


Road Safety Audit Training Workshop


H-GAC Workshop – February 22, 2024

Regional Collaboration • Transportation Planning • Multimodal Mobility

METROPOLITAN PLANNING ORGANIZATION

Workshop Agenda

- 9:00 am – Introduction and Road Safety Audit (RSA) Fundamentals
- 9:15 – Network Screening
  - Network Screening Exercise
- 9:45 – Diagnosis
  - Diagnosis Exercise
- **10:15 – *** Break *****

- 10:30 – Countermeasure Selection
  - Exercise
- 11:20 – Countermeasure Considerations
  - Examples
- 11:50 – Economic Appraisal and Conclusion
- 12:00 pm – Conclude Workshop

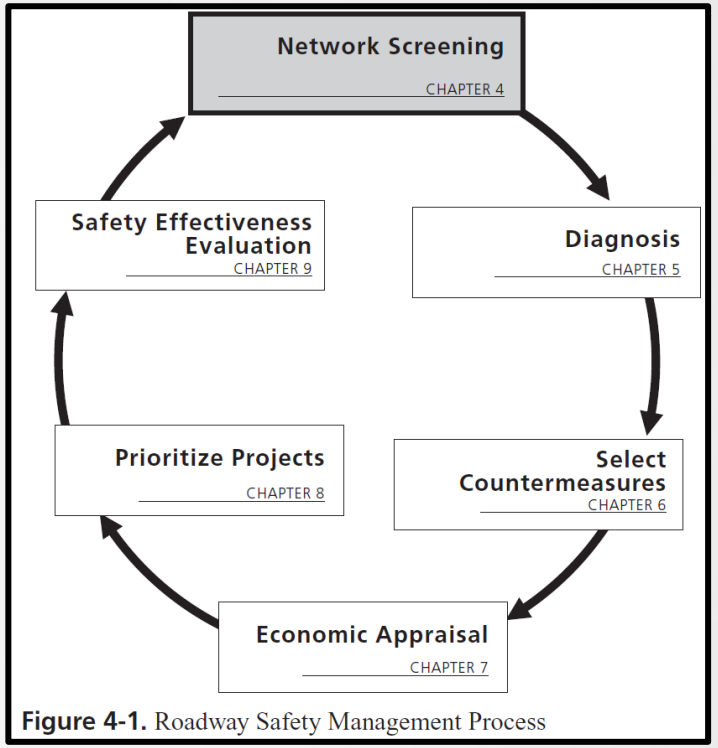


Figure 4-1. Roadway Safety Management Process

Introductions

- Name
- Organization
- Road safety experience
  - Why is safety a priority?
  - What aspect of road safety interests you?
  - What does a safe street look like?
  - Name a safe street (or an unsafe street).
  - Or tell a story…

Survey

- What agency are with?
- What is your experience with RSAs?
- What are you hoping to learn today?

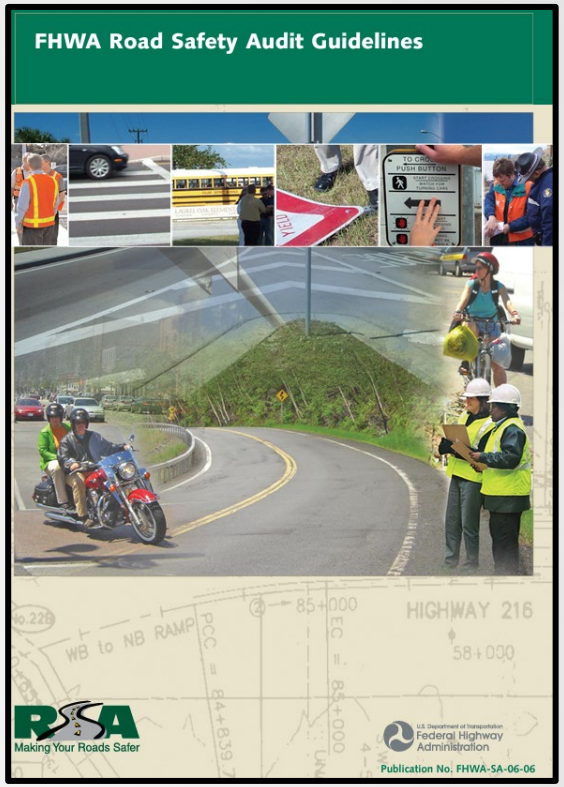
Objectives

1. What is an RSA?
   - Describe the RSA process and purpose.
2. What is the Roadway Safety Management Process?
   - Describe the process and purpose.
3. What are resources for conducting RSAs and steps of the road safety management process?
   - Provide reference material and simulate steps of the process.
4. What countermeasures are used to improve intersection safety?
   - Provide guidance and examples of safety countermeasures.

RSA Fundamentals

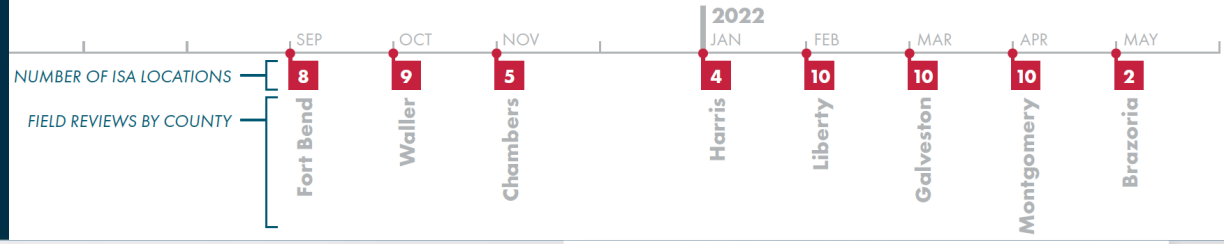
"The best way to initiate the RSA process is to **conduct one or more pilot projects** involving both selected professionals who will become the champions of RSAs and a small number of project managers who can explore the ways in which it is possible to respond and react to audit reports."

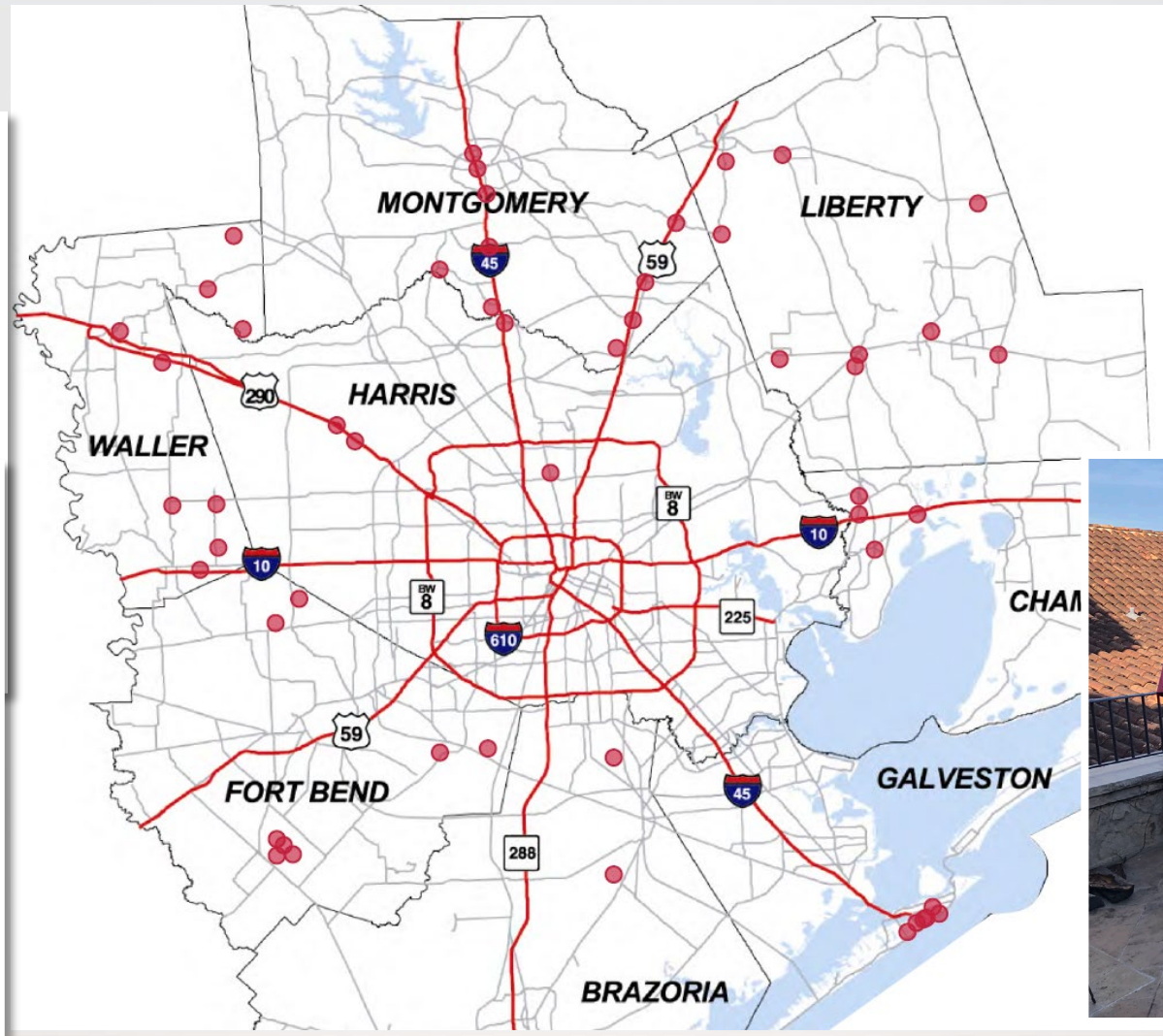
- FHWA's Road Safety Audits Guidelines



Participation in an RSA is the best mechanism to learn the RSA process.

RSA Pilot Projects





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A Road Safety Audit is…

"… the formal safety performance examination of an existing or future road or intersection by an independent, **multidisciplinary team** . It **qualitatively** estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for **all road users** ."

- FHWA's Road Safety Audits Guidelines

A Road Safety Audit is…

1. Focused on road safety.
2. A formal examination.
3. Proactive in nature.
4. Conducted by a multidisciplinary team (more than one auditor).
5. Conducted by an audit team that is independent of the design team.
6. Conducted by an audit team that is adequately qualified.
7. Broad enough to consider the safety of all road users and road facilities.
8. Qualitative in nature.

- FHWA's Road Safety Audits Guidelines

A Road Safety Audit is NOT…

1. Not a means to evaluate, praise or critique design work.
2. Not a check of compliance with standards.
3. Not a means of ranking or justifying one project over another.
4. Not a means of prioritizing one design option over another.
5. Not a redesign of a project.
6. Not a crash investigation or crash data analysis

   Although the crash history of an existing road is reviewed to make sure that previous crash patterns have been addressed.
7. Not a safety review.

- FHWA's Road Safety Audits Guidelines

RSA Process

Crosstimbers RSA Example

Step	Description	Participants	Date
1	Identify **project** or road in-service to be assessed.	H-GAC and COH	Complete
2	Select **RSA team**.	H-GAC and COH	Complete
3	Conduct a **pre-assessment meeting** to review locations.	RSA Team	**8/24**
4	Perform **field observations** under various conditions.	RSA Team	**8/29 & 8/30**
5	Conduct **assessment analysis** and prepare report of findings.	RSA Team	**8/30**
6	Present **assessment findings** to Project Owner/Design Team.	Consultant Team	TBD
7	Project Owner/Design Team prepares **formal response**.	H-GAC and COH	TBD
8	Incorporate findings into **the project** when appropriate.	H-GAC and COH	TBD

FHWA RSA Process

RSA Process

Step 1: Identify project or existing road to be audited

As a result of this step, the project or existing road to be audited is determined and the parameters for a RSA are set.

Step 2: Select RSA Team

As a result of this step, an independent, qualified, and multidisciplinary team of experts suitable for the specific RSA stage is selected.

Step 3: Conduct a pre-audit meeting to review project information

The meeting brings together the project owner, the design team and the audit team to discuss the context and scope of the RSA and review all project information available.

Step 4: Perform field reviews under various conditions

The objective of project data review is to gain insight into the project or existing road, prepare for the field visit and identify areas of safety concerns.
The field visit is used to get further insight into the project or existing road and to further verify/identify areas of safety concern.

Step 5: Conduct audit analysis and prepare report of findings

As a result of this step, the safety issues are identified and prioritized and suggestions are made for reducing the degree of safety risk. The RSA results are then succinctly summarized in the formal RSA report.

Step 6: Present audit findings to Project Owner/Design Team

In this step, audit team orally reports the key RSA findings to the project owner and design team in order to facilitate the understanding of RSA findings.

Step 7: Prepare formal response

Once submitted, the formal response becomes an essential part of the project documentation. It outlines what actions the project owner and/or design team will take in response to each safety issue listed in the RSA report and why some of the RSA suggestions could not be implemented.

Step 8: Incorporate findings into the project when appropriate

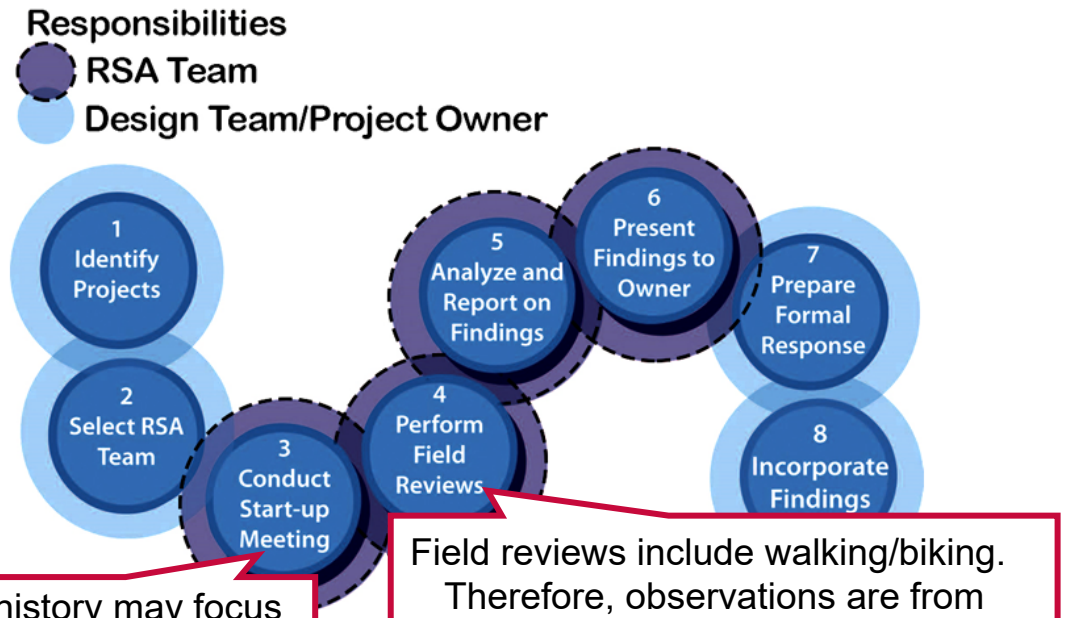
This final step ensures that the corrective measures outlined in the response report are completed as described and in the time frame documented.

Walk and Bike Audits

Pedestrian- and Bicyclist-Focused RSA Process

Same 8-step Process

This section describes the eight steps recommended by FHWA to condu suggestions for adequately considering pedestrians and bicyclists in the process. Figure 17 illustrates the progression of these steps. The responsibilities of the project owner/design team and the RSA Team may vary during an RSA.



Crash history may focus on ped/bike crashes

Field reviews include walking/biking. Therefore, observations are from ped/bike perspective

Figure 17. Graphic. Eight-step RSA process.

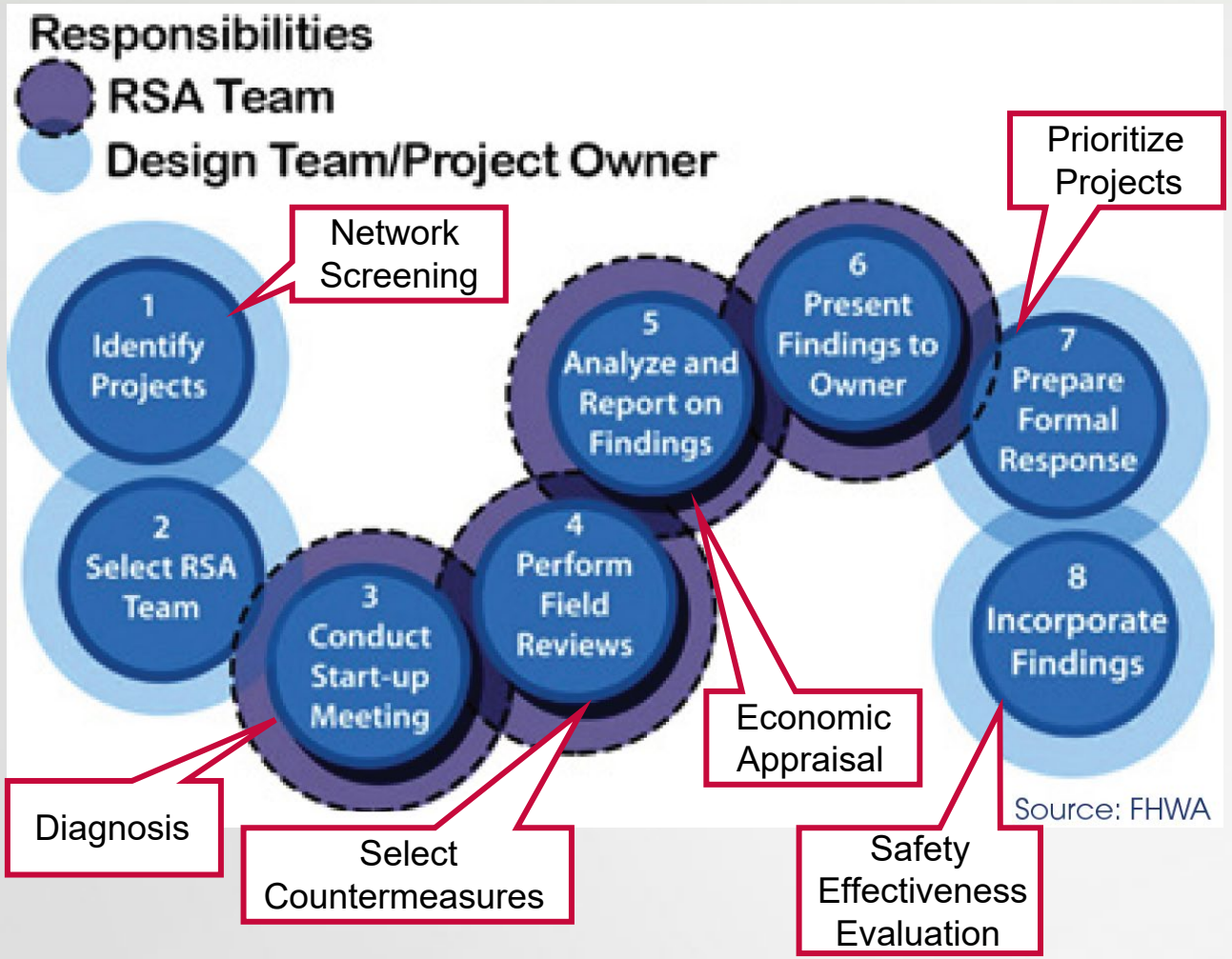
RSA team should include people familiar with ped/bike needs

Optional Members

- **Pedestrian and bicycle advocacy/vendors** – These organizations and businesses—such as local bicycle shops or rentals—have an intimate knowledge of the transportation network, how it is working, and specific concerns/suggestions identified by their members/customers. These perspectives are important, and a representative can be involved in the RSAs or can provide input at the kickoff meeting or a separate meeting. If it is possible to incorporate a bicycle ride, then members of these organizations may be helpful in leading the ride or organizing bikes for participants.
- **Community development** – Representatives from community development or business districts may be able to provide insights from their members and community. Sometimes these conversations can lead to public-private partnerships for implementing improvements or disseminating messaging.
- **School representatives** – If there is a school located within the study area, involve them in the process. Some considerations include how students and staff access the school and provide opportunities for walking and biking. Crossing guards may have insight into safety issues and the interactions and behaviors between students and drivers. If possible, involve students in future efforts to encourage and improve safety for walking and biking.
- **Community leaders** – Community representatives and leadership can provide feedback from community members, at least during the kickoff meeting or a separate meeting.
- **Public transit** – If public transit is present within the study area, understanding the transit types and how transit riders access stops are all important to pedestrian and bicyclist safety.
- **Accessibility representative** – Some of the essential team members should have expertise in ADA requirements for pedestrians and bicyclists. However, it may be beneficial to involve a specialist in this area or members from the accessibility community. The RSA is not a standards check, but having this perspective confirms the facilities work for users of all abilities.

Source: FHWA Pedestrian and Bicyclist Road Safety Audit (RSA) Guide and Prompt Lists (FHWA-SA-20-042)

RSA Process



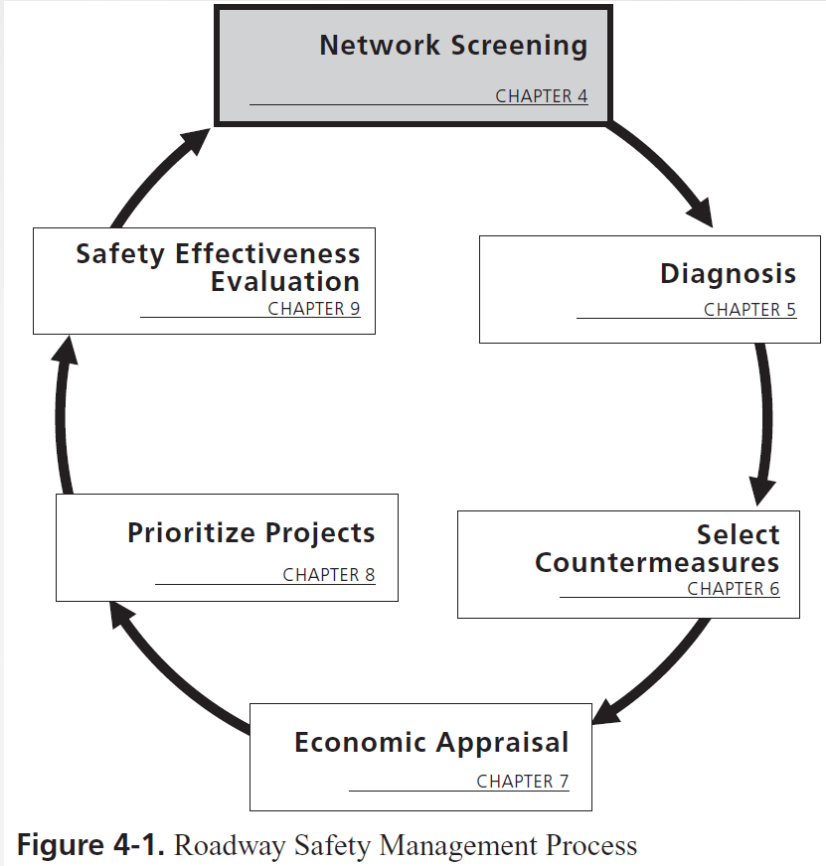


Figure 4-1. Roadway Safety Management Process

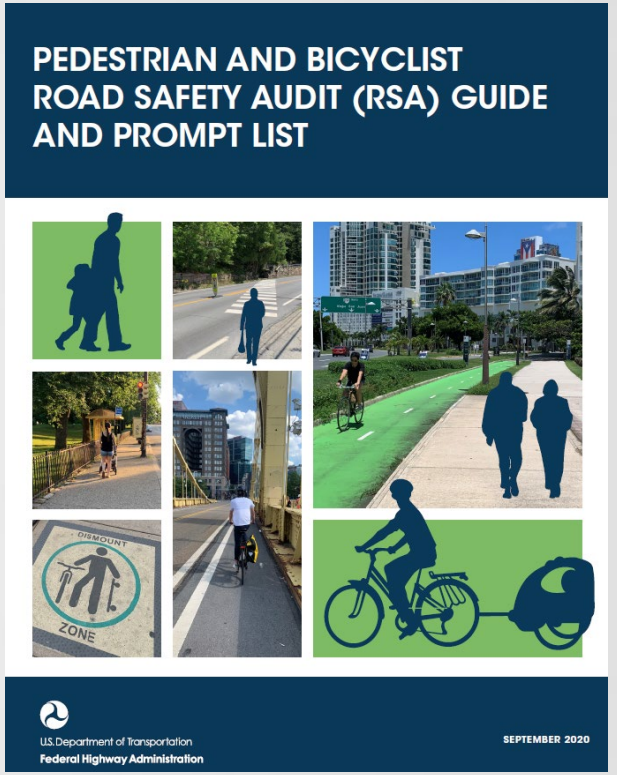
Resources – RSA Fundamentals

RSAs

- FHWA RSA Webpage
- FHWA Road Safety Audits Guidelines (FHWA-SA-06-06)
  - Chapter 7 and Prompt List 6
- FHWA Pedestrian and Bicyclist Road Safety Audit (RSA) Guide and Prompt Lists (FHWA-SA-20-042)
  - Appendix B

Safety Fundamentals

- FHWA Road Safety Fundamentals (FHWA-SA-18-003)
- USDOT National Roadway Safety Strategy
- Highway Safety Manual



Network Screening is…

"a process for reviewing a transportation network to identify and rank sites from most likely to least likely to realize a reduction in crash frequency with implementation of a countermeasure."

Traditional

Network screening can also be used to formulate and implement a policy, such as prioritizing the systemwide deployment of selected, low -cost countermeasures.

