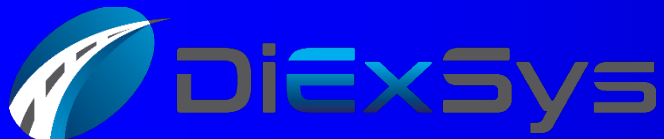




Data Driven Approach to Solving Roadway Safety Problems at Arkansas DOT

Jake Kononov, P.E. Ph.D.



How to Measure Safety

Jake Kononov, P.E. Ph.D.

In Order to Manage Safety Effectively,
We Need to be Able to Measure it

How much Safety can we Expect?

How Many Crashes are too Many?

How much Safety for how much Money
can we Obtain?

How To Measure Safety?

Crash Rate is
the Most Common
Measure of Safety

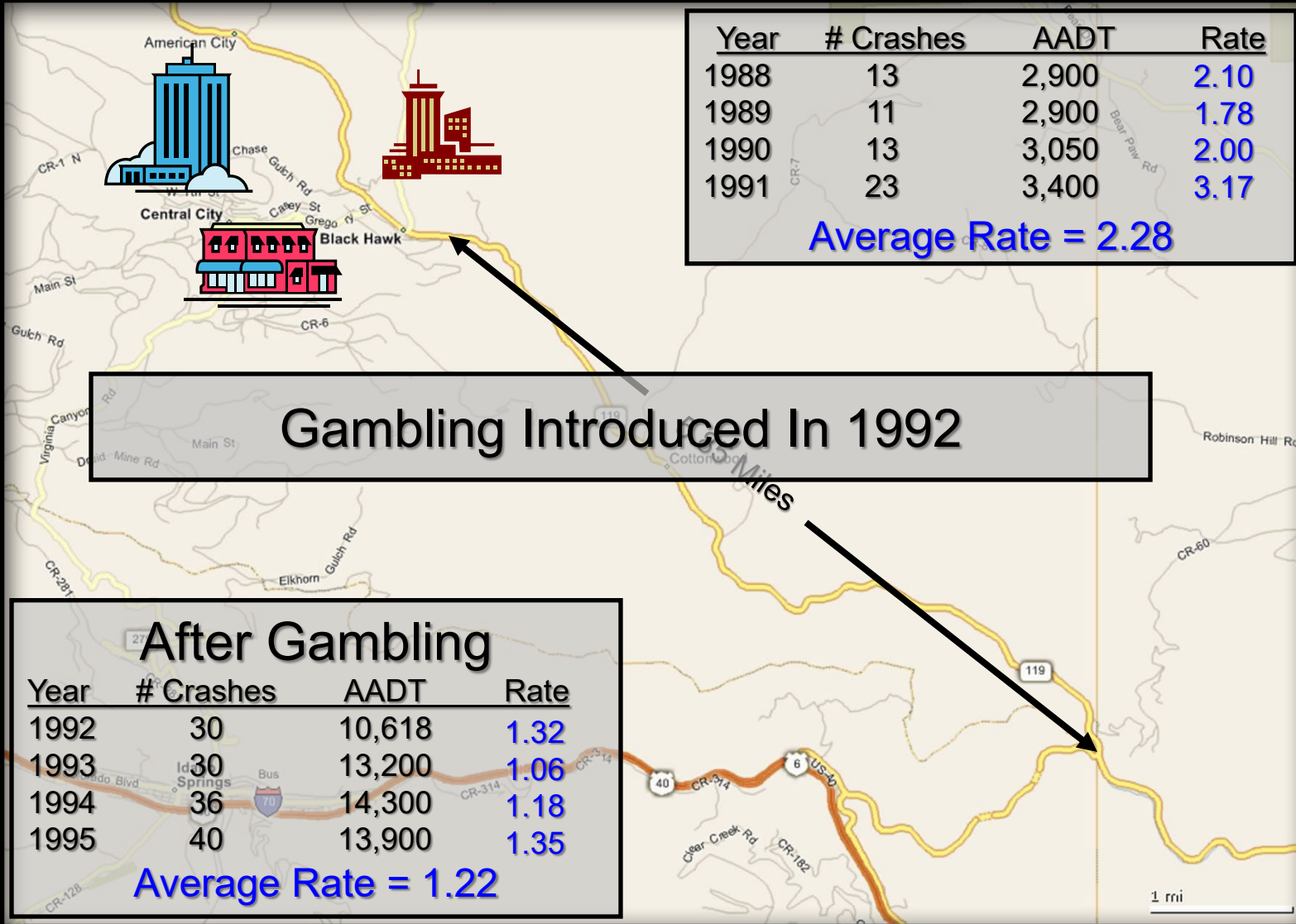
How to Measure Safety

$$\text{Rate} = \frac{\text{\#Crashes} \times 1,000,000}{\text{AADT} \times 365 \times \text{Length}}$$

The general idea is that safety improves as the crash rate decreases

Let's Examine Its Application...

How to Measure Safety

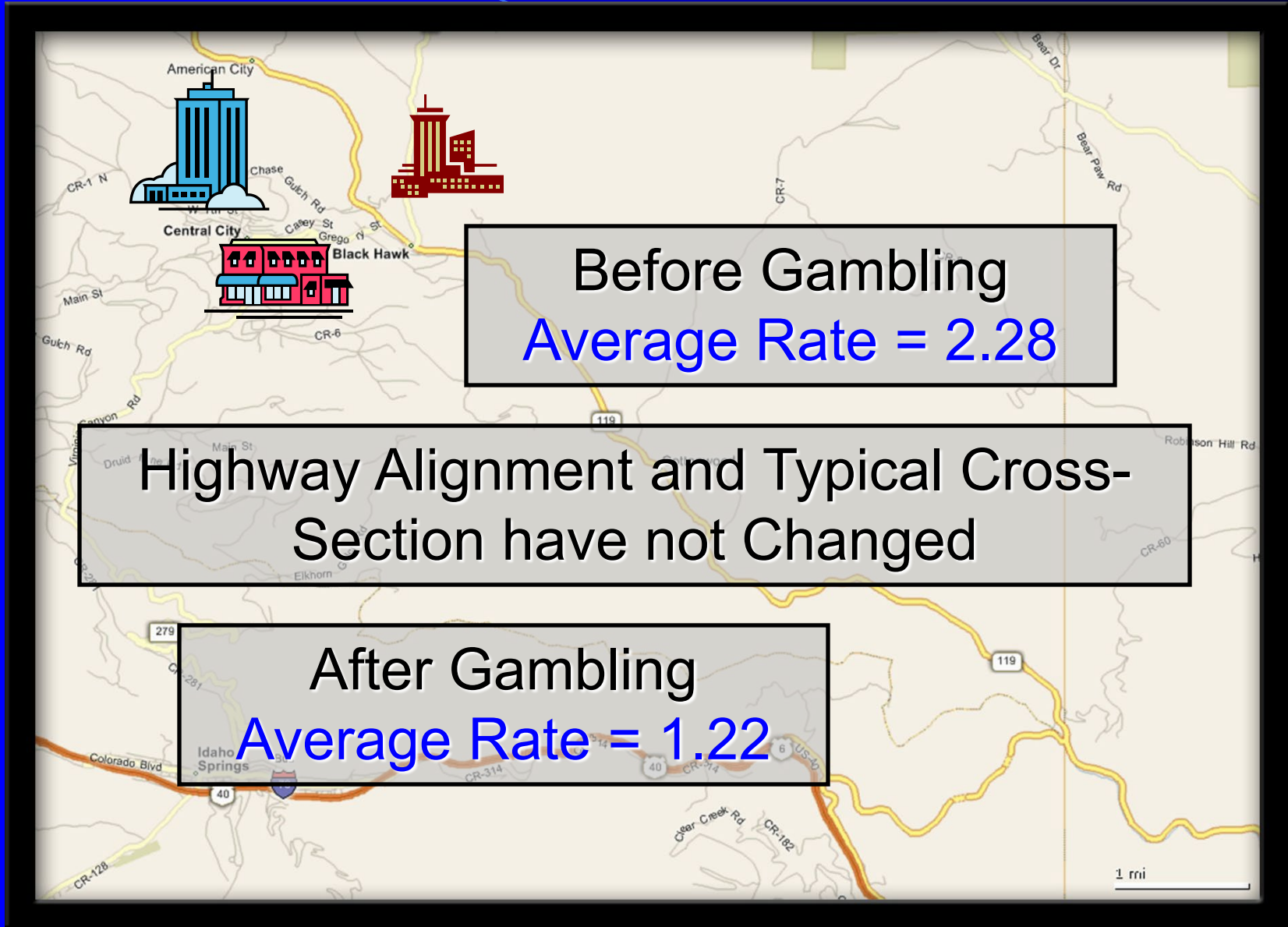


Year	# Crashes	AADT	Rate
1988	13	2,900	2.10
1989	11	2,900	1.78
1990	13	3,050	2.00
1991	23	3,400	3.17
			Average Rate = 2.28

Gambling Introduced In 1992

After Gambling			
Year	# Crashes	AADT	Rate
1992	30	10,618	1.32
1993	30	13,200	1.06
1994	36	14,300	1.18
1995	40	13,900	1.35
			Average Rate = 1.22

