VISION ZERO
WEBB LAREDO

APPENDIX B
SAFETY ANALYSIS

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AADT	Annual Average Daily Traffic
ACS	American Community Survey
CMV	Commercial Motor Vehicle
CRIS	Crash Records Information System
DUI	Driving Under the Influence
FHWA	Federal Highway Administration
HIN	High Injury Network
KABCOU	Injury Severity Scale (Texas): **K:** Fatal injury **A:** Suspected incapacitating injury **B:** Non-incapacitated injury **C:** Possible injury **O:** Not injured **U:** Unknown
KSI	Killed or Serious Injury
KAB	Killed or Any Injury
LRS	Linear Referencing System
OSM	OpenStreetMap
TX	Texas
TxDOT	Texas Department of Transportation
VMT	Vehicle Miles Traveled
VRU	Vulnerable Road User includes Pedestrian, Bicyclists, or Motorcyclist

Introduction

As part of the Vision Zero Webb Laredo Safety Action Plan, an in-depth safety analysis was conducted. The analysis consists of three distinct sections, including a Descriptive Crash Analysis, High Injury Network (HIN), and a Systemic Safety Analysis. The descriptive crash analysis documents the prevalence and patterns of crashes that have taken place in the study area between 2018 and 2022. The analysis examines variables such as crash severity, environmental conditions, demographic data, contributing factors, and more. Following the descriptive crash analysis, a High Injury Network was developed to identify segments of roadway where crashes have occurred in the greatest concentrations and with the highest severities. Finally, a systemic safety analysis was conducted to identify roadway segments in Webb County-Laredo with the highest likelihood of experiencing future high-injury crashes due to specific attributes observed in previous crashes. The resulting network identified in the systemic safety analysis will help officials throughout Webb County prioritize and address roadway safety concerns with the greatest immediate impact.

Descriptive Crash Data Analysis

This section summarizes the results of the crash data analysis conducted as part of the Laredo Safety Action Plan development process. The focus of the Laredo Safety Action Plan is developing a holistic, well-defined strategy to prevent roadway fatalities and serious injuries within Webb County, Texas. To support the Webb County-City of Laredo Regional Mobility Authority in this effort, this descriptive crash analysis details the results of Webb County's reported crashes, including killed and serious injury (KSI), that occurred from 2018 to 2022. The descriptive analysis uses tables and charts to provide an overview of factors and contexts that contribute to reported crashes on the Webb County-City of Laredo road network.

Descriptive Crash Analysis Methodology and Data Sources

This section describes the steps taken to assemble the working datasets (see **Table 1**), as well as the analytical framework used to develop pivot table results for all reported crashes from 2018 through 2022. The section presents descriptive statistics of historical crashes stratified by various attributes, such as injury severity, environmental conditions, behaviors, harmful events, and road user characteristics.

Table 1: Data Sources[1]

Dataset	Source	Dataset(s)
Crash Data	CRIS	Crash, Unit, Person/Primary Person
Roads	TxDOT	Roadway Inventory
Functional Class	TxDOT	Roadway Inventory: functional classification
Lane Count	TxDOT	Roadway Inventory: number of through lanes
AADT	TxDOT	Roadway Inventory: AADT current
Speed	TxDOT City of Laredo OSM	Roadway Inventory: speed limit maximum Laredo Roads: speed OSM ways: max speed tag
Traffic Control	City of Laredo OSM	Laredo Roads: AB/BA traffic light, stop sign flags OSM nodes: highway tag
Age	ACS, 5-year estimates 2021	B01001: Sex by Age
Gender	ACS, 5-year estimates 2021	B01001: Sex by Age

[1] See Appendix A and B for more information regarding how crash data was prepared and consolidated.

Dataset	Source	Dataset(s)
Race and Ethnicity	ACS, 5-year estimates 2021	B03002: Hispanic or Latino Origin by Race
Parks	City of Laredo	Park locations
Schools	City of Laredo	School locations
Transit	El Metro El Aguila	Stops, routes

Summary of Key Findings

Year of crash data: 2018-2022

Total crashes: 43,826

Total fatal (K) crashes: 110

Total serious injury (A) crashes: 345

Crashes by Year: 2022 had the largest share of all KSI crashes across the five years.

Injury Severity: While the majority of crashes resulted in less severe injuries, 110 crashes (0.3% of all crashes) resulted in death and 345 crashes (0.8% of all crashes) resulted in serious injury in Webb County, compared to the City of Laredo in which 85 crashes (0.2% of all crashes) resulted in death and 305 crashes (0.7% of all crashes) resulted in serious injury. Most severe crashes, 77% of fatal and 88% of serious injury crashes, occurred in the City of Laredo. While the population of Webb County outside of Laredo only accounts for 4.5% of the total County population, 23% of fatal crashes and 12% of serious injury crashes occurred in this area. High-speed rural roadways likely contributed to this disproportionate share of KSI crashes.

Crashes by Mode:

- Pedestrians: Pedestrian crashes made up 1.2% of all crashes but 18.5% of KSI crashes
- Bicycles: Bicycle crashes made up 0.3% of all crashes but 2.2% of KSI crashes
- Motorcycles: Motorcycle crashes made up 0.7% of all crashes but 10.9% of KSI crashes
- Motor Vehicles: Motor vehicle crashes made up 97.7% of all crashes but only 68.4% of KSI crashes

CMV Involved Crashes: Compared to statewide average**,** a higher percentage of crashes in Webb County and the City of Laredo from 2018 to 2022 are CMV-involved. CMV-involved crashes are more likely to have a severe outcome than crashes not involving CMVs and this is particularly pronounced for those crashes involving VRUs.

On-System Crashes: More KSI crashes involving all modes, 54.3 %, occurred on-system while more KSI crashes involving vulnerable modes, 61.1%, occurred off-system.

Contributing Factors: The contributing factor that resulted in the most severe outcomes was crashes that occurred as a result of a vehicle speeding or driving at an unsafe speed (36.8% of KSI Crashes).

First Harmful Event: The first harmful events that resulted in the most severe outcomes were crashes with another moving motor vehicle (45.9%), crashes with a fixed object (22.9%), and crashes with pedestrians (16.9%).

Parties Involved: Young adults, aged 20 to 29, individuals who identify as male, and parties of Hispanic ethnicity were most likely to be involved in a KSI crash.

Behavior Emphasis Areas: The behaviors that contributed most to the KSI rate were seat belt usage, drug and alcohol impairment, and driving over the speed limit. Lane departure was also a significant behavioral factor, but most lane-departure related KSI crashes occurred in rural settings and usually did not involve VRUs.

Location Emphasis Areas: Severe crashes occurred most often at intersections. While segment crashes had a lower share of both overall crashes and KSI crashes, segment crashes had a slightly higher rate of resulting in a KSI outcome.

Roadway Characteristic Emphasis Areas (Segments): Both overall and VRU KSI crashes were over-represented in the following roadway types:

- AADT is over 5,000
- Road functional classification is interstate and other principal arterial
- The posted speed limit is 40 mph or higher
- The number of lanes is 3 or more

Roadway Characteristic Emphasis Areas (Intersections): Both overall and VRU crashes were over-represented at intersections where:

- All approaches' total AADT is between 20,000 and 200,000
- The highest functional classification of all approaches is major collector, minor arterial, and other principal arterial
- The highest posted speed limit of all approaches is 40 to 45 mph
- The total number of through-lanes of all approaches is 9 or more

Environmental Emphasis Areas:

- The most severe crashes involving all modes that occurred during the day (8 AM to 8 PM) most often took place during the work week, and severe early morning (6 AM to 8 AM), evening (8 PM to 12 AM), and late night (12 AM to 6 AM) crashes most often occurred over the weekend.
- The most severe crashes involving VRUs that occurred during the day most often took place during the first half of the work week (Monday through Wednesday). Large spikes in VRU KSI crashes occurred during the early morning on Monday, morning and afternoon on Tuesday, and evening on Friday.
- The most severe crashes involving commercial vehicles that occurred during the early morning and morning hours most often took place during the week, and severe evening crashes most often occurred over the weekend, with a significant spike on Sunday. Late night crashes, however, were more evenly distributed across the week, peaking on Thursday.
- Compared to all mode crashes, VRU crashes are overrepresented in Dusk and Dark (with or without light) conditions. More than half of KSI crashes, regardless of mode, occurred near transit stops, schools, and parks.

Crash Trends

The following sections summarize Webb County crash data from 2018 through 2022 to provide statistical trends, temporal patterns, actions leading up to a crash, and environmental characteristics.

Crashes by Year

Figure 1 shows the trend of total and KSI crashes by year within Webb County and the City of Laredo. Both the total and KSI crashes show a dip in the year 2020 which is most likely caused by the COVID pandemic. However, both of them bounce back and trend upward in 2021 and 2022 with their values in 2022 being the highest among the 5-year period. Most of the crashes in Webb County happened within the City of Laredo.

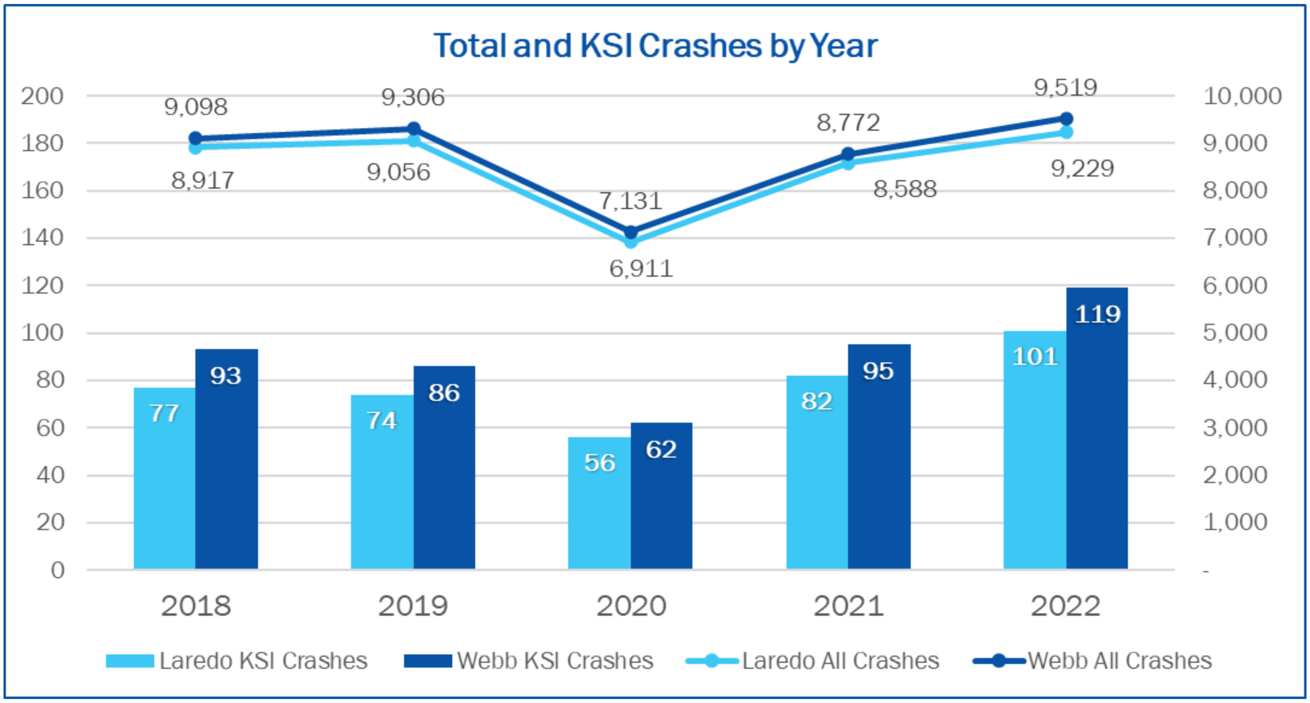


Figure 1: Total and KSI Crashes by Year, Webb County and City of Laredo

The percentage of KSI Crashes by year exhibited in **Figure 2** shows a similar trend with about 1% of total crashes within the County and the City being KSI crashes, which is lower than the statewide value. For all five years, the County-wide KSI rate is higher than that of the City of Laredo, indicating crashes outside the City are more likely to have severe outcomes.

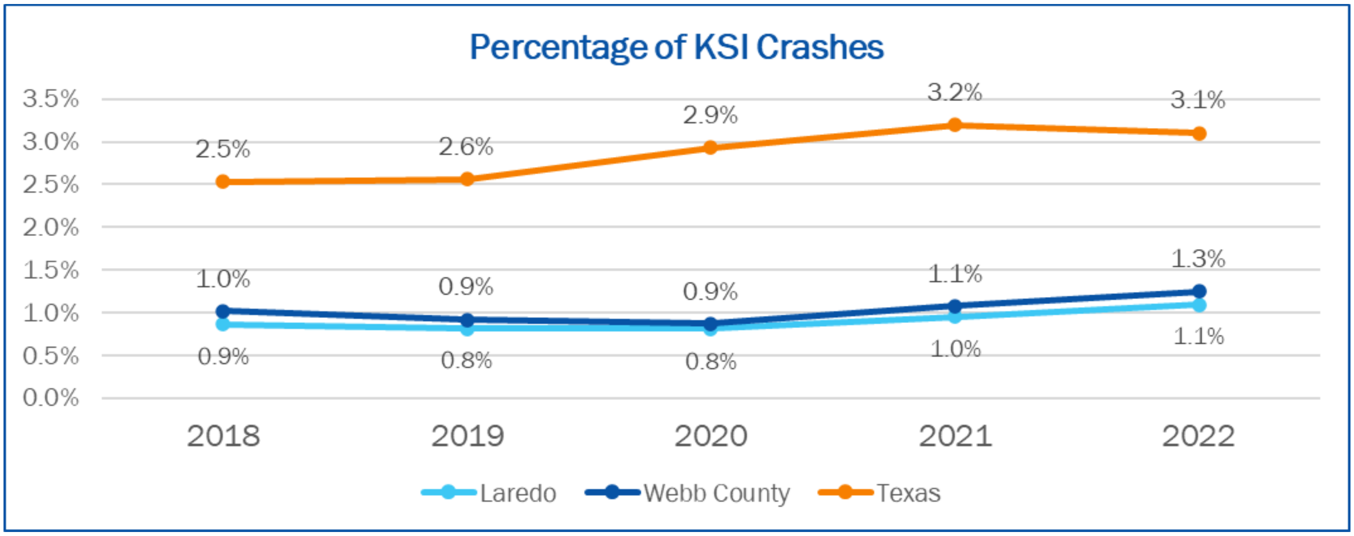


Figure 2: Total and KSI Crashes by Year, Webb County and City of Laredo

Given that the majority of Webb County crashes took place within the city of Laredo, the analysis in the following sections focuses on County-wide statistics unless otherwise noted.

Injury Severity

Table 2 summarizes crashes by injury severity based on the highest level of injury reported to be sustained in the crash. Overall, less severe crashes account for the largest share of crashes. Crashes that resulted in fatalities or injuries (KAB crashes) account for about 8.4% of all crashes within Webb County and 8.1% in the City of Laredo. More details about the location of these crashes and the elements that influenced them, including environmental factors and driver characteristics, will be described throughout this analysis.

Table 2: Crashes by Injury Severity

Injury Severity	Webb County		City of Laredo	
	# of Crashes	% of Crashes	# of Crashes	% of Crashes
Fatal injury (K)	110	0.3%	85	0.2%
Suspected incapacitating injury (A)	345	0.8%	305	0.7%
Non-incapacitating injury (B)	3,199	7.3%	3,067	7.2%
Possible injury (C)	4,232	9.7%	4,125	9.7%
Not injured (O)	35,377	80.7%	34,577	81.0%
Unknown (U)	563	1.3%	542	1.3%
Total	**43,826**	**100.0%**	**42,701**	**100.0%**

Crashes by Mode

Table 3 summarizes crashes by transportation mode. Motor vehicle crashes accounted for 97.7% of total crashes, the highest share of all modes. Pedestrians followed, making up 1.2% of all crashes. Based on KSI data included in the table, it is evident that pedestrians and bicyclists are disproportionately affected by KSI crashes than motor vehicles. While bicycle and pedestrian crashes account for less than 2.0% of total crashes combined, they account for over 20.0% of all KSI crashes. This is detailed by mode in the following list:

- Pedestrians: Pedestrian crashes made up 1.2% of all crashes but 18.5% of KSI crashes
- Bicycles: Bicycle crashes made up 0.3% of all crashes but 2.2% of KSI crashes

- Motorcycles: Motorcycle crashes made up 0.7% of all crashes but 10.9% of KSI crashes
- Motor Vehicles: Motor vehicle crashes made up 97.7% of all crashes but only 68.4% of KSI crashes

While motor vehicle crashes accounted for the largest share of both overall crashes and KSI crashes, when pedestrians or bicyclists were involved in a crash, the risk of death or serious injury increased. Motorcycle crashes trended similarly with far higher rates of KSI crashes than motor vehicles. Overall, the percentage of crashes resulting in KSI is 1%. Motor vehicle crashes alone account for 0.7% and VRU (i.e., pedestrian, bicycle and motorcycle combined) crashes account for 14.4%.

Table 3: Crashes by Mode

Mode	Total # of Crashes	% Share of Crashes	# KSI Crashes	% KSI Crashes by Mode	% Crashes resulting in KSI
Bicycle	145	0.3%	10	2.2%	6.9%
Pedestrian	532	1.2%	84	18.5%	15.8%
Motorcycle	320	0.7%	50	10.9%	15.6%
Motor Vehicle	42,829	97.7%	311	68.4%	0.7%
VRU Total	**997**	**2.2%**	**144**	**31.6%**	**14.4%**
Overall Total	**43,826**	**100.0%**	**455**	**100.0%**	**1.0%**

Due to the large amount of truck traffic moving across the border, a significant proportion of the crashes within Webb County and the City of Laredo are commercial vehicle (CMV) related crashes. The average percentage of CMV-involved crashes among all crashes in the 5-year period between 2018 and 2022 in the Webb County is over 11% and about 10.5% in the City of Laredo, which are much higher than the statewide 6.8%, as shown in **Figure 3**. The statewide CMV crash percentage was stable across the five-year study period. While Laredo and Webb County saw similar trends between 2018 and 2021, the area experienced a significant increase of CMV-related crashes in 2022.

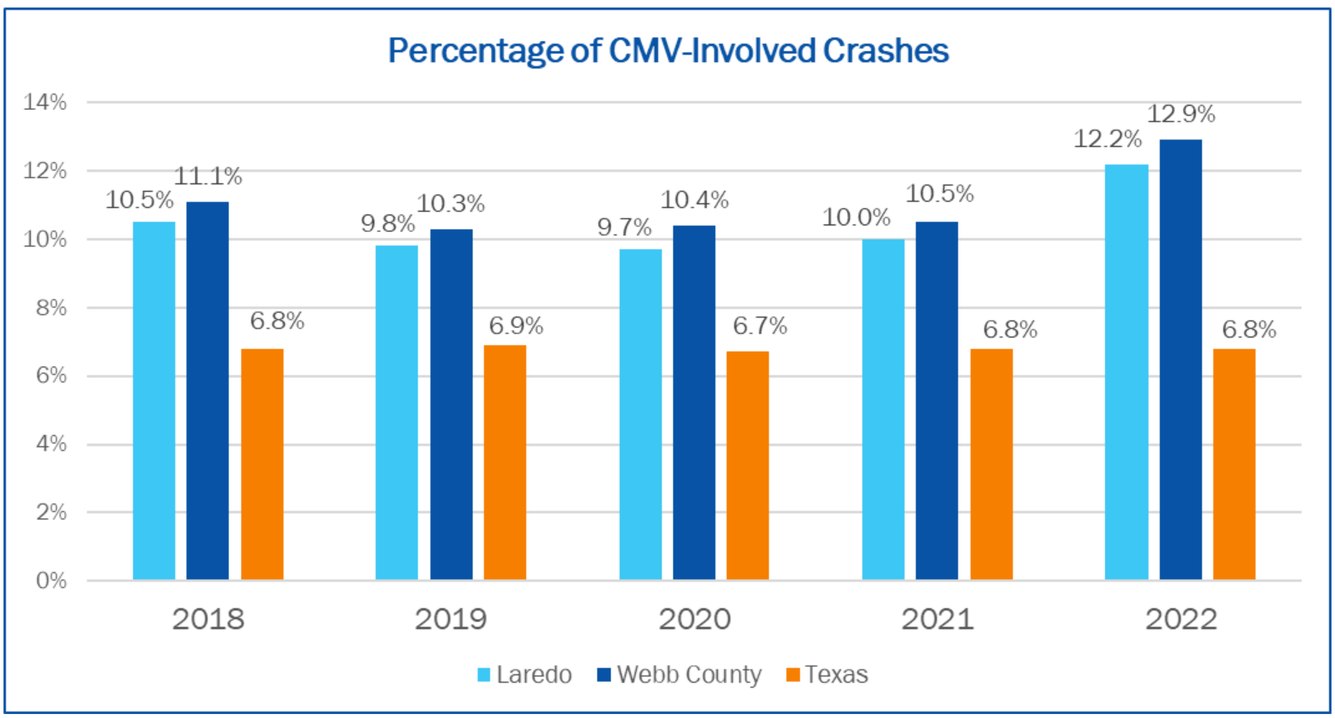


Figure 3: Percentage of CMV-involved Crashes, statewide, Webb County and the City of Laredo

When CMVs are involved in crashes in Webb County and the City of Laredo, alternative modes of transportation were also disproportionately affected. **Table 4** and **Table 5** display Webb County crashes that involved a CMV versus those that did not. CMV-involved crashes are more likely to have a severe outcome than crashes not involving CMVs. This is particularly pronounced for those crashes involving VRUs, due to the high force CMVs can impose on VRUs. As shown in **Table 5**, while few VRUs were involved in commercial vehicle crashes, when they were, the likelihood of it being a KSI crash was far higher. 50% of all bicycle and motorcycle crashes, and 32% of all pedestrian crashes that involved a commercial vehicle resulted in a serious injury or death.

Table 4: Non-CMV Involved Crashes by Mode and Severity

Mode	Total # of Crashes	% Share of Crashes	# KSI Crashes	% KSI Crashes by Mode	% Crashes Resulting in KSI
Bicycle	143	0.4%	9	2.4%	6.3%
Pedestrian	507	1.3%	76	19.9%	14.9%
Motorcycle	314	0.8%	47	12.3%	14.9%
Motor Vehicle	38,002	97.5%	250	65.5%	0.7%
Total	**38,966**	**100.0%**	**382**	**100.0%**	**1.0%**

Table 5: CMV-Involved Crashes by Mode and Severity

Mode	Total # of Crashes	% Share of Crashes	# KSI Crashes	% KSI Crashes by Mode	% Crashes Resulting in KSI
Bicycle	2	< 0.1%	1	1.4%	50.0%
Pedestrian	25	0.5%	8	10.9%	32.0%
Motorcycle	6	0.1%	3	4.1%	50.0%
Motor Vehicle	4,827	99.3%	61	83.6%	1.3%
Total	**4,860**	**100.0%**	**73**	**100.0%**	**1.5%**

On-System Crashes

According to the *Laredo District Strategic Highway Safety Plan*, the district maintains and operates 5,626 on-system roadways.[2] Less than half, 35.2%, of all crashes occurred on-system (**Table 6**). However, on-system crashes accounted for a much higher share, 54.3%, of all KSI crashes, indicating deadlier outcomes when using on-system roads likely due to higher functional classes and speed limits typically found on on-system roadways. **Figure 4** shows on-system and off-system crash impacts on vulnerable road users compared to all mode users.

[2] Laredo District Strategic Highway Safety Plan, Texas Department of Transportation, 2021

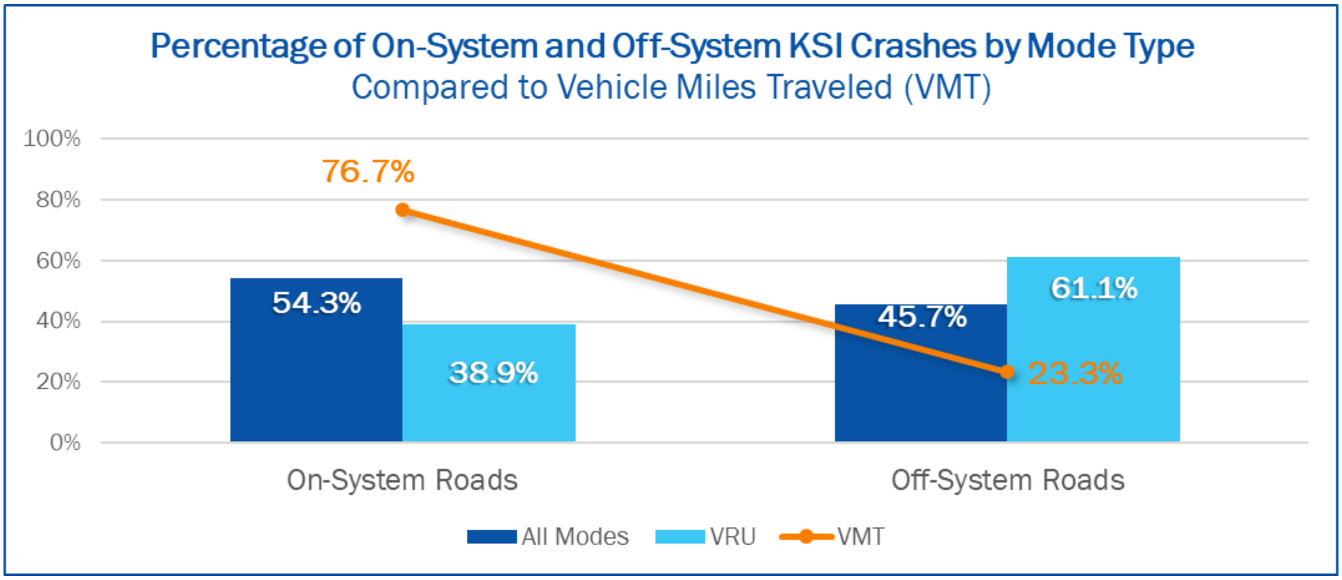


Figure 4: Percentage of All Mode and VRU KSI Crashes by On-System and Off-System Roads

Total crashes and KSI crashes are not over-represented on on-system roads, with slightly over 35% of all crashes and 54% of KSI crashes having happened on on-system roads which carry over 76% of the County's daily VMT[3] during 2018 to 2022. However, crashes that happened on on-system roads are two times more likely to cause fatal or serious injuries, as shown in **Table 6**.

Table 6: All Modes Crashes by On- and Off-System Roads

On- & Off-System Roads	Total # of Crashes	% Share of Crashes	# KSI Crashes	% of KSI Crashes	% Crashes Resulting in KSI	Total VMT (miles)	% Share of VMT
On-System	15,427	35.2%	247	54.3%	1.6%	6,418,082	76.7%
Off-System	28,399	64.8%	208	45.7%	0.7%	1,944,907	23.3%
Total	**43,826**	**100.0%**	**455**	**100.0%**	**1.0%**	**8,362,989**	**100%**

Compared to all modes crashes, a smaller percentage of VRU crashes took place on on-system roads, likely due to the limited accessibility for pedestrians and cyclists on these roadways. However, similar to all modes crashes, on-system crashes involving a VRU were more likely to have a severe outcome compared to crashes on off-system roads (**Table 7**).

Table 7: VRU Crashes by On- and Off-System Roads

On- & Off-System Roads	Total # of Crashes	% Share of Crashes	# KSI Crashes	% of KSI Crashes	% Crashes Resulting in KSI	Total VMT (miles)	% Share of VMT
On-System	303	30.4%	56	38.9%	18.5%	6,418,082	76.7%
Off-System	694	69.6%	88	61.1%	12.7%	1,944,907	23.3%
Total	**997**	**100.0%**	**144**	**100.0%**	**14.4%**	**8,362,989**	**100%**

[3] VMT is calculated by multiplying the most recent AADT data available from the TxDOT Roadway Inventory dataset with roadway centerline miles. The AADT year in TxDOT Roadway Inventory data varies, ranging from 2013 to 2022.

Crash Causation

Collision Manner

The most severe crashes that occurred in Webb County from 2018 to 2022 typically occurred as the result of the action of one motor vehicle (**Figure 5**).

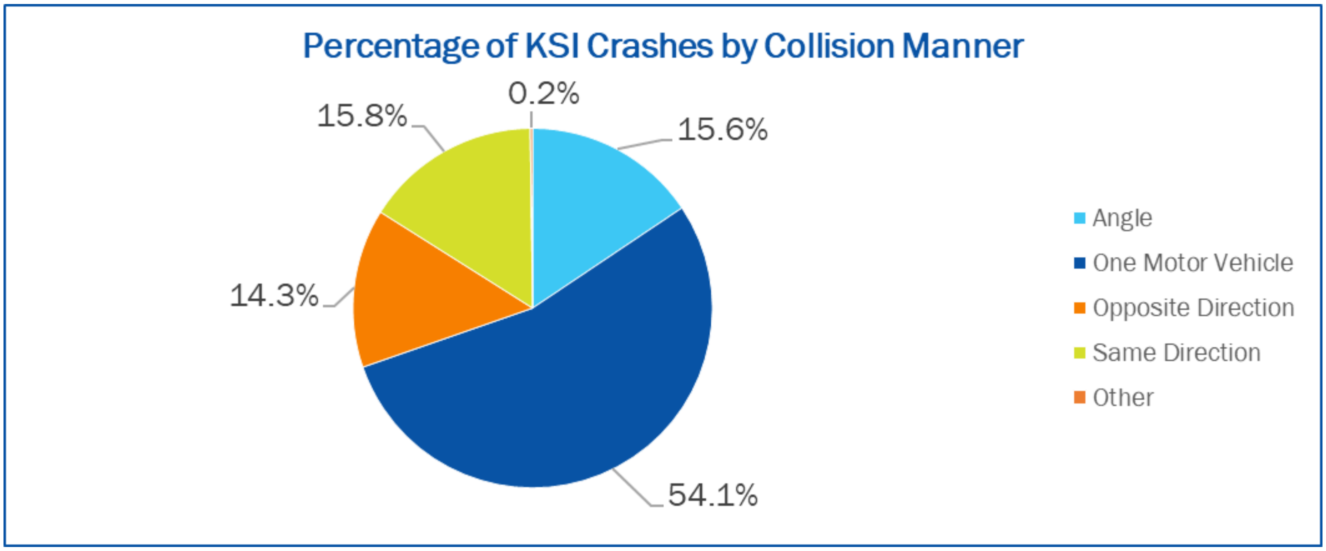


Figure 5: Percentage of KSI Crashes by Collision Manner

Table 8 includes more details on manner of collision and illustrates that the highest share of KSI crashes, 47.5%, were crashes that involved one motor vehicle travelling straight. However, when “one motor vehicle” crashes occurred, there was a relatively small likelihood they would result in a fatality or serious injury. Crashes in which two cars collided while going straight and travelling in opposite directions had a disproportionately high risk, 7.6%, of resulting in a KSI outcome. Opposite direction crashes in which one road user made a right turn and one was stopped also shows a surprisingly high likelihood of being severe (20%). However, this is more likely due to the small sample size of this collision type (only one crash of this manner was recorded over the five years).

Table 8: All Modes KSI Crashes by Collision Manner

Collision Manner	# of KSI Crashes	% of KSI Crashes	% of Crashes that Resulted in KSI
Angle			
Both Going Straight	58	12.8%	1.1%
One Straight-One Left Turn	9	1.9%	0.7%
One Straight-One Right Turn	4	0.8%	0.6%
One Motor Vehicle			
Backing	8	1.8%	0.3%
Going Straight	216	47.5%	2.8%
Turning Left	6	1.3%	0.8%
Turning Right	14	3.1%	1.9%
Other	2	0.4%	0.2%
Opposite Direction			
Both Going Straight	32	7.0%	7.6%
One Right Turn-One Stopped	1	0.2%	20.0%
One Straight-One Backing	1	0.2%	0.2%
One Straight-One Left Turn	31	6.8%	1.9%

Same Direction			
Both Going Straight-Rear End	30	6.6%	0.5%
Both Going Straight-Sideswipe	18	3.9%	0.5%
One Straight-One Left Turn	4	0.9%	0.5%
One Straight-One Stopped	20	4.4%	0.3%
Other			
Other	1	0.22%	0.5%
Total	**455**	**100.0%**	**1.0%**

Contributing Factors

While a specific movement by one or multiple road users may result in a crash, there are a multitude of extraneous factors that could contribute to a crash occurring once movement occurs. In Webb County, the factors that most often contributed to severe crashes (shown in Table 9) were when a driver was speeding or driving at an unsafe speed (36.8%) and when a vehicle failed to yield or disregarded sign or signal directing them to stop or yield (14.4%). These factors, however, did not contribute to the factors that had the highest risk of a crash resulting in a KSI outcome. Crashes were most likely to be severe, 20.7%, when a pedestrian failed to yield, which could indicate a lack of convenient or safe walking paths and crossing locations. Crashes where a vehicle drove in the wrong direction or on the wrong side of the road (7.7%) and crashes where the road user reported impaired roadway visibility (7.3%) were also more often severe.

Table 9: KSI Crashes by Contributing Factors

Contributing Factor	# of KSI Crashes	% of KSI Crashes	% of Crashes that Resulted in KSI
Backed Without Safety	3	0.8%	0.1%
Disregard of Signage, Markings, or Signals	25	6.3%	1.3%
Driver Ill, Fatigued, or Asleep	7	1.8%	3.9%
Driver Distracted or Inattentive	15	3.8%	1.4%
Vehicle Drove the Wrong Way or on the Wrong Side of Road	13	3.3%	**7.7%**
Vehicle Failed to Yield	57	**14.4%**	1.1%
Pedestrian Failed to Yield	17	4.3%	**20.7%**
Faulty Evasive Action	9	2.3%	3.2%
Fleeing or Evading Police	7	1.8%	5.4%
Followed Too Closely	1	0.3%	0.1%
Impaired by Drugs, Alcohol, or Medication	10	2.5%	5.5%
Impaired Visibility	5	1.3%	**7.3%**
Oversized Vehicle/Load or Load Not Secured	2	0.5%	1.2%
Related to Parked or Stopped Vehicle	2	0.50%	0.9%
Speeding or Driving at an Unsafe Speed	146	**36.8%**	1.0%
Related to Lane Departure, Merging, or Passing Vehicle	27	6.8%	0.7%
Improper Turn or Start	9	2.3%	0.5%
Other	42	10.6%	2.4%
Total	**397**	**100.0%**	**1.1%**

First Harmful Event

The first harmful event, which differs from collision type or manner, describes the first event during a crash that results in any level of injury or damage.

There may be multiple harmful events that occur during a single reported crash. As shown in **Figure 6**, crashes in which the first harmful event was a road user colliding with a fixed object (22.9%), a road user colliding with a motor vehicle in motion (45.9%), or a road user colliding with a pedestrian (16.9%) had the most severe outcomes.