Systemic

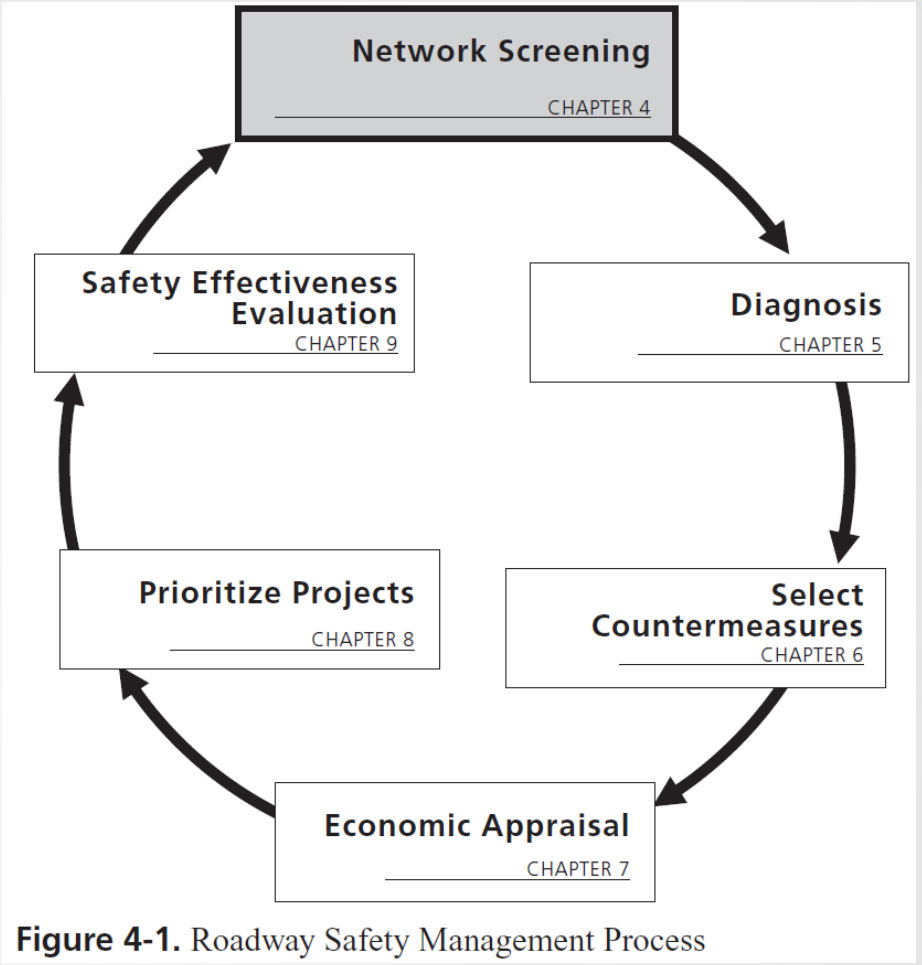
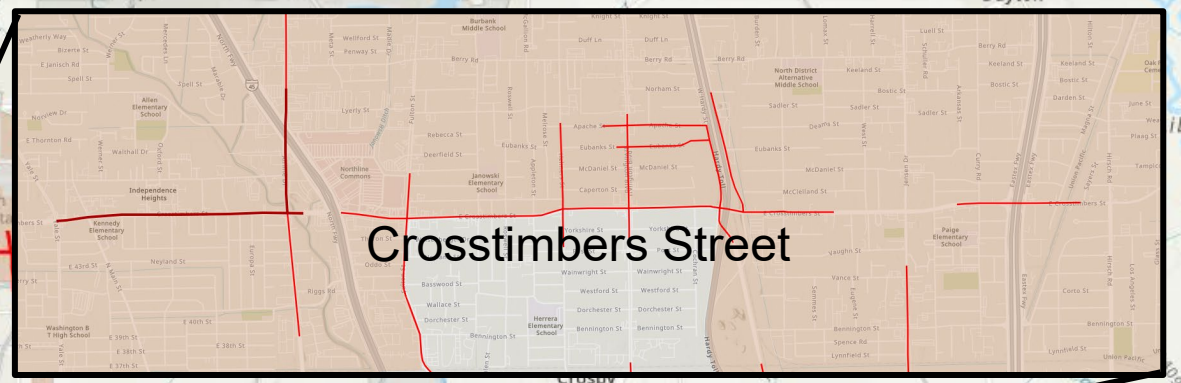


Figure 4-1. Roadway Safety Management Process


Houston
Vision Zero
Action Plan
NOVEMBER 2020


Crosstimbers Street

Network Screening – Step 1

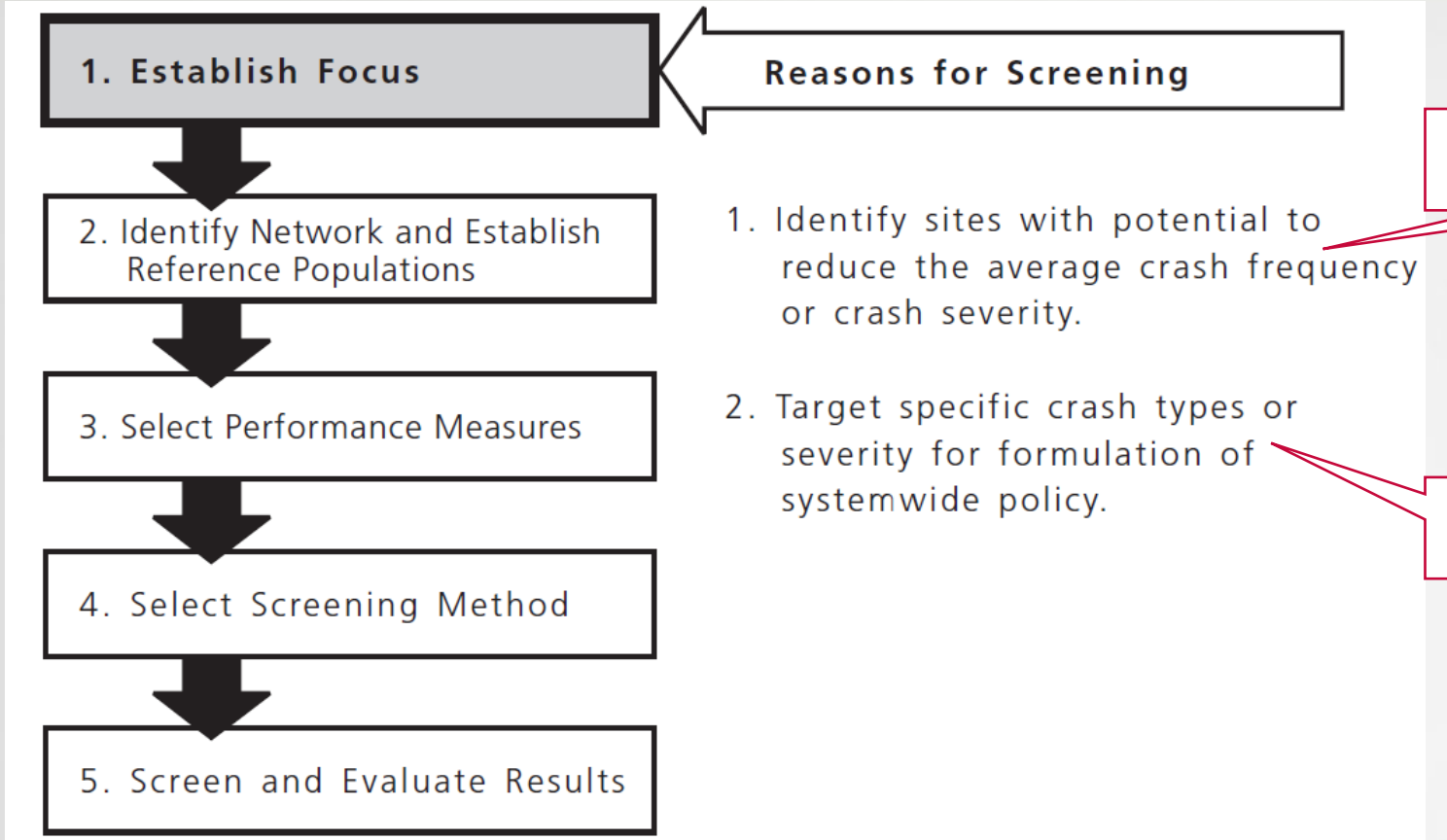
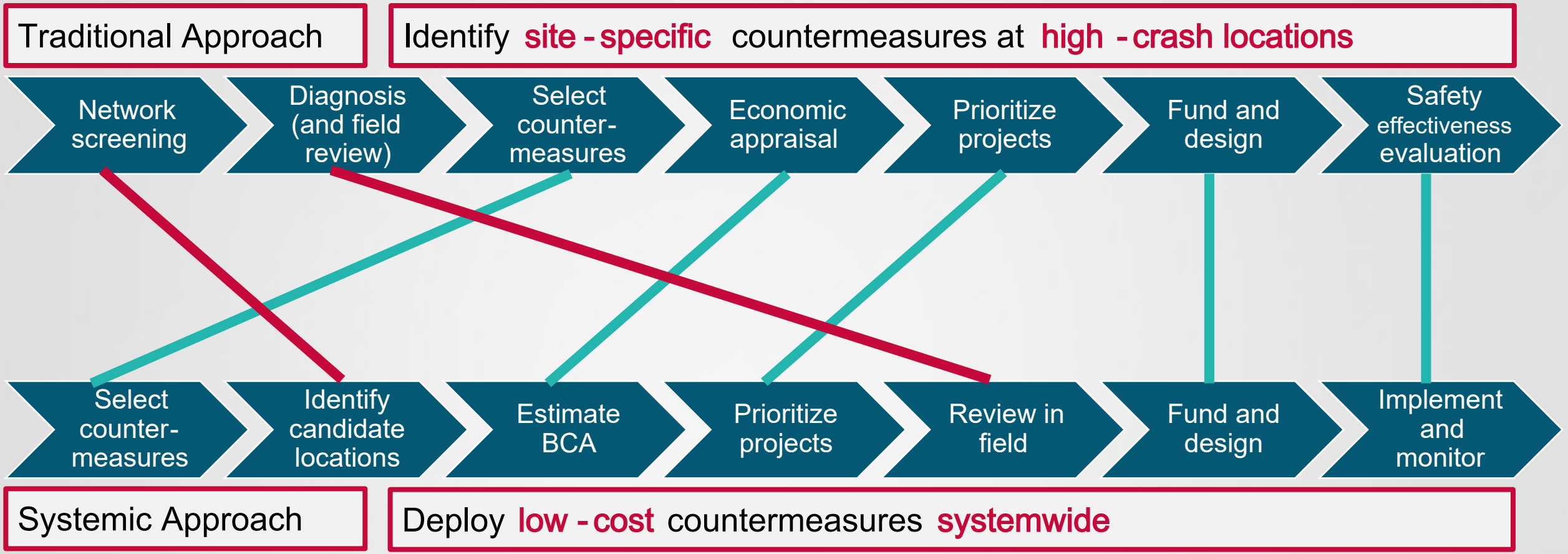


Figure 4-2. The Network Screening Process—Step 1, Establish Focus

Traditional and Systemic



Network Screening – Step 2

1. Establish Focus
2. **Identify Network and Establish Reference Populations**
3. Select Performance Measures
4. Select Screening Method
5. Screen and Evaluate Results

That Can Be Screened

- Intersections
- Segments
- Facilities
- Ramps
- Ramp Terminals
- At-Grade Rail Crossings

Within the region, nearly 40% of all crashes and more than 25% of fatalities occur at intersections.

Figure 4-3. The Network Screening Process—Step 2, Identify Network and Establish Reference Populations

Network Screening – Step 3

1. Establish Focus
2. Identify Network and Establish Reference Populations
3. **Select Performance Measures** ← **One or Multiple**
4. Select Screening Method
5. Screen and Evaluate Results

- Average Crash Frequency
- Crash Rate
- Equivalent Property Damage Only (EPDO) Average Crash Frequency
- Relative Severity Index

Useful if BCR is a priority

Network Screening – Step 3

Performance Measure	Crash Data	Roadway Information for Categorization	Traffic Volume[a]	Calibrated Safety Performance Function and Overdispersion Parameter	Other
Average Crash Frequency	X	X			
Crash Rate	X	X	X		
Equivalent Property Damage Only (EPDO) Average Crash Frequency	X	X			EPDO Weighting Factors
Relative Severity Index	X	X			Relative Severity Indices
Critical Rate	X	X	X		
Excess Predicted Average Crash Frequency Using Method of Moments[b]	X	X	X		
Level of Service of Safety	X	X	X	X	
Excess Predicted Average Crash Frequency Using Safety Performance Functions (SPFs)	X	X	X	X	
Probability of Specific Crash Types Exceeding Threshold Proportion	X	X			
Excess Proportion of Specific Crash Types	X	X			
Expected Average Crash Frequency with EB Adjustment	X	X	X	X	
Equivalent Property Damage Only (EPDO) Average Crash Frequency with EB Adjustment	X	X	X	X	EPDO Weighting Factors
Excess Expected Average Crash Frequency with EB Adjustment	X	X	X	X	

Network Screening – Step 4

1. Establish Focus
2. Identify Network and Establish Reference Populations
3. Select Performance Measures
4. **Select Screening Method**
5. Screen and Evaluate Results

Consistent with Performance Measure(s) Selected

- Sliding Window
- Simple Ranking
- Peak Searching

Simple, used for intersections

Network Screening – Step 5

1. Establish Focus
2. Identify Network and Establish Reference Populations
3. Select Performance Measures
4. Select Screening Method
5. Screen and Evaluate Results

Screening by Node, Segment, or Facility

1) **Common sense:** Are the results what we expected?
2) **Reliability:** Is the underlying data we used reliable?
3) **Validity:** Are the selected performance measures good indicators of our priorities?

Network Screening – Practice Exercise

1. **Objective:** Rank intersections based on their potential for crash reduction.
2. Process:
    1. Organize into groups of four (or five)
    2. Review intersection reference population table
    3. Select performance measures
    4. Rank intersections
    5. Evaluate results
    6. Write down top 3 to 5 intersections (for use later)

Crosstimbers RSA

Corridor Mobility

Project Background

H-GAC and City of Houston are committed to Vision Zero (VZ) with a goal to end traffic deaths and serious injuries. Houston's VZ action plan published in 2020 identified a High Injury Network (HIN), which contains just 6% of Houston's streets and accounts for nearly 60% of traffic deaths and serious injuries. **Crosstimbers Street is among the highest-crash corridors on the HIN**. H-GAC partnered with City of Houston to conduct a Road Safety Audit along Crosstimbers Street, diagnose safety issues, and recommend improvements.

Corridor: Crosstimbers Street

Limits: Yale Street to Hirsch Road

Length: 4.5 miles

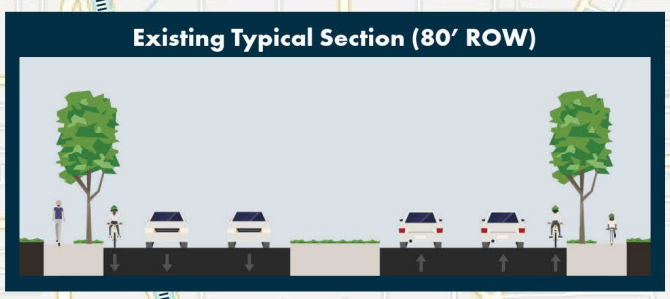
MTFP Designation: T-4-80

MMC Designation: Urban Blvd

ADT: 13,800 - 15,800

Posted Speed: 35mph (30pmh east of Jensen)

Travel Speed: 39-42mph west of Jensen, 34mph east of Jensen



Legend

- Crosstimbers RSA Corridor Limits
- Northline Mall/Transit Center
- Railroad
- METRO Bus Route or Rail Line
- Signalized Intersection
- Park
- School
- Library
- XX ADT (2021 from TCDS)
- XX ADT and Speed (2023)

Northline Transit Center
Connections to METRO Rail Red Line (#700) and Bus Route #s 023, 045, 056, and 096 | ***Northline Transit Center is one of METRO's most frequented stops*** with 2,250 boardings per weekday and 2,000 boardings on Saturday.

UP Lufkin Railroad

Railroad Crossing
#758746S with 7 trains per day

Metro Route #036
Kempwood with 2,134 boardings per day

Metro Route #044
Acres Homes with 1,554 boardings per day

HOV Ramp
Airline-Crosstimbers I-45 HOV Ramp

METRO Rail Red Line
(#700) with 34,123 boardings per day (average weekday in April 2023)

BNSF Houston Railroad

UP West Belt Railroad

Intersections

This corridor includes three diamond interchanges with limited-access facilities, 8 traditional signalized intersections, one at-grade light rail crossing, and one highway-railroad at-grade crossing.

Connectivity

The corridor provides local access the Northline Mall, HCC Northline, and the Northline Traansit Center. Provides regional connectivity as the only roadway between I-610 and Tidwell with connectivity across I-45, Hardy Roll Road, and I-69.

Multimodal

This corridor includes 4' sidewalks on both sides of the road, existing, low-comfort (3'), on-street bike lane, connection to proposed off-street trail and greenway along Little White Oak Bayou, four bus routes, several bus stops, and light rail transit center. Per Houston's Bike Plan, a **high-comfort, dedicated, on-street bikeway is proposed** along the entire Crosstimbers corridor.

Location					Crashes								Persons	
#	0_IntName	Control	Class	TEV	Rate	Total	K	A	B	C	O	U	Total	Cost
1	Yale	Signal	Arterial - Arterial	25,000	111.4	61			3	10	48		191	$ 4,486,100
2	Main	Signal	Arterial - Arterial	20,000	91.3	40		2	3	11	23	1	120	$ 5,051,900
3	Oxford	Stop	Collector - Arterial	15,000	88.3	29			4	7	16	2	92	$ 4,230,200
4	Castor	Stop	Collector - Arterial	15,000	51.8	17		1	1	6	9		53	$ 2,142,800
5	Airline	Signal	Arterial - Arterial	30,000	141.6	93	2	3	6	18	61	3	268	$ 36,225,200
6	I-45 SBFR	Signal	Highway - Arterial	40,000	157.5	138	2	3	12	29	86	6	401	$ 38,987,100
7	I-45 NBFR	Signal	Highway - Arterial	45,000	45.7	45	1		1	10	30	3	132	$ 16,510,900
8	Fulton	Signal	Arterial - Arterial	20,000	248.9	109		5	5	18	78	3	349	$ 12,810,000
9	Bauman	Signal	Arterial - Arterial	15,000	161.3	53		2	7	14	28	2	171	$ 8,522,100
10	Rosewell	Stop	Collector - Arterial	15,000	45.7	15		2		6	7		47	$ 4,135,400
11	Helmers	Signal	Arterial - Arterial	15,000	76.1	25			1	7	16	1	68	$ 2,985,800
12	Irvington	Signal	Arterial - Arterial	30,000	126.3	83	1	1	7	27	44	3	255	$ 23,039,800
13	Hardy SB	Signal	Highway - Arterial	30,000	108.1	71	1		3	18	47	2	216	$ 19,917,500
14	Hardy NB	Signal	Highway - Arterial	30,000	127.9	84		3	8	20	50	3	269	$ 11,397,300
15	Schneider	Stop	Collector - Arterial	15,000	121.8	40		1	4	12	22	1	112	$ 6,746,700
16	West	Stop	Collector - Arterial	15,000	9.1	3				1	1	1	5	$ 411,700
17	Jensen	Signal	Arterial - Arterial	25,000	95.0	52		1	6	14	28	3	174	$ 8,131,000
18	Curry	Stop	Collector - Arterial	15,000	112.6	37		1	1	11	24		109	$ 3,626,000
19	I-69 SB	Signal	Highway - Arterial	25,000	226.5	124	1	4	21	44	52	2	391	$ 31,858,500
20	I-69 NB	Signal	Highway - Arterial	25,000	45.7	25		1	4	8	9	3	71	$ 3,605,900
21	Magna	Stop	Collector - Arterial	10,000	100.5	22			4	6	9	3	66	$ 3,874,600
22	Hirsch	Signal	Arterial - Arterial	15,000	106.5	35			1	14	19	1	94	$ 4,618,200

					Intersection ID:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Attribute	**Description**	**Average Proportion**	**Total**	**Avg**		**Yale**	**Main**	**Airline**	**I-45 SBFR**	**I-45 NBFR**	**Fulton**	**Bauman**	**Helmers**	**Irvington**	**Hardy SB**	**Hardy NB**	**Jensen**	**I-69 SB**	**I-69 NB**	**Hirsch**
	Crash Count	100.0%	1,038	69.2		61	40	93	138	45	109	53	25	83	71	84	52	124	25	35
Severity	K - Fatal	0.6%	8	1.3				**2**	**2**	**1**				**1**	**1**			1		
	A - Major	1.9%	23	2.6			**2**	**3**	2		**5**	**2**		1		**3**	1	**4**		
	B - Minor	8.0%	87	5.8		3	3	6	11	1	5	**7**	1	7	3	8	6	**21**	**4**	1
Event	Motor Vehicle	85.7%	895	59.7		56	33	80	109	36	95	46	20	77	62	70	44	115	20	32
	Fixed Object	8.8%	84	5.6		3	5	8	15	**8**	1	4	**4**	5	6	11	3	7	2	2
	Pedestrian	1.8%	21	3.0			1	**4**	**7**		3		**1**	1			**4**			
	Pedalcyclist	0.6%	7	1.4			**1**	**1**	1		**3**						**1**			
Type	Angle - Both Going Straight	32.7%	369	26.4		23	16	24	42		27	15	4	33	29	**50**	15	**72**	5	14
	One Vehicle - Going Straight	9.6%	95	6.3		2	4	10	18	**7**	7	4	**5**	4	5	10	5	9	2	3
	Opposing - One Straight, One Left	7.6%	72	4.8		5	1	4	6	3	11	**8**	**3**	9	3	1	**6**	6	1	**5**
Factor	Failed to Control Speed	22.8%	229	15.3		14	5	24	23	**17**	29	15	6	25	22	15	4	16	7	7
	Disregard Signal	24.0%	276	19.7		13	13	13	39		15	9	4	26	24	**34**	14	**61**	3	8
Condi -tion	Dark, Lighted	24.9%	256	17.1		11	10	23	31	12	18	13	6	25	20	21	14	37	7	8
	Wet	11.5%	134	9.6		8	3	**17**	17	4	**21**	8	1	14	10	9	8	11		3

Resources – Network Screening

Network Screening

- HSM Chapter 4
- City of Houston Vision Zero
- City of Houston Vision Zero High Injury Map
- H-GAC Transportation Safety Program

Systemic Approach

- TxDOT SHSP
- FHWA Systemic Approach to Safety
- Quick Start Guide Systemic Safety Analysis (FHWA-SA-17-009)

Diagnosis is…

"the identification of the causes of the collisions and potential safety concerns or crash patterns that can be evaluated further."

The activities included in the diagnosis step provide an understanding of crash patterns, past studies, and physical characteristics before potential countermeasures are selected.

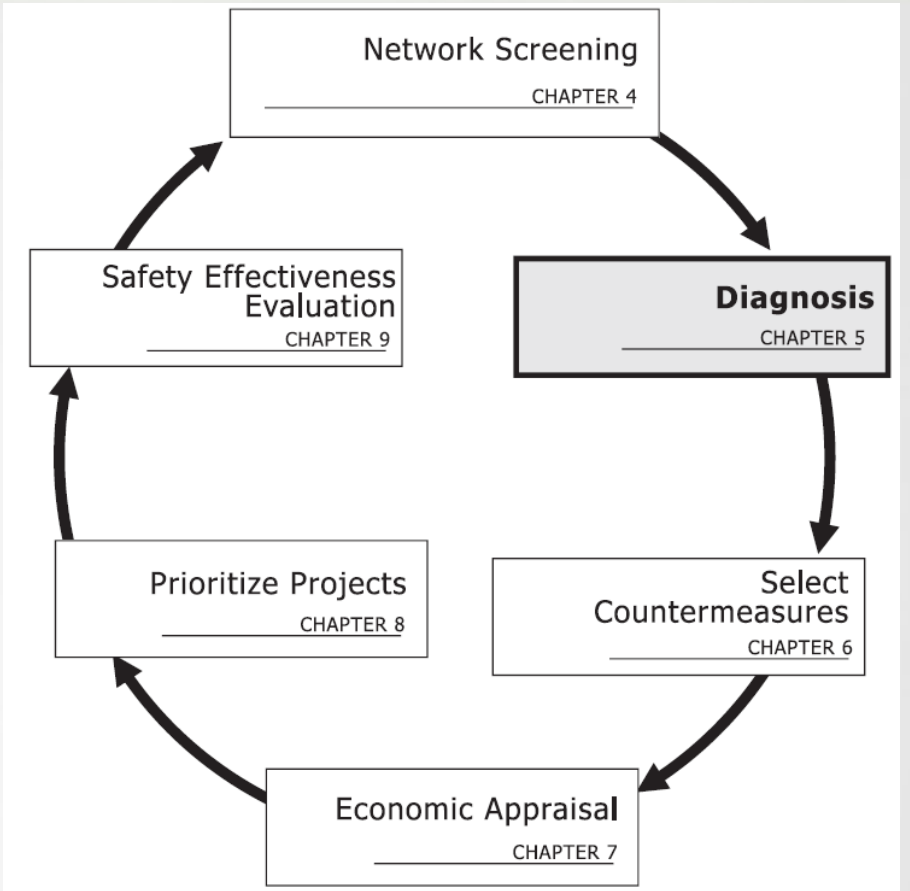


Figure 5-1. Roadway Safety Management Process Overview

Diagnosis – Step 1

Step 1 - Safety Data Review

- Descriptive statistics of crash conditions (e.g., counts of crashes by type, severity, or roadway or environmental conditions)
- Crash locations (i.e., collision diagrams, condition diagrams, and crash mapping using Geographic Information Systems (GIS) tools).

Diagnosis – TxDOT FARS

United States Department of Transportation

NHTSA

Ratings

← RESEARCH & DATA

Fatality Analysis Reporting System (FARS)

Share:

https://www.nhtsa.gov/research-data/fatality -analysis-reporting -system-fars

Detailing the Factors Behind Traffic Fatalities on our Roads

FARS is a nationwide census providing NHTSA, Congress and the American public yearly data regarding fatal injuries suffered in motor vehicle traffic crashes.

How to Access FARS Data

Create your own fatality data run online by using the FARS Query System. Or download all FARS data from 1975 to present from the FTP Site.

- Run a Query Using the FARS Web-Based Encyclopedia
- 2010 FARS/NASS GES Standardization -- Posted 12/8/2011
- FARS and GES Auxiliary Datasets Q & A -- Posted 9/9/2010 These files will complement

Diagnosis – TxDOT CRIS

C.R.I.S. QUERY
Crash Records Information System

Help

Welcome to the TxDOT Crash Query Tool

Perform specific queries and analysis using Texas traffic crash data.

