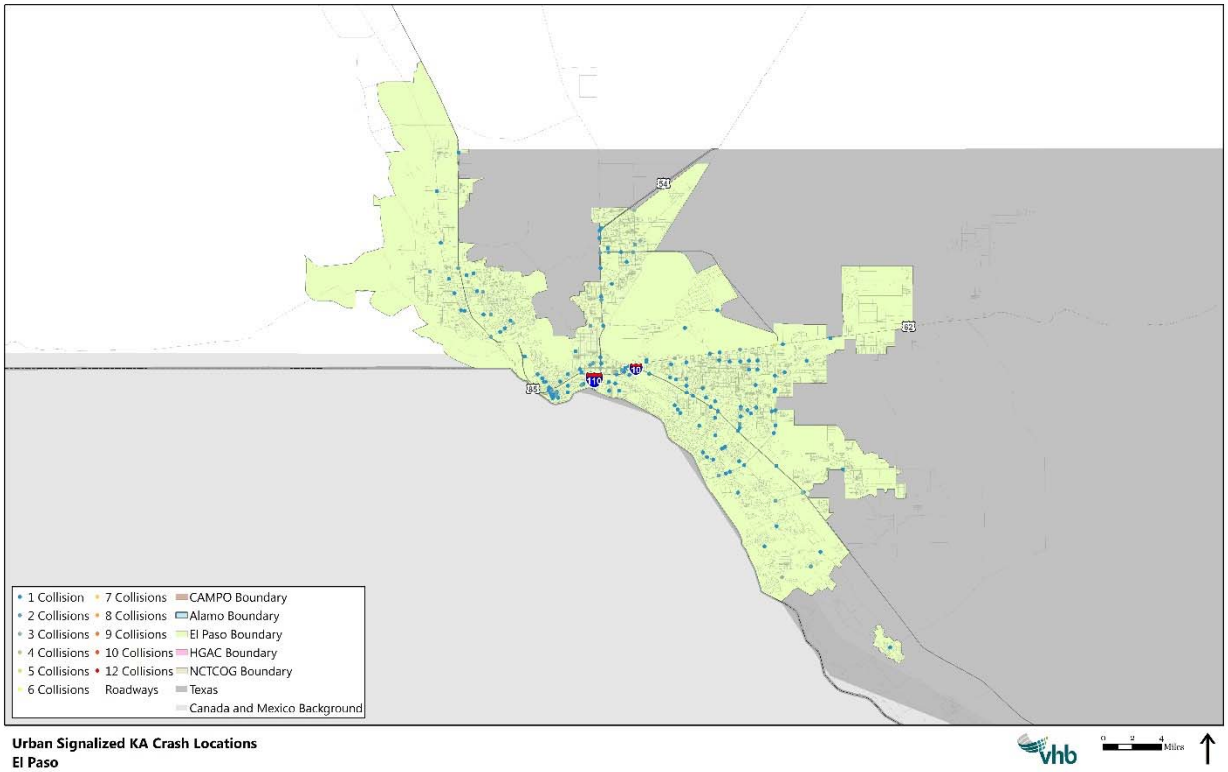
Texas Intersection Safety Implementation Plan

Preliminary Findings for Texas's El Paso Metropolitan Planning Organization



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Texas Department of Transportation

Safe Roads for a Safer Future
Investment in roadway safety saves lives

Introduction

The overall objective of this effort is to develop an Intersection Safety Implementation Plan (ISIP) for the State of Texas by focusing on its five largest Metropolitan Planning Organizations (MPOs):

- Alamo Area MPO (AAMPO) in the San Antonio region.
- Capital Area MPO (CAMPO) in the Austin region.
- El Paso MPO in the El Paso region.
- Houston-Galveston Area Council MPO (H-GAC) in the Houston region.
- North Central Texas Council of Governments (NCTCOG) in the Dallas-Fort Worth region.

The purpose of this report is to present the preliminary findings from the data analyses completed to date and to select which intersection types have the best potential to be enhanced by systemic measures.

The analysis team analyzed intersection crash trends for the five-year period from January 2010 to December 2014. The Texas Strategic Highway Safety Plan (SHSP) reports that more than a third of Texas's fatal and incapacitating-injury crashes in 2013—5,624 in total—were intersection related. Three-quarters of these (74 percent) occurred in urban areas.

The analysis team coordinated with the Texas Department of Transportation (TxDOT) Crash Data and Analysis Section of the Traffic Operations Division and the five MPOs to obtain crash and roadway data from 2010 – 2014. The team obtained intersection crash data from TxDOT's Crash Records Information System (CRIS) and analyzed each region's intersection crashes both at the regional level and at the intersection level, identifying macro trends at the regional level and tailoring the analysis at the intersection level to prioritize intersections based on various risk factors and facility types. The following sections describe the method for each level of analysis.

NOTE: The El Paso MPO comprises El Paso County, Texas, as well as southern Dona Ana County and a small portion of Otero County, New Mexico. Because the State of Texas is the focus of this overall safety effort, the data and discussion within this report pertain to the Texas portion of the El Paso MPO.

State Data Analysis

Population data from the 2009-2013 American Community Survey (ACS) reported the population of Texas as 25,639,373—a 2013 estimation based on survey data collected over a five-year period. [1] Texas has 254 counties and 1,209 municipal governments, which consist of cities, towns, and villages. Figure 1 depicts the population density by census tract for the entire State.

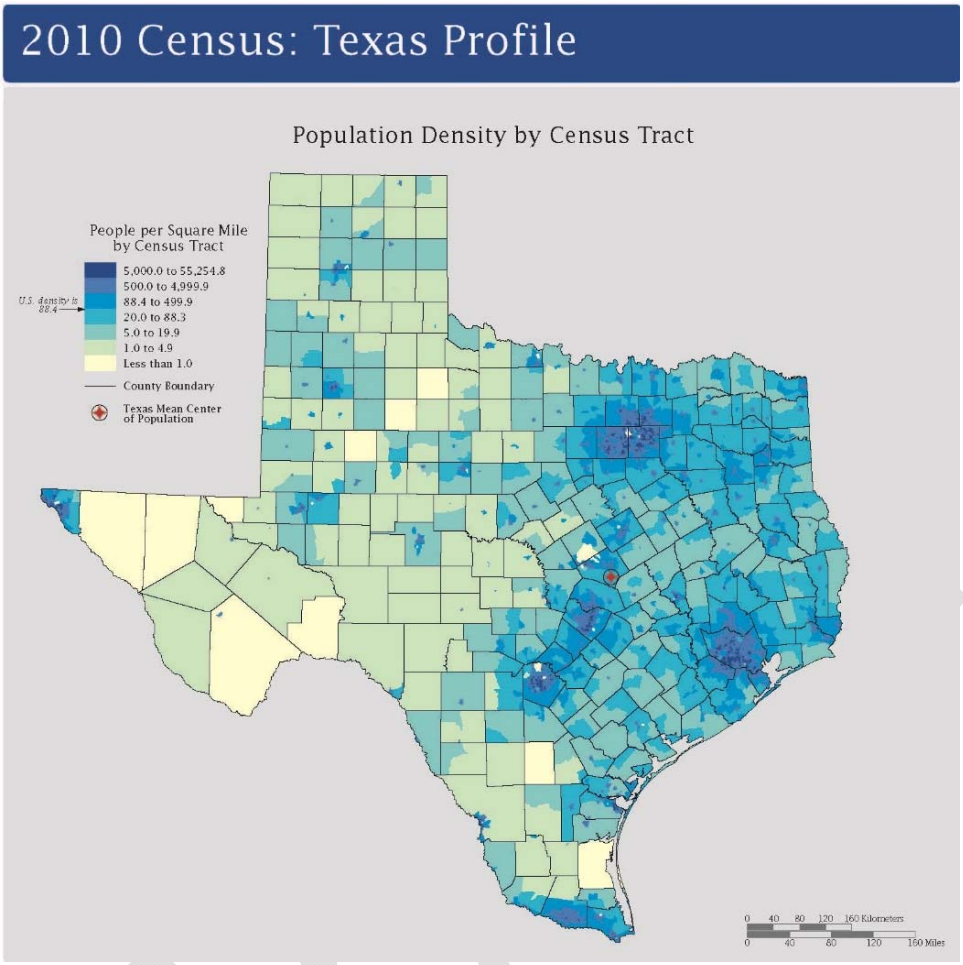

Figure 1. Texas Population Density, 2010 Census. [2]

Table 1 presents the State's largest cities by severe intersection crashes and population. For the purpose of this effort, "severe" crashes refer to those resulting in a fatality (K) or incapacitating injury (A), as defined by Texas's crash report form. Three (3) of every 10 severe intersection crashes statewide occurred in these cities.