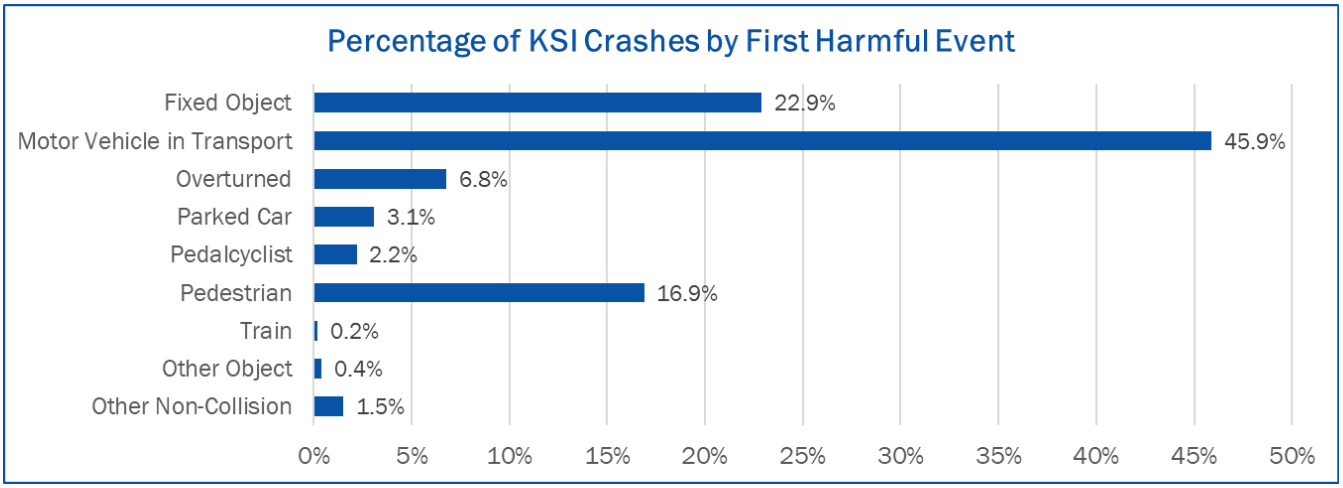


Figure 6: Percentage of KSI Crashes by the First Harmful Event

However, these types of events, except for collisions with a pedestrian, were overall less likely to result in a fatality or serious injury (see **Table 10**). Crashes where a road user collided with a pedestrian were most likely to be KSI crashes out of any other harmful event (16.2%), followed by colliding with a train (12.5%) and overturning a vehicle (10.3%). First harmful event crash trends in Webb County further showcase the disproportionate impact of severe crashes on vulnerable road users and the increased risk vulnerable road users face of being killed or seriously injured during the events of a crash compared to other mode users.

Table 10: All Modes KSI Crashes by First Harmful Event

First Harmful Event	# of KSI Crashes	% of KSI Crashes	% of Crashes that Resulted in KSI
Fixed Object	104	22.9%	2.5%
Motor Vehicle in Transport	209	45.9%	0.7%
Overturned	31	6.8%	10.3%
Parked Car	14	3.1%	0.2%
Pedalcyclist	10	2.2%	6.9%
Pedestrian	77	16.9%	16.2%
Train	1	0.2%	12.5%
Other Object	2	0.4%	0.7%
Other Non-Collision	7	1.5%	6.1%
Total	455	100.0%	1.0%

Parties Involved

In addition to identifying the conditions under which crashes occurred and the specifics of crashes, it is also critical to understand who was most affected by unsafe roadway conditions in Webb County from 2018 to 2022. In the following section, the distribution of people involved in a crash is illustrated by age group, gender, race and ethnicity. These comparisons are based on the number of parties, not the number of crashes, therefore the totals at the bottom of each table are different than the totals in tables that are based on number of crashes. Any given crash may injure multiple parties, at different levels of severity. Note that any recorded crash that left demographic information blank was omitted from this analysis.

Parties by Age, Gender, and Race/Ethnicity

In general, young adult travelers were involved in a larger share of total crashes, with road users aged 20-29 accounting for 24.4% of people involved in crashes (**Figure 7**). When compared to the percentage of the total population that accounts for this age group (15.1% of the population), it appears that people aged 20 to 29 are overrepresented in crashes.

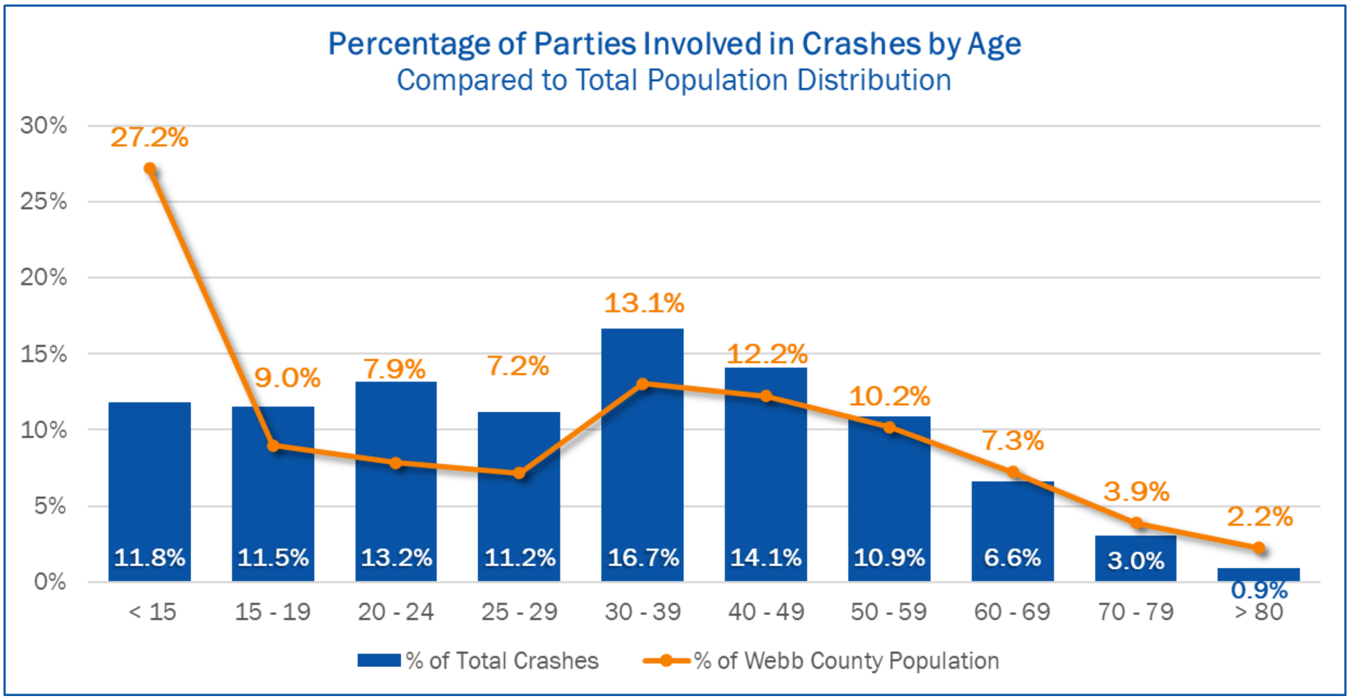


Figure 7: Percentage of Parties Involved in Crashes by Age (Compared to Total Population)

When it comes to gender, men were more likely to be involved in a crash than women, with over half, 55.3%, of total people involved in crashes where gender is known identifying as male (**Figure 8**). Parties who identify as male were disproportionately involved in crashes when compared to the total male population.

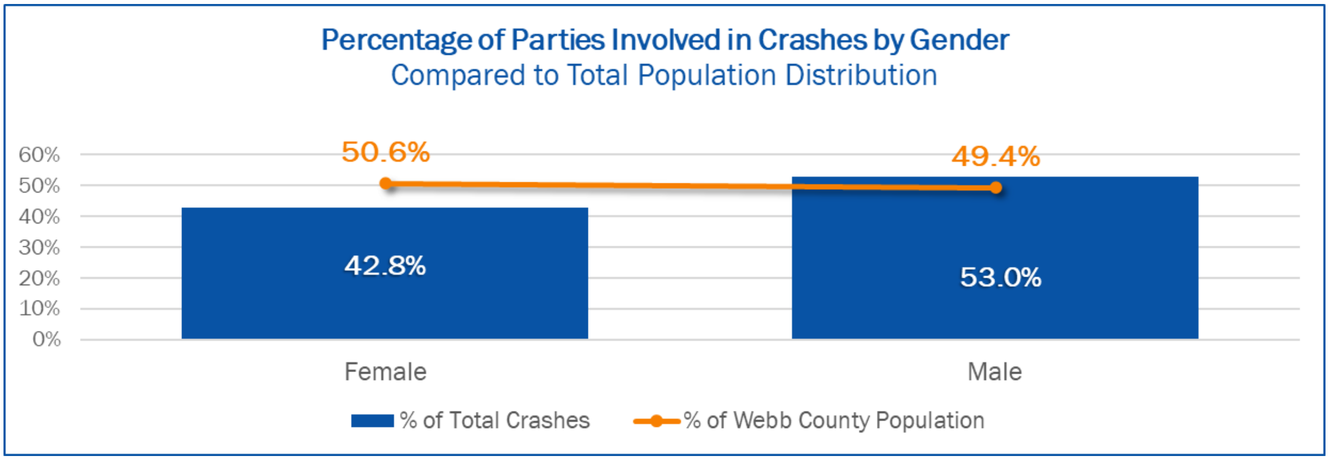


Figure 8: Percentage of Parties Involved in Crashes by Known Gender (Compared to Total Population)

Lastly, depicted in **Figure 9** and in more detail in **Table 11**, Hispanic persons were most likely to be involved in a crash (88.8% of all parties), followed by an unknown race (10.2% where race was not reported), and white persons (6.2% of all parties). While Hispanic individuals made up a large share of total crashes, this group was not overrepresented in crashes given that their percentage among overall population in the County is over 95%. White and black or African American parties were overrepresented in crashes compared to their share among all population in the County.

Table 11: Parties Involved in Crashes by Race and Ethnicity (Compared to Total Population), 2018-2022

Race and Ethnicity	# of Parties	% of Parties	Total Population	% of Population
White	4,615	6.2%	8,927	3.3%
Black Or African American	749	0.8%	891	0.3%
American Indian or Alaskan Native	45	0.1%	69	< 0.1%
Asian	274	0.3%	1303	0.5%
Hispanic	38,792	88.8%	254,894	95.5%
Unknown	4,425	10.2%	879	0.3%
Total	**43,311**	**100.00%**	**266,963**	**100.00%**

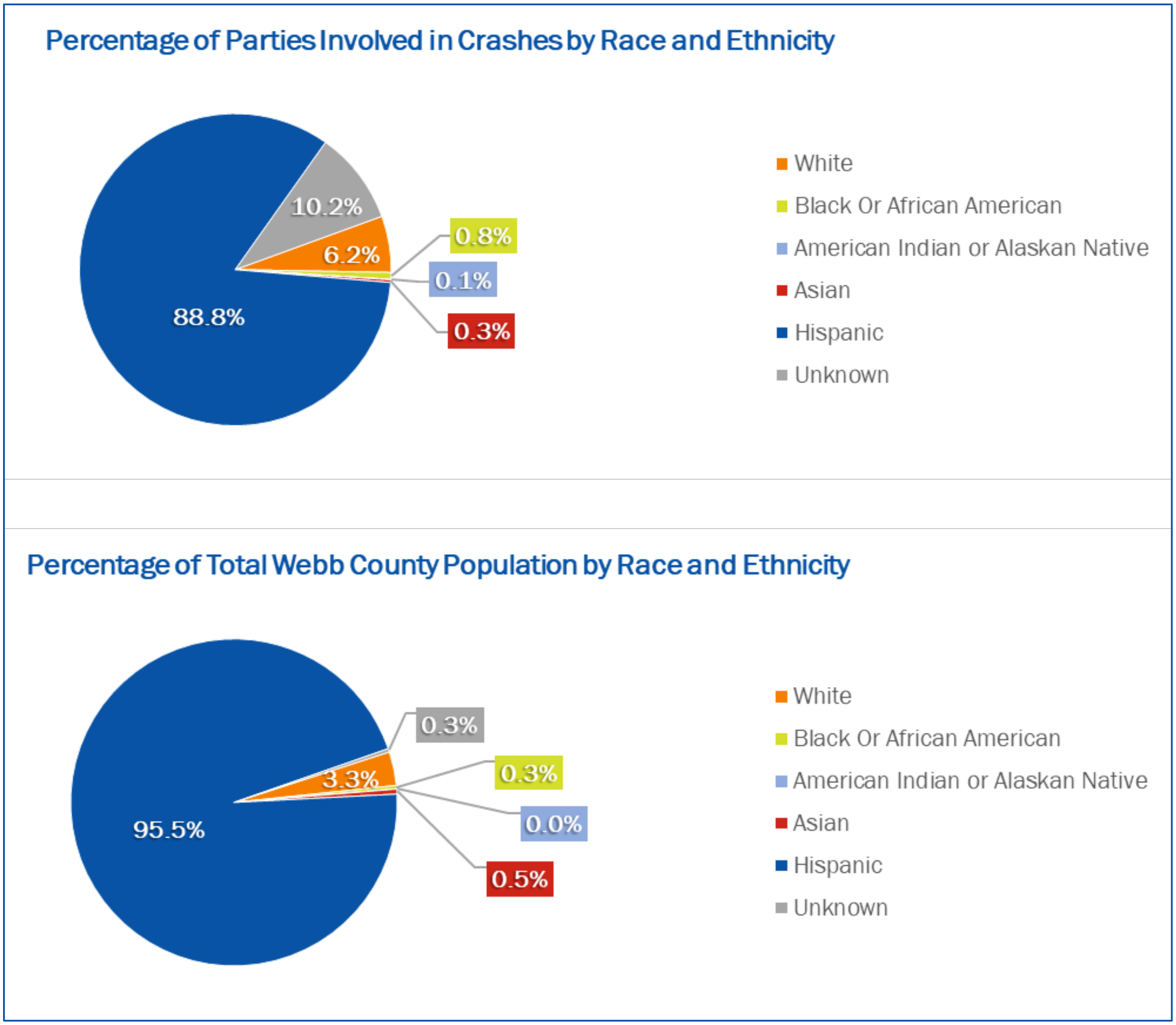


Figure 9: Percentage of Parties Involved in Crashes by Race and Ethnicity (Compared to Total Population)

Behaviors

Seat Belt Usage

When drivers use seat belts, crashes are less likely to result in serious outcomes for everyone. In Webb County, 23.1% of all modes KSI crashes and 2.1% VRU KSI crashes lacked seat-belt use.(**Figure 10**).

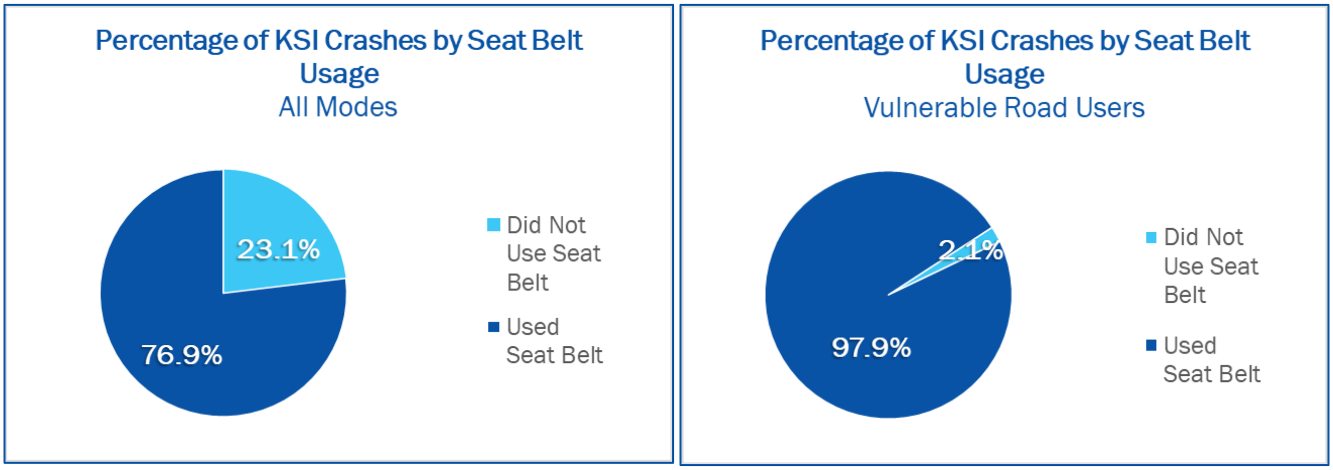


Figure 10: Percentage of KSI Crashes by Seat Belt Usage

Although most KSI crashes involved seat belt usage, crashes were more likely to be severe when seat belts were not used. As shown **Table 12**, in VRU-involved crashes, 20% resulted in KSI outcomes when seat belts were not used compared to 14.4% of KSI rate of all crashes. In all mode crashes, 14.9% resulted in KSI outcomes when seat belts were not used which is much higher than the 1% KSI rate of all crashes.

Table 12: Percent of Crashes that Resulted in KSI by Seat Belt Use

Mode	% of Lacking Seat Belt Usage Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	20.0%	14.4%
All modes	14.9%	1.0%

Unlicensed Drivers

Compared to the statewide average, a larger percentage of crashes in Webb County and the City of Laredo involved a driver without an active license in the five-year period between 2018 and 2022, and this is particularly pronounced for KSI crashes. 51.3% of City of Laredo KSI crashes involve at least one unlicensed driver, which is about twice compared to the statewide level **(Figure 11).**

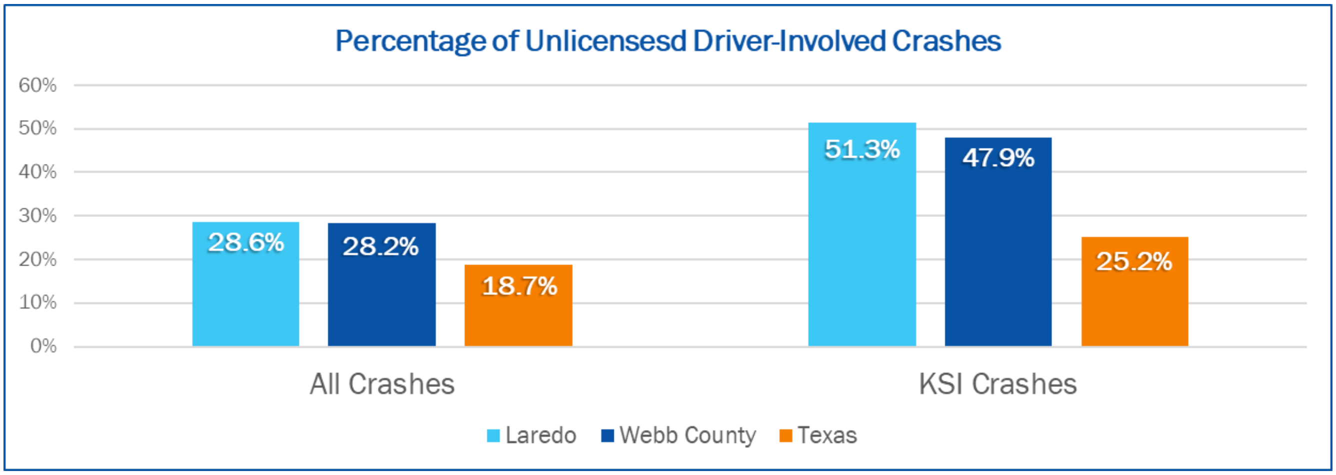


Figure 11: Percentage of Unlicensed Driver-Involved Crashes, Statewide, Webb County, and City of Laredo

Crashes in which at least one unlicensed driver was operating a vehicle made up nearly half of all KSI crashes, with 47.9% of all mode crashes and 45.8% of vulnerable road user-related crashes occurring when an unlicensed driver was involved **(Figure 12).**

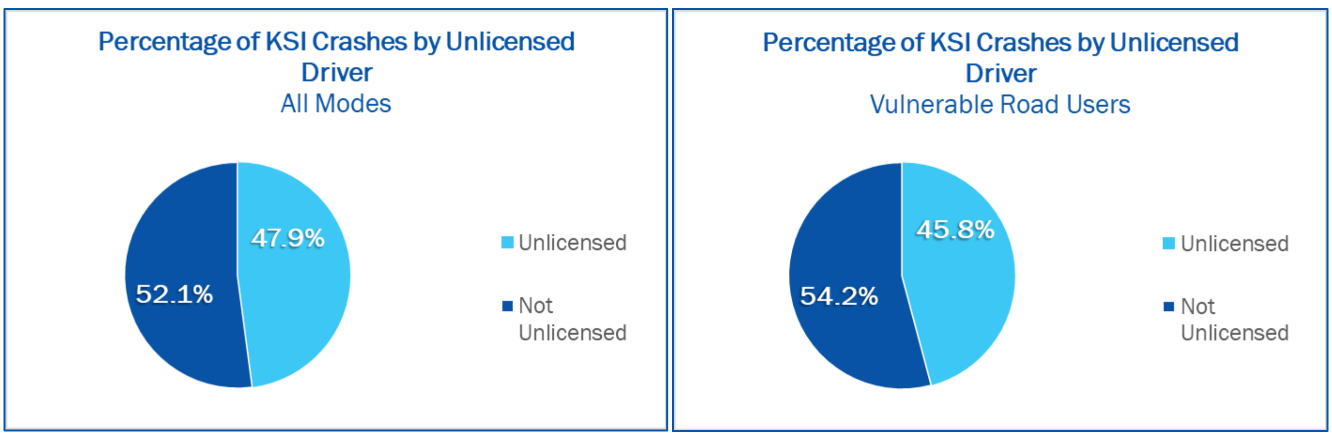


Figure 12: Percentage of KSI Crashes by Unlicensed Driver

Not only do almost half of KSI crashes involved an unlicensed driver, those crashes were also slightly more likely to be severe, likely due to the lack of formal training and testing that are required as part of the process for obtaining a license. As shown in **Table 13**, of all unlicensed driver involved VRU crashes, 16.1% resulted in KSI outcomes compared to 14.4% of KSI rate of all crashes. In all mode crashes, 1.8% resulted in KSI outcomes when an unlicensed driver was involved compared to 1% KSI rate of all crashes.

Table 13: Percent of Crashes that Resulted in KSI by Unlicensed Driver

Mode	% of Unlicensed Driver Involved Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	16.1%	14.4%
All modes	1.8%	1.0%

Fleeing Police

A small portion of all modes crashes and VRU crashes involve road user(s) being chased or pursued by law enforcement (**Figure 13**).

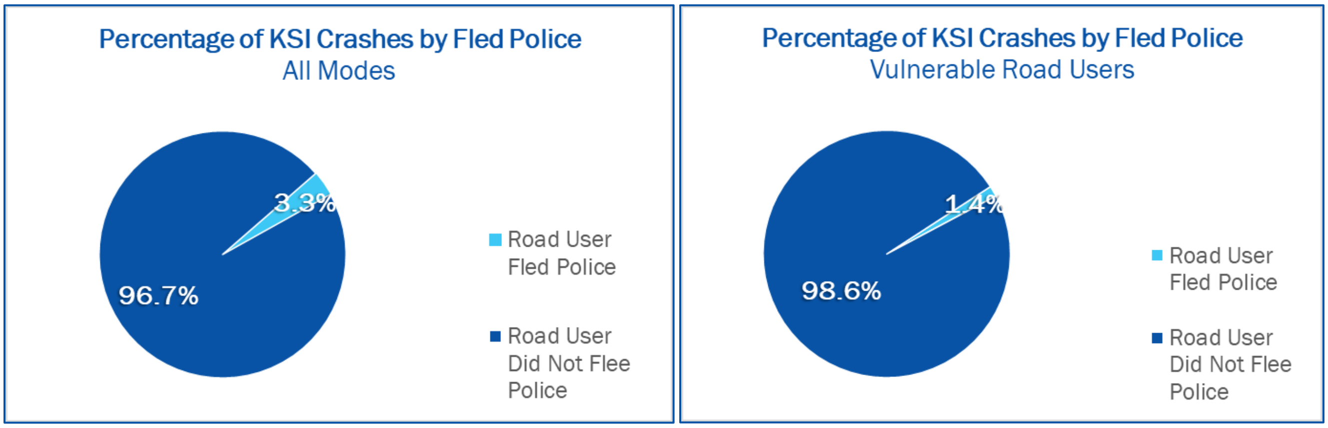


Figure 13: Percentage of KSI Crashes by Whether Road User Fled Police

However, when a police chase was a factor in a crash, the risk of that crash resulting in a fatality or serious injury increased significantly. As shown in **Table 14,** vulnerable road users were significantly impacted, with 100% of crashes that involved a police chase resulting in a fatality or serious injury when VRUs are involved.

Table 14: Percent of Crashes that Resulted in KSI by Whether Road User Fled Police

Mode	% of Fleeing Police-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	100%	14.4%
All modes	7.5%	1.0%

Distracted Driving

Distracted driving does not appear to be a significant factor in crash severity. Only 3.5% of all mode KSI crashes and 2.8% of VRU KSI crashes involve a distracted driver **(Figure 14)**.

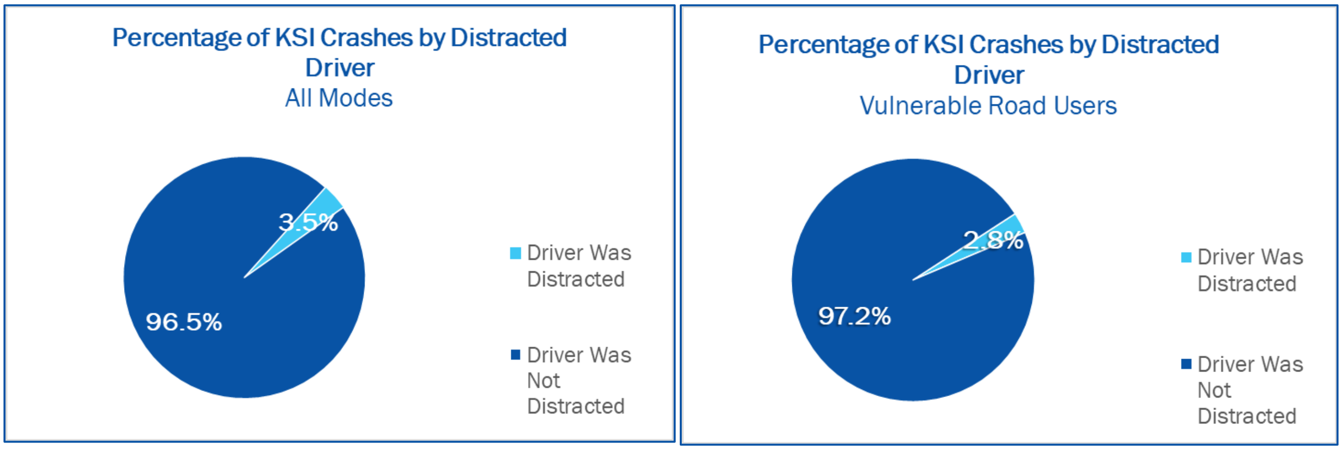


Figure 14: Percentage of KSI Crashes by Distracted Driving

The likelihood of distracted driving- related crashes resulting in KSI outcomes was slightly higher than the overall KSI rate for all modes, but much lower for VRU crashes, indicating distracted driving not being a significant contributing factor for severe VRU crashes **(Table 15).**

Table 15: Percent of Crashes that Resulted KSI by Distracted Driving

Mode	% of Distracted Driver-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	6.8%	14.4%
All modes	1.2%	1.0%

Work Zone

Crashes that occurred in work zones did not make up a large share of total KSI crashes but were more likely to be deadly or severe compared to crashes resulting from some other behavioral factors. Work zone crashes accounted for only 3.5% of all mode KSI crashes and 1.4% of VRU KSI crashes (**Figure 15**).

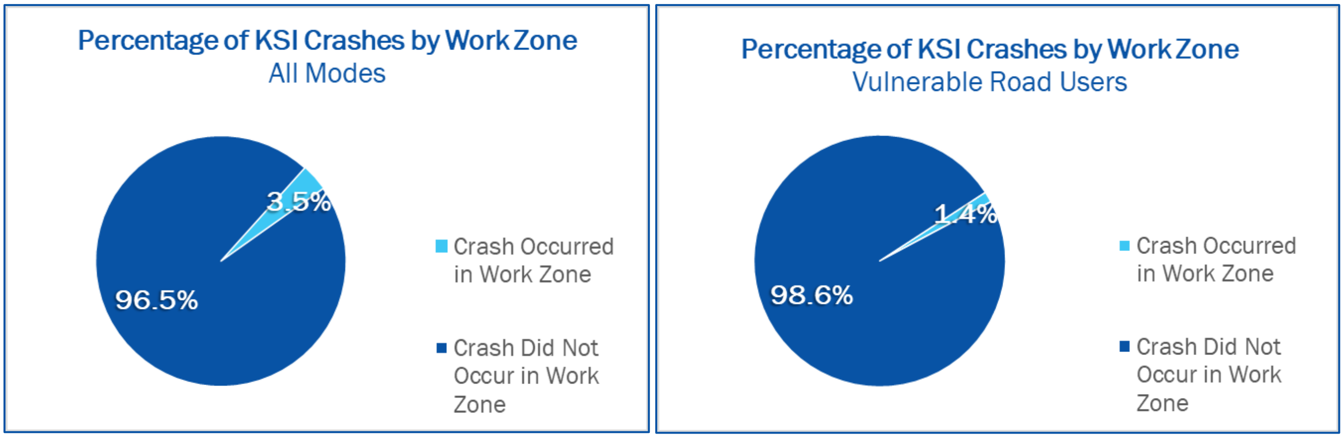


Figure 15: Percentage of KSI Crashes by Work Zone

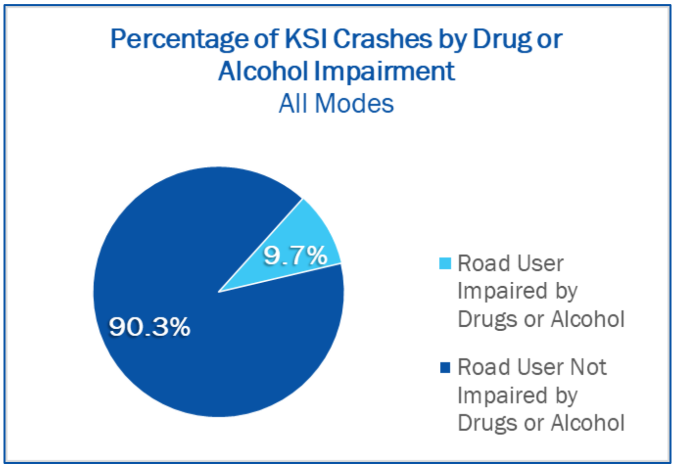
However, as exemplified in **Table 16**, it was more likely that a work zone crash would result in a fatality or serious injury than a crash that took place outside of work zone conditions. This was the case for all road users (3.9%), but especially for vulnerable road users (28.6%).

Table 16: Percent of Crashes that Resulted in KSI by Presence of Work Zone

Mode	% of Work Zone -related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	28.6%	14.4%
All modes	3.9%	1.0%

Alcohol and Drug Impairment

Figure 16 summarizes percentage of KSI crashes by alcohol and drug impairment. These crashes include both when the alcohol level was reported over the legal limit as well as when alcohol or drug use was listed as a contributing crash factor in the collision report. Crashes in which a road user was impaired by drugs or alcohol made up a moderate share of KSI crashes, with 9.7% of all mode crashes and 8.3% of vulnerable road user-related crashes occurring when drug or alcohol impairment was a factor.



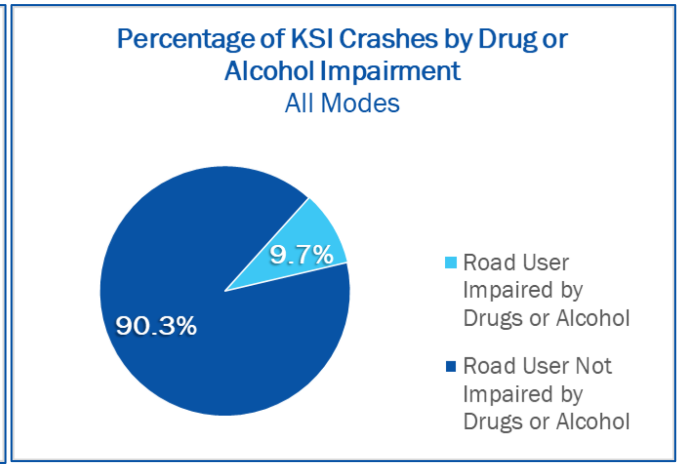


Figure 16: Percentage of KSI Crashes by Whether Road User Was Impaired by Drugs or Alcohol

Additionally, when vulnerable road users were involved in crashes with alcohol and drug impaired road users, the crashes were more likely to be deadly.

Table 17: Percent of Crashes that Resulted in KSI by Whether Road User Was Impaired by Drugs or Alcohol

Mode	% of Drug or Alcohol Impairment-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	63.2%	14.4%
All modes	9.4%	1.0%

Speeding

Speeding was a more influential behavioral element in crashes. Seen in **Figure 17**, over 37% of crashes across all modes and close to 19% of VRU KSI crashes involve speeding.

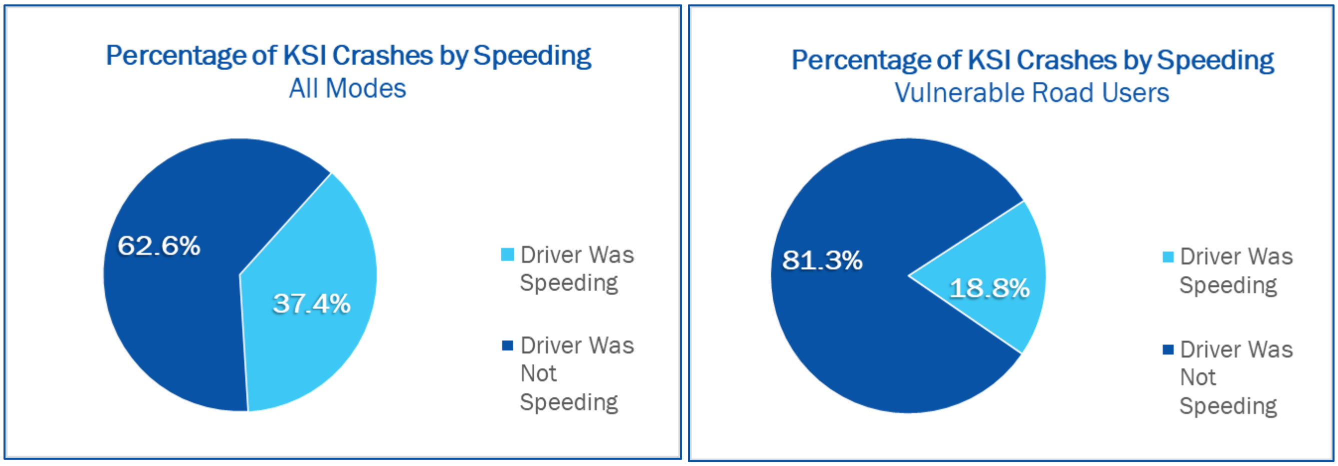


Figure 17: Percentage of KSI Crashes by Whether Driver Was Speeding

Speeding also increases the risk of a crash resulting in a fatality or serious injury. The percentage of crashes resulting in KSI is higher for both all modes crashes and VRU crashes when speeding is involved **(Table 18)**.