How to Measure Safety



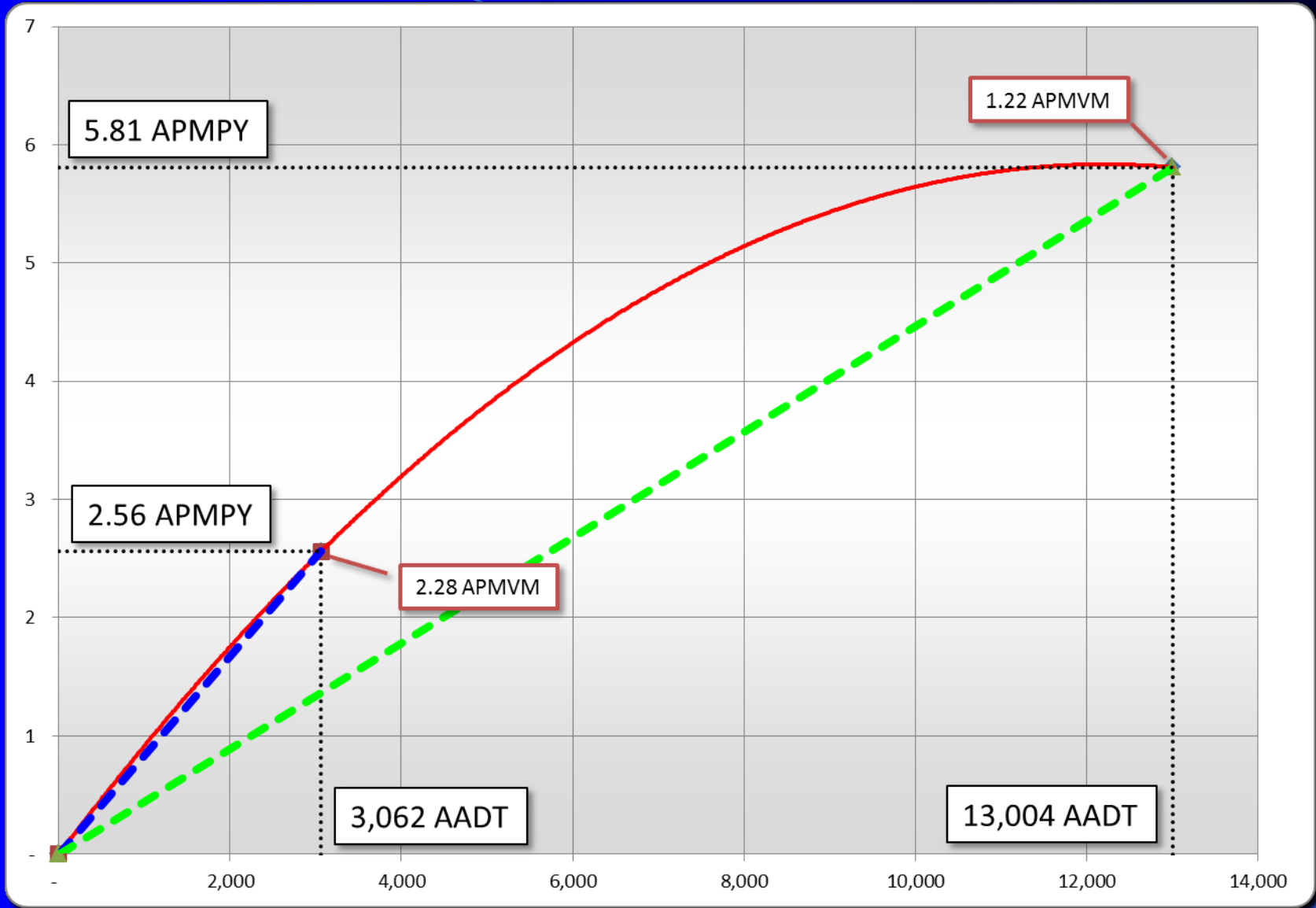
How to Measure Safety

After the Introduction of Gambling, the % of Crashes Involving Alcohol increased 500%.

Is Drinking and Driving in Concert with Gambling Good for Safety?

Probably not, but if Crash Rates are Used as a Measuring Device One Would have to Conclude that it is.

How to Measure Safety



Clearly the Rate is Changing with AADT

In Order to Understand how the Crash
Rate is Changing, We need to
Develop a Relationship between
Safety and Traffic Exposure

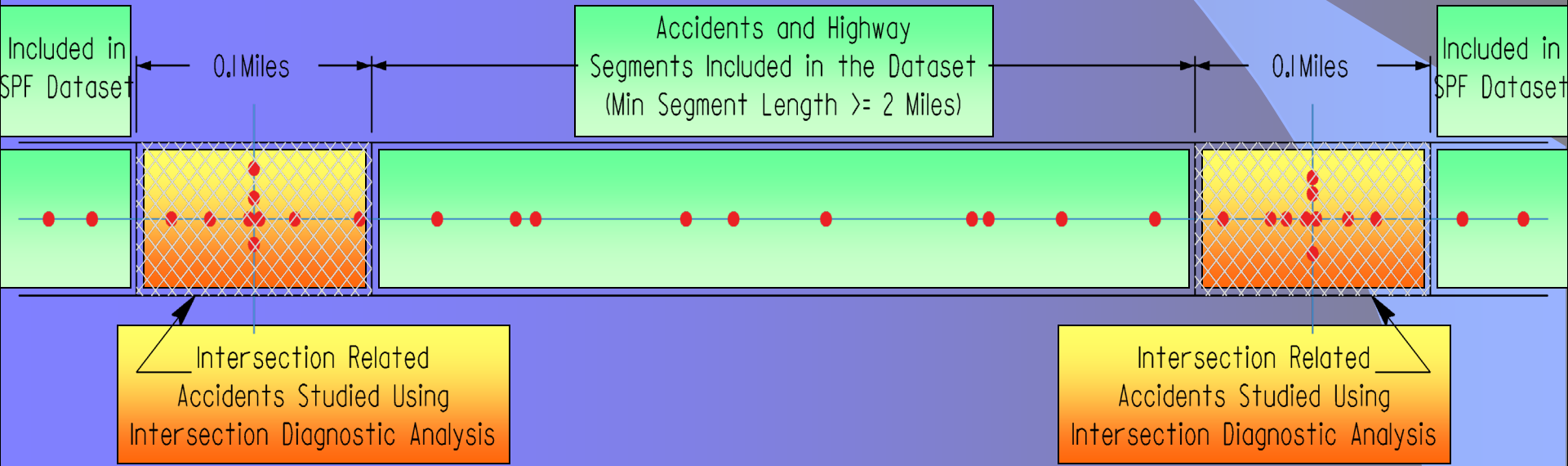
This Relationship is Reflected by,
Safety Performance Function
(SPF)

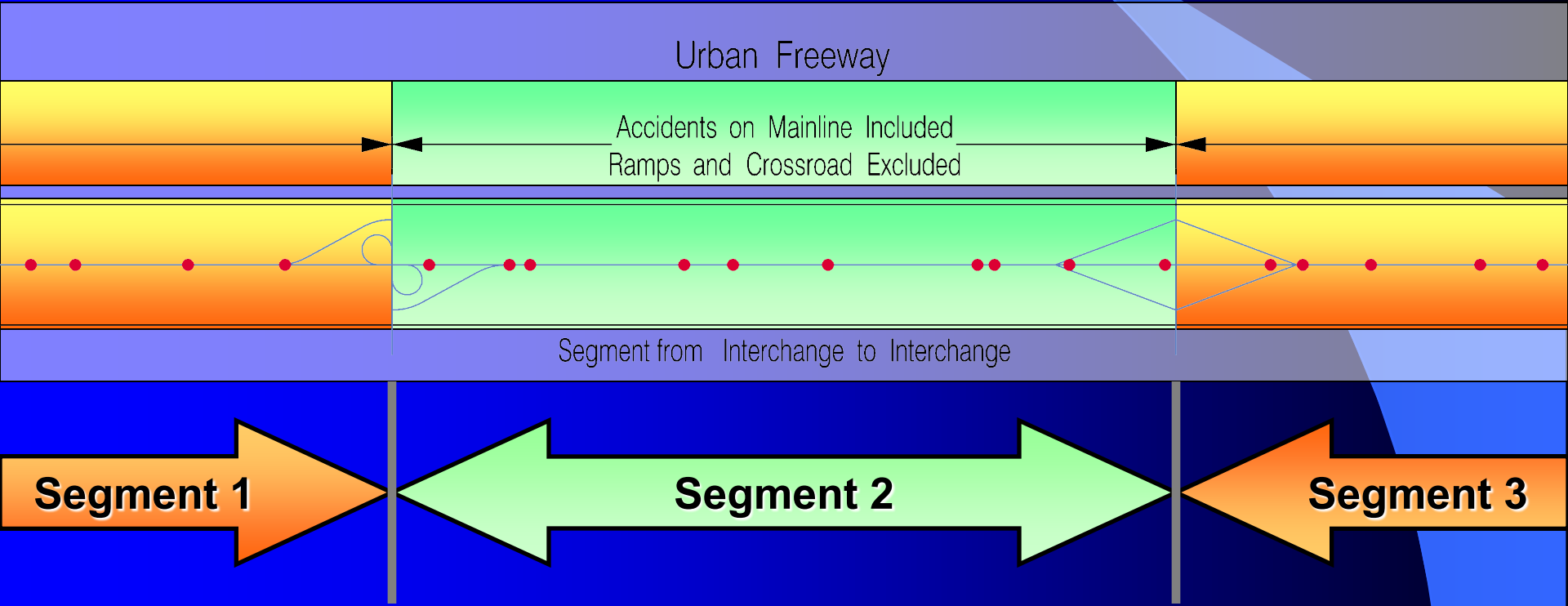
Development of Safety Performance Functions in Rural and Urban Environments

