment is an iterative process, allowing for continuous learning and improvement. Its goal is to improve the safety of pedestrians, bicyclists, and other VRUs by implementing targeted measures and reducing crashes, injuries, and fatalities.

1.3 Document Outline

The VRU Safety Assessment involves a comprehensive statewide analysis of the safety performance of pedestrians and pedalcyclists. The safety assessment analyzes crash data and existing roadway conditions to identify high-risk areas, considers demographics pertaining to the crashes, and incorporates stakeholder consultation and outreach. It also develops strategies based on the systemic and targeted analysis, demographics, and outreach. This analysis and the resulting strategies are tied back to a safe system approach, ensuring strategies are determined based on the full breadth of the system.

The VRU Safety Assessment is organized accordingly:

- Chapter 1 – Introduction
- Chapter 2 – Overview of Vulnerable Road User Safety Performance
- Chapter 3 – VRU Quantitative Analysis
- Chapter 4 – Outreach and Consultation
- Chapter 5 – Strategies and Safe Systems Approach

2. Overview of Vulnerable Road User Safety Performance

The overview of VRU safety provides a high-level statewide overview of historical crash trends in overall crashes and VRU crashes separated by type. By disaggregating the data by VRU types into pedestrians and [1]pedalcyclists, a detailed understanding of the safety performance of these user types can be determined. This overview also compares the performance of VRUs to that of all users, highlighting the specific challenges faced by pedestrians, pedalcyclists, and other VRUs.

2.1 Vulnerable Road User Trends

Trends in fatal and serious injuries are rising for VRUs across the United States. However, this trend is not evenly distributed across all states, with some states experiencing higher levels of fatal crashes than others. This section provides an overview into the specific trends here in Texas for VRUs. The TxDOT online Crash Records Information System (CRIS) database was queried on April 14, 2022 and included a five year (2017-2021) historical view. The crash data query was for the five-year timeframe from January 1, 2017, to December 31, 2021. The CRIS is a live data set; thus, any query to collect data for the same time frame that was collected at a different time may not yield the same results.

The analysis reveals how fatal crashes have been relatively steady in years 2017 through 2019 but then jumped by 7.4% in 2020 and then again by 14.5% in 2021. The rate of serious injuries is even higher in recent years. Serious injuries showed a substantial decrease of 15.4% in years 2018 through 2020 before taking a major swing upwards in 2021, with a 30% increase. These trends in fatal and serious injury crashes for all modes and users are shown in **Figure 2** on the following page.

[1] A pedalcyclist is a person who rides a human-powered vehicle with pedals, such as a bicycle.

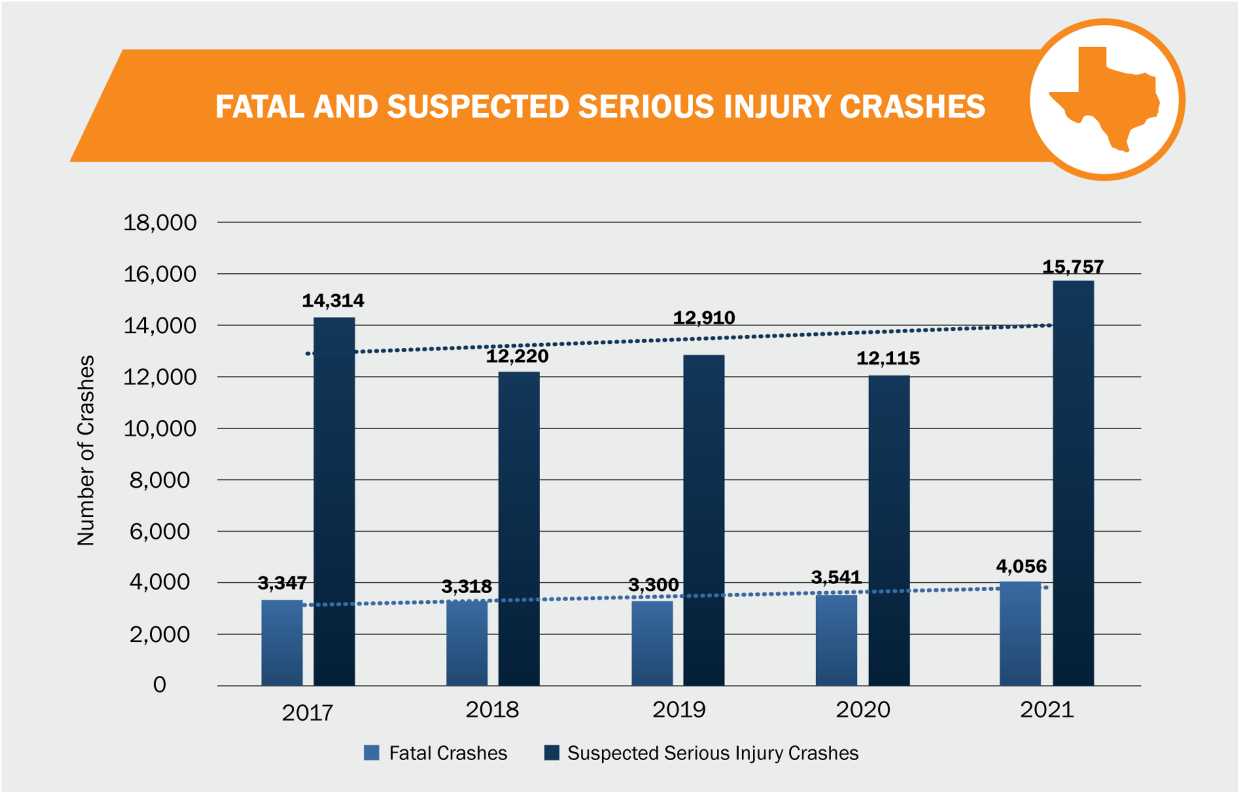

***Figure 2** - Fatal and Suspected Serious Injury Crashes for All Modes (2017-2021)*

The next two figures show crash trends specific to VRUs, disaggregated by user type (pedestrian and pedalcyclists). Pedestrian fatal crashes have seen an increase of 35% from 2017 to 2021, and pedalcyclists fatal crashes have seen an increase of 60% from 2017 to 2021. Whereas, total crashes for all modes have increased at 21% a lower rate than both pedestrian and pedalcyclists crashes. Pedestrians and Pedalcyclists combine for 13% of the total fatal and serious injury crashes occuring on Texas roads. **Figure 3** and **Figure 4** show total fatal and suspected serious injury crashes from 2017 to 2021 for pedestrians and pedalcyclists, respectively.

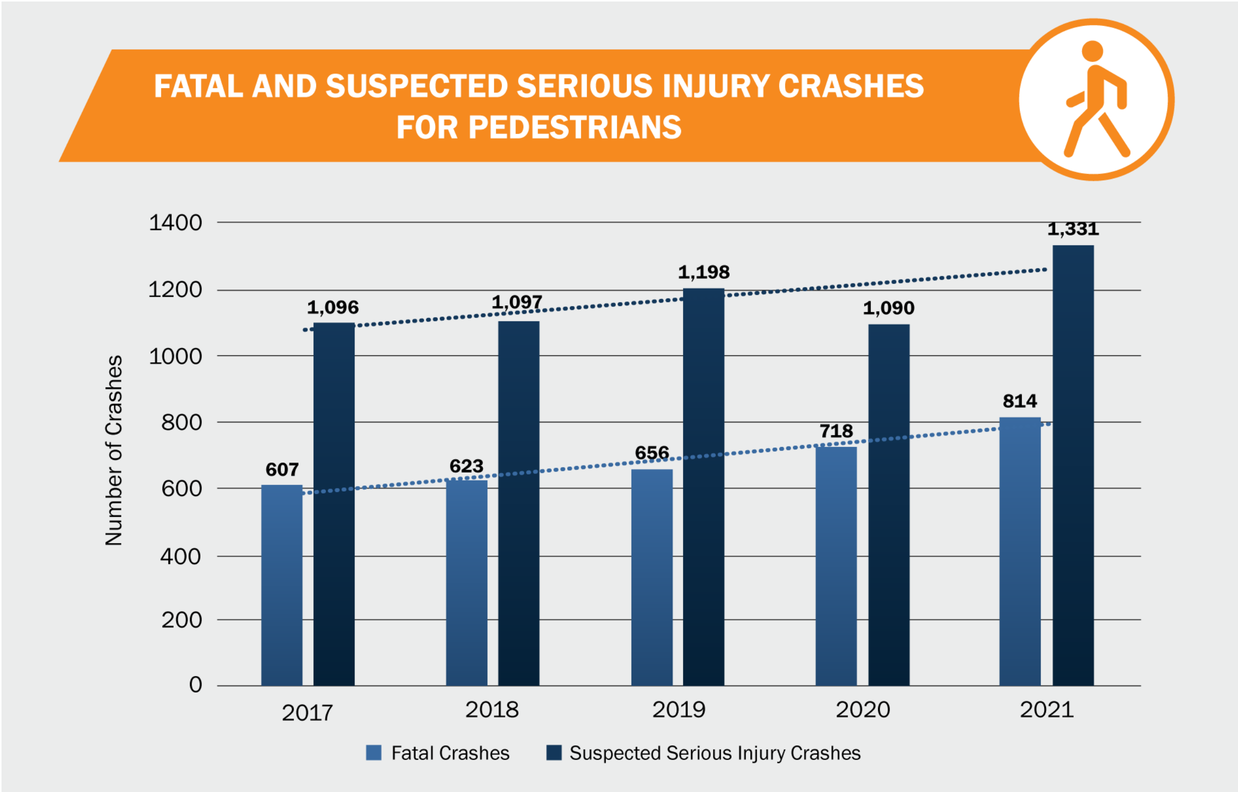

Figure 3 - *Fatal and Suspected Serious Injury Crashes for Pedestrians (2017-2021)*

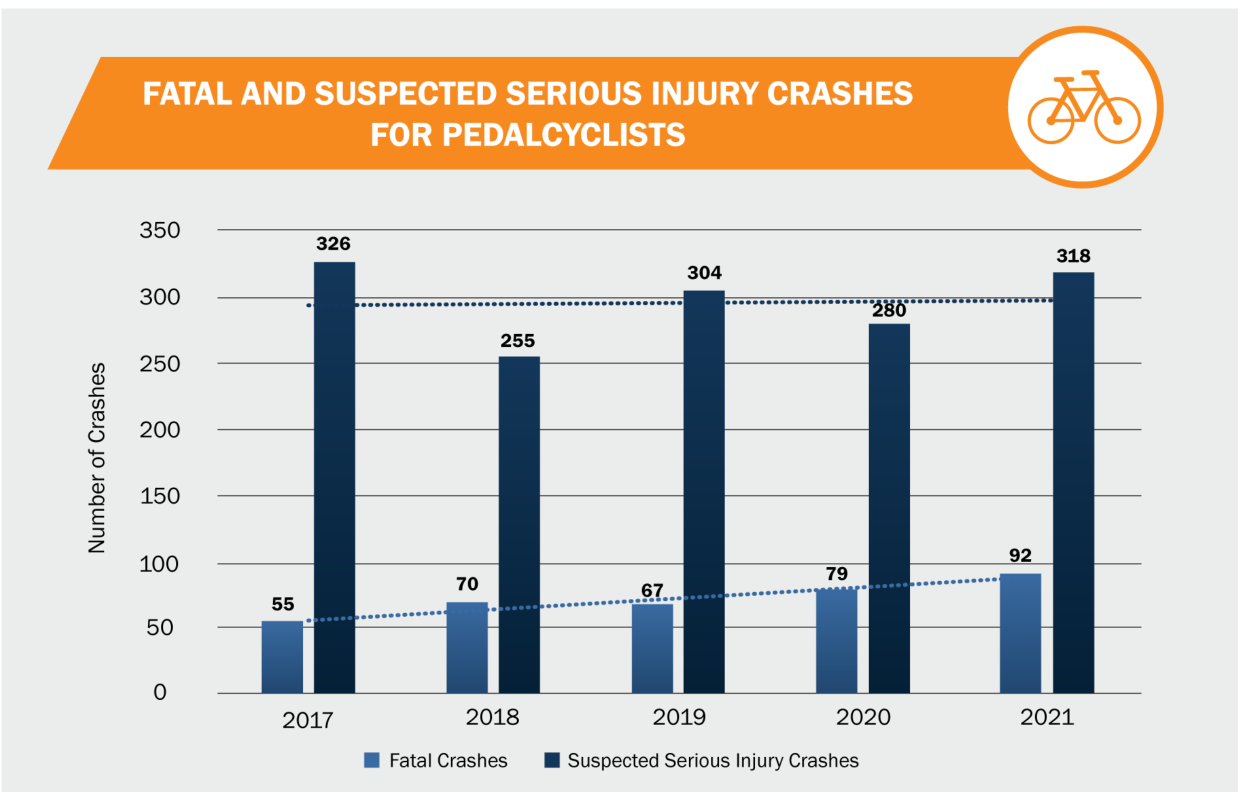

Figure 4 - *Fatal and Suspected Serious Injury Crashes for Pedalcyclists (2017-2021)*

3. VRU Quantitative Analysis

This chapter provides a comprehensive overview of the methodology used to analyze the statewide crash data used for quantitative analysis. It discusses the data sources, the time period of analysis, the different types of analysis performed, the analysis approach, and the overall results. The analysis takes into account important demographic factors to provide an equitable understanding of the challenges faced by different groups. The culmination of this quantitative analysis yields statewide locations of high-risk areas, providing valuable insights into specific locations that require targeted interventions and safety enhancements to provide a safer environment for VRUs.

3.1 Methodology

The methodology for conducting the VRU quantitative analysis was based on the TxDOT Pedestrian Safety Action Plan (PSAP)[2] and the Statewide Bicycle Safety Analysis Summary (SBSAS). The SBSAS can be find as an attachment in the **Appendix B**. The data and analysis outlined in PSAP and SBSAS was used in developing the VRU Safety Assessment. This approach provided a consistent methodology in the way crash data was collected, filtered, and analyzed between all three projects. The PSAP and SBSAS also defined a means to select roadway networks and analysis of the data for identifying high-risk areas as well as hot spots. Demographics and equity were the only variables not used as part of the analysis, although they were used for prioritization of projects in both plans. For these elements, a custom methodology was used for purposes of this VRU Safety Assessment (more information in Section 3.1.4).

Over the past decade, transportation planning professionals and agencies have emphasized and encouraged the use of micro-mobility and other “last mile” means of travel between destinations, which includes electric scooters, electric skateboards, one-wheel electric scooters, etc. These relatively new means of travel are becoming more prevalent, especially in the urban centers, and have introduced more crashes (e.g., new intersections between micro-mobility and conventional vehicles or foreign objects on the roadway). This drives the need to update the crash reports to capture these new modes and causes. This issue is still being studied, and there is currently insufficient data to provide detailed insights. Therefore, crashes associated with micro-mobility were not tracked in the CRIS data set used for this VRU Safety Assessment and were excluded from this methodology. However, TxDOT is now tracking these crashes within the CRIS database and micro-mobility related VRU crashes will be addressed in subsequent updates.

Although safety analysis typically targets only fatal and serious injury crashes, there are instances in the quantitative analysis where fatal, serious and minor injury crashes were used. The main analysis type this was carried throughout was for Systemic Analysis. The decision was driven by the characteristics of vulnerable road

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[2] Texas PSAP Homepage

(https://www.txdot.gov/about/advisory-committees/bicycle-pedestrian-advisory-committee/pedestrian-safety-action-plan.html) user crashes and the need to ensure that the analysis included a broad range of risk factors in order to help develop the systemic risk network. Whereas for Targeted Analysis and Demographic analysis, fatal and serious injury crashes were mainly used. There were a few instances where all crashes were used to analyze the percentages of fatal and serious injury crashes in relation to total crashes.

3.1.1 Crash Data Gathering and Filtering

Crash data from PSAP and SBSAS was used in developing the VRU Safety Assessment. This data was gathered from TxDOT's CRIS online database for the two respective projects. The data was downloaded on April 4, 2022 for the PSAP. The same data set was used for the SBSAS and the VRU Safety Assessment. The CRIS data used was downloaded statewide for a five-year period starting from January 1, 2017 and ending on December 31, 2021[3].

The following four types of crash files from CRIS were used in developing the PSAP, SBSAS, and the VRU Safety Assessment:

- Crash File: contains crash-level information on each individual crash such as the crash severity.
- Unit File: contains vehicle-level information for each crash such as the number of people inside the vehicle and crash contributing factors. When pedestrians are involved in a crash, they can be coded into one single "unit" or into separate "units."
- Primary Person File: contains person-level information regarding the primary person for each unit. Typically, this is used to indicate which of the multiple people involved in a crash was the driver if a vehicle is involved.
- Person Files: contains person-level information regarding all other non-primary person involved in the crash.

These files were the basis for the two types of quantitative analysis performed for PSAP and SBSAS and incorporated into the VRU Safety Assessment. The two types of quantitative analysis were Systemic and Targeted (also known as "Hot Spot"). The subsections below provide more information pertaining to the methodology of these analysis types; and even more detailed methodology can be found in the two respective plans.

3.1.2 Systemic Analysis

Systemic safety involves implementing measures to reduce the risk of crashes at locations with roadway and/or context attributes similar to locations where pedestrian crashes have occurred, known as risk factors. Systemic analysis approaches focus on identifying investment locations with potential risk rather than acting after crashes occur. This approach focuses on identifying and addressing infrastructure issues before they contribute to

[3] CRIS data used for PSAP, and subsequently SBSAA and VRU Safety Assessment was downloaded on April 4, 2022. CRIS data used for Texas Strategic Highway Safety Plan was downloaded on February 22, 2022. Due to the nature of CRIS data there may be minor discrepancies between the two data sets and results.

accidents. As a proactive strategy, systemic safety is a valuable complement to traditional targeted—or hot spot—network screenings.

To address the increasing number of pedestrian- and bicycle-related crashes on Texas roads, a systemic safety analysis was conducted using the guidance of the Systemic Safety Project Selection Tool (SSPST, FHWA Report FHWA-SA-13-019). This analysis identified locations well-suited for systemic treatments to reduce pedestrian crashes. These analyses, along with hot spot screening, creates a comprehensive list of priority locations. The list addresses historical crashes and identifies target areas needing countermeasure investment to reduce crashes on both on- and off-system roadways.

The systemic analysis used TxDOT's Roadway Inventory file containing roadway attributes for both on- and off-system roadways. However, TxDOT GIS Data Management staff do not maintain off-system attributes. Similarly, no statewide database includes intersection attributes. Therefore, off-system roadway segments and intersections were excluded from the systemic analysis. These may be included in future VRU Assessments as GIS data is updated. Agencies that are looking to do their own systemic analysis can start by using their own roadway linework with the most up to date roadway char and apply same methodology as PSAP as a starting point to develop a high-risk network based on systemic analysis. [2]

Intersection crashes were not included in the systemic analysis due to a statewide intersection database featuring locations and detailed attribute information is not available. The systemic analysis identifies potential pedestrian crash risk by considering roadway attributes most common at locations where previous pedestrian crashes have occurred. Furthermore, systemic analysis identifies the locations with greater concentrations of risk factors as potential risk segments. It is not possible to complete a systemic analysis that includes intersection crashes without intersection attributes (i.e., traffic control device types, crosswalk presence, number of lanes entering/exiting, crossing distance, etc.). However, by pairing the systemic risk analysis with a targeted analysis that focuses on previous crashes on both on- and off-system roads, TxDOT's PSAP can identify intersections with historic pedestrian crash concerns. [2]

It's important to note that not all crashes were considered for the systemic analysis, and a list of criteria was used to decide which type of crashes should be included.

The following methodology was used to filter through the crashes from the initial inquiry down to the crashes used for the systemic analysis for the PSAP:[2]

- Pedestrian-related crashes
- Reported motor-vehicle crashes
- Crashes that belong to the fatal (K), serious injury crashes (A), and minor injury crashes (B), crash-severity levels according to the KABCO[4] crash severity rating system

[4] The KABCO scale is a classification system used in accident analysis to categorize the severity of injuries resulting from motor vehicle crashes. The scale consists of six categories: K – Fatal Injury, A – Suspected Serious Injury, B – Suspected

- Crashes that occurred on on-system roads
- Non-intersection-related crashes (i.e., crashes that occurred along the roadway and not at any specific intersection)
- Located crashes (i.e., crashes that had longitude and latitude coordination information)

The process outlined above narrowed down more than three million crashes to 5,590 pedestrian-related crashes, which were used for the systemic analysis. This process is outlined in **Figure 5** below.

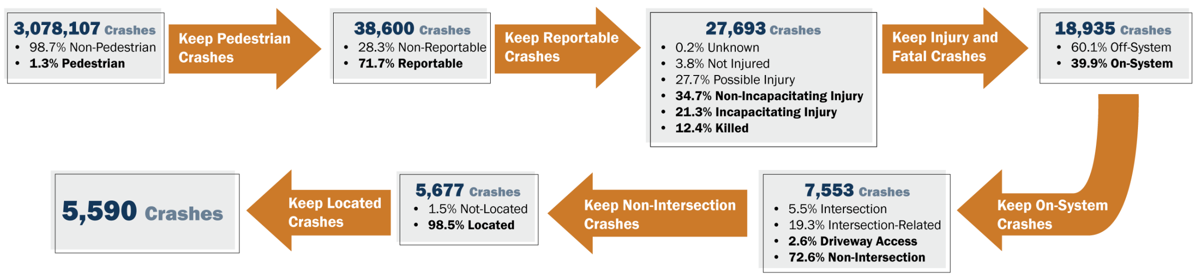

Figure 5 - *Crash Filtering Workflow (Systemic Pedestrian Safety Analysis) from PSAP*

A similar methodology was applied to get the pedalcyclist related crashes in the SBSAS from the same overall dataset. The SBSAS started with 3,087,107 crashes as well and filtered by reportable and pedalcyclist related crashes, which yielded a total of 12,954 crashes. The same filters were then applied as highlighted above to get to 1,018 crashes, which were used for the bicycle systemic analysis. This process is outlined in **Figure 6** below.

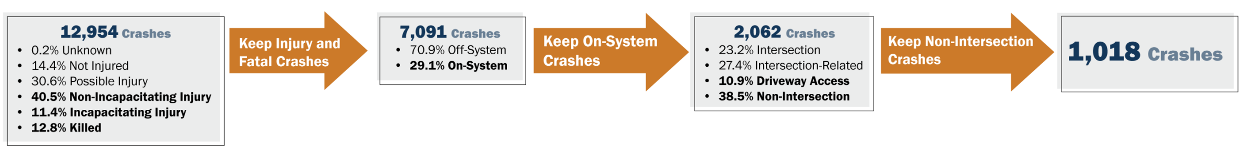

Figure 6 - *Crash Filtering Workflow (Systemic Pedalcyclist Safety Analysis) from SBSAS*

The systemic analysis methodology used the following steps for both pedestrians and pedalcyclists to determine high-risk network areas once the crashes were filtered:

1. Identification of focus facilities
2. Identification of systemic risk factors for pedestrians and pedalcyclists
3. Screening focus facilities for systemic risk factors

The methodology presented below was developed and refined in their respective plans (PSAP and SBSAS) and is summarized below. For additional details, refer to the individual plans. [2]

Minor Injury, C – Possible Injury, O – Not Injured, U – Unknown. More information can be found on the following website: https://safety.fhwa.dot.gov/hsip/spm/conversion_tbl/pdfs/kabco_ctable_by_state.pdf

3.1.2.1 Focus Facilities

Peer group is a combination of the area type, and the functional Systemic analysis does not typically cover all roadways within an analysis area. It is broken out into focus facilities within the analysis area. Developing and identifying focus facilities categorizes the crash types into smaller groups that share similar roadway attributes. The selection of focus facilities is important for determining areas of high risk and prioritizing analysis. Focus facilities were selected for pedestrians and pedalcyclists based on the information provided below. For more detailed methodology refer to the PSAP and SBSAS. [2]

Pedestrians

Focus facilities for the systemic safety analyses for pedestrians were chosen based on the following criterion:

- Area type (urban or rural)
- Functional classification (interstate/freeway or arterial)
- Median type (divided or undivided)
- Posted speed limit (lower speed: $\leq$ 45 mph and higher speed: > 45 mph)

These criteria were used as the basis to generate four systemic peer groups. The peer groups are listed below:

- Urban[5] Arterials
- Rural[5] Arterials
- Urban Interstates and Freeways
- Rural Interstates and Freeways

Peer groups were developed to be able to compare various focus facilities across districts that have roadways with similar characteristics. For a more detailed description on peer groups and focus facilities, refer to the PSAP.[2]

One thing to note is that crashes on the Interstates or Freeways include frontage road crashes. The reason for this was because there was no reliable way to determine the exact location of where the crash occurred on the frontage road. To elaborate, the crash data includes an attribute that designates the crash to a specific section of the roadway (Road Part ID = Service/Frontage Road); however, it does not differentiate the specific frontage road direction (north, east, south, or west of the main lanes). This makes it challenging to align it with the TxDOT roadway inventory attribute, Roadbed ID, which identifies frontage roads and which side they are on.

Functional classes related to collectors, or local functional classes, were combined with arterials. The local roads functional classes did not have enough shared characteristics or risk assessment to develop a stand-alone group. Overall, the result yielded a total of 19,045 miles of TxDOT on-system roadway to be labeled as focus

[5] Urban areas are places where the population is 5,000 or more, while rural areas are places with a population of 5,000 or less. Additional information can be found in CRIS data dictionary under RURAL_URBAN_TYP_LKP (https://ftp.txdot.gov/pub/txdot-info/trf/crash_statistics/automated/publicextractfilespecification.xlsx)

facilities out of the 80,720 on-system miles. The breakdown of the different peer groups by number of miles is provided in **Table 1**.

Table 1 - Focus Facility Miles for Systemic Pedestrian Analysis (PSAP)

Functional Classification Group	Rural (Miles)	Urban (Miles)	Total (Miles)
Interstate/Freeways	1,966	2,355	4,321
Arterials	9,028	5,696	14,724
Total	**10,994**	**8,051**	**19,045**

To determine an overall representation of crashes, all 25 TxDOT Districts were reviewed based on crash data as related to the characteristics above and the roadway inventory unique to each district. Neighboring districts were grouped together if a single district had low volume of K (fatal), A (suspected serious injury), and B (minor injury) crashes to determine specific risk factors. The PSAP provides these district groupings by functional class and area type. [2]

Pedalcyclists

Focus facilities for the systemic safety analyses for pedalcyclists were chosen based on the following criterion:

- Area type (urban or rural)
- Roadway division (one-way, two-way divided, or two-way undivided)
- Number of lanes

The focus facility type was selected if 5% or greater total of K, A, and B crashes were present. Due to the limited number of fatal and serious injury non-intersection crashes involving pedalcyclists on the on-system roadway network, the SBSAS methodology incorporates minor injury crashes as well. Consequently, the analysis for risk factors only focused on specific crash types which included K, A, and B crashes. This methodology is the same as the PSAP.[2] The focus facility type was selected if 5% or higher percentage of K, A, and B crashes were present on the facility. The facilities that met this criterion are depicted by the highlighted red values in the diagram, illustrated in **Figure 7** below.

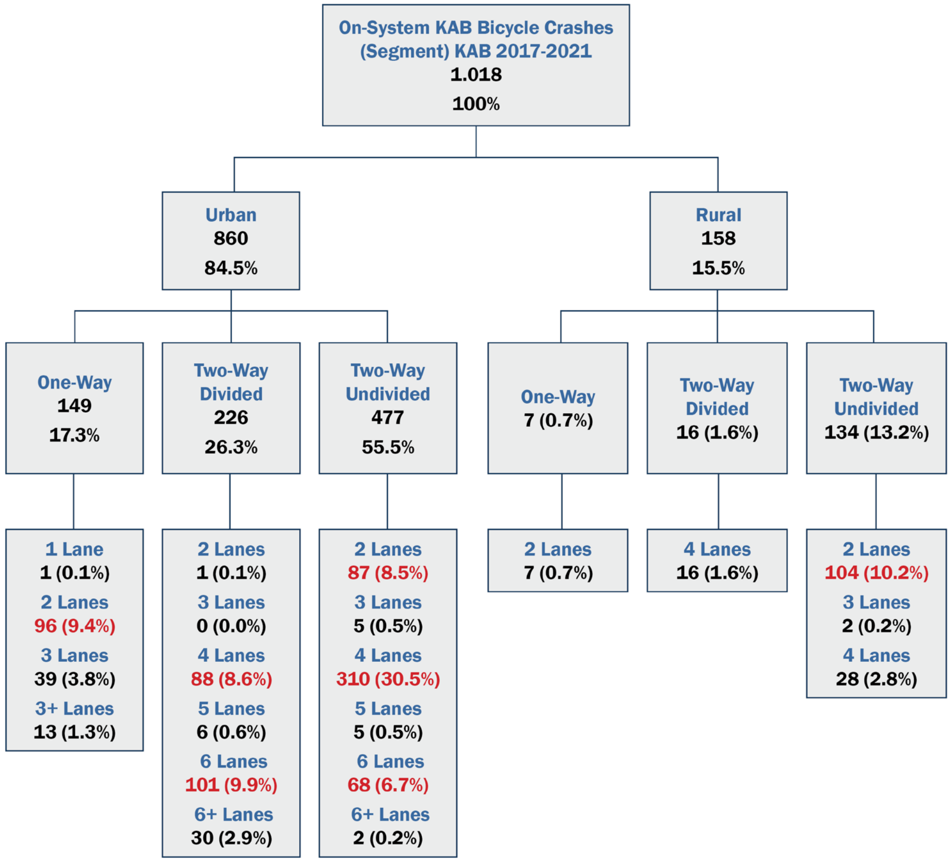

Figure 7 - Focus Facility Selection Criteria

This yielded a total of seven focus facility types:

1. Rural Undivided 2 Lane
2. Urban One-Way 2 Lane
3. Urban Undivided 2 Lane
4. Urban Undivided 4 Lane
5. Urban Divided 4 Lane
6. Urban Divided 6 Lane

3.1.2.2 Risk Factors

Risk Factors

- ARE roadway/traffic characteristics present at locations reported crashes
- ARE NOT necessarily contributing factors and may or may not have contributed to any/ all crashes at an induvial site
- MAY indicate a greater potential for severe pedestrian crashes to occur at the site or similar sites

The systemic approach prioritizes the identification of crash risk factors and mitigation measures. Risk factors are roadway and/or traffic characteristics present at locations with reported crashes. Examples of risk factors include number of lanes, lane widths, crosswalk widths, median type, and other roadway or traffic characteristics present at a location with reported crashes. Risk factors are roadway characteristics that are present at crash locations but may not directly contribute to a crash. Risk factors may indicate greater potential for a crash on a roadway facility with similar characteristics. Although safety analysis typically targets only fatal and serious injury crashes, the overrepresentation analysis for risk factors incorporated fatal, serious injury, and minor injury (K, A, and B) crashes. This decision was driven by the characteristics of vulnerable road user crashes and the need to ensure that the analysis included a broad range of risk factors in order to help develop the systemic risk network.

Pedestrian

Analyzing roadway, traffic, and contextual attributes of crash locations resulted in identification of risk factors for pedestrian-related crashes. If a particular roadway characteristic accounted for a higher proportion of crashes than the centerline miles of that attribute, it was considered an overrepresentation and recommended as a risk factor.

In the example provided in Figure 8 below, roadway functional class is analyzed as a risk factor. The two types of roadway functional classes are Other Principal Arterial and Minor Arterial. Both functional classes have 49% and 51% of the total centerline miles (yellow dashed line) in this specific district, respectively. However, the total percentage of fatal & injury crashes (blue bar), fatal & serious injury crashes (orange bar) and fatal, serious, & minor injury crashes (grey bar) is approximately around 62% for Other Principal Arterials, thus the crashes are overrepresented on this type of functional class. Whereas 38% of these types of crashes occurred on the minor arterial functional classification.

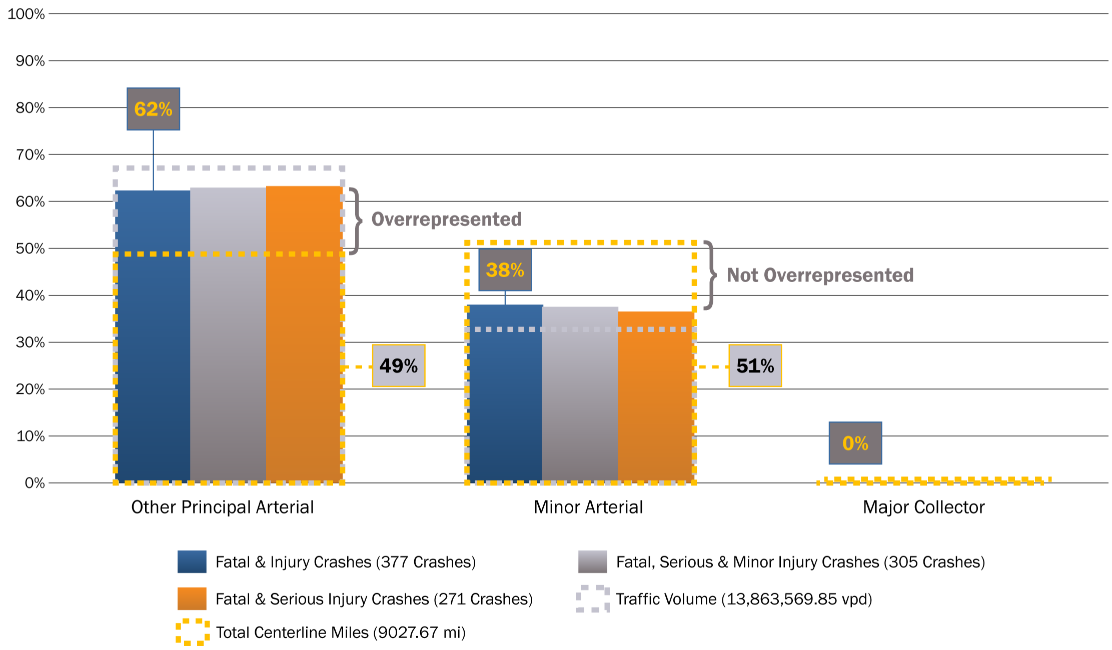

Figure 8 *- Systemic Risk Factor Overrepresentation Example from PSAP*

This analysis was completed for each available attribute in the TxDOT Roadway Inventory file and yielded a total of 32 individual risk factors for the systemic roadway peer groups. Please note that the overrepresentation analysis examines each attribute individually and does not determine causation. **Systemic risk factors should not be misconstrued as crash contributing factors.** This was done for each individual district or district grouping for the four different focus facility types shown in **Table 2**.