Table 1. Six largest Texas cities by 2013 severe intersection crashes and population. [1]

City	Severe (K,A) Int. Crashes	Percent of State Severe Int. Crashes	Population (*2*)	Population Rank	Percent of State Population
Houston	459	8.2%	2,134,707	1	8.3%
San Antonio	360	6.4%	1,359,033	2	5.3%
Dallas	351	6.2%	1,222,167	3	4.8%
Austin	194	3.4%	836,800	4	3.3%
Fort Worth	240	4.3%	761,092	5	3.0%
El Paso	81	1.4%	660,795	6	2.6%
Total	**1,685**	**30.0%**	**6,974,594**	**---**	**27.2%**

Expanding the focus from the city level to the regional level, Table 2 presents the five largest MPOs in Texas by severe intersection crashes and population. Collectively these regions comprise 62 percent of the severe intersection crashes in the State and 67 percent of its population.

Table 2. Five largest Texas MPOs by 2013 severe intersection crashes and population. [1]

MPO	Severe (K,A) Int. Crashes	Percent of Total Severe Int. Crashes	Population (*2*)	Population Rank	Percent of Total Population
NCTCOG	1,413	25.1%	6,567,296	1	25.6%
H-GAC	1,070	19.0%	6,034,967	2	23.5%
AAMPO	496	8.8%	2,024,087	3	7.9%
CAMPO	429	7.6%	1,825,262	4	7.1%
El Paso MPO*	97	1.7%	813,015	5	3.2%
Total	**3,505**	**62.3%**	**17,264,627**	**---**	**67.3%**

** Includes only Texas portion of El Paso MPO*

Regional Data Analysis

The El Paso MPO comprises El Paso County in western Texas, as well as southern Dona Ana County and a small portion of Otero County in southeastern New Mexico. ***For the purpose of this report, the MPO statistics refer only to El Paso County, Texas.*** According to the 2009-2013 ACS, the Texas population of the MPO was 813,015. [1] Figure 2 presents the El Paso MPO population density map.

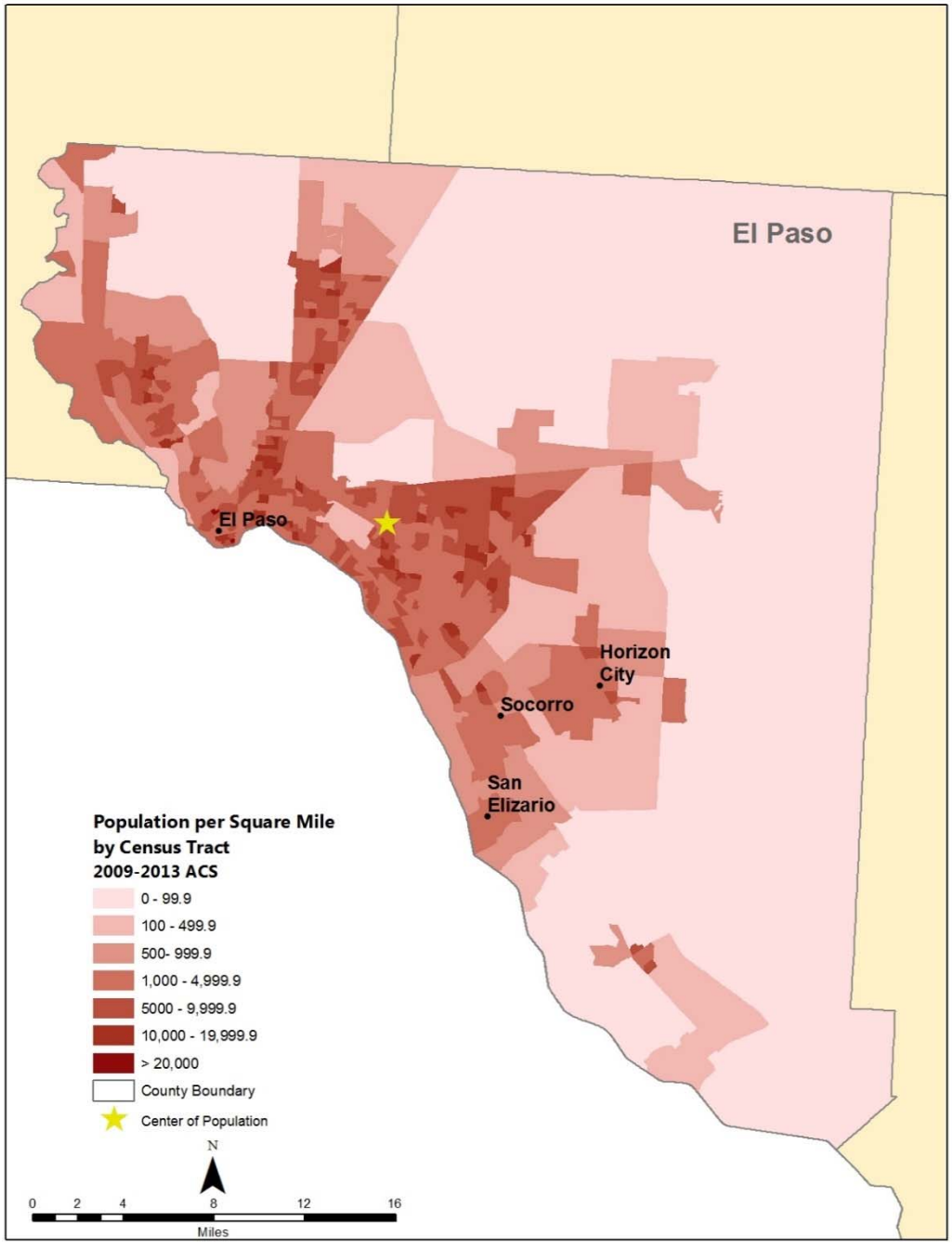

Figure 2. Population density of the El Paso MPO region. [1]

Severe intersection crashes typically mirror population. The seven most populous cities of the El Paso MPO are presented in Table 3 by severe intersection crashes for the five-year period of 2010-2014 and 2013 population. These cities comprise approximately 90 percent of both the region's severe intersection crashes and its population. The four cities listed in bold text showed at least a small overrepresentation in terms of severe intersection crashes relative to their population.

Table 3. Seven largest El Paso MPO cities by severe intersection (KA) crashes and population.