*Jake Kononov, P.E. Ph.D.
Bryan K. Allery, P.E.*

Dataset Preparation

2-Lane Rural Arterial

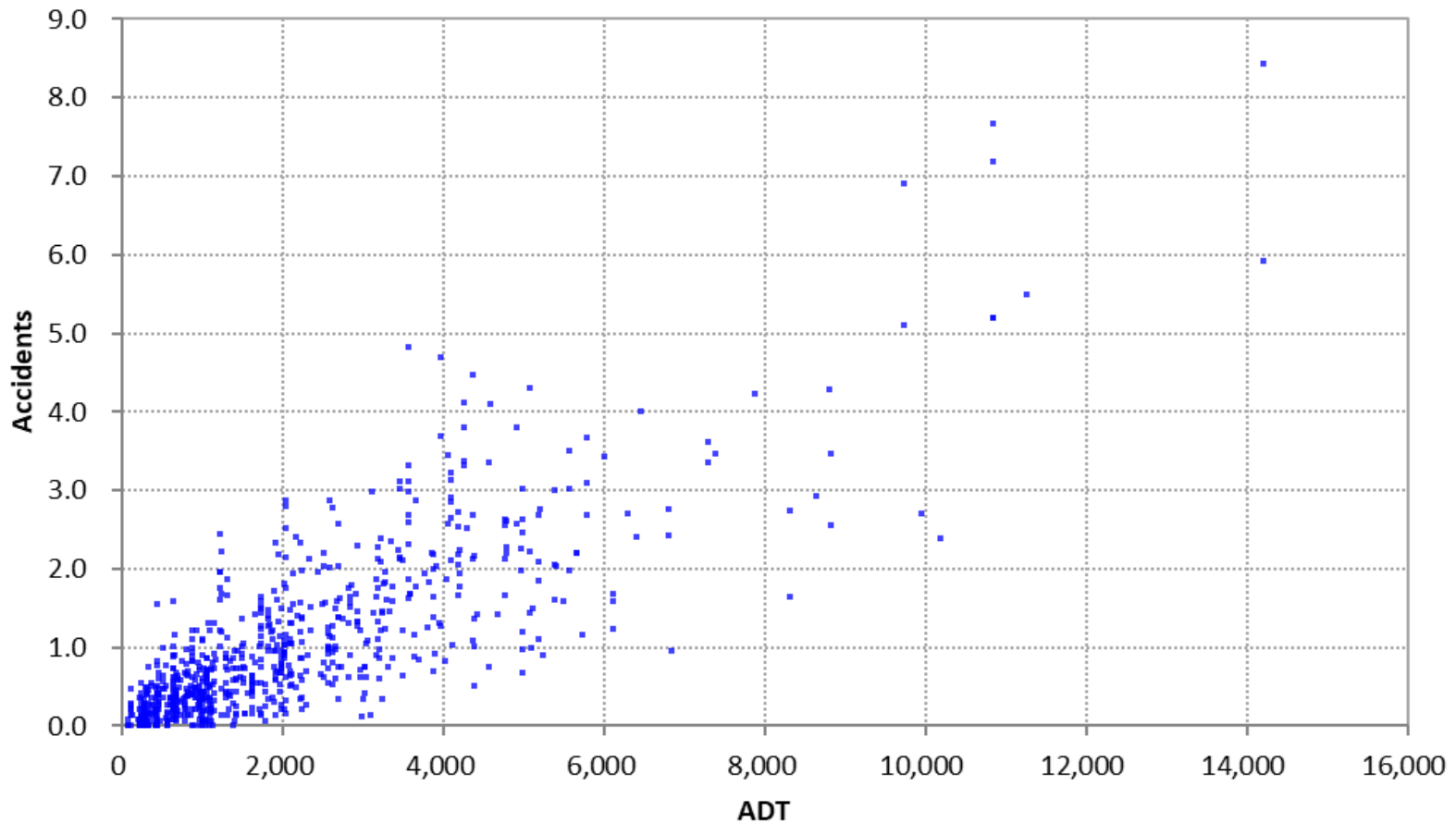




Rural Mountainous 2-Lane Highway LOSS/SPF Graph

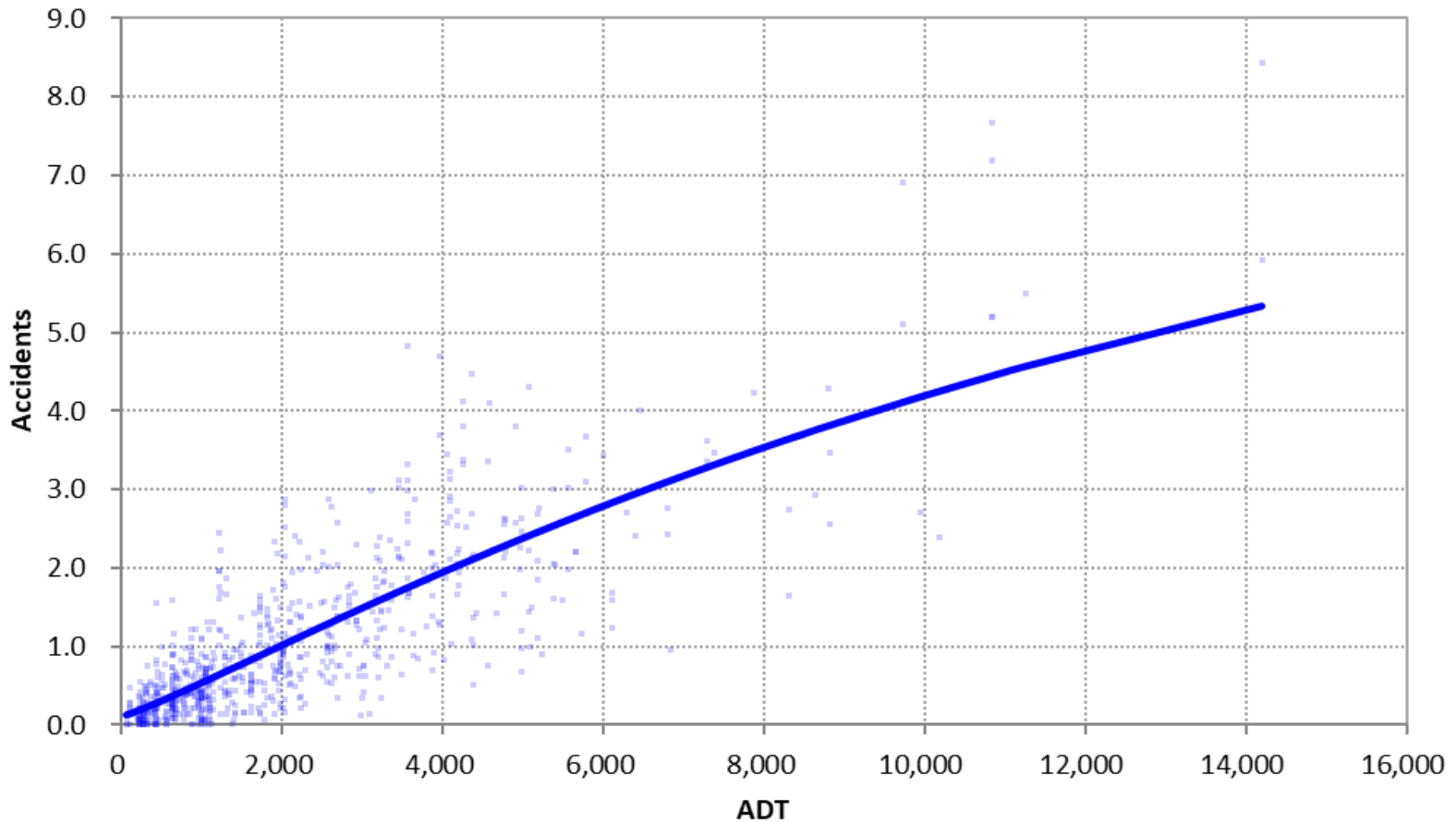
Colorado Rural Mountainous 2-Lane Highway

Total Crashes



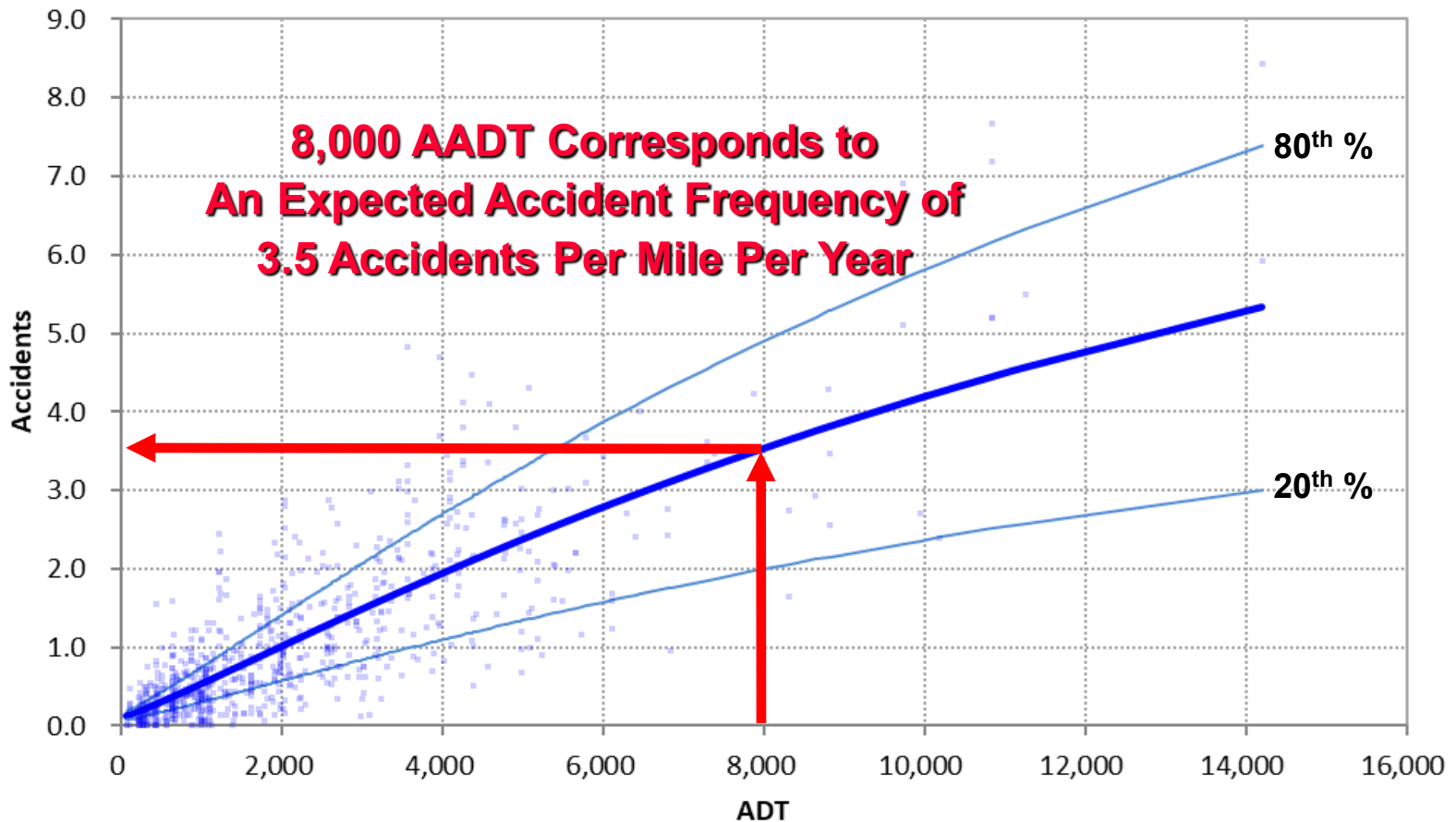
Colorado Rural Mountainous 2-Lane Highway