Table 18: Percent of Crashes that Resulted in KSI by Whether Driver Was Speeding

Mode	% of speeding-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	16.8%	14.4%
All modes	1.2%	1.0%

Lane Departure

When a lane departure was a factor in a crash in Webb County, severity was dependent on the land use context of the crash. Shown in **Figure 18,** lane departure related crashes that occurred on rural roads made up a larger share of KSI crashes (9.2%) than crashes that occurred in urban settings (5.6%). Compared to all mode crashes, the share of lane departure related VRU KSI crashes in both urban and rural settings was extremely low. 1.5% of VRU KSI crashes in urban areas were lane departure related, while none of those were reported in rural areas.

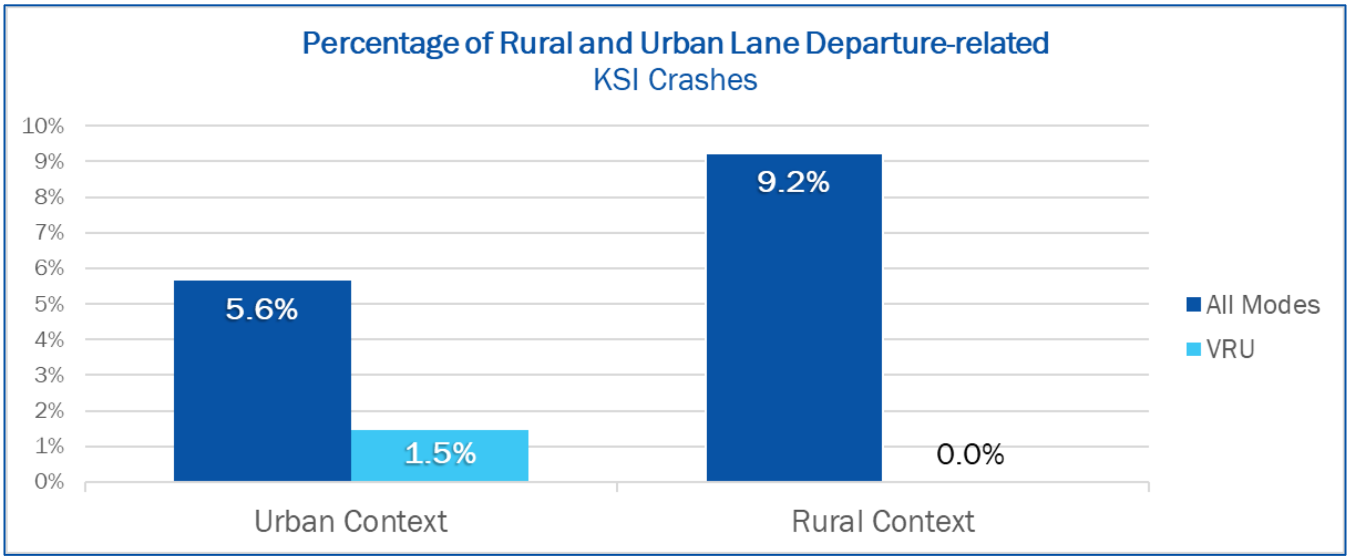


Figure 18: KSI Crashes by Lane Departure

Table 19 further summarizes crashes where a road user departed the lane they were travelling in. Despite a much higher percentage of VRU crashes that resulted in KSI in urban areas than rural areas (lane departure related or not), likely due to lower exposure of VRUs in rural areas, overall, lane-departure related crashes are not more likely to result in KSI.

Table 19: Percent of Rural and Urban Lane Departure-related Crashes that Resulted in KSI

	Urban Context		Rural Context	
Mode	% of Lane Departure-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI	% of Lane Departure-related Crashes that Resulted in KSI	% of All Crashes that Resulted in KSI
VRU	11.8%	13.6%	0.0%	0.8%
All modes	0.6%	0.9%	0.2%	0.2%

Roadway Characteristics

Crash Location (Intersection vs. Segment)

In Webb County, 24,697 crashes occurred at intersections (548 of those crashes involving vulnerable road users), and 14,158 crashes occurred on road segment (279 of those crashes involving vulnerable road users). **Figure 19** illustrates KSI crash frequencies by location type for all modes and vulnerable road users. Like total crashes, KSI crashes occurred most often at intersections (54.3% of all mode crashes, 66.7% of VRU crashes).

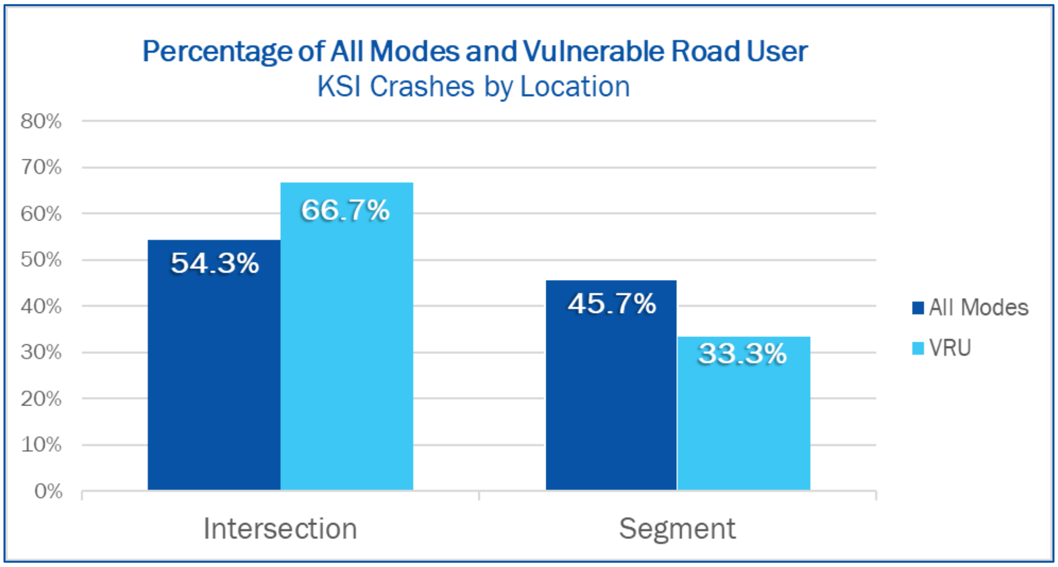


Figure 19: KSI Crashes by Location Type

The following section separately describes the various roadway characteristics associated with crashes on segments versus intersections to display relevant trends at both location types.

Segments: Traffic Volume

Figure 20 summarizes crashes by AADT, or average annual daily traffic, for all modes, compared to the percentage of the total Webb County roadway mileage within each AADT range. Streets with an AADT between 20,000 and 40,000 had the largest share of overall crashes (27.6%), but road segments with AADT's greater than 40,000 made up a greater share of KSI crashes (26.4%) than any other AADT range. However, the majority of the street network throughout the region has an AADT less than 1,000, resulting in relatively low crashes per mile. Roads that had an AADT over 40,000, where the largest percentage of KSI crashes (26.4%) and the second largest percentage of total crashes (24%) occurred, are also segments that make up the least mileage of the total road network (1.5%).

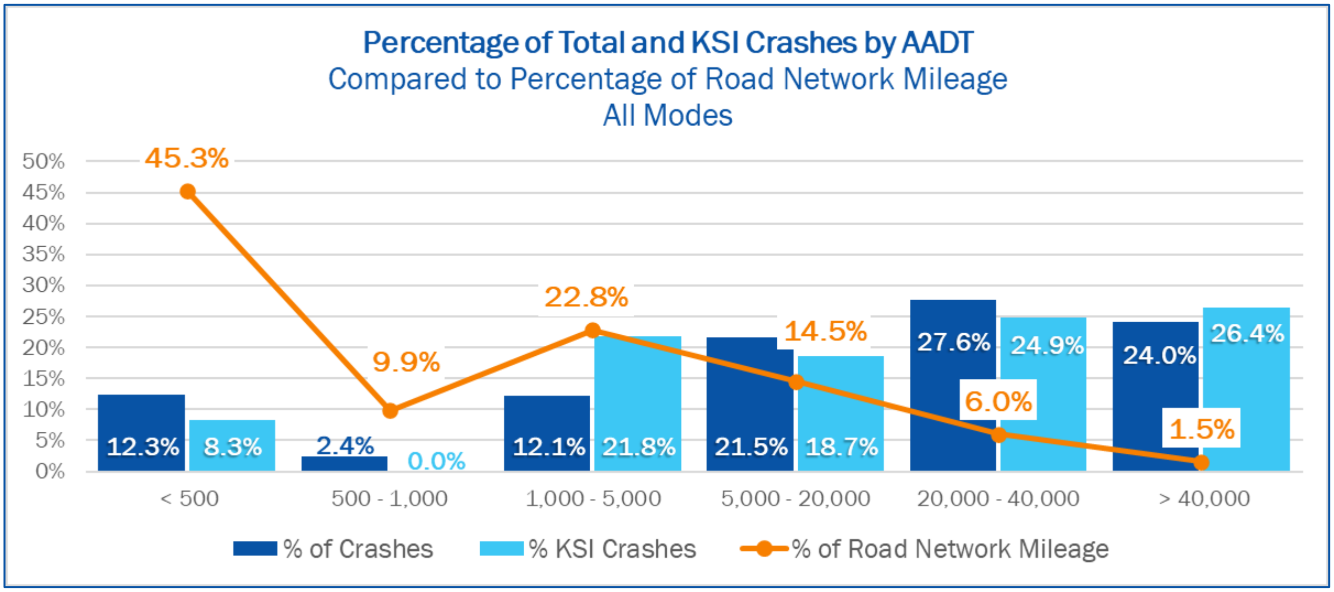
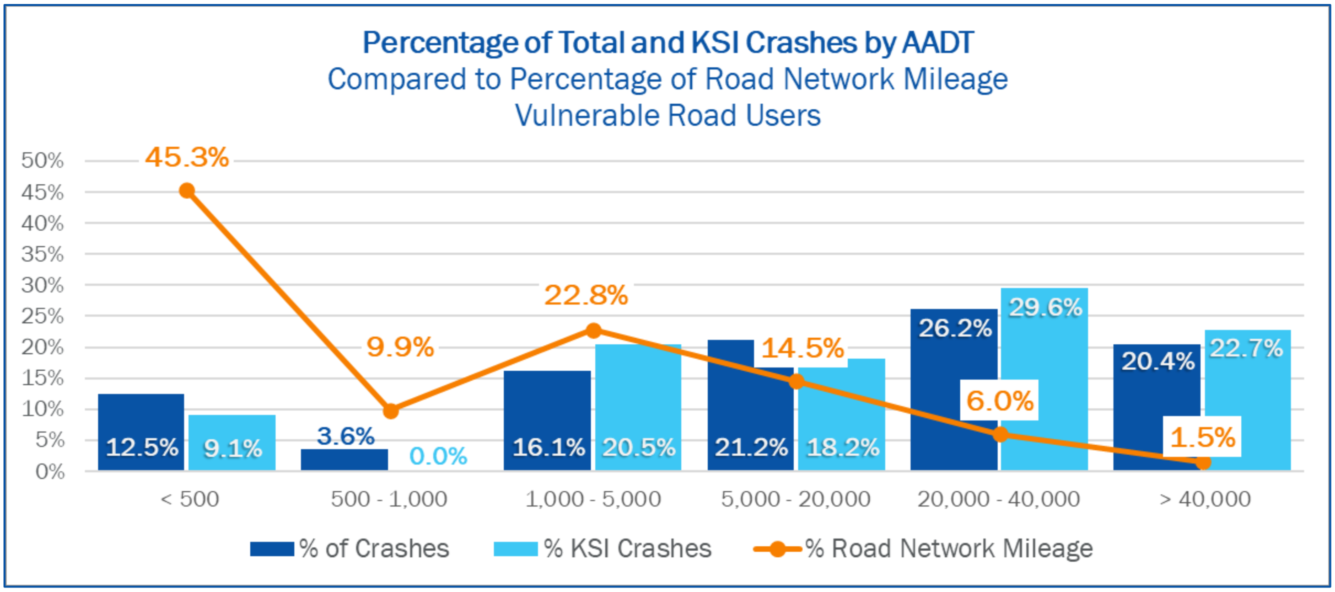


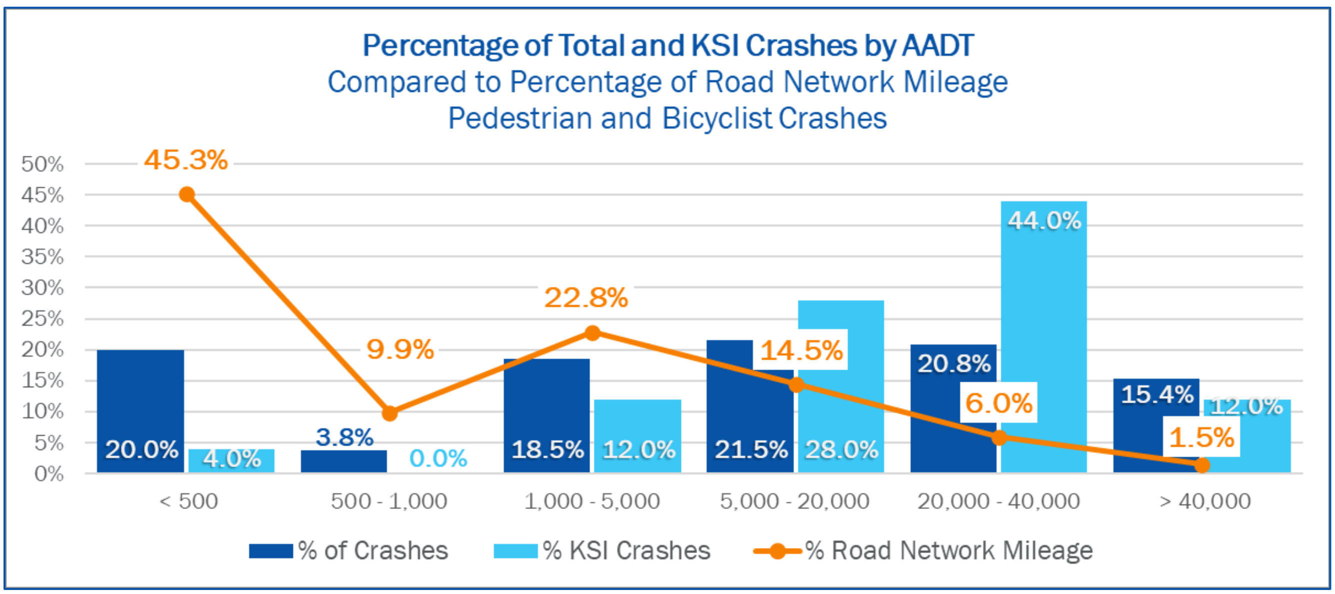
Figure 20: Percentage of All Modes Total and KSI Crashes by AADT

Figure 23(a) summarizes crashes by AADT where vulnerable road users were involved. Like all mode crashes, most VRU crashes occurred on roads where the AADT was above 5,000. However, unlike all mode crashes, instead of the largest roads (i.e., those carry AADT over 40,000), the roadways that carry AADT between 20,000 and 40,000 have the highest share of VRU KSI crashes. Considering that though motorcyclists are counted as VRUs, they usually travel on roadways that are more likely to be used by motor vehicles, we created a separate graph for pedestrian and bicyclist crashes only **Figure 21(b)**. Compared to all modes, a higher percentage (42.3%) of pedestrian and bicyclists involved crashes happened on roadways with AADT no more than 5,000. About the same percentage of pedestrian and bicyclist crashes happened on roadways with AADT between 5,000 and 40,000, mostly on principle arterials as we will see in the next section. However, over half of pedestrian and bicyclist involved KSI crashes happened on roadways with AADT over 20,000, making those roadways most dangerous for pedestrian and bicyclists.

Considering the road network in Webb County is made up predominantly of lower-traffic roadways, a disproportionate percentage of total crashes and KSI crashes appear to be occurring on high-traffic roads with AADT higher than 5,000, regardless of mode involved.



(a) VRU Crashes



(b) Pedestrian and Bicyclist-Involved Crashes

Figure 21: Percentage of VRU Total and KSI Crashes by AADT

Segments: Functional Classification

Figure 22 illustrates crashes by roadway classification for all modes, compared to the percentage of the total Webb County roadway mileage that makes up the various roadway classification types. Principal arterials represent the largest share of total and severe crashes, making up 40.5% of all crashes and 50.3% of KSI crashes. Because principal arterials in Webb County are only 12.3% of total road network coverage, the distribution of all crashes and KSI crashes are concentrated on a small percentage of high-volume roads.

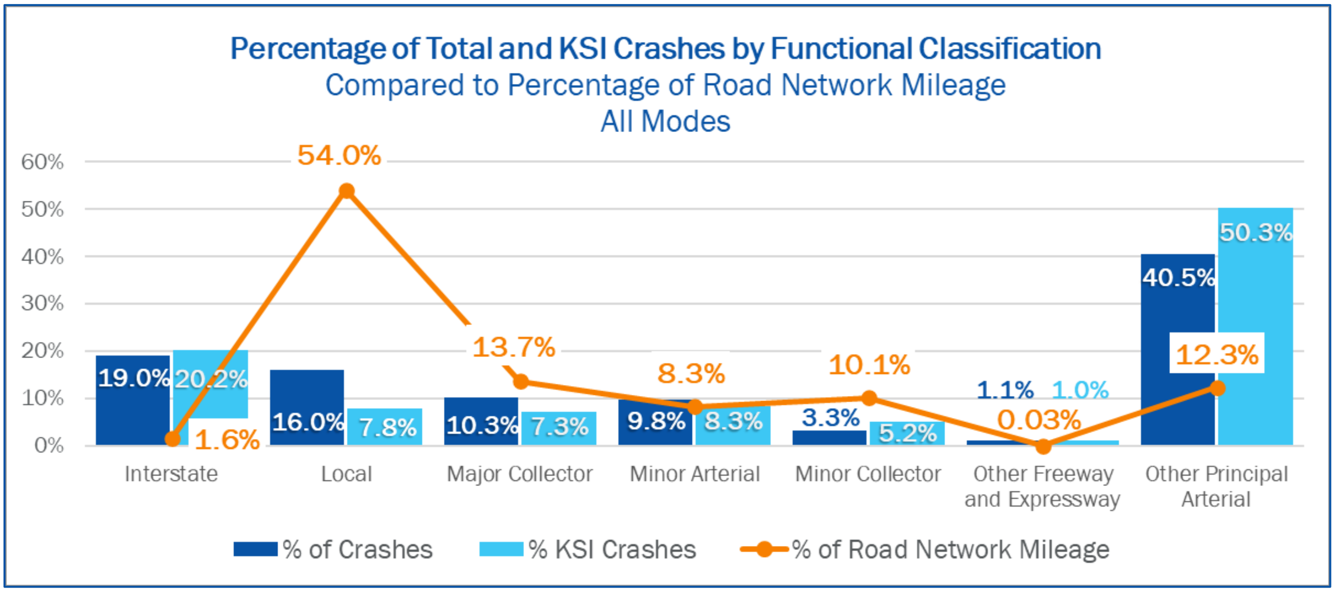
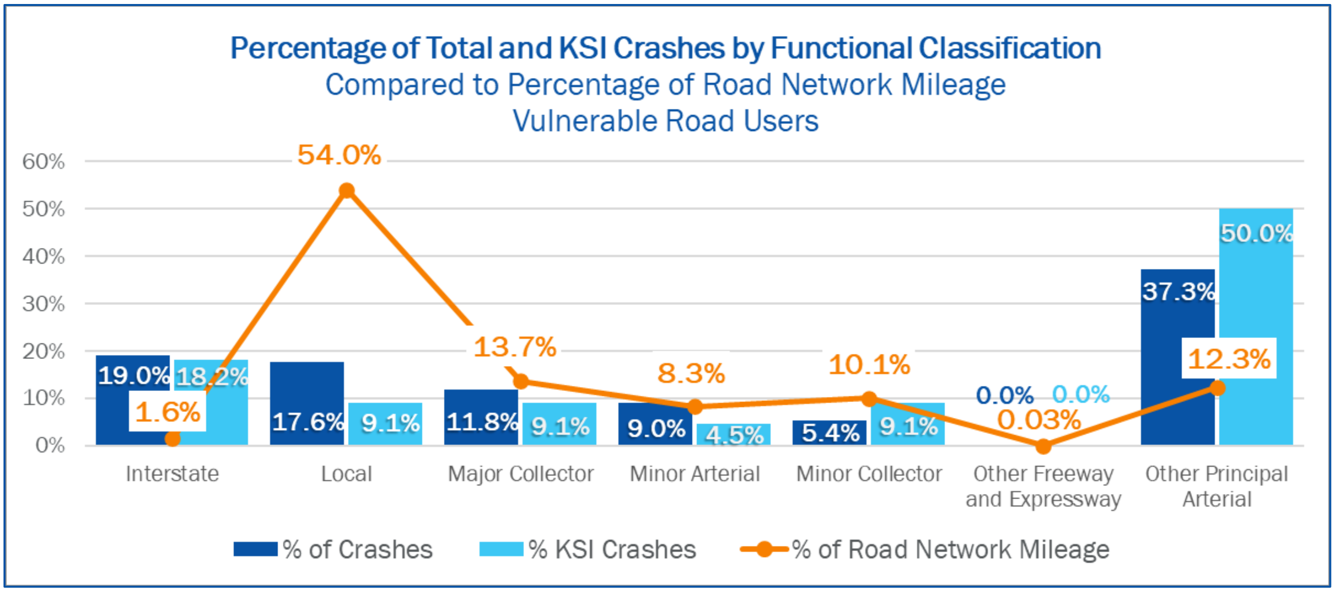


Figure 22: Percentage of All Modes Total and KSI Crashes by Functional Classification

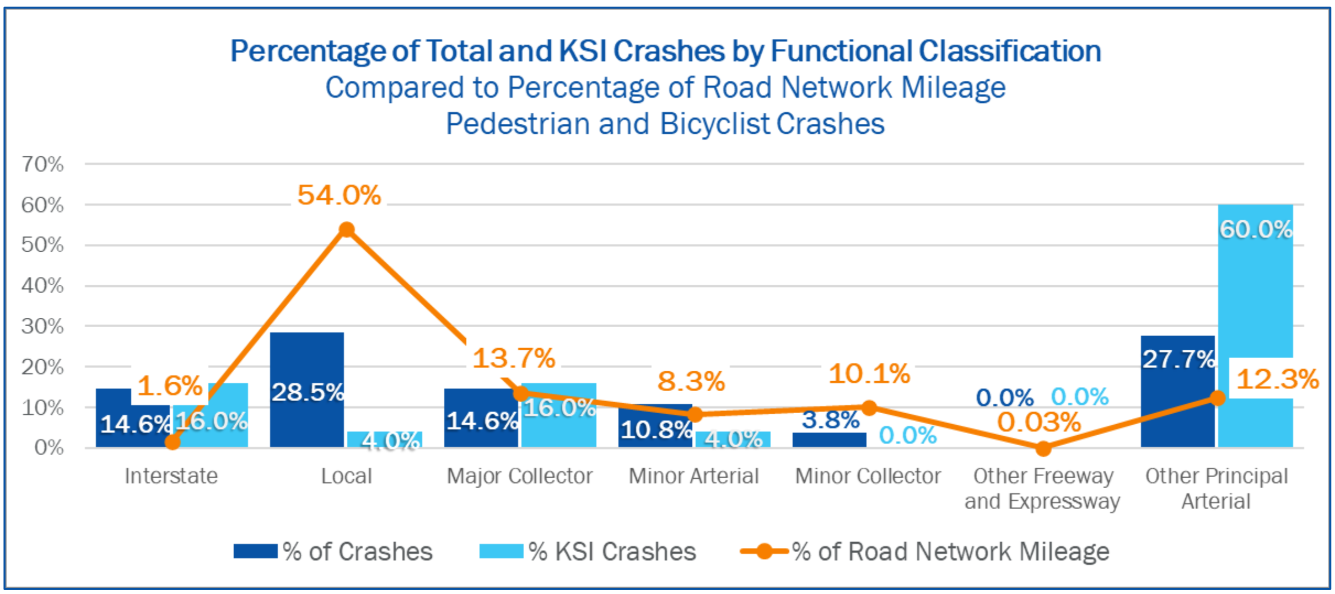
Vulnerable road users, shown in **Figure 23 (a),** tended to have similar experiences on each road type. Principal arterials remain the road type that saw the most total crashes and KSI crashes (37.3% and 50%), with interstates following with the second most total crashes and KSI crashes (19% and 18.2%)[4]. However, if we look at only pedestrian and bicyclist involved crashes, as shown in **Figure 23 (b)**, local road has the highest share of total crashes but the smallest share of KSI crashes. On the opposite, Other Principal Arterials has about the same percentage of total crashes but 15 times more KSI crashes, indicating the danger of these roadways to pedestrians and bicyclists.

Comparing the percentage of roadway mileage and that of total crashes and KSI crashes within each functional class category reveals that a disproportion of total and KSI crashes happened on interstate, other freeway and expressway and other principal arterials, regardless of mode involved.

[4] Note that crashes that happened along frontage roads of access-controlled roadways such as interstate may be categorized as interstate crashes due to limited information in the data and the proximity of those crash data coordinates to interstate mainlines. Besides this data limitation, there are instances of pedestrians trying to cross interstates due to a lack of safe and convenient crossings connecting to their destinations and those often end up with fatalities.



(a) VRU Crashes



(b) Pedestrian and Bicyclist-Involved Crashes

Figure 23: Percentage of VRU Total and KSI Crashes by Functional Classification

Segments: Posted Speed Limit

Figure 24 summarizes crashes by posted speed limit for all roadway users. Crashes occurred most often on roadways with a posted speed limit between 30 and 35 mph (50.9% of total crashes, 35.2% of KSI crashes), which account for 84% of all roads in Webb County. This is most likely due to the fact that these roadways carry the largest portion of VMTs in the County. While roads with a posted speed limit of 50 to 55 mph saw the second highest number of crashes and KSI crashes, making up 21.1% of all crashes, roads with the highest speed limits, greater than 70 mph, had the second highest number of KSI crashes, representing 23.3% of KSI crashes. These higher speed roadways make up smaller shares of the overall roadway network but had increasing numbers of fatal and severe injury crashes.

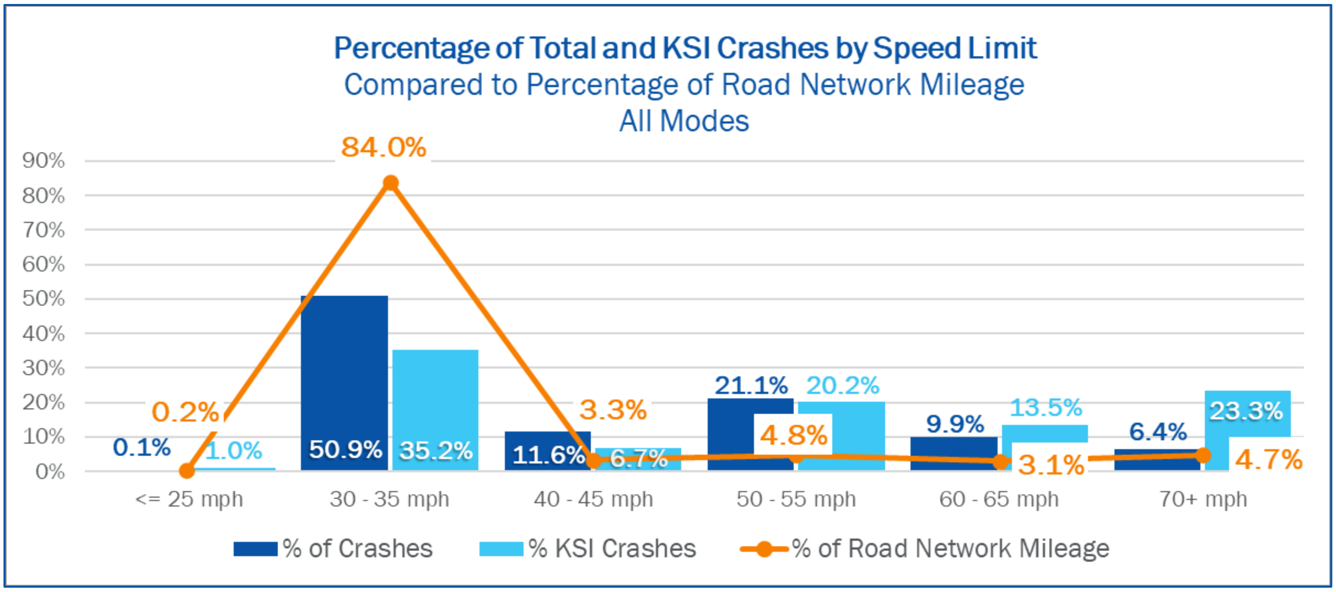
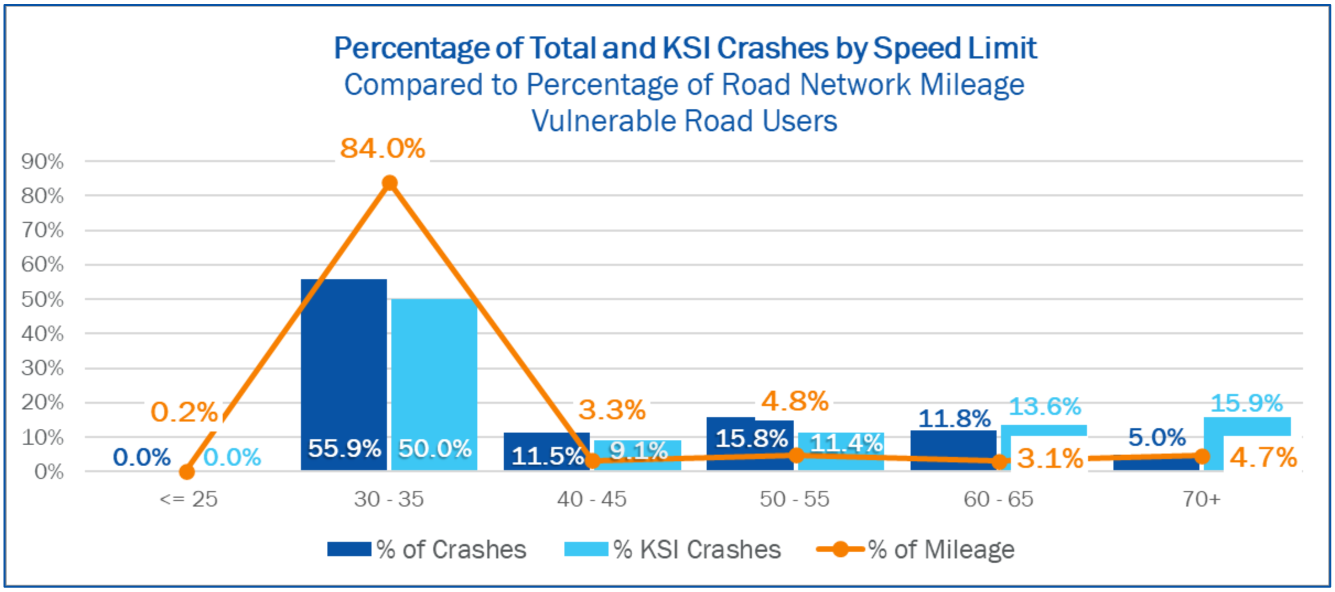


Figure 24: Percentage of All Modes Total and KSI Crashes by Speed Limit

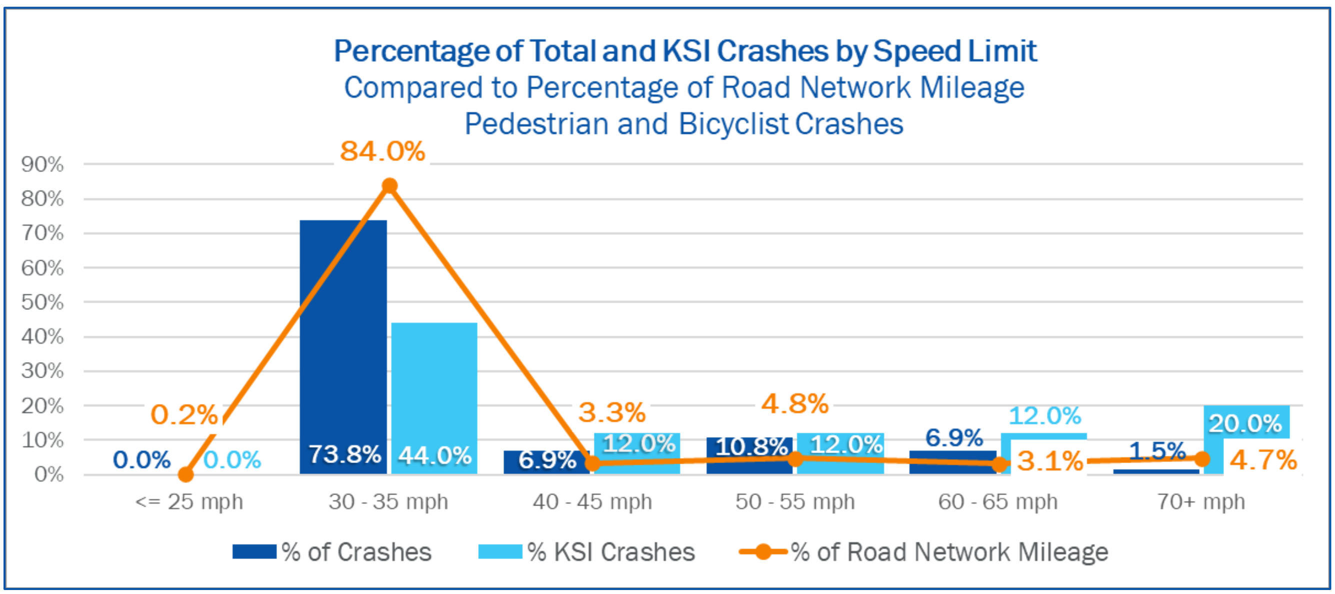
Like crashes involving all modes, VRU crashes and VRU KSI crashes occurred primarily on streets with a posted speed limit between 30 and 35 mph as displayed in **Figure 25 (a)**, but these roads are not overrepresented in either VRU overall or KSI crashes.

Roads with speed limits between 30 and 35 mph saw a rise in both total (55.9% for all VRU crashes and 73.8% for pedestrian and bicyclist involved crashes) and KSI (50% for all VRU crashes and 44% for pedestrian and bicyclist involved crashes) crashes when vulnerable road users were involved compared to total (50.9%) and KSI (35.2%) crashes involving all modes, likely due to high exposure of VRU on these roadways. The share of VRU KSI crashes increase with the increase of speed limit for roadways with speed limit over 35 mph. Roads with the lowest speed limits, less than 25 mph, saw no crashes involving vulnerable road users.