City	Severe Int. Crashes (K,A)	Percent of Region Severe Int. Crashes	Population	Population Rank	Percent of Region Population
El Paso	419	**82.97%**	660,795	1	81.28%
Socorro	25	**4.95%**	32,227	2	3.96%
Clint	4	**0.79%**	839	7	0.10%
Horizon City	3	0.59%	17,736	3	2.18%
Fort Bliss	3	0.59%	8,604	4	1.06%
Anthony	2	0.40%	5,102	5	0.63%
Vinton	1	**0.20%**	1,576	6	0.19%
Total	457	90.49%	726,879		89.41%

2009-2013 ACS 5-year estimates (Total MPO population 813,015—Texas only)

There are a total of 3,548 public road miles within the Texas portion of the El Paso MPO service region that are owned by various agency types, including State, county, town, Federal agency, or other, as presented in Table 4. Municipal agencies and El Paso County maintain approximately 68 percent and 19 percent, respectively, for a combined 86.5 percent of the public road miles, with the State maintaining the vast majority of the remaining 13.5 percent. Urban roadways comprise nearly 90 percent of the total road mileage.

Table 4. Public road length (mi) in the El Paso MPO by type of owner. [3]

	State Highway Agency	County	Town, Township, Municipal	Other	Federal Agency	Total
RURAL	92	254	14	0	0	359
	2.59%	7.15%	0.39%	0.00%	0.00%	10.13%
URBAN	387	419	2,382	1	0	3,188
	10.90%	11.82%	67.13%	0.02%	0.00%	89.87%
Total	479	673	2,395	1	0	3,548
	13.49%	18.97%	67.52%	0.02%	0.00%	100.00%

Table 5 simplifies the information in Table 4 by combining the county and municipal categories into a "local" group and the Federal agency and other categories into an "other" group.

Table 5. Public road length (mi) in the El Paso MPO by State, local, or other. [3]

	State	Local	Other	Total
RURAL	92	268	0	359
	2.59%	7.54%	0.00%	10.13%
URBAN	387	2,801	1	3,188
	10.90%	78.95%	0.02%	89.87%
Total	479	3,068	1	3,548
	13.49%	86.49%	0.02%	100.00%

Table 6 presents the distribution of intersection crashes by severity for the analysis. Each crash is described by the most severe injury that resulted. The following crash severities are used in Texas:

- Fatal (K).
- Incapacitating injury (A).
- Non-incapacitating injury (B).
- Possible Injury (C).
- Non-injury (PDO).

Table 6. Approximate number of El Paso MPO intersection crashes by severity and year.

Year	K	A	B	C	PDO	Unknown	Total	KA	KA as % of Total Crashes
2010	17	75	569	1,538	5,052	200	7,451	92	0.25%
2011	27	79	582	1,441	4,881	204	7,214	106	0.28%
2012	22	101	651	1,513	4,950	114	7,351	123	0.33%
2013	16	81	732	1,469	5,157	54	7,509	97	0.26%
2014	12	75	712	1,558	5,414	96	7,867	87	0.23%
Subtotal	**94**	**411**	**3,246**	**7,519**	**25,454**	**668**	**37,392**	**505**	**1.35%**

Discounting the crashes of unknown severity, the analysis team estimated the total cost of El Paso MPO intersection crashes to be nearly $1.5 billion—or $288 million annually—over the five-year analysis period. The total estimated cost of the KA intersection crashes across the five regions for the same period was $29.6 billion, which corresponds to nearly $6 billion per year. These costs were based on the 2013 average comprehensive costs by injury severity presented in the National Safety Council's *Estimating the Costs of Unintentional Injuries, 2013*. [4] Severe (KA) intersection crashes accounted for 1.4 percent of all intersection crashes and more than 42 percent of the total cost of intersection crashes within El Paso County.

Since KA crashes comprise such a significant portion of the total crash costs, the intersection-level analysis in the following sections will primarily focus on severe crashes. The KA crashes also represent an opportunity to focus the potential countermeasure packages.

Intersection-Level Analysis

The analysis team joined TxDOT's CRIS data with pertinent roadway inventory data from its 2013 Road–Highway Inventory Network (RHiNo) database as the primary data source to determine the ownership (State, County, local, federal or other) of the roadway on which the crash occurred and analyze the focus intersection types and crash types by severity. The RHiNo data included the classification of government agency associated with the street on which the crash occurred. The rural/urban classifications were extracted from the traffic analysis zone (TAZ) shapefiles from the travel demand model provided by the El Paso MPO.

For the purposes of this effort, "intersection ownership" is determined by the ownership of the intersecting streets. An intersection involving at least one TxDOT-maintained cross street is considered State-owned. An intersection involving at least one local street but not involving a TxDOT-maintained street is considered locally-owned. All other intersections fall under the "other" category.

Table 7 presents a breakdown of the El Paso MPO intersection-related crashes according to area type and owner. Forty-eight (48) percent of the intersection-related crashes occurred at intersections involving at least one State road, and practically all of the crashes occurred in urban areas.

Table 7. Distribution of the El Paso MPO intersection crashes by owner and area type.

	State	Local	Other	Total
RURAL	83	70	4	157
	0.22%	0.19%	0.01%	0.42%
URBAN	17,864	19,317	54	37,235
	47.77%	51.66%	0.14%	99.58%
Total	**17,947**	**19,387**	**58**	**37,392**
	48.00%	**51.85%**	**0.16%**	**100.00%**

The analysis team used crash data as the starting point to extract and interpolate locations and characteristics and to determine where the severe crashes are concentrated (e.g., urban intersections, unsignalized intersections, etc.). A unique field for intersection number did not exist. The analysis team used geographic information system (GIS) analysis with a 528-foot buffer to identify the potential intersection node ID at which an individual crash occurred. The corresponding ESRI Street file was used to identify the node locations, as its shapefile is more detailed than that of RHiNo since ESRI includes private roads in its database. (ESRI is a leading GIS software and mapping developer.) Crashes with an identical node ID value were flagged as occurring at the same location, allowing the analysis team to quantify the total number of crashes and compare with the total number of unique (non-duplicating)

locations. This initial level of analysis helped to determine the primary intersection types on which to focus. It is likely this method underestimated the number of intersections; however, the method was not expected to bias the preliminary results as it was assumed the approach would treat all intersection types in a similar manner. Nodes were underestimated because approximately two percent of crashes occurred at the intersection with a private driveway or dirt road and were not included in the ESRI database.

Only the severe (KA) crashes that could be assigned to an intersection are included in this portion of the analysis, as it is an intersection-level analysis. More discussion on assigning crashes to intersections is provided in the *Analysis Methodology* section.

Analysis Methodology

Assigning Crashes to Intersections

TxDOT does not currently have a single database of all intersections in the State, so the analysis team manually compiled an intersection inventory from ESRI Street layer datasets. The team considered all intersection crashes (regardless of severity) within the CRIS database to develop the inventory and assigned a unique intersection identification number to each intersection with one or more crashes in the five-year analysis period.

During the analysis period, there were 505 fatal and serious injury (KA) intersection crashes in the El Paso MPO region. Approximately two percent (8) of these crashes were not assigned an intersection identification number because they occurred at an intersection involving a private driveway or dirt road that was not included in the ESRI database. The remaining crashes (497) were assigned an intersection ID, resulting in 417 identified intersections in the El Paso MPO with at least one fatal or serious injury crash in the five-year period.

Characterizing Intersections

The intersections identified were characterized by maintenance jurisdiction and traffic control and area type. This was done using a combination of fields from CRIS crash data and roadway inventory data.

The analysis team divided maintaining jurisdiction between State maintained, locally-owned, or other. The traffic control at each of these intersections was estimated as signalized or unsignalized based on the CRIS crash data. The criteria listed in Table 8 were used for classifying the control type for the intersection based on the traffic control description (TRAFFIC_CNTL_DESC) field within the crash data.

Table 8. Interpreted traffic control type based on police-reported crash data.