Table 2 *- Statewide Risk Factors for Pedestrians from PSAP*

Attribute Name	Rural Interstates and Freeways	Rural Arterials	Urban Interstates and Freeways	Urban Arterials
Average Daily Traffic (ADT)	X	x	X	X
Area Type			X	X
Bus Pad Offset		x		X
Bus Pad Width				X
TWLTL Presence				X
Crosswalk Presence				X
Crosswalk Width		x		
Curb Cut Offset	x	X		X
Curb Cut Presence				X
Curb Presence			X	X
Functional Class		x	X	X
Highway Division		X		X
Inside Shoulder Type		x		
Inside Shoulder Use				X
Inside Shoulder Width	X	x	X	X
Lane Width		X	X	X
Maximum Speed	X	x	X	X
Median Barrier Present	x	X	X	X
Median Type	X		X	
Median Width	x		X	X
Minimum Right-of-Way	X	x	X	X
Number of Lanes	x	X	X	X
Outside Shoulder Use				X
Outside Shoulder Width		X		X
Roadbed Width	X		X	X
Shoulder Type		X	X	
Sidewalk Condition				X
Sidewalk Presence				X
Surface Width		x	X	X
Transit Stop Presence				X
Truck Percentage	X	x	X	X
Truck ADT	x	X	X	X

There might be some risk factors that seem counterintuitive in the list above such as sidewalk presence. While there is an increased risk of exposure due pedestrians being present where there are sidewalks, this does not mean that sidewalks are unsafe or should not be constructed. Sidewalk presence is just one of many risk factors. Risk factors are roadway attributes that correlate with pedestrian crashes, but these roadway attributes do not necessarily cause or contribute to pedestrian crashes.

Pedalcyclist

Systemic risk factors were analyzed by comparing available roadway characteristics of locations where bicycle crashes have occurred. The risk factors were identified through an evaluation of overrepresentation of KAB pedalcyclist crashes associated with three roadway attributes:

- Traffic volume (AADT)
- Speed limit
- Outside shoulder width

Similar to pedestrian overrepresentation analysis, when a roadway attribute accounted for a higher proportion of crashes than centerline miles, an overrepresentation was determined, and the attribute was recommended as a risk factor. This process was completed individually for each of the three attributes including AADT, speed limit, and outside shoulder width for each focus facility type. **Figure 9** shows systemic risk factor overrepresentation example from SBSAS. In this example, the facility type is an urban divided 4-lane with the risk factor being AADT. All AADT thresholds ranging from 12,000 to 45,000 show an overrepresentation of the percentage of KAB crashes (grey bar) compared to the centerline miles (blue bar) for similar AADT ranges.

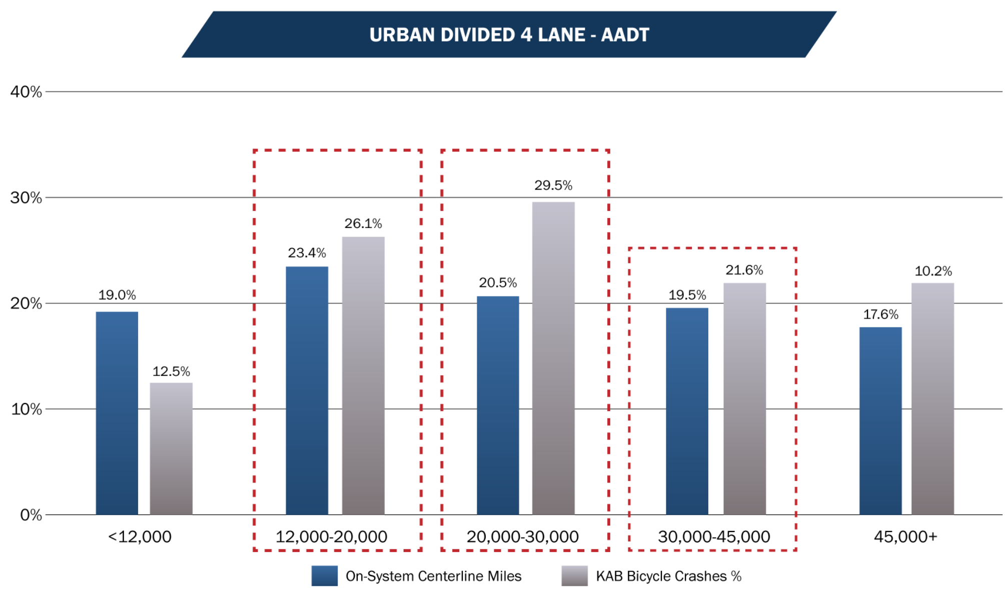

Figure 9 - *Systemic Risk Factor Overrepresentation Example from SBSAS*

Table 3 contains the risk factor (i.e., ADT, posted speed limit, and outside shoulder width) thresholds for pedalcyclists, categorized by area type and facility type.

Table 3 - Risk Factor Thresholds for Pedalcyclists

Area Type	Facility Type	Number of Lanes	ADT range (vpd)	Posted Speed Limit	Outside Shoulder Width (ft)
Rural	Rural Undivided	2	>=2,000	<=65	>=3
Urban	Urban One-Way	2	>=3,000	45	0 or >=4 and <6
	Urban Undivided	2	>=6,000	<=50	>=4 and <10
	Urban Undivided	4	>=11,000	<=45	0
	Urban Undivided	6	>=27,000	<=55	>=0 and <6 or 10
	Urban Divided	4L	>=12,000 and <45,000	<=55	0
	Urban Divided	6L	<36,000	<=55	0

3.1.2.3 Network Screening

Pedestrian

Once the systemic risk factors were developed, each systemic peer group underwent a screening to identify the presence of these risk factors. Each location was assigned a risk score equivalent to the total count of present risk factors. Sites with a relatively higher number of risk factors compared to their peers suggest that these locations could be at an elevated risk for future pedestrian crashes. **Figure 10** shows a risk factor selection example from PSAP.[2]

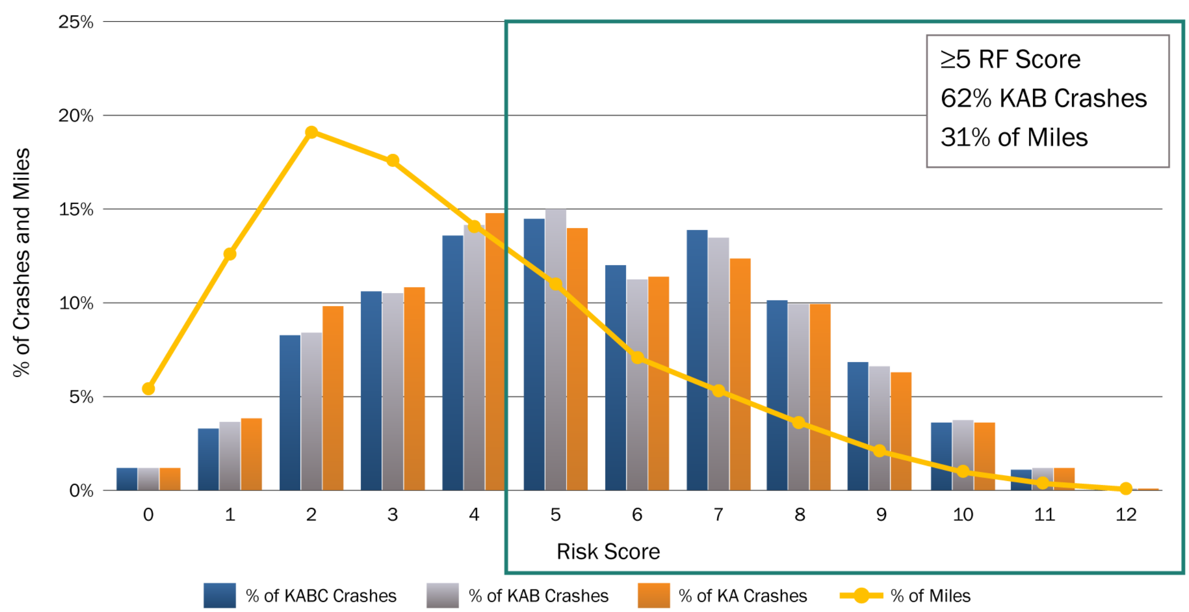

Figure 10 - Risk Factor Selection Example from PSAP

Pedalcyclist

The number of pedacyclist crashes was less than the number of pedestrian crashes. Because there were fewer pedacyclist crashes, there were fewer common risk factors between the pedacyclist crashes. Three risk factors for the pedacyclist analysis were selected: ADT, posted speed limit, and outside shoulder width. Network screening for pedalcyclists was conducted by creating three distinct roadway networks. The first roadway network modeled all roadway segments that had one risk factor greater than its risk threshold. The second roadway network modeled all roadway segments that had two risk factors greater than their risk thresholds. The third roadway network modeled all roadway segments that had all three risk factors greater than their risk thresholds. Pedalcyclist crashes were modeled into these three roadway networks to determine what percentage of the pedalcyclist crashes occurred on roadways with one, two, or three of the risk factors.

The methodology yielded a network showing focus facilities segments with systemic risks for both pedestrians and pedalcyclists. The overall results are provided in 3.2 – Quantitative Analysis Results.

3.1.3 Targeted (Hot Spot) Analysis

Targeted (Hot Spot) analysis uses existing crash data to determine the frequency of crashes at a specific location or corridor segment, or in this case, at all roadways statewide. This analysis identifies hot spots—or locations with high number of crashes relative to their peers—based on crash frequency across the state. The pedestrian targeted analysis differs from the bicyclist targeted analysis due to the methodology used for each. The pedestrian analysis uses a four-step process, whereas the pedalcyclist methodology employs a sliding windows approach, which assesses crash density along network corridors. This technique identifies clusters of fatal and serious injury bicycle crashes occurring in proximity along a roadway segment.

The hot spot analysis uses the same set of crash data as the systemic analysis. **Figure 11** shows the crash filtering method used to filter more than three million crashes from the initial inquiry down to the crashes used for the targeted pedestrian analysis. **Figure 12** shows the crash filtering method used to filter more than three million crashes from the initial inquiry down to the crashes used for the targeted pedalcyclist analysis.

Figure 11 - Crash Filtering Workflow (Targeted Pedestrian Safety Analysis) from PSAP

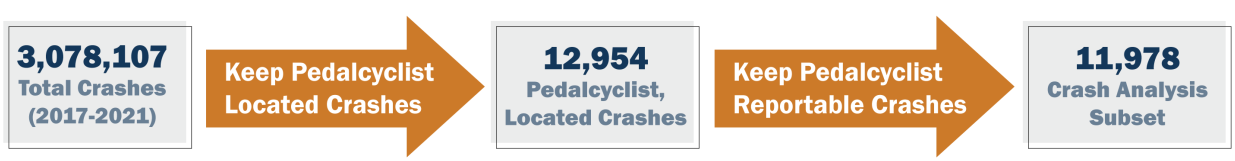

Figure 12 - Crash Filtering Workflow (Targeted Pedalcyclist Safety Analysis) from PSAP

The methodology for targeted analysis is discussed below focusing first on pedestrians and then on pedalcyclists. Each methodology was developed and refined in their respective plans (PSAP and SBSAS).[2] For more details refer to the individual plans.

3.1.3.1 Pedestrians

Following crash filtering, the targeted analysis methodology used the following steps to determine crash density for different roadway segments:

1. Modifying TxDOT Roadway Inventory Network
2. Matching crashes to roadway links
3. Diffusing the effects of crashes across neighboring links
4. Calculating crash density and crash density tiers

Step 1 – Modifying TxDOT Roadway Inventory Network

The Texas roadway network is modeled in a roadway inventory file developed and maintained by TxDOT. This inventory file models thousands of roadway centerline miles across Texas and was used as the foundation for assigning crash data to a geographic location.

The roadway inventory file was categorized into peer groups based on attributes like TxDOT District, system type (on- or off-system), area type, and functional classification. These attribute combinations resulted in 400 potential peer groups; however, only 316 peer groups were analyzed because some attribute combinations were not present in the actual roadway inventory.

The roadway inventory file was modified to assist with matching crashes to areas. This was done by dissolving the roadway network file by the route ID and county fields. The roadway inventory file was then segmented into 0.4 miles for rural roads and 0.2 miles for urban roads. This segmentation of the roadway network allowed for the impact of a single crash to be more smoothly diffused across roadway segments. Prior to segmentation, all roadway lengths varied drastically: some roadway segments were as small as 0.01 mile, and some extended more than 10 miles.

Step 2 – Matching Crashes to Roadway Links

After crash filtering and modification of the roadway segments, the crashes were matched to the adjacent roadways. The analysis methodology used two types of matching based on the crash data attributes. Some crashes had linear referencing information such as a highway system, highway number, highway suffix, and county number. This information was used to match crashes to the appropriate roadways based on the same information present in the roadway inventory file. This was mainly applicable to on-system roadways. The second type of matching performed was based on longitude and latitude data for crashes with no linear referencing data. These crashes were matched to the roadway network based on their proximity to the nearest roadway link within 100 meters. If no roadway link existed within 100 meters, the targeted analysis did not incorporate the crash. The number of crashes that were not incorporated due to this phenomenon was 233 or 0.8% of the overall crashes analyzed. The geospatial projection used for this function was EPSG:3081 which, by default, uses meters.

Step 3 – Diffusing the Effects of Crashes Across Neighboring Links

Once crashes were matched to roadway links, the impact of each crash was spread across four neighboring links (two in each direction) using a sliding window analysis. This analysis generalized crash patterns, which are point events, into linear events formed by a series of segments. For example, if the analysis used a segment length of 0.2 miles with a crash at mile post 0.5 (in the middle of the segment from 0.4 to 0.6), the effects would be diffused across that segment and adjacent segments. This approach provided a broader understanding of crash patterns along the roadway.

Step 4 – Calculating Crash Densities and Crash Density Tiers

Crash density calculation allows for a general comparison between segments of varying lengths. The calculation involved dividing the diffused number of crashes on each link by its length. To avoid skewed density values caused by extremely short segments, minimum lengths of 0.4 miles for rural links and 0.2 miles for urban links were used based on roadway segmentation described above.

The links were classified into five tiers based on their crash densities: Critical, High, Medium, Low, and Minimal. The Jenks Natural Breaks classification method used provided fair comparisons by tailoring the threshold values for each peer group. This approach made sure breaks defining the categories were specific to the characteristics of each peer group.

At the conclusion of all four steps, the methodology yielded a network based on targeted analysis showing the different crash density tiers for all TxDOT roadway segments with a recorded crash. The overall results are provided in Section 3.2 – Quantitative Analysis Results.

3.1.3.2 Pedalcyclists

Like the PSAP, the focused bicycle safety analysis employs a sliding windows approach, which assesses crash density along network corridors. This technique identifies clusters of fatal and serious injury bicycle crashes occurring in proximity along a roadway segment. This approach efficiently highlights high-priority corridors to address fatal and serious injury crashes. The analysis mechanisms are shown in Figure 13.

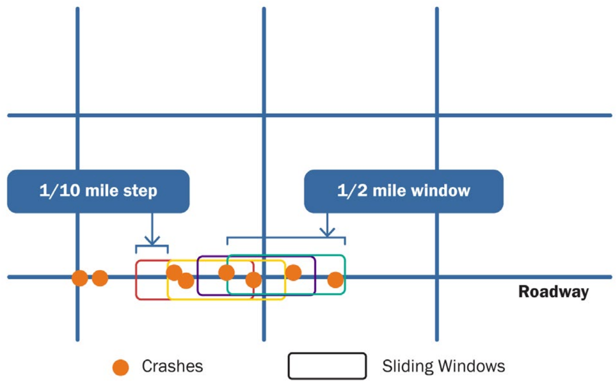

Figure 13 - Sliding Window Analysis Process Diagram from SBSAS

The analysis considered bike crashes both on- and off-system that occurred from 2017 to 2021. Crash severity was determined by a universal weighted scale[6] (KABCO) where severity levels were assigned different weights (K x5, A x4 … O x1). Using these weighted crash scores, segments were selected based on the 85th percentile score as a threshold, allowing adjustment as needed.

3.1.4 Demographics

Pedestrian and pedalcyclist crashes and fatalities have varying impacts on different communities. When analyzing VRUs, demographics is an important factor to consider. Demographics encompass characteristics such as age, gender, race, ethnicity, income, and disability status, which can provide insight on challenges faced by different populations.

The Social Vulnerability Index (SVI), developed by the Center for Disease Control and Prevention (CDC), is a valuable tool for analyzing demographics and equity. It assesses and measures the social vulnerability to potential public health emergencies such as natural disasters, disease outbreaks, or other emergencies that may impact community health.

The CDC SVI incorporates various socioeconomic and demographics factors. It involves four main themes, which are listed below:

- **Socioeconomic Status** – include factors such as below the 150% poverty threshold, unemployment, and housing cost burden
- **Household Characteristics** – include factors such as age (65 and older or 17 and younger), disability, and single-parent household
- **Racial and Ethnic Minority Status** – broken down U.S. Census Bureau categories
- **Housing Type and Transportation** – include factors such as mobile homes, no vehicles, and group quarters

[6] As defined by 23 CFR 490.205 of US Law

The CDC SVI assigns scores based on each theme listed above as well as an overall score. The overall score assigned to each geographic area incorporates all themes and factors. These scores provide a relative measure of vulnerability, allowing for comparisons between communities. The smallest geographical area available in this data set is by Census tract size. Specific variables and calculations used in the CDC SVI may vary by location, as different regions have unique characteristics and challenges. **Figure 14** shows the different themes and variables that go into making the CDC Overall Social Vulnerability Index.

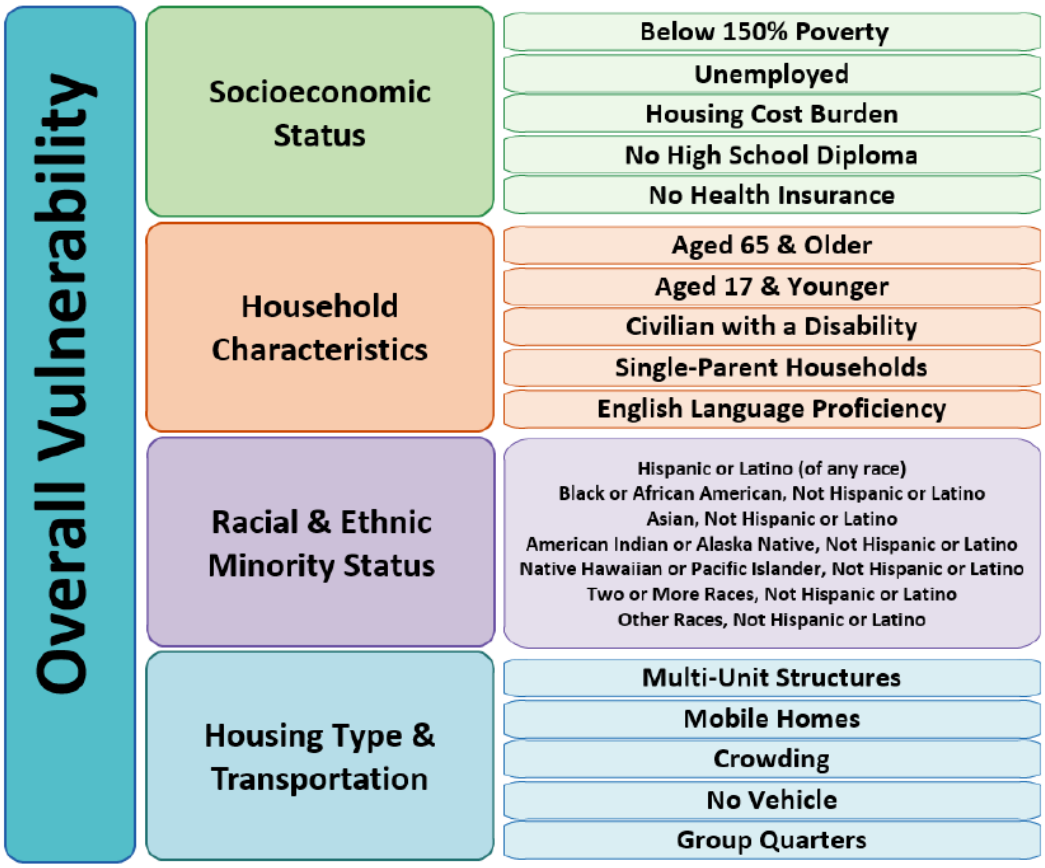

Figure 14 – Social Vulnerability Index: Equity Factors

The CDC SVI is a valuable tool for analyzing demographics and equity considerations related to VRUs. Incorporating various socioeconomic and demographic factors helps create a high-level understanding of the social vulnerability of communities and helps identify disparities and inequities impacting VRU safety. The CDC SVI helps provide insights into the factors affecting various populations, prioritize resources effectively, and develop strategies that promote equity and enhance safety for groups most vulnerable to VRU crashes.

Incorporating CDC SVI into Systemic and Targeted Analysis

The CDC SVI overall score is measured on a scale from 0 to 1, with 0 representing areas with the lowest levels of vulnerability and 1 indicating the highest levels of vulnerability. To provide further granularity, the overall score is divided into quartiles as follows:

- 0 to 0.25 – low level of vulnerability

- **0.25 to 0.50** – low to medium level of vulnerability
- **0.50 to 0.75** – medium to high level of vulnerability
- **0.75 to 1.00** – high level of vulnerability

For the purposes of the VRU Safety Assessment, Census tracts falling within the 4th quartile (0.75 to 1.00 SVI overall score) were considered high vulnerability tracts, and thus, they were the primary focus of the demographics analysis. Out of the total 6,884 Census tracts in Texas, 1,708 were identified as high vulnerability tracts. These tracts were used in conjunction with the systemic and targeted analysis to identify patterns related to VRU crashes. The remainder of the tracts were considered low or lower vulnerability tracts.

Filtered crashes from the systemic and targeted analysis methodology were overlaid with the high vulnerability tracts. Subsequently, various factors such as unemployment, below 150% poverty, housing cost burden, disability, race, and lack of vehicle ownership, were assessed. These factors were only analyzed for the high vulnerability tracts to determine whether VRU crashes within these areas — particularly those involving fatal, serious injury, or minor injury outcomes — occurred at a disproportionate rate compared to other areas.

3.2 Quantitative Analysis Results

The quantitative analysis for VRUs used several types of analysis and demographic considerations in developing a statewide-level overview of the VRU trends for Texas. CRIS data used in developing the analysis included attributes such as crash severity, harmful event type, and roadway characteristics to determine crash density tiers and hot spot areas. Roadway characteristics and risk factors were used to develop systemic risk segments. Demographic considerations encompassed factors based on socioeconomic status, household characteristics, race, ethnicity, housing type, and transportation needs and showed how different population groups were affected based on these factors.

3.2.1 Systemic Analysis

Systemic analysis involves screening a roadway network based on the presence of risk factors. The systemic analysis results for pedestrians and pedalcyclists are provided below in separate subsections. Detailed information such as locations of potential risk areas, focus facilities, and being able to filter by specific geographical information can be found online on the PSAP screening tool.[7]

3.2.1.1 Pedestrians

Systemic safety analysis results were evaluated for the pedestrian focus facilities defined in Section *3.1.2 Systemic Analysis* above. Systemic analysis was conducted for pedestrian crashes that occurred on on-system

[7] TxDOT PSAP Screening Tool (https://amrgeo.jacobs.com/portal/apps/experiencebuilder/experience/?id=d0aa4ae93bcd45298540dc21ba1c713e&draft=true)

roadways only. These focus facilities encompassed 19,045 miles of the total 80,720 on-system miles. Of the total 19,045 miles, 6,241 miles — or 33% of the total miles for focus facilities — were designated as potential systemic risk segments. **Figure 15** displays a map illustrating the status of on-system facilities across the state, distinguishing between those labeled as "Yes" and those marked as "No" for having potential risk segments for pedestrians. These high-risk areas can also be found using the interactive pedestrian safety action tool.

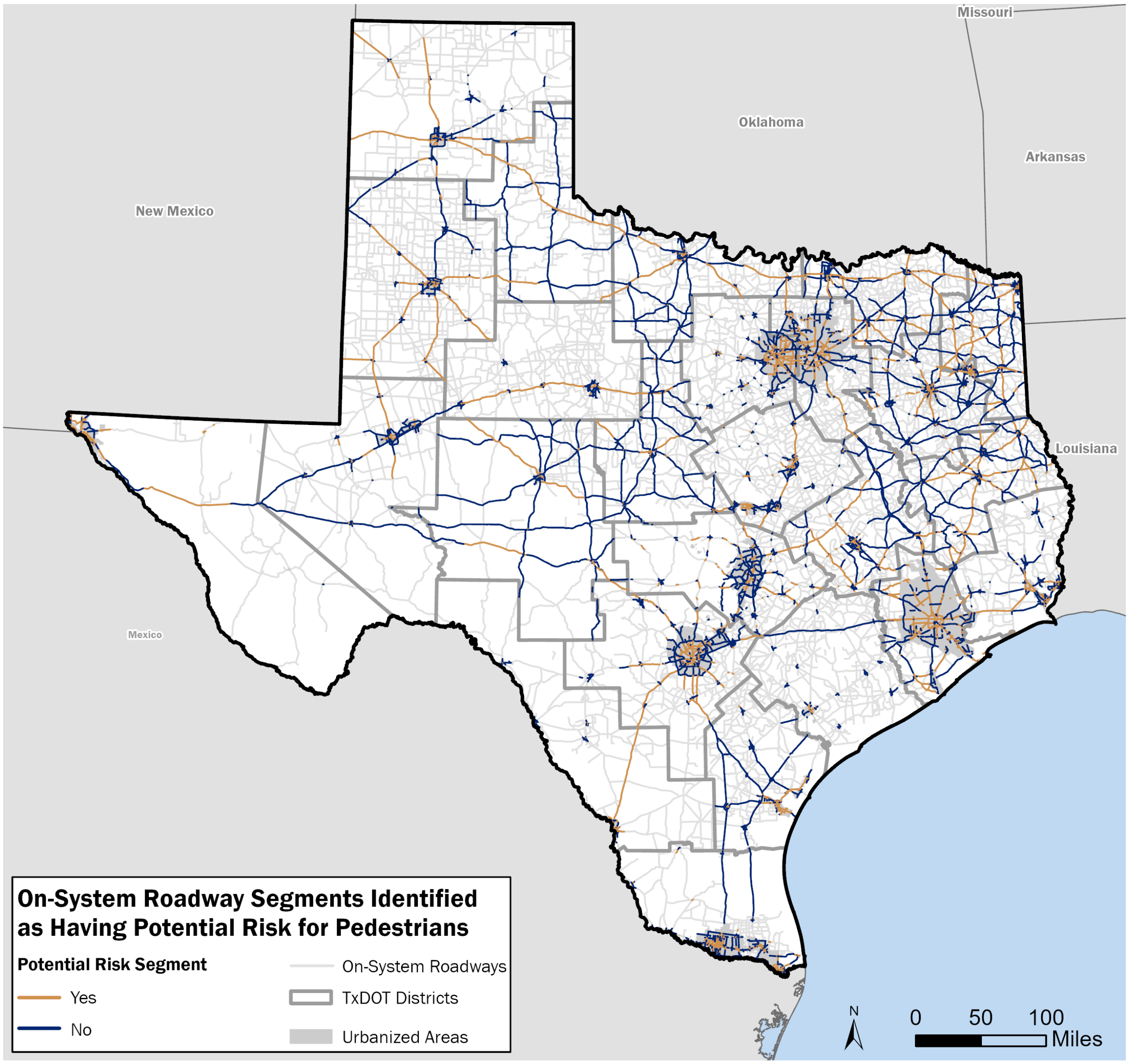

Figure 15 - On-System Roadway Segments Identified as Having Potential Risk for Pedestrians

A detailed analysis was conducted to assess the distribution of systemic risk segments across different vulnerability levels of Census tracts. This involved overlaying the potential high-risk segments with both high vulnerability Census tracts (4th quartile) and low vulnerability Census tracts (1st, 2nd, and 3rd quartiles). The analysis revealed that out of the total 6,241 miles of potential systemic risk segments, 1,310 miles (21%) were located within high vulnerability areas. **Figure 16** shows the focus facilities systemic risk broken down into low vulnerability and high vulnerability.

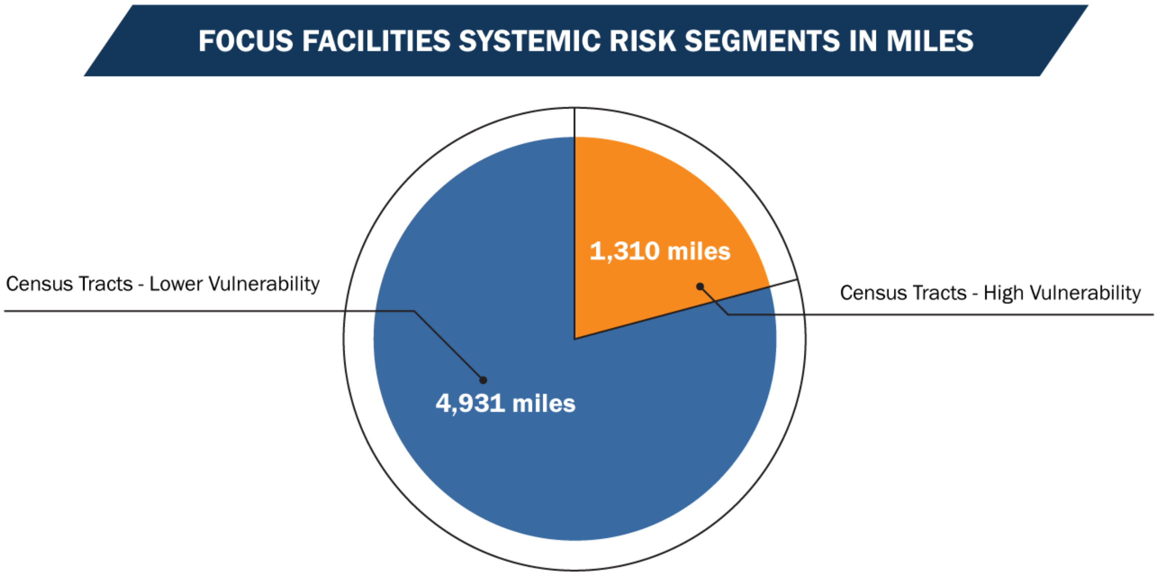

Figure 16 – Breakdown between Potential Risk Segments in High Vulnerability Tracts for Pedestrians

Focus facilities were broken down further to determine if specific locations were more susceptible to VRU-related crashes based on functional classification and area type. **Table 4** below shows the breakdown of pedestrian systemic risk segments by functional class and area type. Based on the systemic analysis, 1,642 miles (29%) of the 5,696 total miles of urban arterials have a combination of risk factors that may put them at a higher risk for pedestrian crashes when compared to other urban arterials. Similarly, 2,806 miles (31%) of the total miles of rural arterials have systemic risk factors potentially placing them at a higher risk for pedestrians when compared to other rural arterials. These risk factors could be crosswalk width, maximum speed, median widths, number of lanes, or lane width.

Urban interstates/freeways accounted for 851 miles (36%) of the total 2,355 miles identified as areas with potential systemic risk for pedestrians. In contrast, rural interstates/freeways accounted for a higher proportion, with 942 miles (48%) of the total 1,966 miles considered as potential systemic risk areas for pedestrians. Potential reasons for rural interstates/freeways having a higher systemic risk for pedestrians include higher speeds, lack of pedestrian infrastructure such as sidewalks, and longer distances for crossings.

Table 4 – Potential Systemic Risk Breakdown by Functional Class and Area Type for Pedestrians

Functional Class	Area Type	Total Focus Facilities (mi)	Potential Systemic Risk Segments (mi)	% Of Potential Systemic Risk Segments
Arterials	Urban	5,696	1,642	29%
Arterials	Rural	9,028	2,806	31%
Interstates/ Freeways	Urban	2,355	851	36%
Interstates/ Freeways	Rural	1,966	942	48%

3.2.1.2 Pedalcyclists

Figure 17 shows the map of statewide on-system facilities that have one, two, or all three of the risk factors associated with it for pedalcyclists. The number of centerline miles associated with each risk factors are listed below; this mileage totals up to the total on-system centerline miles (80,720) for the state.

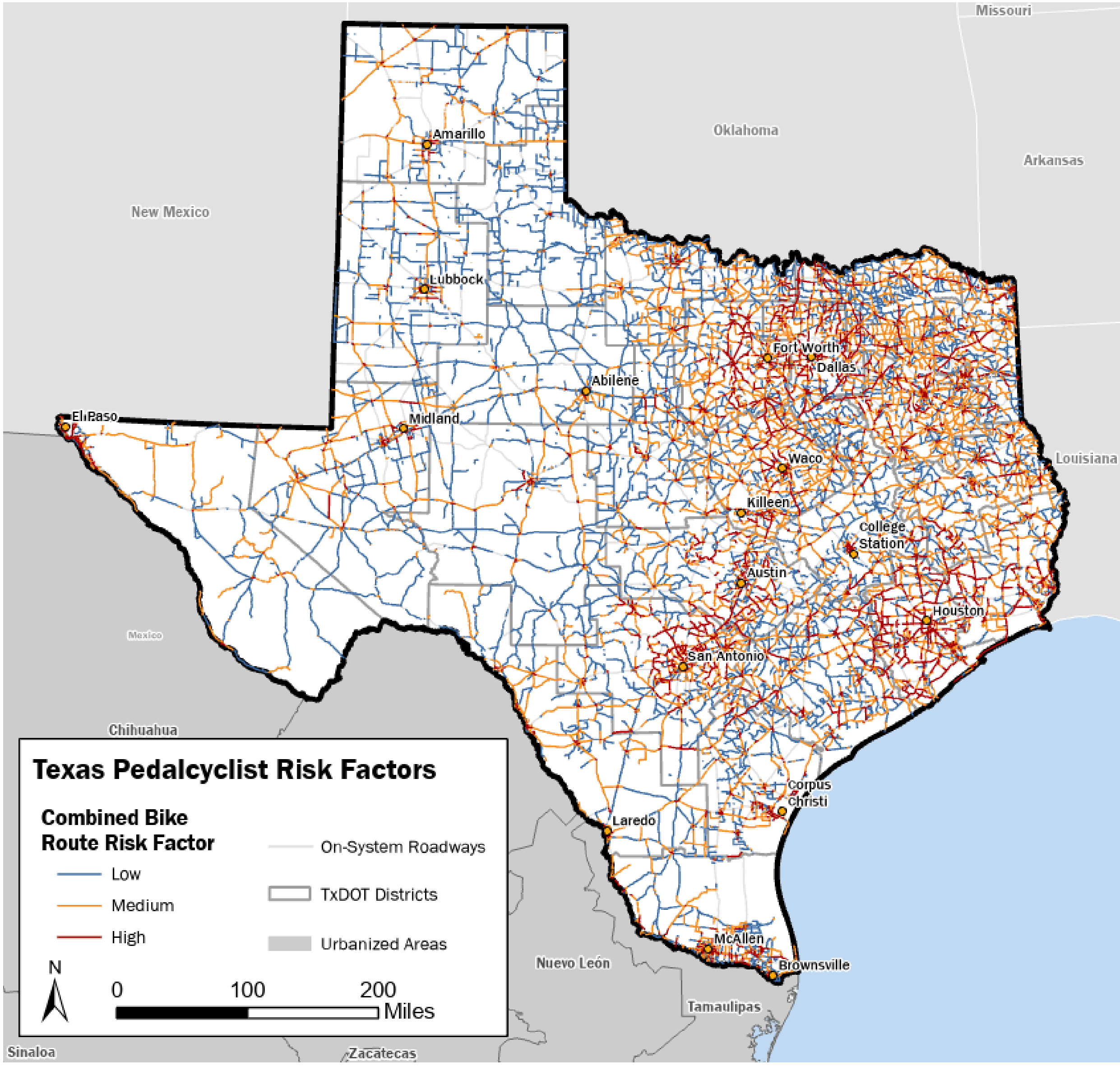

Figure 17 – On-System Roadway Segments with One, Two, or All Three Risk Factors Present for Pedalcyclists

Table 5 provides on-system bicycle risk factors breakdown by centerline miles. It shows the breakdown for the risk factors shown on **Figure 17** between one risk factor, combination of two risk factors, or all three risk factors present.