Comparing the percentage of roadway mileage and that of total crashes and KSI crashes within each speed limit category reveals that a disproportion of total and KSI crashes happened on roadways with speed limit at 40 mph or higher, regardless of mode involved. This again highlight the significant impact of speed limit on safety.



(a) VRU Crashes



(b) Pedestrian and Bicyclist-Involved Crashes

Figure 25: Percentage of VRU Total and KSI Crashes by Speed Limit

Segments: Number of lanes

Figure 26 summarizes crashes by number of lanes for all mode users. Crashes occurred most often on two-lane roads (59.3% of total crashes, 66.3% of KSI crashes), which can be attributed to their contribution to the Webb County road network (91.3% of total road network coverage). Three-lane roads, while being far less prevalent in Webb County, accounted for 19.8% of all crashes, and 17.1% of KSI crashes.

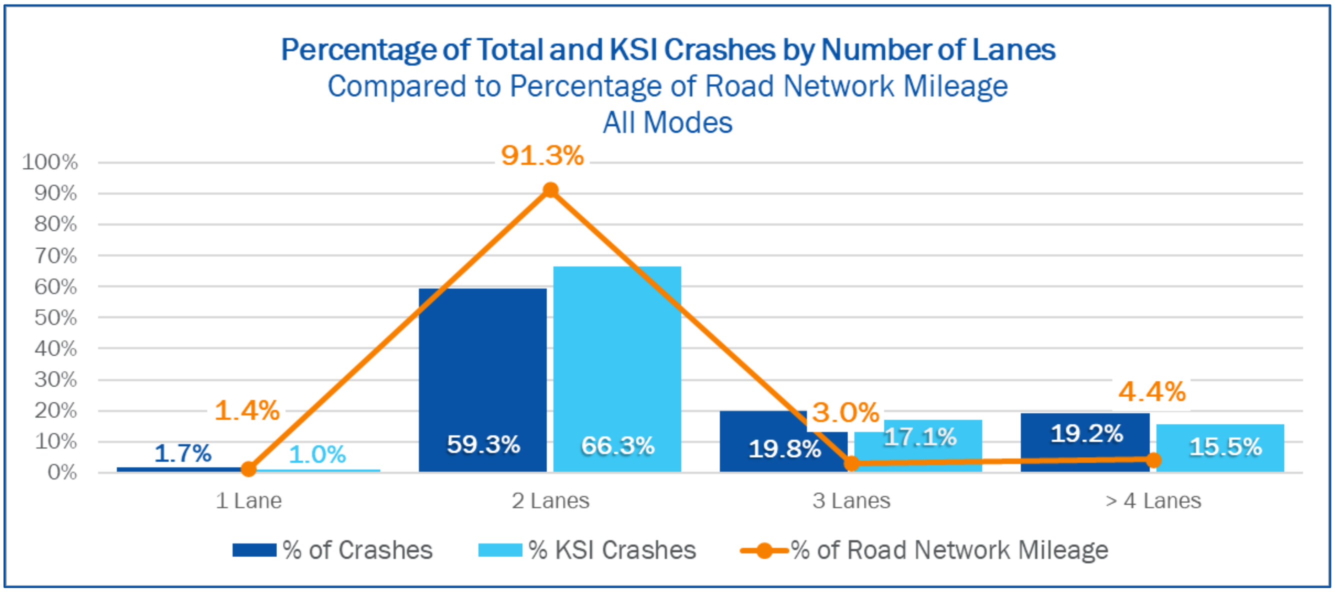
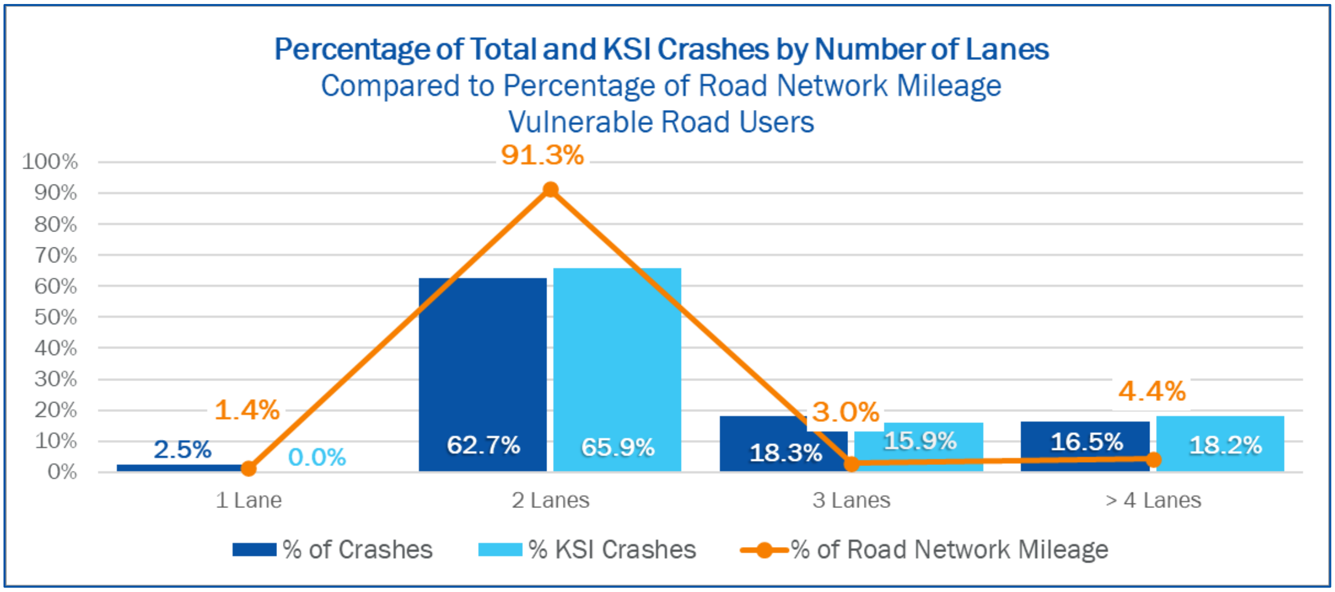


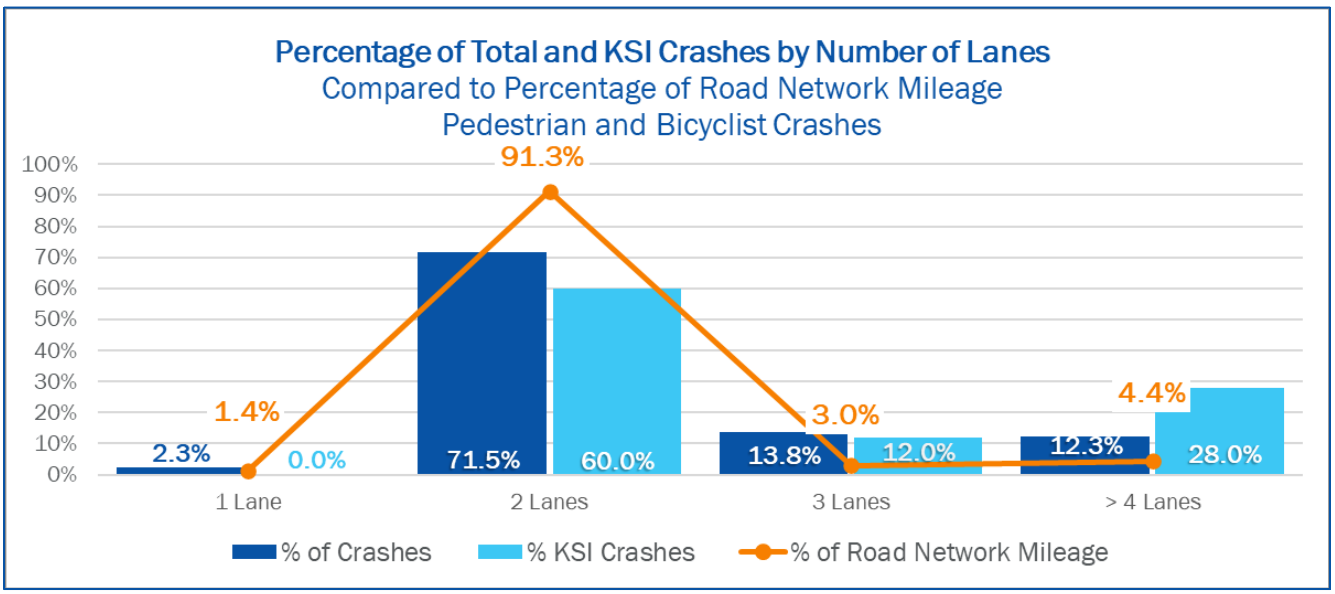
Figure 26: Percentage of All Modes Total and KSI Crashes by Number of Lanes

Figure 27 summarizes crashes by number of lanes for VRUs with chart **(a)** for all VRUs involved crashes and **(b)** for just pedestrian and bicyclist involved crashes. Data for these modes follow a similar trend compared to all modes crashes, with an even larger share of total and KSI crashes having occurred on two-lane roads. Compared to crashes involving all modes, a higher share of severe crashes involving vulnerable road users occurred on those big roads in Webb County with the largest lane counts (18.2% for all VRUs involved crashes and 28% for pedestrian and bicyclist involved crashes vs 15.5% for all modes involved crashes)

All three graphs in **Figure 26** and **Figure 27** demonstrate that roadways with three or more lanes are over-represented in terms of both overall crashes and KSI crashes, regardless of mode involved.



(a) VRU Crashes



(b) Pedestrian and Bicyclist-Involved Crashes

Figure 27: Percentage of VRU Total and KSI Crashes by Number of Lanes

Intersections: Traffic Volume

Figure 28 summarizes crashes by AADT for all modes at intersections. The AADT at intersections represents the sum of AADT of all approaches. Intersections with an AADT between 60,000 to 100,000 had the largest share of both overall crashes (26.2%) and KSI crashes (27.9%). However, the majority of intersections in Webb County have an AADT of 1,000 to 5,000, which make up only 11.5% of all crashes and 11.8% of KSI crashes. A disproportionate percentage of crashes occurred at higher volume intersections with AADTs over 20,000.

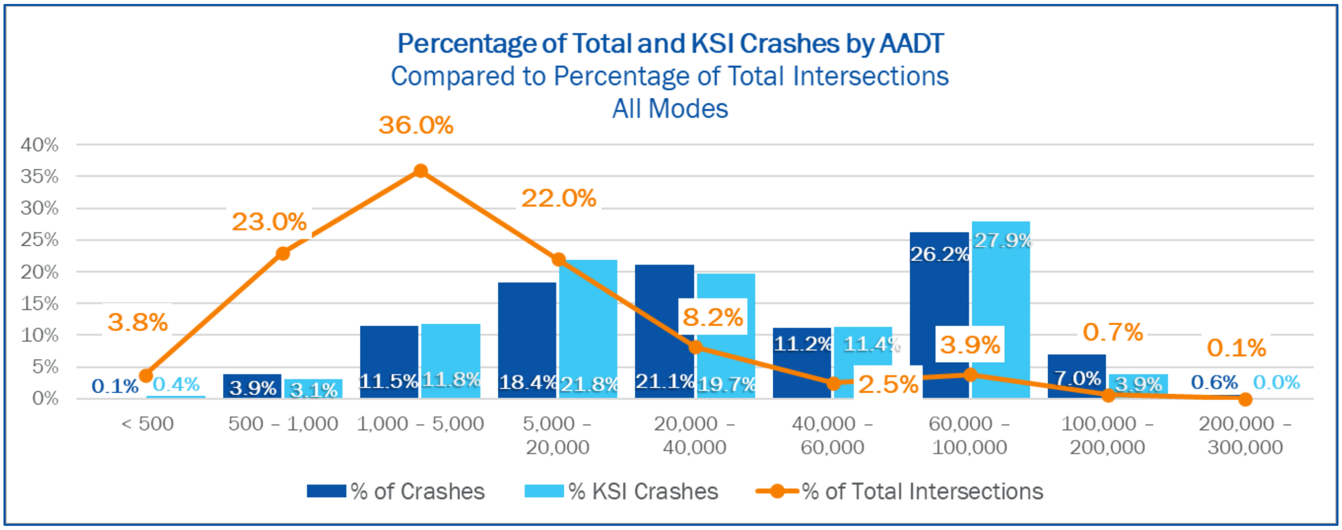


Figure 28: Percentage of All Modes Total and KSI Crashes by AADT

Figure 29, showing AADT at intersections where crashes involving vulnerable road users occurred, indicates similar trends to the above figure. Intersections with AADTs over 5,000 share a disproportion of total and KSI crashes involving vulnerable road users.

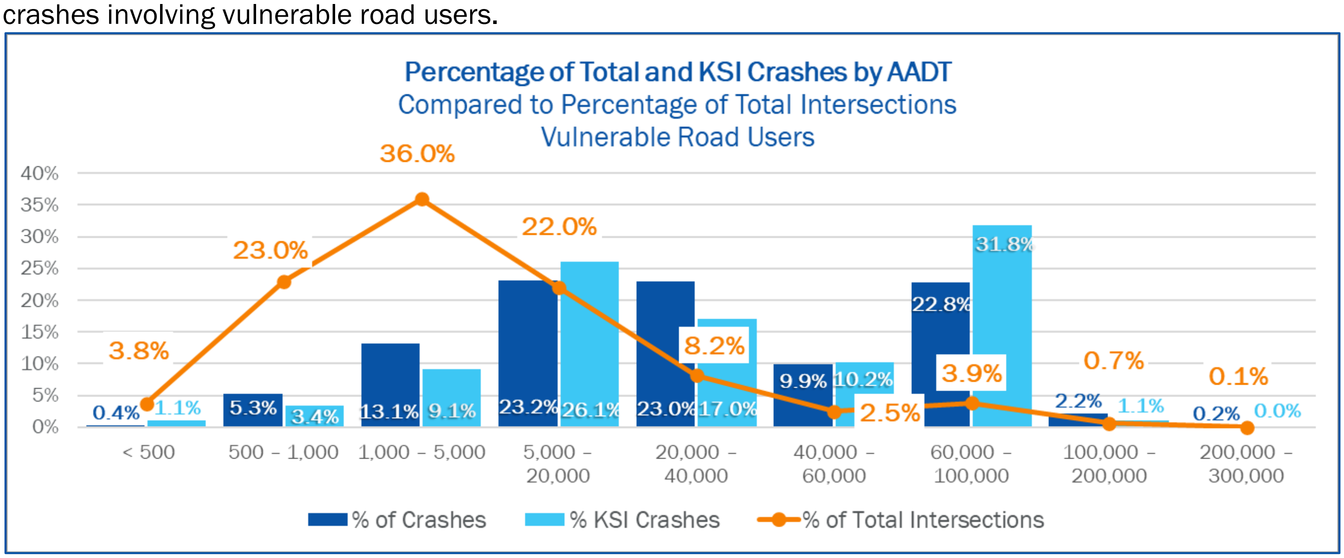


Figure 29: Percentage of VRU Total and KSI Crashes by AADT

Intersections: Highest Functional Classification

Figure 30 illustrates crashes by roadway classification for all modes at intersections, with the classification recorded at each intersection representing the highest of all approaches. Unlike along segments **(Figure 20)** intersections on local roads saw the most total crashes and the most severe crashes (52.6% of total crashes and 58.5% of KSI crashes), but these intersections are not overrepresented in crashes. Crashes at intersections on major collectors made up the second highest share of total crashes and KSI crashes (22.7% and 21%) despite representing only 4.6% of all intersections in Webb County.

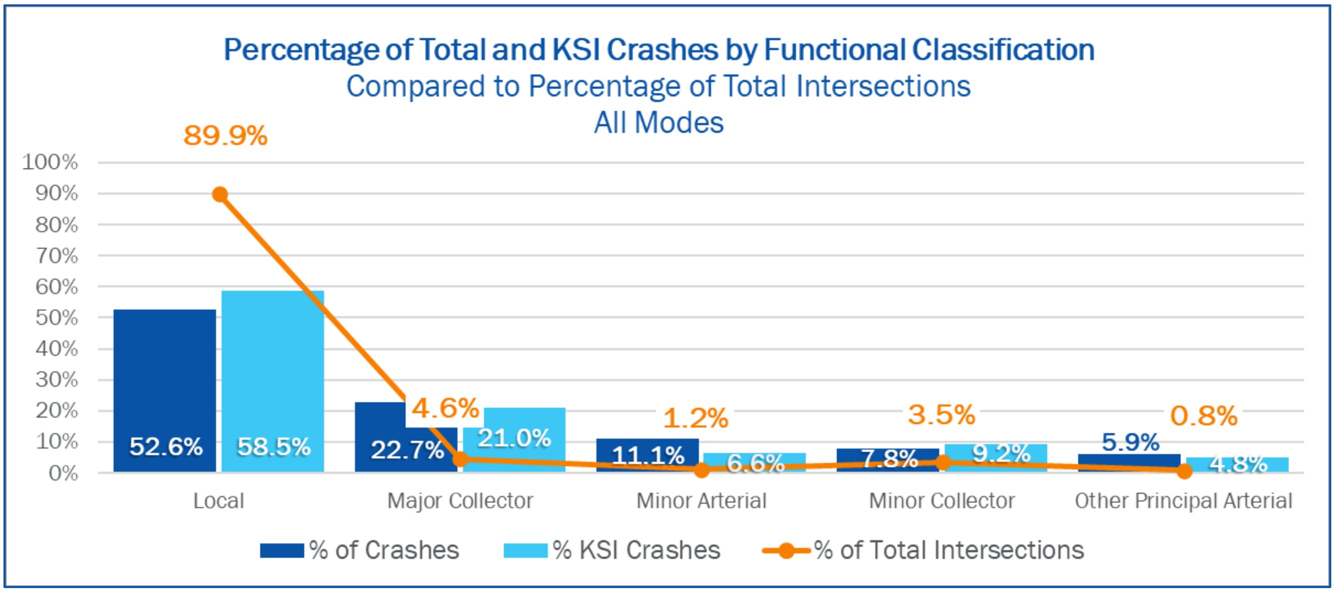


Figure 30: Percentage of All Modes Total and KSI Crashes by Functional Classification

Crash risk for vulnerable road users at intersections on local roads was considerably higher than crashes involving all modes, with 62.5% of all KSI crashes occurring at intersections on local roads **(Figure 31)**. Because vulnerable road users more often use roads with lower traffic volumes where they feel safer or where infrastructure exists to support active travel, this upward trend of VRU crashes on local roads is understandable. In other words, the increased occurrence of VRU crashes at intersections on local roads is primarily due to the higher exposure of vulnerable road users at these locations, and not because these intersections are inherently more dangerous for VRUs. When compared to intersections on roadways with a higher functional class, these local road intersections are not overrepresented in terms of crashes involving vulnerable road users.

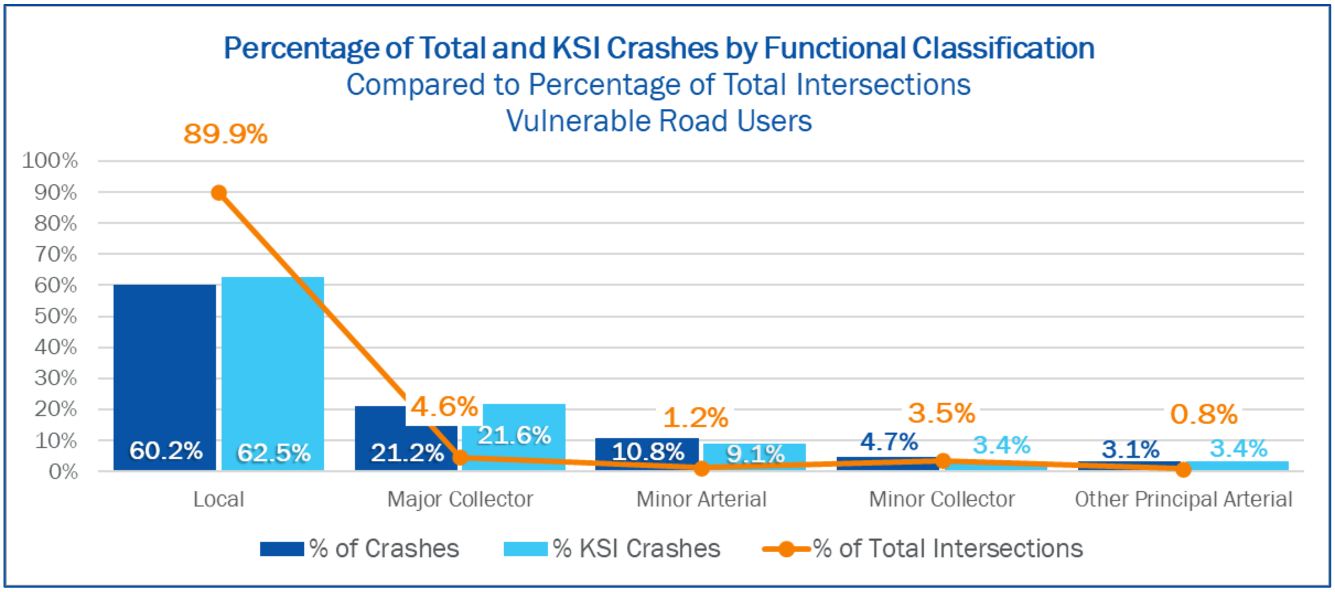


Figure 31: Percentage of VRU Total and KSI Crashes by Functional Classification

Intersections: Highest Posted Speed Limit

Figure 32 highlights crashes by posted speed limit for all roadway users at intersections. The posted speed limit recorded shows the highest posted speed limit of all intersection approaches. Crashes occurred most often at intersections with a posted speed limit of 30 to 35 mph (72.4% of total crashes, 67.7% of KSI crashes) due to the higher proportion of the intersections on roadways with these speed limits. However, a disproportionate share of crashes occurred at intersections with speed limits 40 mph and greater, which combined account for less than 10% of all intersections in Webb County.

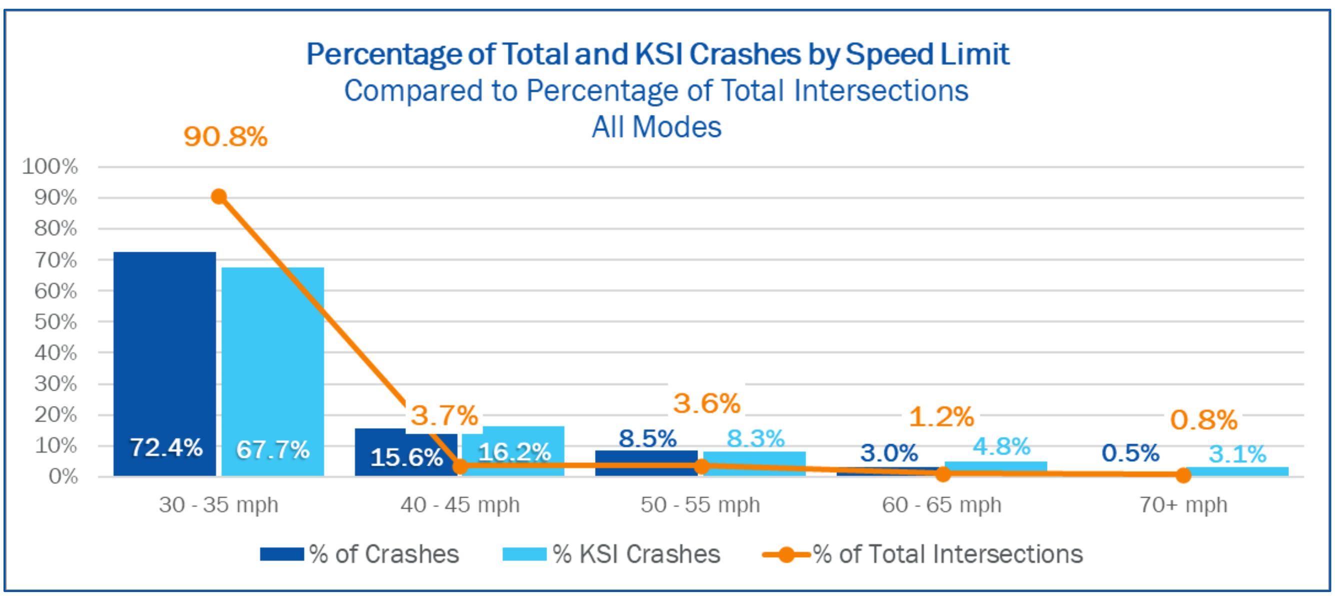


Figure 32: Percentage of Total and KSI All Modes Crashes by Posted Speed Limit

An even higher percentage of vulnerable road user crashes appear to happen at intersections with posted speed limits between 30 and 35 mph (81.4% of total crashes and 71.6% of KSI crashes), compared to all modes (**Figure 33**). This can be attributed to where vulnerable road users are most often found, which is on lower volume, lower classification, and therefore, lower speed limit roads. However, intersections with speed limit less than 40 mph are still not overrepresented in VRU crashes, indicating they are generally safer than intersections with higher speed limits. Roads with posted speed limits between 40 and 45 mph, on the other hand, are where a disproportionate percentage, 22.7%, of severe crashes involving VRUs occur, despite making up only 3.7% of all intersections.

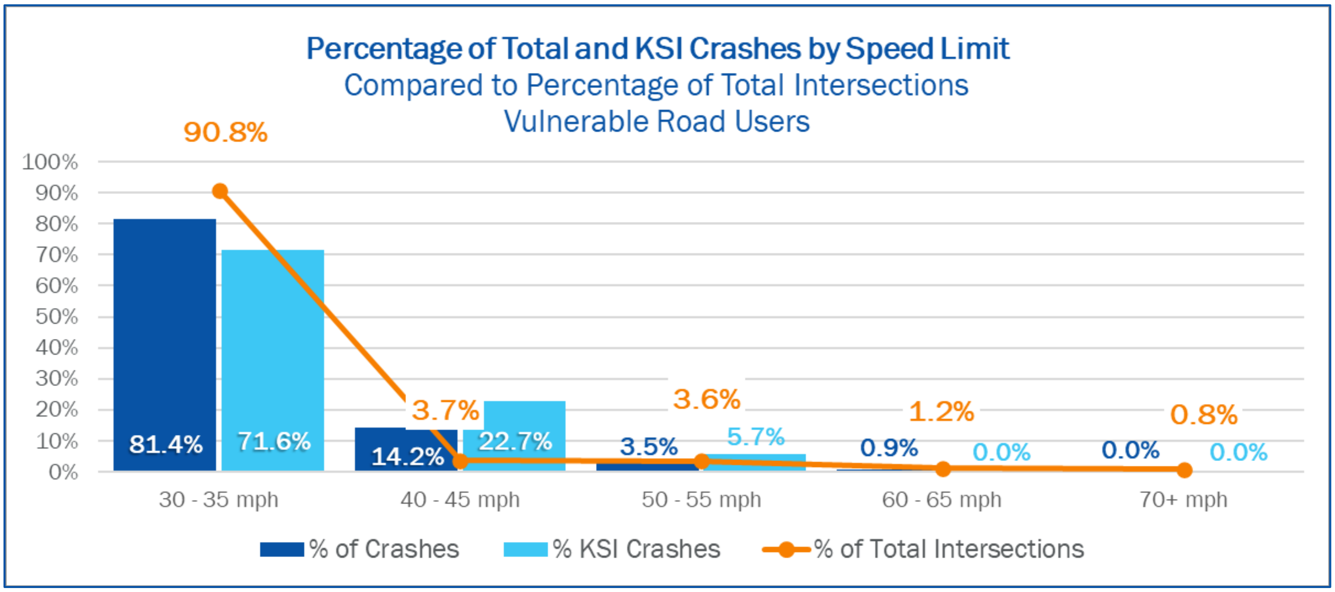


Figure 33: Percentage of Total and KSI VRU Crashes by Posted Speed Limit

Intersection Control: Total Number of Through Lanes

Figure 34 summarizes crashes by the total number of through lanes at intersections for all roadway users. Crashes occurred most often at five to eight lane intersections (61.5% of total crashes, 64.6% of KSI crashes) These approaches are also the most common in Webb County, making up 90.2% of all intersections combined. Nine to 12 lane roads, however, while contributing to a lower share of total (26.7%) and KSI (27.1%) crashes, make up only 8.0% of all intersections and are the most overrepresented type of intersections in terms of both total and KSI crashes.

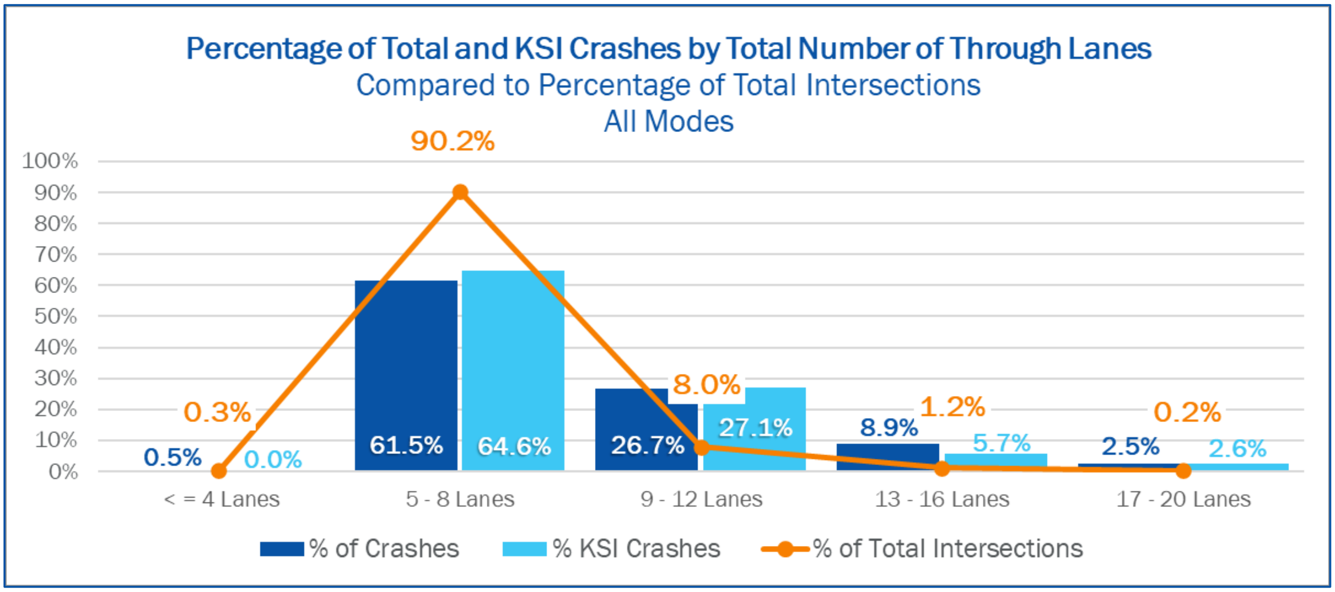


Figure 34: Percentage of Total and KSI All Modes Crashes by Number of Lanes

Figure 35, which shows crashes by the total number of through lanes at intersections for vulnerable road users, suggests similar trends regarding five to eight-lane approaches. However, compared to the above figure, a higher share of KSI crashes occurred at intersections with nine to 12 through lanes (28.4%) and 17 to 20 through lanes (4.6%). Comparing the percentage of intersections and that of total crashes and KSI crashes within each lane number category reveals that a disproportion of total and KSI crashes happened on intersections with 9 or more through lanes from all approaches, regardless of mode involved.

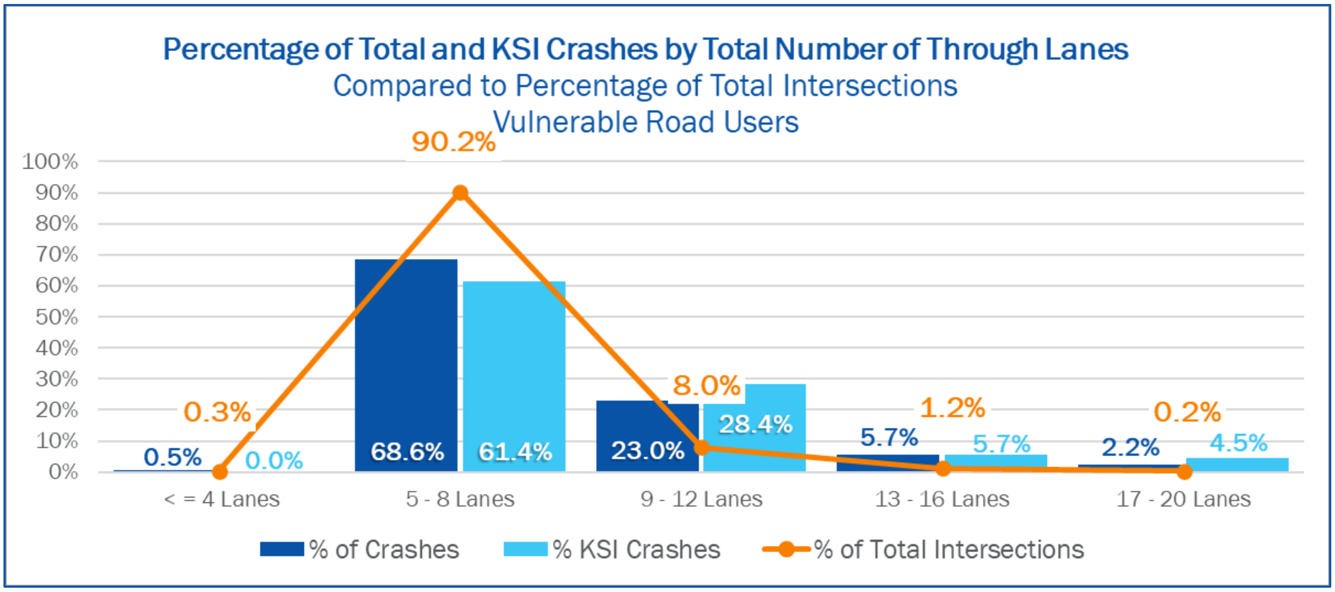


Figure 35: Percentage of Total and KSI VRU Crashes by Number of Lanes

Environmental Characteristics

Time and Day of Crash

Table 20, Table 21 and Table 22 summarize crashes by day of week and time of day for all modes, vulnerable road users, and commercial vehicle involved crashes. Percentages shown represent the percentage of KSI crashes that took place during every time period (where data was available) on any day of the week. For all modes, crashes were fairly evenly distributed across the week with severe daytime crashes (morning through early evening) most often occurring during the week and severe evening and late-night crashes most often occurring over the weekend. Early morning crashes were far less likely to occur on Wednesdays and Thursdays compared to all other days of the week. A summary of all modes KSI crash findings is listed below:

- Early morning KSI crashes were most likely to occur on Monday and Saturday.
- Morning KSI crashes were most likely to occur on Tuesday and Wednesday from 8 AM to 10 AM and Thursday and Friday from 10 AM to 12 PM.
- Afternoon KSI crashes were most likely to occur on Thursday and Sunday from 12 PM to 2 PM and Thursday and Friday from 2 PM to 4 PM.
- Late afternoon KSI crashes were most likely to occur on Thursday.
- Early evening KSI crashes were most likely to occur on Wednesday.
- Evening KSI crashes were most likely to occur on Friday and Saturday from 8 PM to 10 PM and on Friday from 10 PM to 12 AM.
- Late night KSI crashes were most likely to occur on Saturday and Sunday.