ID	TRAFFIC_CNTL_DESC	Interpreted Control Type
1	NONE	Unsignalized
2	INOPERATIVE (EXPLAIN IN NARRATIVE)	Unknown
3	OFFICER	Unknown
4	FLAGMAN	Unknown
5	SIGNAL LIGHT	Signalized
6	FLASHING RED LIGHT	Unsignalized
7	FLASHING YELLOW LIGHT	Unsignalized
8	STOP SIGN	Unsignalized
9	YIELD SIGN	Unsignalized
10	WARNING SIGN	Unsignalized
11	CENTER STRIPE/DIVIDER	Unsignalized
12	NO PASSING ZONE	Unsignalized
13	RR GATE/SIGNAL	Signalized
15	CROSSWALK	Unsignalized
16	BIKE LANE	Unsignalized
17	OTHER (EXPLAIN IN NARRATIVE)	Unsignalized
20	MARKED LANES	Unsignalized
21	SIGNAL LIGHT WITH RED LIGHT RUNNING CAMERA	Signalized
94	REPORTED INVALID	Unknown
95	NOT REPORTED	Unknown

This method is described as "estimating" the traffic control at the intersection because the TRAFFIC_CNTL_DESC field of the crash database has some inherent unreliability. The law enforcement officer reports the control under which crash-involved vehicles were operating, not necessarily the traffic control for the intersection. This reporting likely underestimates the occurrence of signalized control.

The rural/urban classifications were extracted from the El Paso MPO travel demand model traffic analysis zone (TAZ) shapefile provided by the El Paso MPO.

Prioritizing Intersections

The analysis team developed a Microsoft Access database of the severe injury crashes at each intersection that allows focus on and consideration of the following intersection attributes and crash characteristics:

- Location identification information including:
  - Intersection ID.
  - Street names.
  - Jurisdiction.

- Intersection characteristics including:
    - Traffic control.
    - Area type.
- Total fatal and severe injury crashes (injury severity K, or A) occurring at the intersection from 2010 to 2014.
- Crash characteristics (fatal and severe injury only) including:
    - Injury severity level.
    - Lighting condition.
    - Surface condition (e.g., dry).
    - Collision type (e.g., angle – both going straight).
    - Reported harmful event (e.g., motor vehicle in transport).

Analysis of the Results

The analysis team used the Systemic Safety Project Selection Tool to provide a consistent framework for the ISIP process. [5] The Tool is a process that focuses on identifying statewide or regional roadway safety concerns and strategies to address these concerns. Based on the safety data provided, the Tool allows analysts to determine which common risk factors are influencing driver behavior and how crashes occur. Different risk factors may include various system, crash, or facility types.

There are three distinct components of the Systemic Safety Project Selection Tool, as depicted in Figure 2: [5]

- Element 1: Systemic Safety Planning Process.
- Element 2: Framework for Balancing Systemic and Traditional Safety.
- Element 3: Evaluation of a Systemic Safety Program.

Element 1 is the focus of this preliminary findings report. The Systemic Safety Planning Process comprises four steps: identifying focus crash types and risk factors; screening and prioritizing candidate locations; selecting low-cost, highly effective countermeasures; and prioritizing the resulting projects. Each of the four steps is discussed in the following sections.

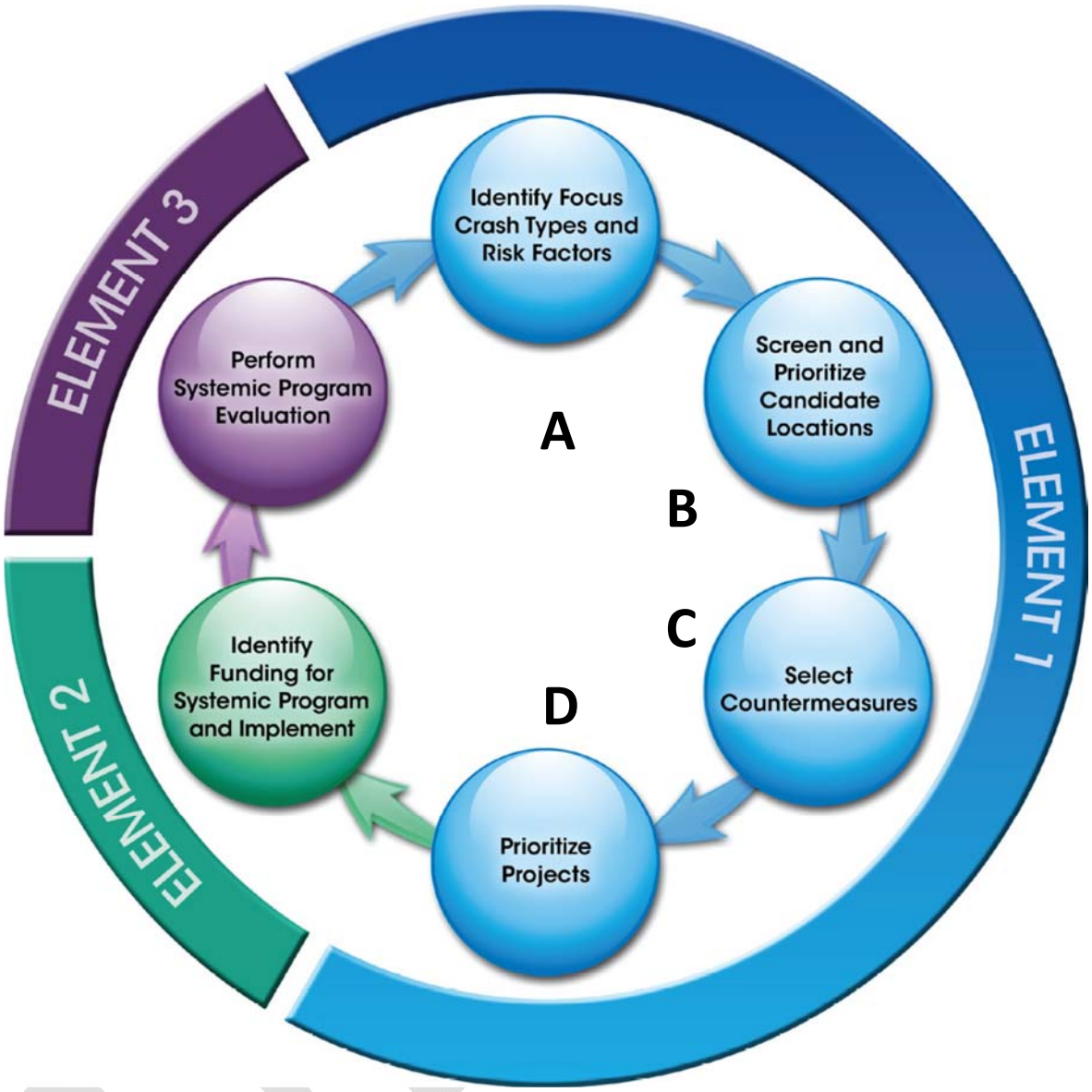

Figure 3. Systemic Safety Project Selection Tool. [5]

A. Identify Focus Crash Types and Risk Factors

The objective of Step A in the process is to identify risk factors commonly associated with each focus crash type experienced across a system. The analysis team examined regional safety data in order to determine common risk factors among the crashes by looking not only at the specific location of the crash but also at the characteristics of the locations. Within this first step are three tasks that allow for improved analysis—

- Task A-1: Selecting Focus Crash Types.
- Task A-2: Selecting Focus Facilities.
- Task A-3: Identifying and Evaluating Risk Factors.

Task A-1: Select Focus Crash Types

The objective of this task is to identify whether the systemic approach will be applied to segments, curves, or intersections. The Texas SHSP identifies four roadway safety emphasis areas, the first of which is *Crash Type & Location*. Included in this area are intersection crashes. According to the SHSP, "an intersection crash is one that occurs within the boundaries of an intersection or in which the first harmful event occurred on an approach to or exit from an intersection and resulted from an activity, behavior, or control related to the movement of traffic through an intersection."