Crash Report Dashboards

Dashboards created by TxDOT provide a consolidated and customizable view of Crash Report Query data

Query Builder

Construct a Crash Report Query by providing the criteria that you are interested in seeing

- Create a new Query using the Query Builder
- Load a Query saved from a previous Query Builder session

Browse Queries Authored by TxDOT

TxDOT has built a set of Queries that you can use

https://cris.dot.state.tx.us/public/Query/app/home

Diagnosis – CR3

Law Enforcement and TxDOT Use ONLY
☐ FATAL ☐ CMV ☐ SCHOOL BUS ☐ RAILROAD ☐ MAB ☐ SUPPLEMENT ☐ ACTIVE SCHOOL ZONE

Total Num. Units 1 | Total Num. Prsns. 1 | TxDOT Crash ID 14979556.1 /2016121506

Texas Peace Officer's Crash Report (Form CR-3 1/1/2015)
Mail to: Texas Department of Transportation, Crash Data and Analysis, P.O. Box 149349, Austin, TX 78714. Questions? Call 844/274-7457
Refer to Attached Code Sheet for Numbered Fields
*=These fields are required on all additional sheets submitted for this crash (ex.: additional vehicles, occupants, injured, etc.).

Page 1 of 2

IDENTIFICATION & LOCATION

*Crash Date (MM/DD/YYYY) 03/18/2016	*Crash Time (24HRMM) 0830	Case ID P160780274		Local Use District 9	
*County Name FORT BEND		*City Name			☒ Outside City Limit
In your opinion, did this crash result in at least $1,000 damage to any one person's property? ☒ Yes ☐ No	Latitude (decimal degrees)		Longitude (decimal degrees)		

ROAD ON WHICH CRASH OCCURRED

*1 Rdwy. Sys. LR	*Hwy. Num.	2 Rdwy. Part 1	Block Num. 10454	3 Street Prefix	* Street Name JESKE	4 Street Suffix RD
☐ Crash Occurred on a Private Drive or Road/Private Property/Parking Lot	☐ Toll Road/ Toll Lane	Speed Limit 35	Const. Zone ☐ Yes ☒ No	Workers Present ☐ Yes ☒ No	Street Desc.	

INTERSECTING ROAD, OR IF CRASH NOT AT INTERSECTION, NEAREST INTERSECTING ROAD OR REFERENCE MARKER

At Int. ☐ Yes ☒ No	1 Rdwy. Sys. LR	Hwy. Num.	2. Rdwy. Part 1	Block Num.	3 Street Prefix	Street Name NEEDVILLE FAIRCHILD	4 Street Suffix RD
Distance from Int. or Ref. Marker 1	☐ FT ☒ MI	3 Dir. from Int. or Ref. Marker E	Reference Marker	Street Desc.			RRX Num.

VEHICLE, DRIVER, & PERSONS

Unit Num.	5 Unit Desc.	Parked Vehicle	Hit and Run	LP State	LP Num.	VIN
1	1	☐	☐	TX	[redacted]	[redacted]

Veh. Year	6. Veh. Color	Veh. Make	Veh. Model	7 Body Style	Pol., Fire, EMS on Emergency (Explain in Narrative if checked)
2003	GRY	FORD	TAURUS	P4	☐

8 DL/ID Type	DL/ID State	DL/ID Num.	9 DL Class	10 CDL End.	11 DL Rest.	DOB (MM/DD/YYYY)
1	TX	[redacted]	C	96	96	11/06/1992

Address (Street, City, State, ZIP) 11010 AUDREY DR NEEDVILLE, TX 77461

Person Num.	12 Prsn. Type	13 Seat Position	Name: Last, First, Middle (Enter Driver or Primary Person for this Unit on first line)	14 Injury Severity	Age	15 Ethnicity	16 Sex	17 Eject.	18 Restr.	19 Airbag	20 Helmet	21 Sol.	22 Alc. Spec.	Alc. Result	23 Drug Spec.	24 Drug Result	25 Drug Category
1	1	1	[redacted]	A	23	H	2	1	1	1	97	N	96		96	97	97

Not Applicable - Alcohol and Drug Results are only reported for Driver/Primary Person for each Unit.

☒ Owner ☐ Lessee | Owner/Lessee Name & Address LONGORIA, REBECCA ANN, 11010 AUDREY DR NEEDVILLE, TX 77461

Proof of Fin. Resp.	26 Fin. Resp. Type	Fin. Resp. Name	Fin. Resp. Num.	27 Vehicle Damage Rating 1	27 Vehicle Damage Rating 2	Vehicle Inventoried
☒ Yes ☐ No ☐ Expired ☐ Exempt	2	ALLSTATE INS. CO.	000000929934224	12-L&T-3		☐ Yes ☒ No

Fin. Resp. Phone Num. (800) 255-7828

Towed By QUALITY TOWING | Towed To [redacted]

VEHICLE, DRIVER, & PERSONS

Unit Num.	5 Unit Desc.	Parked Vehicle	Hit and Run	LP State	LP Num.	VIN
		☐	☐			

Veh. Year	6. Veh. Color	Veh. Make	Veh. Model	7 Body Style	Pol., Fire, EMS on Emergency (Explain in Narrative if checked)
					☐

8 DL/ID Type	DL/ID State	DL/ID Num.	9 DL Class	10 CDL End.	11 DL Rest.	DOB (MM/DD/YYYY)
						/ /

Address (Street, City, State, ZIP)

Person Num.	12 Prsn. Type	13 Seat Position	Name: Last, First, Middle (Enter Driver or Primary Person for this Unit on first line)	14 Injury Severity	Age	15 Ethnicity	16 Sex	17 Eject.	18 Restr.	19 Airbag	20 Helmet	21 Sol.	22 Alc. Spec.	Alc. Result	23 Drug Spec.	24 Drug Result	25 Drug Category

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Proof of Fin. Resp.	26 Fin. Resp. Type	Fin. Resp. Name	Fin. Resp. Num.	27 Vehicle Damage Rating 1	27 Vehicle Damage Rating 2	Vehicle Inventoried
☐ Yes ☐ No ☐ Expired ☐ Exempt				-	-	☐ Yes ☐ No

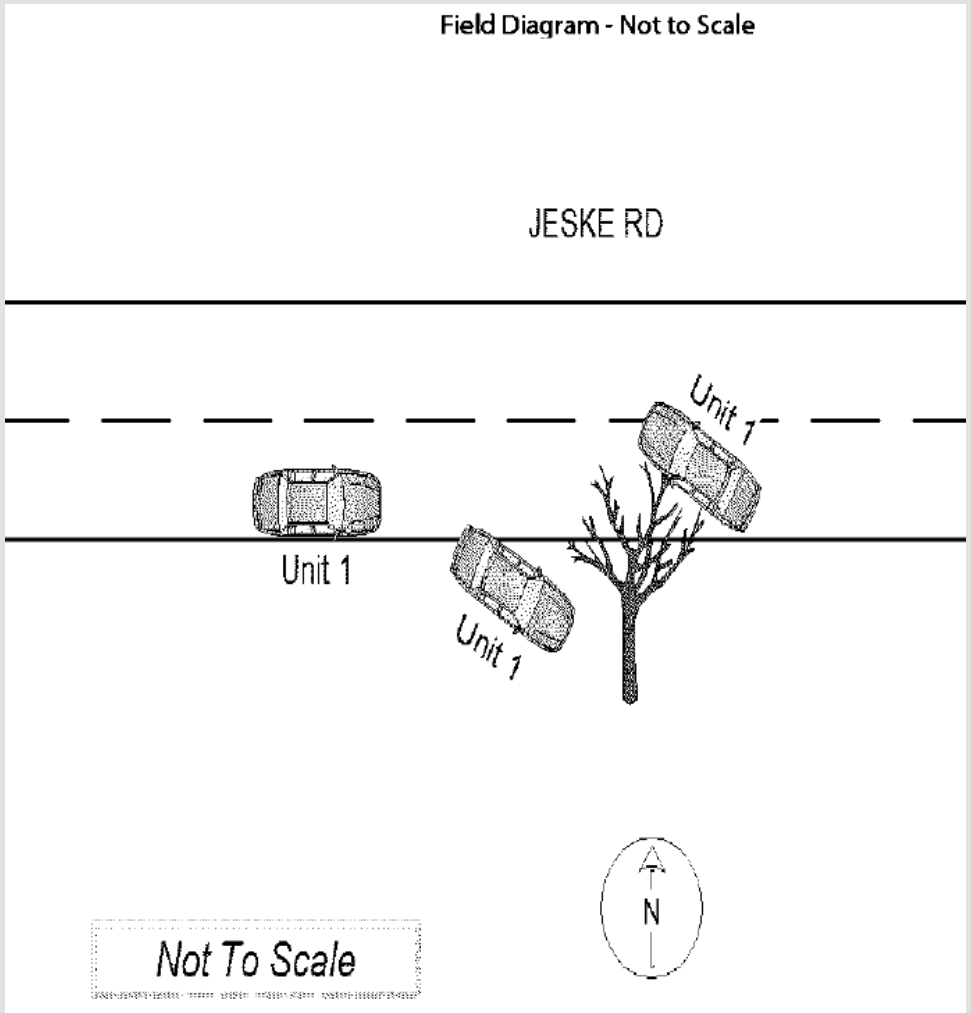
Fin. Resp. Phone Num.

Towed By | Towed To

Investigator's Narrative Opinion of What Happened
(Attach Additional Sheets if Necessary)

UNIT 1 STATED SHE WAS TRAVELLING EAST AND UNSURE HOW SHE CRASHED.IT APPEARS UNIT 1 FAILED TO CONTROL SPEED AND LOST CONTROL OF THE VEHICLE CAUSING HER TO DRIVE INTO THE DITCH.

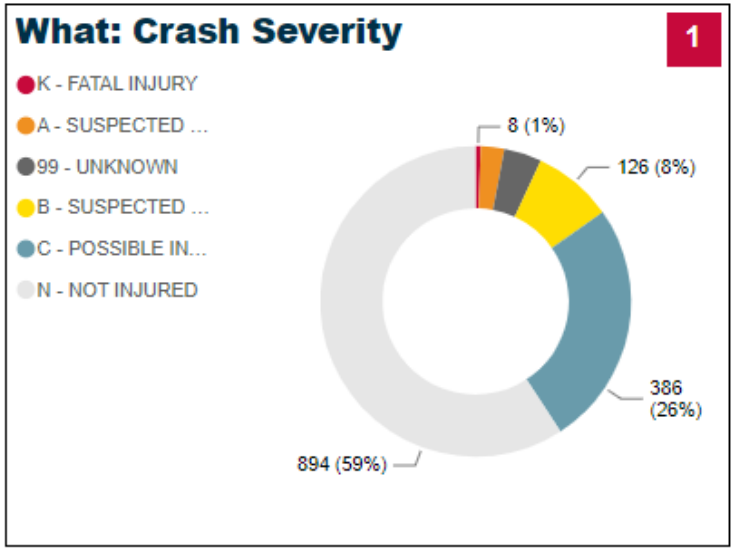
Field Diagram - Not to Scale

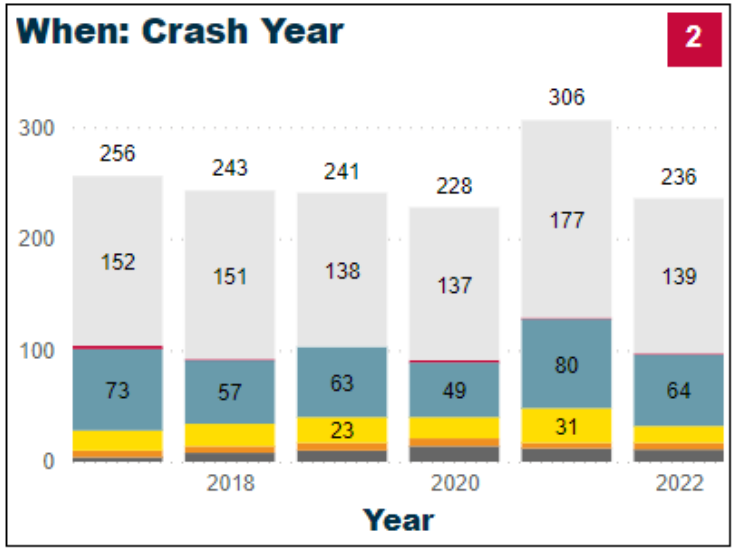


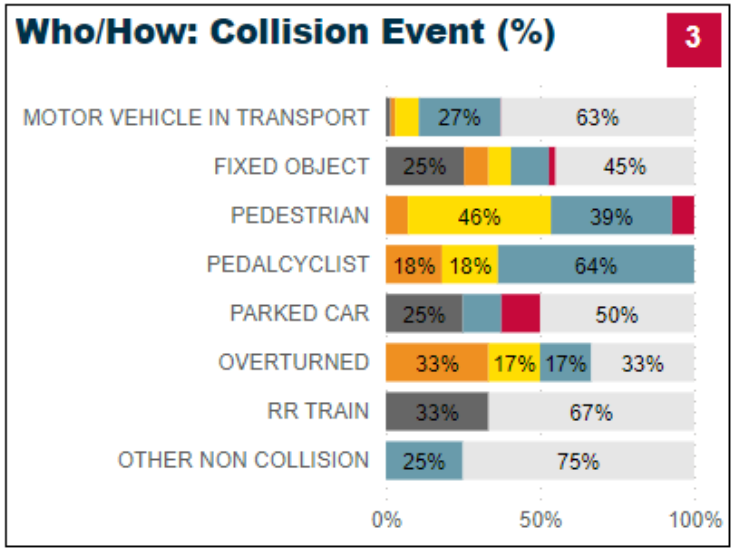
Diagnosis – Step 1

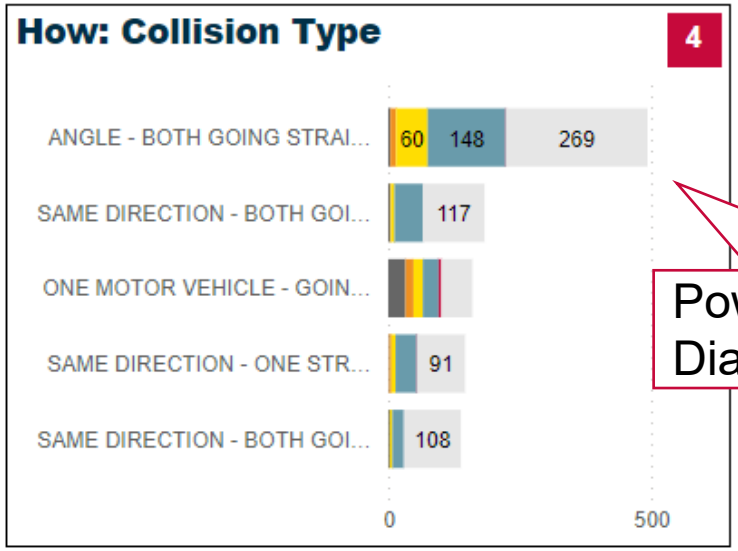
Column	Raw Column Header	TxDOT Description	Priority Attribute	Type
1	Crash_ID	Crash ID – System-generated unique identifying number for a crash	Crash_ID	ID
2	Crash_Fatal_Fl	Fatal Crash Identifier - Indicates that the crash involved one or more	Crash_Fatal_Fl	Crash
9	Crash_Date	Crash Date - Date on which crash occurred	Crash_Date	ID
10	Crash_Time	Crash Time - Time crash occurred	Crash_Time	ID
29	Crash_Speed_Limit	Speed Limit	Crash_Speed_Limit	Facility
33	At_Intrsct_Fl	At Intersection - Indicates if the crash occurred at an intersection.	At_Intrsct_Fl	Key Attribute
48	Wthr_Cond_ID	Weather Condition - The prevailing atmospheric condition reported	Wthr_Cond_ID	Facility
49	Light_Cond_ID	Light Condition - The type and level of light that existed at the time	Light_Cond_ID	Facility
50	Entr_Road_ID	Entering Roads	Entr_Road_ID	Facility
51	Road_Type_ID	Roadway Type	Road_Type_ID	Facility
52	Road_Algn_ID	Roadway Alignment - The geometric characteristics of the roadway	Road_Algn_ID	Facility
53	Surf_Cond_ID	Surface Condition - The surface condition (wet, dry, etc) present at t	Surf_Cond_ID	Facility
54	Traffic_Cntl_ID	Traffic Control - Type of traffic control at the scene of the crash	Traffic_Cntl_ID	Key Attribute
66	Harm_Evnt_ID	IF- First Harmful Event - First Injury or damage producing event	Harm_Evnt_Id	Key Attribute
67	Intrsct_Relat_ID	IF- Intersection Related - Specifies whether a crash occurred at an in	Intrsct_Relat_ID	Key Attribute
68	FHE_Collsn_ID	IF- Manner of Collision - The manner in which the vehicle(s) were m	FHE_Collsn_ID	Crash
69	Obj_Struck_ID	IF- Object Struck - Object Struck is an obstruction in, on, or around	Obj_Struck_Id	Crash
70	Othr_Factr_ID	IF- Other Factor - Additional detail of events/circumstances concern	Othr_Factr_ID	Crash
72	Road_Cls_ID	IF- Road Class - The functional classification group of the priority ro	Road_Cls_ID	Crash
73	Road_Relat_ID	IF- Roadway Relation - Roadway Relation refers to where the First H	Road_Relat_ID	Crash
76	Cnty_ID	County ID – The county in which the crash was located.	Cnty_ID	Location
77	City_ID	City ID - The city in which the crash was located if applicable.	City_ID	Location
78	Latitude	Latitude map coordinate of the crash	Latitude	Location
79	Longitude	Longitude map coordinate of the crash	Longitude	Location
99	Txdot_Rptable_Fl	TxDOT Repotable Flag - Indicates whether a crash occurred on a tra	Txdot_Rptable_Fl	Key Attribute
100	Onsys_Fl	On System Flag - Indicates whether primary road of crash was on th	Onsys_Fl	Key Attribute
102	Crash_Sev_ID	Crash Severity - Most severe injury suffered by any one person inv	Crash_Sev_ID	Key Attribute

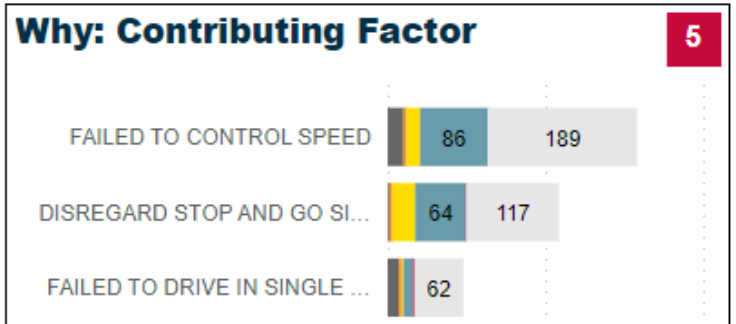
Diagnosis – Step 1

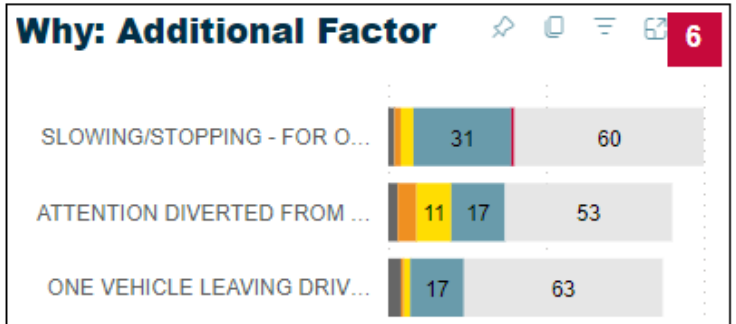












- Data >>> Information
- CRIS data vs Crash Reports

Power BI Crash History Diagnosis Dashboard

Diagnosis – Step 2

Step 2 - Assess supporting documentation

- Current traffic volumes for all travel modes
- As-built construction plans and design criteria
- Inventory of field conditions
- Land use mapping
- Recent transportation studies
- Anecdotal information about travel through the site

Diagnosis – Step 2

Corridor Mobility

Project Background

H-GAC and City of Houston are committed to Vision Zero (VZ) with a goal to end traffic deaths and serious injuries. Houston's VZ action plan published in 2020 identified a High Injury Network (HIN), which contains just 6% of Houston's streets and accounts for nearly 60% of traffic deaths and serious injuries. **Crosstimbers Street is among the highest-crash corridors on the HIN**. H-GAC partnered with City of Houston to conduct a Road Safety Audit along Crosstimbers Street, diagnose safety issues, and recommend improvements.

Corridor: Crosstimbers Street

Limits: Yale Street to Hirsch Road

Length: 4.5 miles

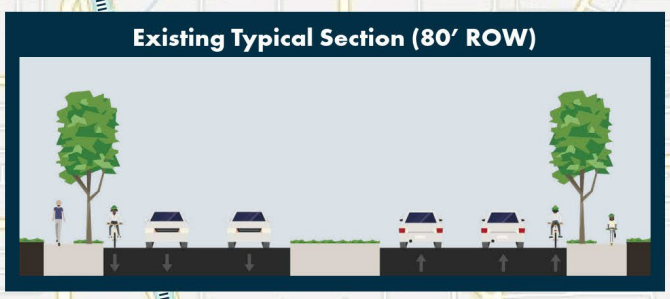
MTFP Designation: T-4-80

MMC Designation: Urban Blvd

ADT: 13,800 - 15,800

Posted Speed: 35mph (30pmh east of Jensen)

Travel Speed: 39-42mph west of Jensen, 34mph east of Jensen



Legend

- Crosstimbers RSA Corridor Limits
- Northline Mall/Transit Center
- Railroad
- METRO Bus Route or Rail Line
- Signalized Intersection
- Park
- School
- Library
- XX ADT (2021 from TCDS)
- XX ADT and Speed (2023)

Northline Transit Center
Connections to METRO Rail Red Line (#700) and Bus Route #s 023, 045, 056, and 096 | ***Northline Transit Center is one of METRO's most frequented stops*** with 2,250 boardings per weekday and 2,000 boardings on Saturday.

UP Lufkin Railroad

Railroad Crossing
#758746S with 7 trains per day

Metro Route #036
Kempwood with 2,134 boardings per day

Metro Route #044
Acres Homes with 1,554 boardings per day

HOV Ramp
Airline-Crosstimbers I-45 HOV Ramp

METRO Rail Red Line
(#700) with 34,123 boardings per day (average weekday in April 2023)

BNSF Houston Railroad

UP West Belt Railroad

Intersections

This corridor includes three diamond interchanges with limited-access facilities, 8 traditional signalized intersections, one at-grade light rail crossing, and one highway-railroad at-grade crossing.

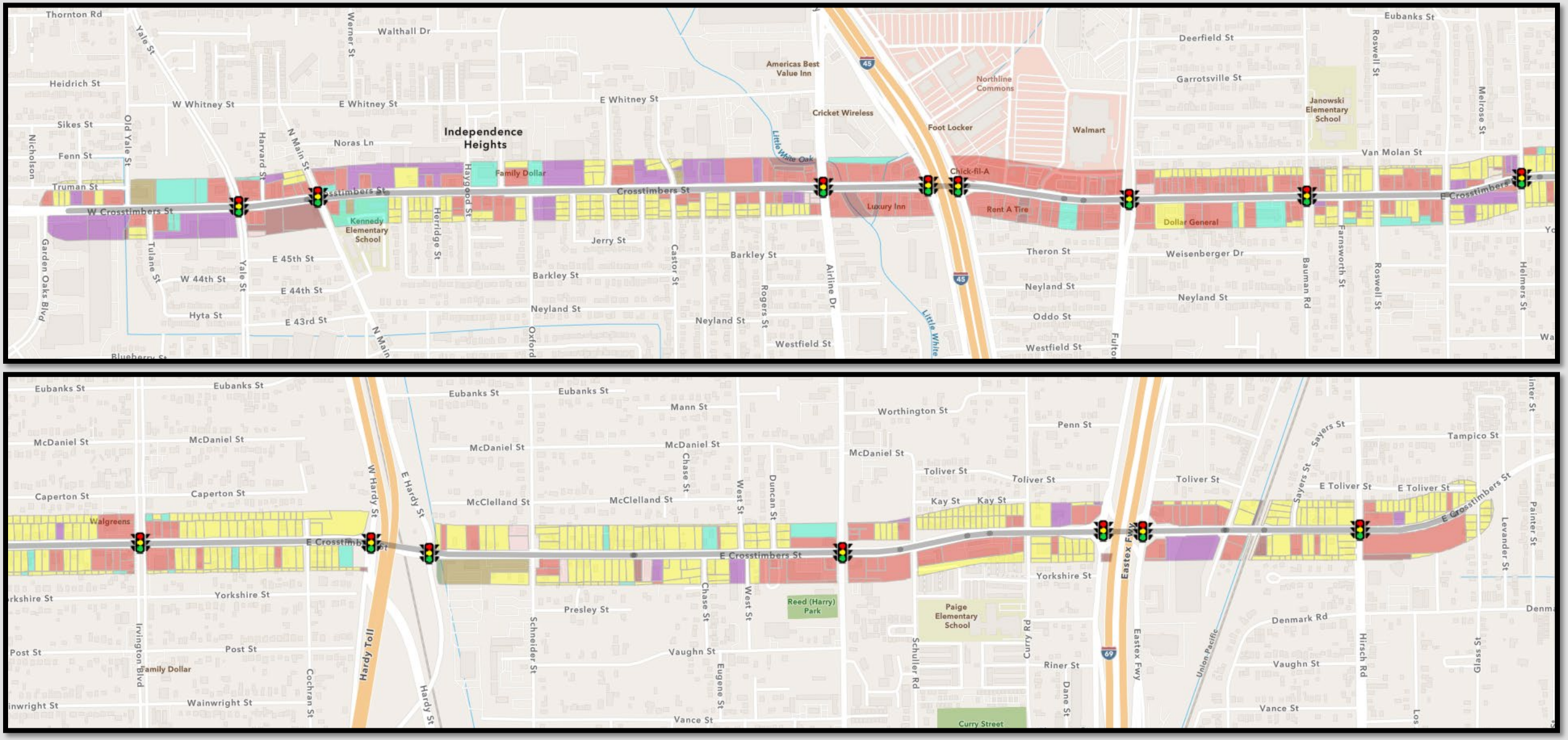
Connectivity

The corridor provides local access the Northline Mall, HCC Northline, and the Northline Traansit Center. Provides regional connectivity as the only roadway between I-610 and Tidwell with connectivity across I-45, Hardy Roll Road, and I-69.

Multimodal

This corridor includes 4' sidewalks on both sides of the road, existing, low-comfort (3'), on-street bike lane, connection to proposed off-street trail and greenway along Little White Oak Bayou, four bus routes, several bus stops, and light rail transit center. Per Houston's Bike Plan, a **high-comfort, dedicated, on-street bikeway is proposed** along the entire Crosstimbers corridor.