Table 20: Percentage of All Modes KSI Crashes by Day of Week and Time of Day

Time of Day	6 AM – 8 AM	8 AM – 10 AM	10 AM – 12 PM	12 PM – 2 PM	2 PM – 4 PM	4 PM – 6PM	6 PM – 8 PM	8 PM – 10 PM	10 PM – 12 AM	12 AM – 6 AM
Day of Week	% of KSI Crashes									
Monday	21.2%	9.5%	16.7%	15.4%	10.0%	7.7%	16.9%	9.4%	2.5%	11.5%
Tuesday	15.2%	23.8%	10.0%	11.5%	16.0%	10.3%	16.9%	9.4%	10.0%	5.8%
Wednesday	3.0%	23.8%	13.3%	11.5%	8.0%	17.9%	18.6%	15.1%	10.0%	4.8%
Thursday	6.1%	9.5%	23.3%	19.2%	20.0%	30.8%	8.5%	9.4%	20.0%	12.5%
Friday	18.2%	19.0%	20.0%	15.4%	24.0%	15.4%	13.6%	20.8%	27.5%	10.6%
Saturday	21.2%	4.8%	10.0%	7.7%	12.0%	10.3%	16.9%	20.8%	17.5%	29.8%
Sunday	15.2%	9.5%	6.7%	19.2%	10.0%	7.7%	8.5%	15.1%	12.5%	25.0%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Early Morning	Morning		Afternoon		Late Afternoon	Early Evening	Evening		Late Night

KSI crashes involving vulnerable road users were far less evenly distributed across the week, with the most severe crashes from the early morning to the beginning of the afternoon more often occurring during the first half of the week, and afternoon to late afternoon KSI crashes more often occurring during the latter half of the week. Early evening to evening severe crashes, however, were spread evenly across all days of the week, with the highest spikes on Fridays. Severe late-night crashes almost exclusively occurred over the weekend, with less than 25% of all late night KSI crashes occurring on the first four days of the week. A summary of VRU KSI crash findings is listed below:

- Early morning KSI crashes were most likely to occur on Monday.
- Morning KSI crashes were most likely to occur on Tuesday from 8 AM to 10 AM and Wednesday from 10 AM to 12 PM.
- Afternoon KSI crashes were most likely to occur on Tuesday from 12 PM to 2 PM and Friday from 2 PM to 4 PM.
- Late afternoon KSI crashes were most likely to occur on Thursday.
- Early evening KSI crashes were most likely to occur on Tuesday.
- Evening KSI crashes were most likely to occur on Friday.
- Late night KSI crashes were most likely to occur over the weekend, especially on Sunday.

Table 21: Percentage of VRU KSI Crashes by Day of Week and Time of Day

Time of Day	6 AM – 8 AM	8 AM – 10 AM	10 AM – 12 PM	12 PM – 2 PM	2 PM – 4 PM	4 PM – 6:00 PM	6 PM – 8 PM	8 PM – 10 PM	10 PM – 12 AM	12 AM – 6 AM
Day of Week	% of KSI Crashes									
Monday	40.0%	0.0%	22.2%	20.0%	6.7%	9.1%	17.2%	3.4%	6.7%	4.8%
Tuesday	20.0%	60.0%	0.0%	40.0%	20.0%	0.0%	20.7%	17.2%	0.0%	9.5%
Wednesday	0.0%	20.0%	33.3%	20.0%	6.7%	27.3%	13.8%	10.3%	26.7%	4.8%
Thursday	0.0%	0.0%	0.0%	0.0%	26.7%	36.4%	13.8%	10.3%	6.7%	4.8%
Friday	20.0%	0.0%	11.1%	0.0%	33.3%	9.1%	13.8%	27.6%	40.0%	23.8%
Saturday	0.0%	0.0%	22.2%	20.0%	0.0%	18.2%	17.2%	17.2%	13.3%	19.0%
Sunday	20.0%	20.0%	11.1%	0.0%	6.7%	0.0%	3.4%	13.8%	6.7%	33.3%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Early Morning	Morning		Afternoon		Late Afternoon	Early Evening	Evening		Late Night

CMV involved morning KSI crashes show comparable results to vulnerable road user involved crashes, with crash hotspots occurring on similar days and at similar times. However, crashes involving CMV's that occurred over the weekend were clustered around the evening hours. Late night crashes were more evenly distributed across all days, compared to severe VRU crashes, peaking on Thursday. A high concentration of early morning and morning crashes occurred at the start of the week on Monday and Tuesday. A summary of CMV-involved KSI crash findings is listed below:

- Early morning KSI crashes were most likely to occur on Monday.
- Morning KSI crashes were most likely to occur on Tuesday from 8 AM to 10 AM and Thursday and Friday from 10 AM to 12 PM.

- Afternoon KSI crashes were most likely to occur on Monday and Thursday from 12 PM to 2 PM and Thursday from 2 PM to 4 PM.
- Late afternoon KSI crashes were most likely to occur on Friday.
- Early evening KSI crashes were most likely to occur on Monday, Wednesday, and Friday, with none occurring on all other days of the week.
- Evening KSI crashes were most likely to occur on Sunday from 8 PM to 10 PM and Friday from 10 PM to 12 AM.
- Late night KSI crashes were most likely to occur on Thursday.

Table 22: Percentage of CMV-involved KSI Crashes by Day of Week and Time of Day

Time of Day	6 AM – 8 AM	8 AM – 10 AM	10 AM – 12 PM	12 PM – 2 PM	2 PM – 4 PM	4 PM – 6:00 PM	6 PM – 8:00 PM	8 PM – 10 PM	10 PM – 12 AM	12 AM – 6 AM
Day of Week	% of KSI Crashes									
Monday	42.9%	0.0%	14.3%	28.6%	7.1%	0.0%	33.3%	0.0%	0.0%	11.1%
Tuesday	28.6%	60.0%	14.3%	14.3%	7.1%	18.2%	0.0%	0.0%	20.0%	11.1%
Wednesday	0.0%	20.0%	14.3%	0.0%	7.1%	18.2%	33.3%	20.0%	0.0%	11.1%
Thursday	0.0%	20.0%	28.6%	28.6%	35.7%	18.2%	0.0%	0.0%	20.0%	33.3%
Friday	28.6%	0.0%	28.6%	14.3%	21.4%	36.4%	33.3%	20.0%	40.0%	0.0%
Saturday	0.0%	0.0%	0.0%	0.0%	14.3%	9.1%	0.0%	0.0%	0.0%	22.2%
Sunday	0.0%	0.0%	0.0%	14.3%	7.1%	0.0%	0.0%	60.0%	20.0%	11.1%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Early Morning	Morning		Afternoon		Late Afternoon	Early Evening	Evening		Late Night

Lighting Condition

Figure 36 summarizes crashes by reported lighting condition for all modes and for vulnerable road users. KSI crashes occurred most often in daylight and when it was dark outside, but lighting was available.

Compared to all mode crashes, VRU crashes are overrepresented in Dusk and Dark (with or without light) conditions.

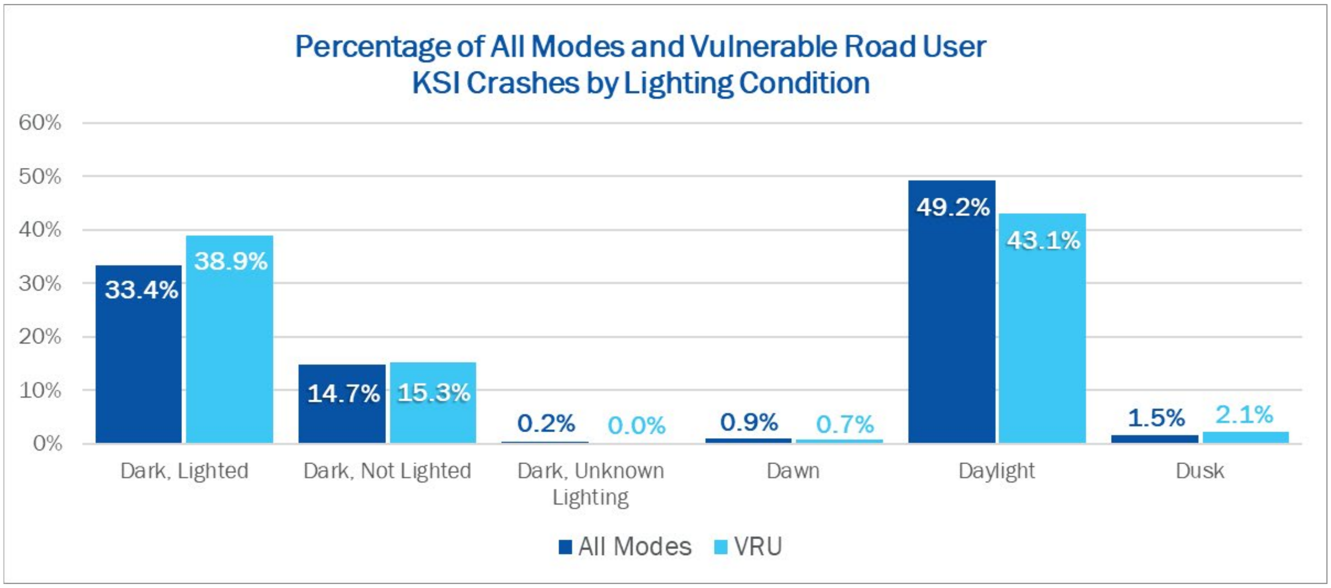


Figure 36: Percentage of KSI Crashes by Reported Lighting Condition

Weather Condition

Figure 37 and **Figure 38** illustrate crashes by reported weather condition for all modes and for vulnerable modes. Regardless of the party involved, most crashes occurred during clear conditions. When it comes to all modes, crashes that occurred during rain and fog made up a larger share of KSI crashes compared to crashes involving vulnerable road users. Clear, cloudy, and rainy weather were the only weather factors in vulnerable road user-involved crashes.

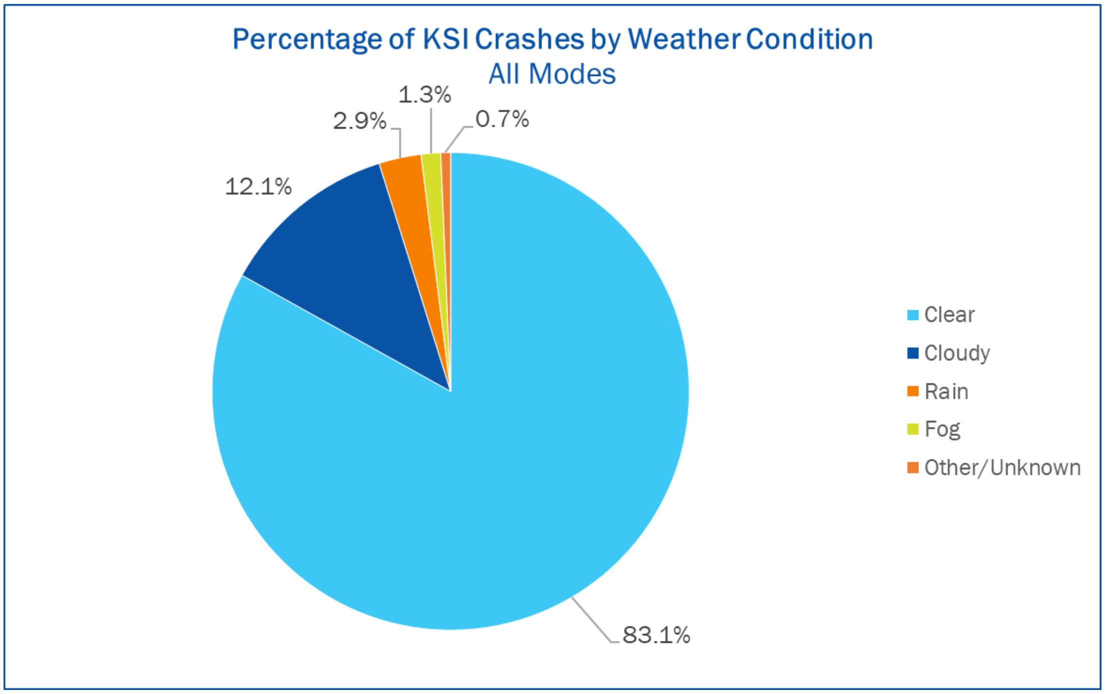


Figure 37: Percentage of All Modes KSI Crashes by Reported Weather Condition

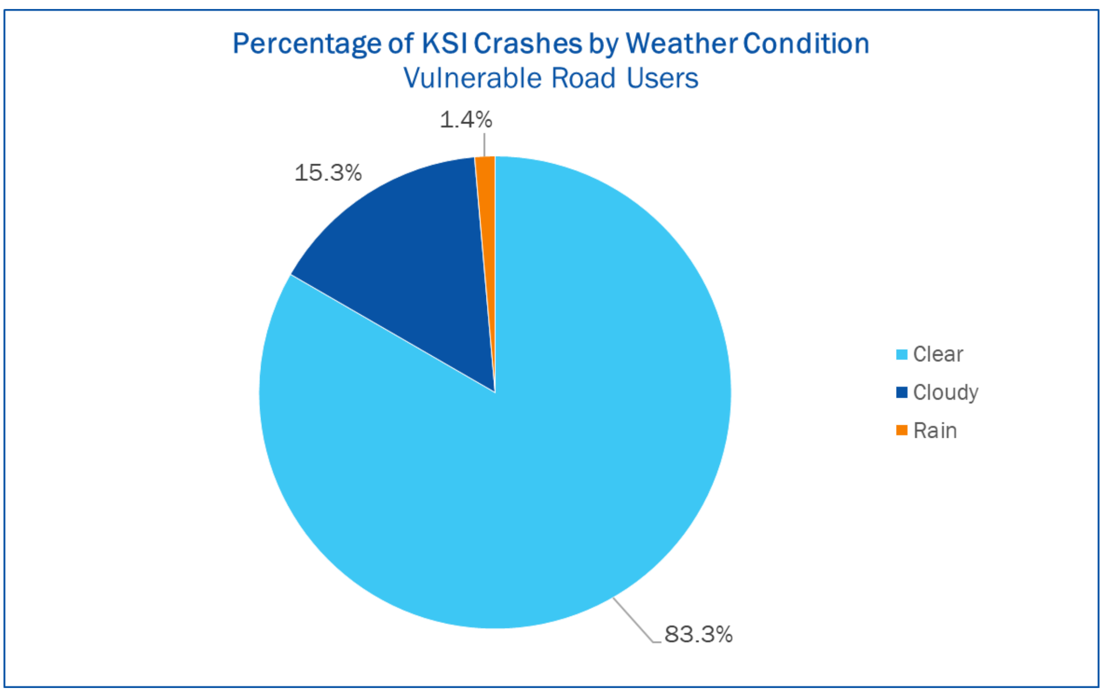


Figure 38: Percentage of VRU KSI Crashes by Reported Weather Condition

Proximity to Destinations

Figure 39 illustrates crashes by proximity to transit stops, schools, and parks for all modes and for vulnerable road users. The following criteria were applied when defining "nearby" for each facility type:

- Crashes near transit include crashes that occurred within 0.25 miles of a transit stop.
- Crashes near schools include crashes that occurred within 0.5 miles of a school.
- Crashes near parks include crashes that occurred within 0.5 miles of a park.

Regardless of involved mode, most crashes happened near transit stops (62.2% of all mode KSI crashes, 70.8% of VRU KSI crashes). 70.8% of all VRU KSI crashes took place within 0.25 miles of a transit stop, 59.0% within 0.5 mile of a school, and 62.5% within 0.5 mile of a park. Instances of severe crashes appear to be more common near transit, schools, and parks when vulnerable road users are involved, likely due to high exposure of VRUs in those areas which highlight the importance of providing VRUs safe access to essential destinations.

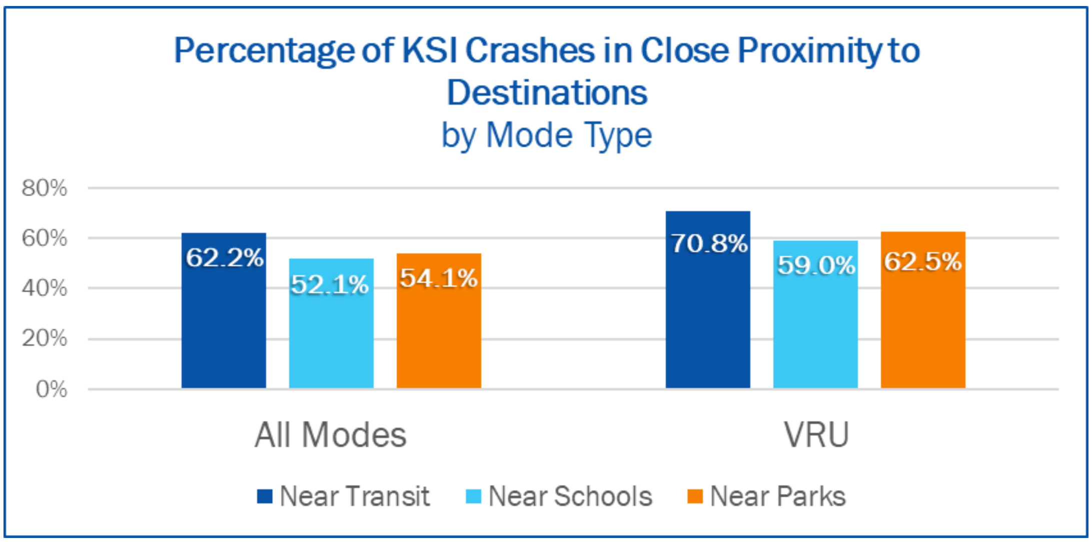


Figure 39: Percentage of KSI Crashes in Close Proximity to Transit, Schools, and Parks

Crash Data Preparation

Crash data for the 5-year period of 2018-2022 was acquired from TxDOT's CRIS data portal. All relational tables were downloaded, although for this analysis, only the crash, unit, person, and primary persons table were used. Prior to the analysis, the person and primary person tables were combined, so any statistics that refer to persons refer to this combined dataset.

Severity

Crash level severity is assigned based on the most severe outcome of those involved, using the KABCO scale. For example, a crash where one person had a suspected minor injury (B), and another person had a possible injury (C), the overall crash would be assigned a severity of suspected minor injury (B). Severity was determined by first examining the severity for all persons involved in each crash, using their injury severity ID. For crashes that did not have any associated persons, information from the unit table was used. For these crashes, severity was determined using the columns that listed the count of each severity (death count, serious injury count, etc.), with the assigned severity being the most severe injury level with a value > 0. Note, for any crash where all severity counts were 0, the crash was assigned not injured(O).

Mode

Crash level mode is assigned based on the most vulnerable mode involved, using the order: pedestrian, bicyclist, motorcyclist, motor vehicle. For example, if a crash involved a pedestrian and motor vehicle, the overall crash would be assigned a mode of pedestrian. VRU modes were considered as pedestrians, bicyclists, and motorcyclists. Mode was first assigned at the person level, based on the person type ID. For any crashes that did not have any associated persons, information from the unit table was used. For these crashes, mode was determined using both the unit description ID to differentiate between pedestrians/bicyclists and motor vehicles (of any variety), and vehicle body style ID to differentiate between motorcycles and all other motorized vehicles.

Behaviors

Crash behaviors were determined using different person, unit, and crash level data, depending on the behavior.

Impairment crashes were any crashes that involved alcohol and/or drug use. This was determined at the person level by any person who had a positive alcohol test result, positive drug test result, or a BAC value > 0.08, and at the unit level by any unit that had a contributing factor of alcohol or drug impairment. Any crash with a person and/or unit meeting the above criterion were flagged as impairment involved.

Distraction crashes were determined based on unit level data. Any unit that listed a contributing factor of driver inattention, or any cell/mobile phone usage (talking, texting, etc.) was considered distracted driving. Any crash that involved a distracted unit was flagged as a distracted driving crash.

Speeding crashes were determined based on unit level data. Any unit that had a contributing factor of unsafe speed, speeding over the limit, or failure to control speed was considered as speeding. Any crash that involved a speeding unit was flagged as a speeding crash.

Aggression crashes were determined based on unit level data. Any unit that had a contributing factor of road rage was considered as aggression related, and any crash that involved an aggressive unit was flagged as an aggression crash.

Lane departures were determined based on unit level data. Any unit that had a contributing factor of changing lanes when unsafe or failure to drive in a single lane was considered as lane departure. Any crash that involved a lane departing unit was flagged as a lane departure crash.

Fleeing police was determined based on unit level data. Any unit that had a contributing factor of fleeing or evading police was flagged, and any crash that involved such a unit was flagged as a fleeing police crash.

No restraint was determined based on person level data. A person that was listed as having a restraint of none was flagged as not using a restraint (i.e. seatbelt or child seat). Note, the value of none differs from the value of not applicable based on context, i.e. the driver of a motor vehicle not using a seatbelt would be listed as none, while a pedestrian, who is technically not wearing a seatbelt either, would be listed as not applicable. Any crash that had involved a no restraint person was flagged as no restraint overall.

Spatial Adjustment

The CRIS data received was already geolocated. For all crashes that were not geocoded to TxDOT on-system roads, these locations were used as they were received. For crashes there were geocoded to TxDOT on-system roadways, post processing was preformed to adjust their location. This was necessary because CRIS snaps all on-system crashes to the combined centerline of the roadway mainline. This means that there is not a way to spatially differentiate crashes that occurred on different sides of a divided highway, nor crashes that occurred on a frontage road from the mainline highway. This effect was more pronounced on one-way paired couplet highways, where the actual directional centerlines were two physically different roads, but the combined centerline was the geographic median and ran through the middle of the block between the two roads.

To correct for this, attributes from the CRIS crash data, and the attributes plus spatial properties of the TxDOT roadway inventory were used in combination. Crashes were subset using the on-system flag and identified as either mainline or frontage road using the roadway part ID. Roadways to adjust the crash locations to were subset from the overall TxDOT roadway inventory as well as identified as mainline or frontage based on its record type. The true azimuth of the roadway segment was also calculated, with the direction of travel being determined by the segment's roadbed identifier. Crashes were then associated in a one-to-many relationship with these roadway segments based on highway number (attributes present in both datasets) and being within a search tolerance based off the roadway's right-of-way width, except for one-way paired couplets, where the distance was based off the distance between the two couplets.

The CRIS data dictionary lists that cardinal roadway direction as an attribute within the crash level dataset, however that attribute was not present within the dataset acquired from the CRIS website. Instead, vehicle direction of travel was used, although this information was not always present within the vehicle level data, and some multi-vehicle crashes had different vehicle directions. For any crashes not matched based on vehicle direction, roadway direction was attempted to be interpreted based on directional elements within the street name reported in the crash, i.e. 'North', 'Northbound', 'NB', 'NBND', etc. Any crash (still matched on the previously described attribute and spatial criterion) with a difference between interpreted direction and roadway azimuth less than 45° for vehicle based direction and 90° for name based direction (vehicle used a lower tolerance because vehicle directions were provided in 45° increments, i.e. northwest, southeast, etc., while name based directions were assumed in 90° increments, i.e. north, south, etc.) was assigned to the closest point on the segment, relative to the original crash location. Using this methodology, approximately 75% of the potentially fixable on-system crashes were relocated.

Location Assignment

Crashes were assigned to their nearest roadway segment or intersection, and then classified as a segment-based or intersection-based crash. Crashes that were not located neither were not assigned, and not used for any spatial descriptive statistics, although they were still used for non-spatial descriptive statistics. Crashes were first assigned to the nearest roadway segment within 50 ft. Then, these crashes were assigned to the nearest intersection within 50 ft, with that the segment that there were associated with also participate within the intersection (as determined by name). That requirement used so that crashes on segments were not assigned to adjacent, but non-connected intersections, such as a crash on a highway being assigned to the intersection of an adjacent frontage road.

Note, this assignment of intersection-based crashes is different from the intersection flag within the original CRIS dataset which is taken from the original crash report and refers to the physical location of the crash being within an intersection, while the distance-based methodology considers an intersection's area of influence. For example, a vehicle being struck whilst queuing at an intersection may not be flagged as physically occurring within an intersection itself, although the conditions that contributed to that crash were influenced by the presence of that intersection.

Spatial Data Consolidation

This analysis used TxDOT's roadway inventory for its base network. This was chosen due to its complete spatial coverage, and almost complete attribute coverage for the study area. However, this dataset did have issues, most notably duplicative linework, topologically inaccurate geometries, and the lack of an associated intersection dataset.

Within the full roadway dataset, roadways come with a combined roadbed centerline, but some roadways also come with additional directional roadbed centerlines for divided roadways. To address the first issue of duplicative geometries, the full roadway inventory was subset based on some of its attributes. Combined centerlines were used for roads that were listed as combined roadbed, and a highway design of either one-way or two-way undivided. Directional centerlines were used for roads that were not listed as combined roadbed, and a not a two-way undivided design. There were some outlier roads which only came as a combined roadbed but were listed as two-way divided roads. For these, they were only added if they were not already caught by the above logic, as determined using spatial overlap analysis.

The TxDOT roadway dataset also did not have topologically accurate geometries, which presented problems for subsequent analyses which relied on spatial precision. The issues were threefold: geometries which were too short and did not connect to each other; geometries which were too long and created overshoot segments; and roadway start/endpoints which were not aligned. The issues of lines being too short were addressed by taking all dangle nodes (start/end points of lines which did not connect to another line) and creating an artificial extension of the original line. If this line intersected with another line, the relative difference in angles was calculated. If this difference was greater than 45°, the original line was extended out to where it met the intersecting line. The issue of lines being too long was handled using the same approach, except that instead of artificially extending the line, the line was artificially shortened, and if the intersection of this shortened line and network was considered valid, the original line was reduced to that location. To address the issue of roadway line's start/end point not being aligned, all unique start/end points were buffered by a slight distance, and any overlapping buffers dissolved. For any point that was not equal the centroid of the buffer, i.e. the input points were nearby, but not coincident, they had their geometry relocated to the centroid of the buffer. For any roadway segments who's start/end points were affected by this, they had the respective first/last vertex set to the updated point's location.

While the TxDOT roadway dataset contained roadway data, it did not contain intersection data, nor was any associated intersection data available. Therefore, intersection locations were created from the roadway data. However, since the dataset is LRS, intersection location could not be determined from where lines start/end naturally intersected with each other. Instead, all candidate intersection locations were generated from the intersection of all lines. This process created points which were not real-world intersections, such as when the line of an overpass cross over a controlled access highway, or a single road is split into multiple segments due to a change in attributes. To remove these, and other false positives, a generated point was only considered an intersection if: it had 3 or more legs, none of the intersecting legs were bridges (as determined by if it had a bridge structure ID), none of the intersecting legs were listed as grade separated, and none of the intersecting legs were access controlled. This yielded a mostly clean intersection dataset. However, there were some locations where the intersection of divided centerlines caused multiple points to be generated for a location that operates as a single intersection. These locations were identified based on spatial proximity, and matching roadway names and functional classes, and where present, these multiple points were collapsed into a single point to represent the overall intersection.

Functional Classification

Functional class was present and fully populated within the TxDOT roadway inventory.

Lane Count

Lane count was present and fully populated within the TxDOT roadway inventory.

Annual Average Daily Traffic (AADT)

Current AADT was present and fully populated within the TxDOT roadway inventory.

Speed Limit

Speed limit was present within the TxDOT roadway inventory, although its coverage varied. Speed limit was present for all on-system roads, but very few off-system roads. Speed limit data was provided by the City of Laredo and conflated onto the network where it was missing. However, this dataset only had coverage for the city, not the full county. Data from county-wide OSM was next conflated onto the network to further fill in data gaps. Finally, any remaining unknown segments were assigned a value based on an average of known values from roads of the same name/functional class within the same location, except for local functional class roads, where the regulatory default of 30 mph was applied.

Intersection Control

Intersection control was assigned to all intersections generated by the previously mentioned process. Control information came from two sources, the City of Laredo, and OSM. Within the City of Laredo's roadway dataset, there were columns that indicated if the start/end of a road segment had a stop sign or traffic light. When indicated, the start/end points of these roads were converted into points. Within OSM, nodes with the highway tag for stop signs and traffic signals were used. For both datasets, those with traffic signals were used as indicated. For stop signs, only all-way stops were assigned to intersections. For City of Laredo data, that was determined if the number of points generated from the lines matched the number of legs of the intersection, and for OSM, if the node was tagged with the value of 'stop' with the additional stop tag of 'all'.