The strategies that should be considered to reduce intersection crashes include countermeasures installed under the Texas Highway Safety Improvement Program (HSIP) and other emerging treatments, as well as the following countermeasures identified in the Texas SHSP:

Engineering

- Implement engineering solutions to reduce red-light running, such as changes in signal timing (i.e., longer yellow, all-red phase).
- Enhance advanced warning at intersections through the use of signing, flashing beacons or transverse rumble strips.
- Provide high friction surface treatments at intersection approaches to reduce vehicle stopping distances.
- Consider the use of roundabouts to reduce the number of incapacitating crashes.
- Add more turn bays and acceleration lanes on high speed rural roads.
- Eliminate limited sight distance on all roads. This includes high speed rural and urban intersections where sight distance limitations exist due to vegetation, signing, and other obstructions.
- Construct grade separations.

Enforcement

- Consider the use of photographic traffic signal enforcement (red light cameras) by municipalities.

Education

- Add information on gap acceptance and intersection crash frequency to a standardized driver education curriculum and to programs targeting elderly drivers.
- Promote better access management policies and practices by educating consultants and developers on driveway regulations in relation to intersections and by coordinating with city, county, and state engineers.

EMS

- Encourage the use of emergency vehicle signal preemption.

Table 9 presents a breakdown of the intersection crashes occurring along State-maintained, locally-owned, or other roadways for the five-year period.

Table 9. El Paso MPO intersection-related crashes by owner type.

	State	Local	Other	TOTAL
Intersection Crashes	**17,947**	**19,387**	**58**	**37,392**

Task A-2: Select Focus Facilities

Task A-2 concentrates on the details of where each crash took place, such as in rural or urban areas, at signalized or unsignalized intersections, along State-owned or locally-owned roads, etc. Table 10 depicts the distribution of intersection crashes by owner type, traffic control type, and area type.

Table 10. Distribution of El Paso MPO intersection crashes by owner, traffic control, and area type.

STATE	Area Type	Total # of Crashes	Fatal	A	B	C	PDO	Un-known
Signalized	Rural	7	0	0	3	1	3	0
	Urban	10,412	32	125	889	2,110	7,185	71
Unsignalized	Rural	76	0	2	11	15	46	2
	Urban	7,363	21	83	552	1,444	5,210	53
Unknown	Rural	0	0	0	0	0	0	0
	Urban	89	0	1	10	21	57	0
	Subtotal	17,947	53	211	1,465	3,591	12,501	126
LOCAL								
Signalized	Rural	5	0	0	1	0	4	0
	Urban	7,255	12	69	674	1,591	4,859	50
Unsignalized	Rural	65	0	1	5	10	39	10
	Urban	11,952	29	129	1,089	2,278	7,951	476
Unknown	Rural	0	0	0	0	0	0	0
	Urban	110	0	1	5	35	66	3
	Subtotal	19,387	41	200	1,774	3,914	12,919	539
OTHER								
Signalized	Rural	0	0	0	0	0	0	0
	Urban	21	0	0	2	5	14	0
Unsignalized	Rural	4	0	0	1	0	3	0
	Urban	32	0	0	4	9	16	3
Unknown	Rural	0	0	0	0	0	0	0
	Urban	1	0	0	0	0	1	0
	Subtotal	58	0	0	7	14	34	3

Per Table 10, 99 percent of the total crashes and KA crashes can be captured in the following four intersection types (listed in order of decreasing total crashes):

1. Local Urban Unsignalized
2. State Urban Signalized
3. State Urban Unsignalized
4. Local Urban Signalized

Therefore, the following 14 intersection types (also listed in order of decreasing total crashes) were eliminated from further consideration, as they collectively accounted for less than one percent of the KA crashes and associated crash costs.

1. Local Urban Unknown
2. State Urban Unknown
3. State Rural Unsignalized
4. Local Rural Unsignalized
5. Other Urban Unsignalized
6. Other Urban Signalized
7. State Rural Signalized
8. Local Rural Signalized
9. Other Rural Unsignalized
10. Other Urban Unknown
11. State Rural Unknown
12. Local Rural Unknown
13. Other Rural Signalized
14. Other Rural Unknown

Task A-3: Identify and Evaluate Risk Factors

In the current analysis, the analysis team identified the following potential risk factors using engineering judgment based upon the focus intersection types selected in Task A-2. Many of these risk factors will be reviewed in Step C as a random sample of selected intersection types are reviewed using online visualization tools:

- Number of lanes.
- Number of legs.
- Traffic volumes.
- Lane and shoulder widths.
- Channelization.
- Median width and type.
- Pavement condition and friction.
- Driveway presence, design, and density.
- Presence of lighting.
- Presence of on-street parking.
- Intersection skew angle.
- Intersection traffic control device.
- Number of signal heads vs. lanes.
- Presence of backplates.
- Presence of advanced warning signs.
- Intersection located in or near horizontal curve.
- Presence of left-turn or right-turn lanes.
- Left turn phasing.
- Allowance of right-turn on red.
- Overhead vs. pedestal-mounted signal heads.
- Pedestrian crosswalk presence, crossing distance, and signal head type.
- Posted speed limit or operating speed.
- Presence of automated enforcement.
- Adjacent land use type.
- Location and presence of bus stops.

B. Screen and Prioritize Candidate Locations

The objective of Step B of the Systemic Safety Planning Process is "to develop a prioritized list of potential locations on the roadway system that could benefit from systemic safety improvement projects." The process to screen and prioritize candidate locations helps to further explore the specific risk factors found in Step A. In order to do this, the analysis team performed the following three tasks (with the first two presented together below):

- Task B-1: Identify Network Elements to Analyze.
- Task B-2: Conduct Risk Assessment.
- Task B-3: Prioritize Focus Facility Elements.

Using the information collected in Step A, the main focus of Step B is crashes classified as K or A. KA crashes account for 1.4 percent of all intersection crashes that occurred in the El Paso MPO region during the analysis period.

Task B-1: Identify Network Elements to Analyze and Task B-2: Conduct Risk Assessment

This section presents the following:

- A summary of the combined results of the data analyses of the five largest MPOs in Texas.
- The results of the data analyses specific to the El Paso MPO region.
- The recommended intersection type(s) on which the ISIP should focus.

Combined Analysis of Texas's Five Largest MPOs

The statewide ISIP is being developed from the analyses of not only the El Paso MPO data but also data from the AAMPO, CAMPO, H-GAC, and NCTCOG regions. Table 11 presents a general summary of the intersections at which the KA crashes occurred relative to the total number of intersections across the five regions. Some key takeaways include the following:

- More than 9 out of 10 KA intersection crashes occur in urban areas.
- There is nearly a 50/50 split between crashes at State- and locally-maintained intersections (i.e., between intersections comprising at least one State-maintained road and intersections not comprising a State-maintained road).
- Signalized intersections are significantly overrepresented in terms of comparing the proportion of KA crashes to the proportion of intersections.

Table 11. Common attributes related to the severe injury (KA) intersection crashes in the five largest MPOs in Texas.

Location Type	No. of KA Crashes	Percent KA Crashes	Total No. of Intersections	Percent of Intersections
Rural	1,623	9.9%	8,817	8.4%
Urban	14,854	90.1%	95,777	91.6%
Subtotal	**16,477**	100%	104,594*	100%
Ownership Type				
State	7,810	47.4%	25,054	22.9%
Local	8,518	51.7%	83,345	76.1%
Other	149	0.9%	1,132	1.0%
Subtotal	**16,477**	100%	109,531*	100%
Traffic Control Type				
Signalized	7,653	46.4%	25,512	20.3%
Unsignalized	8,756	53.1%	97,709	77.7%
Unknown	68	0.4%	2,499	2.0%
Subtotal	**16,477**	100%	125,720*	100%

** As the safety data were derived from various sources (e.g., CRIS and ESRI Street layer), the intersection characteristic data correlate to the crashes rather than the intersections themselves. Consequently, there were instances when conflicting data elements (e.g., signalized and unsignalized) were coded to the same intersection due to multiple crash reports tied to the same location. This created duplicate intersections within the database, which led to the variable intersection subtotals among the categories.*

Figure 4 depicts the comparison of the proportions of the five MPOs' KA intersection crashes to the specific intersection types. Five intersection categories show a measurable overrepresentation when comparing the proportion of KA crashes to the proportion of total intersections. The most meaningful overrepresentation in terms of KA crashes is seen in the State Urban Signalized and Local Urban Signalized categories.