Table 5 – On-System Segment Pedalcyclist Risk Factors by Centerline Miles

Number of Risk Factors	Centerline Miles	Percentage
0 (None)	22,797	28.2%
1 (Low)	29,786	36.9%
2 (Medium)	21,336	26.4%
3 (High)	6,801	8.4%

3.2.2 Targeted (Hot Spot) Analysis

Based on the methodology for Targeted (Hot Spot) Analysis, a total of 28,207 pedestrian crashes were analyzed. This included all crashes categorized according to the KABCO scale that occurred on both on- and off-system roadways. As outlined in the methodology described in Section *3.1.3 Targeted (Hot Spot) Analysis*, crashes were diffused across roadway segments, including on- and off-system roadways, to develop the crash density tiers. These tiers — Critical, High, Medium, Low, and Minimal — were then mapped to provide a high-level overview of hot spot locations across the State. The targeted analysis yielded a total of 13,980 miles of roadway out of 317,510 total on- and off-system roadway miles. The breakdown of the mileage by crash density tier is provided in **Table 6** below.

Table 6 – Total Miles by Crash Density Tiers for Pedestrians

Crash Density Tiers	Length (mile)
Critical	1,717
High	1,307
Medium	3,825
Low	4,541
Minimal	2,590
Total	**13,980**

The pedestrian targeted analysis was also filtered by area type. Looking at the crash density tier segments by area type showed that most of the crashes occurred on roadways in urban areas. This observation aligns with the expectation that more densely populated regions tend to have a higher pedestrian presence. The total crash density mileage for rural areas amounted to 2,634 miles, while 11,346 miles for urban areas. However, Critical crash density tiers showed a comparable mileage between urban and rural area types. Focusing on these Critical crash density areas for further investigation could yield valuable insights into the reasons behind their higher crash density when compared with other roadway segments. **Figure 18** shows the comparison between area types for the different crash density tiers.

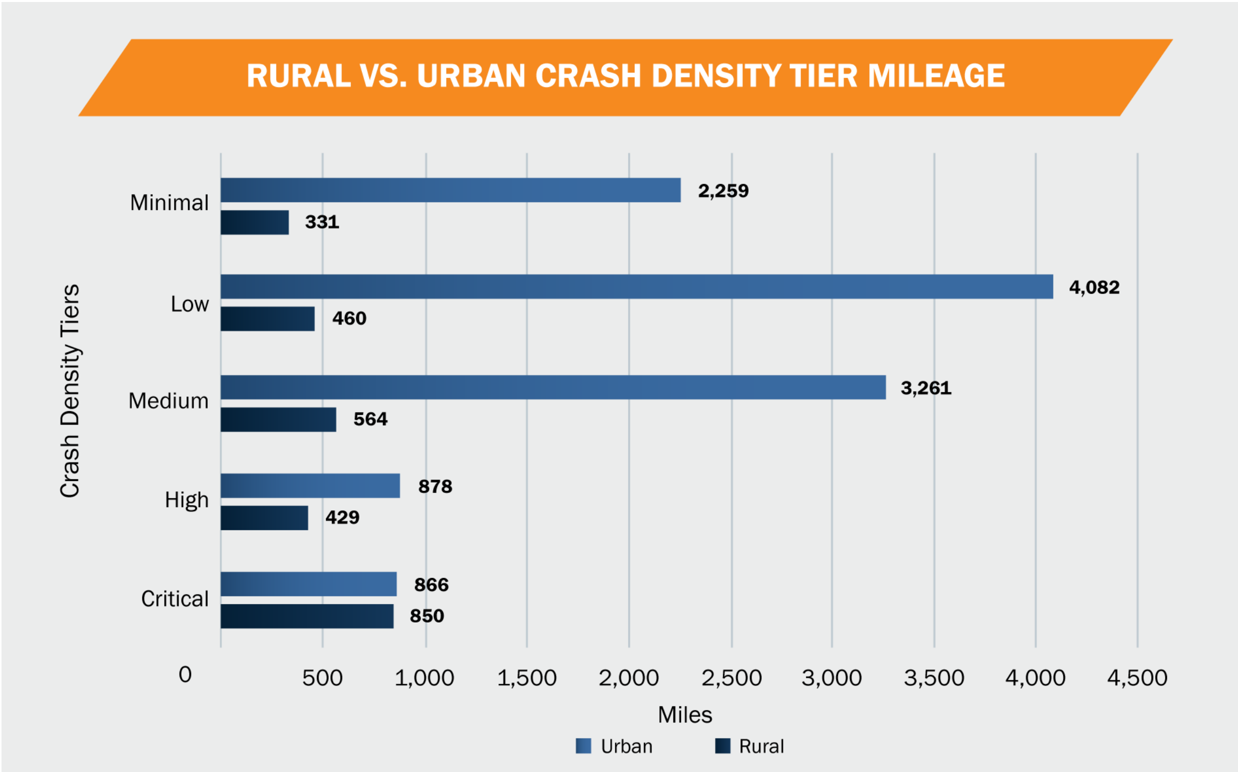

Figure 18 – Rural vs. Urban Crash Density Tier Mileage for Pedestrians

The Critical and High crash density tiers accounted for approximately 21% of the total on- and off-system roadway mileage. These roadway segments could serve as a starting point for stakeholders and other agencies to focus on and examine the causes for higher crash densities. **Figure 19** is a map of the state Texas which outlines the areas where the various pedestrian crash density tiers of facilities are generally located. **Figure 20** is a map of the state Texas which shows the targeted analysis crash density map for pedalcyclists from SBSAS. The pedestrian targeted analysis showed more critical crashes at smaller intervals along on-system roadways when compared to the bicyclist targeted analysis.

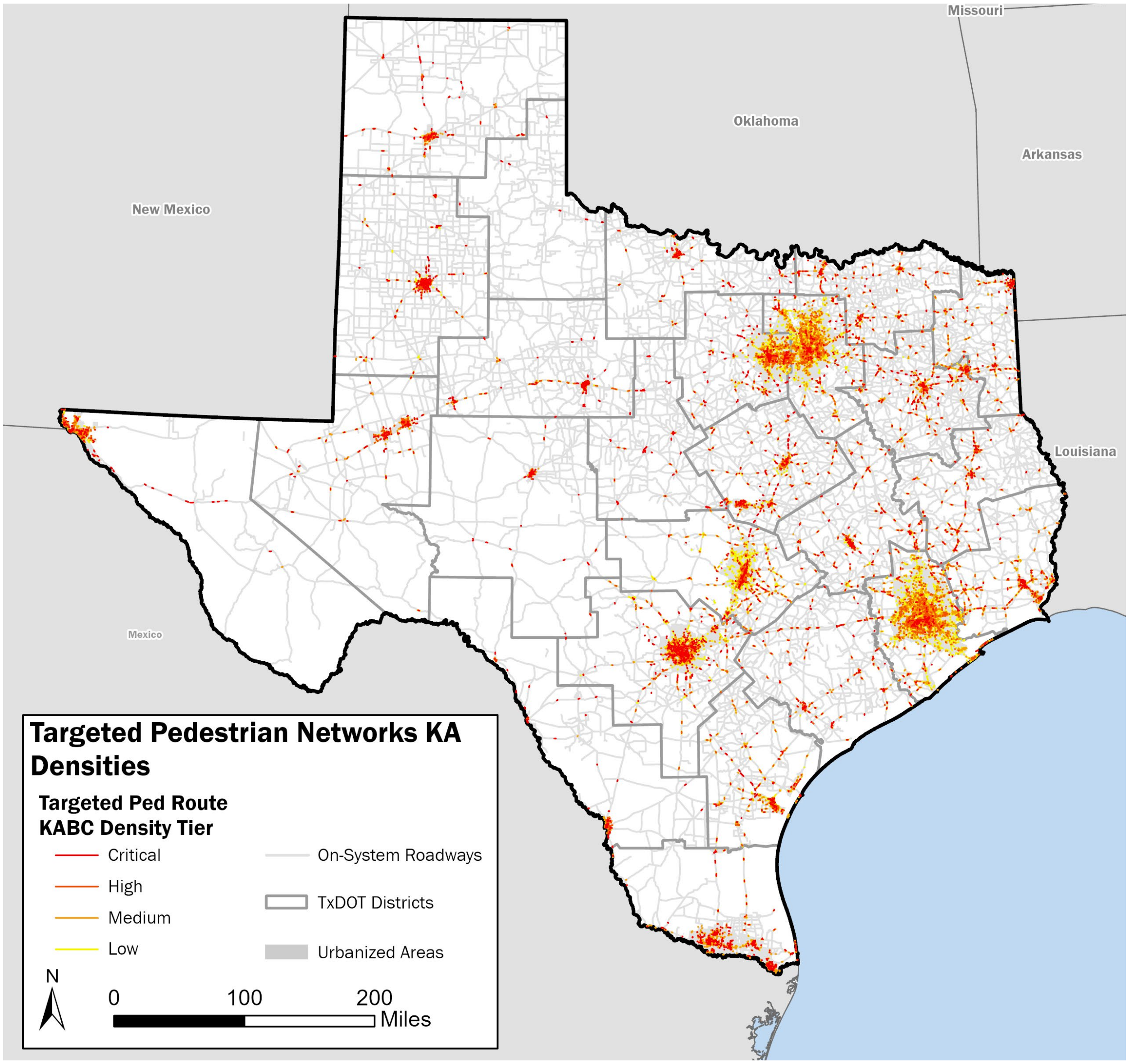

***Figure 19** – Targeted Analysis Pedestrian Crash Density Tier Map for Pedestrians from PSAP*

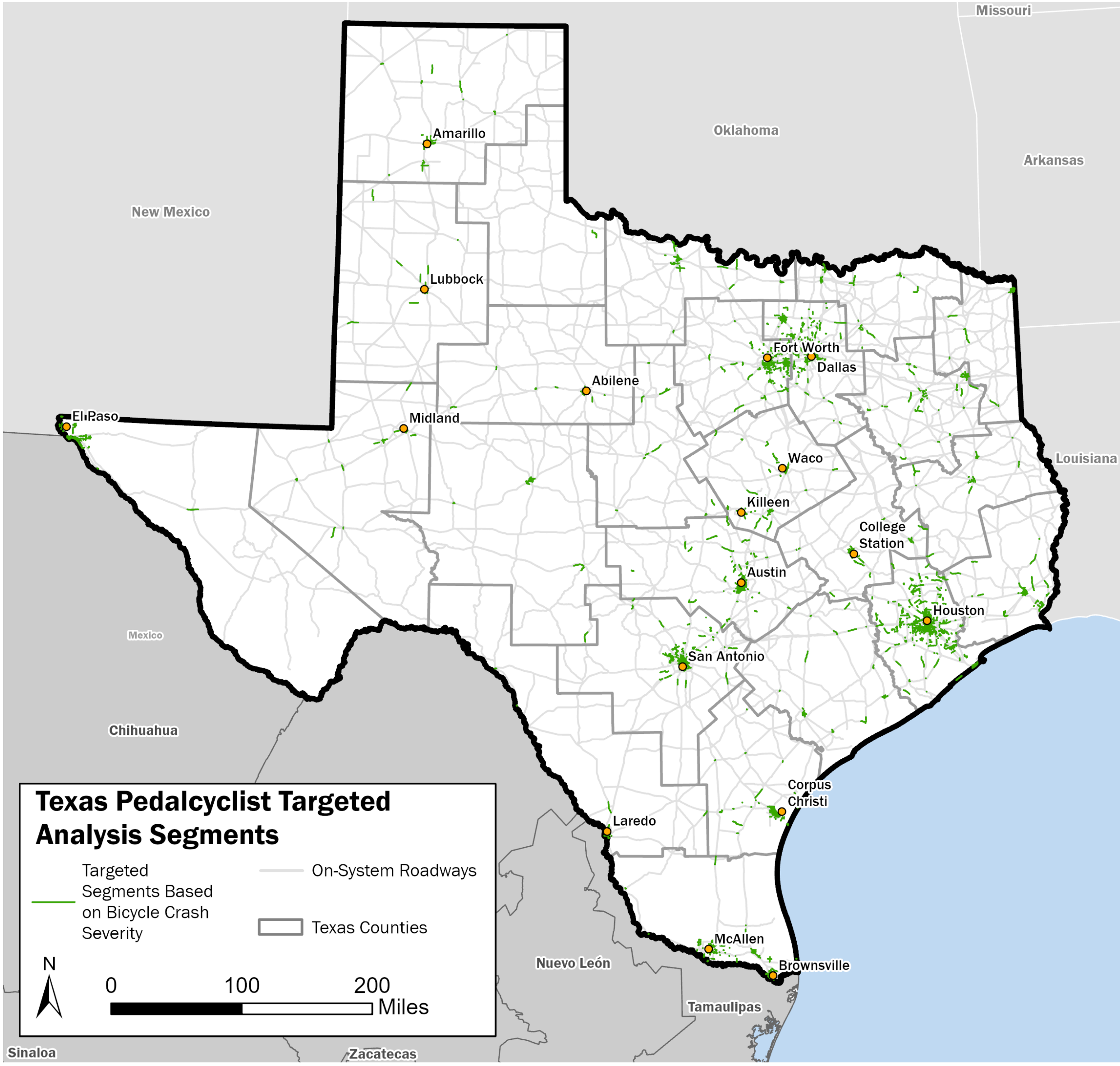

Figure 20 – Targeted Analysis Crash Density Map for Pedalcyclists from SBSAS

3.2.2.1 Functional Class

The pedestrian targeted analysis was also analyzed from a functional class perspective. The TxDOT Roadway Inventory file identifies a total of seven functional classes: Local, Minor Collector, Major Collector, Minor Arterial, Principal Arterial, Freeway and Express, and Interstate. These seven classes make up approximately 320,000 miles of roadway, with the Local functional classification comprising the largest portion and accounting for more than 235,000 miles.

Table 7 below shows the comparison between the total mileage of each functional class and the mileage associated with crash density within the respective functional class.

Table 7 – Comparison Between Pedestrian Crash Density Mileage and Statewide Centerline Miles

Functional Class	Crash Density Roadway Mileage	TxDOT Roadway Inventory Centerline Mileage	% Comparison
Local	3,501	211,312	2%
Minor Collector	163	15,943	1%
Major Collector	2,282	51,150	4%
Minor Arterial	3,276	18,554	18%
Principal Arterial	2,990	14,756	20%
Freeway and Expressway	541	1,776	30%
Interstate	1,228	4,019	31%

The Local functional class has the highest crash density roadway mileage with 3,501 miles. However, this accounts for approximately 2% of the total roadway mileage. This suggests a relatively lower concentration of crashes on local roadways in comparison to the total mileage of local roadways. Both Minor Collector and Major Collector roadways exhibit a lower crash density roadway mileage in comparison to the total mileage for those functional classes, each representing less than 5% of their total roadway functional classification.

Minor Arterial roadways exhibit a significantly higher crash density roadway mileage of 3,276 miles, representing 18% of the total roadway mileage within this class. This indicates a notable concentration of crashes on minor arterial roads. Similarly, Principal Arterial roadways also show a relatively high crash density roadway mileage of 2,990 miles, accounting for 20% of the total roadway mileage within this class. This suggests a considerable concentration of crashes on principal arterial roads.

Both Freeway and Expressway, as well as Interstate roadways, demonstrate a similar percentage of crash density mileage when compared to the total mileage, 30% and 31%, respectively. This could stem from various factors. One factor could be the inclusion of frontage roads when associating crashes to Freeway, Expressway, and Interstates, which might account for some of the variation. Other possible reasons could include that these types of facilities often act as significant barriers for pedestrians going from one place to another. Apart from that, these facilities typically lack pedestrian accommodations.

Table 8 shows information related on-system pedalcyclist by functional class. The crash pattern aligns with statewide bicycle crash statistics, revealing a more frequent occurrence of bicycle crashes on urban roadways compared to rural ones. Nearly half of the bicycle crashes on rural on-system routes resulted in fatalities or serious injuries, while approximately one-quarter of the urban on-system bicycle crashes resulted in fatalities or serious injuries. When it comes to the type of urban roads, urban arterials and urban collectors accounted for over 80% of all bicycle accidents. Specifically, urban arterials exhibited the highest rate of bicycle accidents, with

2.95 incidents per 100 centerline miles per year, followed by urban collectors at 0.88 bicycle accidents per 100 centerline miles per year.

Table 8 – On-System Pedalcyclist Crashes by Functional Classification

Functional Classification	Area Type	Centerline Miles	Total Crashes	Total Crash Percentage	Total Crashes per 100 Centerline Mile Per Year	Fatal and Serious Injury Crashes[1]
Interstate and Other Freeway	Rural	2,130	4	0.2%	0.04	2 (50.0%)
	Urban	2,580	81	5.0%	0.63	22 (27.2%)
Arterial	Rural	18,780	90	5.6%	0.1	49 (54.4%)
	Urban	7,066	1,041	64.5%	2.95	237 (22.8%)
Collector	Rural	43,690	112	6.9%	0.05	58 (51.8%)
	Urban	6,132	270	16.7%	0.88	80 (29.6%)
Local	Rural	211	0	0.0%	-	0 (0.0%)
	Urban	132	1	0.1%	0.15	0 (0.0%)
Unknown	-	-	14	0.9%	-	3 (21.4%)
Total	-	80,720	1,613	100.0%	0.40	451 (28.0%)

[1] Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category.

3.2.2.2 Light Conditions

Pedestrian crashes are evenly distributed between daylight and dark conditions, with approximately a 50-50 split. However, dark condition crashes account for 81% of the total fatal pedestrian crashes on Texas roadways, with 45% of the crashes in dark not lighted conditions and the remaining 36% in dark but lighted conditions. **Figure 21** shows the breakdown of light conditions for all pedestrian crashes. Urban and rural areas experienced similar percentages of nighttime fatal crashes, both account for roughly 81%. The main difference between the two areas is that 81% of fatal crashes in rural area occur in dark, not lighted conditions, whereas 41% of urban fatal crashes occur in dark not lighted conditions.

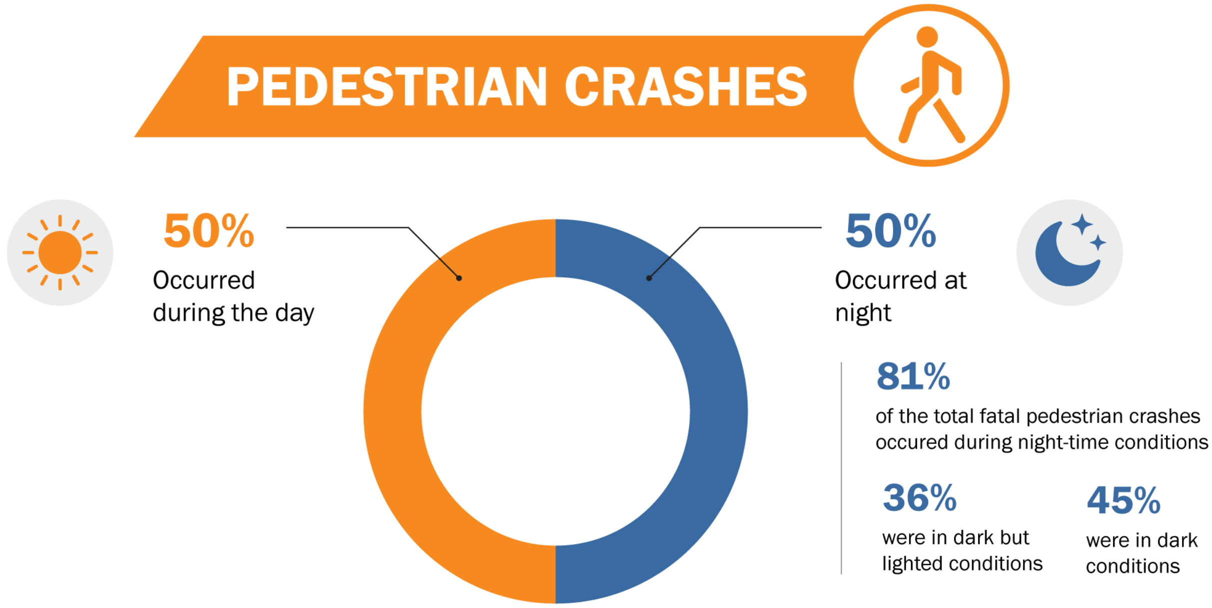

Figure 21 – Pedestrian Crashes as a Function of Light Conditions

In contrast to pedestrian crashes, the majority of pedalcyclist crashes occur during daylight conditions. Approximately 72% of crashes occur during daylight conditions, and 28% occur during nighttime conditions. Like pedestrian fatal crashes, the majority of fatal crashes do occur at night with 63% of the crashes occurring during dark conditions. **Figure 22** shows the breakdown of light conditions for all pedalcyclist crashes.

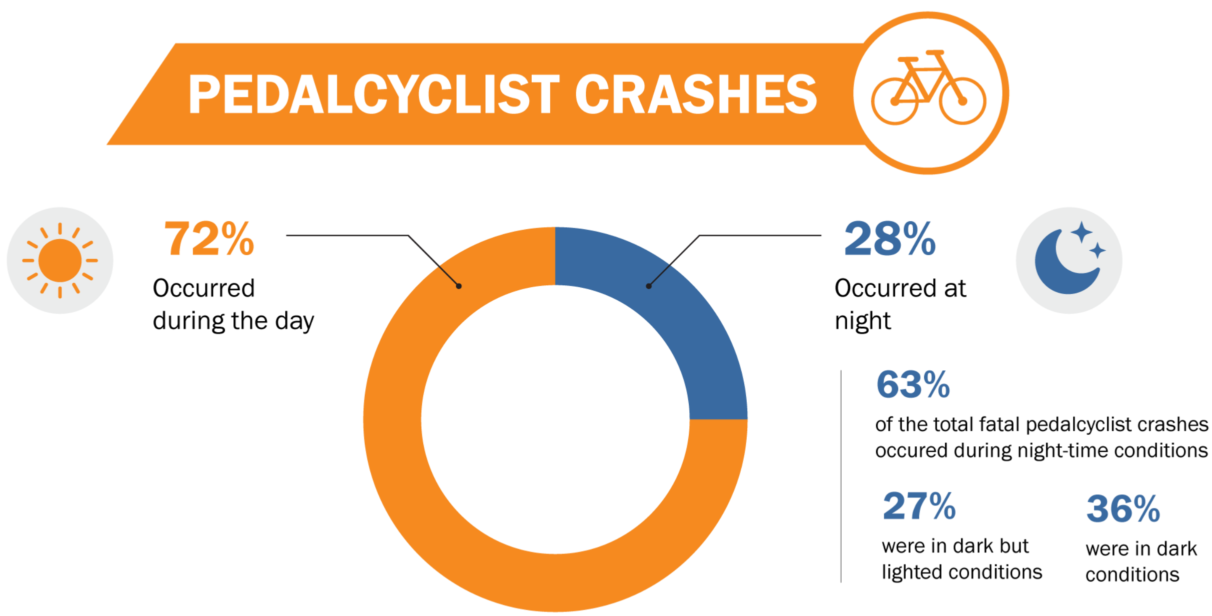

Figure 22 – Pedalcyclist Crashes as a Function of Light Conditions

3.2.2.3 Time of Day/Day of Week

General pedestrian crash trends focus on the peak travel hours and late night. 47% of pedestrian fatal and serious injury crashes occur between 6PM and midnight. In terms of the days of the week, there is no major noticeable difference Sunday through Thursday. However, there is an increase for fatal and pedestrian crashes on Fridays and Saturdays. Pedestrian crash trends are shown in Table 9.

Table 9 – Pedestrian Crash Trends by Time of Day and Day of Week

Pedestrian Crashes (K & A)								
Time of Day	**MON**	**TUE**	**WED**	**THU**	**FRI**	**SAT**	**SUN**	**TOTAL**
12:00 AM	124	83	105	95	127	272	273	**1,079**
3:00 AM	102	96	93	83	96	133	153	**756**
6:00 AM	140	146	153	153	157	82	82	**913**
9:00 AM	92	88	99	84	79	80	50	**572**
12:00 PM	93	81	96	86	91	89	63	**599**
3:00 PM	133	161	148	126	172	115	101	**956**
6:00 PM	296	315	347	329	380	364	250	**2,281**
9:00 PM	243	244	250	287	393	372	285	**2,074**
TOTAL	**1,223**	**1,214**	**1,291**	**1,243**	**1,495**	**1,507**	**1,257**	**9,230**

General trends for all pedalcyclist crashes are focused on the peak travel hours, with very few crashes occurring during late night or early morning hours. Pedalcyclist fatal and serious injury crashes are focused around the afternoon peak hours with the majority occurring between 3 PM to 9 PM. There were no major differences between the days of the week for pedalcyclist fatal or serious injury crashes, except for Sunday. Sunday had the fewest pedalcyclist crashes. Pedacyclist crash trends are shown in Table 10.

Table 10 – Pedalcyclist Crash Trends by Time of Day and Day of Week

Pedalcyclist Crashes (K & A)								
Time of Day	**MON**	**TUE**	**WED**	**THU**	**FRI**	**SAT**	**SUN**	**TOTAL**
12:00 AM	12	4	17	10	21	21	26	**111**
3:00 AM	18	11	8	10	13	16	11	**87**
6:00 AM	35	27	32	29	28	31	13	**195**
9:00 AM	35	30	25	22	21	34	21	**188**
12:00 PM	28	27	25	39	36	42	20	**217**
3:00 PM	56	57	55	54	57	47	58	**384**
6:00 PM	57	66	62	68	56	59	32	**400**
9:00 PM	48	33	35	39	34	37	38	**264**
TOTAL	**289**	**255**	**259**	**271**	**266**	**287**	**219**	**1,846**

3.2.2.4 Area Type

The data on pedestrian and pedalcyclist crashes shows that crashes align with the population distribution of the state, with 84% of pedestrian crashes occurring in urban areas and 16% occurring in rural areas. The division is similar for pedalcyclist crashes with 85% of crashes occurring in urban areas and 15% occurring in rural areas (see **Figure 23**). Fatal and serious injury crashes are overrepresented for rural areas with 22% of these types of crashes occurring in rural areas and 78% occurring in urban areas. This distribution was the same for pedestrians and pedalcyclists. However, most of the rural crashes were focused on the fringes of urban areas.

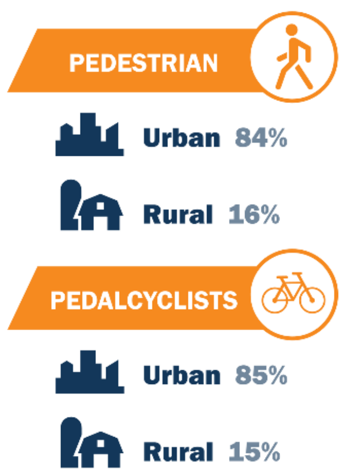

Figure 23 - Pedestrian and Pedalcyclist Crash by Area Type

The five major metropolitan statistical areas (MSAs) make up approximately 70% of Texas's population. The five metropolitan areas are: Austin-Round Rock-Georgetown, Dallas-Fort Worth-Arlington, El Paso, Houston-The Woodlands-Sugarland; and San Antonio-New Braunfels. These five metropolitan areas roughly account for 76% of both pedestrian and pedalcyclist crashes, and between 72% to 74% of pedestrian and pedacyclist fatal and serious injury crashes. The pedestrian fatal crash rates for these five metropolitan areas are shown in **Figure 24**. The pedalcyclist fatal crash rates for these five metropolitan areas are shown in **Figure**

25. These crash rates were developed using the 5-Year American Community Survey (ACS) total population estimates for the years 2017, 2018, 2019, 2020, and 2021 for the MSAs and the State of Texas[8,9].

Pedestrian crash rates have been consistently high for the San Antonio-New Braunfels MSA for five of the crash years. El Paso MSA crash rate spiked during 2018 and 2019 above the statewide average but has been below the statewide average since 2020. Houston-The Woodlands-Sugarland MSA has been below the statewide average for four out the last five years, however, the crash rate trend for Houston-The Woodlands-Sugarland MSA has been increasing. Austin-Round Rock-Georgetown and Dallas-Fort Worth-Arlington MSAs crash rates have been fluctuating above and below the statewide average.

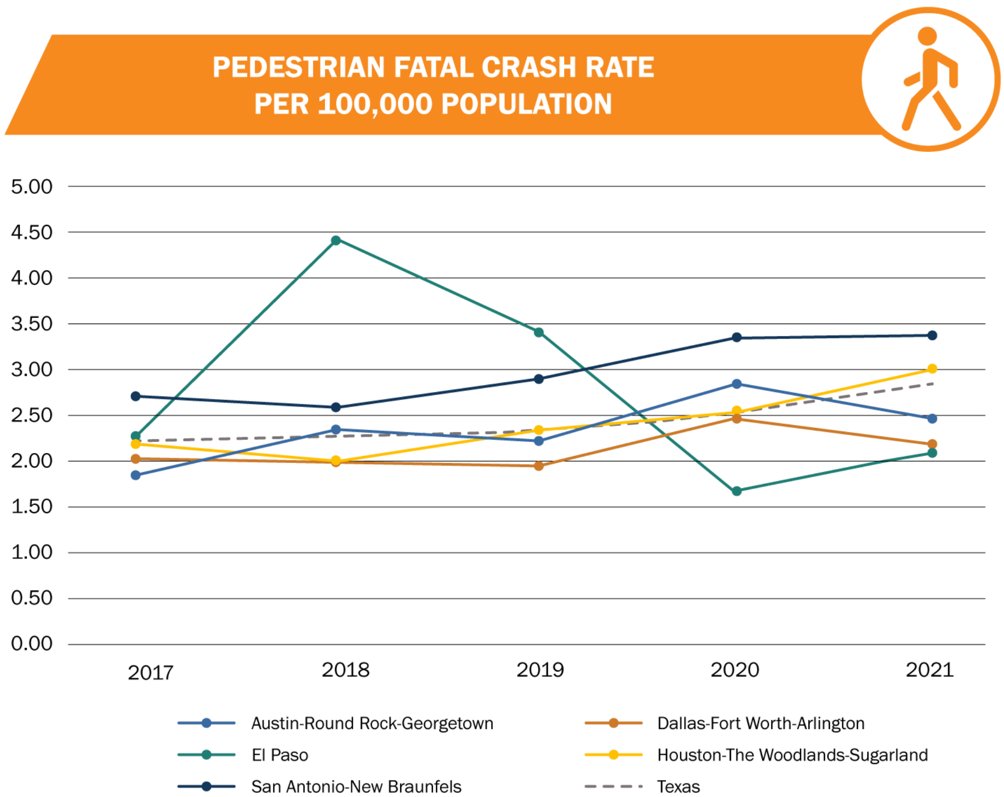

Figure 24 – Pedestrian Fatal Crash Rate for Major Metropolitan Areas in Texas

For pedalcyclists, the Houston-The Woodlands-Sugarland MSA rate was consistently above the statewide average, and the Austin-Round Rock-Georgetown MSA has been above the statewide average since 2019. The remaining MSAs were below the statewide average.

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[8] Populations for MSAs and the State of Texas were taken from Census Bureau website (https://data.census.gov/table) using the 5-Year ACS Estimates from table B01003.

[9] MSA boundaries were based of US Census 2020 Core Based Statistical Area and Counties map (48_Texas_2020 (census.gov)).

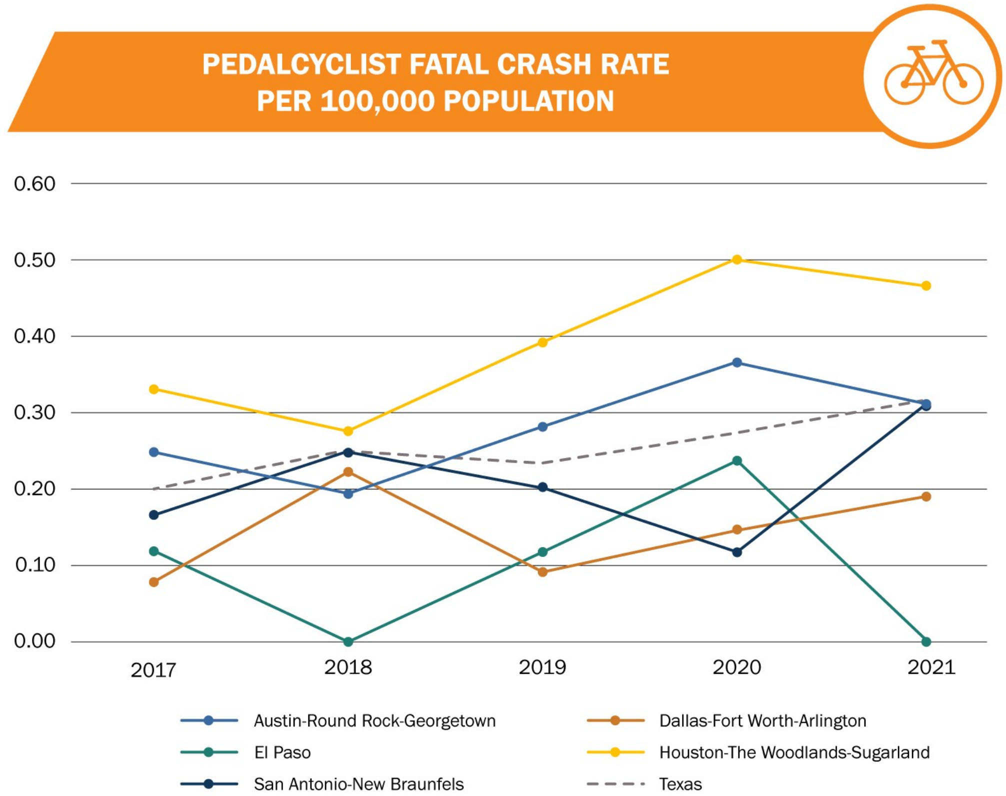


Figure 25 – Pedalcyclist Fatal Crash Rate for Major Metropolitan Areas in Texas

3.2.2.5 Intersection Related

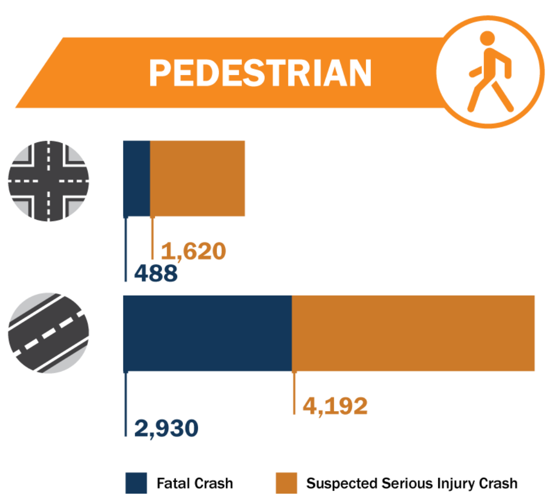


Figure 26 - Intersection and Midblock Fatal and Serious Crashes (Pedestrian)

Intersection-related crashes constitute 37% (10,422) of the total pedestrian crashes, along with 23% (2,108) of all fatal and suspected serious injury incidents. Conversely, midblock or non-intersection-related crashes contribute to 77% (7,122) of fatal and suspected serious injury occurrences (see **Figure 26**). The crash rates for fatal and suspected serious injury crashes at intersections are roughly half of those observed for midblock or non-intersection-related crashes. A little over 20% of intersection crashes result in fatalities or suspected serious injuries. This figure rises to 40% for midblock or non-intersection related crashes, highlighting potential safety benefits intersections provide as pedestrian crossing points. Intersections offer lower speeds and safety-oriented design elements such as crosswalks, pavement markings, and pedestrian signals.