Crash Maps

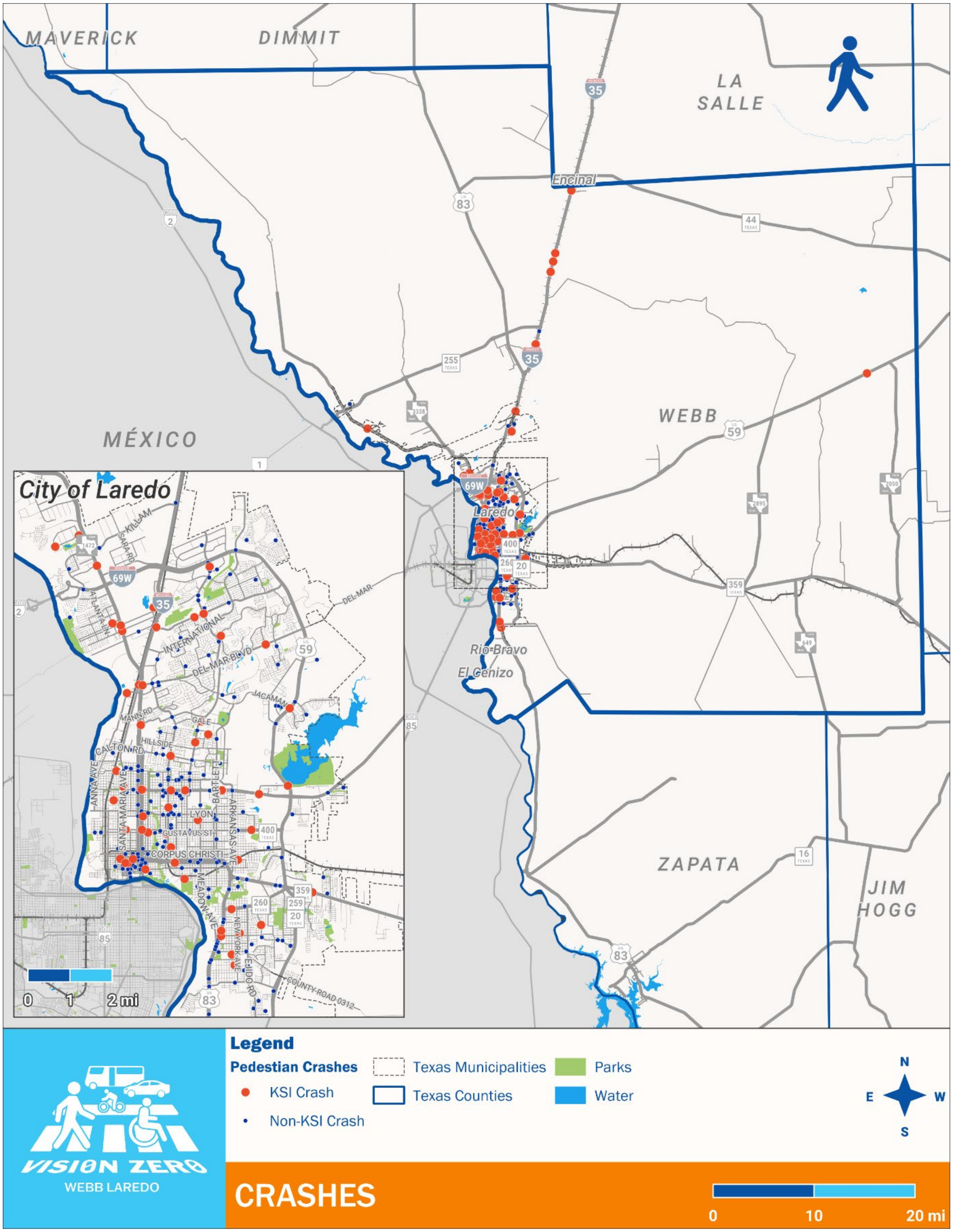


Figure 40: Pedestrian Crash Map

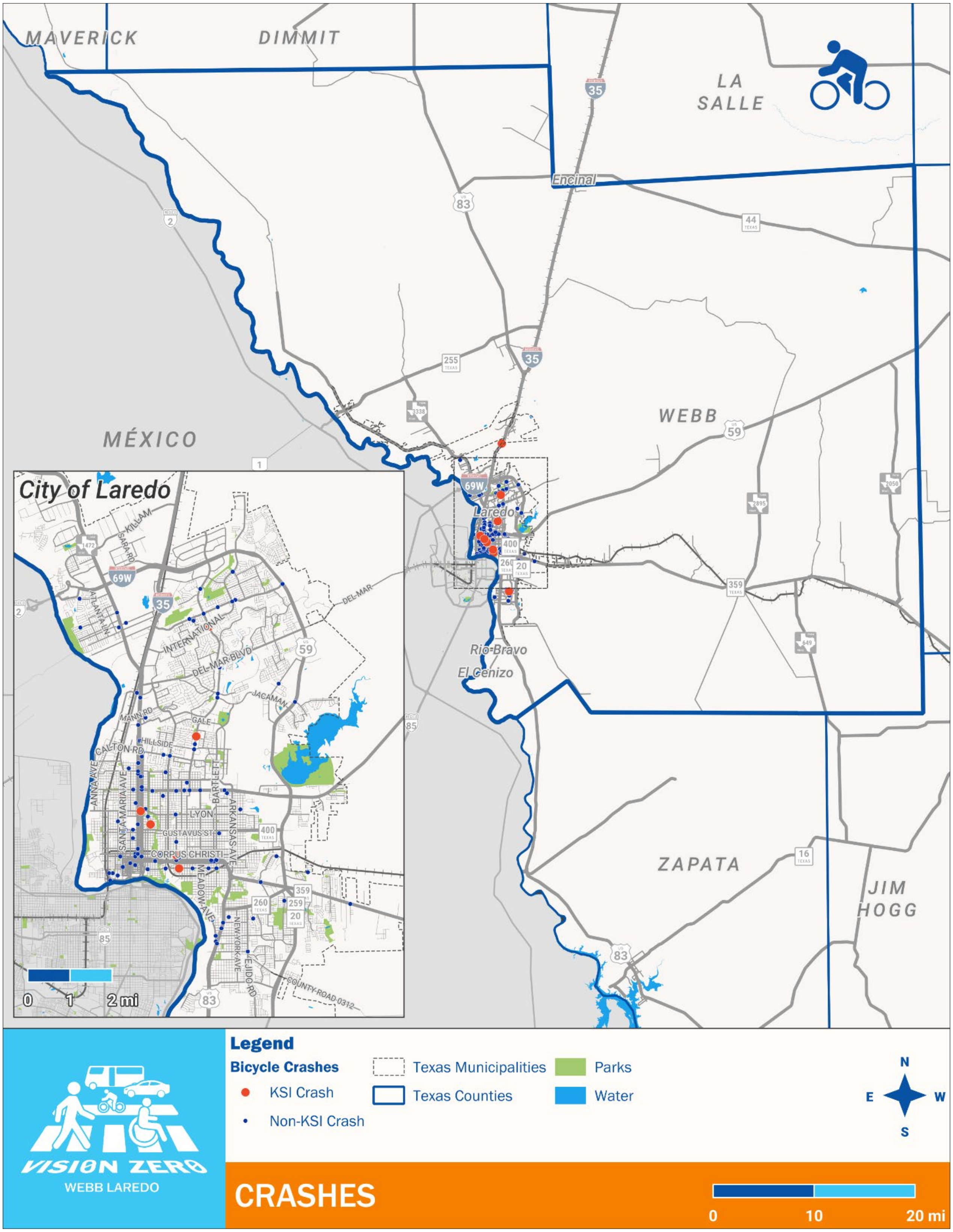


Figure 41: Bicycle Crash Map

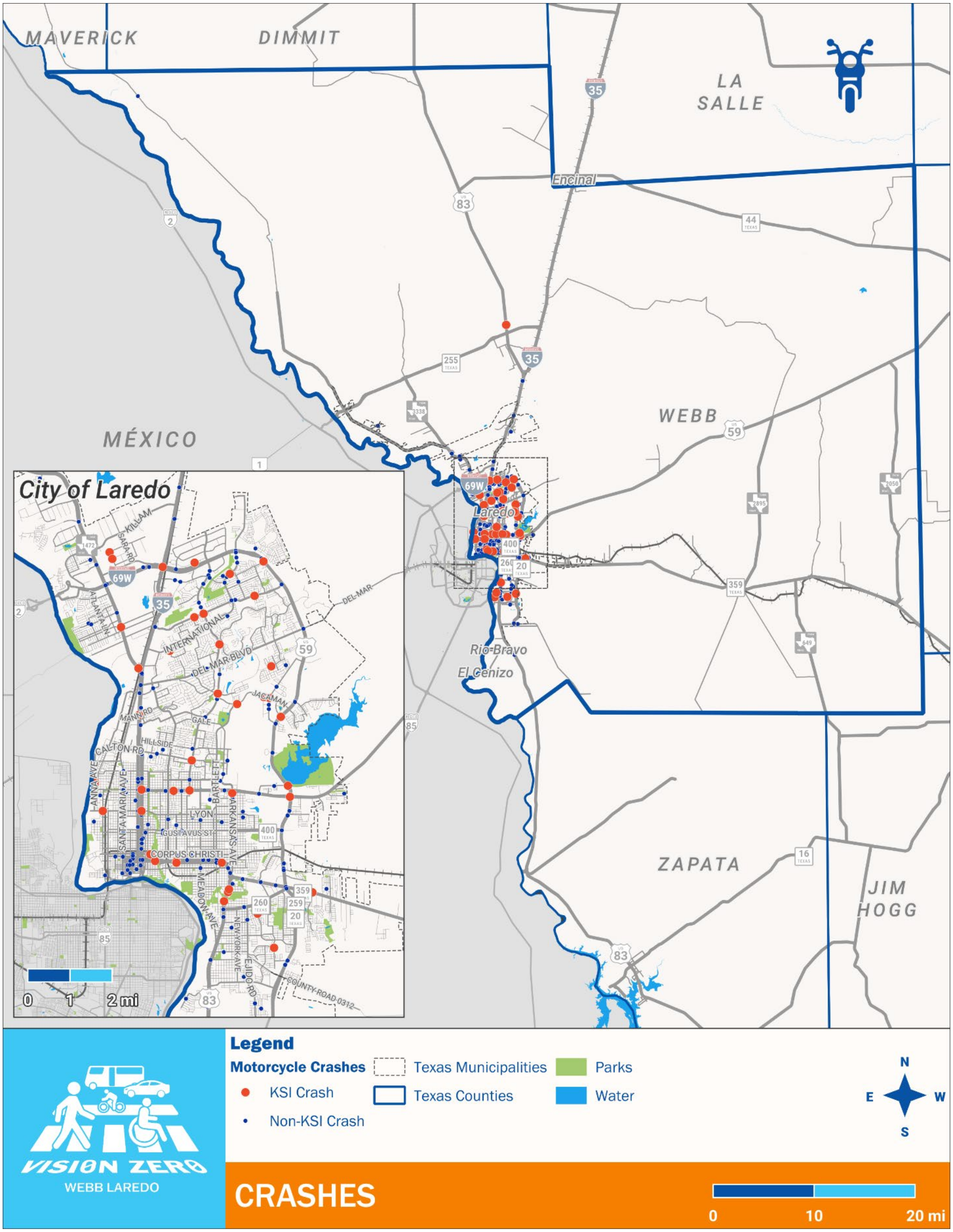


Figure 42: Motorcycle Crash Map

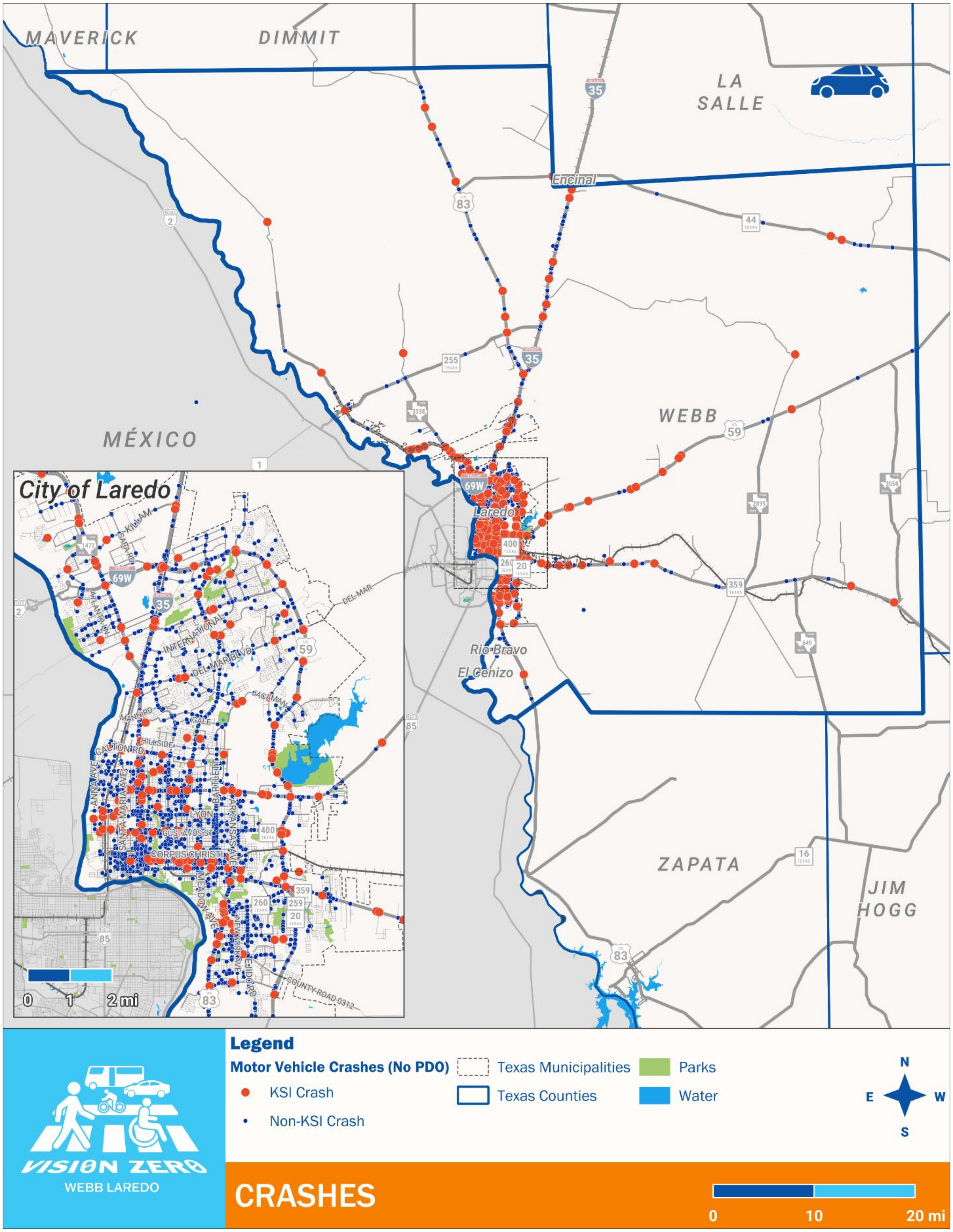


Figure 43: Motor Vehicle Crash Map

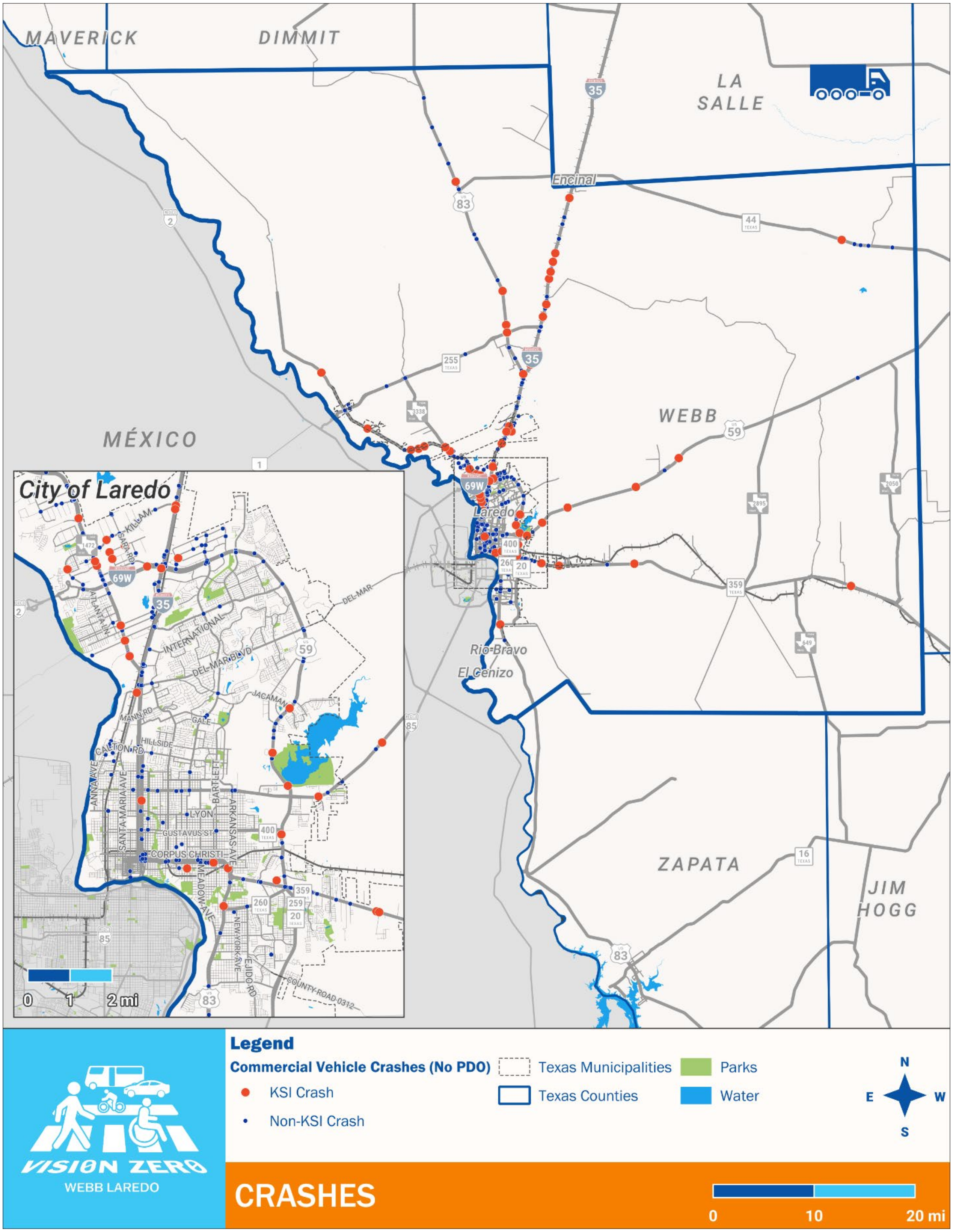


Figure 44: Commercial Vehicle Crash Map

High Injury Network

The following High Injury Network (HIN) and Sliding Windows Analysis maps were created as part of the Laredo Safety Action Plan. The following memo describes the crash data sources, methodologies, and thresholds for the development of the maps created.

Crash Data Sources

Crash data for the 5-year period of 2018-2022 was acquired from TxDOT's CRIS data portal. All relational tables were downloaded. The crash, unit, person, and primary persons tables were used for this analysis. For additional information on how crash mode and severity were assigned, see Crash Data Analysis Report.

Sliding Windows Analysis Methodology

A sliding windows analysis helps understand crashes throughout a transportation network and identify segments with the highest crash density and crash severity. The analysis works by determining the number and severity of crashes along a longer segment (the window) of a roadway and sliding that window along the network at set intervals. In this approach, the virtual window is moved along each corridor, counting the number of crashes by density and severity by mode that occurred within each successive segment. A buffer of 75 feet on either side of the segment is used to capture crashes that are not precisely aligned with the roadway network. An example of a sliding windows analysis is shown below.

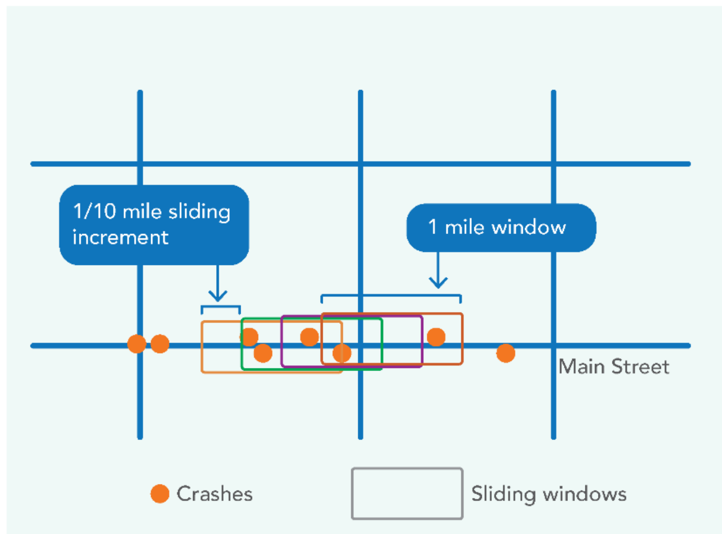


Figure 45: Sliding Windows Analysis Methodology

Given the large size and diversified urban form of Webb County, two separate sliding window analyses were run: one for urban areas, and one for rural areas. This was so that different parameters more appropriate to each context could be used. The urban HIN used a 0.5 mile long window, which slid along the network at 0.1 mile increments, while the rural HIN used a 2 mile long window, which slid at 0.5 mile increments. For both networks, all roads were split based on name, functional class, and contiguity. Both intersection and segment crashes were included in this evaluation, as the focus is on overall corridor conditions.

The sliding windows analysis was done for each mode (bicycle, pedestrian, motorcycle, and motor vehicle), as well as commercial vehicle (CMV) related crashes. For modal crashes, a crash was assigned a single mode based on the most vulnerable mode involved, for example, a crash between a motor vehicle and a bicyclist would be classified as a bicycle crash. For CMV-related crashes, any crash that is flagged as CMV involved in CRIS (regardless of modes involved) was counted for that sliding window analysis.

The score for each window was determined based on the frequency and severity of crashes by mode. Fatal injury (K) and suspected serious injury crashes (A) were weighted x3, suspected serious injury (B) crashes were weighted x2, and possible injury (C) were weighted x1, no apparent injury (O), and unknown injury (U) were weighted x0. Once the weights are established and applied to the crashes, the number of crashes is aggregated to each window, incorporating the crash severity weighting. For example, if a segment had 1 A crash, 1 B crash, 2 C crashes, and 5 O crashes, it would receive a score of 7; (1x3) + (1x2) + (2x1) + (5x0).

Sliding Window Analysis Maps

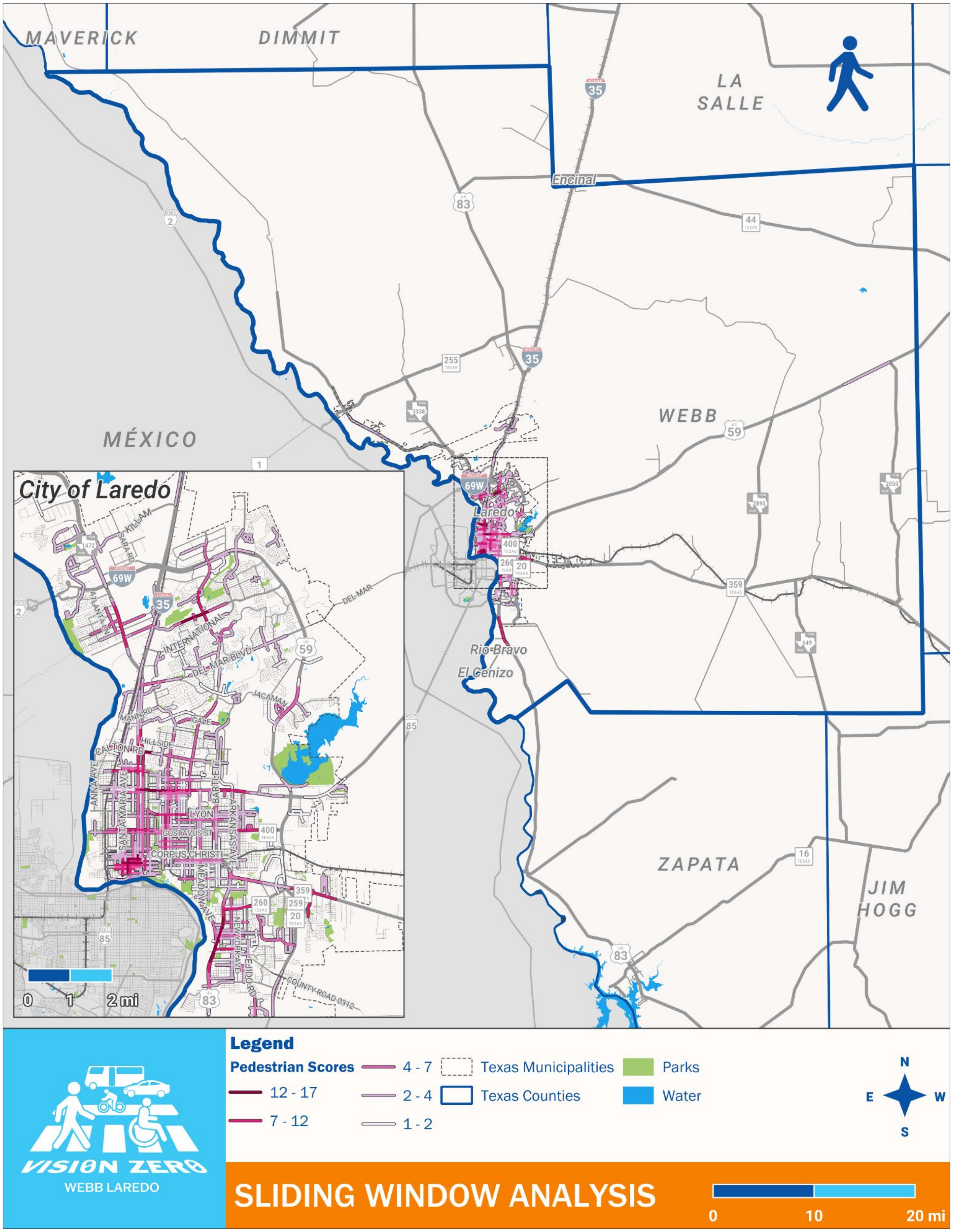


Figure 46: Sliding Window Analysis Pedestrian Scores Map

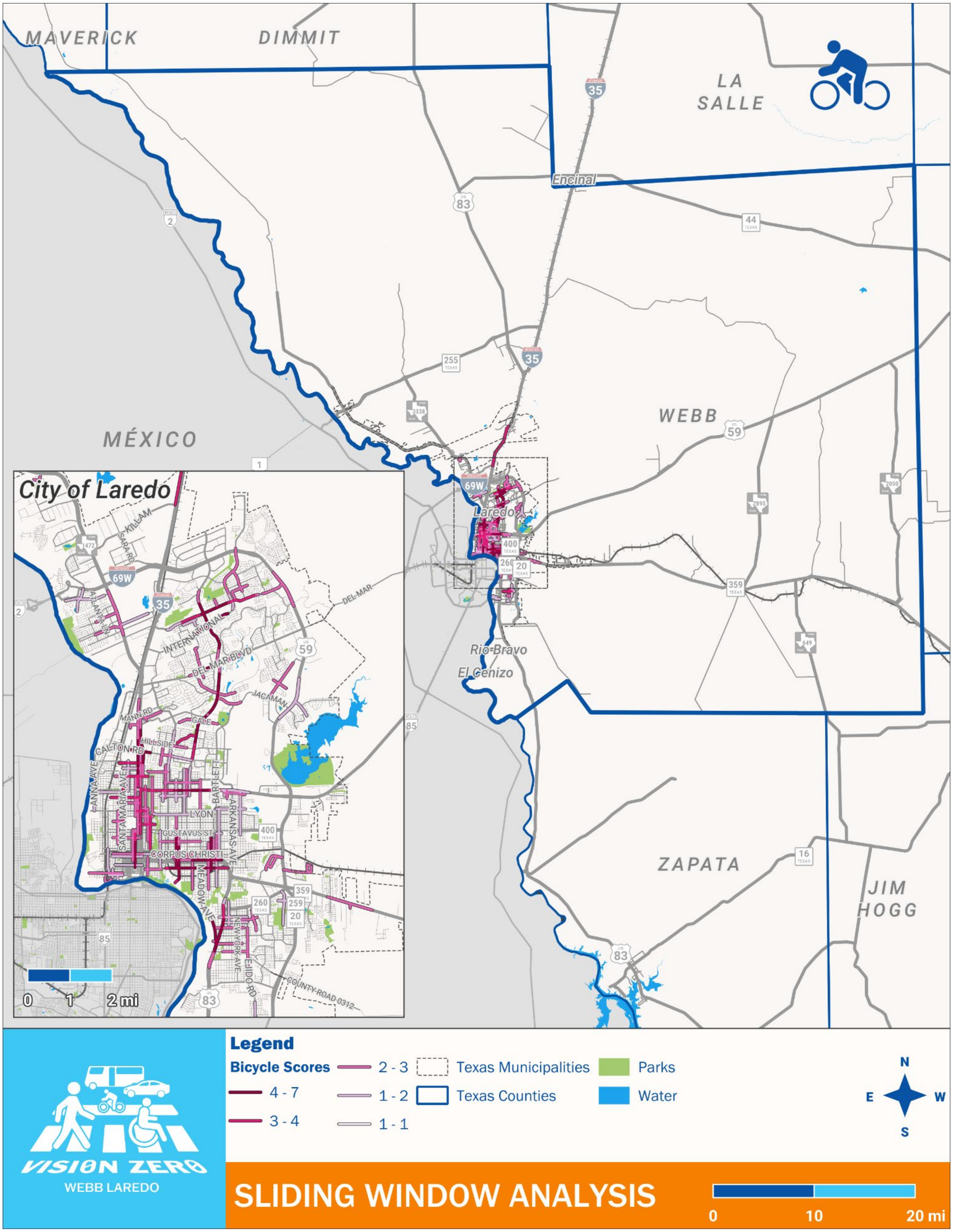


Figure 47: Sliding Window Analysis Bicycle Scores Map

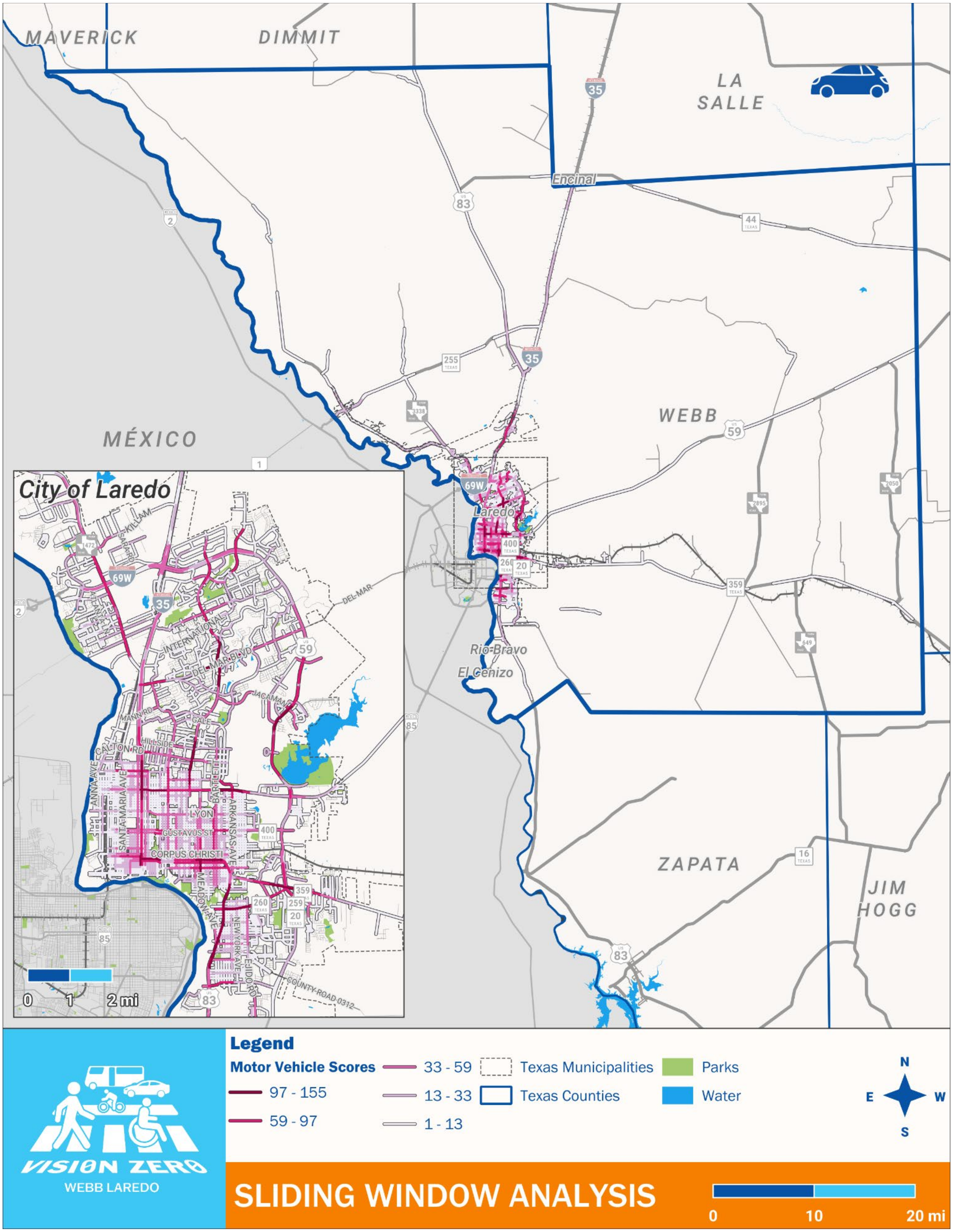


Figure 48: Sliding Window Analysis Motor Vehicle Scores Map

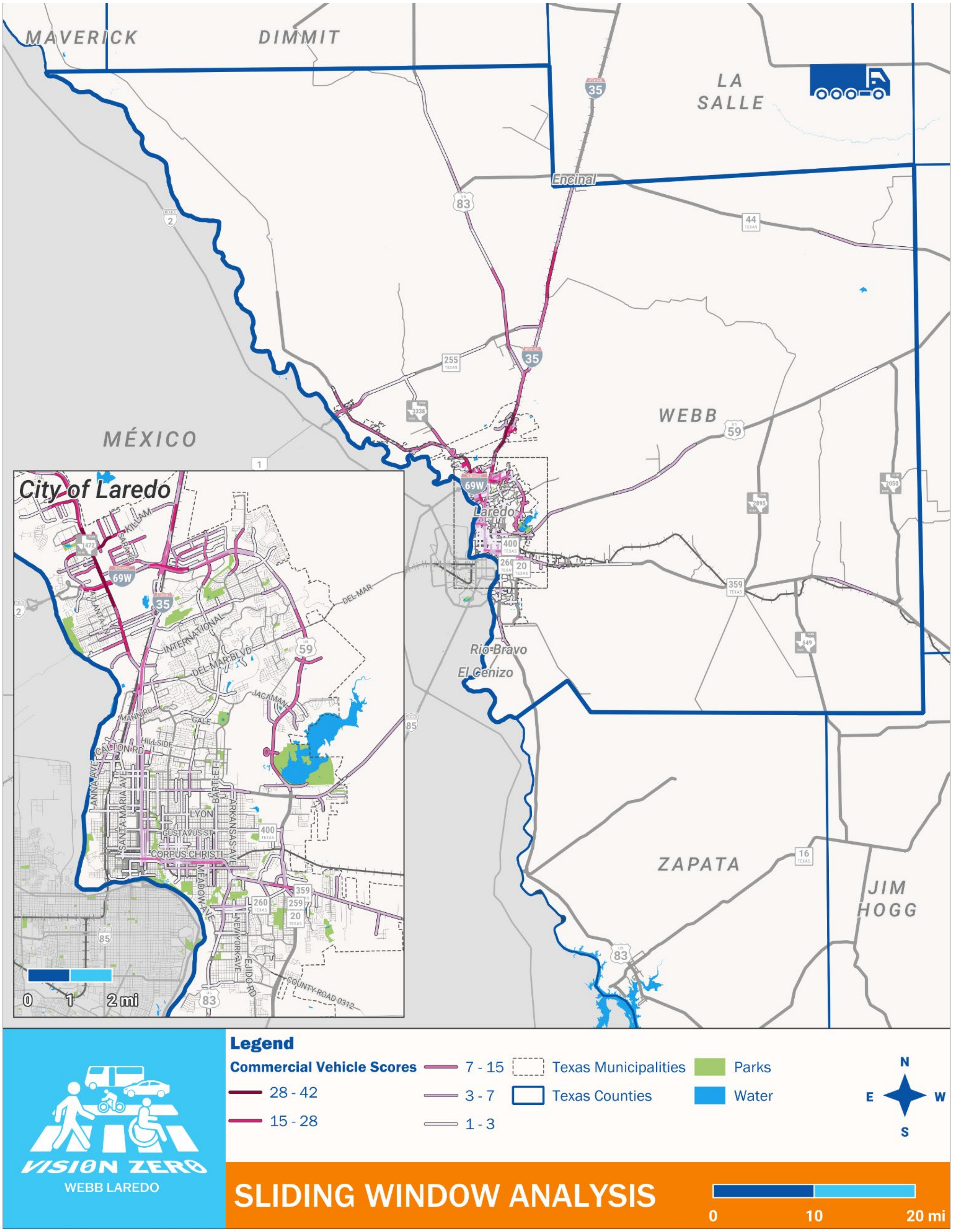


Figure 49: Sliding Window Analysis Commercial Vehicle Scores Map

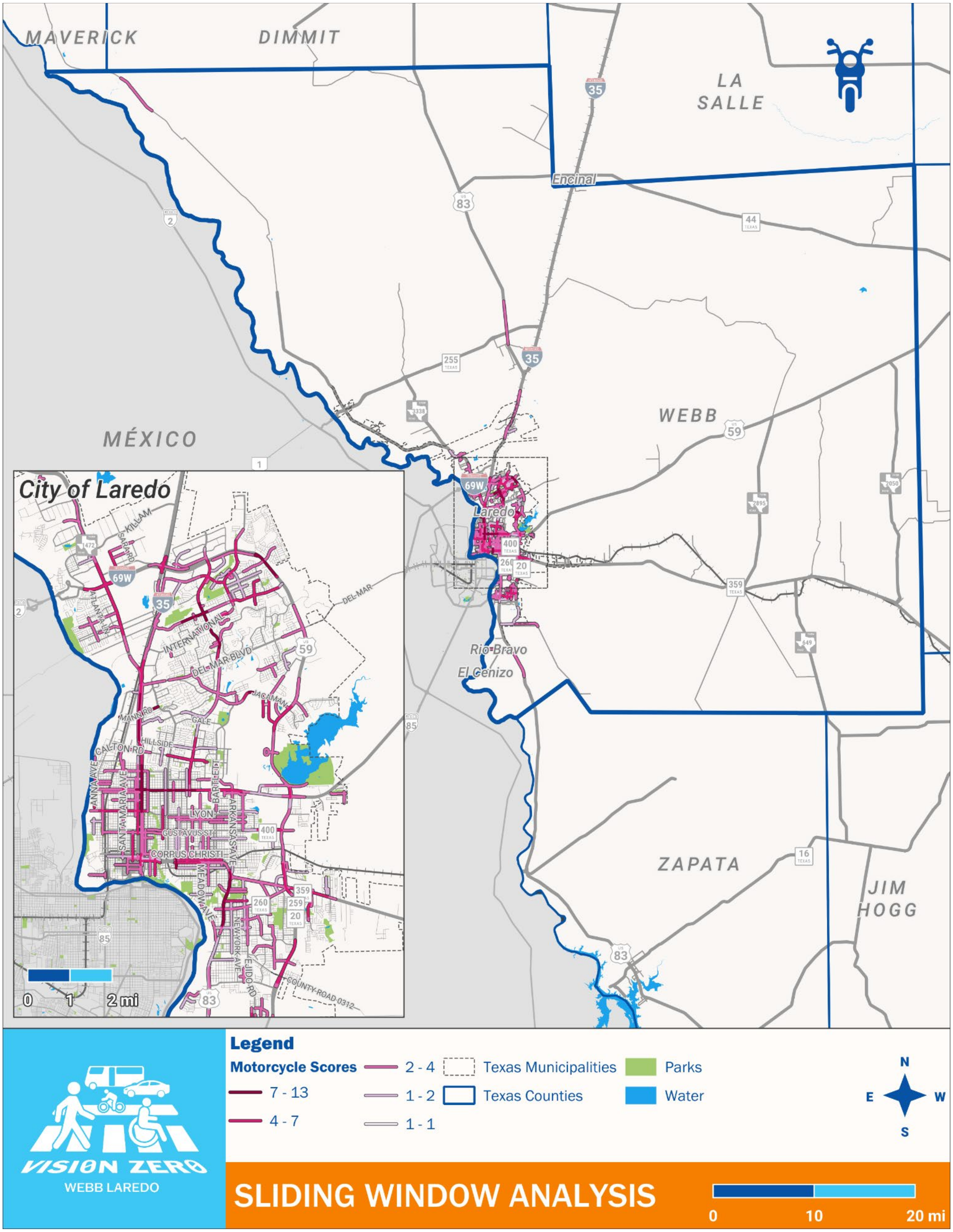


Figure 50: Sliding Window Analysis Motorcycle Scores Map

Development of High Injury Network

The development of a HIN is a key element of a safety plan to help prioritize where historic crashes have occurred at the greatest density and severity. The HIN development process involves developing crash density estimates along street corridors throughout the region, weighing them by crash severity, and then identifying the highest crash risk sections for each mode individually from the sliding windows analysis.