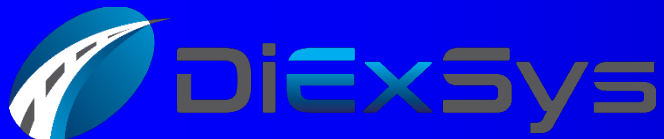
Total Crashes



Colorado Rural Mountainous 2-Lane Highway

Total Crashes

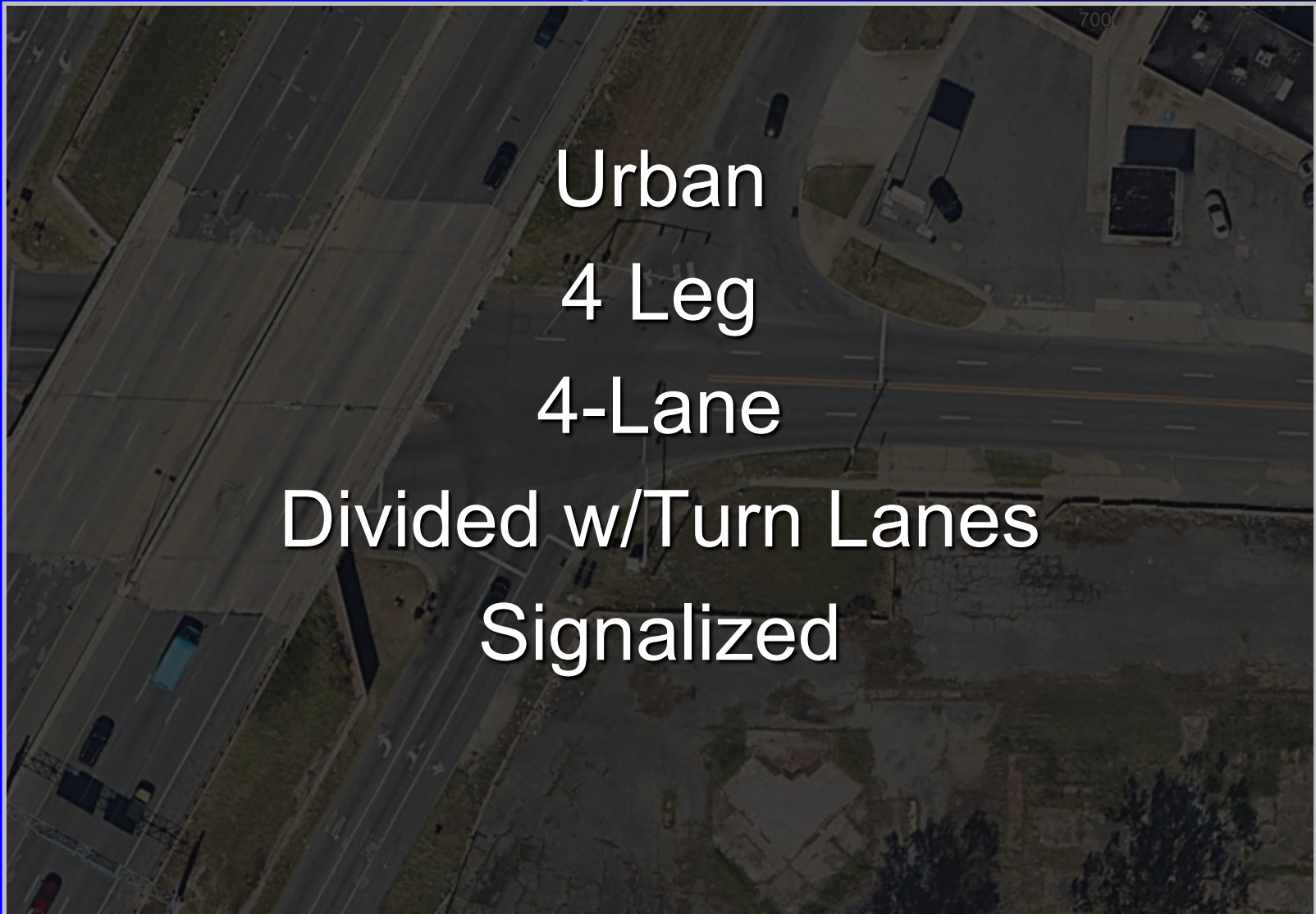




Safety Performance of Signalized Intersections

*Jake Kononov, P.E. Ph.D.
Bryan K. Allery, P.E.*

Signalized Intersection Roosevelt and I-30 E Frontage



Signalized Intersection Roosevelt and I-30 E Frontage

2018 to 2024

Mainline AADT = 24,000

Side Road AADT = 12,000

7 Year Crash History

PDO = 101

INJ = 64

FAT = 0

9.1 Crashes(Inj + Fat)/Year

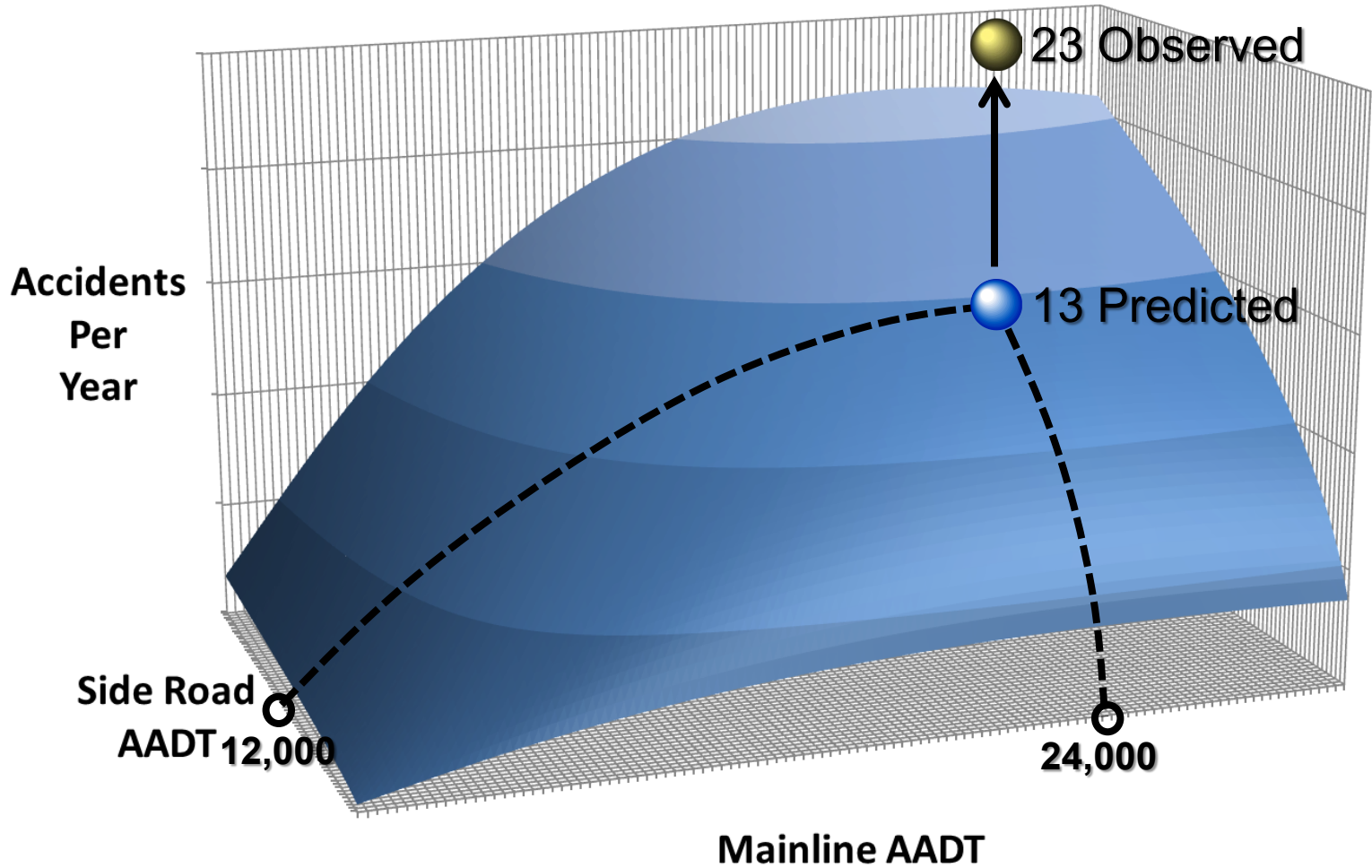
23.6 Crashes(Total)/Year

Do We Have a Safety Problem?

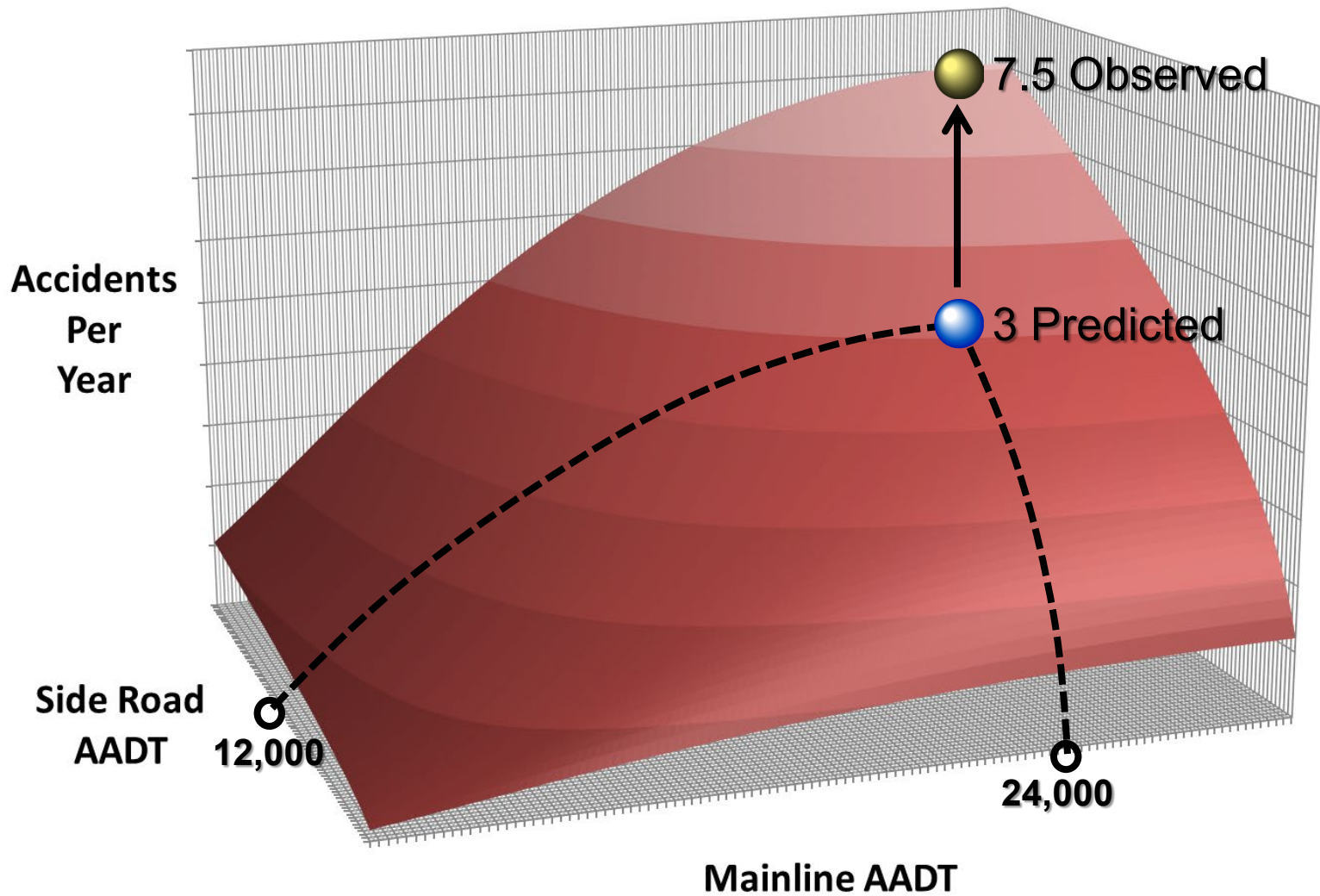
The Safety Performance Function of an Intersection can be viewed Mathematically as a 3-Dimensional Response Surface, where:

$$\# \text{ Crashes/Year} = f(ADT_{\text{Mainline}}, ADT_{\text{Side Road}})$$

Intersection SPF (Total)

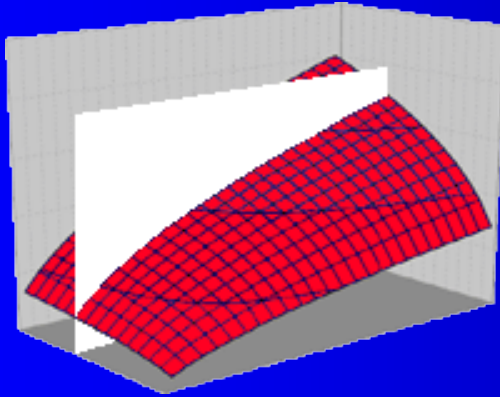


Intersection SPF (Severity)