Diagnosis – Step 2



Diagnosis – Step 3

Step 3 - Assess field conditions

- HSM Appendix 5B - Site Characteristic Consideration
- HSM Appendix 5D - Field Review Checklist

TRAFFIC OPERATIONS

- Do past studies indicate excessive speeds at or through the site?
- If the site is a signalized intersection, is there queuing on the intersection approaches?
- If the site is a signalized intersection, what signal warrant does the intersection satisfy? Does the intersection currently satisfy the signal warrants?
- Is there adequate capacity at or through the site?
- What is the proportion of heavy vehicles traveling through the site?
- Does mainline access to adjacent land negatively influence traffic operations?

GEOMETRIC CONDITIONS

- Is the roadway geometry in the vicinity of the site consistent with the adopted functional classification?
- What are the available stopping sight distances and corner sight distances at each driveway or intersection?
- Have there been recent roadway geometry changes that may have influenced crash conditions?
- How does the site design compare to jurisdictional design criteria and other related guidelines? (Non-compliance or compliance does not directly relate to safe or unsafe conditions, though it can inform the diagnostic process.)

PHYSICAL CONDITIONS

- Do the following physical conditions indicate possible safety concerns:
  - pavement conditions;
  - drainage;
  - lighting;

- Is appropriate sight distance available to all users on each intersection approach?
- Is the horizontal and vertical alignment appropriate on each approach leg?
- Are pavement markings and intersection control signing appropriate?
- Are all approach lanes adequately designed based on the composition of traffic using the intersection?
- Is the roadway cross-slope adequately draining rainfall and snow runoff?
- Is the median, curbs, and channelization layout appropriate?
- Are turning radii and tapers adequately designed based on the traffic composition using the intersection?
- Is roadway lighting appropriately installed and operating?
- Are traffic signs appropriately located and clearly visible to the driver on each approach leg?
- Is the pavement free of defects, and is there adequate skid resistance?
- Are parking provisions satisfactory?
- Is traffic signal phasing appropriate for turning traffic on each approach?
- Are driveways and other access points appropriately located on each intersection approach leg?

Diagnosis – Step 3

Geometry		
Sight distance	✓	Stopping, intersection, and decision sight distances are appropriate.
Turning radii or tapers	✓	Turning radii and tapers are adequate dimensions.
Curb	✓	Median, curbs, and channelization are appropriate.
Pavement	✓	Pavement is free of defects and there is adequate skid resistance.
Drainage	✓	The roadway does not flood nor is there water ponding in the vicinity of the intersection.
Alignment	✓	Horizontal alignment, vertical alignment, and cross -slope are appropriate (no lane shifts or drainage issues).
Edge treatment	✓	Edge treatments are the appropriate type and dimension.
Context		
Driveways	✓	Driveway spacing and access restrictions in the vicinity of the intersection are appropriate.
ADA compliance	✓	Sidewalk, ramp, and/or crosswalk facilities are ADA compliant.
Alternative modes	✓	There are no concerns regarding alternative modes (considering intersection context and surrounding land uses).
Vulnerable user volume	✓	There are no concerns regarding vulnerable user groups (considering intersection context and surrounding land uses).
Heavy vehicles	✓	There are no concerns regarding heavy vehicles, truck maneuvers, or emergency vehicles.

Operation		
Speed	✓	Posted speed is appropriate for road class and context.
Lighting	✓	Roadway and intersection lighting is adequate during dark and rain conditions.
Pavement markings	✓	Vehicle pavement markings are appropriate and clearly visible.
Signs	✓	Overhead and ground -mounted signs appropriately located and clearly visible.
Capacity, delay, and queuing	✓	Intersection capacity and storage is adequate (no cycle failure and queues stored in turn pockets).
Approach lanes	✓	Approach lane configurations accommodate intersection traffic.
Signals	✓	Signal heads are appropriate with regard to number, locations, and visibility.
Turn type	✓	Left-turn type is appropriate with regard to volume, speed, and sight distance.
Clearance interval	✓	Yellow and red times an appropriate duration (considering speed and crossing distance).
Intersection control	✓	Intersection control appropriate (considering warrants).

Diagnosis – Practice Exercise

1. **Objective:** Identify potential safety concerns at 3 high -crash intersections.
2. Process:
    1. Organize into groups of four
    2. Determine 2 to 3 intersections for further review
    3. Examine crash history information (request PowerBI handout)
    4. Assess field conditions (use online (App) maps to review aerial)
    5. Write down 5 observations at each intersection (for use later)

					Intersection ID:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Attribute	**Description**	**Average Proportion**	**Total**	**Avg**		**Yale**	**Main**	**Airline**	**I-45 SBFR**	**I-45 NBFR**	**Fulton**	**Bauman**	**Helmers**	**Irvington**	**Hardy SB**	**Hardy NB**	**Jensen**	**I-69 SB**	**I-69 NB**	**Hirsch**
	Crash Count	100.0%	1,038	69.2		61	40	93	138	45	109	53	25	83	71	84	52	124	25	35
Severity	K - Fatal	0.6%	8	1.3				**2**	**2**	**1**				**1**	**1**			1		
	A - Major	1.9%	23	2.6			**2**	**3**	2		**5**	**2**		1		**3**	1	**4**		
	B - Minor	8.0%	87	5.8		3	3	6	11	1	5	**7**	1	7	3	8	6	**21**	**4**	1
Event	Motor Vehicle	85.7%	895	59.7		56	33	80	109	36	95	46	20	77	62	70	44	115	20	32
	Fixed Object	8.8%	84	5.6		3	5	8	15	**8**	1	4	**4**	5	6	11	3	7	2	2
	Pedestrian	1.8%	21	3.0			1	**4**	**7**		3		**1**	1			**4**			
	Pedalcyclist	0.6%	7	1.4			**1**	**1**	1		**3**						**1**			
Type	Angle - Both Going Straight	32.7%	369	26.4		23	16	24	42		27	15	4	33	29	**50**	15	**72**	5	14
	One Vehicle - Going Straight	9.6%	95	6.3		2	4	10	18	**7**	7	4	**5**	4	5	10	5	9	2	3
	Opposing - One Straight, One Left	7.6%	72	4.8		5	1	4	6	3	11	**8**	**3**	9	3	1	**6**	6	1	**5**
Factor	Failed to Control Speed	22.8%	229	15.3		14	5	24	23	**17**	29	15	6	25	22	15	4	16	7	7
	Disregard Signal	24.0%	276	19.7		13	13	13	39		15	9	4	26	24	**34**	14	**61**	3	8
Condi -tion	Dark, Lighted	24.9%	256	17.1		11	10	23	31	12	18	13	6	25	20	21	14	37	7	8
	Wet	11.5%	134	9.6		8	3	**17**	17	4	**21**	8	1	14	10	9	8	11		3

Crash History Observations (by Intersection)

Name	Notable Observation
1. Yale	• Three alcohol-related crashes • High bus stop activity on three corners • Booker T. Washington High School located on Yale, south of Crosstimbers
2. Main	• Two A-Injury crashes • One bicycle crash
3. Airline	• Two K-Fatal crashes • Three A-Injury crashes • Four pedestrian crashes • One bicycle crash • 17 wet-surface crashes
4. I-45 SBFR	• Two K-Fatal crashes • Seven pedestrian crashes • Five alcohol-related crashes
5. I-45 NBFR	• One K-Fatal crash • Eight fixed object crashes • Seven One Motor Vehicle (OMV) crashes • 17 speed-related crashes
6. Fulton	• Five A-Injury crashes • Three bicyclist crashes • 21 wet-surface crashes • Six train-related crashes • Northline Transit Center reported 2,250 boardings per weekday

Name	Notable Observation
7. Bauman	• Two A-Injury crashes • Seven B-Injury crashes • Eight left-turn crashes (permitted left-turn at all approaches) • Janowski Elementary School located on Bauman, north of Crosstimbers
8. Helmers	• Four fixed object crashes • One pedestrian crash • Five OMV crashes • Three left-turn crashes (permitted left-turn at NB/SB approaches)
9. Irvington	• One K-Fatal crash
10. Hardy SB	• One K-Fatal crash
11. Hardy NB	• Three A-Injury crashes • 50 (60%) right-angel crashes (compared to 33% average) • 34 (41%) disregard signal crashes (compared to 24% average)
12. Jensen	• Four pedestrian crashes • One bicycle crash • Six left-turn crashes (protected-only left-turn at all approaches)
13. I-69 SB	• Four A-Injury crashes • 21 B-Injury crashes • 72 (58%) right-angel crashes (compared to 33% average) • 61 (49%) disregard signal crashes (compared to 24% average)
14. I-69 NB	• Four B-Injury crashes
15. Hirsch	• Five left-turn crashes (protected-only left-turn at all approaches)

Resources – Diagnosis

- HSM Appendix 5B and 5D
- City of Houston Vision Zero Crash Dashboard
- H-GAC Regional Crash Data Viewer
- TxDOT CRIS Crash Query Tool
- TxDOT CRIS Standard Extract File Specification
- TxDOT Crash Data Visualizations
- FHWA Signalized Intersections Informational Guide (FHWA-SA-13-027)
  - Chapter 6 – Safety Analysis Methods

Technical Resources

FHWA (Federal Highway Administration)

- FHWA Safety Program
- Highway Safety Improvement Program (HSIP)
- HSIP Manual
- State Highway Safety Plan (SHSP)
- Intersection Safety
- Local and Rural Road Safety Program
- Roadway Departure Safety
- Pedestrian and Bicycle Safety
- Speed Management Safety
- Highway Safety Manual (HSM)
- Work Zone Safety
- Rail-Highway Grade Crossing

AASHTO (American Association of State Highway and Transportation Officials)

- Highway Safety Manual
- AASHTO bookstore
  Roadside Design Guide, Green Book, Highway Safety Manual

Start Here

ATSSA (American Traffic Safety Services Administration)

- Roadway Safety Outreach Program

National Highway Institute (NHI)

- Course Catalogue

GHSA (Governor's Highway Safety Association)

Safety in TIAs

- Incorporating-Safety-in-TIAs_ITE-Technical-Brief
- Incorporating-DDSA-in-TIA_How-to-Guide_FHWA

NCHRP (National Cooperative Highway Research Program)

- NCHRP Report500 (22 emphasis areas)
- NCHRP Report 350 (Safety Performance Evaluation of...
- NCHRP report search

AAA – Foundation for Traffic Safety

- Main Website

NHTSA (National Highway Traffic Safety Administration)

NCHRP Report 500

A Guide for Reducing Speeding-Related Crashes
April 8, 2009
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 23: Guidance for Imple

A Guide for Addressing Collisions Involving Motorcycles
January 24, 2009
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 22: Guidance for Imple

Safety Data and Analysis in Developing Emphasis Area Plans
September 4, 2008
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 21: Guidance for Imple

A Guide for Reducing Head-On Crashes on Freeways
June 23, 2008
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 20, Guidance for Imple

A Guide for Reducing Collisions Involving Young Drivers
December 19, 2007
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 19, Guidance for Imple

A Guide for Reducing Collisions Involving Bicycles
April 25, 2008
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 18, Guidance for Imple

A Guide for Reducing Work Zone Collisions
February 15, 2006
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 17, Guidance for Imple

A Guide for Reducing Alcohol-Related Collisions
October 14, 2005
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 16, Guidance for Imple

A Guide for Enhancing Rural Emergency Medical Services
October 13, 2005
TRB's National Cooperative Highway Research Program (NCHRP) Report 500, Vol. 15, Guidance for Imple

A Guide for Reducing Crashes Involving Drowsy and Distracted
October 7, 2005
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementat

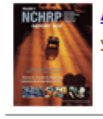
A Guide for Reducing Collisions Involving Heavy Trucks
July 16, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 Volume 13: Guidance for Im

A Guide for Reducing Collisions Involving Heavy Trucks
July 16, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 Volume 13: Guidance for Implementation of the AASHTO Strategi

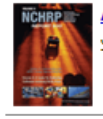
A Guide for Reducing Collisions at Signalized Intersections
August 18, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 Volume 12: Guidance for Implementation of the AASHTO Strategi

A Guide for Increasing Seatbelt Use
July 7, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway

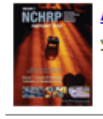
A Guide for Reducing Collisions Involving Pedestrians
July 9, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500: Guidance for Implementation of the AASHTO Strategic Highway S



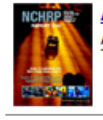
A Guide for Reducing Collisions Involving Older Drivers
June 18, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



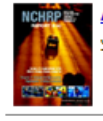
A Guide for Reducing Collisions Involving Utility Poles
June 15, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



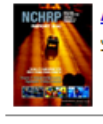
A Guide for Reducing Collisions on Horizontal Curves
June 10, 2004
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



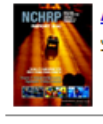
A Guide for Addressing Run-Off-Road Collisions
August 28, 2003
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



A Guide for Addressing Unsignalized Intersection Collisions
July 18, 2003
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



A Guide for Addressing Head-On Collisions
July 18, 2003
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway



A Guide for Addressing Collisions with Trees in Hazardous Locations
July 18, 2003
TRB's National Cooperative Highway Research Program (NCHRP) Report 500 -- Guidance for Implementation of the AASHTO Strategic Highway

Countermeasure Selection is…

the identification of improvements to address the respective contributing factors (observed during diagnosis).

A “countermeasure” is a roadway strategy intended to decrease crash frequency or severity

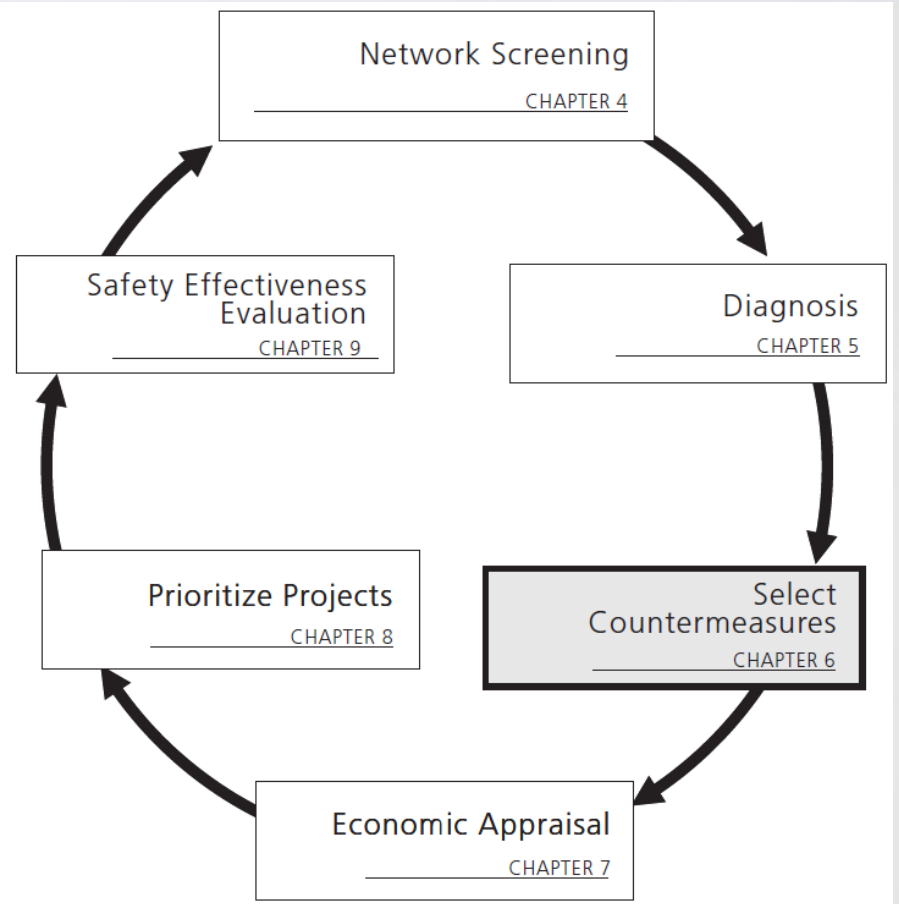


Figure 6–1. Roadway Safety Management Process Overview

Countermeasure Selection

Step 1 – Identify Contributing Factors

- Perspectives to Consider (Haddon Matrix)
- Contributing Factors for Consideration

Step 2 - Select Potential Countermeasures

- Identify factors contributing to the cause of crashes at the subject site
- Identify countermeasures which may address the contributing factors; and
- Conduct cost-benefit analysis, if possible, to select preferred treatment(s) (Economic Evaluation).

Countermeasure Selection – Perspectives

Table 6-1. Example Haddon Matrix for Rear-End Crash

Period	Human Factors	Vehicle Factors	Roadway Factors
Before the Crash (Causes of the hazardous situation)	distraction fatigue inattention bad judgment age cell phone use impaired cognitive skills deficient driving habits	bald tires worn brakes	wet pavement polished aggregate steep downgrade poor signal coordination limited stopping sight distance lack of warning signs
During the Crash (Causes of crash severity)	vulnerability to injury age failure to wear a seat belt	bumper heights and energy absorption headrest design airbag operations	pavement friction grade
After the Crash (Factors of crash outcome)	age gender	ease of removal of injured passengers	the time and quality of the emergency response subsequent medical treatment

Countermeasure Selection – Factors

Crashes Involving Bicyclists and Pedestrians

Common types of crashes and possible contributing factor(s) in crashes involving pedestrians are listed below. These are not intended to be comprehensive lists of all crash types and contributing factors.

Possible contributing factor(s) to crashes involving pedestrians include the following:

- Limited sight distance
- Inadequate barrier between pedestrian and vehicle facilities
- Inadequate signals/signs
- Inadequate signal phasing
- Inadequate pavement markings
- Inadequate lighting
- Driver has inadequate warning of mid-block crossings
- Lack of crossing opportunity
- Excessive speed
- Pedestrians on roadway
- Long distance to nearest crosswalk
- Sidewalk too close to travel way
- School crossing area

Crash history will tell you **what** occurred, contributing factors focus on **why** a crash occurred. Field observations and officer narratives and are particularly informative.

Examples of contributing factors associated with a variety of crash types are provided in the following HSM Section 6.2.2.

Example here regarding pedestrian/bicycle crashes.

Countermeasure Selection – Factors

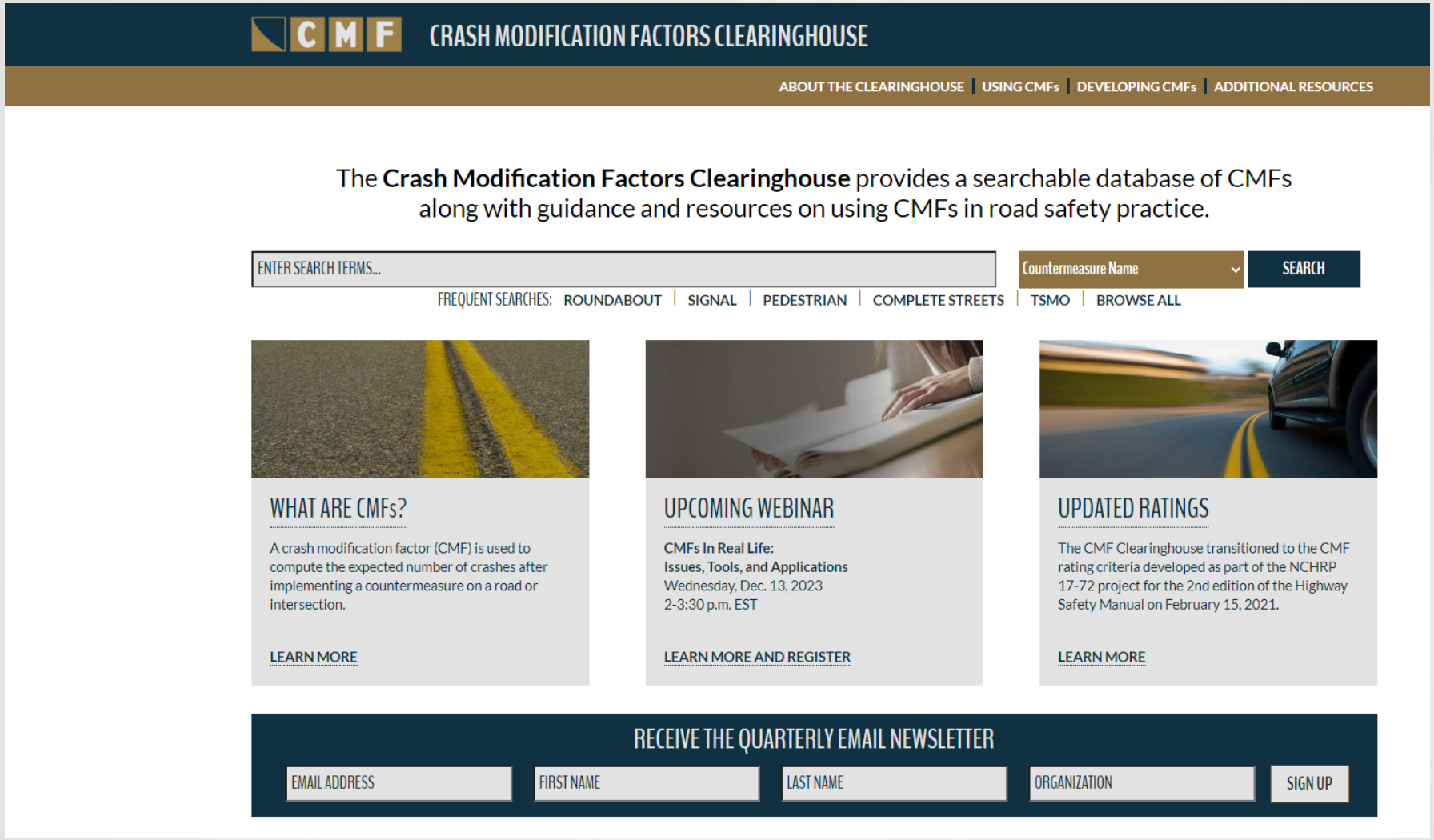
Crash Type	Possible Contributing Factors	Possible Treatment Group (Chapter)
Rear-end crashes	• Sudden and unexpected slowing or stopping when motorists make left turns in and out of driveways along corridor.	• Median treatments (Chapter 8)
	• Sudden and unexpected slowing or stopping when motorists make right turns in and out of driveways along corridor.	• Access management (Chapter 8)
	• Too much slowing and stopping along corridor due to turbulent traffic flow.	• Change signal control from pre-timed to actuated (Chapter 9)
	• Too much slowing and stopping along intersection approaches due to traffic-control issues. • Drivers caught in intersection during red phase due to inadequate traffic control or inadequate change and clearance interval. • Traffic signal not conspicuous or visible to approaching drivers, causing sudden and unexpected slowing or stopping movements.	• Change signal control from pre-timed to actuated (Chapter 9) • Red light camera enforcement (Chapter 10)
	• Sudden and unexpected slowing or stopping due to inadequate intersection capacity.	• Change signal control from pre-timed to actuated (Chapter 9) • Individual movement treatments (Chapter 11)
Angle crashes	• Drivers caught in intersection during red phase due to inadequate traffic control or inadequate change and clearance interval. • Traffic signal not conspicuous or visible to approaching drivers, causing drivers to get caught in intersection during red phase. • Drivers caught in intersection during red phase	• Modify change and clearance intervals (Chapter 9) • Increase size of signal; Add supplemental signal heads; Provide backplates (Chapter 10)

Exhibit 6-16. Crash types commonly identified, possible causes, and associated treatments.

FHWA Signalized Intersections Informational Guide (FHWA -SA-13-027)

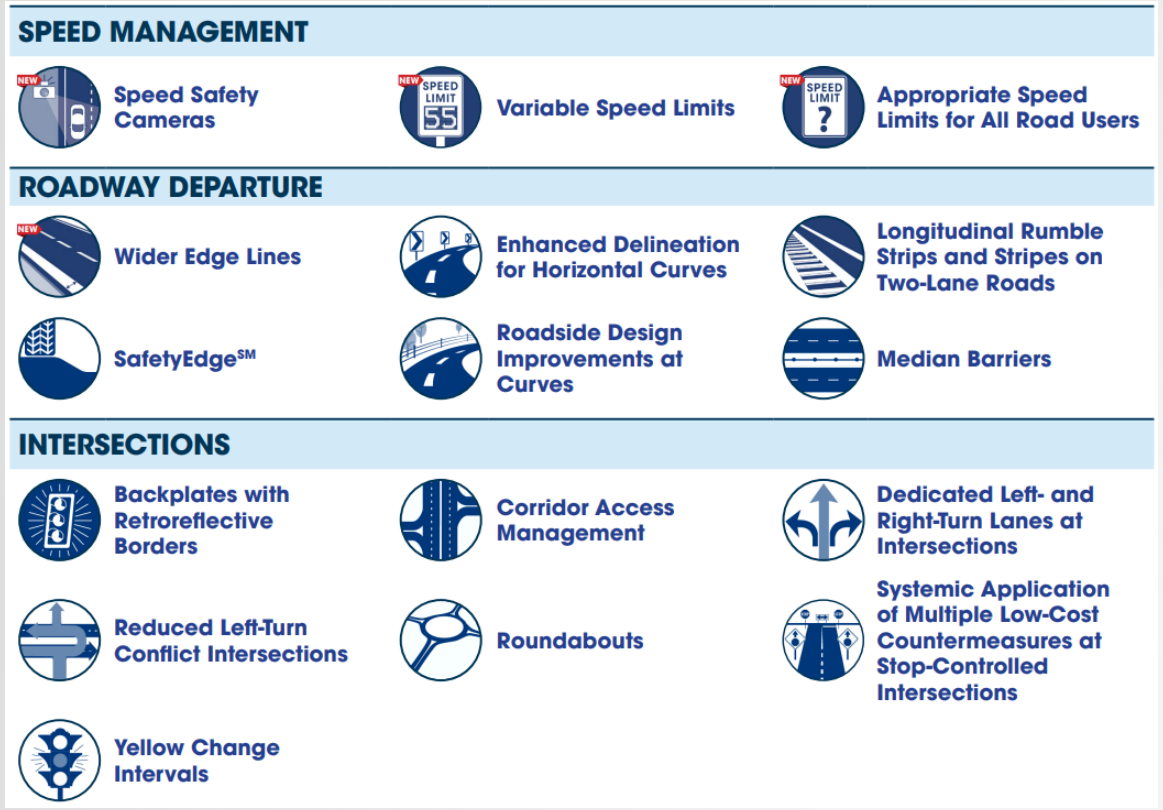
Perspectives / Factors

Countermeasures – CMF Clearinghouse



Source: FHWA

Countermeasures – FHWA Proven



FHWA PSCs are a collection of 28 countermeasures and strategies effective in reducing roadway fatalities and serious injuries.