High Injury Network Process

Development of the HIN should emphasize that the key goal of the safety action plan is the elimination of fatal and serious injury crashes. The combination of crash injury severity and frequency ascertained from the sliding windows analysis helps to achieve that goal by providing scores for all segments. The next step in the process is to examine those scores to determine where the areas of highest injury are. This is done using the following steps:

1. Map the sliding window analysis results for each mode (as well as commercial vehicles) individually.
2. For each mode, determine the threshold score required to be included in the HIN for that mode. This step eliminates streets that have a lower crash density thereby prioritizing streets that have higher crash severities and frequencies.
3. With a HIN created for each mode, create an overall HIN, which is comprised of any segment that is on one or more modal HIN.

High Injury Network Thresholds

The goal of setting the sliding windows score threshold is to settle on a score for each mode that will identify key corridors where safety risk is highest. These scores differ by mode and location in some instances due to the differences in the number of crashes for each. For example, a score of 10 may be high for the pedestrian network, but relatively low for a motor vehicle network since there are so many more motor vehicle crashes than pedestrian crashes. A segment that meets or exceeds the threshold score for that mode will be assigned as being part of that mode's HIN. The threshold scores used for the Laredo Safety Action Plan are listed below in **Table 23**.

Table 23: High Injury Network Thresholds Scores

	Mode	Threshold Score
Urban	Pedestrian	8
	Bicycle	5
	Motorcycle	9
	Motor Vehicle	75
	Commercial	15
Rural	Pedestrian	5
	Bicycle	3
	Motorcycle	3
	Motor Vehicle	25
	Commercial	15

After these thresholds were applied, both the modal and overall HINs were created. Comparing the fraction of crashes – especially KSI crashes – that are on the HIN against the fraction of roads that make up the HIN (by roadway centerline mileage) illustrates how a small subset of roads account for a disproportionate share of crashes, especially KSI crashes.

Table 24: Percentage of All and KSI Crashes on HIN Roadways by Mode

Mode	Percentage of Crashes on HIN		Percentage of Roadways that are HIN
	All	KSI	
Pedestrian	22.18%	32.14%	1.14%
Bicycle	23.45%	50.00%	0.61%
Motorcycle	28.75%	30.00%	0.64%
Motor Vehicle	28.05%	30.23%	3.11%
Commercial	35.62%	41.10%	2.07%
Overall	**27.97%**	**30.99%**	**5.78%**

High Injury Network Maps

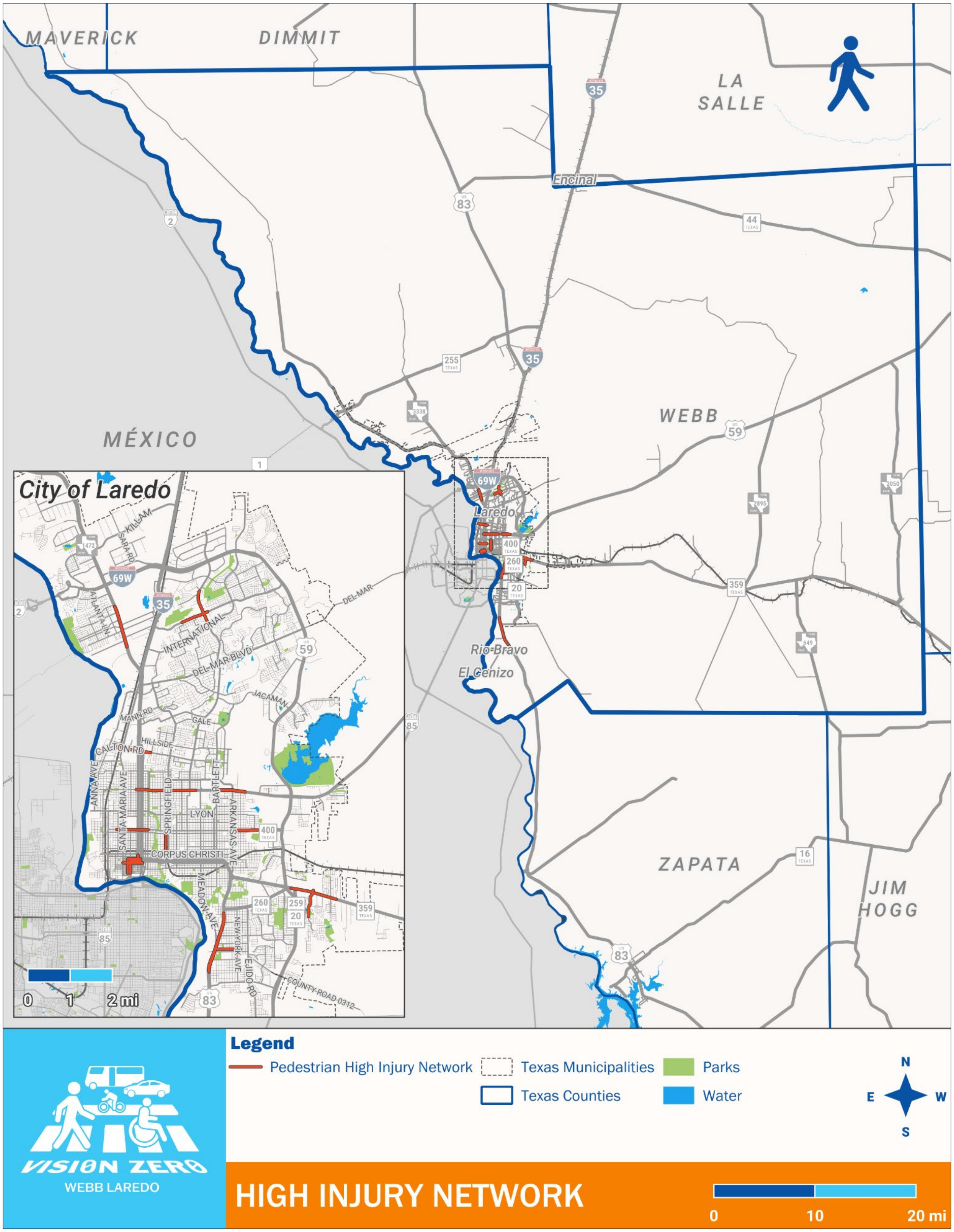


Figure 51: Pedestrian High Injury Network Map

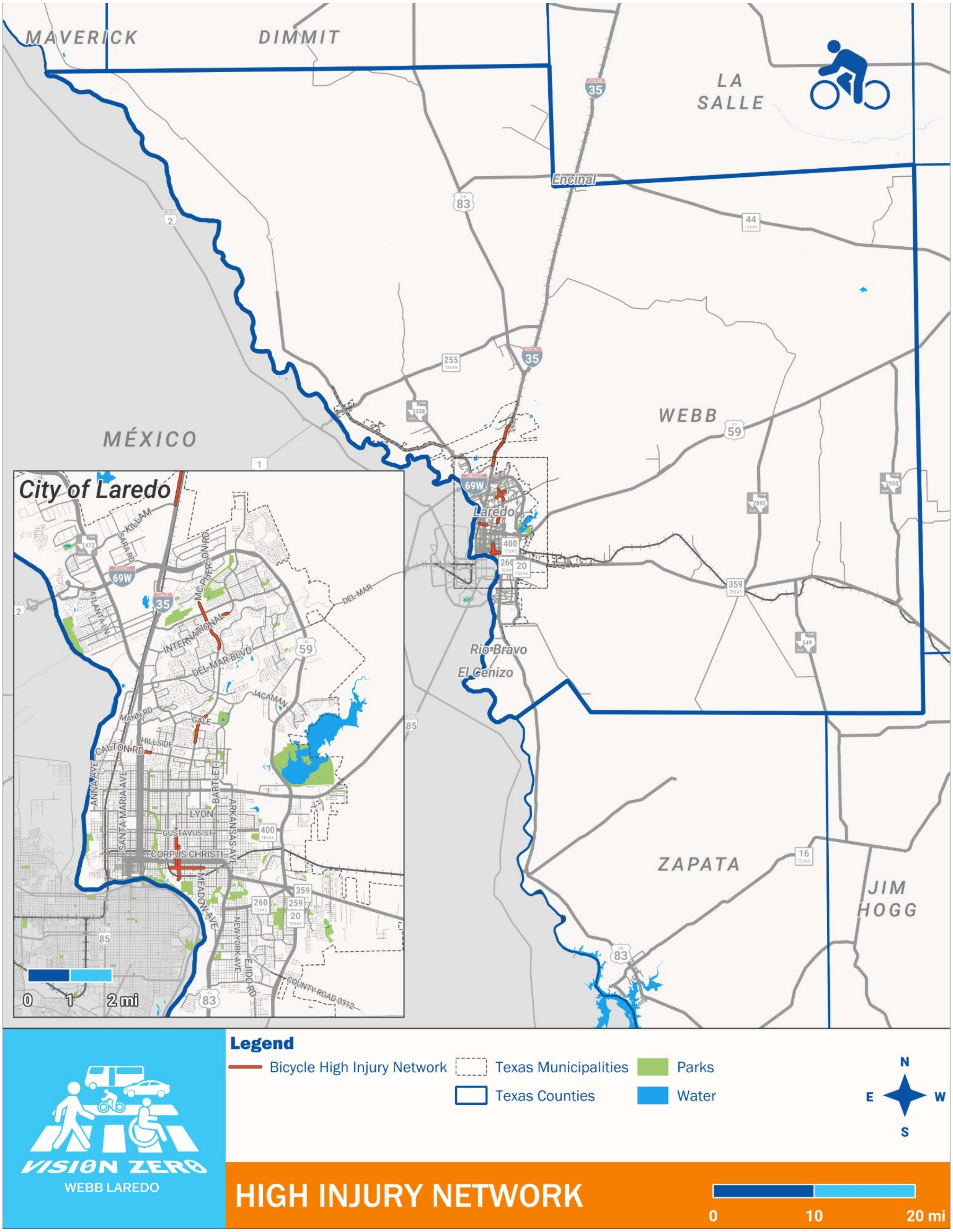


Figure 52: Bicycle High Injury Network Map

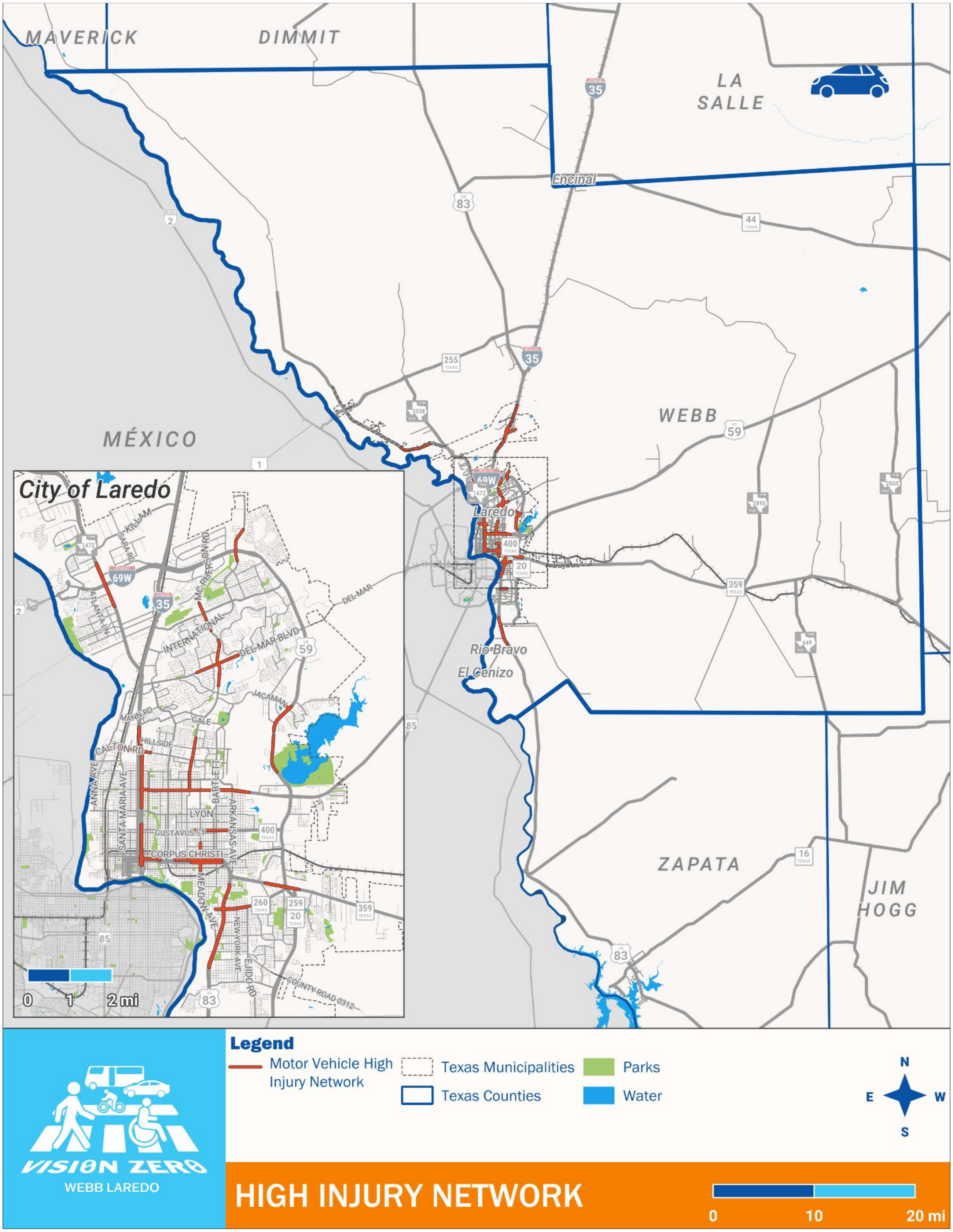


Figure 53: Motor Vehicle High Injury Network Map

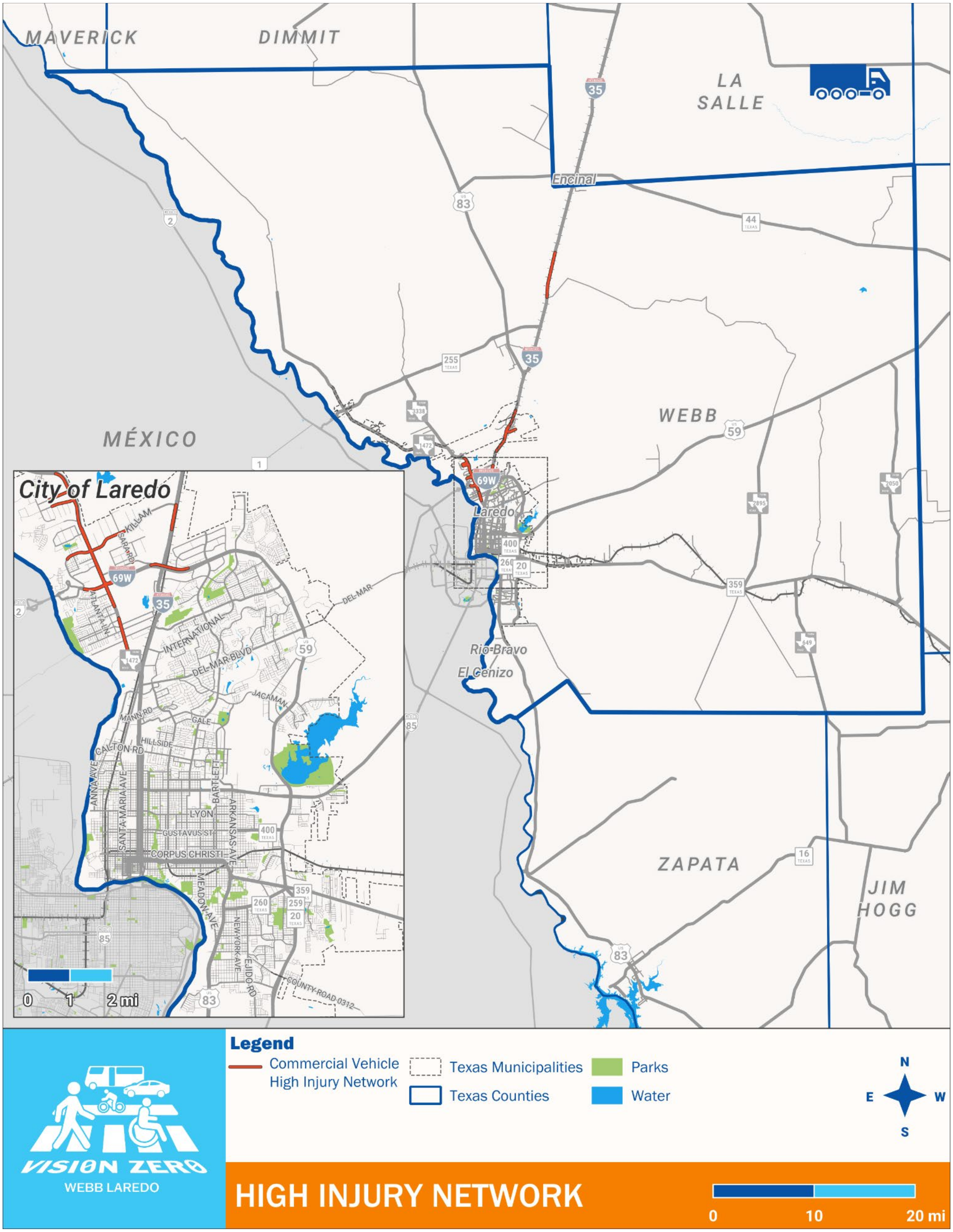


Figure 54: Commercial Vehicle High Injury Network Map

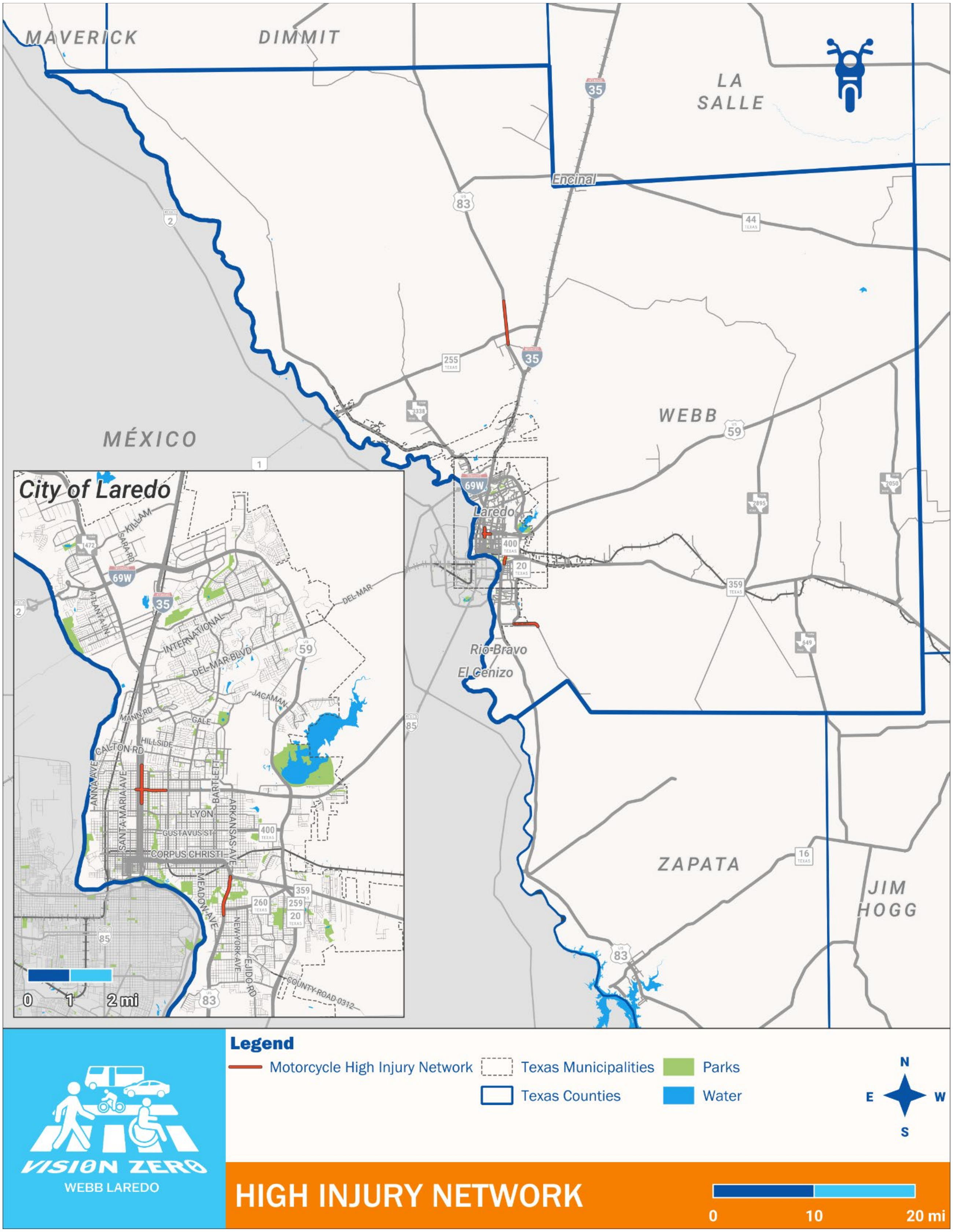


Figure 55: Motorcycle High Injury Network Map

Systemic Safety Analysis

The purpose of this section is to document the systemic analysis process and results conducted as part of the Laredo Safety Action Plan. This systemic analysis will help the Webb County-City of Laredo Regional Mobility Authority identify roadway facilities with the greatest potential for safety improvement by identifying combinations of roadway attributes and other contextual factors associated with above-average serious crash frequencies for different crash modes.

Systemic Screening Factors

One of the key outcomes of the systemic safety analysis is the identification of attributes of roadway facilities that have been found to correlate with high crash frequency. These are also known as systemic screening factors or risk factors. Combinations of these factors identify roadway facility profiles that are associated with higher crash frequencies. However, it is important to note that this does not necessarily indicate a causal relationship, nor that these individual factors should necessarily be the target of treatments. For example, though the presence of nearby pedestrian generators may be found as a factor that correlates with elevated pedestrian crash frequencies, this does not mean that these generators should be removed, but instead that facilities near such generators may require additional safety investment.

Screening factors and roadway facility profiles should be studied from a practical and policy-driven perspective to determine what components may be reasonable targets of safety improvements and which should be viewed primarily as non-causal correlations.

Table 25 includes all roadway segment attributes that were prepared and identified as candidate risk factors for consideration in the analysis. Factors considered in the analysis were limited by data quality and availability.

Table 25. Factors Screened for Systemic Analysis

Screening Factor	Description
State Roadway System	On or off the state roadway system
Land Use Setting	Rural or urban context
Truck Route	Designated truck route or not
Functional Class	High functional class (arterials and freeways) or low functional class (collectors and local streets)
Speed Limit	Binned speed limit range of ≤35 MPH, 40-45 MPH, or 50+ MPH
Lane Configuration	Two-lane or multilane configuration
Lane Width	Average width of through lanes on the segment
Traffic Volume Range	Average annual daily vehicular traffic of 0-1,000, 1,000-5,000, 5,000-20,000, or 20,000+
Population ≤18 Years Old	Percent of population within the census block group at or below 18 years of age
Zero Vehicle Household Rate	Percent of households within the census block group which have zero vehicles
Population Below 2X Poverty Level	Percent of population within the census block group at or below 2X the poverty level

Analysis Process

The systemic analysis focused on the study period of 2018 through 2022. The target study roadway facilities included all public roadways, except for access-controlled roads which were excluded for the pedestrian and bicycle modes. Consolidated roadway data was analyzed to retaining all relevant roadway cross-sectional and context attributes. Additional census and network data attributes were applied to the segmented data as needed to include the screening factors.

The systemic analysis screening process is based on a decision tree machine learning algorithm where each factor is screened individually to determine whether the factor distinguishes between locations with relatively high and low average crash densities per mile. For categorical factors such as functional classification, the algorithm considers each unique classification individually. For numerical factors such as the poverty rate of the surrounding community, it considers all potential breakpoints by which the numerical values could be split. The algorithm screens all factors recursively to identify the most correlated factor and continues until a set of factors is identified as a facility profile. Figure 56 illustrates the decision tree algorithm where three correlated factors define a high-risk facility profile.

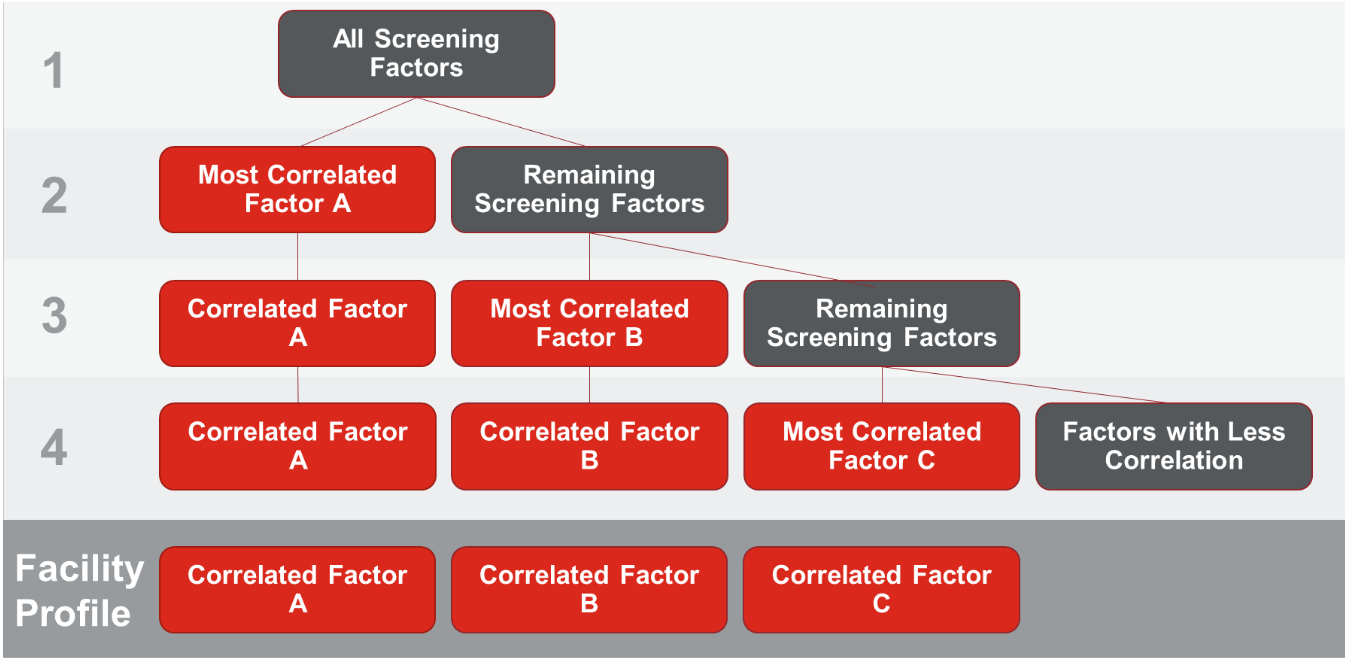


Figure 56. Illustration of Decision Tree Screening Process

Crash Data Sources and Limitations

Crash data for the 5-year period of 2018-2022 was acquired from TxDOT's CRIS data portal. All relational tables were downloaded. The crash, unit, person, and primary persons tables were used for this analysis. For additional information on how crash mode and severity were assigned, see Crash Data Analysis Report.

Local law enforcement agencies submit the crash reports that provide the raw crash data. Although crash reports are currently the best way to obtain information about a large number of crashes, they have limitations. Crash severity may have limited accuracy because those completing reports typically don't have medical training, and victims of crashes may be unaware of internal injuries masked by adrenalin. The total number of crashes may be underreported due to fears, language barriers, financial concerns, and more. Crash reports may not capture the effects of speed in crashes, as the first responders are typically on the scene after the crash has occurred and witnesses outside a crash are not typically interviewed about operator speed. Even when crash reports are perfect, they do not record near misses or the self-limiting behavior of travelers who don't feel safe in currently configured networks. It is useful to keep these limitations in mind when using crash data and to vet data with priority populations as part of the planning process.

Analysis Results

In the following subsections, systemic analysis results are broken out by crash mode, outlining the unique risk factors and priority rankings associated with each unique facility profile. Each subsection provides definitions of unique facility profiles identified by the analysis and their associated risk factors, crash score and mileage metrics associated with these profiles, and a summary figure. Profiles are grouped into five tiers, from critical to minimal, highlighting the facilities that are associated with the highest to lowest risk for severe crashes based on present risk factors. Based on these profiles and their tiers, we were able to identify those roadway segments associated with higher levels of crash risks for each mode, as shown in the maps included in the next section.

The score for each facility profile was determined based on the frequency and severity of crashes by mode across all roadways under a given facility profile. Fatal injury (K) and suspected serious injury crashes (A) were weighted x3, suspected minor injury (B) crashes were weighted x2, and possible injury (C) were weighted x1, not injured (O), and unknown injury (U) were weighted x0. Once the weights are established and applied to the crashes, the number of crashes is aggregated to all roadways within each facility profile, incorporating the crash severity weighting.

Motor Vehicles

Table 26. Facility Profile Definitions for Motor Vehicles

Facility Profile Tier	Facility Profile Definition				
	Traffic Volume Range	Setting	Speed Limit	Truck Route	Lane Configuration
Critical	20,000+	Urban	≤45 MPH		
High	20,000+	Urban	50+ MPH		Multilane
Medium	20,000+	Urban	50+ MPH		Two-lane
	5,000-20,000			No	
Low	<5,000	Urban			
	20,000+	Rural			
	5,000-20,000			Yes	
Minimal	<5,000	Rural			

Table 27. Facility Profile Metrics for Motor Vehicles

Facility Profile Tier	Facility Profile Metrics									
	Avg. Crash Score per Mile		Miles		Crash Score		Miles Share		Crash Score Share	
Critical	63.33	63.33	39.1	39.1	2,478	2,478	2.3%	2.3%	23.0%	23.0%
High	40.35	40.35	30.6	30.6	1,233	1,233	1.8%	1.8%	11.4%	11.4%
Medium	22.92	22.61	24.8	156.1	568	3,530	1.4%	9.0%	5.3%	32.7%
	22.56		131.3		2,962		7.6%		27.5%	
Low	3.82	3.74	746.7	865.8	2,851	3,242	43.2%	50.1%	26.4%	30.1%
	3.68		59.8		220		3.5%		2.0%	
	2.88		59.3		171		3.4%		1.6%	
Minimal	0.47	0.47	637.0	637.0	298	298	36.8%	36.8%	2.8%	2.8%

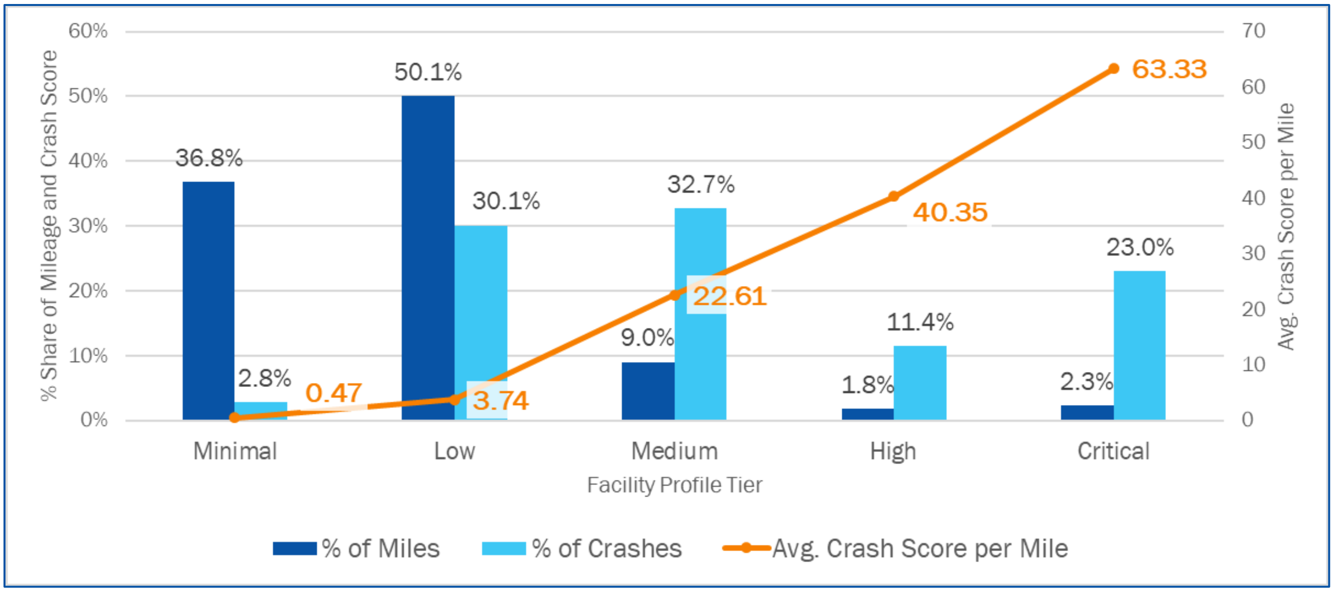


Figure 57. Facility Profile Tier Comparison for Motor Vehicles

Motorcycles

Table 28. Facility Profile Definitions for Motorcycles

Facility Profile Tier	Facility Profile Definition			
	Traffic Volume Range	Setting	Speed Limit	Population ≤18 Years Old
Critical	20,000+	Urban	≤45 MPH	
High	20,000+	Urban	50+ MPH	≤45%
Medium	20,000+	Urban	50+ MPH	>45%
Low	<20,000			
Minimal	20,000+	Rural		

Table 29. Facility Profile Metrics for Motorcycles

Facility Profile Tier	Facility Profile Metrics									
	Avg. Crash Score per Mile		Miles		Crash Score		Miles Share		Crash Score Share	
Critical	2.81	2.81	39.1	39.1	2,486	2,486	2.3%	2.3%	23.1%	23.1%
High	1.52	1.52	32.9	32.9	931	931	1.9%	1.9%	8.7%	8.7%
Medium	1.25	1.25	22.4	22.4	847	847	1.3%	1.3%	7.9%	7.9%
Low	0.16	0.16	1,574.4	1,574.4	6,272	6,272	91.1%	91.1%	58.3%	58.3%
Minimal	0.03	0.03	59.8	59.8	220	220	3.5%	3.5%	2.0%	2.0%