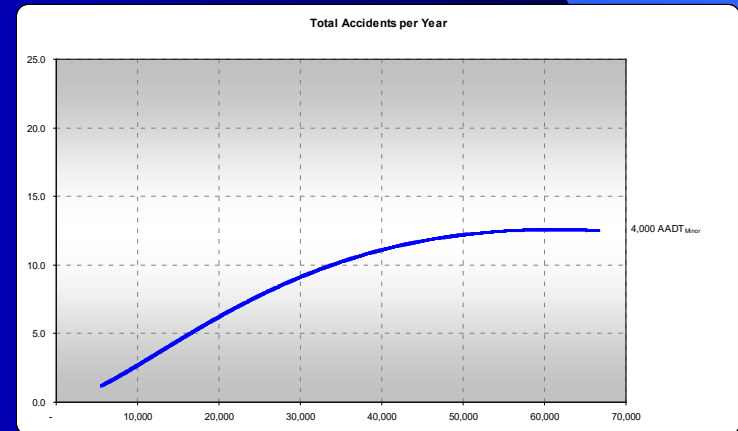
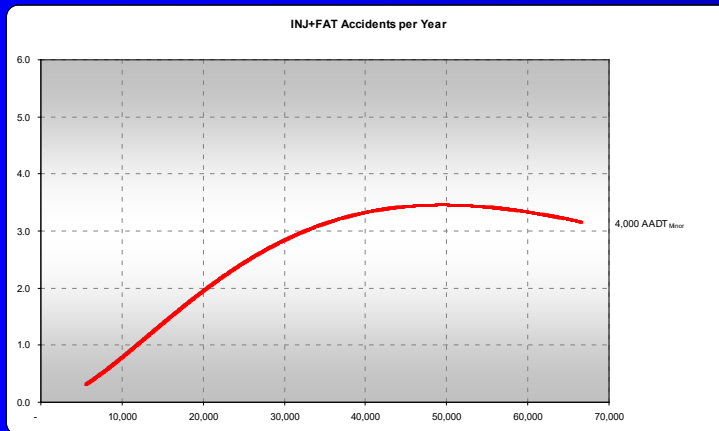
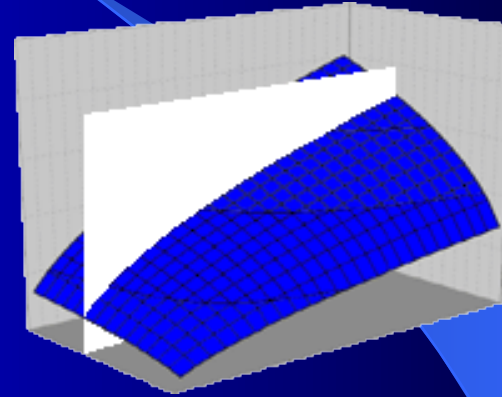


SPF Response Surfaces and Slice Graph

Injury + Fatal



Total

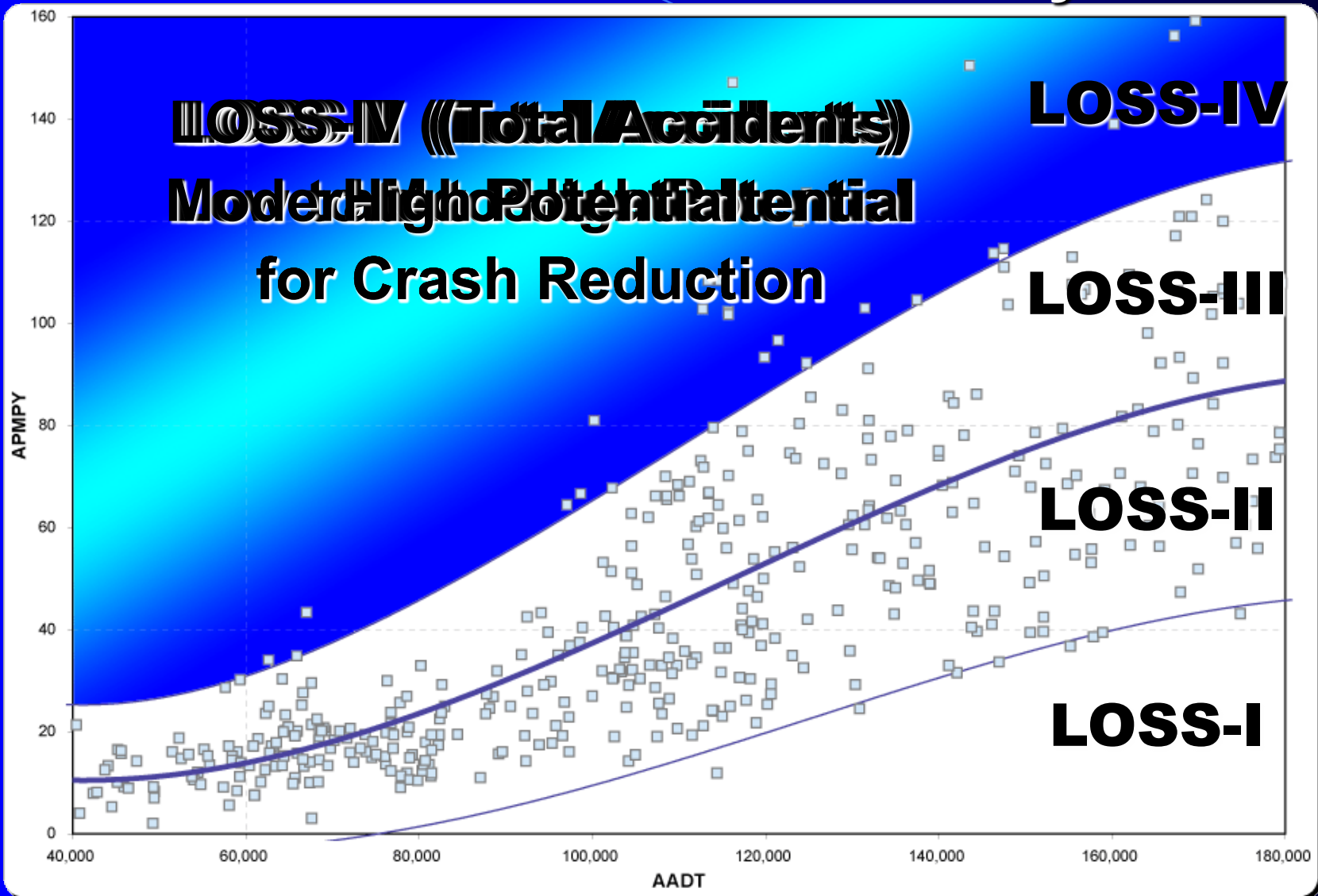


Level of Service of Safety (LOSS) Analysis

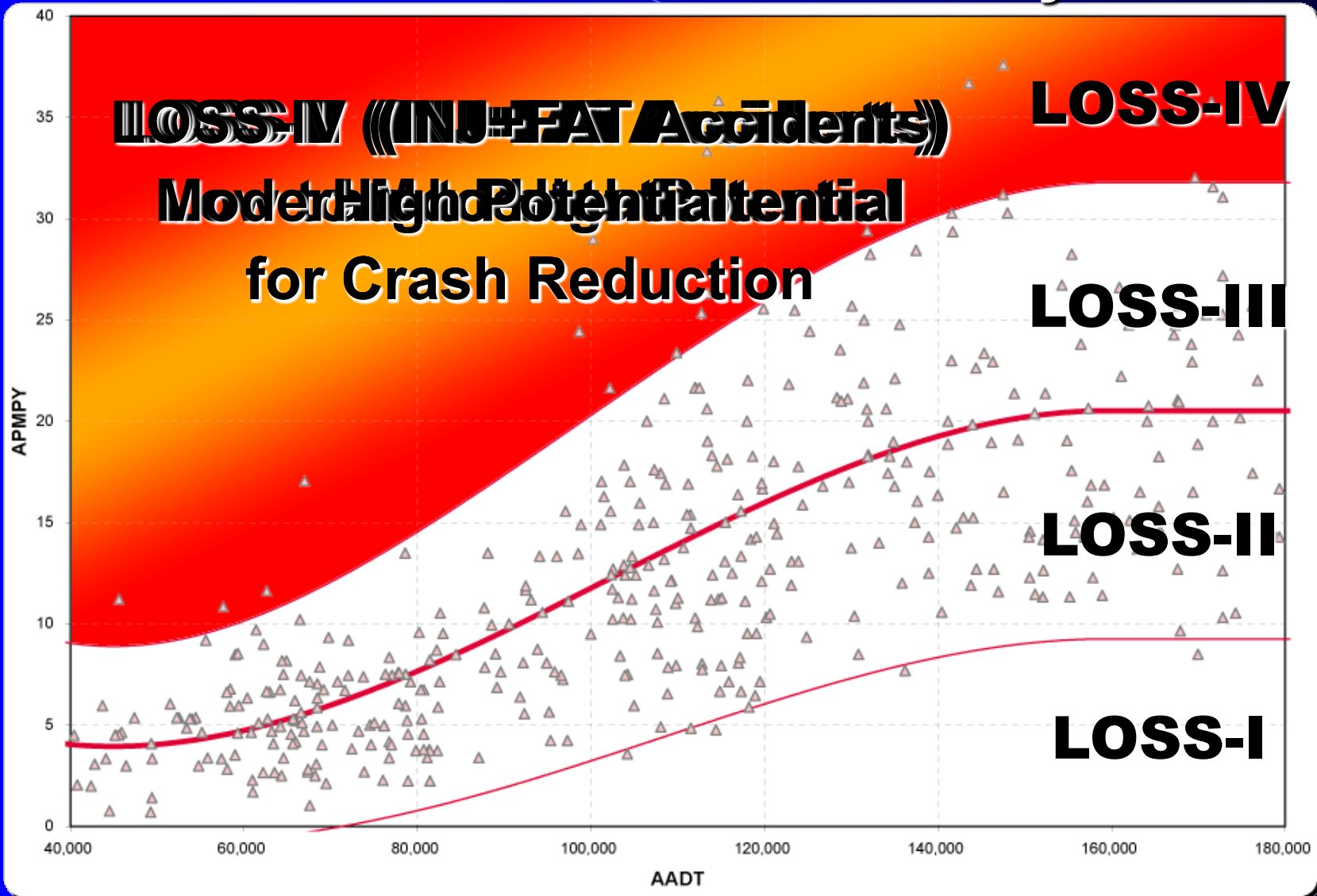
*Jake Kononov, P.E. Ph.D.
Bryan K. Allery, P.E.*

Level of Service of Safety (LOSS)
on Every Segment or Intersection
is Described from the Perspective
of Both Frequency and Severity