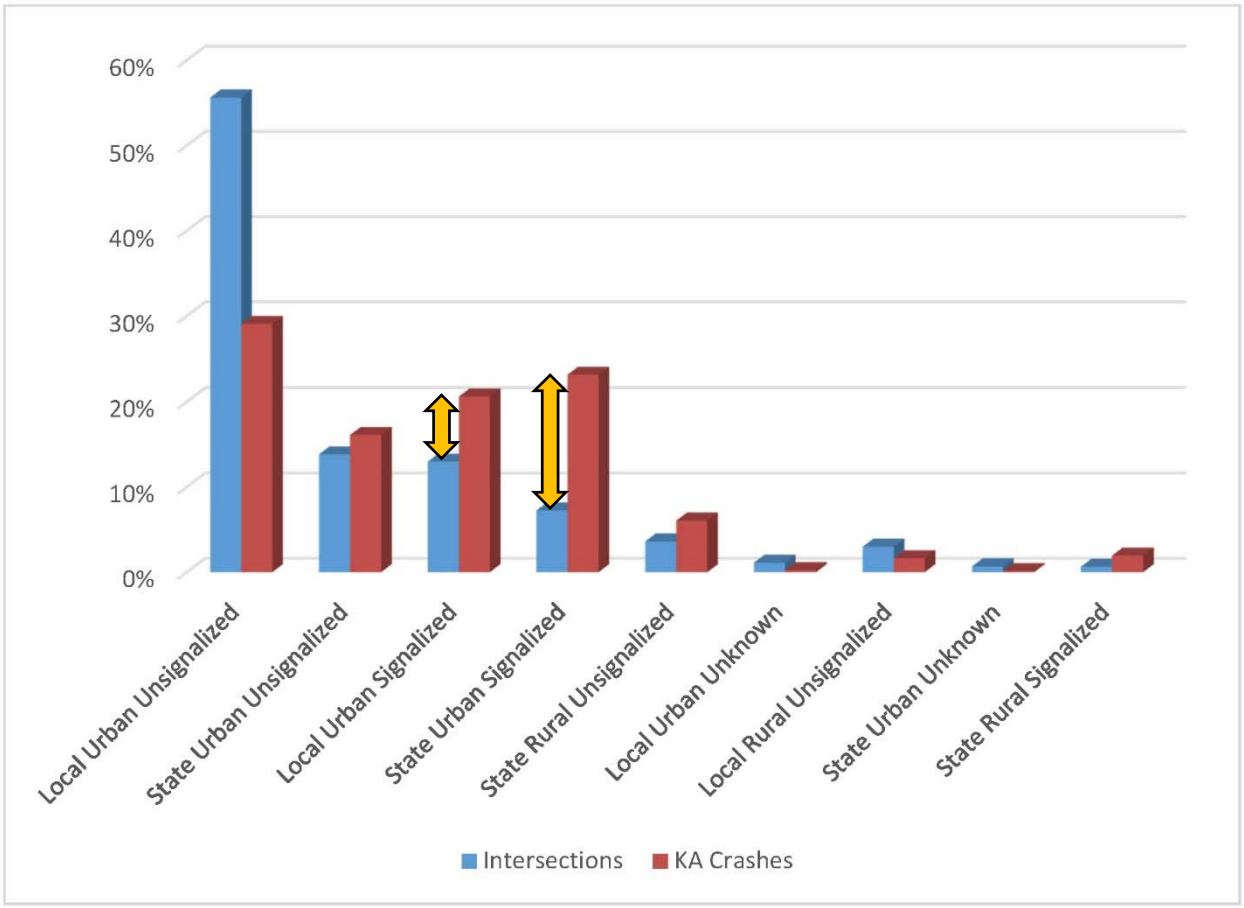

Figure 4. Distribution of the five largest Texas MPOs' severe injury (KA) intersection crashes by area type and traffic control.

El Paso MPO Regional Analyses

This section presents the results of the data analyses specific to the Texas portion of the El Paso MPO region. Table presents a general summary of the intersections at which the KA crashes occurred relative to the total number of intersections across the region.

Table 12. Common attributes related to El Paso MPO severe injury intersection crashes.

Location Type	No. of KA Crashes	Percent KA Crashes	Total No. of Intersections	Percent Intersections
Rural	3	1%	67	1%
Urban	502	99%	6,668	99%
Subtotal	**505**	100%	6,735*	100%
Ownership Type				
State	264	52%	1,623	23%
Local	241	48%	5,510	77%
Other	0	0%	32	0%
Subtotal	**505**	100%	7,165*	100%
Traffic Control Type				
Signalized	238	47%	1,792	22%
Unsignalized	265	52%	6,259	76%
Unknown	2	0%	172	2%
Subtotal	**505**	100%	8,223*	100%

** Because the El Paso safety data were derived from various sources (e.g., CRIS and ESRI Street layer), the intersection characteristic data correlate to the crashes rather than the intersections themselves. Consequently, there were instances when conflicting data elements (e.g., signalized and unsignalized) were coded to the same intersection due to multiple crash reports tied to the same location. This created duplicate intersections within the database, which led to the variable intersection subtotals among the categories. The actual intersection count for El Paso was determined to be 6,731.*

The analysis team highlights the following roadway inventory attributes to describe where these KA intersection crashes occurred:

- Land use—99 percent of the El Paso MPO's severe intersection crashes occurred in urban areas compared to 1 percent rural.
- Ownership type—52 percent of the KA crashes occurred at intersections involving at least one State-maintained road despite such intersections comprising only 23 percent of the El Paso MPO's intersections.
- Traffic control—considering the 503 KA intersection crashes for which the traffic control type is known, 47 percent occurred at signalized intersections despite the fact that only an estimated 22 percent of the El Paso MPO's intersections is signalized.

Each of the focus intersection types are further divided into different elements to determine which would be the most beneficial to analyze. Table depicts the number of KA intersection crashes and the number of associated intersection types categorized by the following attributes:

- Owner type (State-maintained, locally-owned, or other intersections).
- Land use (rural or urban area).
- Traffic control (signalized, unsignalized, or unknown).

The four focus categories identified in Table 10—which capture 99 percent of the region's KA crashes—are listed in boldface type.

Table 13. Distribution of the El Paso MPO's severe intersection crashes by traffic control and area type.