For pedalcyclists, a large proportion of crashes occur at intersections compared to non-intersections. Intersection-associated crashes account for 60% (7,818 cases) of the total pedalcyclist crashes, as well as 45% (837 cases) of fatal and suspected serious injury crashes (see **Figure 27**). Midblock or non-intersection-related crashes contribute to 55% (1,009 cases) of fatal and suspected serious injury cases. Like crashes involving pedestrians, midblock crashes involving pedalcyclists prove to be more dangerous and have a higher fatality rate. This could be attributed to elevated speeds and reduced driver anticipation of both pedestrian and pedalcyclist crossings in midblock scenarios.

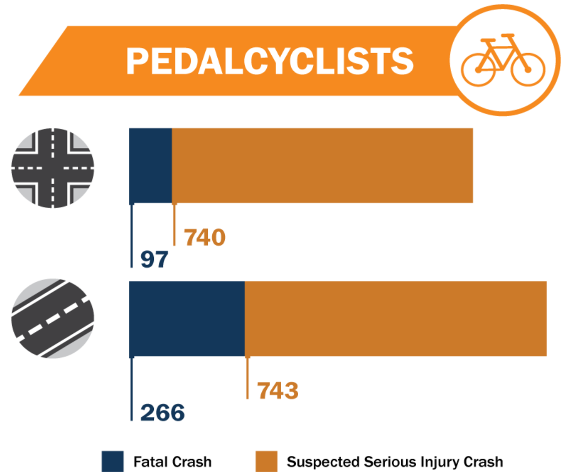


Figure 27 - Intersection and Midblock Fatal and Serious Crashes (Pedalcyclist)

3.2.2.6 Speed

Elevated speeds correspond to an increased probability of fatal or suspected serious injury crashes involving pedestrians and pedalcyclists. A study conducted by AAA[10] and cited by FHWA underscores that slight increments in vehicle speeds yield disproportionate increases in death risks. The study's findings indicate that a pedestrian struck by a vehicle moving at 23 mph faces a 10% risk of fatality. At 32 mph, the risk increases to 25%; at 42 mph, the risk increases to 50%; at 50 mph, the risk increases to 75%; and at 58 mph, the risk increases to 90%.

Figure 28 shows a combined bar and line chart. The bar graph illustrates the overall count of pedestrian and pedalcyclist crashes linked to different speed limits on roadways. Meanwhile, the line graph shows the rate of fatal and suspected serious injury crashes corresponding to each speed limit. This data demonstrates that as the travel speeds increase, so does the correlation with higher risk of vulnerable road user injury or death.

[10] AAA Foundation for Traffic Safety, [Impact Speed and a Pedestrian's Risk of Severe Injury or Death - AAA Foundation for Traffic Safety]()

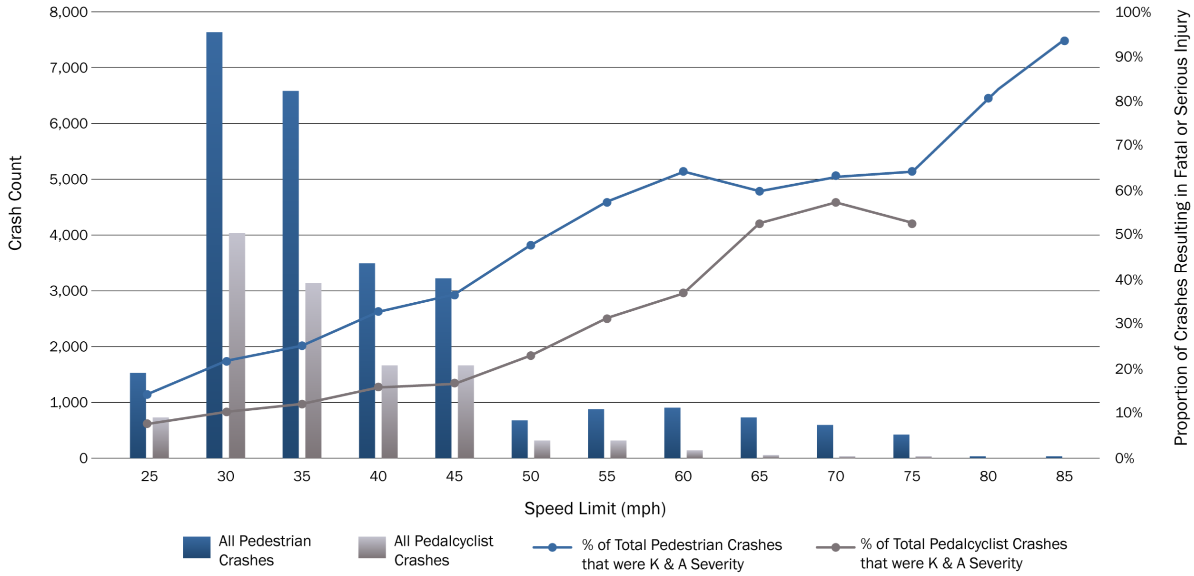


***Figure 28** – Fatal and Suspected Serious Injury Crashes as a Function of Speed Limit for Pedestrians and Pedalcyclists*

While higher speeds increase the likelihood of fatal or suspected serious injury crashes, a significant proportion of fatal or serious injury crashes occur on roads with speed limits ranging from 30 to 45 mph. These roadway segments account for approximately 70% of all K and A crashes involving pedestrians and pedalcyclists. This subset of roadways encompasses roughly 31% (97,308 miles) of the total centerline miles in Texas, with 30 mph speed limit segments constituting 83,928 of the 97,308 miles. A focused approach on mitigating fatal and serious injury crashes on these roadway segments will be critical as they account for the majority of fatal and serious injury crashes.

For pedestrian fatal and serious injury crashes, 7% of crashes had speeding attributed as a contributing factor. Speeding related data was not available for pedalcyclist crashes. Although speeding is an emphasis area in the Texas SHSP, a driver does not have to be speeding for a crash to be fatal since even low speed crashes can be deadly for VRUs.

3.2.2.7 Transit

There is limited transit information provided in the C.R.I.S. data set. However, an analysis based of the adjacency of pedestrian and pedalcyclist crashes was performed to determine if there was any pattern. Transit stops were downloaded from United States Department of Transportation Website (USDOT)[11]. This dataset does not include all urban and rural transit stops; therefore, it's likely that it underrepresents the total number of transit stops. Analysis based on three different distances from transit stops was performed to determine the percentage of pedestrian and pedalcyclists fatal and serious injury crashes that occur within those distances of transit stops. One thing to note is that these distances were buffer distances around the transit stops and not route distances.

[11] Transit stops (https://geodata.bts.gov/datasets/usdot::national-transit-map-stops/explore)

The difference between the two is that a buffer distance might include a larger area than the route distance due to the circuitous nature of roadways.

The results in **Figure 29** show that 1,887 fatal and serious injury crashes for pedestrians occurred within 250 feet of a transit stop. These crashes account for 20% of the overall fatal and serious injury crashes for pedestrians. The results are similar for pedalcyclists, where 18% (327) fatal and serious injury crashes occurred within 250 feet of a transit stop. This number only increases with increasing the distance away from a transit stop, 39% of pedestrian and 33% of pedalcyclists crashes occurring within 1,000 feet of a transit stop. These results make sense as transit stops are likely where there is more pedestrian and pedalcyclist present.

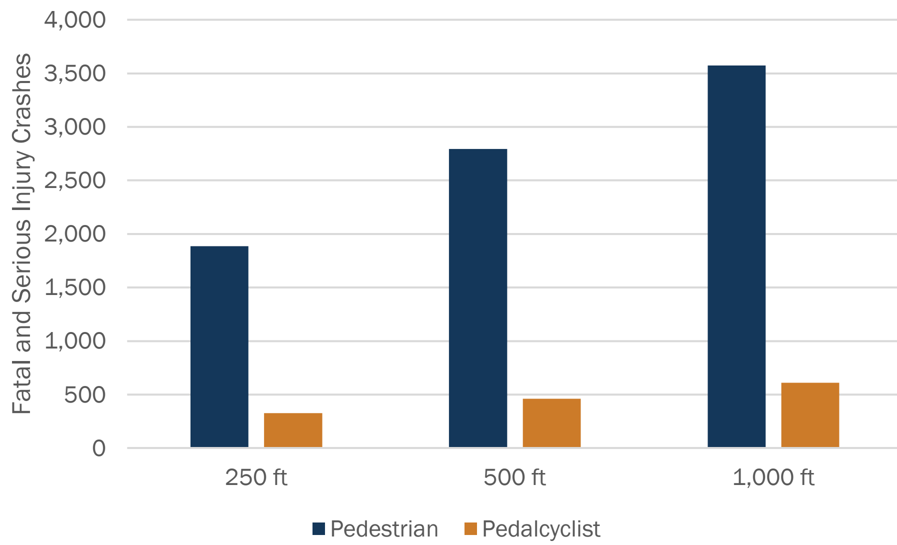


Figure 29 – Pedestrian and Pedalcyclist Crashes Adjacency to a Transit Stop

3.2.3 Demographics

Per the demographic methodology stated above, a total 1,708 out of the 6,884 Census tracts were considered high vulnerability (i.e., in the 4th quartile). These tracts were selected based on the SVI overall score being 0.75 or higher. The remainder of the tracts (5,176) were considered low or lower vulnerability tracts (i.e., 1st through 3rd quartile, SVI score of 0.75 or lower). *Figure* 30 below shows a map of differentiating the high vulnerability tracts from the lower vulnerability tracts. The high vulnerability tracts fall along the population lines and account for approximately 25% of the population of the state.

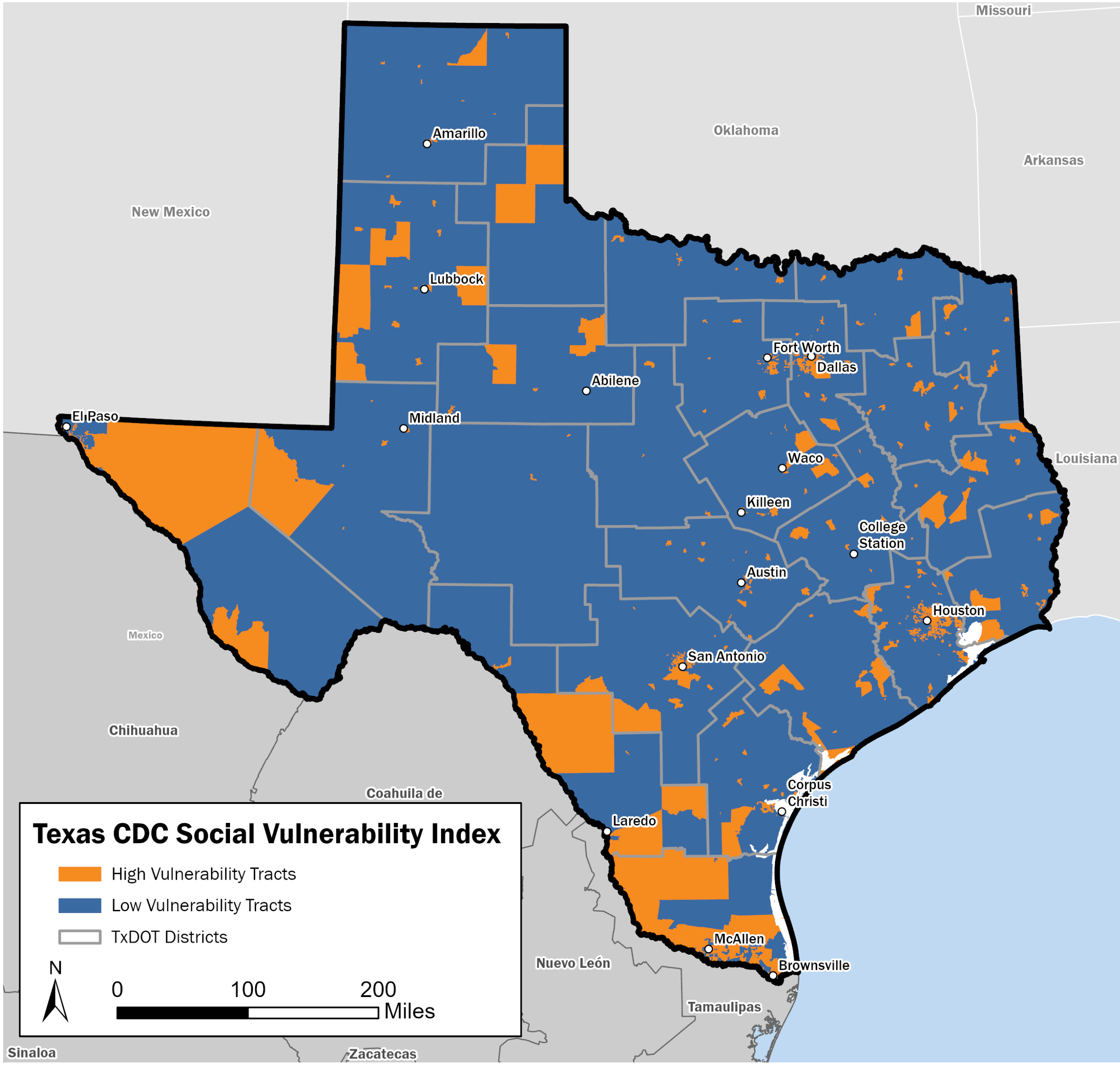


Figure 30 – Texas CDC SVI Tracts

Figure 19 and **Figure 20** show targeted analysis maps for pedestrians and pedalcyclists, respectively. The targeted roadway network from these maps was applied to the CDC SVI tracts to determine what percentage of the targeted network for pedestrians and pedalcyclist fell under the high vulnerability tracts. Approximately, 36% and 31% of the targeted network for pedestrians and pedalcyclists falls within the high vulnerability tracts, which is about 11% (pedestrian) and 7% (pedalcyclists) overrepresentation for targeted networks based on vulnerability.

Table 11 - Percentage of Targeted Network within High Vulnerability Tracts

Targeted Network	Total Targeted Network Mileage	Mileage in High Vulnerability Tracts	% of Mileage in High Vulnerability Tracts
Pedestrian	13,980	4,999	36%
Pedalcyclists	3,570	1,095	31%

Figure 31 shows a comparison of pedestrian fatal and serious injury crashes with breakdown of crashes that occur in high vulnerability Census tracts compared to those occurring in low vulnerability tracts. The table shows that high vulnerability Census tracts account for approximately 39% of all fatal and serious injury crashes but account for 25% of the total tracts.

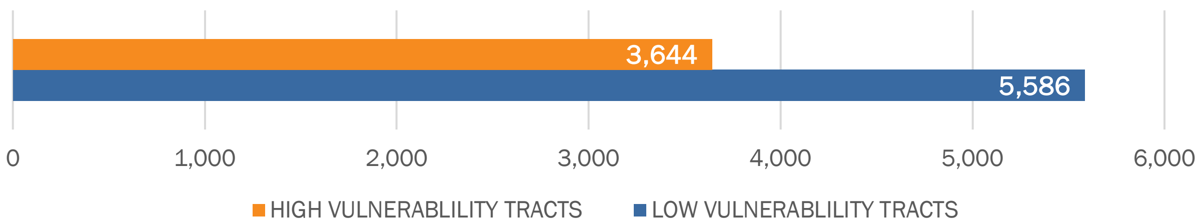


Figure 31 – Pedestrian Fatal and Serious Injury Crashes by Vulnerability

Similarly, **Figure 32** shows a comparison of pedacyclist fatal and serious injury crashes with breakdown of crashes that occur in high vulnerability Census tracts compared to those occurring in low vulnerability tracts. The table shows that high vulnerability Census tracts account for approximately 33% of all fatal and serious injury crashes but account for 25% of the total tracts.

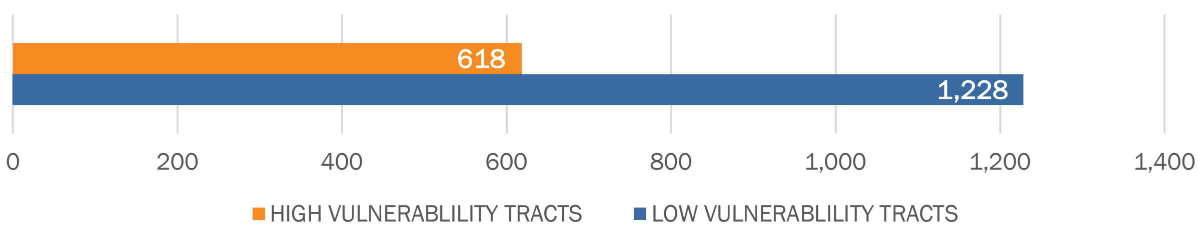


Figure 32 – Pedalcyclists Fatal and Serious Injury Crashes by Vulnerability

All four of the major SVI themes (Socioeconomic Status, Household Characteristics, Racial & Ethnic Minority Status, and Housing Type & Transportation) were analyzed to determine if census tracts categorized as high vulnerability (75th percentile or higher overall SVI score) would show a higher-than-average percentage of fatal and serious injury crashes for VRUs. Each of the four themes show greater than 30% representation of fatal and serious injury crashes in the tracts where the specific themes are in the 75th percentile or higher. For example, the tracts that are in the 75th percentile for Housing Type & Transportation vulnerability indicate that 38% of the fatal and serious injury crashes take place within these tract categories. Similarly, 38% fatal and serious injury crashes occur in tracts that have 75th percentile Socioeconomic Status related vulnerabilities. There is an overrepresentation of fatal and serious injury crashes in Census tracts categorized as high vulnerability. Note that these themes overlap, meaning that certain tracts share multiple themes. This is shown in **Figure 33**.

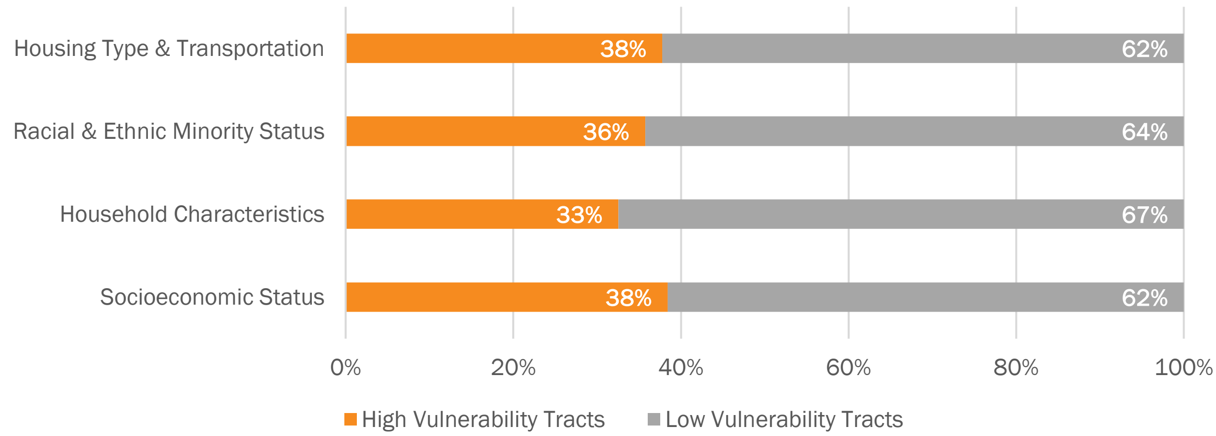


Figure 33 – Percentage of Fatal and Serious Injury Crashes for VRUs Based on SVI Themes

The two themes that are slightly higher than others are Housing Type & Transportation and Socioeconomic Status related vulnerabilities. This makes sense as these themes encompass below 150% poverty thresholds, housing cost burden, no vehicle ownership, and other factors that might affect one's ability to use a vehicle and rely more on an alternative mode of transportation such as transit, walking, or biking.

Additional analysis was performed on the specific variables within the two themes that showed a higher overrepresentation of fatal and serious injury crashes. These two themes were Socioeconomic Status and Housing Type & Transportation. The five variables that make up the Socioeconomic Status theme are listed below:

- No Health Insurance
- No High School Diploma
- Housing Cost Burden
- Unemployed
- Below 150% Poverty

All five of these variables were overrepresented when compared between the high vulnerability tracts and the low vulnerability tracts. Each of them accounted for approximately 30% or higher percentage of VRU fatal or serious injury crashes, while accounting for 25% of the total tracts. Four out of the five variables in the Socioeconomic Status related vulnerability tracts showed 35 – 37% of VRU fatal or serious injury crashes occurring in them. Similar to the themes, these variables overlap, meaning that certain tracts share multiple variables. **Figure 34** shows VRU percentage of high vulnerability tracts based on the variables that make up the Socioeconomic Status CDC SVI Theme.

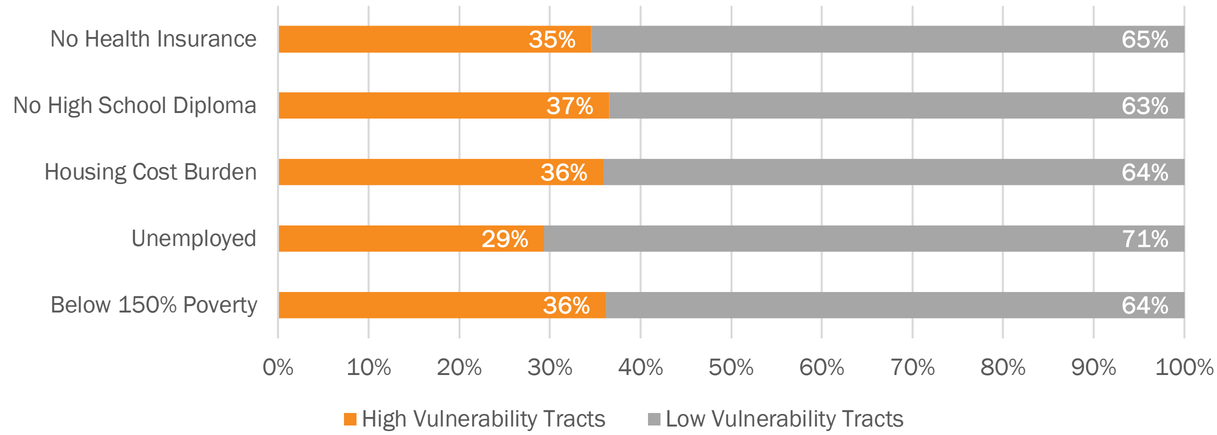


Figure 34 – VRU Fatal and Serious Injury Crashes Based on Socioeconomic Status Related Vulnerable Tracts

For the Housing Type & Transportation theme related analysis, the five variables that make up the theme are listed below:

- Group Quarters
- No Vehicle
- Crowding
- Mobile Homes Structures
- Multi-Unit Structures

Unlike Socioeconomic Status, the Housing Type & Transportation variables vary. Some of these variables show 5 – 7% overrepresentation, while one variable (mobile homes) is not overrepresented. However, the variable linked to No Vehicle ownership vulnerability indicates that 38% of fatal and serious injury crashes happen in areas with this vulnerability. This represents a 13% increase, showing that these crashes are more common in such tracts. This makes sense as the population in tracts that have high levels of vulnerability associated with no vehicle ownership are more like to walk or bike for work or basic needs, thus putting them at greater risk for a VRU related crash. **Figure 35** shows VRU percentage of high vulnerability tracts based on the variables that make up the Housing Type & Transportation Related CDC SVI Theme.

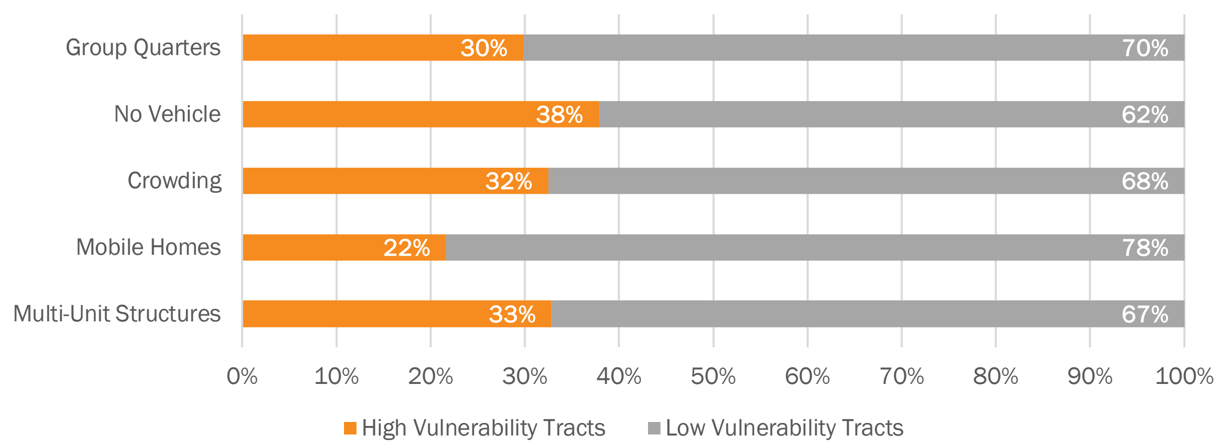


Figure 35 - VRU Fatal and Serious Injury Crashes Based on Housing Type & Transportation Related Vulnerable Tracts

3.2.3.1 Prioritization

Although no specific projects are mentioned in the VRU Safety Assessment, it is recommended that when TxDOT, MPOs, cities, and other agencies are selecting projects, they pay extra attention U.S. Census Tracts are deemed vulnerable per the CDC SVI Index. Specifically, U.S. Census Tracts that are high vulnerability and higher levels of no vehicle ownership, below 150% poverty threshold, or high housing cost burden. The PSAP prioritizes projects based on the CDC SVI, which could be used by agencies as a starting point for project prioritization and implementation.[2] Below is how the PSAP prioritizes projects based on the two types of analysis.

The on-system Systemic Analysis segments were prioritized according to the following measures:

1. Potential risk designation
2. Count of KA crashes on segment (highest to lowest)
3. Overall Social Vulnerability Index (SVI) Value (highest to lowest)
4. Accumulation of suggested countermeasures

Meanwhile, the on- and off-system segments resulting from the Targeted analysis were prioritized according to the following measures:

1. Critical KA Crash Density Tier
2. Count of KA crashes on segment (highest to lowest)
3. Overall Social Vulnerability Index (SVI)
4. Accumulation of suggested countermeasures

4. Outreach and Consultation

The stakeholder coordination process for VRU Safety Assessment involved engagement with Metropolitan Planning Organizations (MPOs) in Texas. To further facilitate understanding and engagement, TxDOT organized two open house webinars for the MPOs. These webinars served as platforms to present an overview of the VRU Safety Assessment, including the project timeline, analysis methodology, VRU crash trends, and next steps. The idea behind these open houses meetings was to give the MPOs a primer of the VRU Safety Assessment and the methodology prior to one-on-one meetings.

Following the open house calls, TxDOT scheduled individual meetings with each MPO to get their feedback perspective related to VRU safety in their respective regions. These one-on-one meetings allowed for focused discussions on various aspects of VRU safety. TxDOT sought the MPOs' insights on how the VRU Safety Assessment can support their efforts to reduce fatalities and use off-system safety funds. The meetings covered potential regional implementation strategies for VRU safety, ongoing VRU-related crash mitigation measures within the MPOs, observed challenges, and suggestions for enhancing the assessment process. These one-on-one meetings also showcased the PSAP Screening Tool[7] developed as part of the PSAP.[2] MPOs were given a briefly tutorial on how to use the tool and the purpose of it. MPOs were shown how to locate crash density tiers within their jurisdictions and potentially use those locations as a starting point for further analysis and prioritization of corridors for possible improvements. A total of 21 out of 23 MPOs in Texas were involved. Common themes emerging from their combined responses is provided below.

Behavior-Related Issues

Driver and pedestrian behavior contribute significantly to VRU-related crashes. Common factors include distracted driving, speeding, alcohol use, and crossing midblock.

Education and Awareness

Most MPOs highlighted a need for comprehensive education and outreach efforts to raise awareness among both drivers and VRUs about safe behaviors. Some MPOs focused on targeting specific demographics such as school children, young adults, or other members of the communities for a more tailored approach in addressing issues. MPOs also mentioned the need for safety campaigns to bring to light the issues associated with VRU safety and make people more aware of they are perceptive to change and implementation of VRU-related infrastructure.

Infrastructure Deficiencies

Many MPOs identified inadequate or outdated infrastructure as a major challenge. This includes lack of sidewalks, bike lanes, and pedestrian crossings. Almost all MPOs sited lighting as an issue. There were also challenges implementing VRU-related infrastructure in more established areas due to the high cost of implementing ADA improvements.

Funding Constraints

Funding limitations present a recurring challenge for MPOs. Specifically, smaller MPOs have a harder time pursuing grant opportunities due to the high level of effort involved. Grant match requirements for VRU can be a barrier for financially constrained areas or areas where VRU investment is not favorable. Decision-makers can be reluctant to fund VRU-related infrastructure due to the lack of perceived benefits. There are often funding disparities between roadway infrastructure and VRU-related infrastructure.

Perception and Prioritization

Decision-makers and the public may not fully recognize the severity of VRU-related issues, leading to challenges in prioritizing VRU-related safety improvements. VRU initiatives are often seen as diverting finds from projects related to vehicles, and they also carry an implication that this infrastructure will go unused. Some regions face challenges related to weather conditions, which influence the perception of walking and biking as viable modes of transportation.

Collaboration and Coordination

Effective collaboration among MPOs, government agencies, law enforcement, and other stakeholders is crucial for successful implementation of safety measures.

4.1 Feedback from MPO Coordination

The common themes emerging from the one-on-one coordination calls with the MPOs are provided in **Table 12**. Additional information from the one-on-one coordination meetings is provided in individual subsections pertaining to each MPO. Although there are certain themes that were not mentioned by various MPOs, that does not mean those themes are not areas of concerns or areas of need for the MPOs.

Table 12 – MPO Common Themes Matrix

MPO	Common Themes from MPO Responses					
	Behavior-Related Issues	Education and Awareness	Infrastructure Deficiencies	Funding Constraints	Perception and Prioritization	Collaboration and Coordination
Alamo Area	X		X			X
Amarillo	X		X	X		
Bryan-College Station	X	X		X		X
Captial Area	X	X	X			X
Corpus Christi		X	X			
El Paso	X	X	X	X		
Houston-Galveston Area Council	X	X	X		X	
Killeen-Temple	X		X	X		
Laredo-Webb		X		X	X	
Longview	X			X		X
Lubbock		X	X		X	X
North Central Texas Council of Governments	X	X	X			
Permian Basin	X	X		X		
Rio Grande Valley	X	X	X	X		
San Angelo	X		X	X	X	X
South East Texas Regional Planning Council		X	X	X		X
Texarkana	X		X	X	X	
Tyler	X		X	X		
Victoria	X	X	X	X	X	X
Waco			X	X	X	X
Wichita Falls	X	X		X		X

4.1.1 Alamo Area MPO

Alamo Area MPO (AAMPO) mentioned they have been working with FHWA over the past few years to address high levels of VRU-related fatalities and serious injury crashes. The public maintains a level of general concern regarding VRU safety, and AAMPO has been taking steps such as conducting walking audits to help implement VRU safety-related infrastructure. The MPO tries to do 1-2 every year and works with neighborhood associations or partner cities to conduct the walking audits. These audits have been successful in implementing VRU safety infrastructure and have received good feedback overall. AAMPO mentioned they would like to evaluate monitoring VRU-related crashes using lidar technology to help better implement countermeasures and assess crash causes. Lidar sensors have the capability of identifying and classifying different objects and can record the real-time movement of all road users at a given intersection. Its abilities to collect real-time data with high speed and accuracy gives Lidar technology a proactive approach in evaluating VRU-related crashes.

The main contributing factors for AAMPO VRU-related crashes are lighting and pedestrian/driver behavior. One of the things that could also help reduce VRU-related crashes would be implementation of complete streets. Some of the other challenges the MPO mentioned were related to project solicitation disconnects between the local and regional levels. The transportation network is a connected network. Although more difficult to coordinate, it would be beneficial to the overall region to implement safety projects from a regional perspective based on long-range planning rather than individual projects.

4.1.2 Amarillo

Amarillo MPO recently finished a multimodal plan aimed at addressing connectivity issues, multimodal design, safety, and efficiency. The MPO is also collaborating with the Texas A&M Transportation Institute to develop a Safety Action Plan. There has been recent movement within the region to take more action towards addressing VRU safety.

Conflicts between VRUs and motorized vehicles are commonly due to lower visibility at night and challenges in crossing wide street with high speeds. The main factors contributing to incidents involving VRUs are identified as distracted driving, speeding, and related behaviors. The MPO perceives driver behavior and awareness of VRUs as problematic, with crashes often linked to behavior issues.

While some VRU safety initiatives exist, funding constraints present another challenge for the Amarillo MPO in addressing VRU safety.

Funding Constraints

The MPO notes the challenge of bringing facilities up to ADA, particularly for older facilities, bridges, and underpasses. The MPO has partnered with the City of Amarillo and their grant writer to help apply for grants like Transportation Alternative Grants, the Raise Grant, and the Reconnecting Communities Grant to support safety initiatives. The Raise Grant application has not yielded results, and the MPO encounters challenges associated with finding matching funds.

4.1.3 Bryan-College Station

The Bryan-College Station MPO has a very involved Active Transportation Advisory Council that has been working with TxDOT and the MPO in providing feedback for the Districtwide Bike Plan and other active transportation-related plans. A policy has recently been adopted requiring 5% allocation of [12]CAT 2 funds for bike and pedestrian projects, with VRU-related safety components included in roadway projects.

Challenges for the MPO include pedestrian inattention, the need for better understanding of road rules between VRUs and drivers, and issues related to visibility due to glare and low levels of lighting.

The Bryan-College Station MPO is improving safety through separated bike lanes and sidewalks. The MPO is currently collaborating with TxDOT to develop a bicycle and pedestrian roadway network plan.