Countermeasures – DOT & HSIP

100 - Signing and Signals

101 Install Warning/Guide Signs	
Definition:	Provide advance signing for unusual or unexpected roadway features where no signing existed previously.
Reduction Factor (%):	20%
Service Life (Years):	6
Maintenance Cost:	N/A
Preventable Crash:	(Vehicle Movements/Manner of Collision = 20-22 or 30) OR (Roadway Related = 2, 3 or 4)
107 Install Traffic Signal	
Definition:	Provide a traffic signal where none existed previously. This does not include the installation of flashing beacons.
Reduction Factor (%):	35%
Service Life (Years):	10
Maintenance Cost:	$3,400 (Isolated) $3,900 (Interconnected) $5,400 (Diamond Interchange)
Preventable Crash:	[(Intersection Related = 1 or 2) AND (Vehicle Movements/Manner of Collision = 10-39)] OR (First Harmful Event = 1 or 5)
108 Improve Traffic Signals	
Definition:	Improve existing intersection signals to current design standards.
Reduction Factor (%):	24%
Service Life (Years):	10
Maintenance Cost:	N/A
Preventable Crash:	(Intersection Related = 1 or 2) AND [(Vehicle Movements/Manner of Collision = 10-39) OR (First Harmful Event = 1 or 5)]
110 Install Pedestrian Signal	
Definition:	Provide a pedestrian signal at an existing signalized location where no pedestrian phase exists, but pedestrian crosswalks are existing, or in conjunction with Refer to W.C. 403 for installation of pedestrian crosswalks.
Reduction Factor (%):	34%
Service Life (Years):	10
Maintenance Cost:	N/A
Preventable Crash:	First Harmful Event = 1

TxDOT HSIP Work Codes

H32: Install New Guardrail (Not Median Barrier Application)

Description: A semi-rigid barrier typically consisting of connected segments of metal railing supported by posts and blocks.

Images from FHWA

Applications: Guardrails should be installed where there is evidence (i.e. crash history) of the need to shield motorists from a roadside hazard that has a higher risk for fatal or serious injury crashes than the guardrail itself. Potential roadside hazards could be point hazards (such as a bridge pier or utility pole), medium-sized hazards (such as roadside culverts), and long hazards (such as steep roadside slopes).

Considerations: Guardrails themselves are a roadside obstacle that a motorist can potentially strike (subsequently creating a lot of potential maintenance costs as well) so it is important to minimize guardrail installation to locations where you are protecting a motorist from roadside hazards that have a higher risk for fatal or serious injury crashes.

Special Conditions: For more guidance on installation of guardrails please see NCHRP Report 638.

ODOT CRF Value:

47%

Reduction in Run off the Road Crashes at All Injury Severities (Excludes PDO's)

Range of Effectiveness:

44% - 47%

Safety Effects:

Because guardrail systems are designed to absorb energy during a crash, and the entire assembly is designed to move or deflect during an impact, guardrail systems usually minimize potential injuries in run off the road or roadway departure crashes.

References:

Crash Modification Factors Clearinghouse (CMF ID: 38)

ODOT HSIP Countermeasure Appendix

FDOT Complete Streets Explorer Tool

Countermeasure Toolbox

111 Interconnect Signals

Provide a communication link between two or more adjacent signals in a corridor. Specify all signalized intersections to be included in the interconnection.

10% 10 $0	All

113 Install Delineators

Install post-mounted delineators to provide guidance.

12% 7 $0	(Roadway Related = 2 , 3 or 4) AND (Light Condition = 3, 4 or 6)

114 Install School Zones

Place school zones to include flashers, signing and/or pavement markings where none existed previously. Refer to W.C. 403 for pedestrian crosswalk markings.

20% 5 $0	All

118 Replace Flashing Beacon with a Traffic Signal

Replace an existing flashing beacon at an intersection with a traffic signal.

25% 10 $1,300	(Intersection Related = 1 or 2) AND [(Vehicle Movements/Manner of Collision = 10-39) OR (First Harmful Event = 1

125 Install Advanced Warning Signals and Signs (Curve)

Provide flasher units and signs in advance of a curve where none previously existed.

15% 10 $1,300	(Roadway Related = 2, 3 or 4) OR (Vehicle Movements/Manner of Collision = 20- 24 or 30)

128 Install Advanced Warning Signs (Intersection)

Provide signs in advance of an intersection where none previously existed.

5% 6 $0	Intersection Related = 1 or 2

130 Install Advanced Warning Signs (Curve)

Provide signs in advance of a curve where none previously existed.

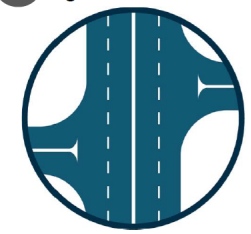
5% 6 $0	(Roadway Related = 2, 3 or 4) OR (Vehicle Movements/Manner of Collision = 20- 24 or 30)

131 Improve Pedestrian Signals

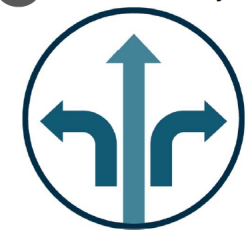
Bring existing pedestrian signal units into conformance with current standards.

10% 10 $0	First Harmful Event = 1

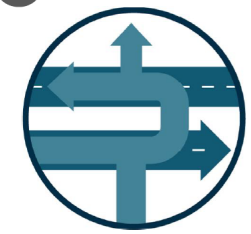
611 Corridor Access Management



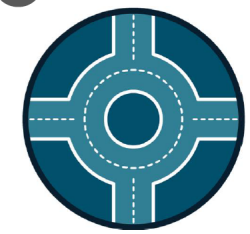
612 Left-and Right-Turn Lanes at Two-Way



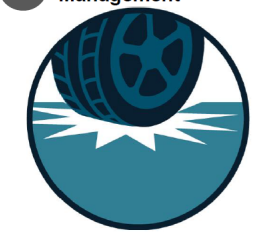
613 Reduced Left-Turn Conflict Intersections



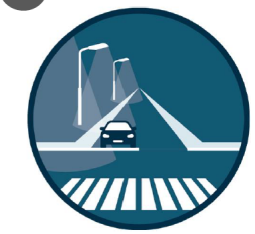
614 Roundabouts



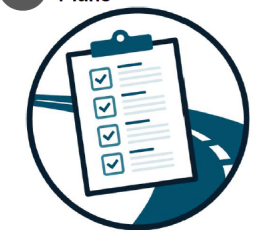
625 Pavement Friction Management



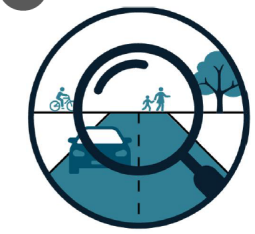
626 Lighting



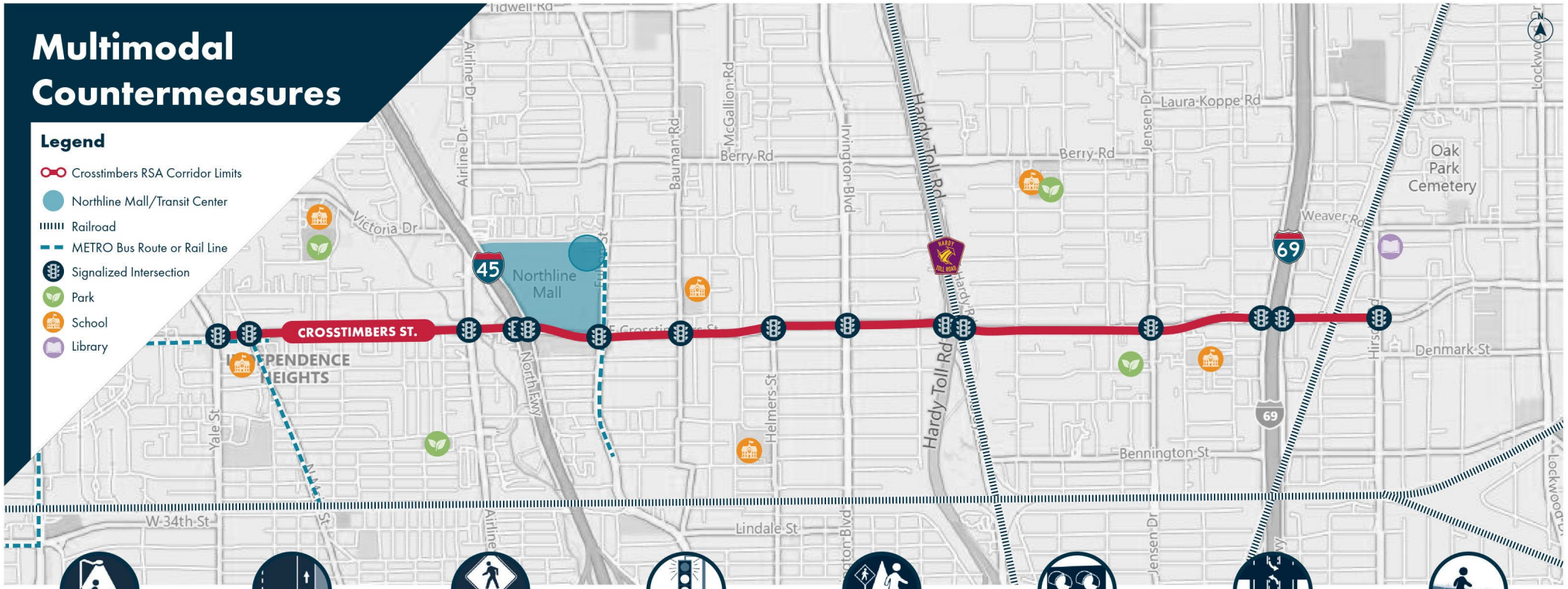
627 Local Road Safety Plans



628 Road Safety Audits



Multimodal Countermeasures



CROSSWALK VISIBILITY ENHANCEMENTS

Safety Benefits

High-visibility crosswalks can reduce pedestrian injury crashes up to **40%**

Intersection lighting can reduce pedestrian crashes up to **42%**

Advance yield or stop markings and signs can reduce pedestrian crashes up to **25%**

BICYCLE LANES

Safety Benefits

Bicycle Lane Additions can reduce crashes up to **49%** for total crashes on urban 4-lane undivided collectors and local roads

30% for total crashes on urban 2-lane undivided collectors and local roads

Separated bicycle lanes may provide further safety benefits. FHWA is anticipating completion of research in Fall 2022

RECTANGULAR RAPID FLASHING BEACONS (RRFB)

Safety Benefits

RRFBs can reduce crashes up to **47%** for pedestrian crashes

RRFBs can increase motorist yielding rates up to **98%** (caries by speed limit, number of lanes, crossing distance, and time of day)

LEADING PEDESTRIAN INTERVAL

Safety Benefits

13% reduction in pedestrian-vehicle crashes at intersections

MEDIANS AND PEDESTRIAN REFUGE ISLANDS IN URBAN AND SUBURBAN AREAS

Safety Benefits

Median with marked crosswalks
46% reduction in pedestrian crashes

Pedestrian Refuge Island
56% reduction in pedestrian crashes

PEDESTRIAN HYBRID BEACONS

Safety Benefits

55% reduction in pedestrian crashes

29% reduction in total crashes

15% reduction in fatal and serious injury crashes

ROAD DIETS

Safety Benefits

4-lane to 3-lane road diet conversions
19-47%
reduction in total crashes

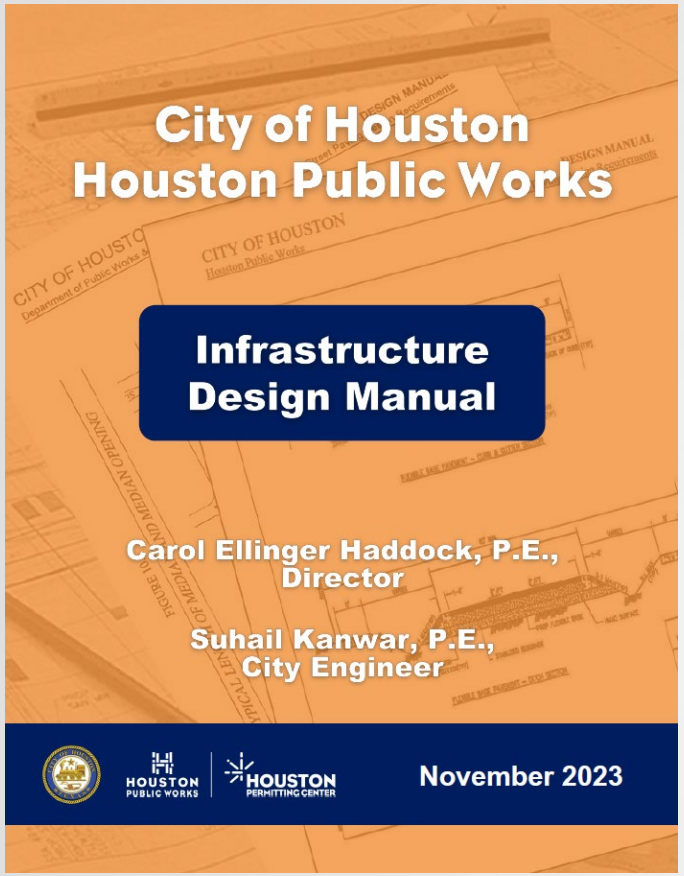
WALKWAYS

Safety Benefits

Sidewalks
65-89%
reduction in crashes involving pedestrians walking along roadways

Paved Shoulders
71%
reduction in crashes involving pedestrians walking along roadways

Countermeasures – City IDM



Page 15-15, Safety Analysis

1. Safety Analysis

   a. The Safety analysis module is used to assess crash history and identify safety concerns along a corridor or at one or more intersections.

      (1) Use TxDOT CRIS crash database [10] to assess crash trends over a 5-year period.

      (2) Determine if the corridor is on the City of Houston Vision Zero High Injury Network (HIN) [11].

      (3) Compute corridor crash rates using crash data and traffic counts. Compute intersection crash rates at signalized locations. Collect new traffic counts if none are currently available. See Section 15.2.04 - Traffic Volumes for requirements for traffic volume data.

      (4) Determine whether there are any crash trends or hotspots within the project area.

      (5) If the corridor or intersection is on the HIN, identify and describe the crashes that contribute to that designation.

      (6) Summarize crash reports by at least these factors:

2. Corridor and Access Management Analysis

   This module is intended to define features for roadway segments between intersection of public streets. The cross section of the road shall be determined following the steps below, in order. NOTE: The number of general-purpose lanes shall not be the starting point for determination of cross section.

   a. Determine walking, biking and transit needs.

      (1) Document Existing Condition in relation to the Multimodal Service Standards (MMSS) defined in 15.2.01.

      (2) Determine, document and provide recommendations for pedestrian realm dimensions and features as per the Multimodal Service Standard and Chapter 17, Section 3 - Pedestrian Elements Requirements.

Page 15-16, Corridor Analysis

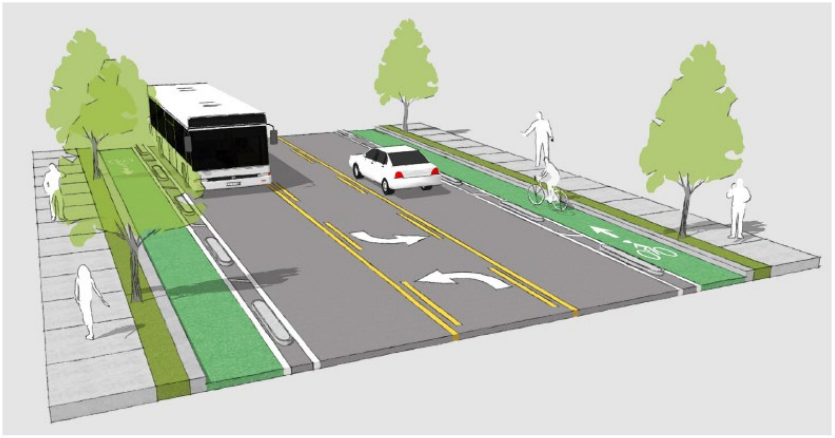


Figure 17.22 – SINGLE DIRECTION PROTECTED BIKE LANE WITH PRE-CAST CURB

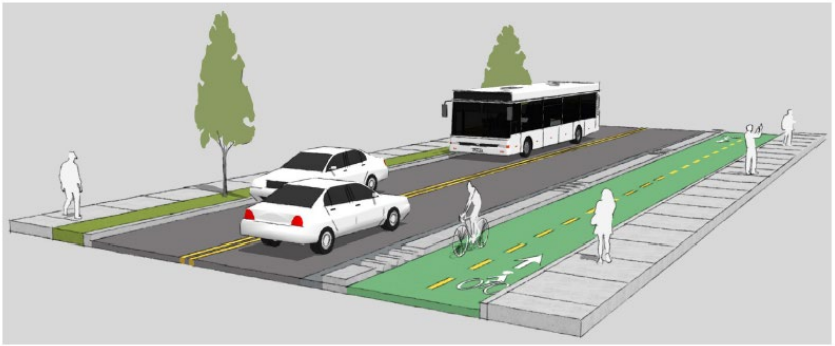
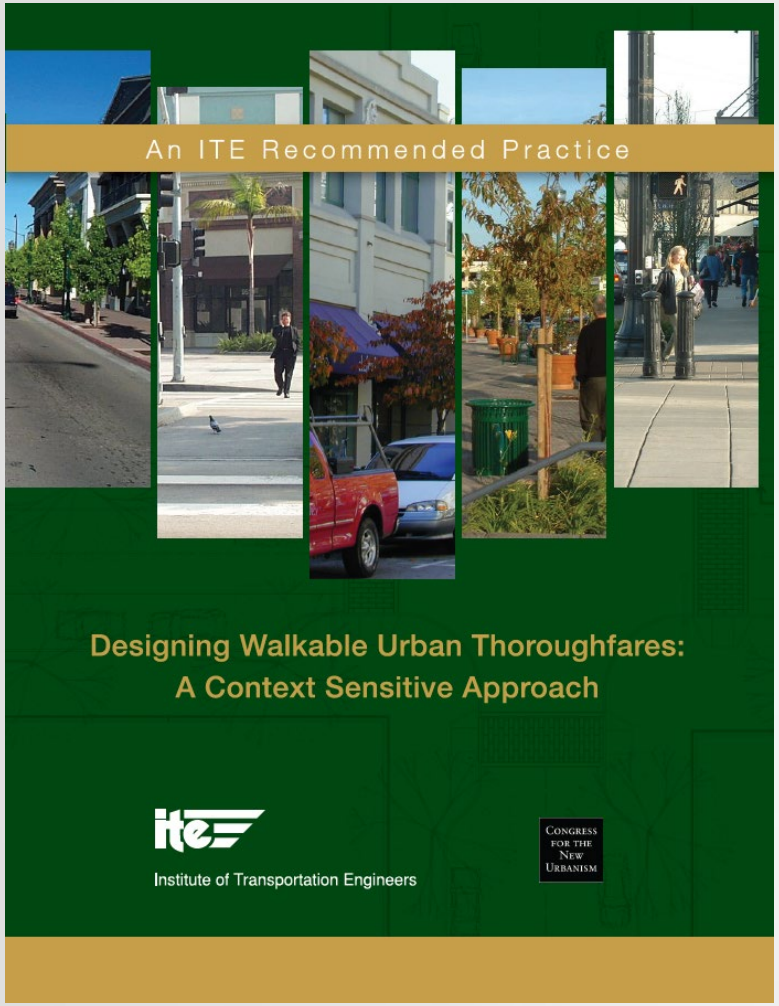


Figure 17.23 – BIDIRECTIONAL PROTECTED BIKE LANE WITH CAST-IN-PLACE CURB

Chapter 17, Pedestrian, Bicycle, and Transit Design Requirements

Countermeasures – ITE



law enforcement and transit service providers. The process of implementing a speed management program benefits from public involvement to understand how the community uses thoroughfares and how it perceives various speed management methods. Bicycle and pedestrian advocacy groups should also be involved in the process. Effective speed management requires knowledge of the existing traffic patterns, both quantitative and qualitative. Quantitative measures of traffic counts, intersection turn movements and speeds help to determine the existing condition and the need. Qualitative information, often gathered from the public or through observation, can explain behavioral issues. Implementation of speed management should be examined along corridors and across jurisdictions. It is important for a corridor to have a consistent speed through different jurisdictions if the character and context also remain constant.

The following is a list of speed management techniques or measures commonly used in the United States on thoroughfares designated as arterials or collectors:[1]

Active Measures

- Roundabouts, particularly when used within a "roundabout corridor."
- Road diets (reducing the number of lanes by adding medians, converting travel lanes to parking, or adding bike lanes).
- Lateral shifts or narrowing (curb extensions with a center island or other techniques that require vehicles to move out of a straight path or create neckdowns).
- Smaller curb-return radii to slow turning vehicles and the elimination of free-flow channelized right-turn lanes.
- Provision of on-street parking where adjacent land uses and activities will generate demand.
- Speed humps and speed tables (not widely used on arterials and lack support of emergency service providers).
- Speed cushions or speed platforms (less impact on emergency vehicles than hump and tables).
- Narrowed travel lanes.
- Raised crosswalks combined with curb extensions to narrow street.
- Speed actuated traffic signals where a vehicle traveling at excessive speeds will trigger the signal to change to red.

Passive Measures

- Synchronized signals to create progression at an appropriate speed.
- Radar trailers/speed feedback signs flashing "SLOW DOWN" message when speed exceeds a preset limit (most effective when coupled with enforcement).
- Visually narrowing road using pavement markings.
- Visually enclosing street with buildings, landscaping and street trees.
- Variable speed limits (using changeable message signs based on conditions).
- Speed enforcement corridors combined with public education.
- Flashing beacons on intersection approaches to slow traffic through the intersection.
- Speed limit markings on pavement.
- Mountable cobblestone medians or flush concrete bands delineating travel lanes for visual narrowing
- Shared streets using signs and pavement markings (such as bicycle boulevards).
- Automated speed enforcement (including red-light enforcement).

Thoroughfare Speed Management

Table 10.1 Pedestrian and Bicycle Features at Signalized Intersections

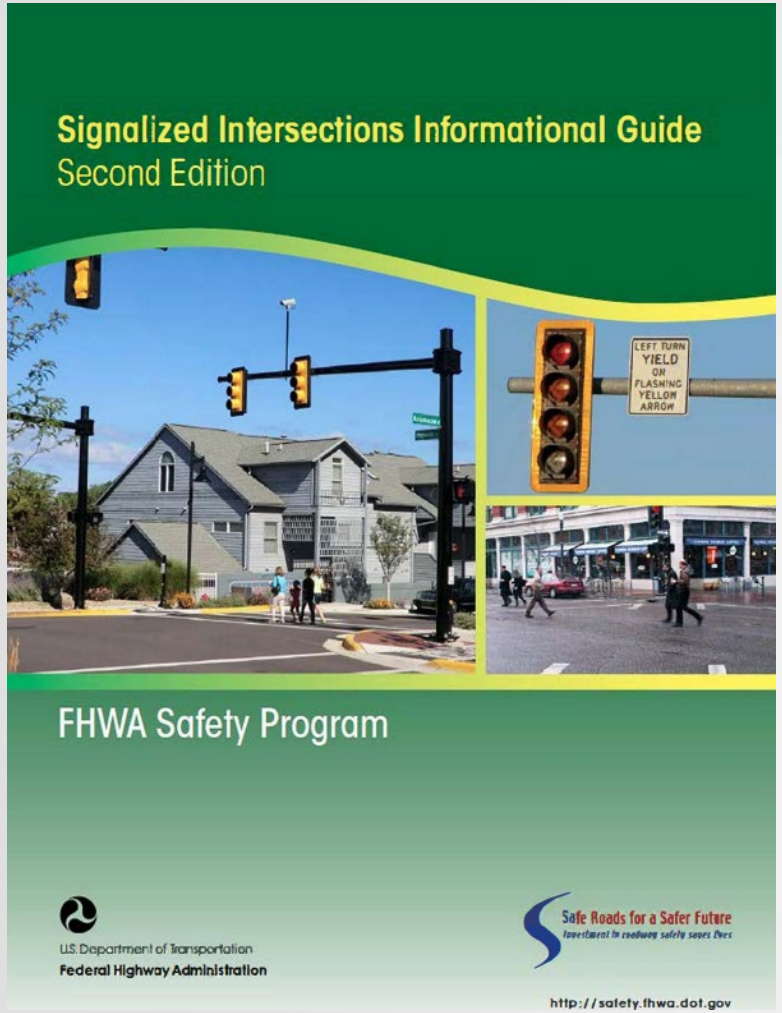
Shorter and more visible crosswalks	• Crosswalks on all approaches; • Longitudinal markings (possible use of colored and/or textured paving); • Reduced overall street widths by reducing the number of travel and turn lanes, or narrowing travel lanes; • Curb extensions with pedestrian push buttons on extensions; and • Median refuges on wide streets (greater than 60 feet) with median push buttons.

Priority for pedestrians, bicyclists, and accessibility	• Shorter cycle lengths, meeting minimum pedestrian clearances (also improves transit travel times);
	• Longer pedestrian clearance times (based on 3.5 feet/sec. to set flashing (clearance) time and 3.0 feet/sec for total crossing time);
	• Reduced conflicts between pedestrians and turning vehicles achieved with:
	  ◦ Pedestrian lead phases;
	  ◦ Scramble phases in very high pedestrian volume locations;
	  ◦ Restricted right turns on red when pedestrians are present during specified hours; and
	  ◦ Allowing right turns during cross-street left turn phases reduces the number of right turn conflicts during pedestrian crossing phase.

Low speed channelized right turn lanes	• Adequate sized islands for pedestrian refuge; • Raised pedestrian crossing/speed table within channelized right turn lane; and • Signal control of channelized right turn in high pedestrian volume locations.
Improved pedestrian information	• Pedestrian countdown timers; and • "Look Before Crossing" markings or signs.
Bicycle features	• Bicycle lanes striped up to crosswalk (using "skip lines" if vehicular right turns are allowed); • Bicycle detectors on high volume routes, or bicyclist-accessible push buttons; • Adequate clearance interval for bicyclists; • Colored paving in bicycle/vehicle lanes in high-conflict areas; and • "Bike Boxes" (painted rectangle along right hand curb or behind crosswalk) to indicate potential high-conflict area between bicycles continuing through an intersection and right turning vehicles, and to allow bicyclists to proceed through intersection or turn in advance of vehicles.