STATE	Area Type	KA Crashes	Percent of KA	Total Intersections	Percent of Intersections	Ratio of % KA to % Ints
Signalized	Rural	0	0.00%	4	0.09%	0.00
	Urban	**157**	**31.09%**	**853**	**9.61%**	**3.24**
Unsignalized	Rural	2	0.40%	19	0.19%	2.10
	Urban	**104**	**20.59%**	**1,420**	**15.13%**	**1.36**
Unknown	Rural	0	0.00%	0	0.00%	-
	Urban	1	0.20%	71	0.89%	0.22
	Subtotal	264	52.28%	2,367	25.89%	-
LOCAL						
Signalized	Rural	0	0.00%	1	0.01%	0.00
	Urban	**81**	**16.04%**	**1,170**	**13.29%**	**1.21**
Unsignalized	Rural	1	0.20%	48	0.12%	1.70
	Urban	**158**	**31.29%**	**5,027**	**59.13%**	**0.53**
Unknown	Rural	0	0.00%	0	0.00%	-
	Urban	1	0.20%	100	1.15%	0.17
	Subtotal	241	47.72%	6,346	73.70%	-
OTHER						
Signalized	Rural	0	0.00%	0	0.00%	-
	Urban	0	0.00%	9	0.10%	0.00
Unsignalized	Rural	0	0.00%	2	0.02%	0.00
	Urban	0	0.00%	24	0.28%	0.00
Unknown	Rural	0	0.00%	0	0.00%	-
	Urban	0	0.00%	1	0.00%	-
	Subtotal	0	0.00%	36	0.41%	-
	TABLE SUBTOTAL	505	100.00%	8,749	100.00%	

Three of the intersection categories listed in boldface type in Table show a measurable overrepresentation when comparing the proportion of the El Paso MPO's KA crashes to the proportion of its total intersections. Figure 5 depicts the comparison of the proportions of the El Paso MPO's KA intersection crashes to intersection types.

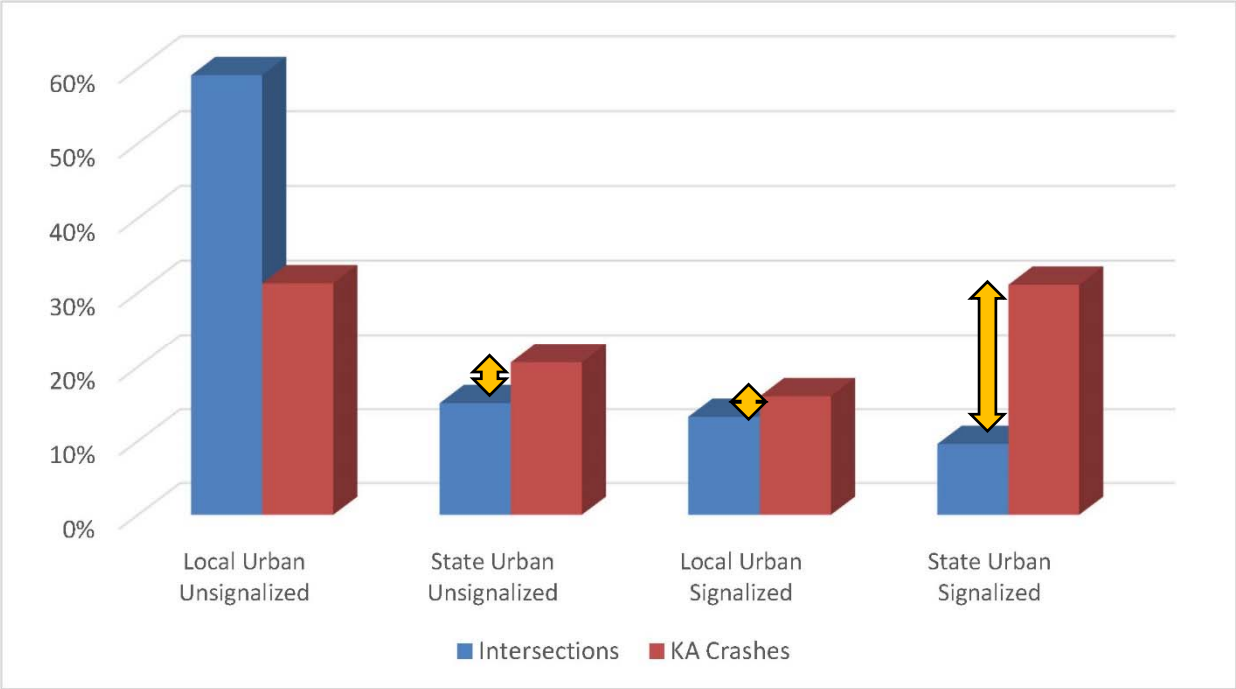

Figure 5. Distribution of El Paso MPO severe (KA) intersection crashes by area type and traffic control.

Recommended ISIP Focus

The analysis team suggests to focus on urban signal-controlled intersections, regardless of whether these intersections are State-maintained or locally-owned. State and Local Urban Signalized intersections comprise less than 23 percent of the intersections within the El Paso MPO region, yet nearly 47 percent of the severe (KA) intersection crashes—238 of them during the five-year study period—occurred at such intersections. These KA crashes occurred at 184 urban signalized intersections, which equates to 3 percent of the 6,731 intersections analyzed across the region. Similar trends emerge when considering all five MPO regions collectively, as approximately 20 percent of the intersections are State and Local Urban Signalized, yet nearly 44 percent of the KA crashes occur at such intersections.

The distribution of El Paso MPO State and Local Urban Signalized KA intersection crashes in terms of the TxDOT collision types is presented in Table 14 and Figure 6. Not surprisingly, seven of every ten severe intersection crashes involved more than one vehicle, with 37 percent classified as angle type collisions characterized by "two vehicles approaching each other at an angle."

Table 14. Detailed distribution of El Paso MPO severe intersection collision types.

Collision Type	Count	Percent
ANGLE - BOTH GOING STRAIGHT	83	35%
OD ONE STRAIGHT-ONE LEFT TURN	53	22%
OMV VEHICLE GOING STRAIGHT	38	16%
OMV VEHICLE TURNING LEFT	21	9%
SD ONE STRAIGHT-ONE STOPPED	19	8%
OMV VEHICLE TURNING RIGHT	7	3%
ANGLE - ONE STRAIGHT-ONE LEFT TURN	5	2%
SD ONE STRAIGHT-ONE LEFT TURN	4	2%
SD BOTH GOING STRAIGHT-SIDESWIPE	2	1%
SD ONE STRAIGHT-ONE RIGHT TURN	1	0%
SD BOTH LEFT TURN	1	0%
SD BOTH GOING STRAIGHT-REAR END	1	0%
OMV OTHER	1	0%
OD BOTH GOING STRAIGHT	1	0%
ANGLE - ONE LEFT TURN-ONE STOPPED	1	0%
Total	**238**	**100%**

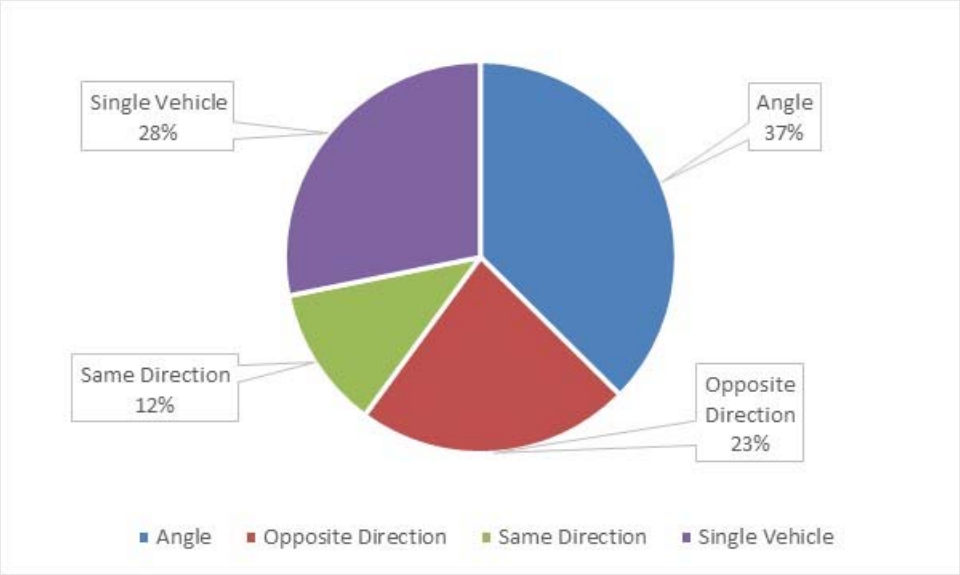

Figure 6. General distribution of El Paso MPO severe intersection collision types.