Collaboration and Coordination

Existing initiatives encompass a sidewalk master plan and partnerships with educational institutions to familiarize students with various transportation options. However, gaps remain in VRU awareness and safe practices. Specific safety technologies are proposed such as a smart intersection system that audibly warns pedestrians as transit vehicles approach. Funding and actionable plans emerge as key challenges in implementing effective measures for VRU safety improvement.

4.1.4 Capital Area Metropolitan Planning Organization (CAMPO)

Since the pandemic, CAMPO has had an increase in pedestrian fatalities each year. One notable danger zone is the I-35 corridor through the heart of Austin, where most fatalities occur. Nighttime seems to be a particularly risky period, with 80-90% of fatal crashes happening then, often linked to high alcohol use.

Improving awareness and safety measures is a challenge due to the rise in behavior-related crashes. CAMPO suggested that it would be helpful to start incorporating the use of technology like Wejo data to track near misses and analyze hard braking incidents. CAMPO also suggested advocating for car companies to incorporate impairment detection technology aligned with the IIJA. One of the initiatives other regions have incorporated well is outreach programs to schools and educational sessions about the dangers of driving.

CAMPO emphasized that the Safe System Approach needs to be prioritized with additional emphasis on safe Vehicles through mandating impairment detection systems and other similar technologies to mitigate risk.

4.1.5 Corpus Christi

The Corpus Christi MPO’s key challenges in improving VRU safety include the misconception that pedestrians are always at fault and the need to reduce speeding throughout the area. Pedestrians are often blamed universally for incidents. The City of Corpus Christi also struggles with inadequate sidewalk infrastructure, and a recent policy passed allowing road reconstruction to take place without sidewalk updates.

[12] “Cat 2” funding, or Category 2 funding is funding allocated to metropolitan and urban area corridor projects

One of the other issues mentioned was that traffic signals lack coordination and interconnection, which causes people to speed between the block to try catching the downstream traffic signal. Common conflicts between VRUs and motorized vehicles are attributed to pedestrians appearing in areas not anticipated and poor lighting. Successful practices from other regions suggest updating the CRIS database with additional vehicle details for a more comprehensive analysis, along with improved data quality achieved through training officers to code crashes more accurately. The Diexsys Vision Zero Suite, used in Colorado, was suggested by the MPO as a useful tool for analyzing safety and crash data at a local and regional level.

The Corpus Christi MPO is leading efforts to raise awareness and promote pedestrian safety during the month of October, which is designated as Pedestrian Safety Month by the NHTSA.

Education and Awareness

4.1.6 El Paso

The El Paso MPO mentioned that the existing sidewalk and bicycle infrastructure and adequate design are lacking. Some of the concerns related to infrastructure include outdated/faded pavement markings, inadequacies in crosswalk signals, and the presence of neighborhoods adjacent to busy arterials. There are several commercial corridors in El Paso such as Mesa Street with neighborhoods on one side and commercial on the other. In these locations, crossing the street on foot or bicycle cannot be done safely due to high speeds on the corridor and a lack of connections for pedestrian infrastructure. Common conflicts observed between VRUs and motorized vehicles include issues like non-marked pedestrian crossings, nighttime crashes, alcohol-related crashes, inadequate lighting, and challenges with pedestrian crossings at intersections.

Some of the challenges the region faces are related to insufficient funding and a lack of political prioritization. There is a common conception in El Paso that walking or biking is impractical due to climate conditions. The region perceives TxDOT's focus as primarily towards vehicular mobility rather than VRU safety. There are also unique challenges that arise when navigating an influx of population during the day due to the port of entries and adjacency to Mexico. All education and outreach must be multi-cultural and bi-lingual. The MPO sees education as a crucial factor in addressing crashes involving VRUs.

4.1.7 Houston-Galveston Area Council (HGAC)

HGAC mentioned a lack of a pedestrian-focused advocacy groups in Houston compared to other major cities and regions. Behavior-related issues were seen as the main cause of a lot of crashes, including drivers' unfamiliarity with accommodating pedestrians and a lack of education for both drivers and pedestrians. Additionally, concerns about driver behavior and awareness, especially in high pedestrian areas like Galveston, were raised, along with the need for increased law enforcement and education.

Infrastructure challenges, lack of maintenance, and weather are frequently mentioned as a deterrent to walking or biking in the region. Other challenges include perception behind implementing VRU-related infrastructure such as bike lanes, addressing the needs of those without transportation choices, equity, and effective outreach and education for the diverse nature of the community.

HGAC currently has initiatives underway to address VRU safety such as the Bay-Area Ped-Bike Safety Plan and the Active Transportation Plan in Houston.

4.1.8 Killeen-Temple MPO (KTMPO)

Safety is a major concern in the KTMPO area for elected officials, the Technical Advisory Committee, and the Bicycle and Pedestrian Advisory Committee. These groups have provided letters in support of implementing improvements to help reduce VRU-related crashes.

Killeen-Temple MPO identifies the main factors contributing to incidents involving VRUs as a combination of driver and pedestrian behavior, including people crossing interstates, speeding, and distracted driving.

Behavior-Related Issues

Insufficient infrastructure also adds to poor behavior. Implementing infrastructure improvements such as midblock crossings in the right locations could help reduce VRU-related crashes.

Regarding current initiatives and programs, the City of Temple has performed a sidewalk inventory, but not all cities in the region have one. Challenges and barriers in improving VRU safety include concerns about funding allocation, particularly for off-system projects, and the transient population due to the military base, which leads to a higher-than-normal number of drivers unfamiliar with local roads. Education and messaging are also needed to bring awareness.

Some cities in the region have been able to prioritize infrastructure while others have not due to growth dynamics along the I-35 corridor. There are efforts in the cities of Temple and Belton to repurpose old railroad paths for facilities that could contribute to VRU safety improvements.

4.1.9 Laredo-Webb County

One of the major challenges Laredo-Webb County MPO sees is educating the public between the tradeoffs of safety versus mobility improvements.

The Laredo-Webb County MPO encounters challenges with the perception that safety and traffic calming improvements negatively impact vehicular movement.

Perception and Prioritization

Other opportunities include visual presentation of safety materials (i.e., brochures or ads) to garner better support and understanding and funding. The MPO has limited bandwidth, making it difficult to apply for funding grants even if qualified. There is also a perception by the public that plans are being developed but there is not enough implementation.

While there is not a comprehensive city- or county-wide sidewalk inventory, crowdsourcing and assistance from transit resources, like the Metro, have proven valuable in developing inventory. The area also needs a focus on resiliency. The Laredo-Webb County area is an evacuation route for the Rio Grande Valley, and roads can get overcrowded during evacuation, which can be dangerous. The resiliency of the transportation network also needs to tie back to safety and filling in VRU-related infrastructure. The MPO partners with local police departments, Webb County sheriff's office, Laredo School District, and other Independent School Districts to run back to school campaigns with a focus on pedestrian safety.

The Texas A&M Transportation Institute is currently providing support with the congestion management process and helping develop a safety action plan.

4.1.10 Longview

The Longview MPO recently worked on developing a Bicycle and Pedestrian Plan to highlight the locations with missing infrastructure that has been a useful tool in advocating for VRU-related infrastructure. The plan also highlighted roadways with high levels of pedestrian traffic stress due to the type or lack of infrastructure.

Common conflicts between VRUs and motor vehicles are behavior-related. A lot of conflicts occur around pedestrians crossing midblock, but it is hard to deter the behavior. The main challenge in improving VRU safety is funding. There is a consensus and desire to take more action to improve safety and implement more sidewalks; however, there is a reluctance to allocate required resources. The MPO mentioned that while there are additional funding opportunities like CAT 10 for carbon reduction and the Highway Safety Improvement Program (HSIP), competition-based funding is harder to pursue rather than formula-based funding. It is harder for smaller-staffed MPOs or cities to pursue competition-based funding due to the time and effort required and the potential chance of not getting the funding after expending the effort.

To enhance overall safety for VRUs, more discussions need to shed light on safety concerns. Community engagement and raising awareness regarding safety issues slowly gets the general public and elected officials on board to make the necessary changes to improve safety.

4.1.11 Lubbock

Lubbock MPO mentioned there is a notable absence of advocacy groups for pedestrian safety, with only a bike group currently in existence. An ad hoc pedestrian committee has been formed, including an ADA representative from Texas Tech, which has engaged in mapping pedestrian and bike crashes over several years and identified problematic intersections. The MPO is currently working on developing a long-range plan to help address some of the safety-related issues.

The City of Lubbock started a sidewalk gap analysis, but the project remains unfinished. A walk and bike plan was created with stakeholder input, including a priority list. Some of the challenges include wide 110-foot right-of-way due to roads in this area that are designed to help with drainage. Although the roads are wide, speeding is not a major problem the Lubbock area experiences. Issues are more centered along the lines of access and inadequate driveway spacing. Numerous commercial lots will have multiple driveways adjacent to each other, which leads to a lot of conflict points for pedestrians.

In terms of contributing factors to crashes involving VRUs, the Loop 289 area stands out, where missing pedestrian facilities and inadequate accommodations for pedestrians cause issues. Transit-related concerns, particularly midblock crossings due to bus stop locations, are also conflicts in the area. The MPO recognizes that comprehensive community education is necessary before implementing new pedestrian and bike infrastructure. The community is resistant to the implementation of VRU-related infrastructure due to the perception that it does not provide much benefit. There is also a reluctance from the development community to support shared-use permits and pedestrian-friendly features for similar reasons.

Lubbock MPO mentioned that Colorado has completed successful programs employing temporary striping and rubber stoppers to emulate potential infrastructure to help facilitate outreach, perform pre/post analysis, and receive community feedback.

Education and Awareness

These steps help build safer infrastructure and promote community engagement, fostering a safer environment for all road users.

4.1.12 North Central Texas Council of Governments (NCTCOG)

NCTCOG has undertaken several initiatives in developing maps and other tools to track safety-related issues. They recently develop a Top 100 Corridors for Roadway Safety Audits and recently completed a Regional Pedestrian Safety Action Plan. These efforts are paralleled with education and outreach programs, which vary based on location, time of day, and day of the week. Education and outreach programs are important aspects of addressing overall VRU safety in the region. Collaborative efforts with law enforcement in the area focus on addressing red light running and speeding issues to help mitigate VRU-related crashes.

Regarding challenges and barriers, visibility has been identified as a key concern, with outreach efforts focused on making VRUs more visible to motorists. Location and land use play a significant role, with 90%-95% of crashes occurring in urban areas. NCTCOG mentioned Downtown Dallas and adjacent areas as hot spots for pedestrian crashes, including other factors such as lack of traffic enforcement and incidents of people running red lights.

Additionally, a substantial portion of crashes involve males aged 23 to 29, often occurring in dark conditions. Addressing these challenges and targeting specific demographics and conditions will be important in implementing effective measures for enhancing VRU safety and maximizing effectiveness.

4.1.13 Permian Basin

Permian Basin MPO mentioned an increasing receptiveness to implementing pedestrian and bike transportation projects and has created an encouraging environment for addressing these concerns. The public is generally concerned regarding the safety of VRUs, evident from instances like pedestrians resorting to walking in turn lanes due to the lack of sidewalks. There is currently an initiative to develop a hike and bike trail around Midland to help bring more exposure and awareness around biking.

Some contributing factors identified by the MPO were driver inattentiveness and lack of awareness, with a considerable proportion of motorized vehicles being company-owned and driven carelessly.

Poor lighting and the absence of sidewalks on new roads are contributing factors to crashes involving VRUs. While existing road infrastructure mandates sidewalk installation, there are ways to bypass the implementation.

Infrastructure Deficiencies

VRUs need to be more aware of safe practices. Proposed measures for improving VRU safety include public awareness campaigns, increased signage (such as "share the road" signs), and campaigns highlighting pedestrian injuries and fatalities. Challenges to implementing effective safety measures include the need for better coordination between the TxDOT and relevant organizations during infrastructure planning and properly allocating funds to address issues. In one case, a TxDOT initiative led to significant investment in sidewalk, lighting, and signals on FM 2020 in the region to help improve VRU safety.

4.1.14 Rio Grande Valley

The Rio Grande Valley MPO faces unique challenges with VRU safety. They have a large constituent of population that comes down during the winter months, also known as “Winter Texans,” who arrive in RVs during October and leave in May. Many of these folks are typically use walking or biking as a mode of transportation and have voiced concerns related to the infrastructure and safety.

There is also a large young population (30% under 18), so there needs to be a more focused outreach and education program to help reduce crashes amongst a vulnerability population.

In terms of the infrastructure, a lot of infrastructure is not maintained. Pedestrian signal heads are outdated or do not function. There is also low-lying terrain due to the river delta which presents its own challenges when trying to build infrastructure such as sidewalks or shared use path. In unincorporated areas like Colonia's, the lack of basic amenities and steep drainage slants pose infrastructural challenges. Lack of lighting in Colonia's and other areas was also identified as a factor contributing to unsafe conditions.

Currently, a resiliency plan is being developed to help integrate some of the transportation- and drainage-related challenges. The MPO has been exploring cost-effective measures to mitigate VRU crashes such as using reflective paint, Rapid Rectangular Flashing Beacons (RRFBs), and solar-powered lighting in rural areas. Some improvements implemented by TxDOT have been effective in reducing crashes such as midblock crossings and raised medians.

Education and training are needed at local and regional levels, and the MPO also sites a need for the implementation of design criteria and guidance for different road options. The MPO is partnering with law enforcement to conduct a traffic safety training.

4.1.15 San Angelo

San Angelo MPO mentioned that safety conditions for pedestrians and cyclists are lagging behind vehicular safety measures. This is attributed to the prevailing mindset that prioritizes motorized vehicles over pedestrians and cyclists. The impending construction of interstates I-14 and I-27 adds to the complexities related to VRU safety, and land use and considerations for a rail port will also increase freight traffic.

Developers in the area have also opposed building sidewalks, citing increased housing costs and development costs. Conflicts between VRUs and motorized vehicles are most prevalent near downtown, where individuals from lower-income areas travel to downtown for essential services like hospitals and buses. Infrastructure deficiencies are likely a major contributor to crashes involving VRUs. The absence of sidewalks throughout most of the City and inadequate lighting are also concerns. Space limitations, especially in older parts of the City with narrow streets and limited right-of-way, pose additional challenges.

Garnering community support is a top priority for the MPO, which involves the need to explain the necessity of VRU-related infrastructure improvements. However, there are ongoing initiatives, such as the City's shared use path project, aimed at enhancing bicycle and foot travel. Despite the challenges mentioned above, the City's active bike-riding community has been advocating for separated lanes or widened shoulders, particularly as highway widening narrows the existing shoulders, making cycling more hazardous.

The transit agency has also worked with the City and San Angelo University to implement a bus shuttle system for students. The bus shuttle system has been successful, and its services have been expanded since implementation.

Collaboration and Coordination

4.1.16 South East Texas Regional Planning Council (SETRPC)

Board members do not seem to place significant emphasis on pedestrian safety, and while there are some VRU hot spot areas, they are not widespread.

A major emphasis is placed on public information and early education in schools to raise awareness about safety. TxDOT is organizing a Vision Zero safety class for the MPO, to help improve VRU safety.

Education and Awareness

The most common conflicts between VRUs and motorized vehicles are attributed to a lack of infrastructure such as sidewalks and dedicated VRU-related facilities. Retrofitting existing areas for better safety is seen as challenging. While speeding-related issues are acknowledged, they are not considered a widespread concern.

Challenges in enhancing VRU safety include raising public awareness and conducting effective outreach efforts. Collaborative efforts with law enforcement and the Department of Public Safety are mentioned, focusing on back-to-school reminders and awareness campaigns.

Funding remains a crucial factor in implementing safety measures. The MPO has a hike and bike plan supported by the community, and some cities have applied for grants such as Safe Routes to Schools (SRTS) and SS4A. However, challenges arise due to the grant match proportion requirements, such as 80/20, which can hinder implementation.

4.1.17 Texarkana

Texarkana MPO has unique challenges with the MPO boundary being split between two states. One of the major corridors, Highway 71 (State Line Avenue), falls right on the state line between Texas and Arkansas. This is also a higher crash corridor. Sometimes crashes get attributed to Texas and other times attributed to Arkansas. Developing a cohesive plan and studies requires more effort due to multiple avenues of coordination.

Public concern for VRU-related crashes is also rising due to recent crashes, although business owners seem less engaged. Concerns are raised about compromised safety on State Highways, where conflicts arise between VRUs and motorized vehicles due to insufficient infrastructure like sidewalks and lighting. Limited funding and right-of-way constraints exacerbate the issue.

Educational initiatives to address driver and pedestrian behaviors are needed to reduce VRU related crashes. The MPO has challenges with funding and staffing, which are recognized as barriers to implementing effective safety measures. The MPO mentioned that tools such as Justice40 Initiative, strategies from partner entities, and other crash screening tools have been helpful as the MPO does not have the bandwidth to develop a tool. It has also been harder for the MPO to pursue grant applications due to staffing and capacity.

4.1.18 Tyler

Tyler MPO mentioned a stronger focus on improvements for bicyclists versus pedestrians because the bicyclist community has been more vocal. The City of Tyler has restriped some of their wider roadways to include bike lanes, which helped slow traffic down.

Factors contributing to incidents include low lighting conditions and inadequate sidewalk infrastructure, especially on rural roads. Cyclists generally adhere to more road rules as compared to pedestrians. Pedestrians will often jaywalk and cross midblock where there are no crossings present. Driver and pedestrian behavior are some of the other contributing factors for VRU-related crashes.

Tyler MPO has developed a sidewalk inventory as well as an Active Transportation Plan. Typically, when an entity in the region pursues grant funding, the MPO tries to coordinate with them to make sure improvements align with the plan.
Some of the challenges with VRU-related infrastructure are tied to funding, the need for an effective plan prioritizing improvements, and challenges with formatting and effectively coordinating outreach and safety campaigns. Another challenge is targeting and addressing behavioral issues.

4.1.19 Victoria

In Victoria, there is a lack of bike lanes, an inadequate sidewalk network, and signals in need of updates. The absence of comprehensive plans for sidewalks exacerbates the issue. Current practices in Victoria do not include requiring a sidewalk to receive a certificate of occupancy, indicating a potential oversight in safety considerations during development and amplifying the sidewalk infrastructure gap. Additionally, high speeds are a concern, as speed limits are often exceeded, posing a threat to VRU safety. Although decision-makers recognize the importance of better safety conditions, they are challenges to prioritize these changes.

Victoria MPO mentioned there are challenges incorporating VRU safety-related projects due to perception issues and limited funding.

Perception and Prioritization

The MPO also hosts quarterly meetings with the Traffic Management Team (TMT), which includes police departments, county sheriffs, and other traffic-related staff (county engineers, TxDOT, and EMS,) to coordinate safety- and operational-related improvements.

The Victoria MPO is developing an Active Transportation Plan to address some of the issues. However, challenges persist due to funding disparities and differing priorities. Funding for pedestrian infrastructure is not given the same level of support as roads, leading to hurdles in obtaining financial backing for improvements. Moreover, despite the MPO's engagement with grant writers, decision-makers remain resistant to investing in VRU projects, often due to perceived limited returns on investment.

Victoria MPO mentioned that the Dutch Model of Sustainable Safety was a successful campaign in raising awareness and implementing infrastructure to help reduce VRU-related crashes. However, the MPO acknowledges that a similar campaign would be hard to implement in the states due to challenges with public involvement. Education and community-led practices were also suggested as alternatives to rigid safety designs, which could be a lower-cost solution. A Safe Systems Approach was acknowledged along with incorporating safety technologies and features in vehicles to help reduce VRU-related crashes.

4.1.20 Waco

The bike advocacy and walking groups actively express their concern regarding unsafe conditions for VRUs. However, public perception is that conditions are generally safe since the usage of these facilities is low, so overall number of crashes with VRUs are low.

Lasalle Avenue was identified as unsafe due to a high-speed limit of 45 mph, coupled with inadequate infrastructure for pedestrians. Similarly, Bagby Avenue poses challenges due to both high pedestrian and vehicular traffic.

Compared to the other MPOs, Waco MPO has a more design-focused approach to reducing VRU-related crashes. Waco MPO mentioned that drivers around the world are probably distracted to similar levels as they are in the U.S. due to the smart phones in most parts of the world. Therefore, Waco MPO wants to focus more on the spatial and design side of things with implementing more context-sensitive solutions to influence driver and pedestrian behavior. The MPO noted lessons from Hoboken, NJ, where a focus on placemaking contributed to no fatalities in four consecutive years, highlighting the importance of context-specific solutions.

Challenges and barriers to improving VRU safety include complex land use issues that hinder mixed-use development and infrastructure connectivity. Some areas prioritize freight movement, making pedestrian/bicycle infrastructure implementation less feasible. Funding shortages and difficulty garnering support for VRU-related improvements are also significant challenges.

4.1.21 Wichita Falls

The Wichita Falls MPO region has significant advocacy efforts by groups such as the MPO's BPAC and a robust cyclist group. A notable development is the Circle Trail system, a 26-mile path that promotes bicycle usage, connectivity, and access to transit. Funding has played a crucial role, with the MPO securing $9M through 11 grants over a decade. Wichita Falls has a good transportation network with minimal peak hour congestion, and people can typically get in the City within 15 minutes. The City also has good transit ridership which ties into the Shepard Airforce Base and helps airmen with their transportation needs.

Common conflicts between road users and motorized vehicles were observed in busy shopping areas, particularly during peak holiday times. Contributing factors to crashes or incidents involving VRUs were distracted behavior (particularly from drivers using cell phones), awareness, and the challenge of audibly detecting electric vehicles.

Although Wichita Falls MPO has been able to secure grant funding, the primarily challenge is funding limitations and navigating how to maximize resources.

5. Strategies and Safe Systems Approach

The United States Department of Transportation (USDOT) recently adopted the Safe System Approach as the guiding model to address roadway safety. It differs from the conventional safety approach in that it acknowledges both human mistakes and human vulnerability and designs a redundant system to protect everyone. This holistic strategy recognizes the multifaceted nature of crashes and consists of five elements:

Safer People: Promoting safe behaviors among all road users through education, awareness, and responsible actions to minimize risky behaviors and errors.

Safer Roads: Designing roadways to prioritize safety, incorporating features that mitigate harm, especially for VRUs like pedestrians and cyclists.

Safer Vehicles: Enhancing vehicle safety technologies to prevent crashes or lessen their impact, encouraging the adoption of advanced driver assistance systems (ADAS) to protect occupants and others.

Safer Speeds: Prioritizing safe speeds over traffic flow, including appropriate speed limits, road design that encourages safe speeds, and leveraging education, enforcement, and technology to discourage speeding.

Post-Crash Care: Managing crashes after they happen by improving emergency medical responses, providing safe environments for first responders, and minimizing secondary crashes, focusing on preventing crash injuries from becoming fatal.

The Safe System Approach plays an important role in addressing the safety for VRUs. By implementing these five elements, the approach aims to prevent crashes, reduce their severity, and provide proper care in case of accidents. The strategy centers on creating road environments that account for human error, designing roads for VRUs, encouraging responsible behavior, enhancing vehicle safety, and improving access to emergency medical care. Ultimately, the approach strives to comprehensively address all aspects of the transportation system, working towards a holistic reduction in fatal and severe injury crashes.

5.1 Strategies

The strategies presented below were developed based of the quantitative analysis performed for the VRU Safety Assessment, which included systemic analysis, targeted analysis, demographics, and considerations of equity, along with the feedback received from the MPOs.

- **5.1.1 Planning and Engineering** – Focus on context-sensitive design solutions that influence behavior such as reducing speed limits, implementing context sensitive solutions, etc.
- **5.1.2 Education** - Behavior related issues were some of the most common cited issues by the MPOs and are challenging to address. This section provides several countermeasures specific to different kinds of behaviors along with public education and outreach.
- **5.1.3 Enforcement** – Collaborate with law enforcement agencies to enforce traffic rules, especially at high-risk areas, entertainment districts, and other places where conflicts exist with motor vehicles and VRUs.
- **5.1.4 Funding** – Leverage various sources of funding to implement effective VRU safety initiatives.
- **5.1.5 Data Analysis and Evaluation** - Use data analysis to identify hotspots, track trends, and monitor crash data. This informs evidence-based decision-making and resource allocation.
- **5.1.6 Emergency Management Services (EMS)** – Implement an Emergency Management Services (EMS) strategy involving coordination with EMS providers to enhance post-crash care, minimize injuries, and improve VRU safety.
- **5.1.7 Collaboration** – Foster collaborative partnerships among transportation agencies, law enforcement, and local governments to help address VRU-related issues.

5.1.1 Planning and Engineering

Effective planning, infrastructure, and design are essential components of improving VRU safety. The Safe System Approach integrates these elements to minimize risks for pedestrians, cyclists, and other vulnerable users. Safer road designs, such as complete streets policies, prioritize diverse road user needs, while well-designed intersections, proper lighting, and pedestrian-friendly features enhance safety. Inclusive urban and rural planning makes sure all users are considered, promoting safe active transportation options. A comprehensive approach—spanning planning to design—results in roadways that prioritize VRU safety and reduce associated risks.

These strategies may be implemented by the following entities: TxDOT, Texas Transportation Institute (TTI), MPOs, Council of Governments (COGs), Cities, Counties, and advocacy groups.

5.1.1.1 Update/Add Work Codes to TxDOT HSIP

Currently, there are eight primary work codes that are directly applicable in addressing VRU related crashes, and various secondary work codes. There should be a focus on developing new work codes in order to address are a larger array of crashes to help mitigate the number of VRU related fatal and serious injury crashes. Refer to PSAP for the provided countermeasures and verify which of those engineering-related countermeasures aren't currently included in the TxDOT HSIP work code.[2] The ones not included in the TxDOT HSIP work code should be reviewed and determined if those are feasible to add to the wok code, as these countermeasures are on that help mitigate VRU related crashes. Examples of these countermeasures are In-Street Pedestrian Signs, Raised Pedestrian Crosswalks, and Shared Use Path.

5.1.1.2 Adequate Lighting

Most MPOs presented lack of adequate lighting as a major issue. Approximately, 80% of pedestrian and 61% pedalcyclists fatal and serious injury crashes occurred at night during dark or unlighted conditions. Confirming proper lighting along roadways and at intersections to improve visibility for VRUs, especially during nighttime hours, can effectively reduce fatal and serious injury crashes.

Solar powered lighting can offer lower cost options and does not require conduit, trenching, or boring across roadways in order to connect the light back to the electrical service. This can be a lower-cost option for treating intersection or safety lighting, especially in rural areas.

The following link provides access to the FHWA Lighting Handbook, a document designed to provide recommendations regarding the design and application of roadway lighting:

- https://highways.dot.gov/safety/other/fhwa-lighting-handbook-2023

5.1.1.3 Develop Safety and VRU-Related Plans

There are already several efforts under way by MPOs, cities, and other entities to develop Safety Action Plans to leverage safety-related funding. However, there are still entities without a complete sidewalk inventory or other plans for VRU-related infrastructure.

This should be a priority for jurisdictions in order to have an understanding of localized issues and be able to prioritize implementation based on safety-, demographic-, and equity-related factors.

Safety action plans should be prioritized based on demographics and equity related issues. As was noted in the analysis above, approximately 39% of pedestrian and 33% of pedalcyclist crashes occurred in highly vulnerable census tracts.

TxDOT has finalized the pedestrian safety action plan which highlights crash trends, higher risk areas.[2] TxDOT has also developed a web-based interface for public agencies to use when screening for action plans. Detailed analysis to specific jurisdictions and locations can be performed via the PSAP Screening Tool. The following link provides access to the PSAP screening tool:

- https://amrgeo.jacobs.com/portal/apps/experiencebuilder/experience/?id=d0aa4ae93bcd45298540dc21ba1c713e&draft=true

It is recommended that TxDOT, MPO, and local government staff use the PSAP screening tool, the prioritization results, and recommended countermeasures for scoping safety projects and other roadway projects.

5.1.1.4 Intersection improvements

Design intersections with features like pedestrian countdown timers, leading pedestrian intervals, and dedicated bicycle signals to enhance visibility and safety of VRUs at intersections.

Increase the angle of right-turn channelization to closer to 90 degrees can help reduce the speed at which drivers take right-turns and help reduce the impact of crashes for VRU, if and when they occur. Especially for urban facilities with higher volumes of VRU traffic.

The following links provide countermeasures to help increase safety at various types of intersections. These can be used to help increase safety at intersections.

- Stop Controlled – https://safety.fhwa.dot.gov/intersection/stop/index.cfm
- Signalized – https://safety.fhwa.dot.gov/intersection/signal/index.cfm
- Roundabouts – https://safety.fhwa.dot.gov/intersection/roundabouts/index.cfm

5.1.1.5 Safety and Operational Cross Section Optimization

Safety and Operational Xross Section Optimization (SOXSOP) evaluates the trade-offs between lane, median and shoulder configurations within the existing roadway width that may be needed during the design life of the highway.. Please contact TxDOT's Design Division or Traffic Safety Division for more information.

5.1.1.6 Context Sensitive Design

Design roadways with appropriate speed limits that consider the surrounding environment, such as residential areas, school zones, or areas with high pedestrian and cyclist volumes, to make sure vehicle speeds are compatible with VRU presence.

5.1.1.7 Improve VRU Safety Around Transit Stops

Foster partnerships with transit agencies throughout the design phase to enhance the safety of pedestrians and pedalcyclists around transit stops, providing secure transit access.

The following link provides access to a FHWA document on improving safety for pedestrians and pedalcyclists accessing transit:

- https://safety.fhwa.dot.gov/ped_bike/ped_transit/fhwasa21130_PedBike_Access_to_transit.pdf

5.1.1.8 Develop Midblock Crossing Safety Guidance

Identify and develop best practices to mitigate or help reduce the number of crashes occurring at midblock.

5.1.1.9 Providing Dedicated Infrastructure

Design and implement sidewalks, crosswalks, bike lanes, and shared-use paths to separate VRUs from motorized traffic.

5.1.1.10 Analyze Demographic and Census Data

An analysis of demographic and census data can provide a wholistic perspective on the variability that exists in communities surrounding pedestrian and pedalcyclist facilities. An analysis of this data can allow for a more inclusive approach to VRU analysis.

5.1.1.11 Walking Audits

Partner with local neighborhood associations, businesses, and other stakeholders to perform walking audits to help implement VRU safety infrastructure and bring awareness to the issues.

5.1.2 Education

During the agency coordination phase, behavior related issues stood out as a common theme among the MPOs. Common behavioral issues include distracted driving, pedestrians crossing midblock without yielding, drug or alcohol use, speeding, and road rage. A combination of targeted countermeasures related to these behaviors in conjunction with education and awareness are recommended based on the feedback received from the MPOs and the National Highway Traffic Safety Administration.

These strategies may be implemented by the following entities: TxDOT, MPOs, Council of Governments (COGs), Cities, Counties, and advocacy groups.

5.1.2.1 Alcohol and Drug-Impaired Driving, Walking, or Biking

There are several different types of strategies when addressing alcohol and drug-impaired driving, walking, or biking. Some of these are associated with developing laws such as Open Container, License Revocation, or High-Blood Alcohol Concentration Sanctions. Other strategies target enforcement, prevention, or outreach. Below is a list of countermeasures associated with dealing with alcohol or drug-impaired driving behavior. Some of these are already implemented in locations across Texas.

- Revocation or License Suspension
- Alternative Transportation Partnerships with Bars

5.1.2.2 High-Visibility Cell Phone/Text Messaging Enforcement

This strategy is also tied to enforcement and would require local law enforcement to seek out cell phone users through patrols and other enforcement techniques.

5.1.2.3 Public Service Announcements (PSAs)

Use TxDOT's Traffic Safety Campaigns website for PSAs on TV, radio, social media, and public platforms to raise awareness about VRU safety, sharing real-life stories and safety tips. These resources are available on the TxDOT or FHWA websites. [13]

5.1.2.4 Collaboration with Local Media/Social Media Engagement

Partner with local newspapers, radio stations, and television channels to feature safety stories, interviews, and discussions to increase awareness. Use social media platforms to share safety tips, success stories, videos, and infographics, engaging with the public in an accessible and interactive manner. Running short 5–10s ad campaigns on media platforms such as YouTube or Instagram can be a low-cost and effective way of educating the public and bringing awareness to the issue.

5.1.2.5 Safety Campaigns

Launch targeted safety campaigns during high-risk periods such as back-to-school season, holidays, and special events to remind drivers and pedestrians of the importance of caution.

5.1.2.6 School Outreach Programs

Collaborate with schools to integrate road safety education into the curriculum, teaching students about safe walking, biking, and driving practices.

5.1.2.7 Driver Education Programs

Partner with driving schools to include comprehensive VRU safety education for new and experienced drivers, emphasizing the need for vigilance around pedestrians and cyclists.

5.1.2.8 Pedestrian Safety Education

Develop targeted campaigns educating pedestrians on safe crossing practices, the importance of designated crosswalks, and using pedestrian signals. This strategy would be most effective if used on targeted audiences or communities.

5.1.2.9 Community Workshops

Organize interactive workshops in local communities to educate residents about the rights and responsibilities of both drivers and pedestrians on the road. These workshops may focus on specific vulnerable populations such as the unhoused population in a community.

[13] TxDOT's Traffic Safety Campaigns (https://www.txdot.gov/safety/traffic-safety-campaigns.html)

5.1.2.10 Community Engagement Events

Organize safety fairs, town hall meetings, and community events to provide VRUs with safety resources, materials, and demonstrations. These events may focus on specific vulnerable populations such as the unhoused population in a community.

5.1.3 Enforcement

Enforcement is essential in addressing speeding related VRU crashes by deterring dangerous behaviors, ensuring compliance with traffic laws, and enhancing road safety. By holding individuals accountable for their actions, enforcement helps reduce the likelihood of severe crashes, protects VRUs, and creates a sense of responsibility among all road users. Effective enforcement sends a strong message that safety rules must be followed, fostering a culture of compliance and respect that is important for preventing VRU crashes and improving overall road safety.

While enforcement may be vital for road safety, it can be viewed negatively due to concerns about its fairness, potential for over-policing, and focus on punishment rather than addressing underlying issues. Balancing effective enforcement with community trust is crucial for a positive impact on road safety.

These strategies may be implemented by the following entities: Cities and Counties.

5.1.3.1 Distracted Driving

Launch campaigns targeting distracted driving behaviors, including cellphone use while driving, to reduce incidents caused by driver inattention.

5.1.3.2 Community Engagement with Law Enforcement

Facilitate town hall meetings, community forums, or workshops where law enforcement officers can interact with the public to address concerns, educate about pedestrian and driver responsibilities, and build trust between law enforcement and the community.

5.1.4 Funding

Developing effective strategies for funding is crucial to address VRU safety concerns identified by the analysis and the MPOs. Nearly every MPO recognized funding as a challenge. Several MPOs also requested to learn more about additional funding opportunities that are available. The following strategies aim to address the issues around funding.

These strategies may be implemented by the following entities: TxDOT, Texas Transportation Institute (TTI), MPOs, Council of Governments (COGs), Cities, and Counties.

5.1.4.1 Grant Writing Expertise

Building capacity within MPOs or developing partnerships with cities and other municipalities to leverage grant writing expertise to secure competitive grants.