Urban 6-Lane Freeway



Urban 6-Lane Freeway



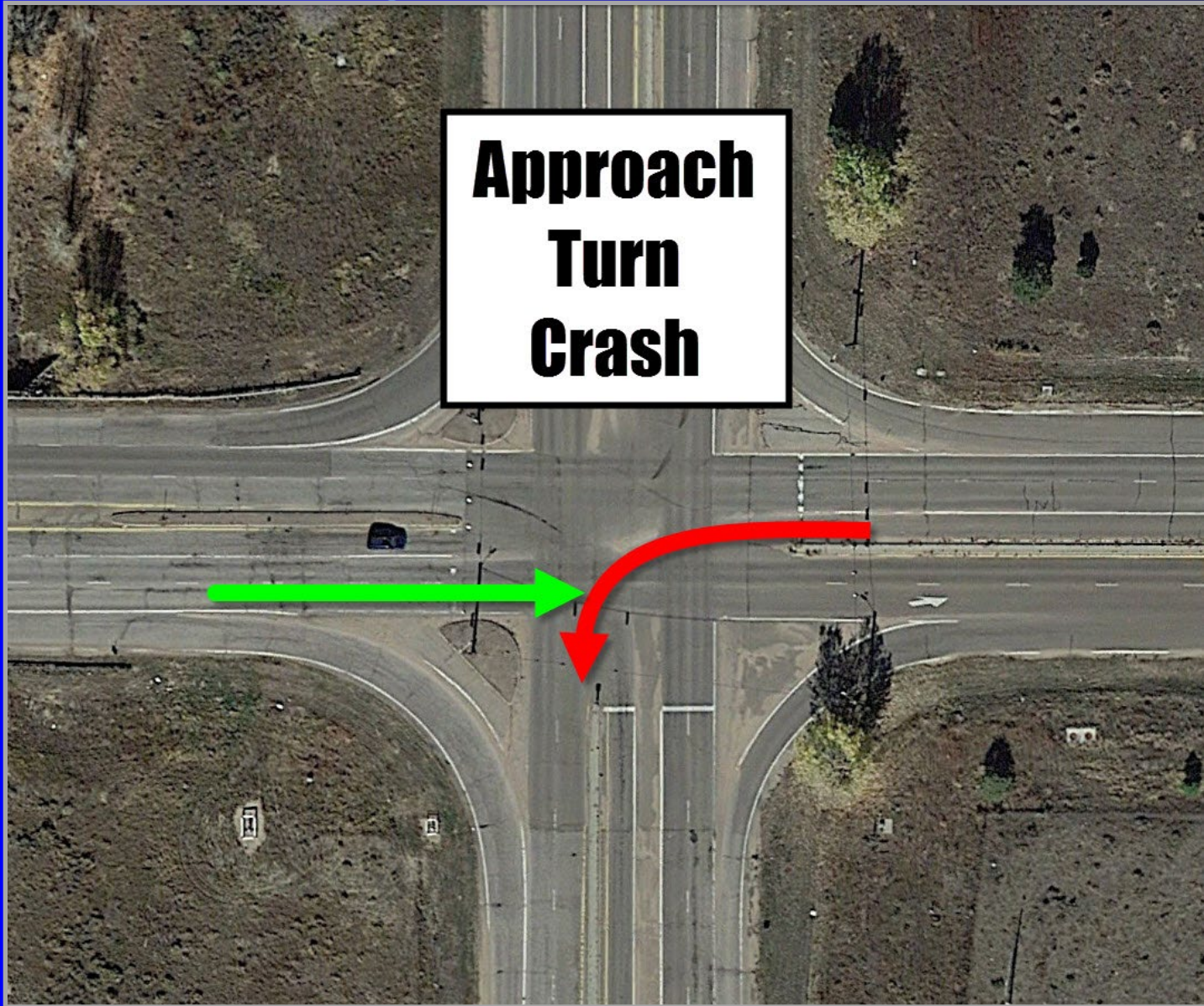
Why is Level of Service of Safety (LOSS) Concept Needed?

- Quantitatively Assesses and Qualitatively Describes the Degree of Safety or Un-Safety of a Roadway Segment or Intersection
- Communicate the Magnitude of Safety Problem of a Roadway Segment or Intersection to Other Professionals, Elected Officials, Law Enforcement, the Press, or the Traveling Public

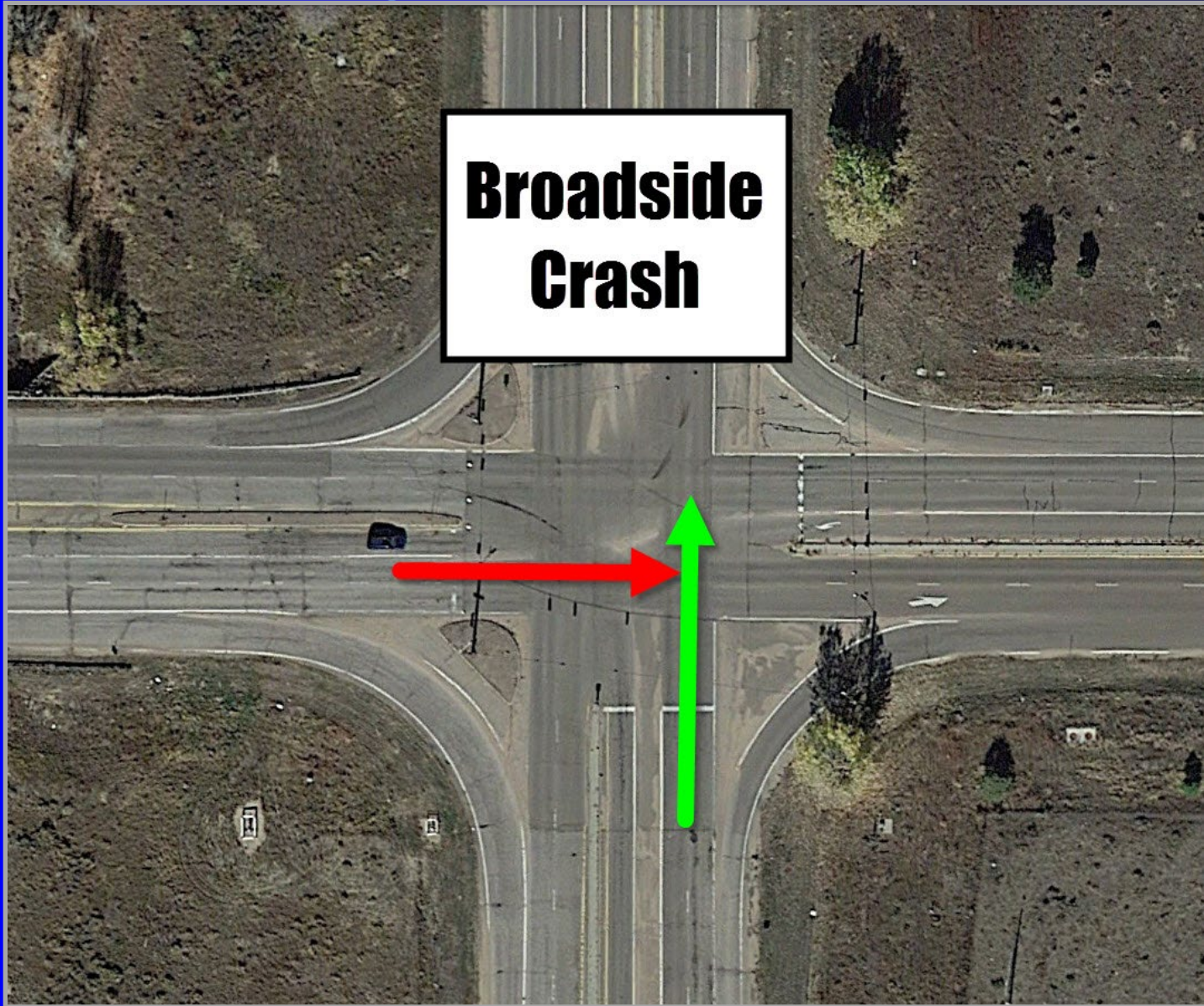
Typical Intersection Crash Type Pie Chart