Table 10.1 Pedestrian and Bicycle Features at Signalized Intersections

Countermeasures – FHWA Intersection Guide



Characteristic	Potential Benefits	Potential Concerns
Safety	Reduction in right-turning vehicle/pedestrian collisions. Fewer right-turn-on-red violations.	May increase right-turning/through vehicle rear-end collisions due to increased speed differential. Large vehicle off-tracking.
Operations	Less overall delay due to reduction in time needed to serve pedestrian movement.	May adversely affect operation if curb extension replaces a travel lane. Right-turn movements delayed. Emergency vehicles may be significantly delayed.
Multimodal	Shorter crossing distance. Facilitates the use of two perpendicular ramps rather than a single diagonal ramp. Better visibility between pedestrians and drivers.	May be more difficult for large trucks and buses to turn right.
Physical	None identified.	Drainage may be adversely affected.
Socioeconomic	Low to moderate costs.	None identified.
Enforcement, Education, and Maintenance	None identified.	None identified.

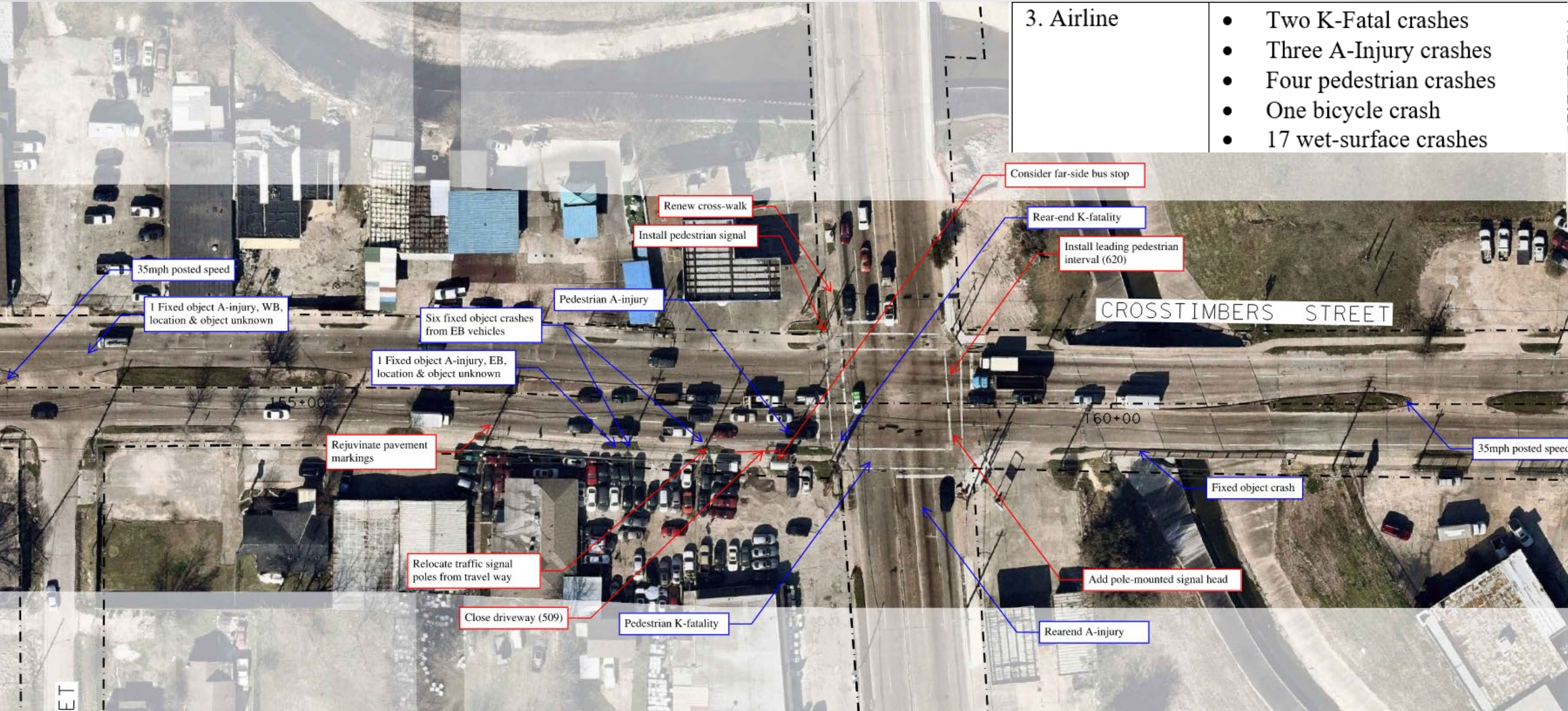
Exhibit 9-4. Summary of issues for curb extensions.

Countermeasure Selection – Practice Exercise

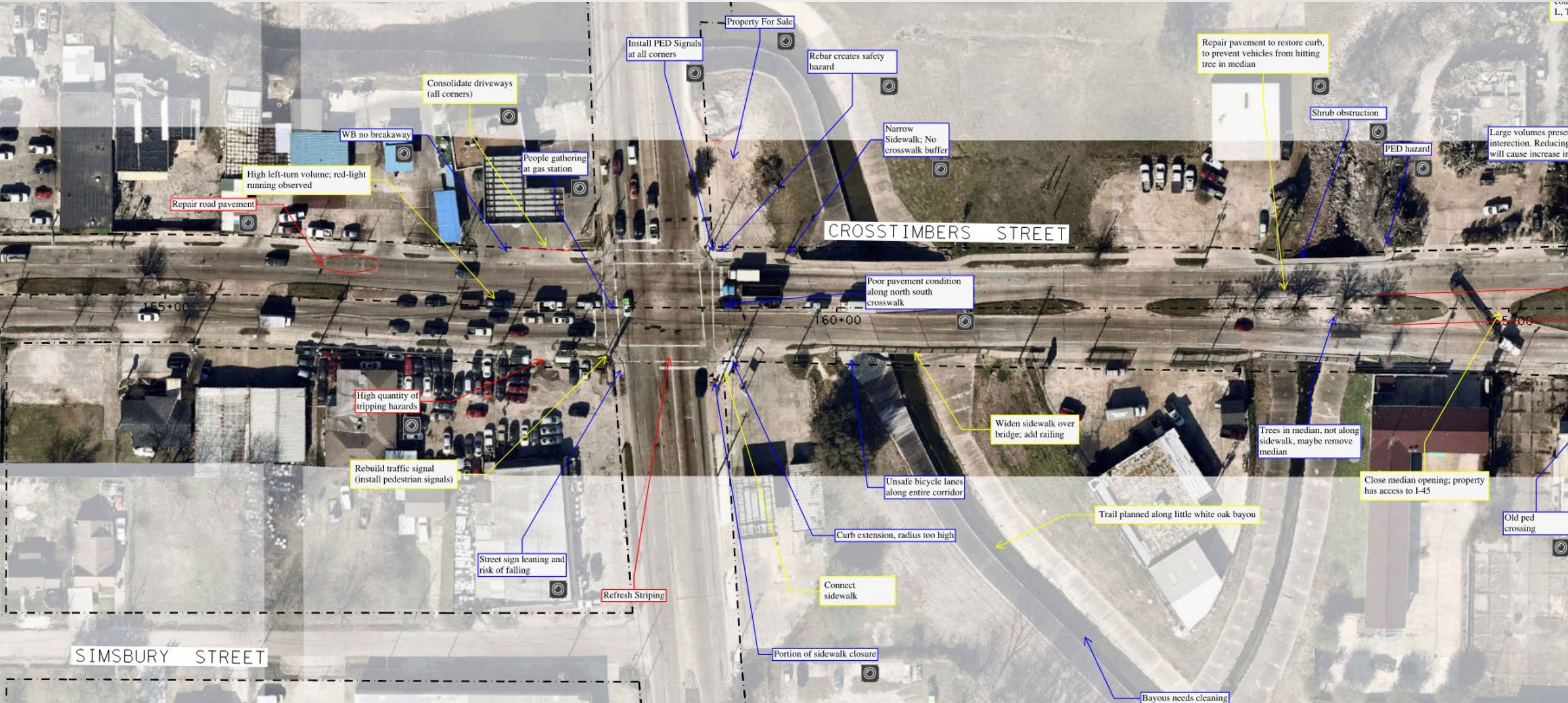
1. **Objective:** Identify improvements to address safety concerns at two high -crash intersections.
2. Process:
    1. Organize into groups of four
    2. Determine 1 to 2 intersections for further review
    3. Review observations and further evaluate contributing factors
    4. Select countermeasures at each intersection
    5. Organize an observation -improvement table at each intersection

Desktop Observations (Airline)

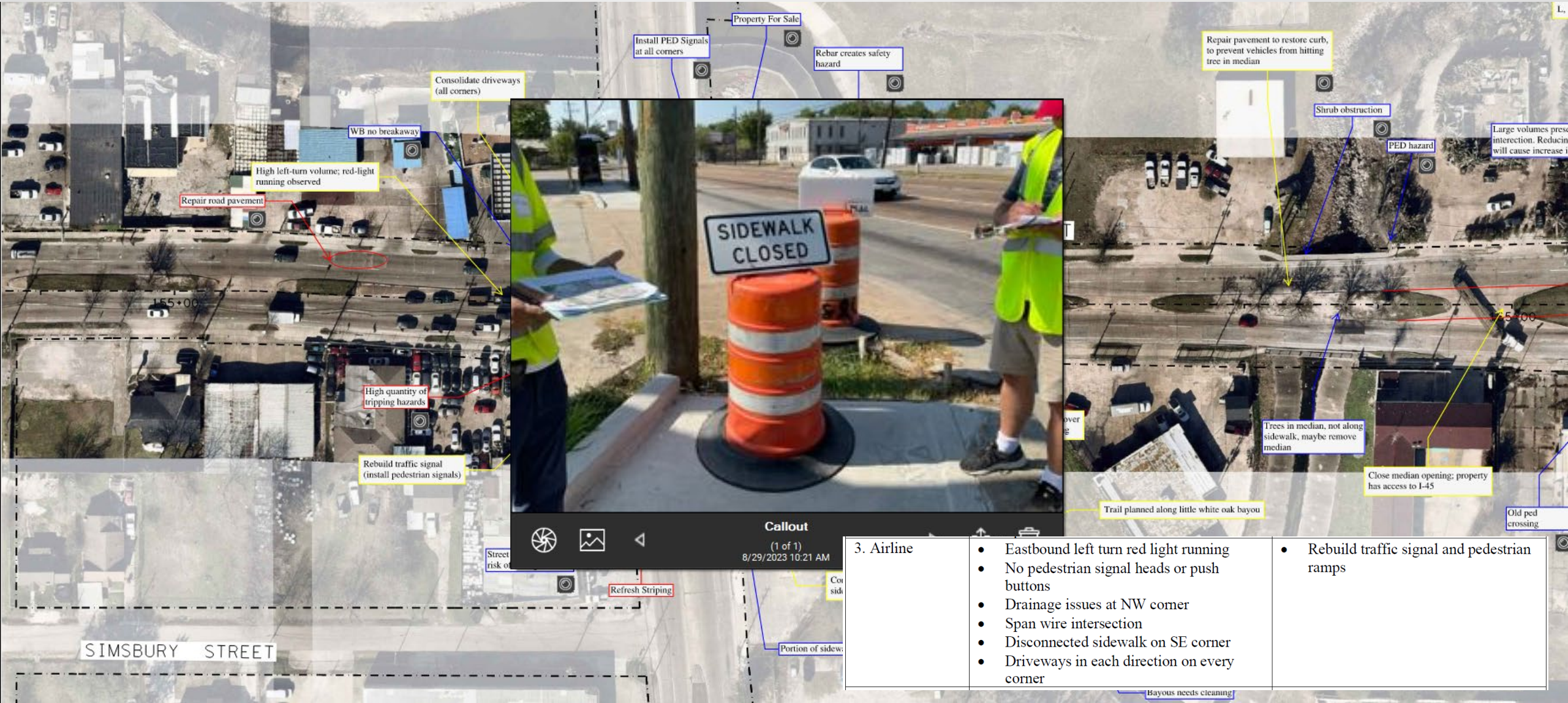
3. Airline	• Two K-Fatal crashes • Three A-Injury crashes • Four pedestrian crashes • One bicycle crash • 17 wet-surface crashes



Field Observations (Airline)



Field Observations (Airline)



3. Airline	• Eastbound left turn red light running • No pedestrian signal heads or push buttons • Drainage issues at NW corner • Span wire intersection • Disconnected sidewalk on SE corner • Driveways in each direction on every corner	• Rebuild traffic signal and pedestrian ramps

Engineering Countermeasures (by Intersection)

Improvement	Yale	Main	Airline	I-45 SBFR	I-45 NBFR	Fulton	Bauman	Helmers	Irvington	Hardy SB	Hardy NB	Jensen	I-69 SB	I-69 NB	Hirsch
Improve (rebuild) traffic signal	✓	✓	✓		✓		✓	✓	✓	✓	✓		✓	✓	
Convert to mast arm mounted signal	✓	✓	✓				✓	✓	✓						
Install retroreflective backplates	✓	✓	✓		✓		✓		✓	✓	✓				
Install one signal head per lane on every approach	✓				✓		✓		✓	✓	✓		✓	✓	
Additional signal heads/balls				✓	✓		✓		✓	✓	✓	✓	✓	✓	
Provide intersection safety lighting				✓	✓	✓	✓						✓	✓	
Refresh pavement markings	✓	✓	✓		✓		✓	✓	✓						✓
Install high-visibility crosswalk	✓	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓	✓
Replace standard crosswalk with continental crosswalks			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Install/Improve sidewalks								✓		✓	✓				✓
Install pedestrian signals			✓						✓	✓	✓				
Install pedestrian push buttons (APS)	✓	✓	✓				✓	✓	✓	✓	✓		✓	✓	
Install/Improve pedestrian ramps		✓					✓	✓	✓	✓	✓				
Consider LPI -Leading Pedestrian Interval		✓	✓	✓	✓	✓			✓	✓	✓	✓			
Review yellow change intervals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Review all red intervals	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Signal timing coordination	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Consider increasing green extension on actuated signal timing			✓						✓			✓	✓	✓	
Install speed limit sign after every major intersection	✓			✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
Improve sight triangle/distance			✓			✓		✓	✓				✓	✓	

METROPOLITAN PLANNING ORGANIZATION

Resources – Countermeasure Selection

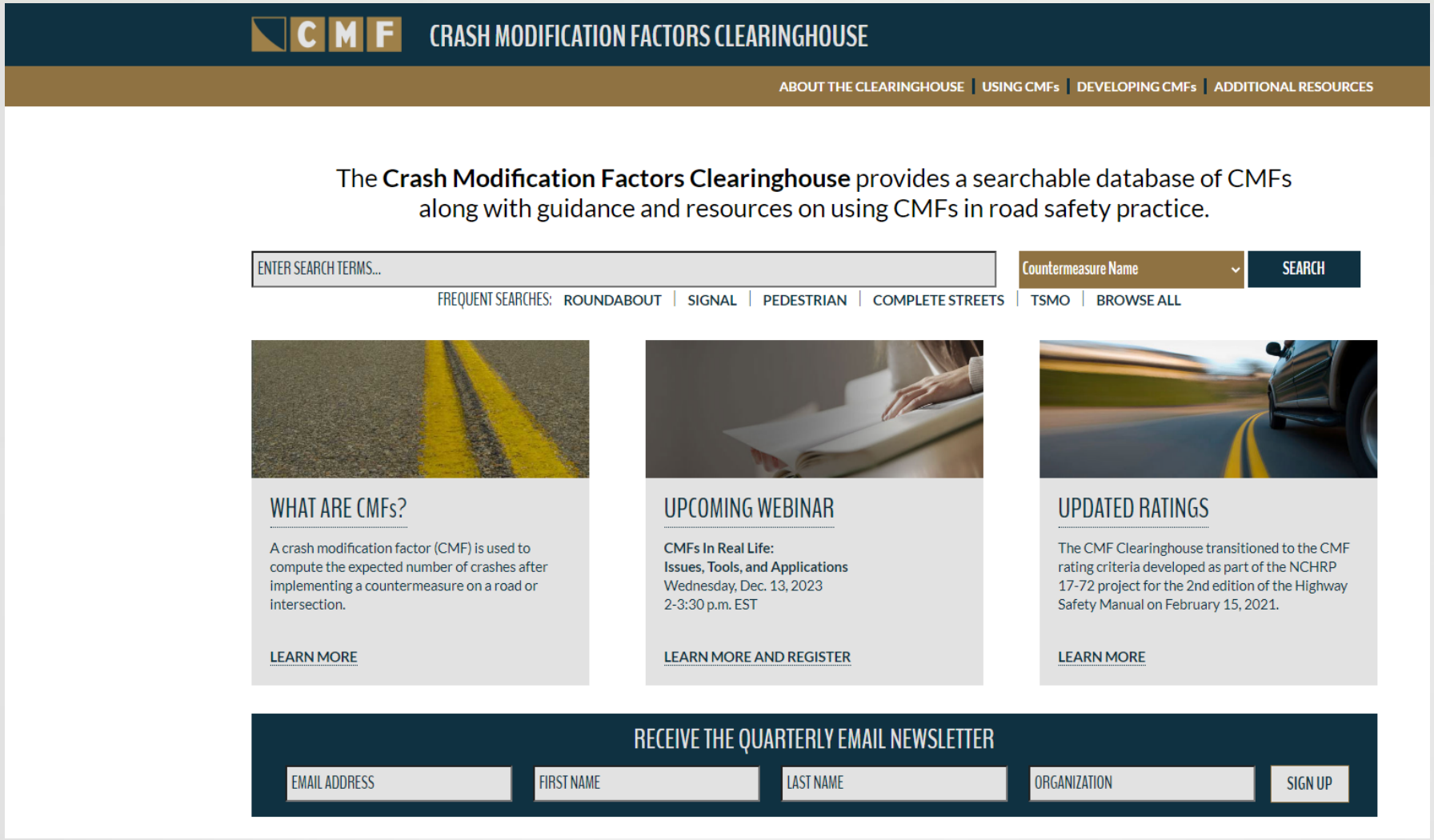
Site-Specific

- City of Houston IDM
- ITE Complete Streets
- FHWA Signalized Intersections Informational Guide (FHWA-SA-13-027)
  - Chapter 6 – Safety Analysis Methods
  - Summary of Issues table (by treatment)
- USDOT Moving to a Complete Streets Design Model: Appendix 2: Key Resources and References

Systemic

- FHWA Proven Safety Countermeasures webpage
- Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections (FHWA-SA-09-020)
- DOT Resources (such as TxDOT and FDOT)

CMF Selection - Clearinghouse



Source: FHWA

CMF Selection - Context

- Area type
- Roadway type
- Intersection type/geometry
- Traffic control
- Traffic volume
- Crash type
- Crash severity

CMF Selection - Quality

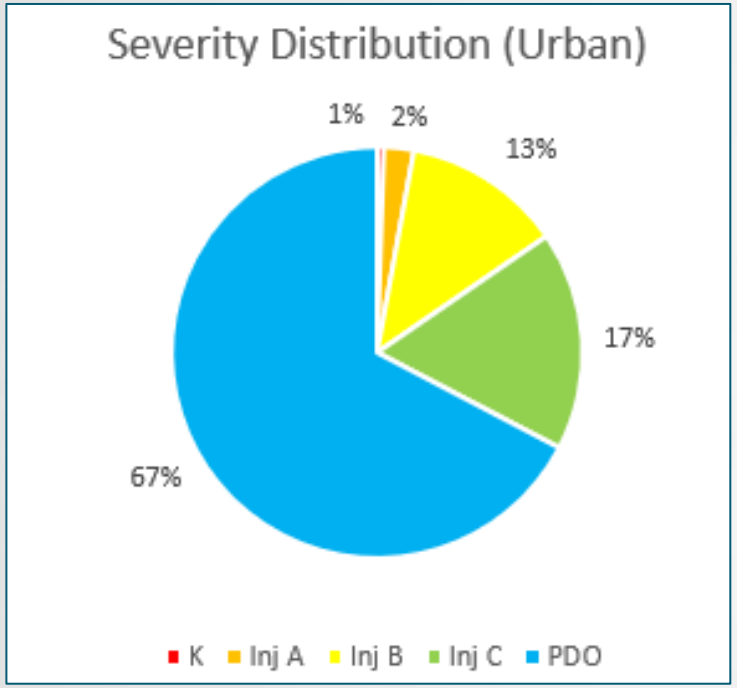
- Quality is very important
- Can result in incorrect project selection

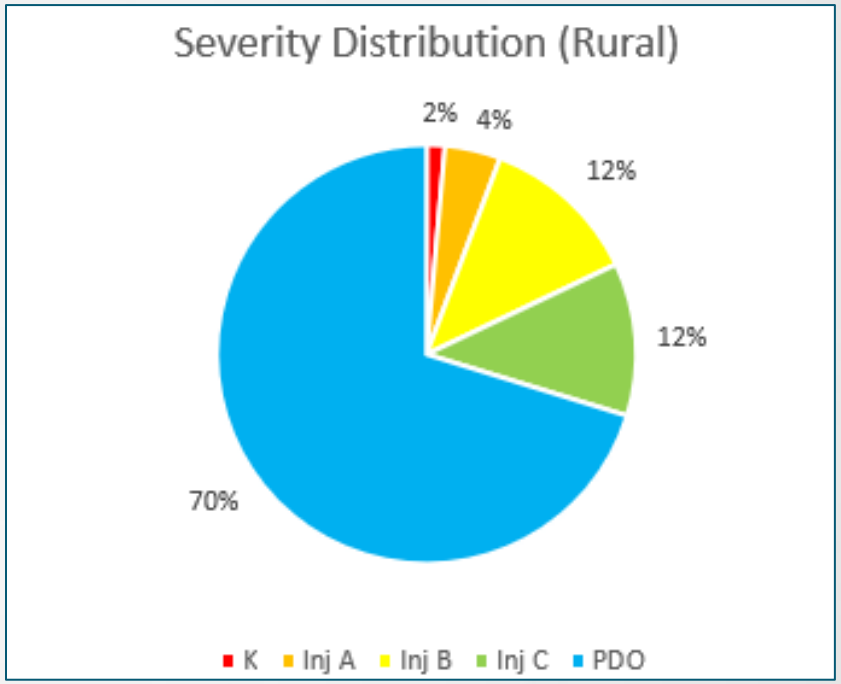
CMF ID	317	320	4122	7845	7851
CMF	0.66	0.33	0.51	0.67	0.66
Star Rating					
Rating Score Total	*100*	*140*	*65*	*110*	*55*
Crash Type	*Angle*	*Angle*	*Angle,Head on,Left turn,Rear end,Rear to rear,Right turn,Sideswipe*	*Angle*	*Left turn*
Crash Severity	*KAB*	*KAB*	*All*	*All*	*All*
Area Type	*Urban*	*Urban*	*Urban*	*Urban*	*Urban*

Source: Crossroads

Countermeasure Selection Examples

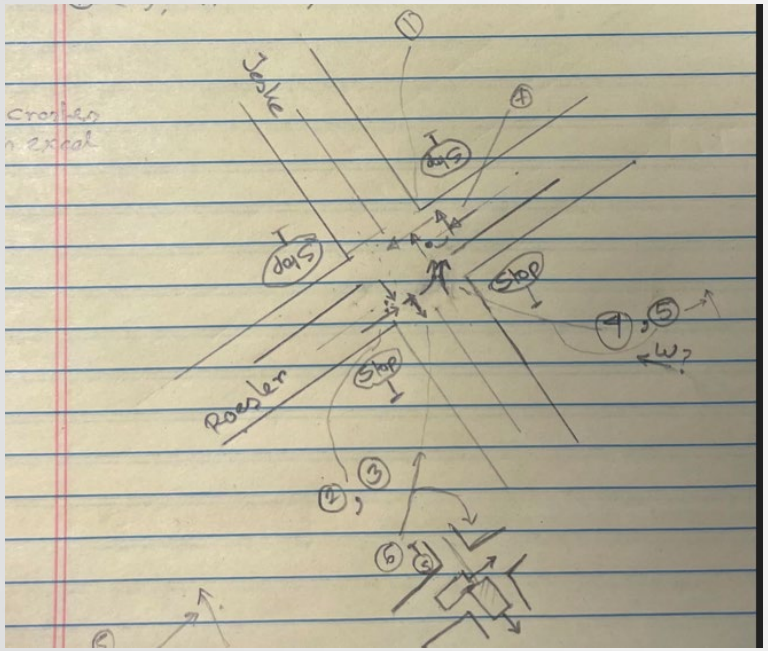
- Total crashes (2022): 555,229 (73% urban)
- % KA: ~4%

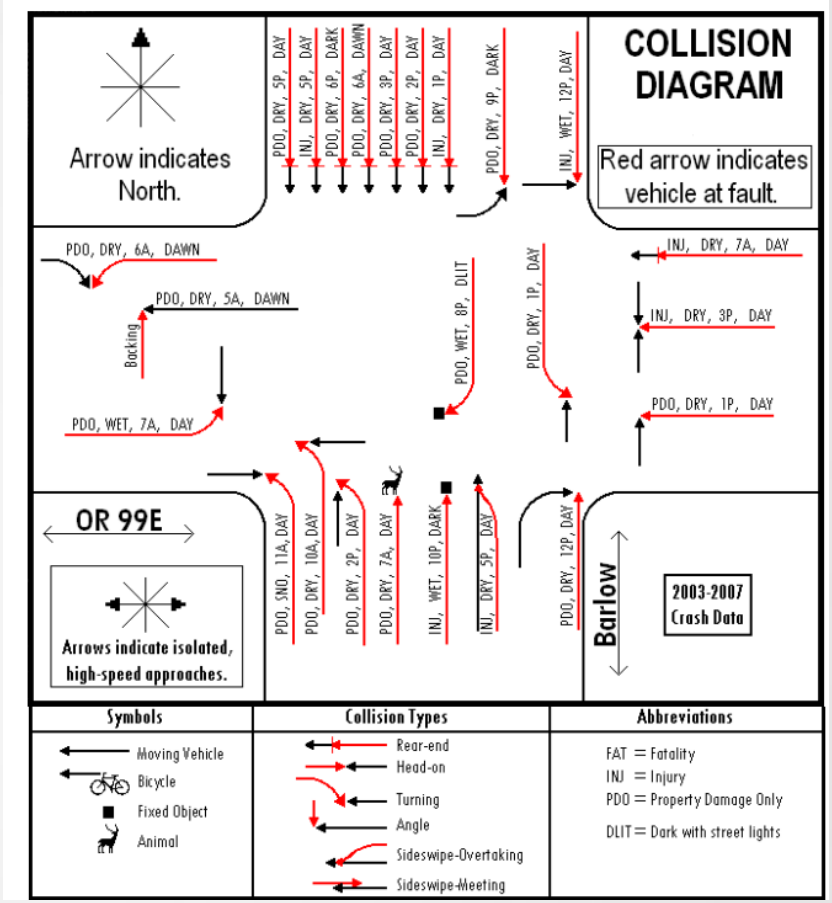




Countermeasure Selection Examples - What information do we need?