5.1.4.2 Public-Private Partnerships

Collaborating with private sector entities such as developers, corporations, and local businesses, for additional funding opportunities through sponsorships, donations, or shared-use agreements.

5.1.4.3 Advocate for Policy Changes

MPOs can advocate for policy changes at higher levels of government that prioritize VRU safety funding or allocate a percentage of transportation funds specifically for pedestrian and pedalcyclist improvements.

5.1.4.4 Incorporate Safety into Existing Projects

Integrating VRU safety improvements into broader transportation projects such as road maintenance, repaving, or new developments, can help optimize available funds and create cost-effective solutions.

5.1.4.5 Creative Funding Mechanisms

Exploring innovative funding mechanisms such as tax incentives, special assessments, crowdfunding, or impact fees, can generate additional revenue streams for VRU safety projects.

5.1.4.6 Highway Safety Improvement Program (HSIP)

Funds received through the HSIP, a core Federal-aid program, are administered by the TxDOT Traffic Safety Division and as part of the TxDOT Unified Transportation Program. HSIP aims to significantly reduce traffic fatalities and serious injuries on all public roads, including non-State-owned roads. The program requires a data-driven, strategic approach to improving highway safety on all public roads with a focus on performance. The three funding types that MPOs and other agencies may pursue are:

District Targeted: Directs funds towards safety countermeasures supporting a reduction in fatal and serious injury crashes by 3.25% each year. **These funds rely heavily on crash data, specifically fatal/incapacitating injury crashes and non-incapacitating injury crashes (K, A, and B crashes). Without any crash data at the proposed location, your project will score a "0."**

Helpful Hint: Access TxDOT's crash database (CRIS) to check your site's crash data.
Link to CRIS

District Systemic: Directs funds towards district-wide systemic improvement projects using proven safety countermeasures to reduce the risk of fatal and serious injury crashes. **These funds do not have the same crash-data requirements as District Targeted funds and can be directed to general improvements.**

District Off-System: Off-system funds will be programmed by district in the same manner as the On-System Targeted except for the use of KA off-system crash data.

How to Partner with TxDOT

When a potential highway safety project location is identified, it is important to work with your TxDOT District HSIP coordinator. Asking your coordinator how much funding is available is a useful step in determining the likelihood that a submitted project will receive funding.

Additional Information for MPOs

MPOs cannot be the lead agency on an application; however, they can partner with TxDOT or local municipalities to apply. Start a discussion with TxDOT or a potential municipal partner and be prepared to share the specifics of high injury crash sites and the general needs of the community at large.

Additional Information for Other Agencies

Cities can apply for on- and off-system funding. Off-system projects ideally have buy-in before an application is submitted. Work with an HSIP coordinator to gauge how likely your proposed project is to receive funding.

Eligibility

All Texas public roadways are eligible for participation under the HSIP. Consider the following when selecting a project for submission:

- Is the strategy, activity, or project consistent with the priorities of Texas' SHSP? These priorities include:
    - Roadway and Lane Departure
    - Speed Related
    - Intersection Safety
    - Occupant Protection
    - Impaired Driving
    - Distracted Driving
    - VRUs: Pedestrian and Pedalcyclist
    - Post-Crash Care
    - Younger Drivers and Older Drivers
- Does the project address a serious crash risk such as a hot spot, systemic risk factor, road segment, or crash type that has been identified through a data-driven process?
- Is the project likely to contribute to a significant reduction in fatalities and serious injuries?
- Is this project consistent with the District Annual Safety Plan?

Each eligible proposed highway safety project is subjected to a benefit-cost analysis. The formula used for this purpose is the Safety Improvement Index (SII). **In its most basic form, the SII is the ratio of the annual savings in preventable crash costs that have occurred at a location to the cost of constructing the proposed improvement.**

Funding Match Requirement

The HSIP is federally funded. Program funds are eligible to cover 90% of project construction costs. State or local participation must cover the remaining 10% of project construction costs.

5.1.4.7 *Other Grant Funding Opportunities*

Other funding opportunities are listed in **Table 13**.

Table 13 - Other Grant Funding Opportunities

ID	Program	Program Acronym	Initiative	Grant Categories	Grant Administrator	Potential Improvements	Available Funding	Typical Award Size	Local Match
1	Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation	PROTECT	Program to make surface transportation more resilient to natural hazards, including climate change, sea level rise, flooding, extreme weather events, and other natural disasters through support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk costal infrastructure	Planning Grant	USDOT	Resilience planning, predesign, surface transportation assessment, evacuation planning	$45M total	$100K minimum	0% local match, 100% federal match
				Resilience Grant (Construction)		Rehabilitation/reconstruction of existing roadway, mitigation against floodwaters, structural stormwater controls, expansion of evacuation route, ITS, enhancing counterflow measures	$803M total	$500K minimum	20% local match, 80% federal match
2	Reconnecting Communities Program	RCP	Supports planning and construction grants to restore community connectivity through removal, retrofit, mitigation, or replacement of transportation infrastructure facilities	Planning Grant	USDOT	Grade separated intersections (railroads, highways, etc.), arterial road improvements, pedestrian connectivity bridges, highway improvements	~$50M annually (2022-26)	$2M maximum	20% local match, 80% federal match
				Capital Construction Grant			~$150M annually (2022-26)	$5M minimum	50% local match, 50% federal match

***Table 13** – Other Grant Funding Opportunities (continued)*

ID	Program	Program Acronym	Initiative	Grant Categories	Grant Administrator	Potential Improvements	Available Funding	Typical Award Size	Local Match
3	Safe Streets and Roads for All Grant Program	SS4A	USDOT program that focuses on improving roadway safety by significantly reducing or eliminating roadway fatalities and serious injuries through the development and implementation of a safety action plan	Action Plan Grant	USDOT	Vision Zero Plan, Safety Action Plan, ADA Transition Plan, Safe Routes to School (SRTS) Plan	$1B annually (2022-26) <$150M for Texas $177M rolled over from 2022 Call	Between $100K-$10M	20% local match, 80% federal match
				Implementation Grant (Construction)		Roadway widening/safety treatments, pedestrian accommodations, grade separated intersections, advanced transportation technology		Between $2.5M-$25M	
4	Transportation Alternatives Set-Aside Program	TASA	Targets safety improvement projects related to bicycle, pedestrian, or micro-mobility	Construction Grant	TxDOT	Sidewalk improvements, shared-use path, bicycle infrastructure improvements	$250M total (2023)	$250K-$25M per project	20% local match, 80% federal match (accepts TDCs as 20% match, if applicable)
				Non-Infrastructure Grant (Planning)		SRTS Plan, Bike Plan, Pedestrian Plan, Safety Action Plan, ADA Transition Plan		$100k minimum	

***Table 13** – Other Grant Funding Opportunities (continued)*

ID	Program	Program Acronym	Initiative	Grant Categories	Grant Administrator	Potential Improvements	Available Funding	Typical Award Size	Local Match
5	Highway Safety Improvement Program	HSIP	TxDOT sponsored program initiated to improve safety along roadways	Construction Grant	TxDOT	Traffic signal improvements, sidewalks, signage and pavement markings, detection upgrades, capacity improvements (highly reliant on crash data)	Varies for on- and off-system facilities and by TxDOT District	$100K-$1M per location	10% local match, 90% TxDOT match
6	Rebuilding American Infrastructure Sustainably and Equitability	RAISE	Program to help urban and rural communities move forward on projects that modernize roads, bridges, transit, and intermodal transportation and make our transportation systems safer, more accessible, more affordable, and more sustainable	Planning Grant RAISE Merit Construction Grant	USDOT	Highway, bridge, road projects, public transportation, intermodal projects, and planning or pre-construction activities for any of these activities	$7.5B total (2022-26)	$5M minimum $25M maximum ($225M max. per state)	20% local match, 80% federal match
7	Strengthening Mobility and Revolutionizing Transportation	SMART	Program to conduct demonstration projects focused on advanced smart city or community technologies and systems in a variety of communities to improve transportation efficiency and safety	Planning and Prototyping Implementation Grant	USDOT	Coordinated Automation (AV), connected vehicles, sensor-based infrastructure, smart grid, smart technology traffic signals (ATSPMs)	$100M annually (2022-26)	Up to $2M with 30-50 awards per cycle	0% local match, 100% federal match

Table 13 *– Other Grant Funding Opportunities (continued)*

ID	Program	Program Acronym	Initiative	Grant Categories	Grant Administrator	Potential Improvements	Available Funding	Typical Award Size	Local Match
8	Transit-Oriented Development Pilot	TOD	Provides funding to communities to integrate land use and transportation planning with a new transit project	Planning Grant	FTA	Improve multimodal connectivity and accessibility, improve transit access for pedestrian and bicycle traffic, identify infrastructure needs, and enable mixed-use development near transit stations	$13.4M total (2023)	Between $360K-$1.6M	20% local match, Up to 100% federal match
9	The National Recreational Trails Fund	NRTF	Funds motorized and non-motorized recreational trail projects	Construction Grant	TPWD/FHWA	Construction of new recreational trails, existing trail improvement, trailhead or trailside facility development, and trail corridors acquisition	$5.14M total (2023)	Between $60K-$300K $600K maximum	20% local match, 80% federal match

5.1.5 Data Analysis and Evaluation

Data analysis can help provide insights into the factors contributing to VRU-related crashes, crash locations, patterns, and contributing factors. It can help identify transportation agencies identify high-risk areas and trends, enabling targeted interventions.

These strategies may be implemented by the following entities: TxDOT, Cities, and Counties.

5.1.5.1 Improving the Quality of Data Recorded for CRIS.

A major challenge in establishing a robust dataset pertains to its reliability. The quality of the output relies on the quality of the input. Therefore, ensuring consistency and accuracy in data collection requires ongoing collaboration and training between law enforcement personnel. This involves equipping peace officers with the necessary skills to effectively populate the Peace Officer Crash Report. It is important for peace officers to understand the pivotal role they play in recording the data and that precision in reporting plays in facilitating engineers’ and planners' analyses and decision-making processes.

5.1.6 Emergency Management Services (EMS)

Implement an EMS strategy encompassing coordination and collaboration of EMS providers. This strategy aims to enhance post-crash care effectiveness, to provide emergency medical assistance, minimize injuries, and improve overall VRU safety.

These strategies may be implemented by the following entities: Cities and Counties.

5.1.6.1 Feedback from First Responders

Gather insights from emergency responders and medical professionals involved in VRU-related crash incidents to understand the dynamics and contributing factors.

5.1.6.2 Emergency Response Awareness Campaign – Driver Education

Initiate an educational initiative focused on reorienting drivers about appropriate actions when first responders are navigating to crash scenes, particularly in high-traffic zones or during peak periods.

5.1.6.3 Improve Incident Clearance Efforts

Collaborate with law enforcement agencies and other first responders to implement advanced traffic incident management practices. This includes faster clearance of crash scenes to minimize the risk of secondary crashes and reduce congestion, benefiting both responder safety and the traveling public.

5.1.7 Collaboration

The collaboration strategy centers on fostering partnerships and alliances among various stakeholders to collectively address VRU safety challenges. By engaging Metropolitan MPOs, law enforcement agencies, local governments, community organizations, advocacy groups, and other relevant parties, this strategy aims to pool expertise, resources, and perspectives to create comprehensive solutions that enhance VRU safety across diverse communities and road environments.

These strategies may be implemented by the following entities: TxDOT, Texas Transportation Institute (TTI), MPOs, Council of Governments (COGs), Cities, Counties, and advocacy groups.

5.1.7.1 Regional Coordination

Encourage collaboration among neighboring jurisdictions and MPOs to share best practices, data, and strategies for consistent VRU safety improvements across a broader region.

5.1.7.2 Multi-Sector Task Forces

Form multi-sector task forces or committees focused on VRU safety, comprising representatives from transportation, law enforcement, public health, education, engineering, and community organizations.

5.1.7.3 Regular Meetings

Organize regular meetings, workshops, or seminars that bring together stakeholders to discuss challenges, progress, and new strategies for VRU safety improvement.

5.1.7.4 Auto-Manufacturers Engagement

Collaborate with automobile manufacturers to enhance VRU safety through the integration of advanced driver assistance systems (ADAS) and vehicle-to-pedestrian communication technologies.

Partner with automobile manufacturers to show emerging technologies and trends and how these can be leveraged to improve pedestrian safety such as hard braking data, near misses, seat belt activation, and other safety-related data.

6. Appendix

Appendix A – Acronyms

AAA – American Automobile Association

AADT – Annual Average Daily Traffic

AAMPO – Alamo Area Metropolitan Planning Organization

ACS – American Community Survey

ADA – The Americans with Disabilities Act

ADAS – Advanced Driver Assistance Systems

ADT – Average Daily Traffic

CAMPO – Capital Area Metropolitan Planning Organization

CDC – Center for Disease Control and Prevention

CRIS – Crash Records Information System

DOT – Department of Transportation

EMS – Emergency Management Services

FARS - Fatality Analysis Report System

FHWA – Federal Highway Administration

GIS – Geographic Information Systems

HGAC – Houston-Galveston Area Council

HSIP – Highway Safety Improvement Program

IIJA - Infrastructure Investment and Jobs Act

KTMPO – Killeen-Temple MPO

MPO – Metropolitan Planning Organization

MSA – Metropolitan Statistical Area

NRTF – The National Recreational Trails Fund

PROTECT – Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation

PSA – Public Service Announcement

PSAP – Pedestrian Safety Action Plan

RAISE – Rebuilding American Infrastructure Sustainably and Equitably

RCP – Reconnecting Communities Program

RRFB – Rapid Rectangular Flashing Beacons

RTZ – Road-to-Zero

SBSAS – Statewide Bicycle Safety Analysis Assessment

SETRPC – South East Texas Regional Planning Council

SHSP – State Highway Safety Plan

SII – Safety Improvement Index

SMART – Strengthening Mobility and Revolutionizing Transportation

SRTS - Safe Routes to Schools

SS4A – Safe Streets and Roads for All

SSPST – Systemic Safety Project Selection Tool

SVI - Social Vulnerability Index

TASA – Transportation Alternatives Set-Aside Program

TMT – Traffic Management Team

TOD – Transit Oriented Development Pilot

TV – Television

TxDOT – Texas Department of Transportation

USDOT – United States Department of Transportation

VRU – Vulnerable Road User

Appendix B – Statewide Bicycle Safety Analysis Summary

MEMO

October 2023

To: TxDOT Transportation Planning & Programming Division

From: Jim Meyer, AICP
Carol Zhou, AICP

Subject: SLRTP WA#3 Statewide Bicycle Safety Analysis Summary - Final

1. Introduction

The State's on-system transportation network connects communities, regions, the entire State and destinations outside of Texas. While many bikeways are planned and funded at the local level, the State is well-positioned to develop regional visions for bikeways on the state network to improve safety, connectivity, and access within and between districts. Developing a regional framework is vital as the State works to provide safe, thoughtfully designed, well-maintained facilities for bicyclists within each district and between districts, providing connectivity across the State. This document summarizes the findings from the statewide bicycle safety analysis conducted as part of the Statewide Long-Range Transportation Plan (SLRTP) WA#3 - statewide assessment of bikeways and the development of pilot District Bike Plans.

2. Statewide Bicycle Crash Summary

This section focuses primarily on identifying the overall bicycle crash patterns in Texas. The crash data for the years 2017-2021 was processed using a Python script based on the raw dataset received from Texas Department of Transportation (TxDOT)'s Pedestrian Safety Action Plan (PSAP) team. This data was shared between the two study teams to ensure that consistent data and processing criteria were used in conducting further analyses.

The statewide analysis is based on a total of 12,954 all bicycle crashes, and 1,846 fatal and serious injury bicycle crashes that occurred during 2017-2021. The following descriptive analysis is based on factors available in TxDOT's Crash Records Information System (CRIS):

- On-system vs off-system
- Crash location (urban/rural, intersection/non-intersection, mainlane/frontage road)
- Light condition
- Vehicle manner of collision

Although CRIS includes roadway characteristics data, not all crash records have values in those roadway related attributes. Over 9,000 records of the bicycle crashes have null values in data variables such as annual average daily traffic (AADT), functional classification, number of lanes, and road type. To address this, the study team selected on-system segments as the target network and performed spatial join in ArcGIS to assign crashes to segments based on the TxDOT's road-highway inventory network (RHiNO). More details can be found in Section 3.

Table 1 provides bicycle crash statistics based on-system vs off-system. Of the 12,954 bicycle crashes, the majority (over 70%) occurred on off-system roadways. However, in terms of crash severity, on-system bicycle crashes resulted in a greater percentage (61.8%) of fatal and serious injury crashes compared to those occurring on off-system facilities (38.2%).

Table 1 Bicycle Crash Statistics by On-system vs Off-system

Crash Factors	Description	Centerline Mileage	Centerline Mileage Percentage	Total Crashes	Total Crash Percentage	Fatal and Serious Injury Crashes	Fatal and Serious Injury Crash Percentage
On-system vs Off-system	On-System	80,720	25.4%	3,623	28.0%	1,141 (31.5%)[1]	61.8%
	Off-System	236,790	74.6%	9,331	72.0%	705 (7.6%)	38.2%
Total		317,510	100%	12,954	100%	1,846 (14.3%)	100%

1 Percent in () indicates the percentage of fatal and serious injury crashes of the total crashes in the corresponding category

Table 2 provides bicycle crash statistics by crash location. The majority of bicycle crashes occurred on urban roadways, however, a higher percentage of bicycle crashes (21.1%) that occurred on rural facilities resulted in fatalities and serious injuries. A total of 60.3% all bicycle crashes occurred at intersections or were reported as intersection-related, followed by 29.1% at non-intersections (segment), and 10.6% at driveways. A greater proportion of the crashes at non-intersections were found to result in fatalities and serious injuries compared to the crashes at intersections. In terms of road part, mainlane crashes were found to be more prevalent than frontage road crashes; however, bicycle crashes involving frontage roads were found to have a slightly greater percentage of fatal and serious injury crashes.

Table 2 Bicycle Crash Statistics by Crash Location

Crash Factors	Description	Total Crashes	Total Crash Percentage	Fatal and Serious Injury Crashes	Fatal and Serious Injury Crash Percentage
Urban vs Rural	Urban	11,020	85.1%	1,437 (13.0%)[1]	77.8%
	Rural	1,934	14.9%	409 (21.1%)	22.2%
Total		12,954	100%	1,846 (14.3%)	100%
Location	Intersection or Intersection Related	7,818	60.3%	837 (10.7%)	45.3%
	Driveway Access	1,370	10.6%	103 (7.5%)	5.6%
	Non-Intersection	3,766	29.1%	906 (24.1%)	49.1%
Total		12,954	100%	1,846 (14.3%)	100%
Road Part	Mainlane	12,119	93.6%	1,711 (14.1%)	92.7%
	Frontage Road	622	4.8%	115 (18.5%)	6.2%
	Other	213	1.6%	20 (9.4%)	1.1%
Total		12,954	100%	1,846 (14.3%)	100%

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

Table 3 provides bicycle crash statistics by vehicle manner of collision. Overall, about 68% of vehicles were going straight ahead at the time of the crash. Most fatal and serious injury bicycle crashes involved vehicles going straight.

Table 3 Bicycle Crash Statistics by Vehicle Manner of Collision

Crash Factors	Description	Total Crashes	Total Crash Percentage	Fatal and Serious Injury Crashes	Fatal and Serious Injury Crash Percentage
Collision Type	One Vehicle Going Straight	8,809	68.0%	1,498 (17.0%)[1]	81.1%
	Turn Related	3,951	30.5%	324 (8.2%)	17.6%
	Reverse Related/ Other	194	1.5%	24 (12.4%)	1.3%
Total		12,954	100%	1,846 (14.3%)	100%

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

Table 4 summarizes bicycle crash statistics by lighting condition. Although most of the crashes occurred during daylight (70.6%), they resulted the lowest percentage of fatal and serious injury crashes. Approximately 11%, 18%, and 29% of all bicycle crashes resulted in fatalities and serious injuries during daylight, dark-lighted, and dark-not lighted conditions respectively.

Table 4 Bicycle Crash Statistics by Light Condition

Crash Factors	Description	Total Crashes	Total Crash Percentage	Fatal and Serious Injury Crashes	Fatal and Serious Injury Crash Percentage
Light Condition	Daylight	9,150	70.6%	1,044 (11.4%)[1]	56.6%
	Dark, Lighted	2,142	16.5%	391 (18.3%)	21.2%
	Dark, Not Lighted	1,123	8.7%	329 (29.3%)	17.8%
	Other (dawn, dusk, dark-unknown lighting, unknown)	539	4.2%	82 (15.2%)	4.4%
Total		12,954	100%	1,846 (14.3%)	100%

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

3. Targeted Bicycle Safety Analysis

The targeted bicycle safety analysis is performed using a sliding windows analysis, which is a method for measuring crash density along network corridors. Along a length of roadway, if many fatal and serious injury bicycle crashes occur in close sequence, underlying roadway characteristics that are shared along the corridor are likely contributing to the safety problem. A simpler hotspot analysis would likely miss these conditions since the crashes are stretched along a length of roadway rather than concentrated in a single discrete location. As a result, a sliding window analysis is a quick and efficient way to communicate the highest priority corridors in a network for eliminating fatalities and serious injuries.

The mechanics of the sliding window analysis are shown in **Figure 1.** Count of crashes or a weighted crash score is tabulated within a defined window size (e.g., ½ mile), moving in baby steps (e.g., 1/10 mile) along corridors. The study team used Python, PostgreSQL/PostGIS and ArcGIS to develop the targeted bicycle safety analysis. The analysis was based on all bike crashes on- and off-system between 2017 and 2021. The weighted crash scores were based on crash severity using the full KABCO scale weighted 5-1 (K x5, A x4 … O x1). Based on the weighted crash scores, targeted segments were selected based on 85% percentile of scores as a cut-off point (greater than or equal to). This is a threshold that can be adjusted accordingly. The results are shown in **Figure 2.**

Figure 1 Sliding Window Analysis Process Diagram

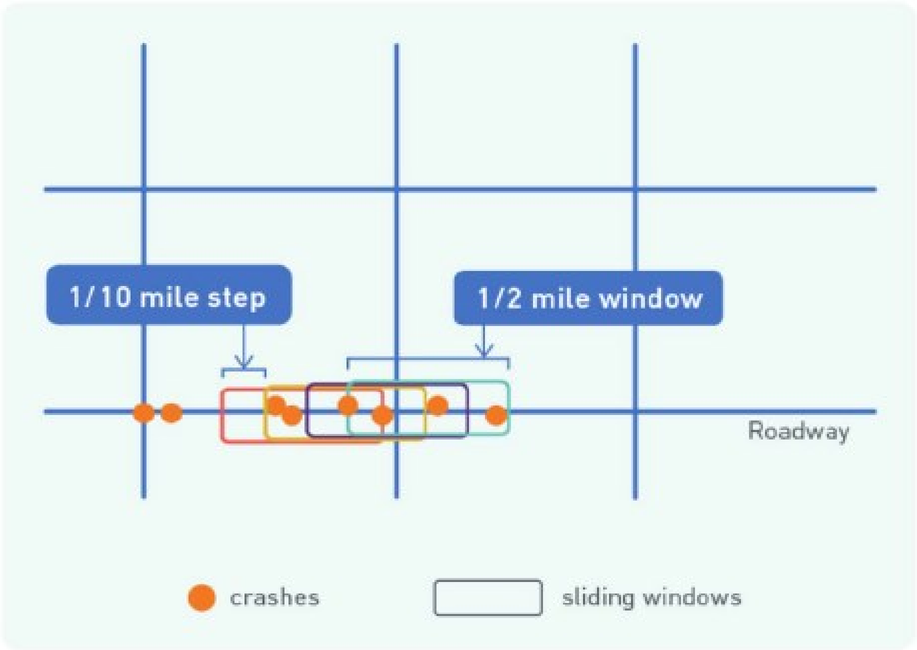
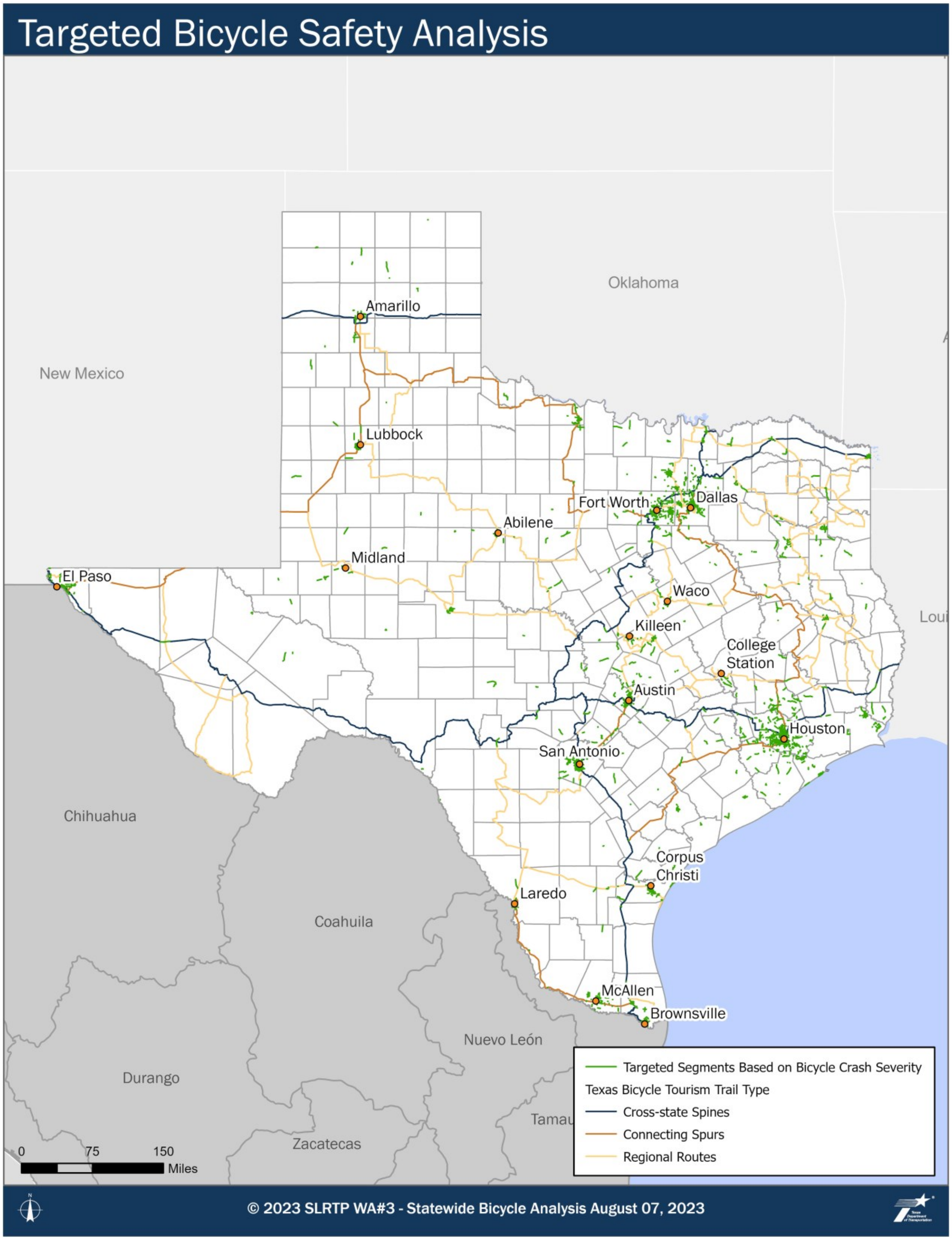


Figure 2 Targeted Bicycle Safety Analysis



4. On-system Segment Crash Trend Analysis

This section presents bicycle crash characteristics based on the on-system segments as the target network. During the analysis years, of the total 12,954 bicycle crashes, 3,623 crashes occurred on the on-system network including both intersections and non-intersections. Although intersection related bicycle crashes were found to be more prevalent, reliable intersection related factors (e.g., number of lanes on major approach, intersection control, turning movement proportions) were not available to support this analysis. As a result, crashes that occurred at intersection or are intersection related were excluded from the systemic analysis. This resulted in a total of 1,613 non-intersection bicycle crashes associated with TxDOT's on-system facilities.

Assigning Crashes to Segments

To summarize the bicycle crash trends by roadway characteristics, crashes were assigned spatially to the roadway segments in ArcGIS. CRIS and RHiNo data were processed as described below:

- The first step was to split the RHiNo dataset into two categories including mainline segments (RDBD_ID IN (KG, LG, RG)) and frontage road segments (RDB_ID IN (XG, AG)). Since it could be challenging to detect which direction of the frontage road a bicycle crash is associated with, as a default, all bicycle frontage road crashes were snapped to the right frontage road segments (RDBD_ID = AG). This was considered acceptable considering that the directional difference (XG and AG frontage roads) in relevant roadway-related factors is minimal, compared to the difference between mainlanes and frontage roads. This is particularly useful in the case of frontage road crashes that are often snapped on the centerline of a road making the distinction between frontage road crashes and mainlane crashes challenging.
- A custom script was then developed to snap the crashes to the centerlines. In short, this was done by iterating through the list of highway names, selecting crashes that shared the same highway or street name, and performed the Snap Analysis Tool for each iteration. This resulted in a more accurate dataset as compared to simply snapping a crash to the nearest centerline.

On-System Segment Bicycle Crash Descriptive Analysis

A total of 1,613 bicycle crashes were spatially joined to the on-system facilities which constitute 80,720 centerline miles of state on-system roadway network. This section presents on-system segment bicycle crash characteristics based on functional classification, number of lanes, traffic volume, and posted speed limit.

Table 5 provides on-system bicycle crash statistics by functional classification. Based on these statistics, the crash pattern appears consistent with the statewide bicycle crashes – urban roadways experienced a much higher frequency of bicycle crashes compared to rural roadways. Approximately half of the rural on-system bicycle crashes resulted in fatalities or serious injuries, whereas about a quarter of the urban on-system bicycle crashes were fatal or serious injury crashes. Urban arterials and urban collectors experienced over 80% of total bicycle crashes. The urban arterial category experienced the highest bicycle crash rate of 2.95 bicycle crashes per 100 centerline mile per year. This was followed by urban collectors with 0.88 bicycle crashes per 100 centerline mile per year.

Table 5 On-system Segment Bicycle Crashes by Functional Classification

Functional Classification	Centerline Miles	Total Crashes	Total Crash Percentage	Total Crashes per 100 Centerline Mile per Year	Fatal and Serious Injury Crashes
Rural Interstate and Other Freeway	2,130	4	0.2%	0.04	2 (50.0%)[1]
Rural Arterial	18,780	90	5.6%	0.1	49 (54.4%)
Rural Collector	43,690	112	6.9%	0.05	58 (51.8%)
Rural Local	211	0	0.0%	-	0 (0.0%)
Urban Interstate and Other Freeway	2,580	81	5.0%	0.63	22 (27.2%)
Urban Arterial	7,066	1041	64.5%	2.95	237 (22.8%)
Urban Collector	6,132	270	16.7%	0.88	80 (29.6%)
Urban Local	132	1	0.1%	0.15	0 (0.0%)
Unknown	-	14	0.9%	-	3 (21.4%)
Total	80,720	1,613	100%	0.40	451 (28.0%)

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

Table 6 provides on-system bicycle crash statistics by number of lanes. A majority of bicycle crashes occurred on either four-lane or two-lane facilities; these two facilities experienced more than 70% of the analyzed bicycle crashes. The six- lane facilities experienced the highest crash rate of 3.48 bicycle crashes per 100 centerline mile per year. On the other hand, the two-lane facilities experienced the highest proportion (35.5%) of fatal and serious injury crashes, higher than the average of 28.0% for all on-system facilities.

Table 6 On-system Segment Bicycle Crashes by Number of Lanes

Number of Lanes	Centerline Miles	Total Crashes	Total Crash Percentage	Total Crashes per 100 Centerline Mile per Year	Fatal and Serious Injury Crashes
1	74	1	0.1%	0.27	0 (0.0%)[1]
2	64,271	442	27.4%	0.14	157 (35.5%)
3	1,531	75	4.6%	0.98	20 (26.7%)
4	12,474	715	44.3%	1.15	182 (25.5%)
5	138	20	1.2%	2.91	5 (25.0%)
6	1,700	296	18.4%	3.48	70 (23.6%)
7+	531	50	3.1%	2.41	17 (26.6%)
Unknown	-	14	0.9%	-	3 (21.4%)
Total	80,720	1,613	100%	0.40	451 (28.0%)

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

Table 7 provides on-system bicycle crash statistics by traffic volume. Low volume roadways (i.e., with AADT ≤ 5,000 vehicles per day (vpd)) experienced the lowest number of bicycle crashes per 100 centerline mile per year. However, a greater proportion of these crashes resulted in fatalities and serious injuries. The highest bicycle crash rate of 2.75 bicycle crashes per 100 centerline mile per year was observed on roads with AADT range between 20k – 30k vpd.

Table 7 On-system Segment Bicycle Crashes by Traffic Volume

AADT (vpd)	Centerline Miles	Total Crashes	Total Crash Percentage	Total Crashes per 100 Centerline Mile per Year	Fatal and Serious Injury Crashes
<=5,000	60,514	257	15.9%	0.08	114 (44.4%)[1]
5,000-10,000	8,373	260	16.1%	0.62	86 (33.1%)
10,000-20,000	6,007	471	29.2%	1.57	119 (25.3%)
20,000-30,000	2,388	328	20.3%	2.75	68 (20.7%)
30,000-40,000	1,236	155	9.6%	2.51	29 (18.7%)
40,000-50,000	568	41	2.5%	1.44	11 (26.8%)
50,000+	1,634	87	5.4%	1.06	21 (24.1%)
Unknown	-	14	0.9%	-	3 (21.4%)
Total	80,720	1,613	100%	0.40	451 (28.0%)

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

Table 8 summarizes on-system bicycle crash statistics by posted speed limit. Roadways with 35 mph posted speed limit experienced the highest bicycle crash rate of 3.23 crashes per 100 centerline mile per year. Overall, a greater percentage of fatal and serious injury crashes was found to be on high-speed facilities while low-speed facilities experienced higher crash rates.

Table 8 On-system Segment Bicycle Crashes by Posted Speed Limit

Posted Speed Limit	Centerline Miles	Total Crashes	Total Crash Percentage	Total Crashes per 100 Centerline Mile per Year	Fatal and Serious Injury Crashes
<= 30 mph	1,994	58	3.6%	1.49	9 (15.5%)[1]
35 mph	2,654	140	8.7%	3.23	24 (17.1%)
40 mph	4,308	209	13.0%	2.92	50 (23.9%)
45 mph	15,415	435	27.0%	1.40	92 (21.1%)
50 mph	6,352	125	7.7%	1.07	39 (31.2%)
55 mph	48,803	416	25.8%	0.39	146 (35.1%)
>= 60 mph	118,943	216	13.4%	0.09	88 (40.7%)
Unknown	-	14	0.9%	-	3 (21.4%)
Total	80,720	1,613	100%	0.40	451 (28.0%)

1 Percent in () indicates the percentage of fatal and suspected injury crashes of the total crashes in the corresponding category

5. Systemic Risk Factor Analysis

While the targeted safety analysis relies on crash history to identify locations with the greatest demonstrated safety issues associated with bicycling, the risks of roadway characteristics on the frequency and severity of bicycle crashes were studied in more detail in this section. The objective of systemic risk factor analysis is to identify the risk factors that are associated with bicycle crashes. Due to lack of detailed roadway data available for off-system roadways, the systemic risk analysis is focused on the on-system roadway network only. Federal Highway Administration (FHWA)'s System Safety Project Selection Tool (**Figure 3**) was used to identify focus crash types and risk factors.