Table presents the nature of the severe (KA) intersection crashes according to the reported harmful event description, which provides additional insight on the nature of the collision. Seven (7) of every 10

crashes involved another motor vehicle, while approximately 1 of every 5 crashes involved a pedestrian or bicyclist.

Table 15. Reported harmful event for El Paso MPO severe intersection collisions.

Harmful Event	Count	Percent
Motor vehicle in transport	171	72%
Pedestrian	48	20%
Fixed object	16	7%
Pedalcyclist	2	1%
Overturned	1	0%
Total	**238**	**100%**

Basic crash analyses were also conducted to explore trends in the reported lighting condition, surface condition, and weather condition for the severe intersection crashes, and these will be considered when selecting crash countermeasures.

Task B-3: Prioritize Focus Facility Elements

The 238 severe injury (KA) crashes in the El Paso MPO occurred at 184 intersections, which may be too many locations to effectively treat in a short timeframe with limited resources. Therefore, the analysis team suggests applying a threshold to the crashes to assist with prioritizing a subset of the urban signalized intersections. While the analyses have centered on KA crashes, additional prioritization alternatives are derived by also considering the number of non-incapacitating injury (B) crashes that occurred at the focus intersections. Table 16 presents a breakdown of intersections that can be targeted based on various crash thresholds. The first three rows consider only KA crashes, while the remaining rows also apply thresholds to the B crashes occurring during the analysis period. If a threshold of three or more KA crashes is selected, 15 percent of El Paso MPO KA intersection crashes can be addressed by targeting 6 percent of the KA intersection crash locations; likewise, if a threshold of either three or more KA crashes or two KA crashes and four or more B crashes is applied, then more than one-quarter of the KA crashes can be addressed by targeting just one-eighth of the KA crash locations.

Table 16. Potential crash thresholds for El Paso MPO systemic treatments.

Crash Threshold	KA Crashes		Intersections		B Crashes
	Number	Percent	Number	Percent	
2 or more KA crashes	94	39.7%	40	21.9%	152
3 or more KA crashes	36	15.2%	11	6.0%	47
4 or more KA crashes	9	3.8%	2	1.1%	12
3 or more KA crashes OR 2 KA crashes and 10 or more B crashes	38	16.0%	12	6.6%	59
3 or more KA crashes OR 2 KA crashes and 8 or more B crashes	40	16.9%	13	7.1%	67
3 or more KA crashes OR 2 KA crashes and 6 or more B crashes	50	21.1%	18	9.8%	99
3 or more KA crashes OR 2 KA crashes and 5 or more B crashes	56	23.6%	21	11.5%	114
3 or more KA crashes OR 2 KA crashes and 4 or more B crashes	60	25.3%	23	12.6%	122

Similarly, Table 17 presents the potential crash thresholds and their corresponding reach for the five MPOs combined. The rightmost column provides a simple estimate of how an overall statewide funding amount—$45 million in this case—would translate as a per-intersection average for the various thresholds identified. For example, selecting a threshold of three or more KA crashes or two KA crashes and four or more B crashes would allow nearly 40 percent of the five regions' KA intersection crashes to be addressed by targeting 19 percent of the KA intersection crash locations, with an allowable average cost of nearly $50,000 per intersection.

Table 17. Potential crash thresholds for statewide systemic treatments.

Crash Threshold	KA Crashes		Intersections		B Crashes	Avg. per-intersection cost assuming $45M funding
	Number	Percent	Number	Percent		
2 or more KA crashes	3,782	52.5%	1,373	28.7%	8,242	$ 32,775
3 or more KA crashes	2,006	27.9%	485	78.9%	4,507	$ 92,784
4 or more KA crashes	1,178	16.4%	209	34.0%	2,919	$ 215,311
3 or more KA crashes OR 2 KA crashes and 10 or more B crashes	2,162	30.0%	563	11.8%	5,518	$ 79,929
3 or more KA crashes OR 2 KA crashes and 8 or more B crashes	2,298	31.9%	631	13.2%	6,088	$ 71,315
3 or more KA crashes OR 2 KA crashes and 6 or more B crashes	2,506	34.8%	735	15.4%	6,751	$ 61,224
3 or more KA crashes OR 2 KA crashes and 5 or more B crashes	2,660	37.0%	812	17.0%	7,136	$ 55,419
3 or more KA crashes OR 2 KA crashes and 4 or more B crashes	2,846	39.5%	905	18.9%	7,508	$ 49,724

Ultimately, the threshold applied for this effort will be determined by TxDOT and the participating local agencies based on the (1) selected package of systemic countermeasures (and its associated cost), (2) actual funding level available, and (3) decisions on prioritization across all participating MPOs.

C. Select Countermeasures

The third step of the Systemic Safety Planning Process involves developing "low-cost, highly effective countermeasures" that can be utilized at the candidate locations. Once the preliminary findings are approved and the selection of the suggested intersection types receive concurrence from the MPOs, TxDOT, and FHWA, the analysis team will move forward to estimate current deployment levels, crash thresholds, and a planning-level benefit-cost ratio analysis for each possible systemic countermeasure that may address the selected intersection types and current crash types. The team also will ask for feedback on the current use or acceptance of the proposed countermeasures and eliminate any measures that may not be used in Texas.

D. Prioritize Projects

Developing a list of safety-improvement projects is the last step in the Systemic Safety Planning process. Throughout this step, each crash location will be evaluated using the criteria calculated in Step C to help determine which countermeasures would be most effective for these areas. Finally, each countermeasure package will be prioritized based on its cost relative to current funding availability, benefits through expected crash reduction, and ability to be quickly deployed relative to any contractual issues or institutional constraints.

Conclusions and Next Steps

The methodology utilized to identify the best systemic approach aligns with the State SHSP's statement that "Texas must continue to seek safety improvements by deploying a diverse set of countermeasures that address both engineering and behavioral issues." The selected approach embodies the data-driven decision making noted by the SHSP to achieve Texas's mission of reducing the "human and societal costs of motor vehicle crashes, deaths, and injuries by implementing effective highway safety countermeasures." As roadway safety data—particularly intersection data (e.g., number of approach legs, entering traffic volumes, maintenance jurisdiction)—become more available and more accurate, this approach can be modified to better address intersection safety systemically and encompass all public roadways.

The SHSP identifies intersections as a focus of its critical emphasis area, *Crash Type & Location*. This proposed systemic approach will complement the ongoing SHSP initiative to reduce the number of fatal and incapacitating injury intersection-involved crashes by five percent. Based on the preliminary analysis, the project team proposes that the best systemic approach is to target the severe KA intersection crashes. The severe crashes comprise nearly 50 percent of the total cost of intersection crashes. Analyzing the severe crash intersections further reveals the top intersection type as ***urban signalized***. El Paso MPO's 238 severe intersection crashes occurred at 184 locations across the region, and these crashes comprise 47 percent of the region's total severe intersection crashes.

In order to focus the systemic approach within the El Paso MPO region, the project team suggests looking at a subset of the urban signalized intersections. Several thresholds were presented in Table 16 to indicate how many crashes could be targeted relative to the number of intersections treated. The project team will assist the MPOs, TxDOT, and FHWA in determining the final threshold to be applied for the entire effort.

Based upon feedback from the El Paso MPO, TxDOT, and FHWA, the project team will continue to develop and refine a number of countermeasure packages as part of Step C. These packages will be presented in a straw man outline as part of Step D.

References

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5. "Systemic Safety Project Selection Tool," U.S. Department of Transportation Federal Highway Administration, July 2013, http://safety.fhwa.dot.gov/systemic/fhwasa13019/sspst.pdf