- Crash history and descriptive statistics
- Collision diagram
- Field conditions/operations





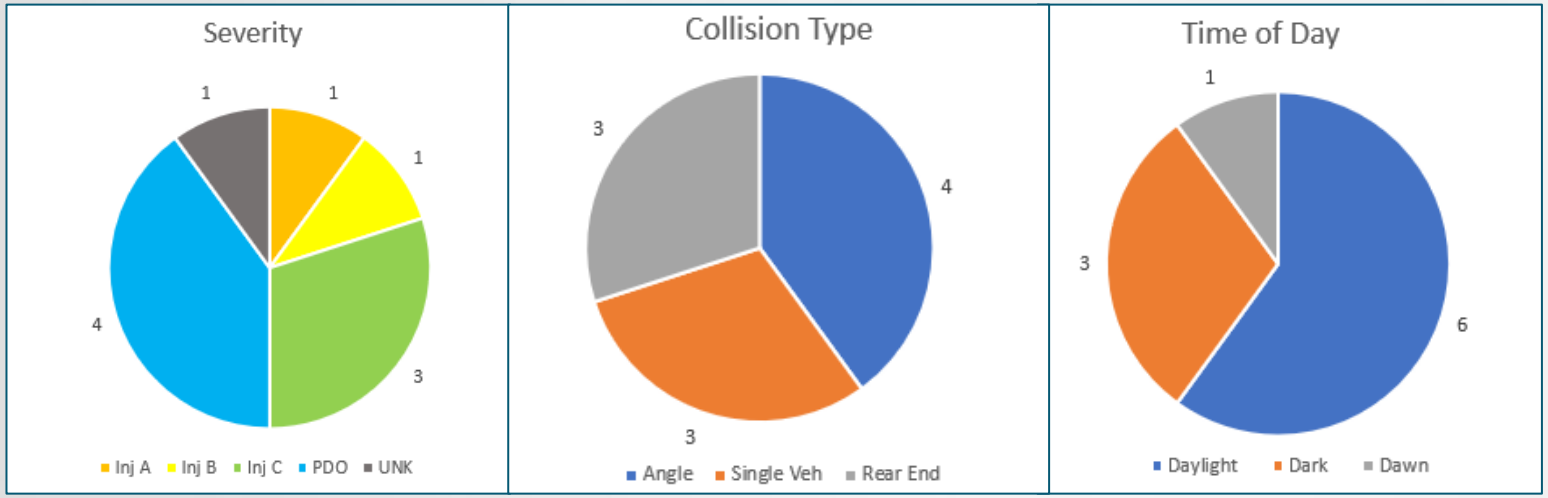
Source: Oregon DOT

Countermeasure Selection Example 1

- Rural road
- Speed limit: 50 mph
- Minor road stop -controlled
- AADT: 2300 (FM 1236), 350 (Jeske Rd)
- No horizontal l and vertical curves
- No lighting

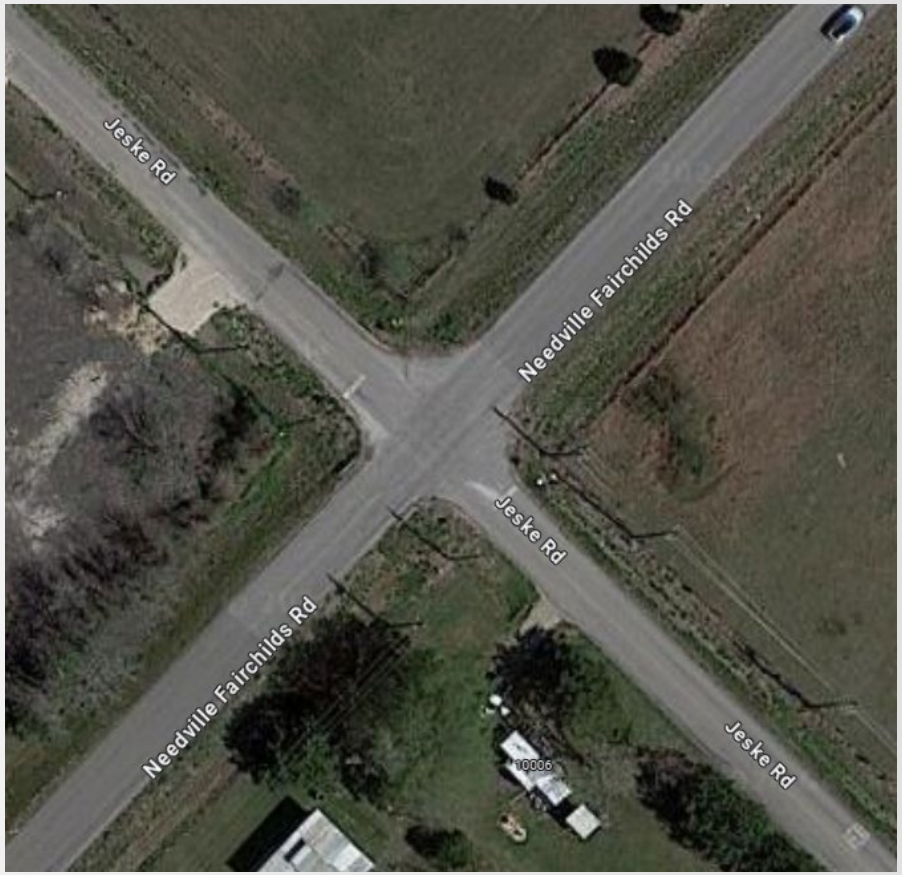
Example 1 - Crash History

- Total recorded crashes: 10 (5 -year)
- Predicted crashes: 2 (5-year)



Example 1 - Why are these crashes happening?

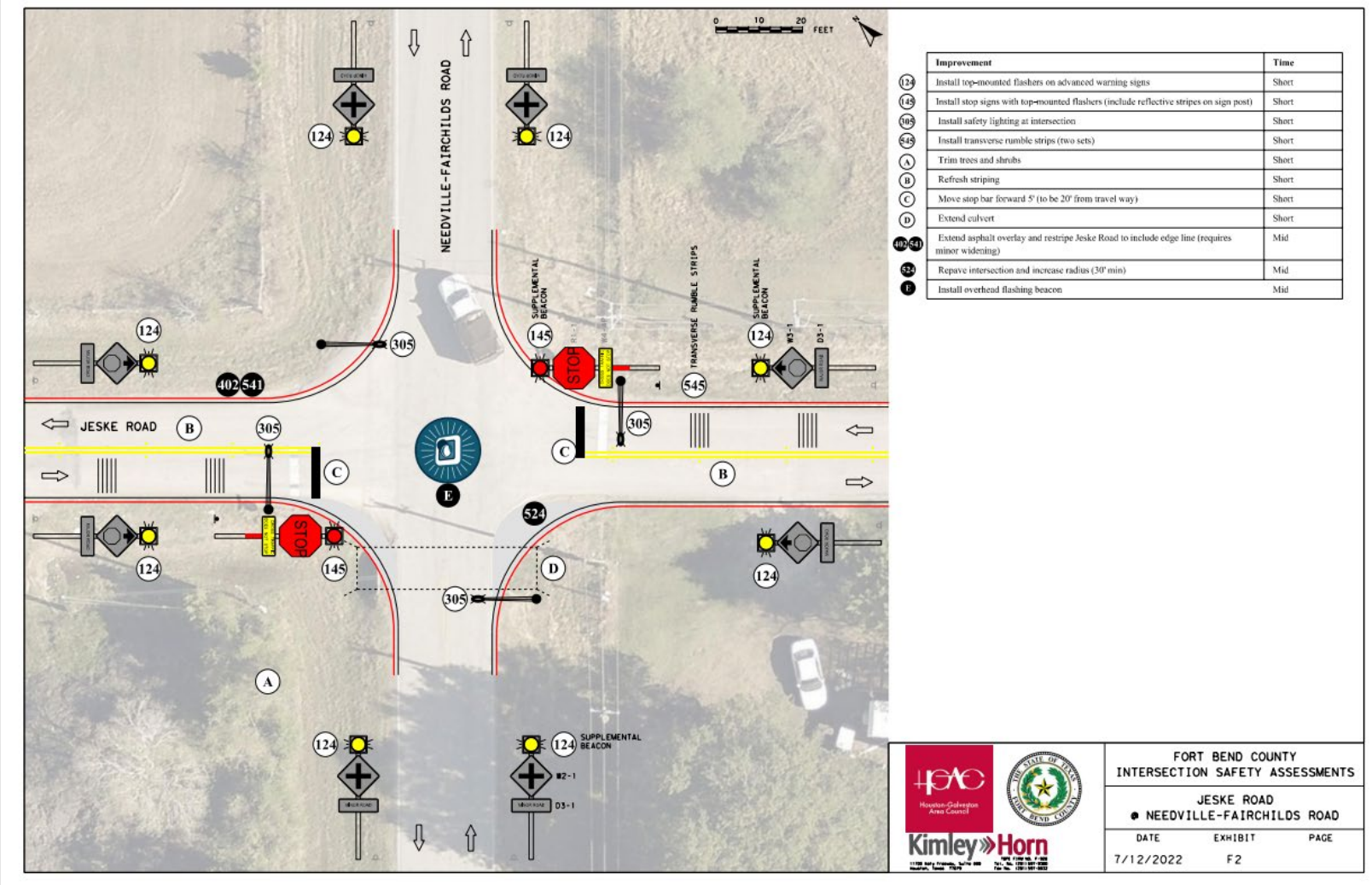
- Speeding
- Unaware of the presence of intersections
- Roadside obstructions
- Dark conditions



Example 1 - What CM would you propose?

- Supplement STOP sign with Flashing Beacon (FB)
- Overhead FB
- Advance warning signs (with or w/o FB)
- Intersection illumination
- Clear roadside obstructions
- Transverse rumble strips

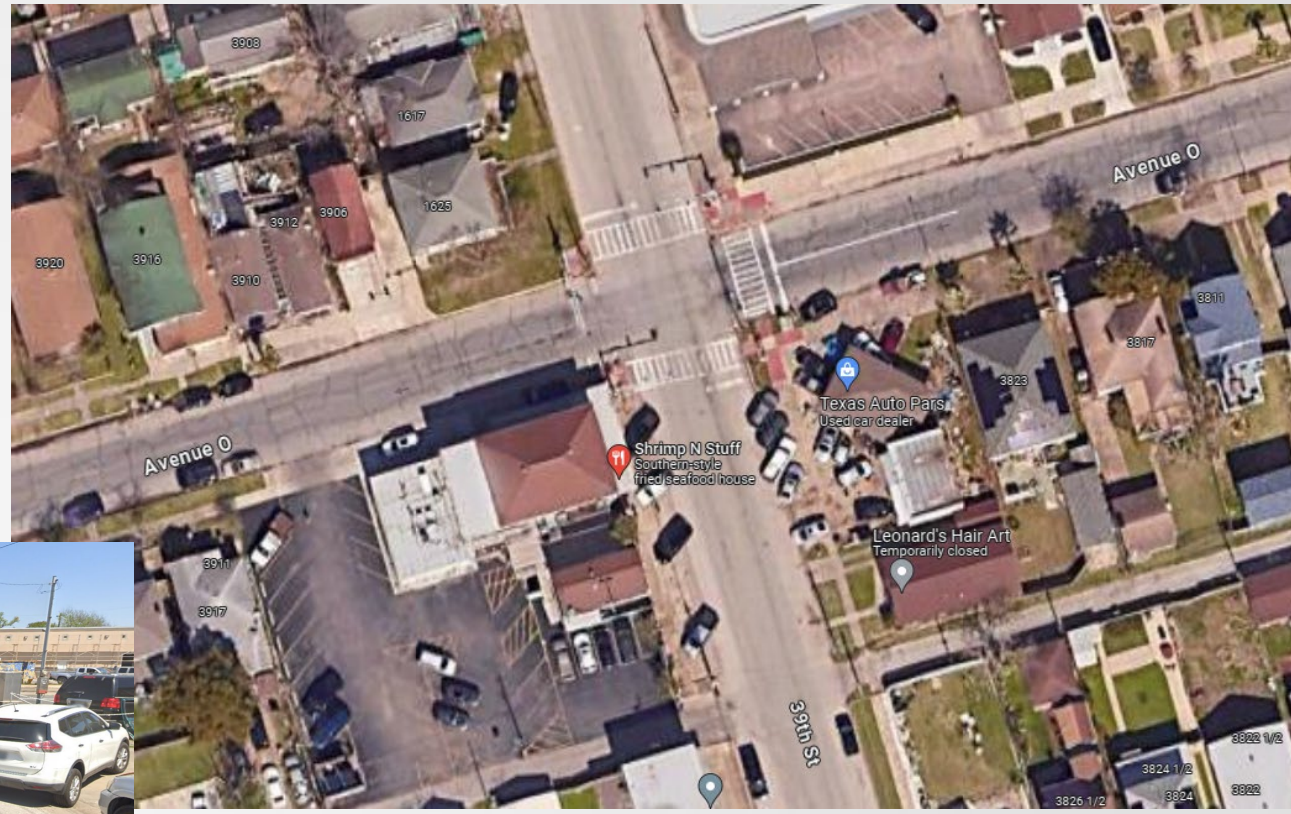
Example 1 - What CM would you propose?

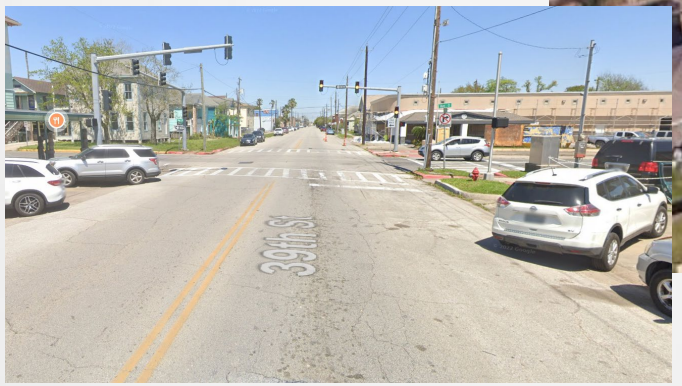


	Improvement	Time
124	Install top-mounted flashers on advanced warning signs	Short
145	Install stop signs with top-mounted flashers (include reflective stripes on sign post)	Short
305	Install safety lighting at intersection	Short
545	Install transverse rumble strips (two sets)	Short
A	Trim trees and shrubs	Short
B	Refresh striping	Short
C	Move stop bar forward 5' (to be 20' from travel way)	Short
D	Extend culvert	Short
402 541	Extend asphalt overlay and restripe Jeske Road to include edge line (requires minor widening)	Mid
524	Repave intersection and increase radius (30' min)	Mid
E	Install overhead flashing beacon	Mid

Countermeasure Selection Example 2

- Urban road
- Speed limit: 30 mph
- Signal-controlled
- AADT: 3,300 (39 th), 2,550 (Ave O)
- Parking allowed
- Spotty illumination

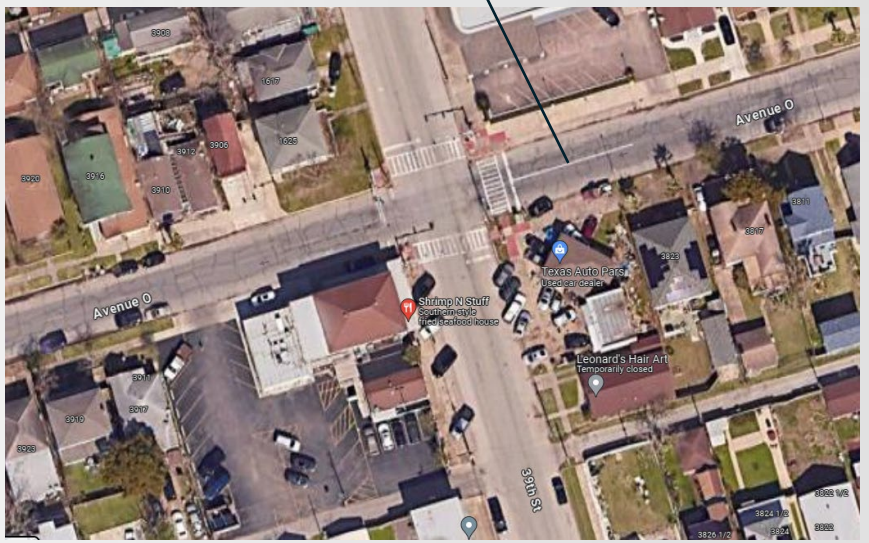


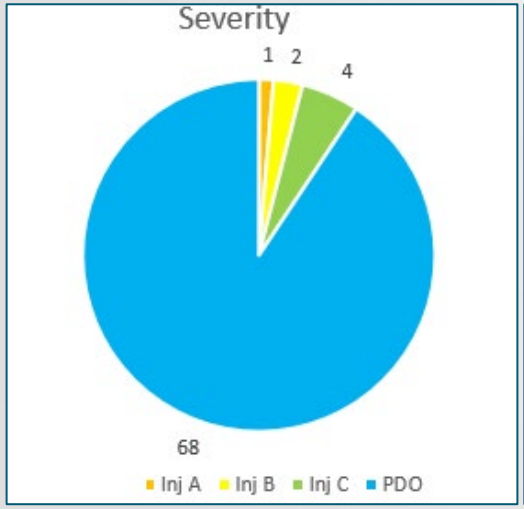


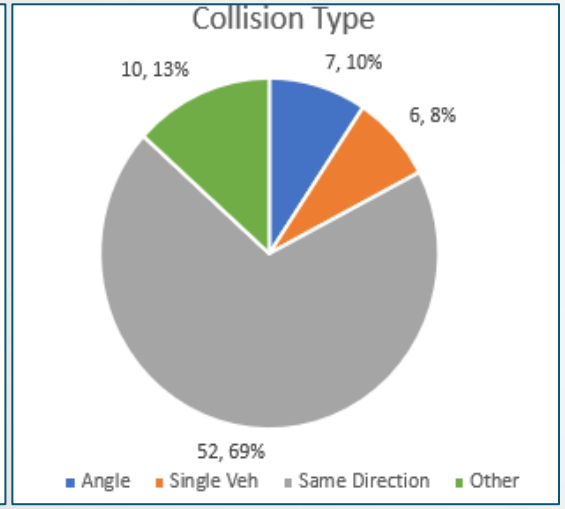
Example 2 - Crash History

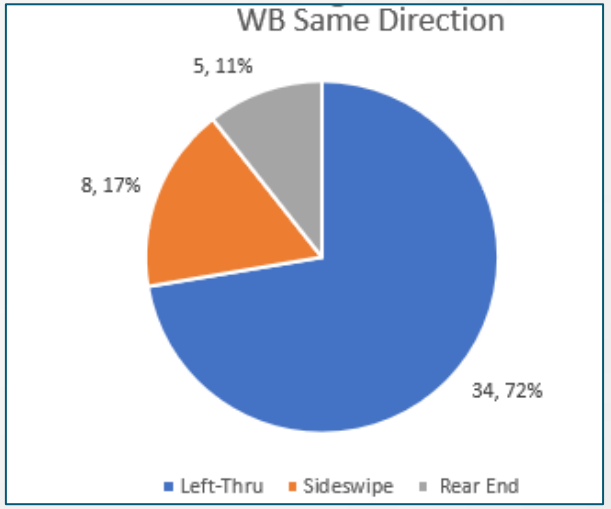
- Total recorded crashes: 75 (5 -year)
- Predicted crashes: 3 (5-year)
- 2 bicycle crashes
- 47 same direction cashes in WB direction

20+ left -thru crashes



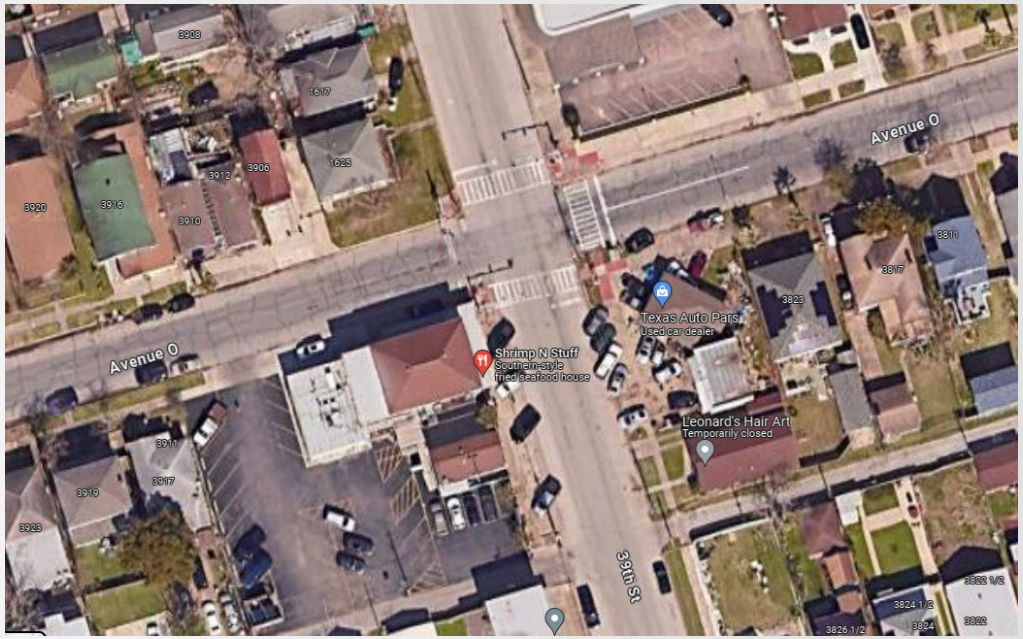






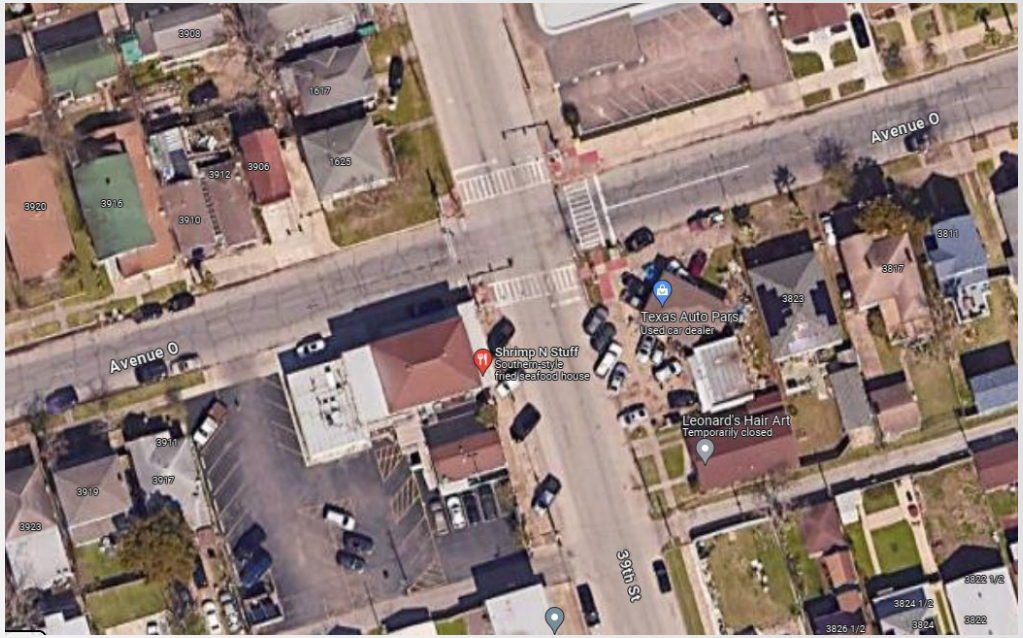
Example 2 - Why are these crashes happening?

- Speeding
- Disregard signal
- Turns from wrong lane
- Unsafe backing
- Driver impatience
- Unsafe lane change

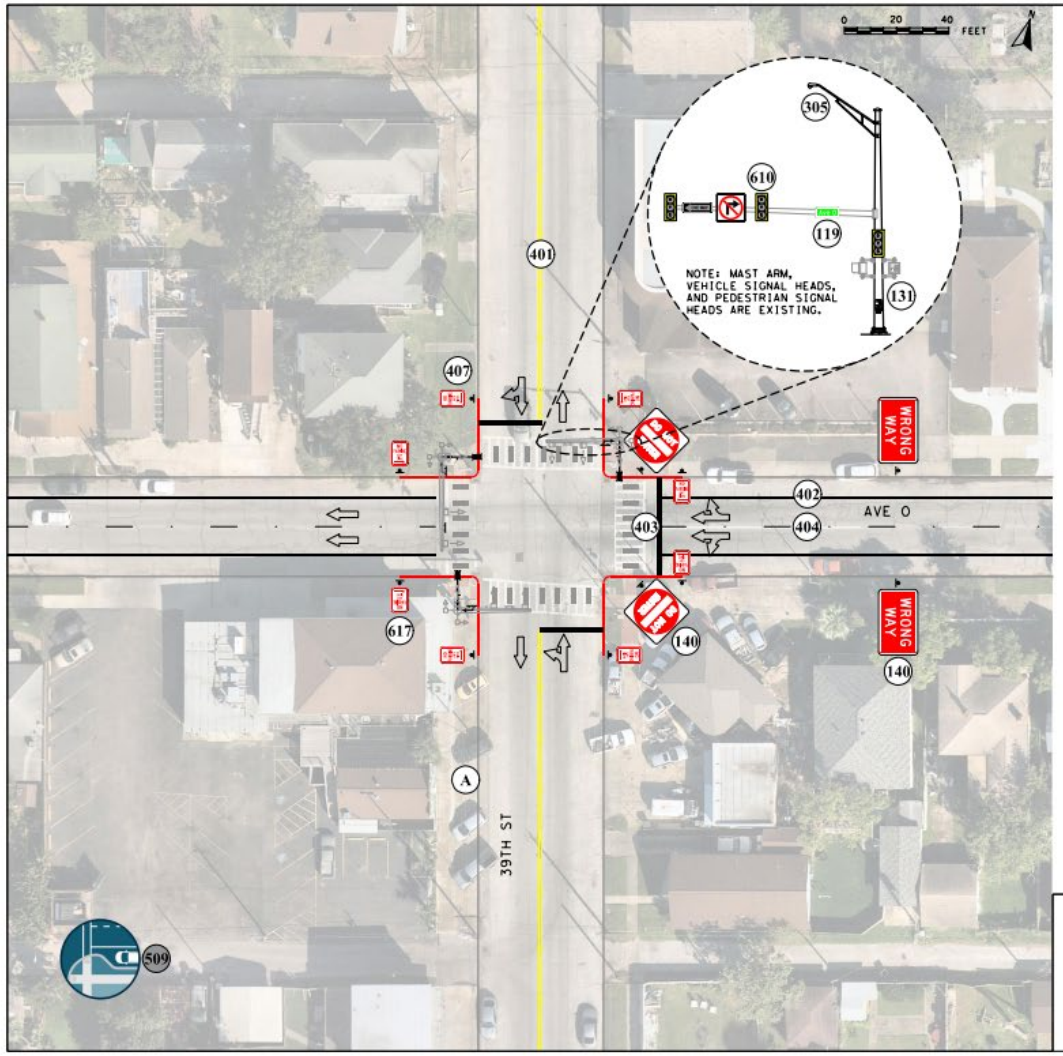


Example 2 - What CM would you propose?