Select Focus Crash Types

Figure 3 FHWA's Systemic Safety Planning Process

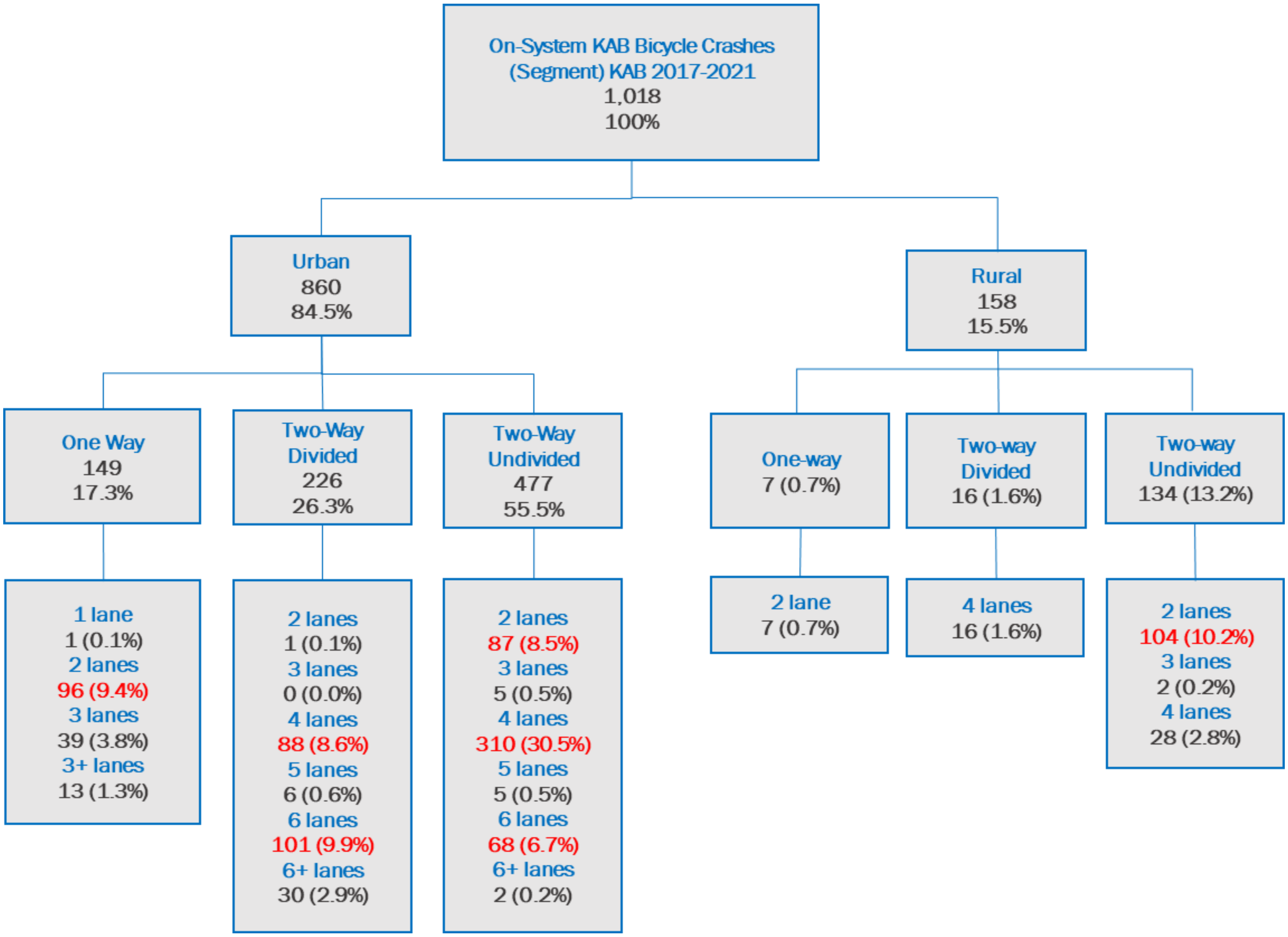
Source: Systemic Safety Project Selection Tool, FHWA

The focus crash types were established based on the scope of work and stakeholder input. The TxDOT's Strategic Highway Safety Plan (SHSP) focused on the fatal and serious injury crashes for identifying the emphasis areas. Given that there were relatively few fatal and serious injury bicycle crashes that occurred on the target network, the study team decided to include minor injury crashes into the analysis. As a result, the focus crash types for the risk factor analysis were fatal (K – killed), suspected serious injury (A – incapacitating injury), and suspected minor injury (B – non-incapacitating injury) bicycle crashes (KAB type). This resulted in a total of 1,018 bicycle crashes for the systemic analysis.

Select Focus Facilities

To identify the focus facility type, the focus type crashes were documented in a crash tree diagram based on the roadway characteristics available in the roadway inventory data. These roadway characteristics included area type (urban vs rural), roadway division, and number of lanes. This diagram technique helped identify and select the facility types where the focus crash types most frequently occurred. For the purpose of this analysis, the focus facility type was selected if 5% or greater of total KAB crashes were present. This is a threshold that can be adjusted accordingly. The selected facilities are represented by the red highlighted values in the diagram, as shown in **Figure 4.**

Figure 4 Bicycle Crash Tree Diagram (KAB type)



To summarize, a total of seven focus facility types were identified for the risk factor analysis.

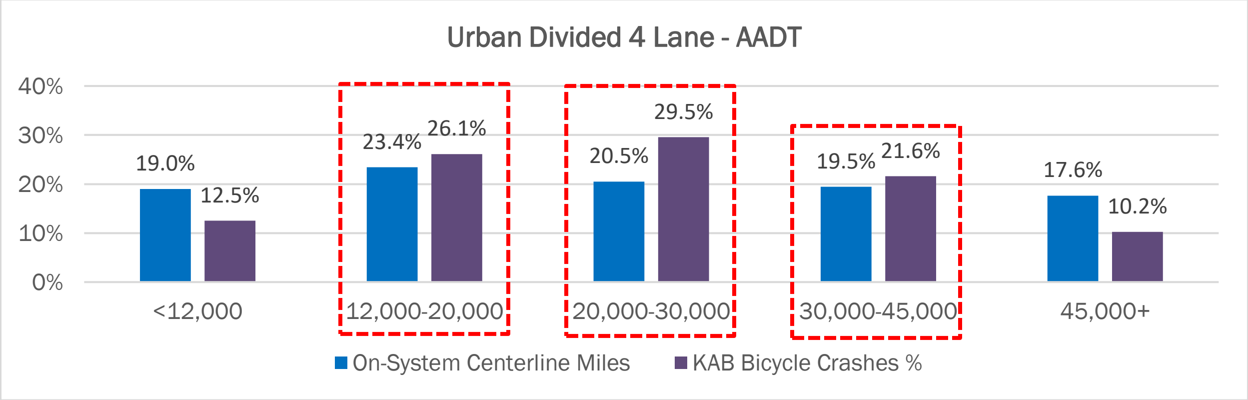
1) Rural Undivided 2L
2) Urban One-way 2L
3) Urban Undivided 2L
4) Urban Undivided 4L
5) Urban Undivided 6L
6) Urban Divided 4L
7) Urban Divided 6L

Identify and Evaluate Risk Factors

Systemic risk factors were analyzed by comparing available roadway characteristics of locations where bicycle crashes have occurred. More specifically, the risk factors were identified through an evaluation of overrepresentation of KAB bicycle crashes associated with three roadway attributes, including traffic volume (AADT), speed limit, and outside shoulder width. When a roadway attribute accounted for a higher proportion of crashes than centerline miles, an overrepresentation was determined, and the attribute was recommended as a risk factor. TxDOT staff confirmed the use of the KAB crash in the systemic analysis to provide additional consistency with statewide crash severity performance measures.

The team also considered the bikeway presence data, collected through the TxDOT Comprehensive Accessibility Program (TCAP), as a potential risk factor. The TCAP bikeway presence data covers a very low percentage of the on-system road miles, which may not be statistically sufficient for the analysis. This low coverage issue coupled with the relatively small sample size of the KAB bicycle crashes may lead to misleading results. Therefore, the team decided to eliminate the TCAP bikeway presence data from the systemic risk analysis.

Figure 5 Systemic Risk Factor Overrepresentation Example



The example in **Figure 5** illustrates the traffic volume attribute for the urban divided 4-lane facilities. In this example, the blue bars represent the percentage of on-system centerline miles while the purple bars represent the percentage of KAB bicycle crashes occurring on roadways with the corresponding AADT ranges. For AADT that falls in the range of 12k to 20k, 20k to 30k, 30k to 45k vpd, all of the purple bars are larger than their corresponding blue bars, indicating that **AADT range of 12k to 45k** is overrepresented for KAB bicycle crashes and would be recommended as a risk factor.

This process was completed individually for each of the three attributes including AADT, speed limit, and outside shoulder width for each focus facility type, as shown in **Attachment A.**

Table 9 contains the critical values associated with each of the bicycle risk factors for the statewide network.

Table 9 Risk Factor Thresholds

	Facility type	Number of Lanes	ADT range (vpd)	Posted Speed Limit (mph)	Outside Shoulder Width (ft)
Rural	Rural Undivided	2	>=2,000	<=65	>=3
Urban	Urban One-way	2	>=3,000	45	0 or >=4 and <6
	Urban Undivided	2	>=6,000	<=50	>=4 and <10
	Urban Undivided	4	>=11,000	<=45	0
	Urban Undivided	6	>=27,000	<=55	>=0 and <6 or 10
	Urban Divided[1]	4L	>=12,000 and <45,000	<=55	0
	Urban Divided	6L	<36,000	<=55	0

Summary of Risk Factors Analysis

Based on the critical ranges identified in the previous step, a group of GIS maps (**Figure 6-9**) and summary tables (**Tables 10-11**) are developed to visualize the geographic locations of those identified roadway segments with potential risks and summarize the total centerline miles and percentages associated with the risk factors.

Table 10 Summary of Centerline Miles by Number of Risk Factors

Number of Risk Factors	Centerline Miles	Percentage
0	22,797	28.2%
1	29,786	36.9%
2	21,336	26.4%
3	6,801	8.4%

[1] For urban divided roadways (4L, 6L), only segments with outside shoulder width of 12 feet or less were included in the shoulder width risk analysis due to erroneous shoulder width data identified in the RHiNO

Table 11 Summary of Centerline Miles by Risk Factor Category

	Presence of Risk Factor	Centerline Miles	Percentage
ADT as a Risk	No	61,360	76.0%
	Yes	19,360	24.0%
Speed as a Risk	No	43,093	53.4%
	Yes	37,626	46.6%
Shoulder Width as a Risk	No	44,844	55.6%
	Yes	35,876	44.4%

Figure 6 On-System Segments with One Risk Factor

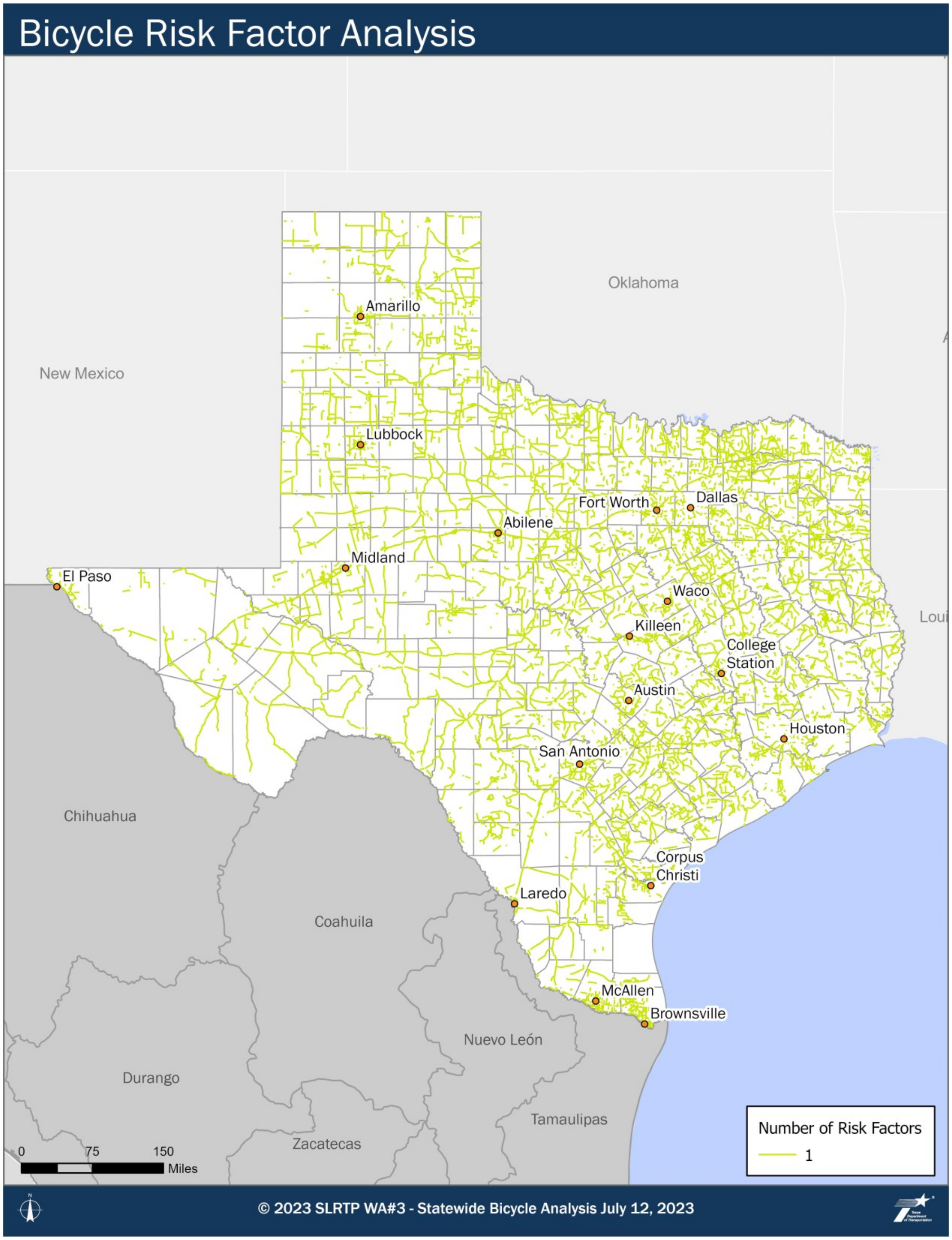


Figure 7 On-System Segments with Two Risk Factors

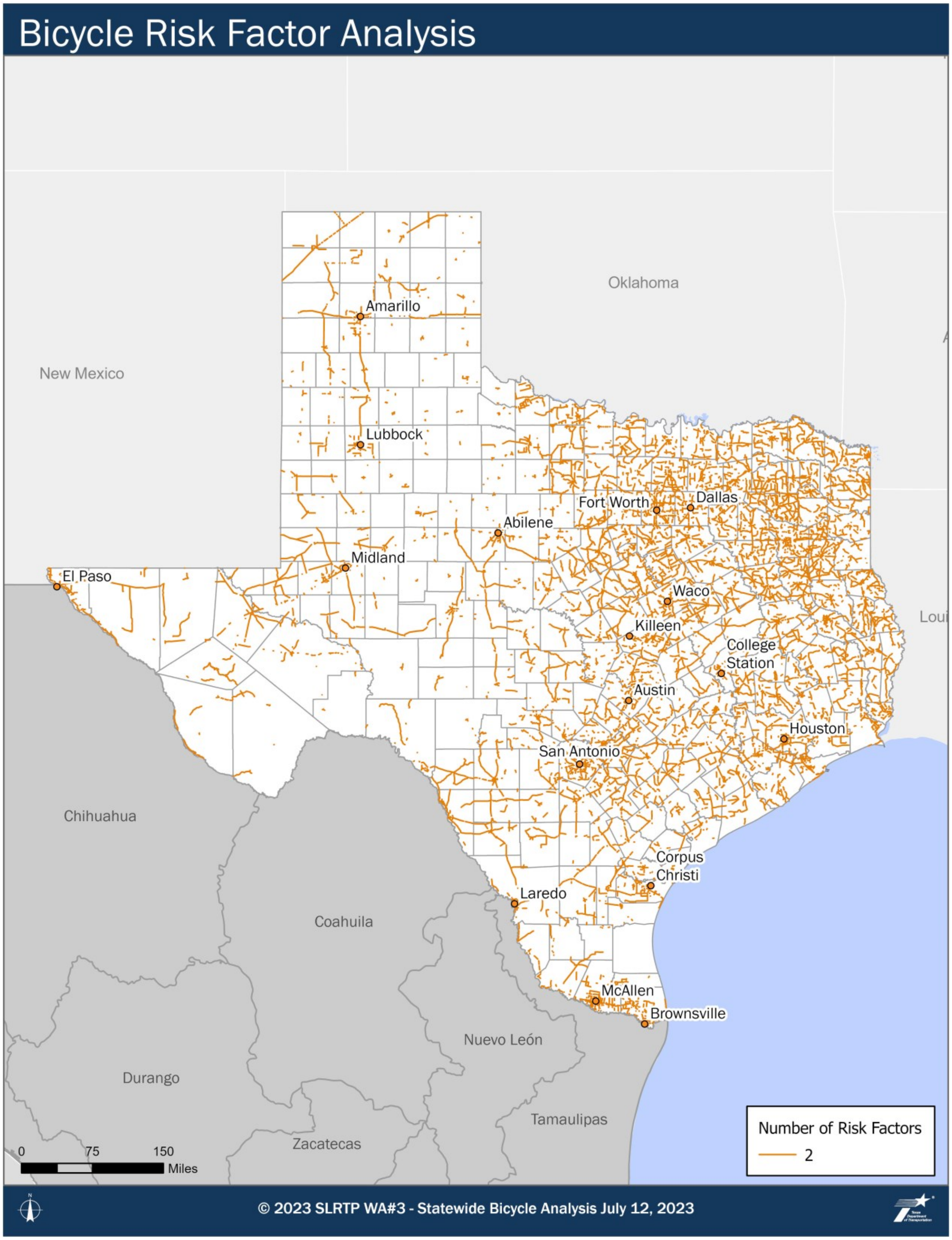


Figure 8 On-System Segments with Three Risk Factors

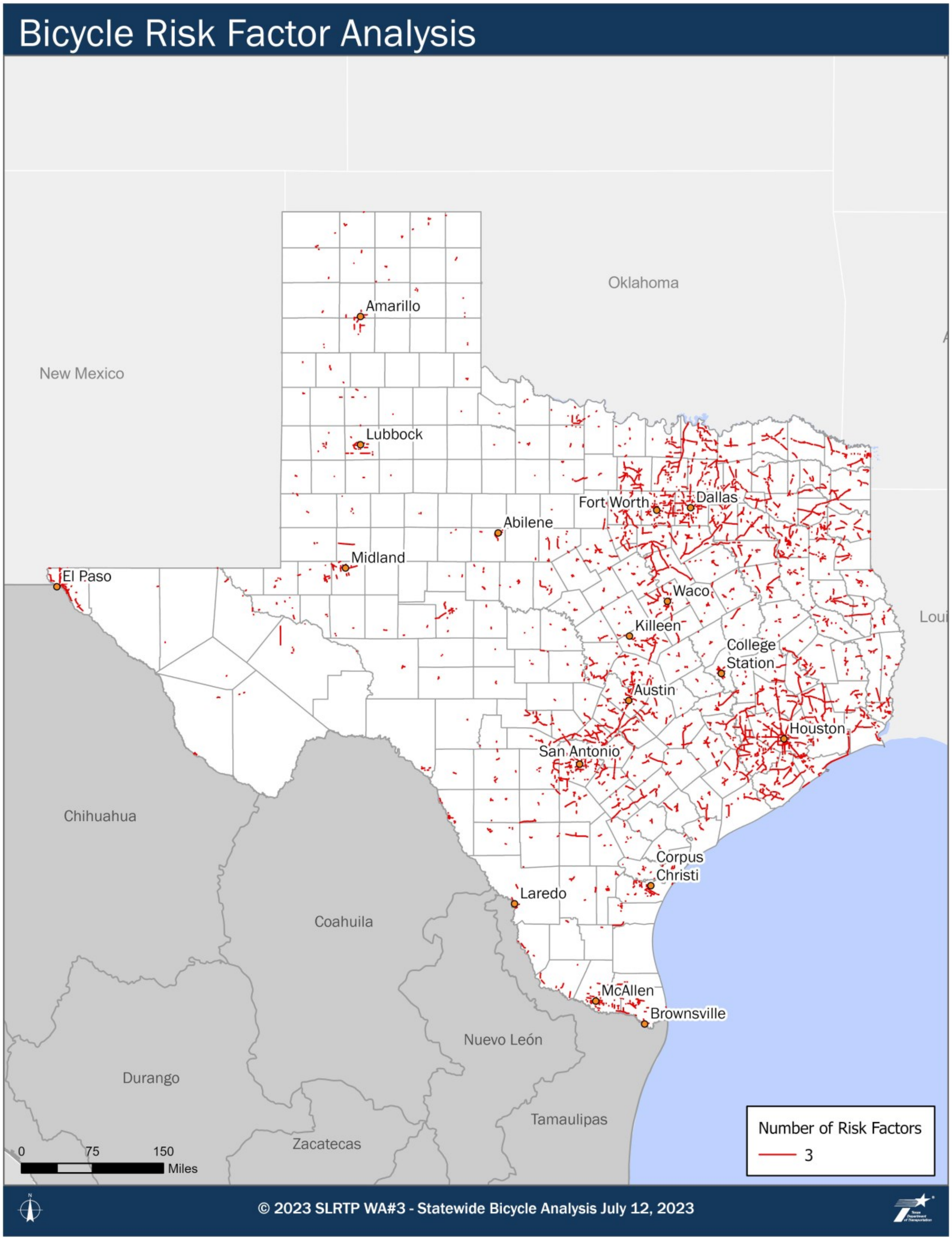
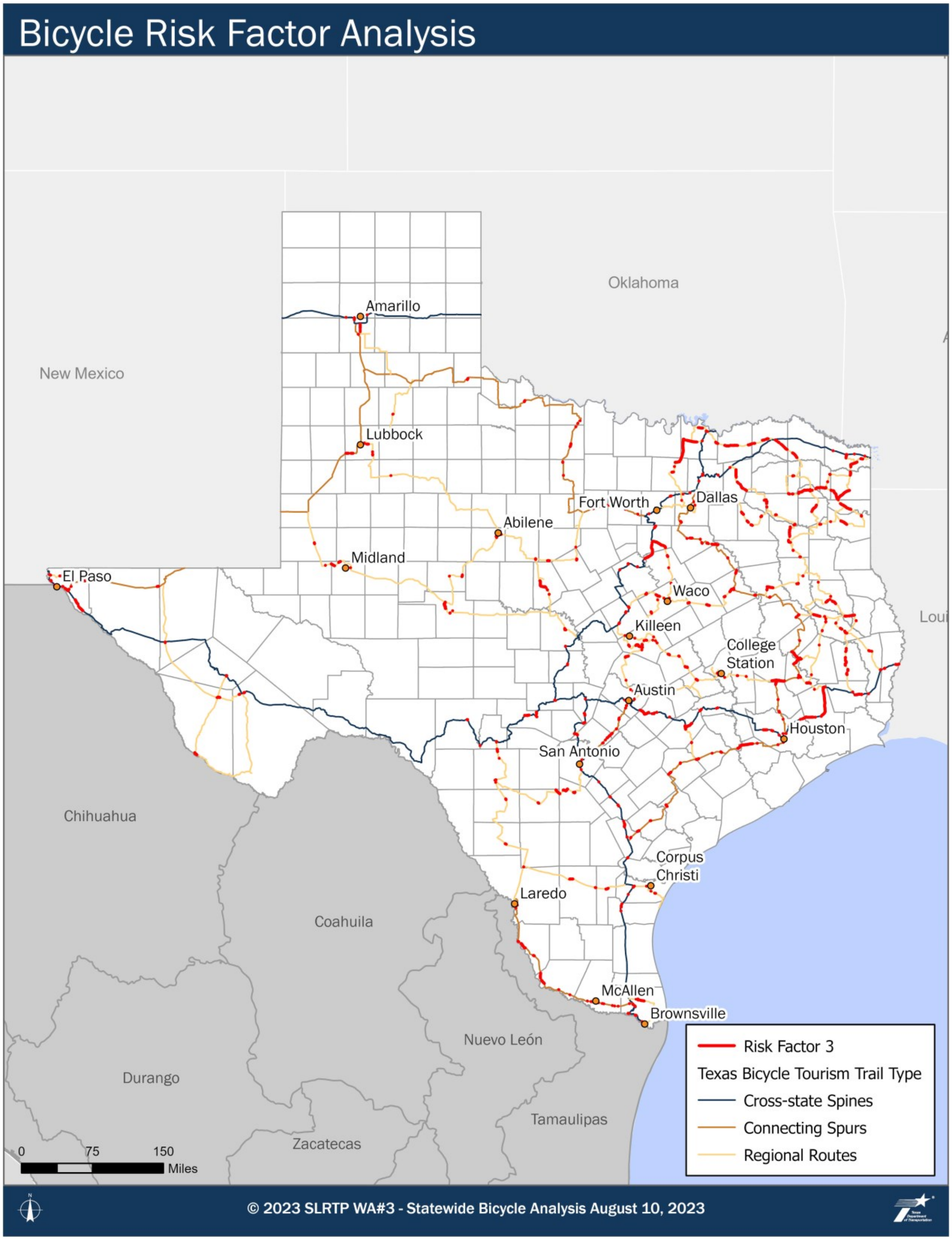
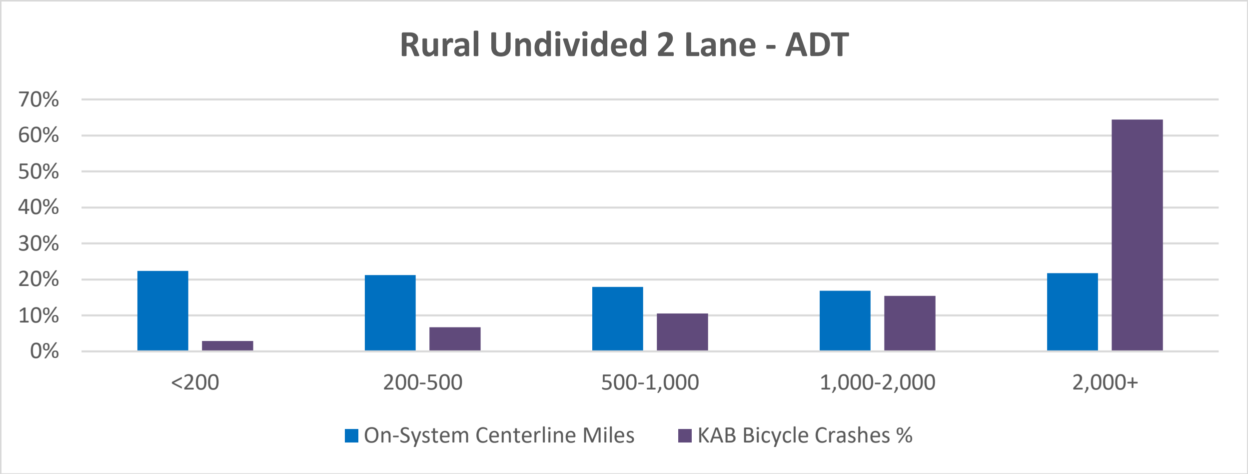


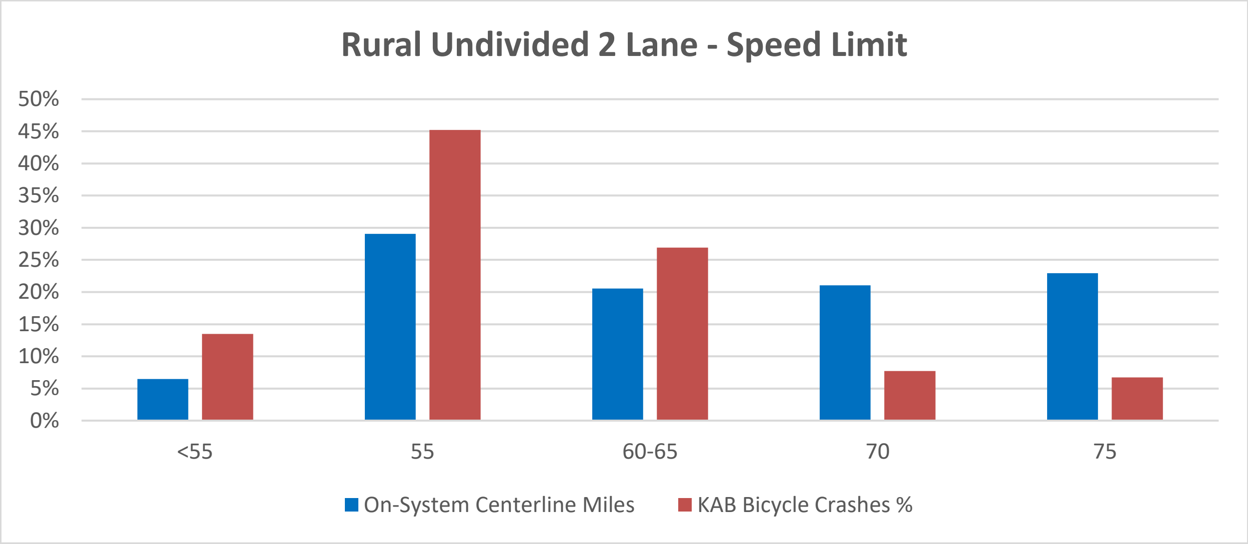
Figure 9 On-System Segments with Three Risk Factors Overlaid with BTTS