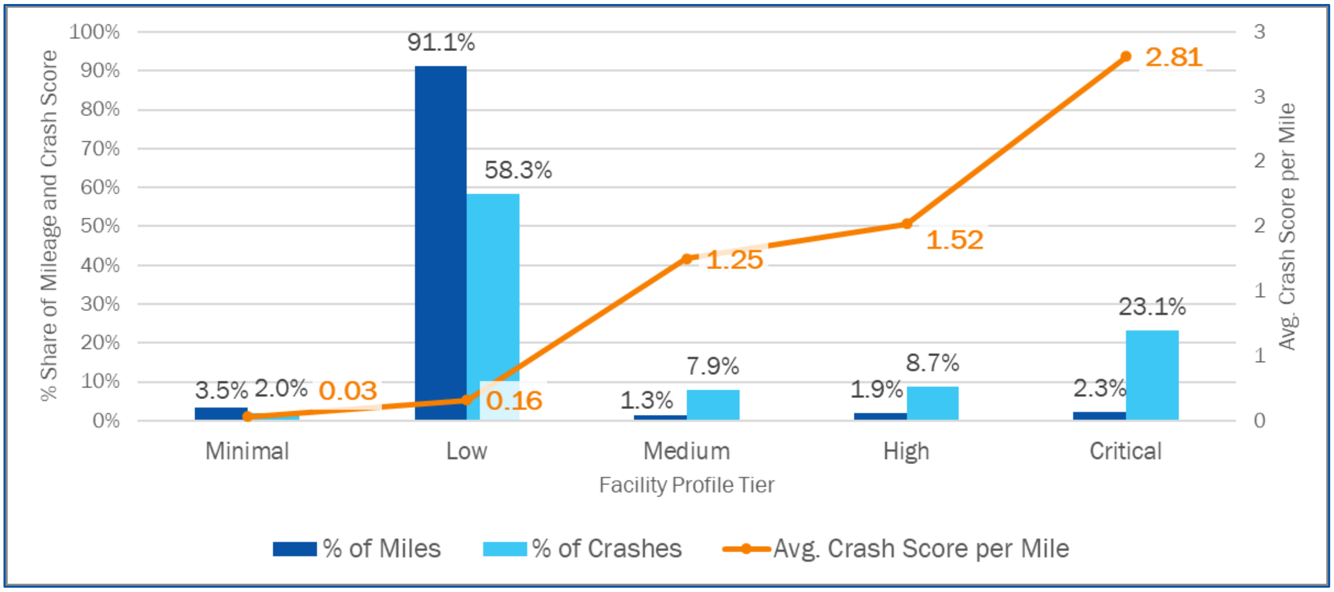


Figure 58. Facility Profile Tier Comparison for Motorcycles

Bicyclist

Table 30. Facility Profile Definitions for Bicycles

Facility Profile Tier	Facility Profile Definition						
	Zero Vehicle Household Rate	Population ≤18 Years Old	Traffic Volume Range	Lane Width	Speed Limit	Setting	State Roadway System
Critical	>25%	>45%		≥11 ft			
	≤25%		20,000+				Off-system
High	≤25%		20,000+		≤35 MPH		On-system
Medium	>25%	>45%		<11 ft			
	>25%	≤45%					
Low	≤25%		20,000+		40+ MPH		On-system
	≤25%		<20,000			Urban	
Minimal	≤25%		<20,000			Rural	

Table 31. Facility Profile Metrics for Bicycles

Facility Profile Tier	Facility Profile Metrics									
	Avg. Crash Score per Mile		Miles		Crash Score		Miles Share		Crash Score Share	
Critical	2.32	2.07	7.3	19.3	267	970	0.4%	1.2%	2.8%	10.3%
	1.92		12.0		703		0.7%		7.5%	
High	1.10	1.10	10.9	10.9	931	931	0.7%	0.7%	9.9%	9.9%
Medium	0.71	0.54	14.2	47.8	89	610	0.9%	2.9%	0.9%	6.5%
	0.48		33.6		521		2.1%		5.5%	
Low	0.12	0.11	43.0	858.4	1,315	6,436	2.6%	52.7%	14.0%	68.4%
	0.11		815.5		5,121		50.1%		54.4%	
Minimal	0.00	0.00	692.4	692.4	458	458	42.5%	42.5%	4.9%	4.9%

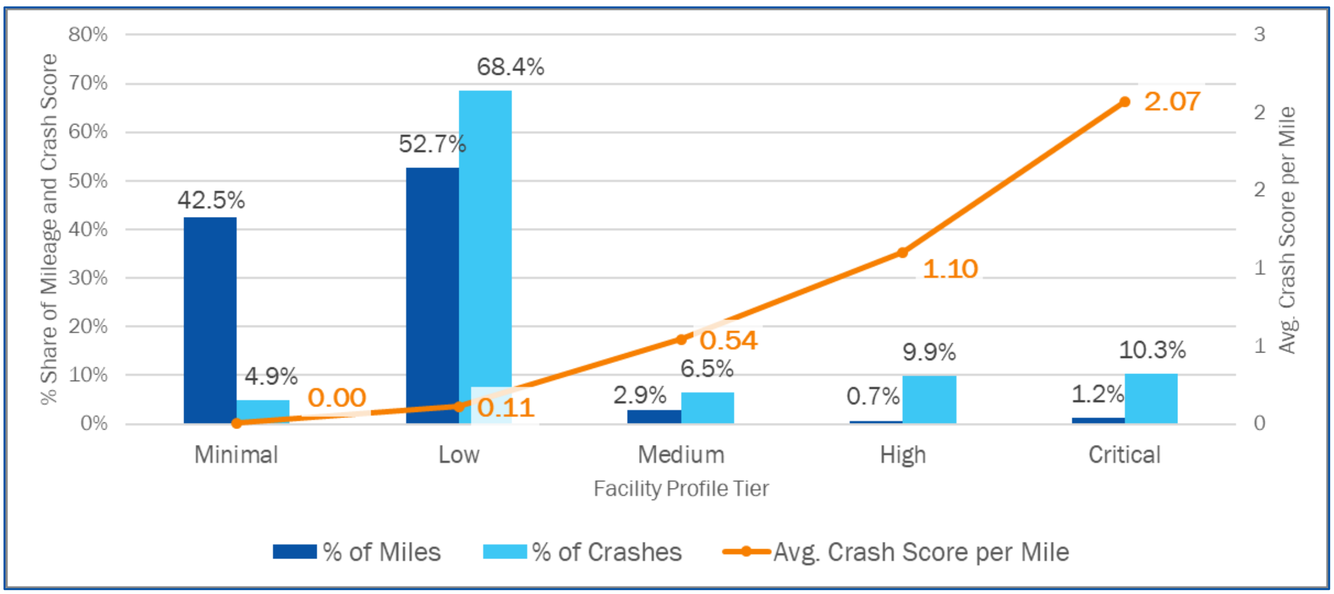


Figure 59. Facility Profile Tier Comparison for Bicycles

Pedestrian

Table 32. Facility Profile Definitions for Pedestrians

Facility Profile Tier	Facility Profile Definition				
	Zero Vehicle Household Rate	Functional Class	Traffic Volume	Setting	Speed Limit
Critical	>45%	High			
High	≤45%		20,000+		≤35 MPH
	>45%	Low			
Medium	≤45%		20,000+		40-45 MPH
	≤45%	High	<20,000	Urban	
Low	≤45%		20,000+		50+ MPH
	≤45%	Low	<20,000	Urban	
Minimal	≤45%		<20,000	Rural	

Table 33. Facility Profile Metrics for Pedestrians

Facility Profile Tier	Facility Profile Metrics									
	Avg. Crash Score per Mile		Miles		Crash Score		Miles Share		Crash Score Share	
Critical	6.69	6.69	6.4	6.4	353	353	0.4%	0.4%	3.8%	3.8%
High	4.17	4.04	19.9	26.5	1,406	1,487	1.2%	1.6%	14.9%	15.8%
	3.67		6.5		81		0.4%		0.9%	
Medium	2.27	1.48	15.4	111.4	711	3,209	0.9%	6.8%	7.6%	34.1%
	1.35		96.0		2,498		5.9%		26.6%	
Low	0.45	0.38	31.1	792.1	874	3,898	1.9%	48.6%	9.3%	41.4%
	0.38		761.0		3,024		46.7%		32.2%	
Minimal	0.04	0.04	692.4	692.4	458	458	42.5%	42.5%	4.9%	4.9%

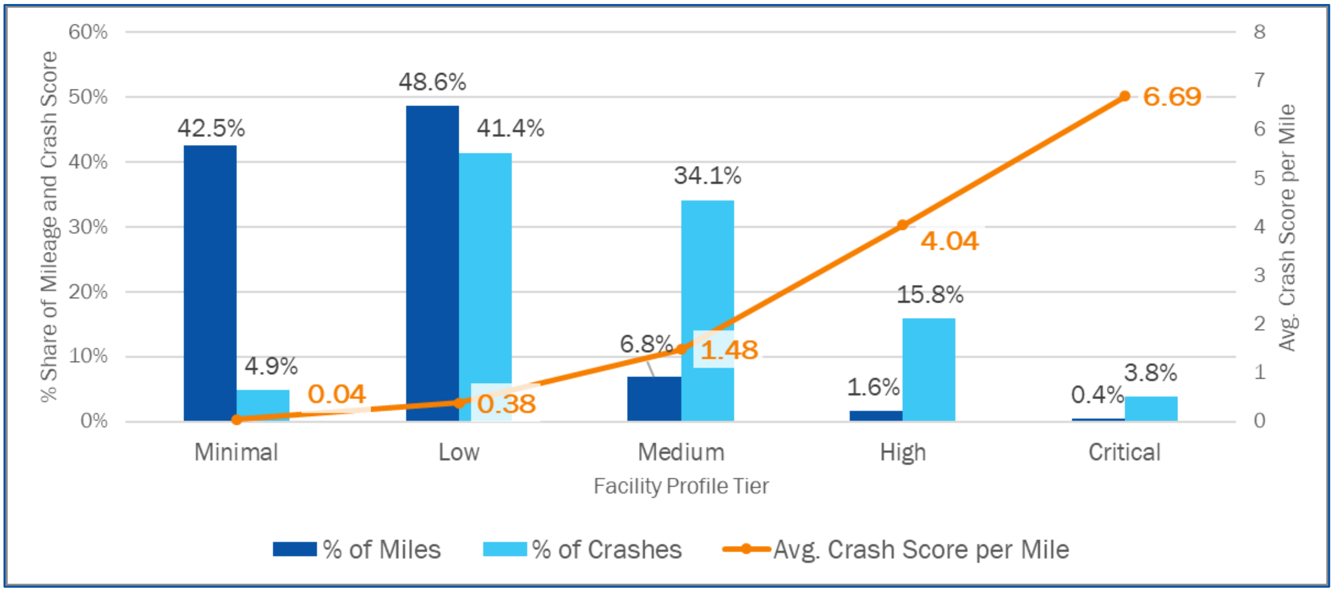


Figure 60. Facility Profile Tier Comparison for Pedestrians

Commercial Motor Vehicle

Table 34. Facility Profile Definitions for Commercial Motor Vehicles

Facility Profile Tier	Facility Profile Definition			
	Traffic Volume Range	Truck Route	Population Below 2X Poverty Level	Zero Vehicle Household Rate
Critical	20,000+	No		
High	5,000-20,000	Yes	>45%	≤5%
Medium	20,000+	Yes		
	5,000-20,000			>25%
Low	5,000-20,000		≤45%	≤5%
	5,000-20,000			5-25%
Minimal	<5,000			

Table 35. Facility Profile Metrics for Commercial Motor Vehicles

Facility Profile Tier	Facility Profile Metrics									
	Avg. Crash Score per Mile		Miles		Crash Score		Miles Share		Crash Score Share	
Critical	3.85	3.85	94.5	94.5	4,279	4,279	5.5%	5.5%	39.7%	39.7%
High	3.43	3.43	37.9	37.9	631	631	2.2%	2.2%	5.9%	5.9%
Medium	1.84	1.78	59.8	71.9	220	537	3.5%	4.2%	2.0%	5.0%
	1.48		12.1		317		0.7%		2.9%	
Low	1.02	0.73	51.0	140.6	435	2,185	3.0%	8.1%	4.0%	20.3%
	0.57		89.6		1,750		5.2%		16.2%	
Minimal	0.22	0.22	1,383.7	1,383.7	3,149	3,149	80.0%	80.0%	29.2%	29.2%

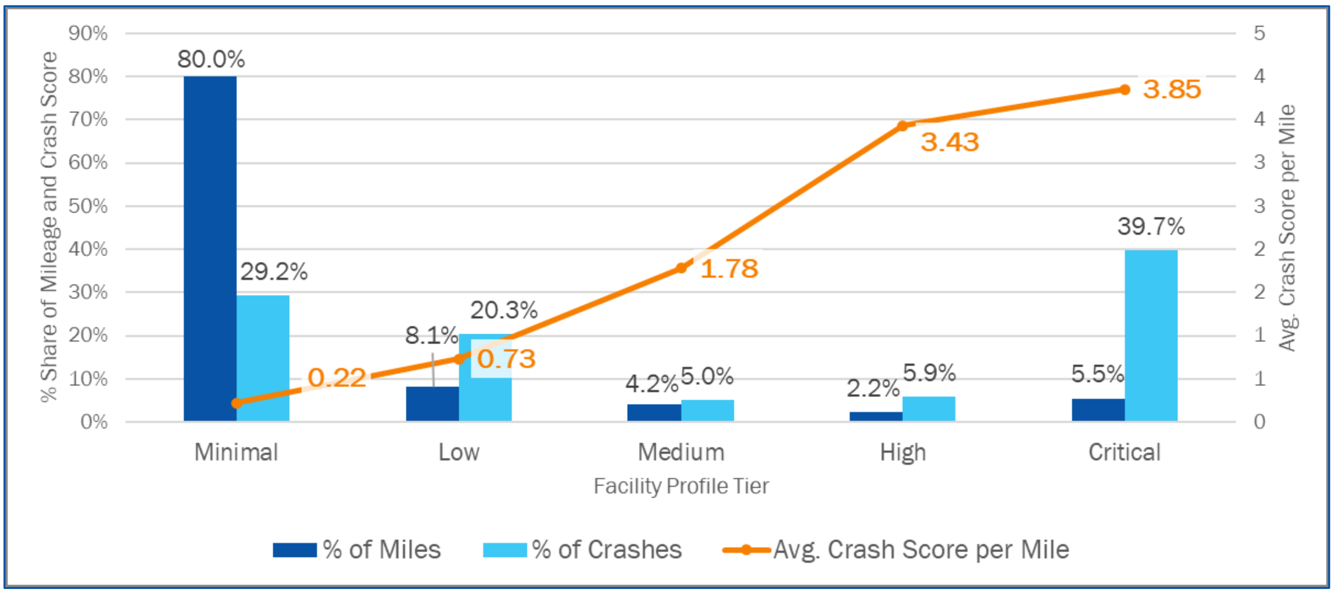


Figure 61. Facility Profile Tier Comparison for Commercial Motor Vehicles

Analysis Mapping, Conclusions, and Next Steps

Maps showing the results of the crash mode facility profile analysis models, highlighting the top three tiers of facilities within the study area, namely the Critical, High, and Medium tiers are included at the end of this memo. The risk factors captured in the systemic analysis can be used to evaluate all roadways in the study areas and identify relatively high- and low-risk roadway segments. Locations on the Critical, High, and Medium tiers should be specifically targeted for broad implementation of low-cost systemic safety improvements, regardless of whether crashes have happened at those locations. This proactive, systemic approach can complement other improvements that are reactive and focused on locations with elevated and repeating patterns of crashes over time. Following the process laid out in the FHWA Systemic Safety Project Selection Tool, the project team will identify systemic safety treatments for those priority locations identified from this analysis. This would include reviewing and confirming prevailing types of crashes and risk factors associated with high-risk facility types, identifying potential program-level solutions, and then performing a logical assignment of those solutions on candidate locations. At a later stage of this project, the project team will consider the results from this and other safety analyses, equity analyses, and stakeholder and public engagement in concert to identify roadway facilities to target for safety project opportunities.

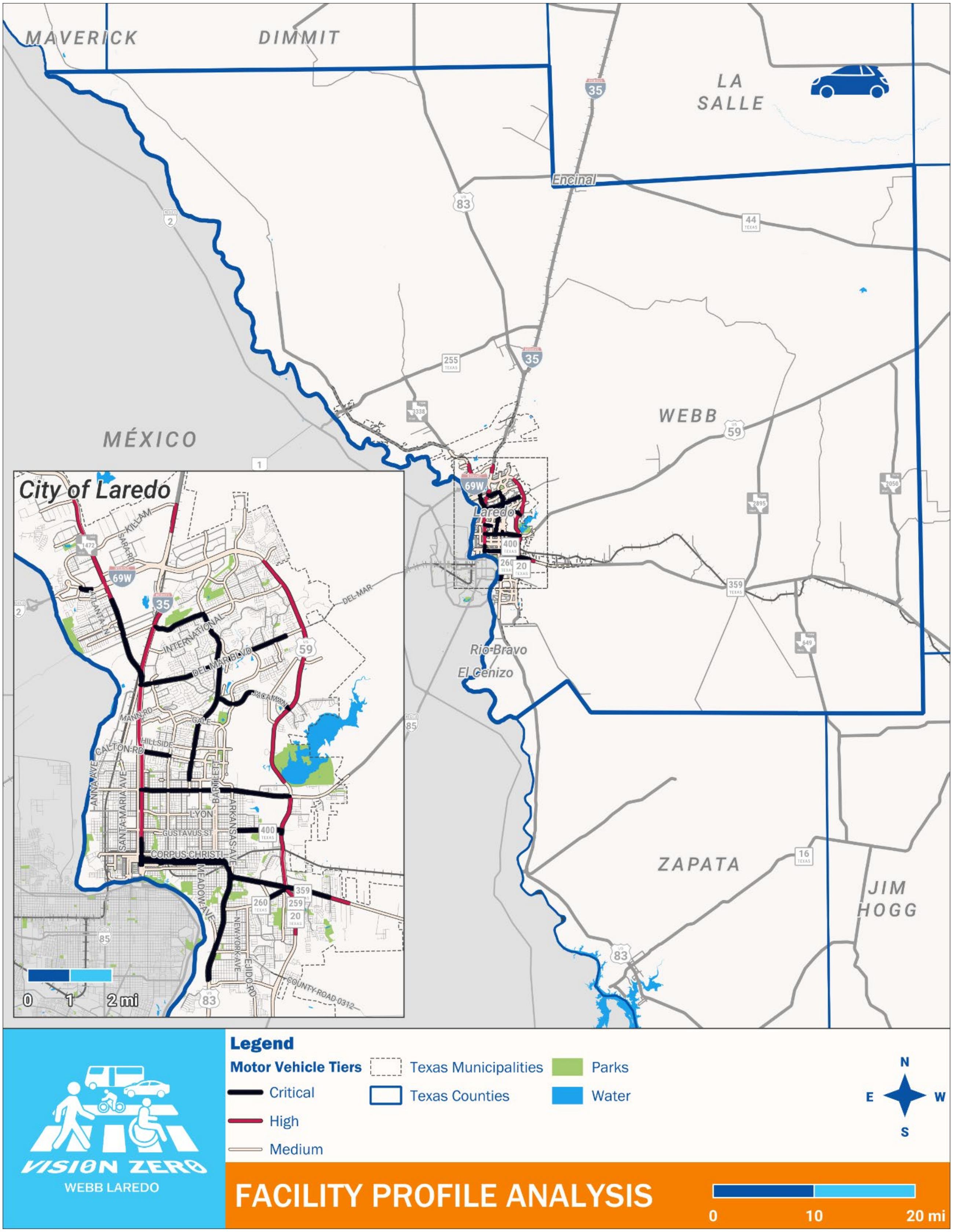


Figure 62. Facility Profile Analysis Mapping for Motor Vehicles

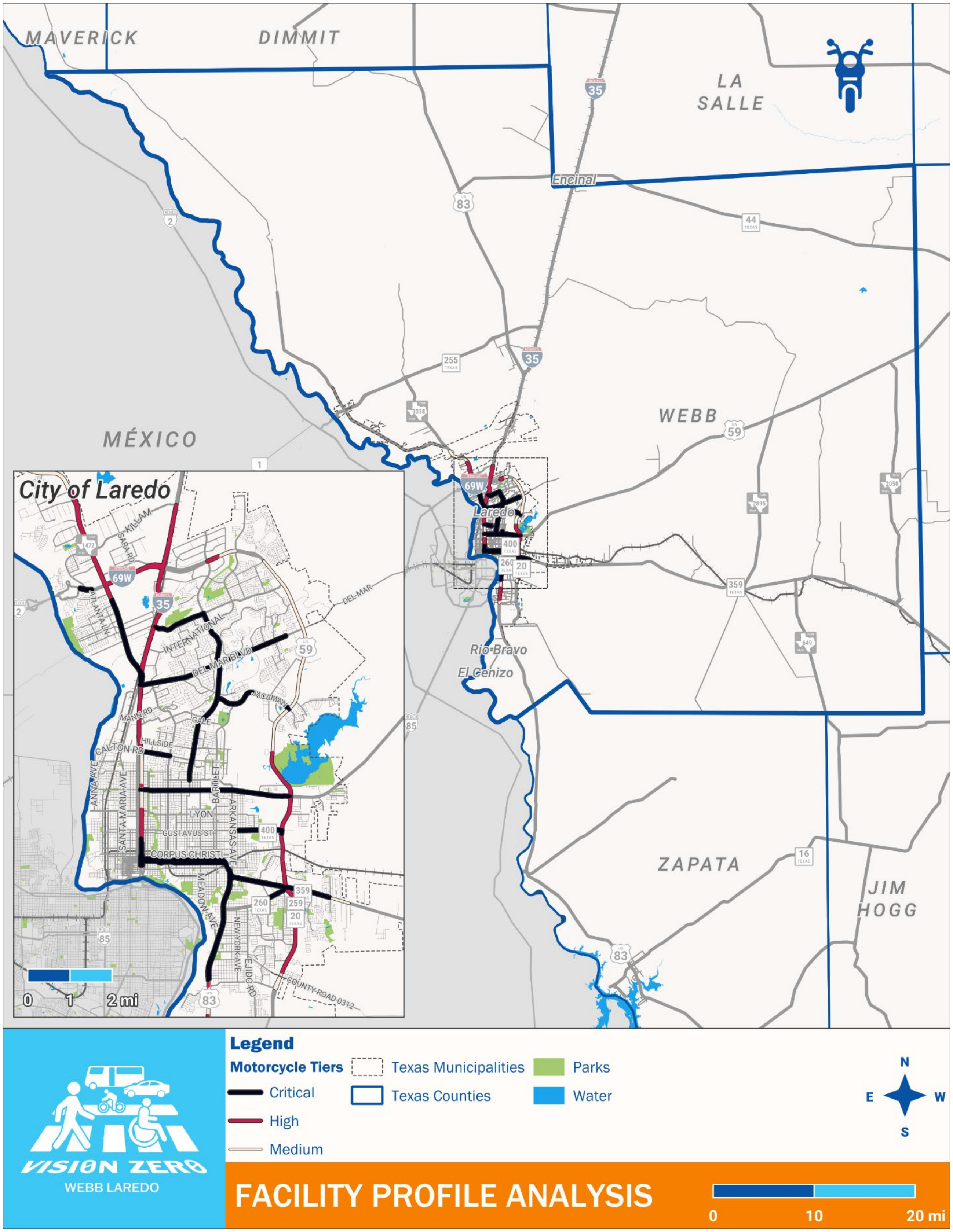


Figure 63. Facility Profile Analysis Mapping for Motorcycles

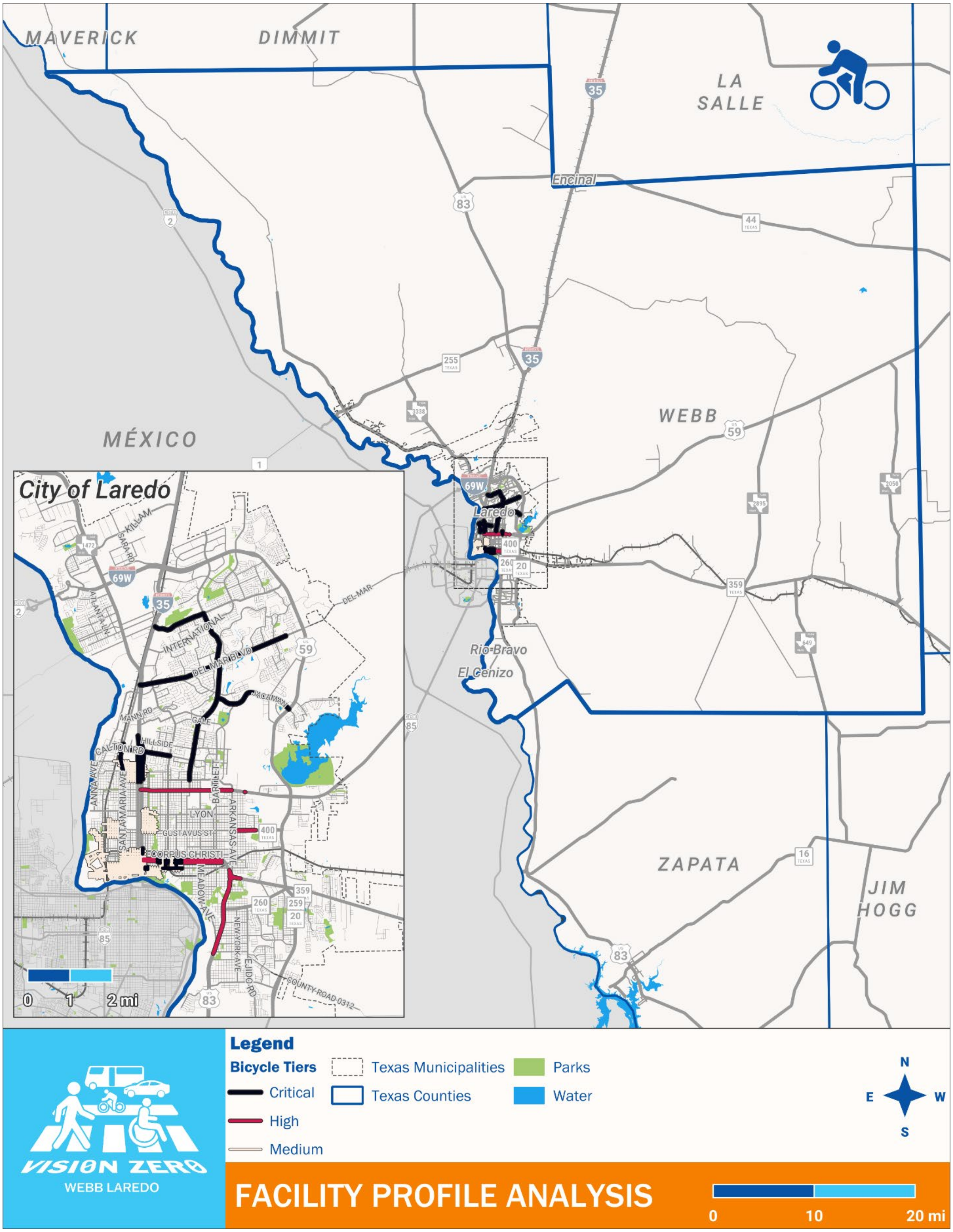


Figure 64. Facility Profile Analysis Mapping for Bicycles

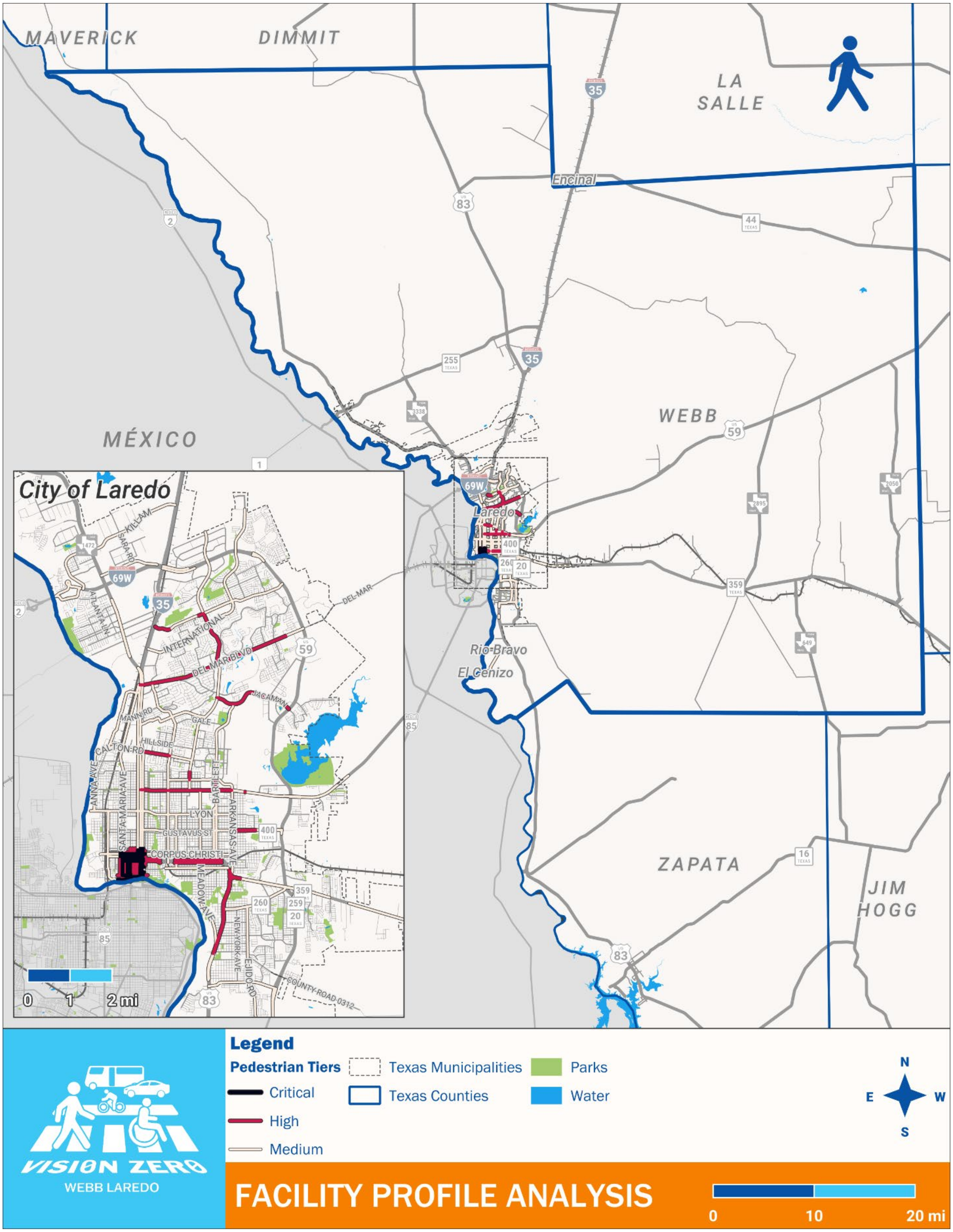


Figure 65. Facility Profile Analysis Mapping for Pedestrians

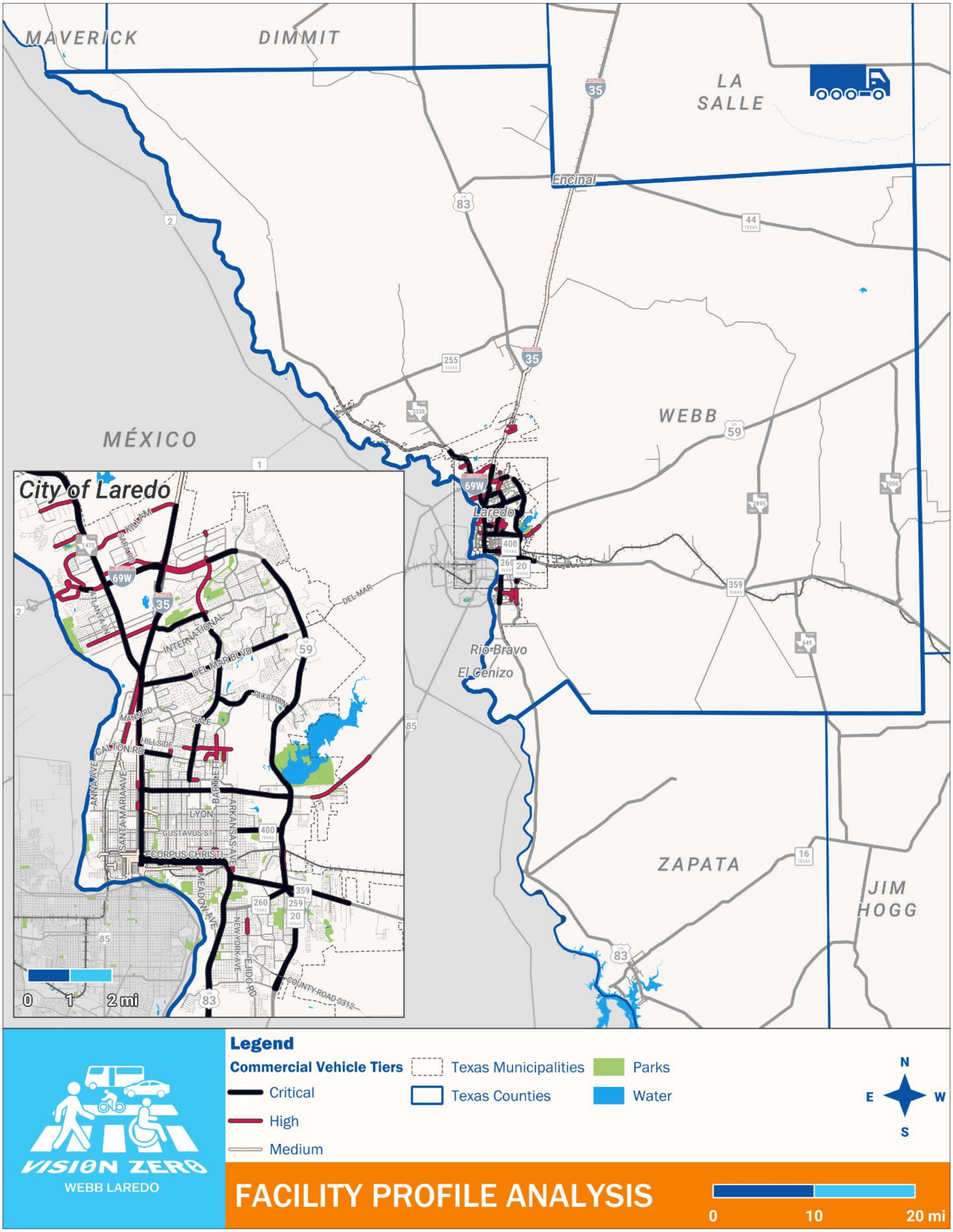


Figure 66. Facility Profile Analysis Mapping for Commercial Motor Vehicles