- Add pavement arrows
- Lane control sign
- Signal timing
- Increase signal conspicuity
- Better parking management
- Intersection illumination



Example 2 - What CM would you propose?



	Observation	Improvement
119	Poor conspicuity of traffic signs	Install movement restriction signs and street name signs overhead on mast arms
131	Missing/damaged pedestrian push buttons	Install pedestrian push buttons (APS)
140	History of crashes related to wrong-way driving and improper turning	Add "Do Not Enter" signs at intersection
140	History of crashes related to wrong-way driving and improper turning	Add "Wrong Way" signs downstream of intersection
305	History of dark, not-lighted condition crashes; high pedestrian/bicycle volumes	Provide intersection safety lighting
401	Missing/damaged pavement markings	Refresh pavement markings
402	History of crashes involve collisions with parked cars; observed speeding due to excessive lane width	Add solid stripe for on-street parking lane
403	Missing/damaged pedestrian crosswalk	Install pedestrian crosswalk (high-visibility continental crosswalk)
404	History of crashes related to wrong-way driving and improper lane changes	Install type II-C-R RPMs
407	Missing/damaged sidewalks	Install sidewalks
610	Poor conspicuity of traffic signal heads	Install backplates with retroreflective borders
617	Parked cars obstruct sight distance for right-turning vehicles and reduce visibility of pedestrians at crossing locations	Restrict parking within 30' of intersection
A	History of crashes involve collisions with parked cars; angled parking located within functional area of intersection requires backing into travel lane with limited sight distance	Convert angled parking to parallel, curb cut-back, or off-street parking
509	On-street parking; high pedestrian/bicycle volumes; poor visibility at crossing location	Construct curb extensions

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CITY OF GALVESTON
INTERSECTION SAFETY ASSESSMENTS

AVE O • 39TH ST

DATE	EXHIBIT	PAGE
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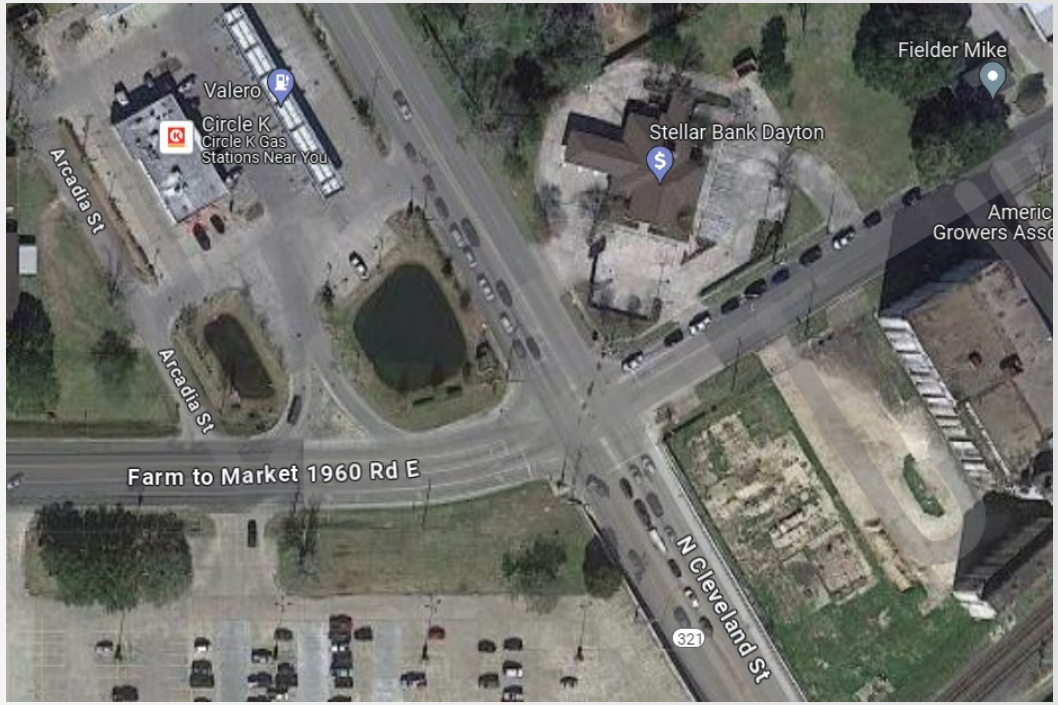
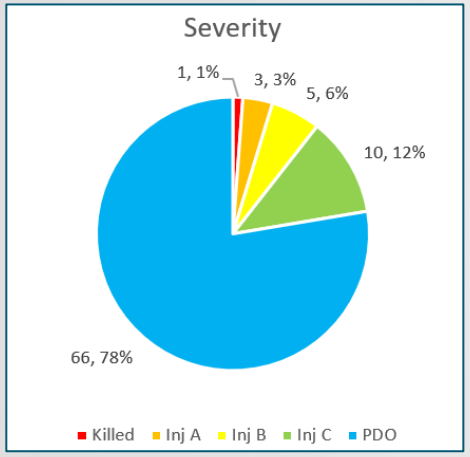
Countermeasure Selection Example 3

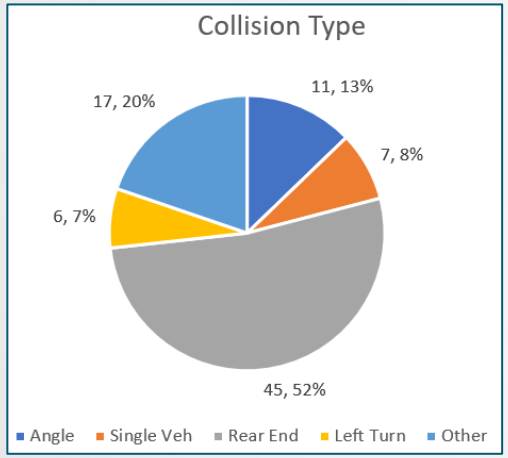
- Urban road
- Speed limit: 35 (FM 1960) & 45 (Hwy 321) mph
- Signal-controlled
- AADT: 15,000 (FM 1960) & 20,700 (Hwy 321)
- Safety illumination
- Business on all corners



Example 3 – Crash History

- Total recorded crashes: 86 (5-year)
- Predicted crashes: 15 (5-year)
- 15 driveway-related crashes
- K crash due to police chase





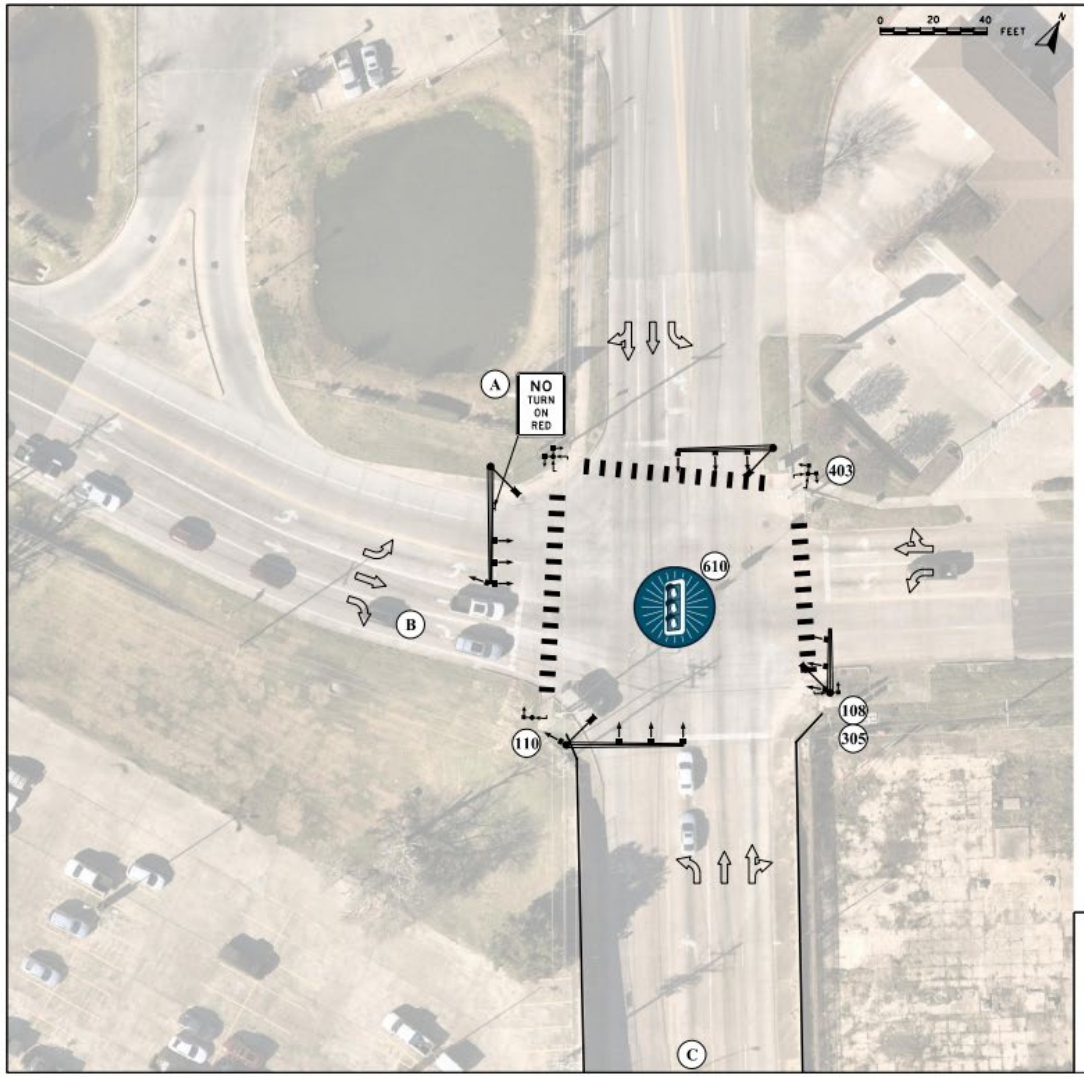
Example 3 - Why are these crashes happening?

- Speeding
- Disregard signal
- Diver inattention/impatience
- High traffic volume
- Presence of driveways

Example 3 - What CM would you propose?

- Signal timing
- Yellow and red clearance time
- Increase signal conspicuity
- Install ped signals/crosswalks
- Consolidate/relocate driveways

Example 3 - What CM would you propose?



	Observation	Improvement
108	Existing Z-span signal with signal heads not aligned with travel lanes	Rebuild traffic signal as mast arm; consider near-side head for EB approach
110	Sidewalk and curb ramps present but no crosswalk striping or pedestrian signal elements observed	Install pedestrian signal elements and phasing
305	Pattern of crashes occurring during dark, unlighted conditions; queuing spills into underpass	Improve intersection and underpass lighting
403	Sidewalk and curb ramps present but no crosswalk striping or pedestrian signal elements observed	Install pedestrian crosswalk striping
610	Existing backplates without retroreflective borders; retroreflective backplates are proven to reduce crashes	Install backplates with retroreflective border
A	Retaining wall restricts sight distance from WB approach	Restrict right-turn on red from WB approach
B	Could provide additional EB right-turn capacity	Provide right-turn overlap for EBR
C	Queuing at intersection of SH 321 at US 90 (<1,000 feet south) interferes with operations at SH 321 at FM 1080/FM 1960	Review signal timing at SH 321 at US 90

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INTERSECTION SAFETY ASSESSMENTS

HWY 321 • FM 1008

DATE	EXHIBIT	PAGE
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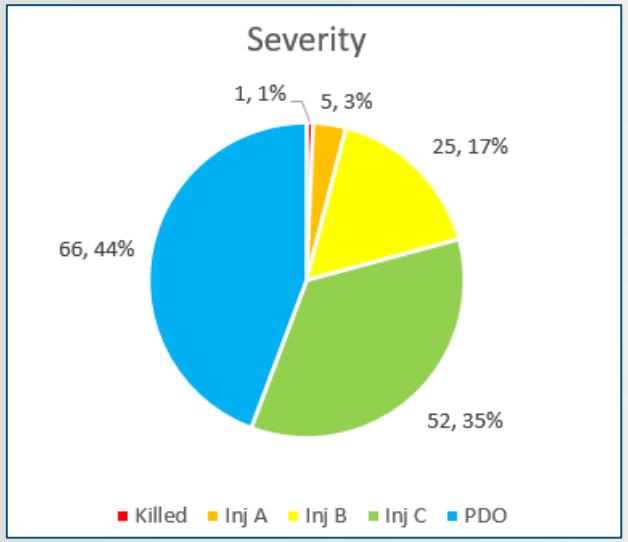
Countermeasure Selection Example 4

- Urban diamond interchange
- Speed limit: 35 (Crosstimbers) & 45 (FR) mph
- Signal-controlled
- AADT: 12,000 (Crosstimbers) & 3000/7000 (FR)
- Bike lanes

Example 4 – Crash history

- Total recorded crashes: 149 (5 -year)
- K: angle crash at west terminal (SB -WB)
- 60% angle and 16% rear end crashes



Row Labels	NORTH	SOUTH	WEST	Grand Total
EAST	20	36		56
NORTH			6	6
SOUTH			15	15
SOUTHWEST			1	1
Grand Total	**20**	**36**	**22**	**78**

Example 4 - Why are these crashes happening?

- Speeding
- Disregard signal
- Diver inattention/impatience

Example 4 - What CM would you propose?

- Signal timing
- Yellow and red clearance time
- Increase signal conspicuity
- Law enforcement

Economic Appraisal is…

"performed to compare the benefits of potential crash countermeasure to its project costs."

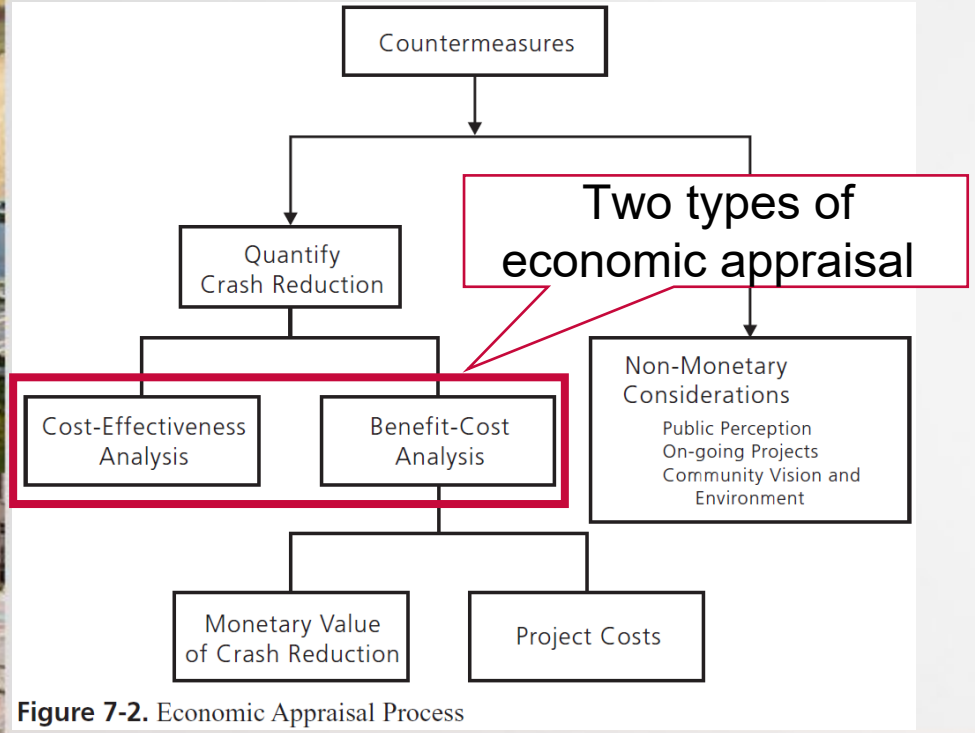


Figure 7-2. Economic Appraisal Process

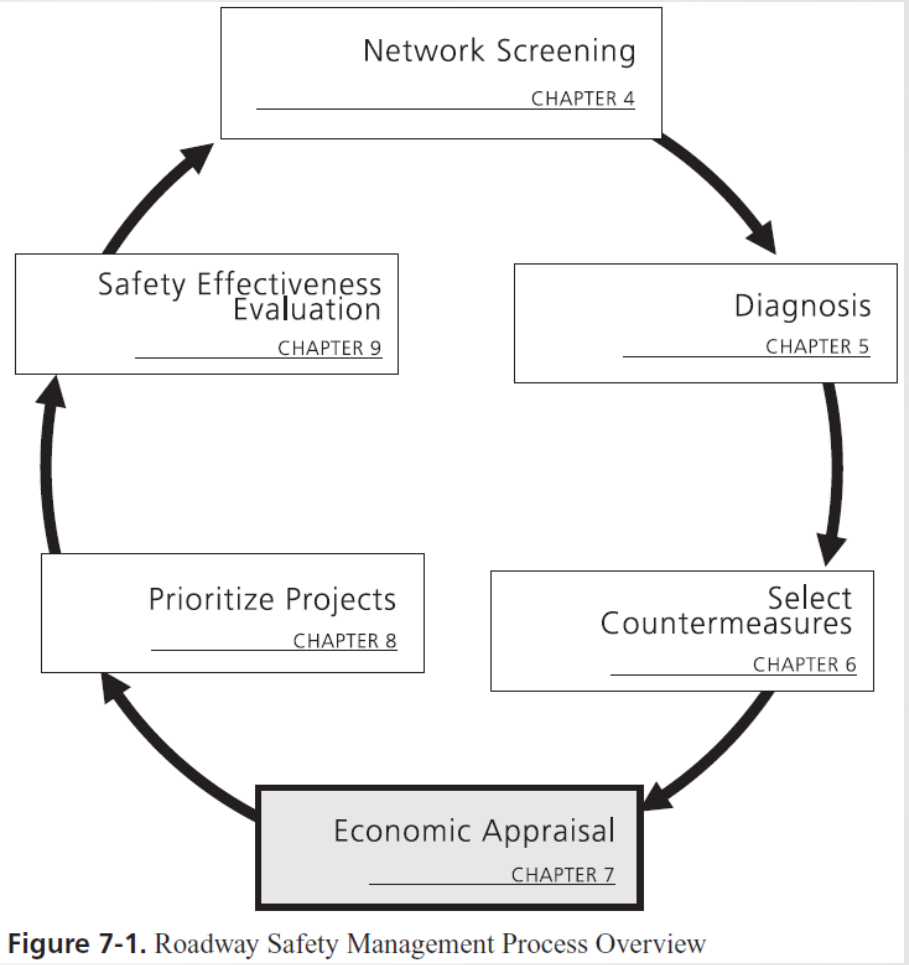
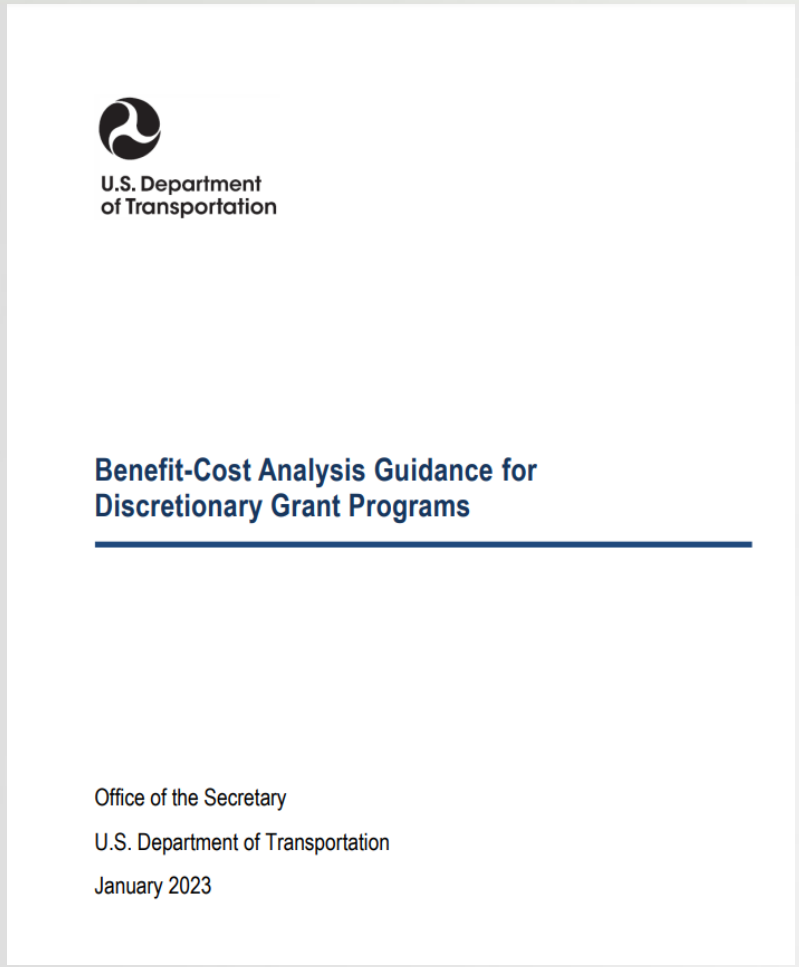


Figure 7-1. Roadway Safety Management Process Overview

Benefit - Cost Analysis (BCA)

- Benefit-cost ratios (B/C) indicate the cost effectiveness of a project.
- Safety benefits are the monetized value of annual savings in preventable crash costs, reported in present value.
- Costs primarily refer to construction cost.
- While B/C does not establish the need (or lack of need) for a project, it can be a useful tool for comparison and prioritization of projects.

BCA Methodology - USDOT



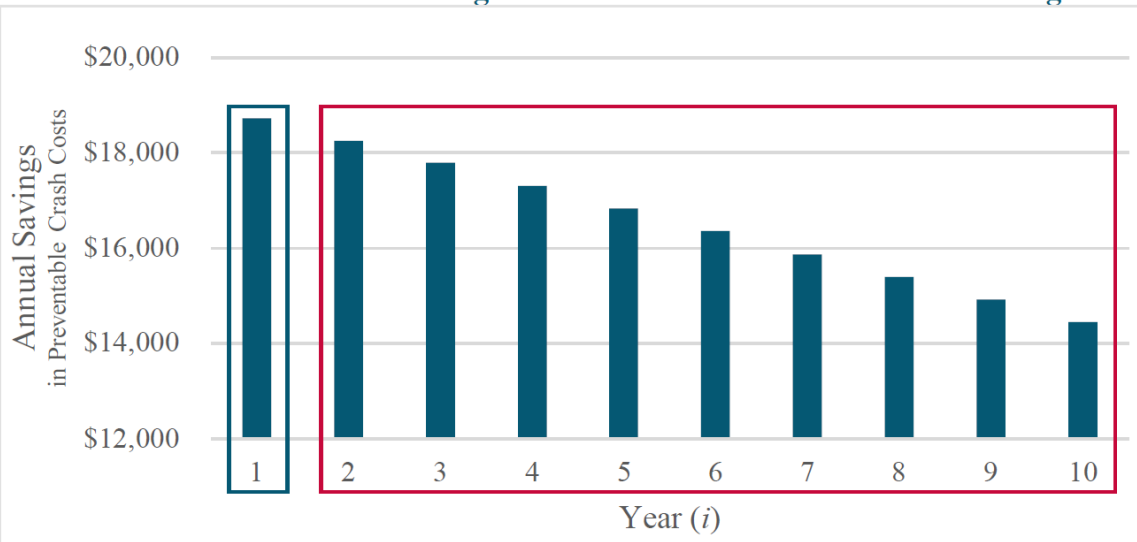
BCAs are often a component of funding applications, as a tool for prioritizing projects. Therefore, the BCA methodology should align with the funding provider (USDOT, TxDOT, H-GAC).

BCA Methodology - HSIP

Safety Benefits (B) = The monetary benefit of a safety improvement is equal to the cost of crashes prevented by the improvement.

The present worth of project benefits over its service life (B) is the amortized sum of annual savings (S).

Figure 3-1 – Present Value of Annual Savings



Year (*i*)	Annual Savings (S)
1	$18,713
2	$18,250
3	$17,780
4	$17,305
5	$16,827
6	$16,347
7	$15,868
8	$15,390
9	$14,916
10	$14,446
Total (B)	**$165,854**

$3,700,000	(K) Fatal crash
$3,700,000	(A) Incapacitating Injury Crash
$520,000	(B) Non-Incapacitating Injury Crash

$$S = \frac{R(CfF + CiI)}{Y} - M \qquad Q = \left(\frac{Aa - Ab}{Ab} \div L\right) S$$

$$B = \frac{S + \frac{1}{2}Q}{1.06} + \sum_{i=2}^{L} \left[\frac{\left(S + \frac{1}{2}Q\right) + (i-1)Q}{(1.06)^i}\right]$$

$$SII = \frac{B}{C}$$

Source: TxDOT's HSIP guidelines (year 2021)

Economic Appraisal - Implementation

Key Ingredients

Fundamentals	• Familiarity with FHWA's RSA process • Early coordination of field review schedule • Frequent and clear communication with RSA team • Timely production of RSA recommendations/report
Technical Expertise	• Expertise with safety countermeasures and intersection design /operations
Local Knowledge	• Familiarity with RSA locations, agency staff , and agency design preferences

Survey – Training Evaluation


Thank You!


Regional Collaboration • Transportation Planning • Multimodal Mobility

METROPOLITAN PLANNING ORGANIZATION