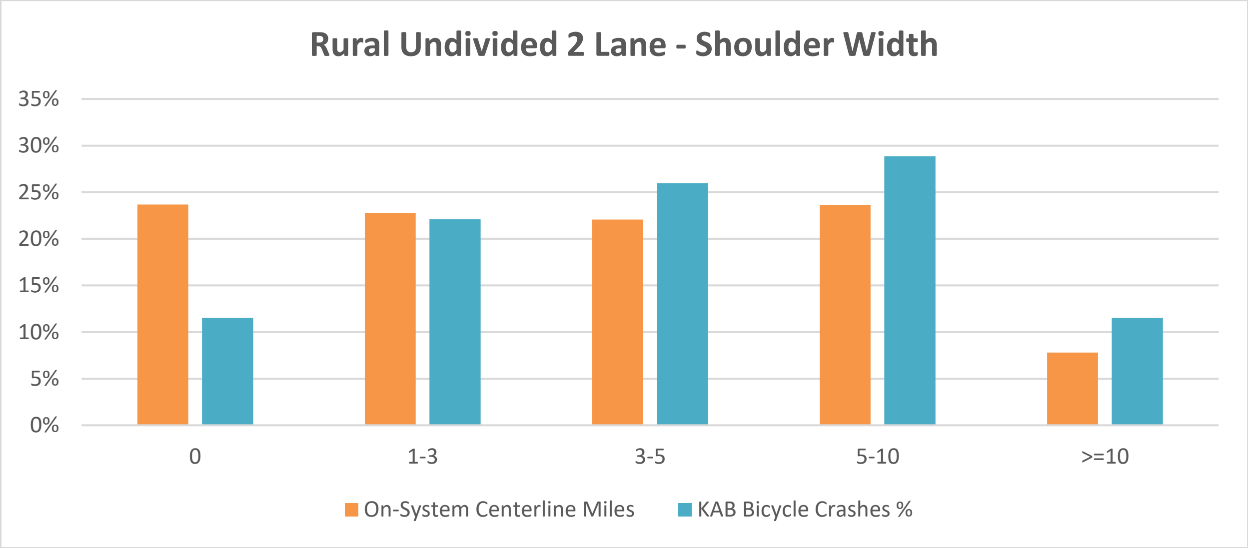


Attachment A – Overrepresentation Analysis by Facility Type

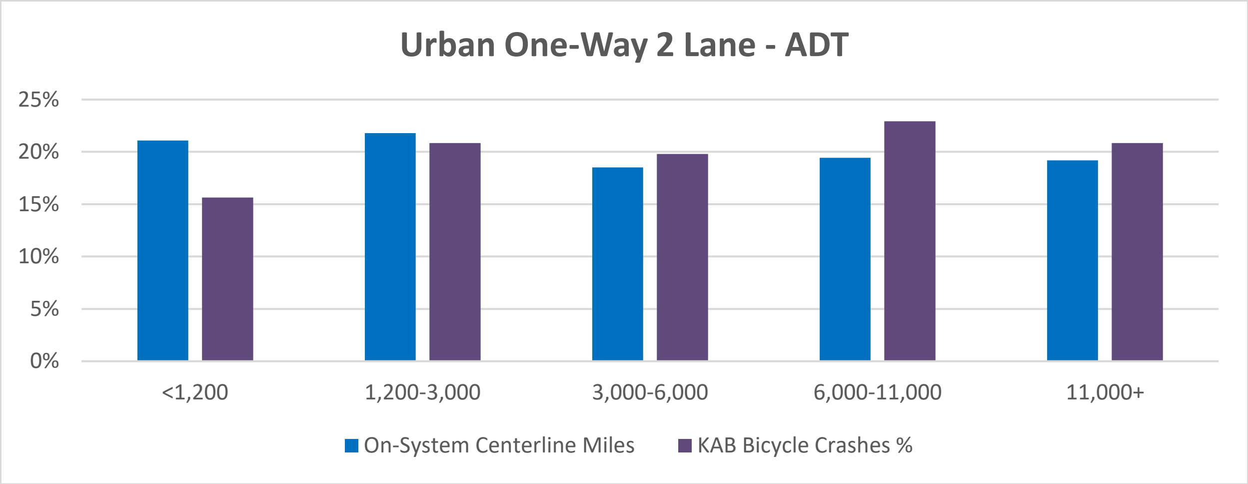
Rural Undivided 2L

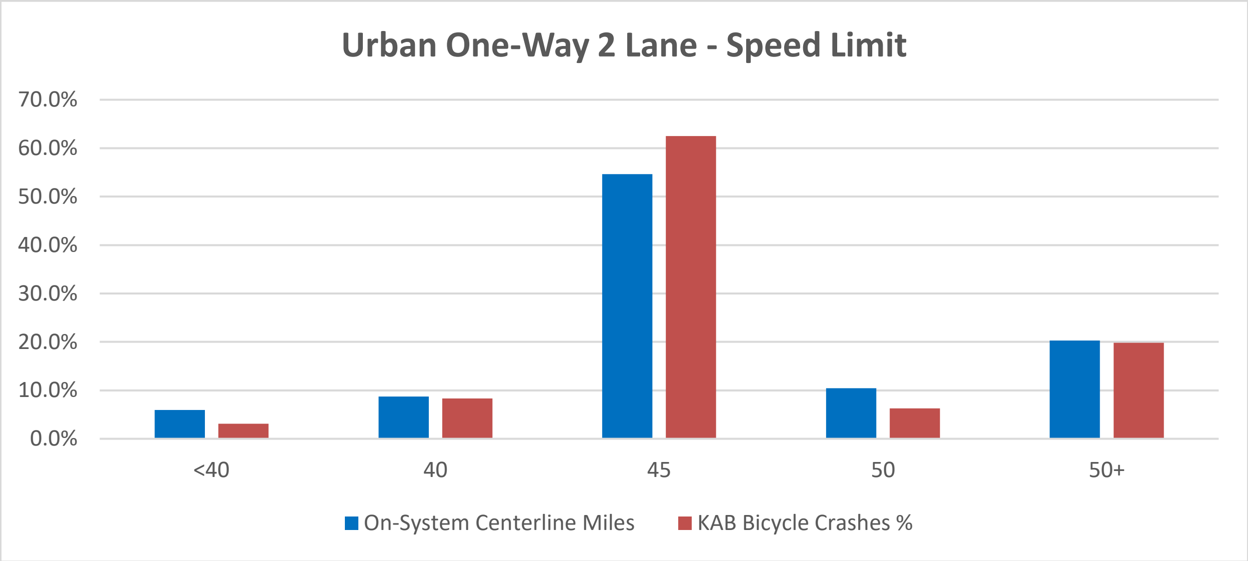


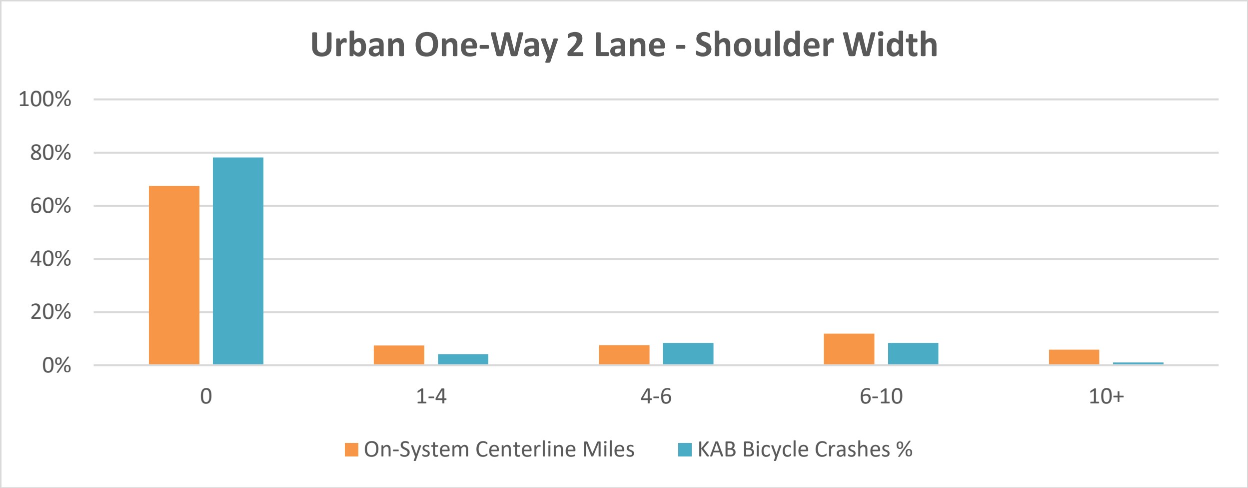




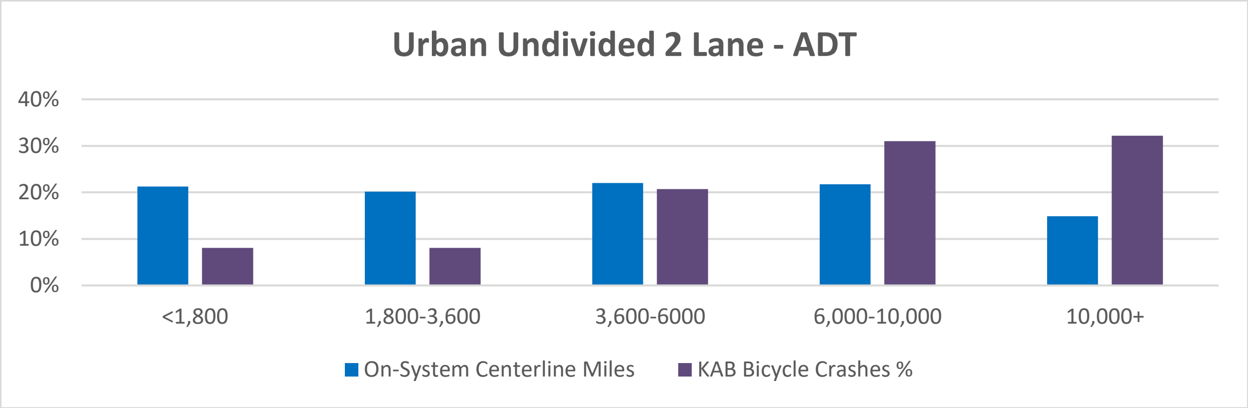
Urban One-Way 2L (all frontage roads)

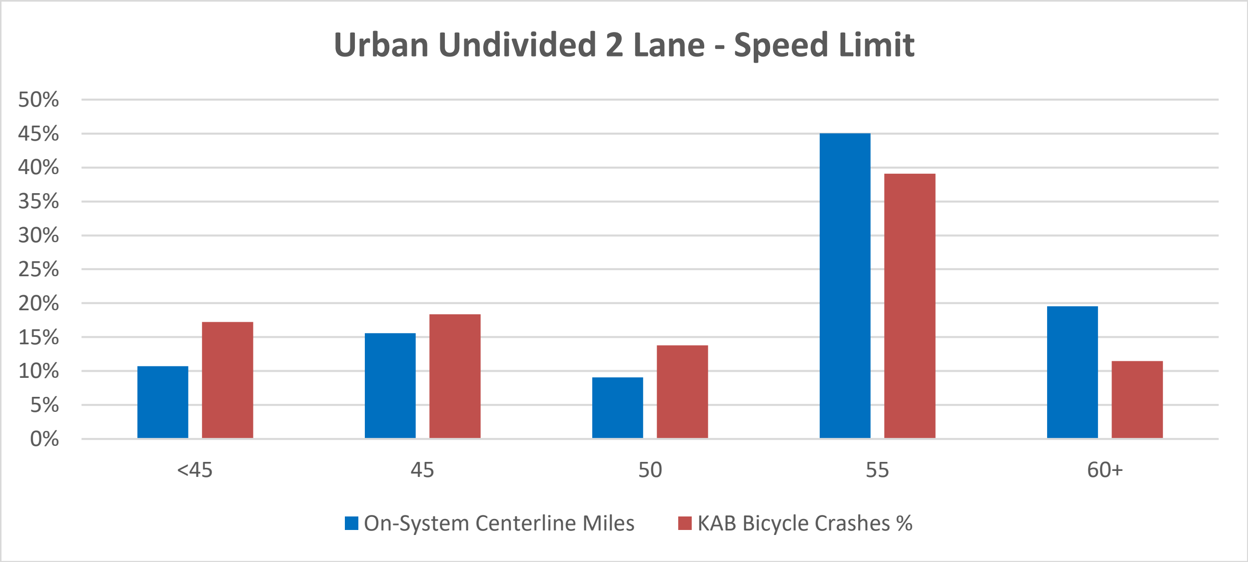


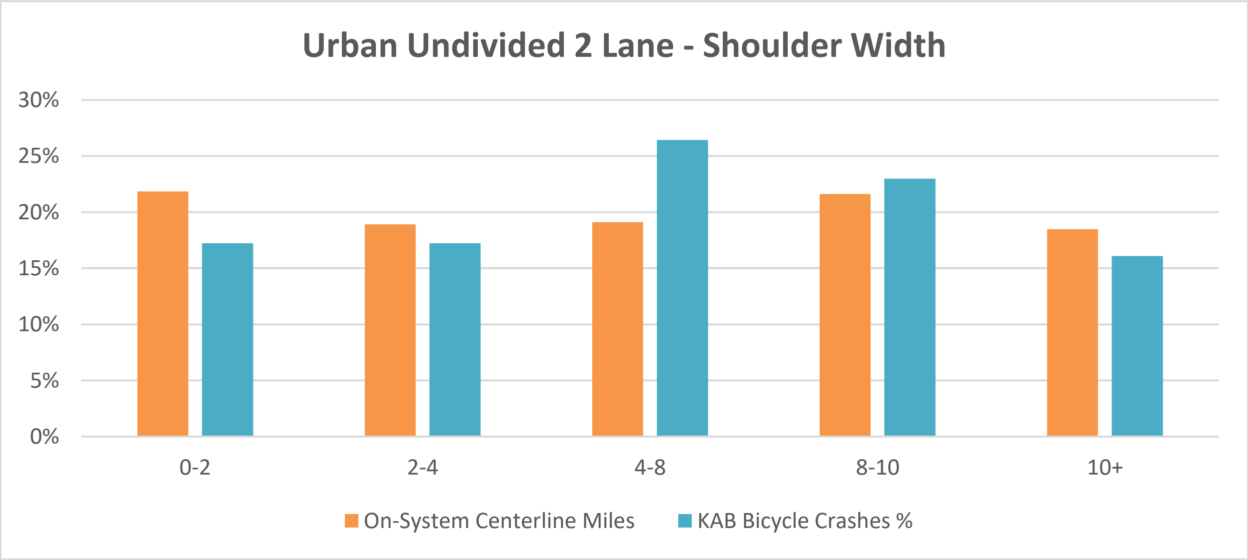




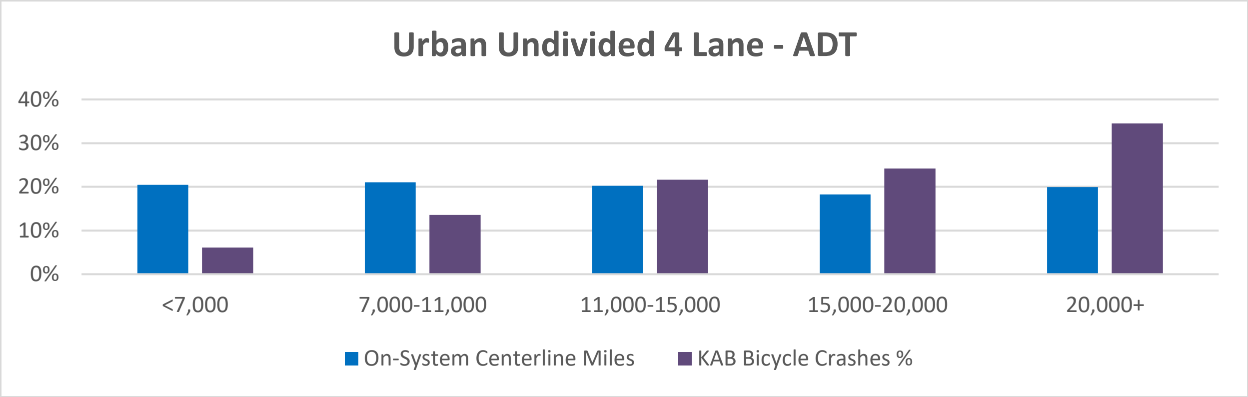
Urban Undivided 2L

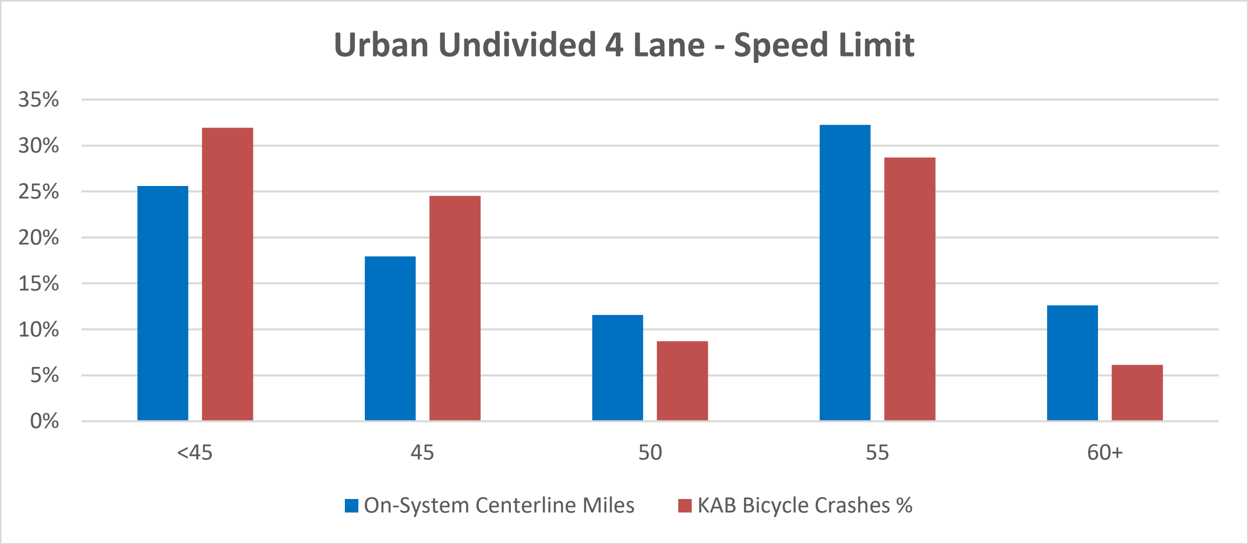


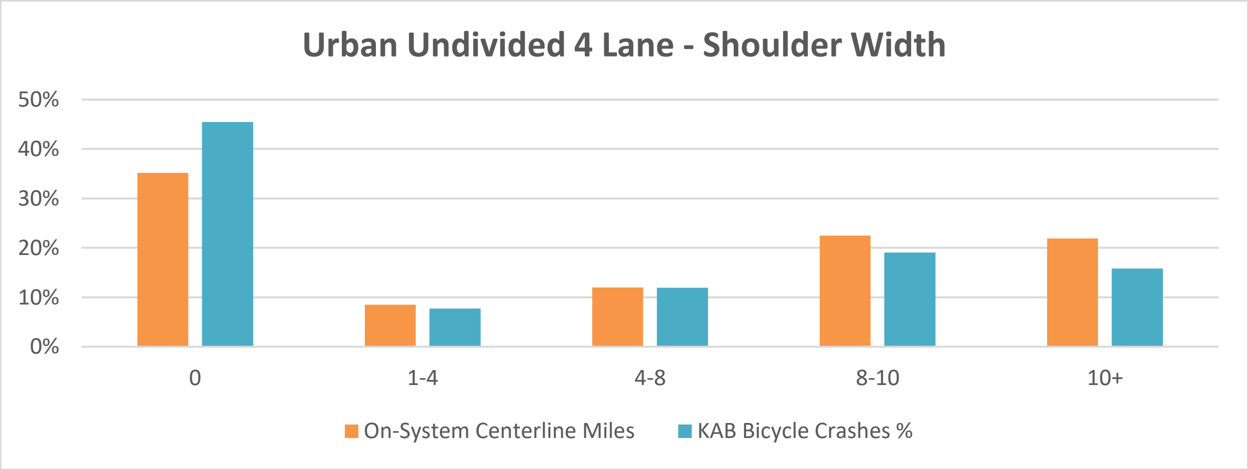




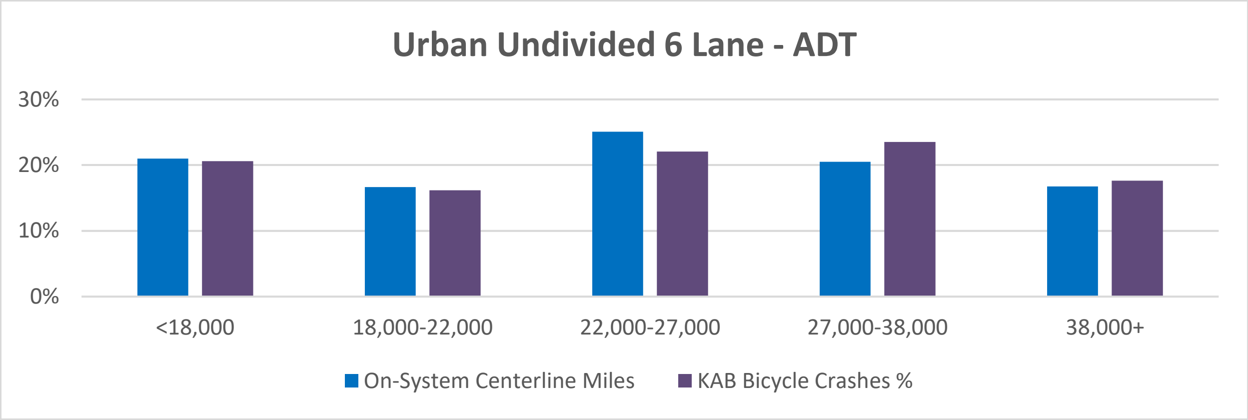
Urban Undivided 4L

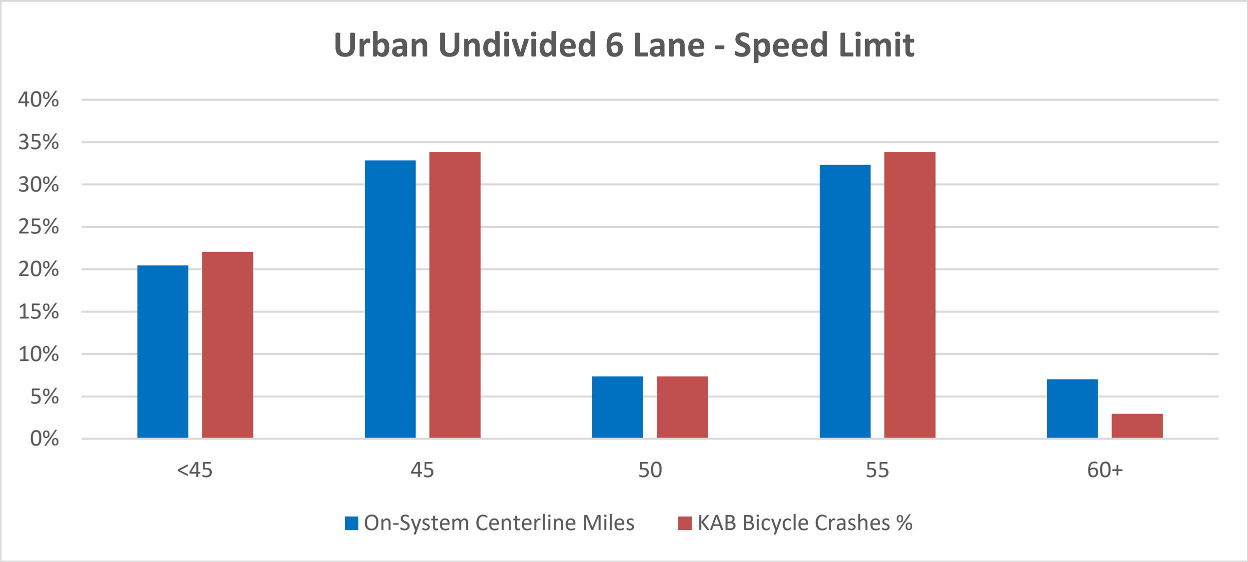


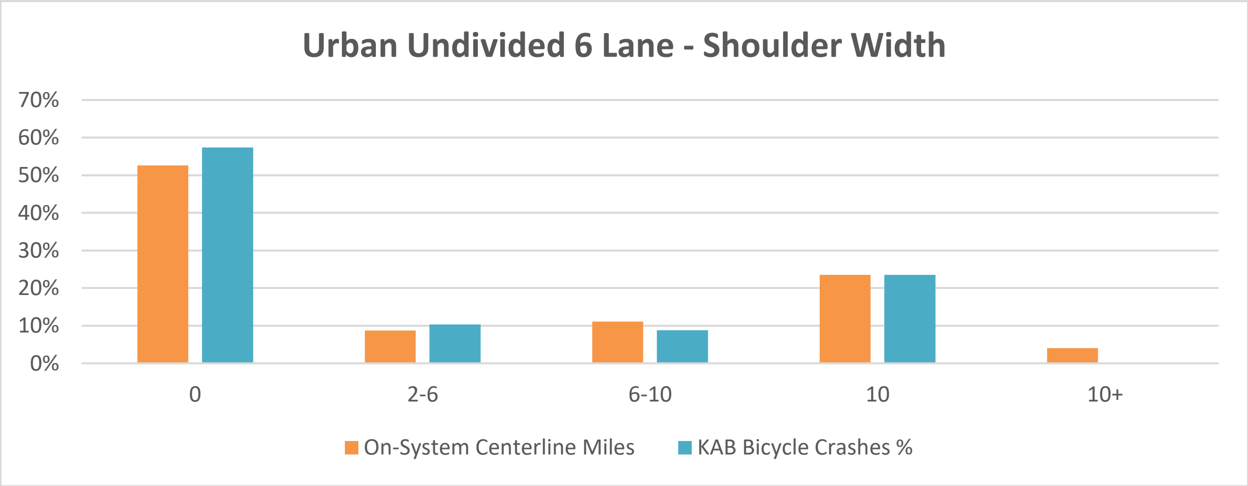




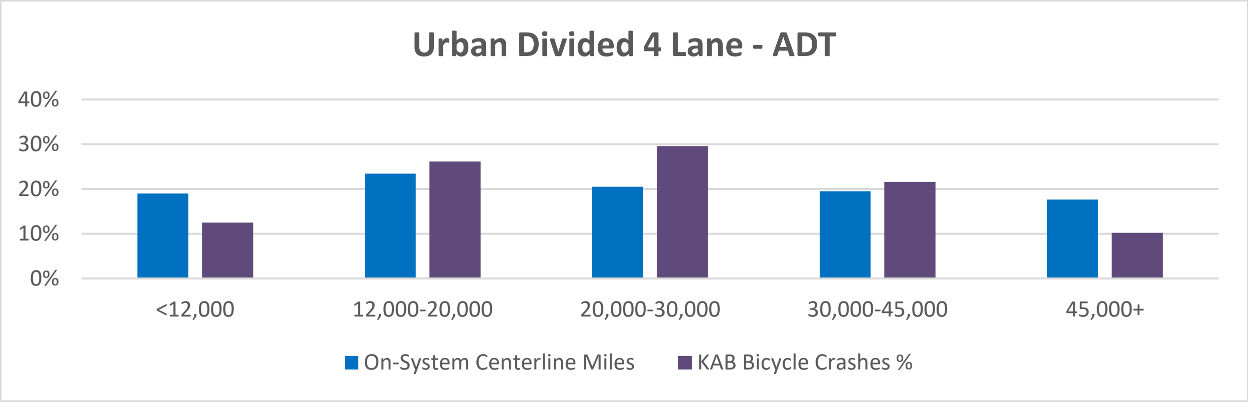
Urban Undivided 6L

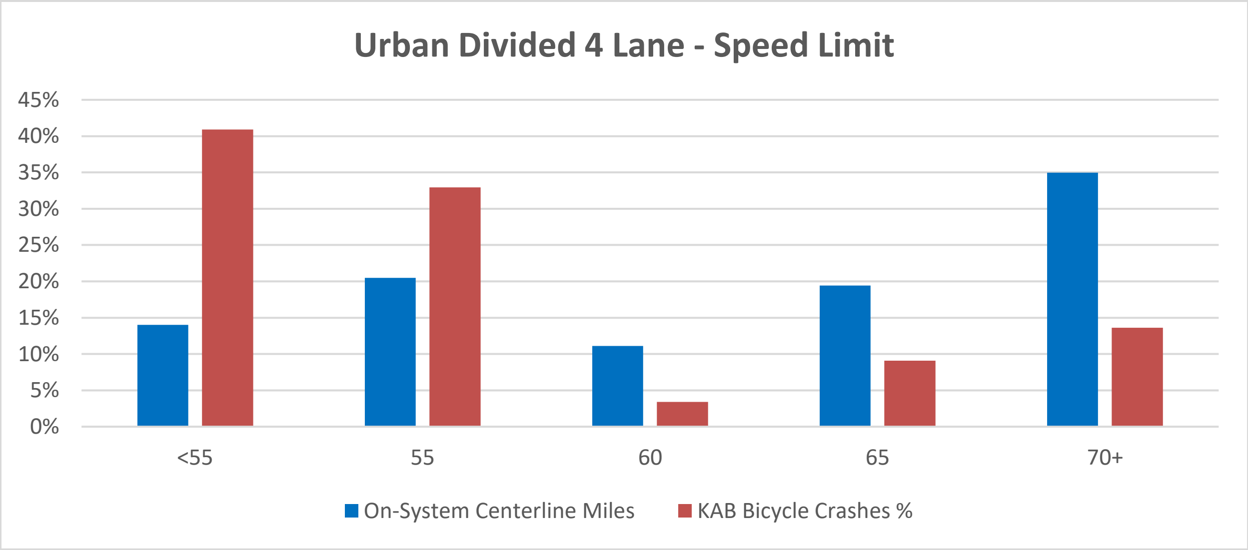


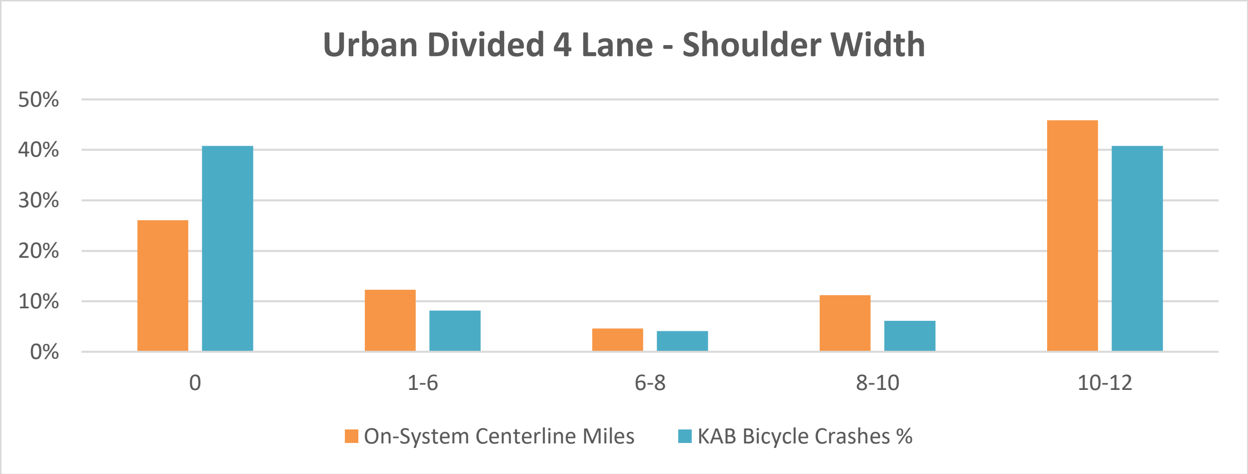




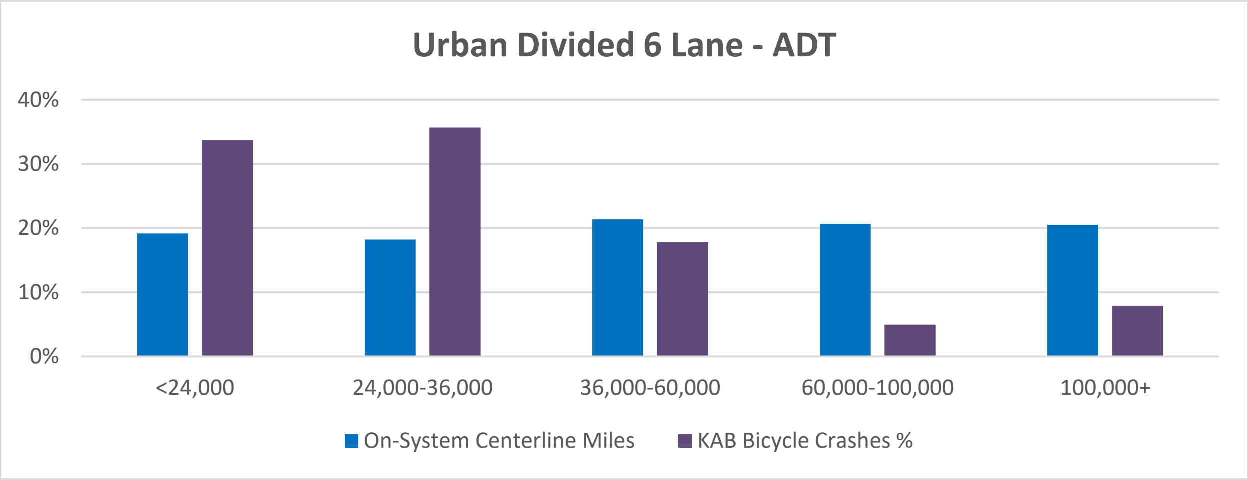
Urban Divided 4L

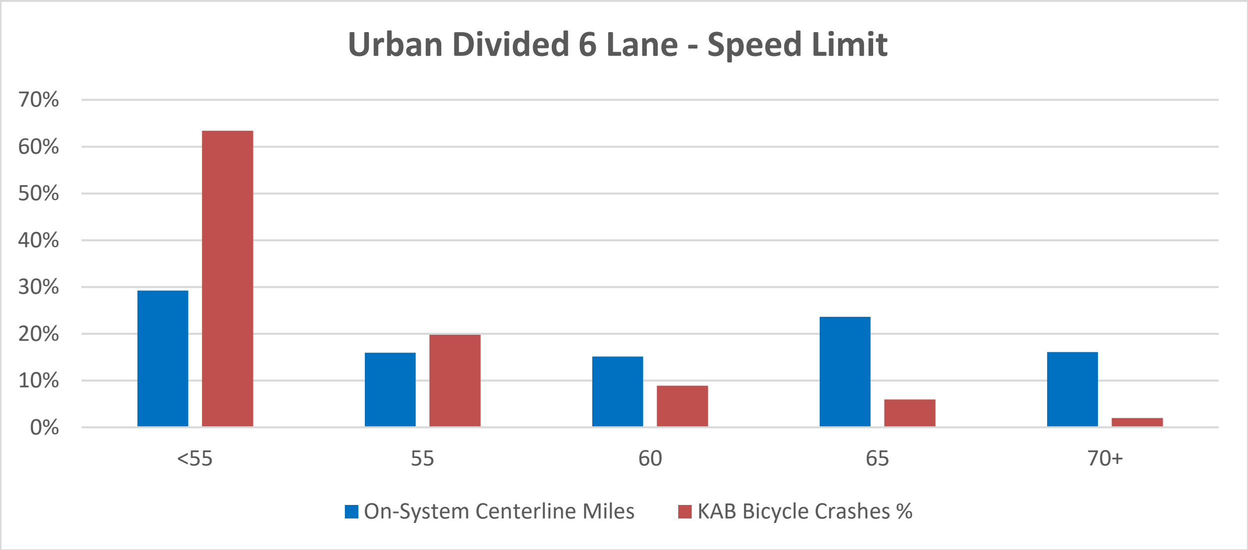


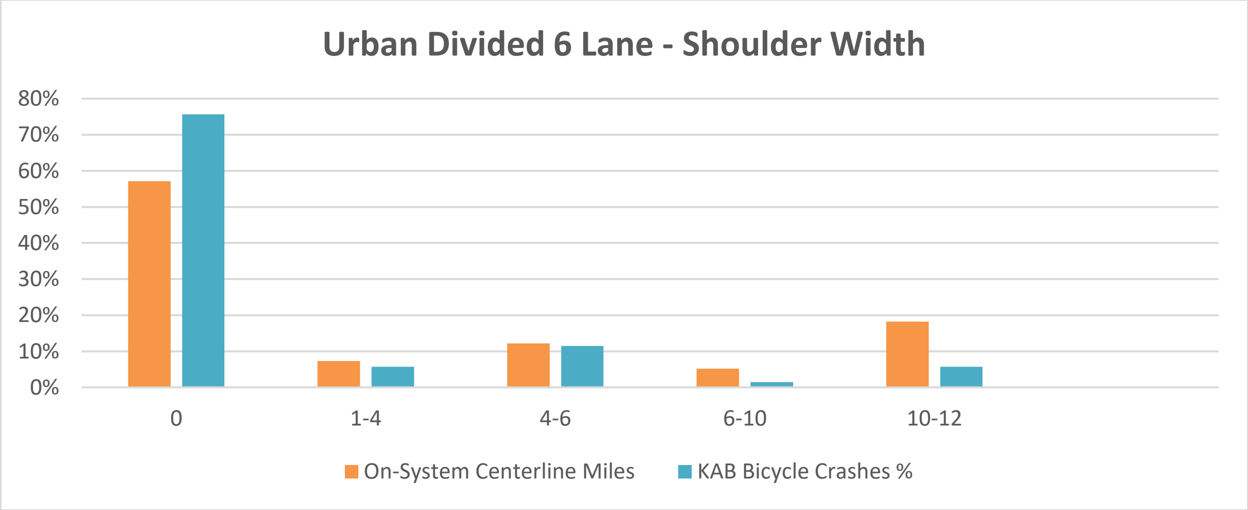




Urban Divided 6L







Texas Department of Transportation

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November 14, 2023

Mr. Edward Ofori
Acting Division Administrator
Federal Highway Administration – Texas Division
300 E. 8th Street, Rm 826
Austin, Texas 78701

Dear Mr. Ofori:

In accordance with requirements for the Vulnerable Road User (VRU) Safety Assessment (VRUSA) as described in 23 U.S.C. 148(l), as amended by the Infrastructure Investment and Jobs Act (IIJA) (Pub. L. 117-58, also known as the "Bipartisan Infrastructure Law" (BIL)), the 2022- 2027 Texas Strategic Highway Safety Plan (SHSP) is being updated to include a VRU Safety Assessment. This is being routed to you for your approval of the VRU Safety Assessment development process. The Texas Department of Transportation (TxDOT) led a process consistent with statute. The VRUSA update engaged a diverse set of stakeholders including State highway safety representation; metropolitan, city, and regional planning organizations.

With assistance from the Kimley-Horn and Associates, Inc. (KH), Jacobs Engineering, and AECOM, a collaborative and holistic approach was utilized to address the increasing trends of VRU fatalities and serious injuries. The VRUSA includes an analysis of vulnerable road user fatalities and serious injuries; consideration of demographics; identification of high-risk areas; report outs of consultation with MPOs and local governments; and a program of strategies to reduce safety risks to vulnerable road users in identified high-risk areas. The VRUSA utilized the Safe System Approach and Complete Streets Model where possible.

We have attached the VRUSA for your review and approval. If you have any questions, please reach out to Mr. Michael Chacon, Division Director, Traffic Safety Division.

Sincerely,

DocuSigned by:
0E1B35AE191749E...
Marc Williams, P.E.
Executive Director

Cc: Mr. Ed Burgos-Gomez, FHWA
Ms. Amelia Hayes, FHWA
Ms. Rubaiet Islam, FHWA