*Jake Kononov, P.E. Ph.D.
Bryan K. Allery, P.E.*

Crash Types

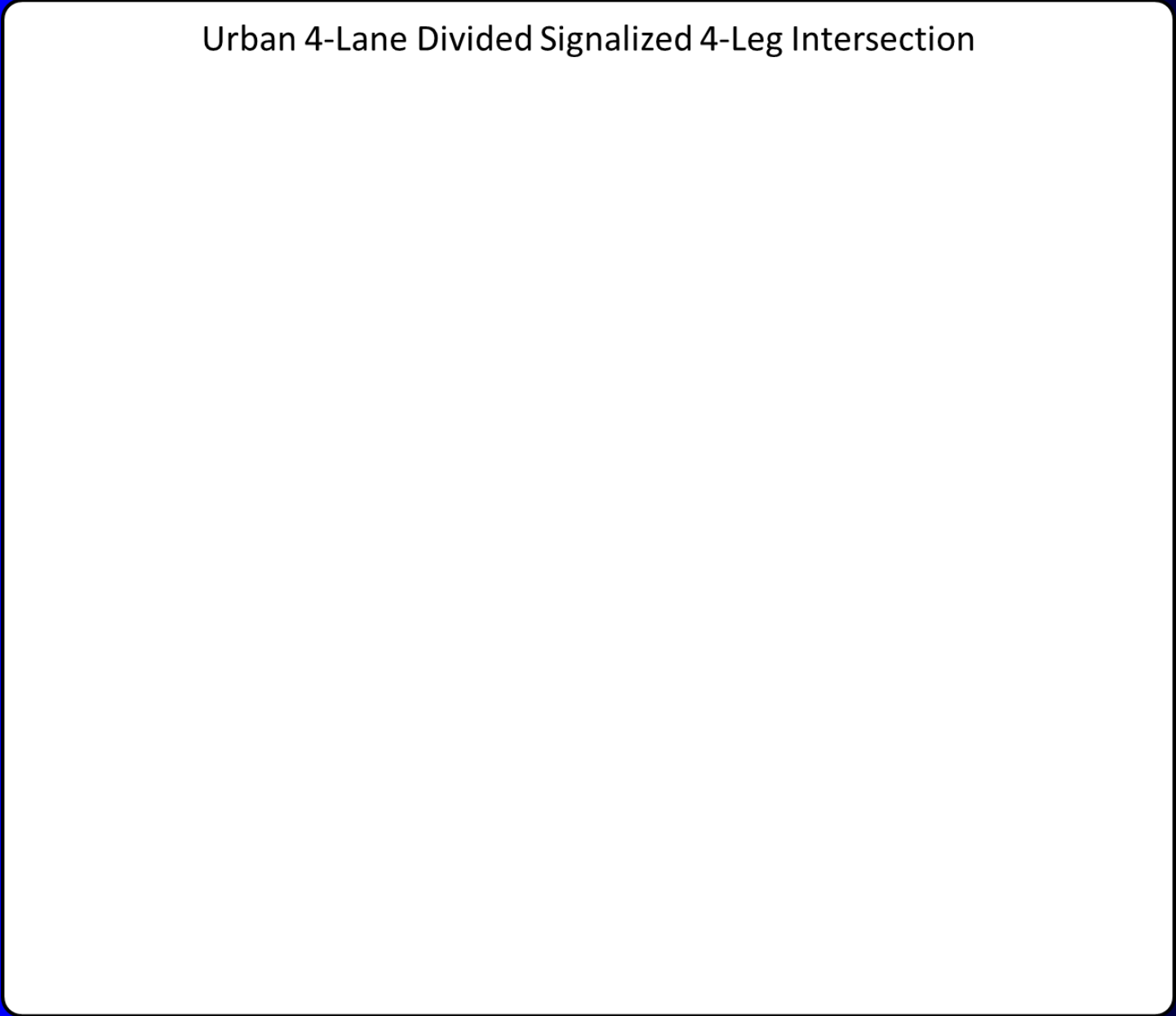


Crash Types



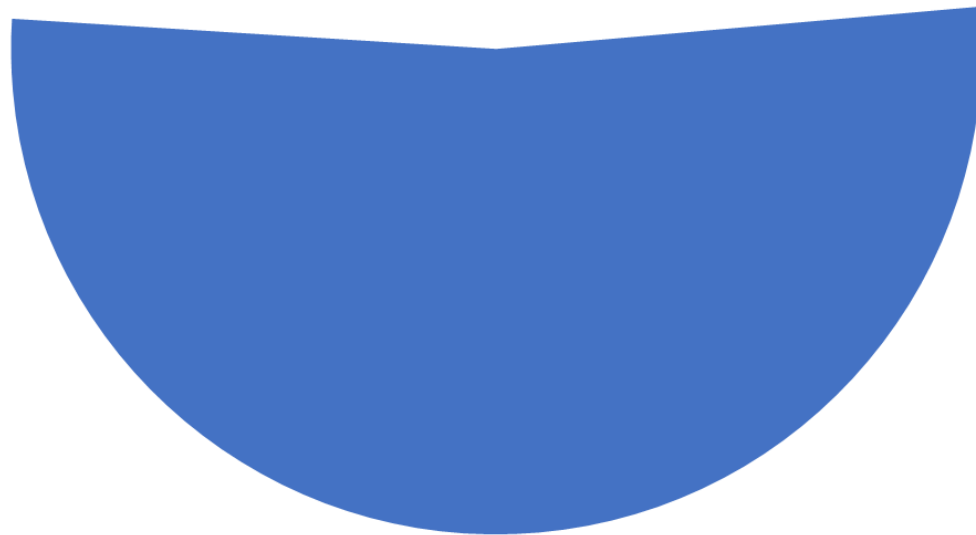
Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection



Typical Intersection Pie Chart

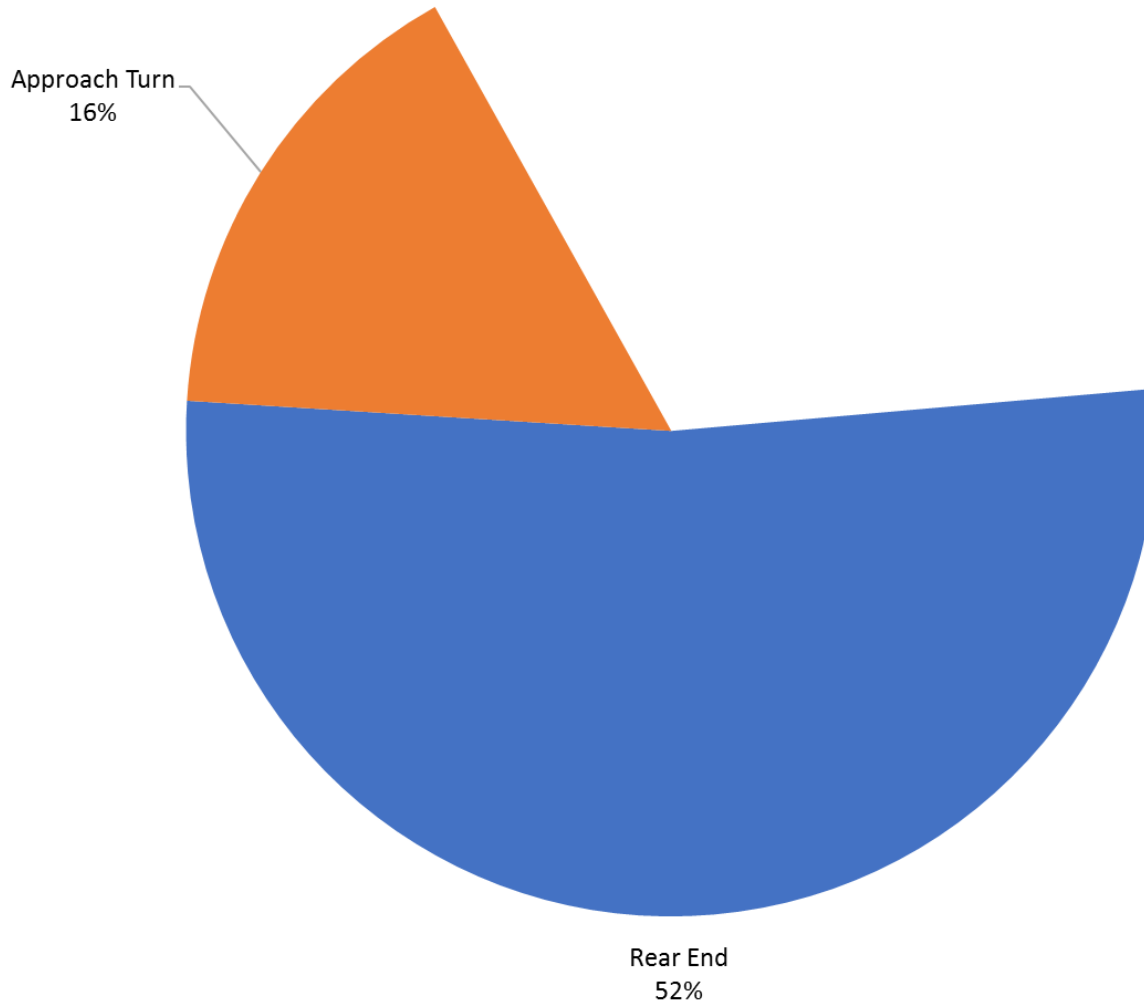
Urban 4-Lane Divided Signalized 4-Leg Intersection



Rear End
52%

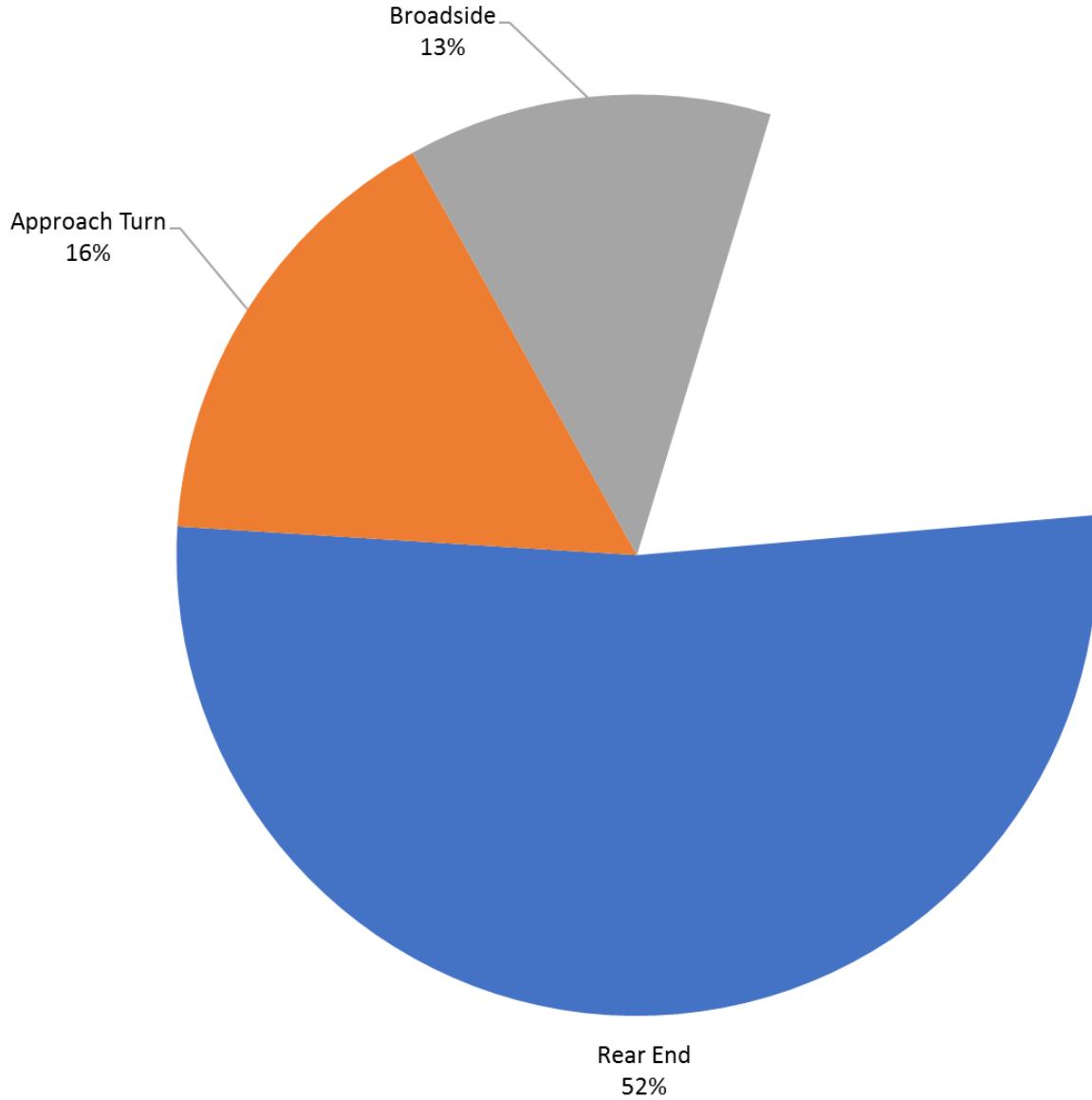
Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection

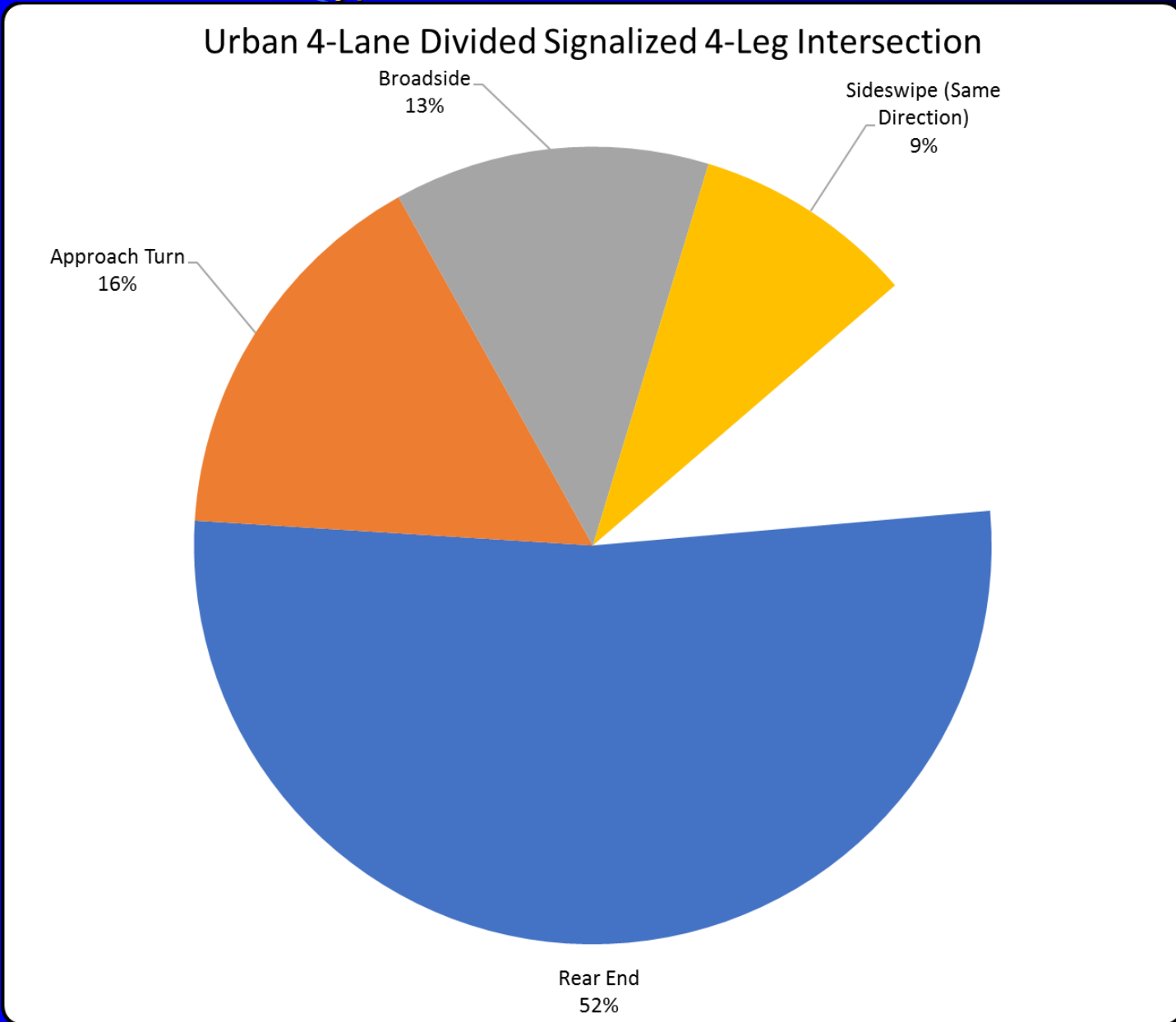


Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection

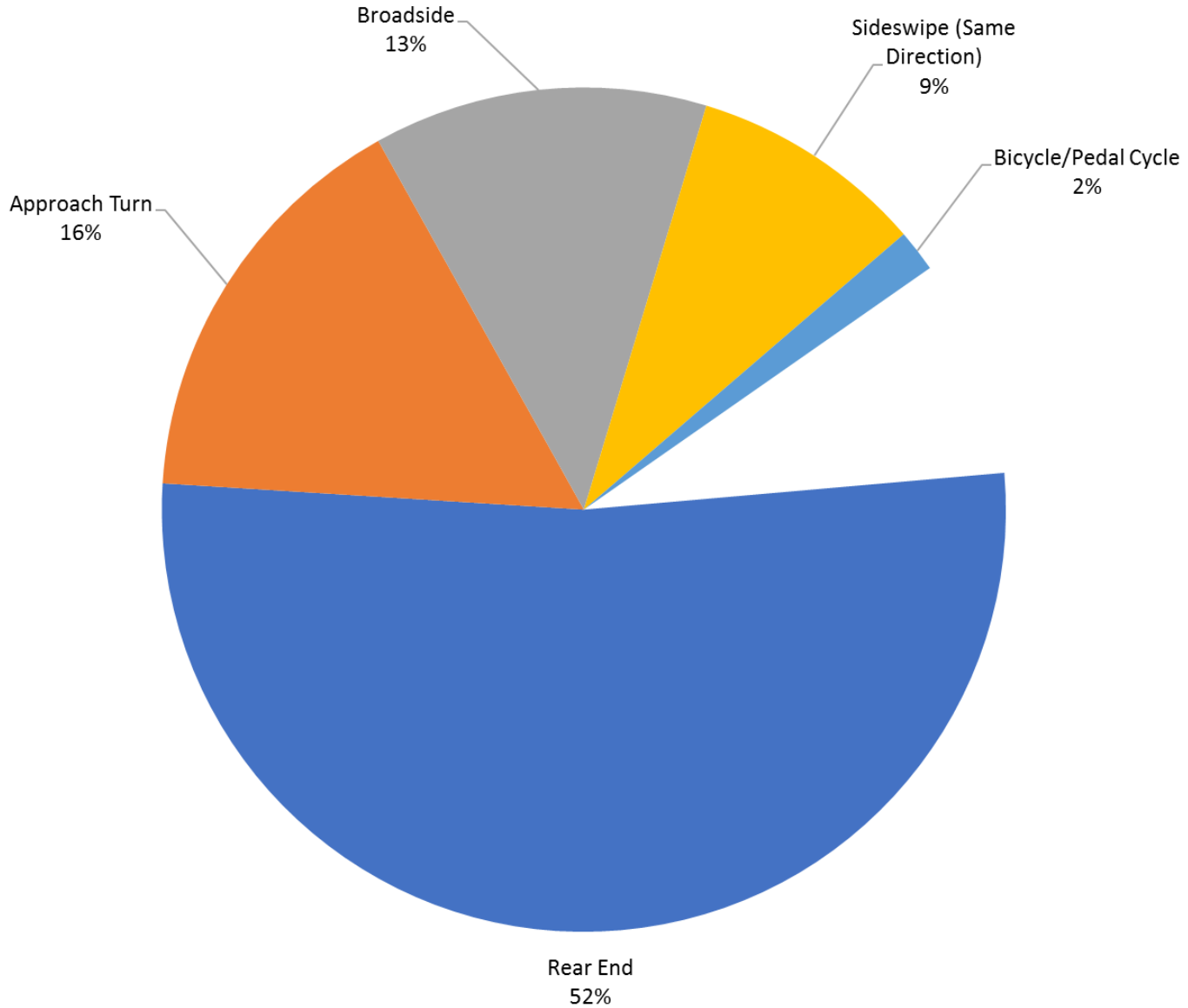


Typical Intersection Pie Chart



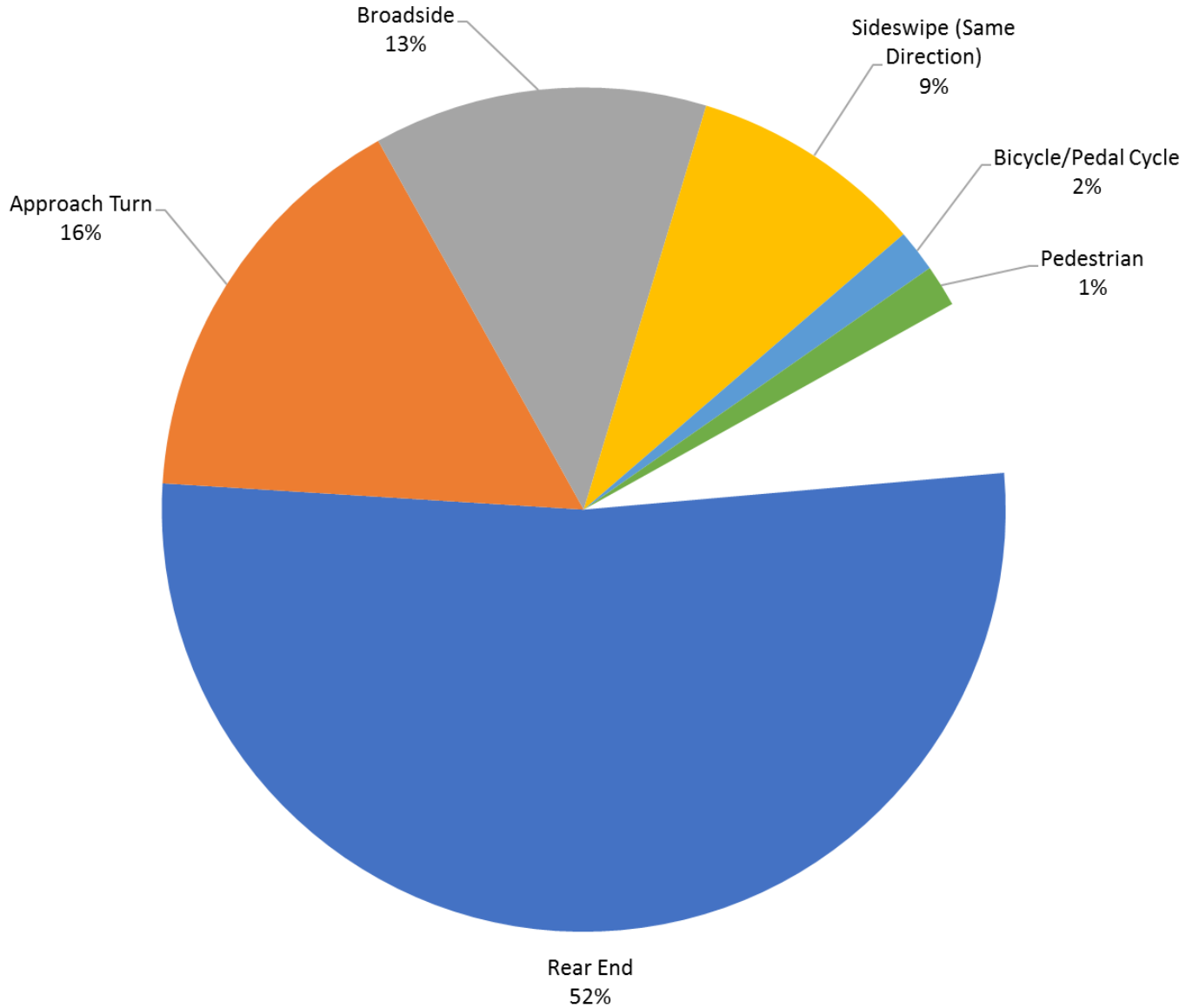
Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection



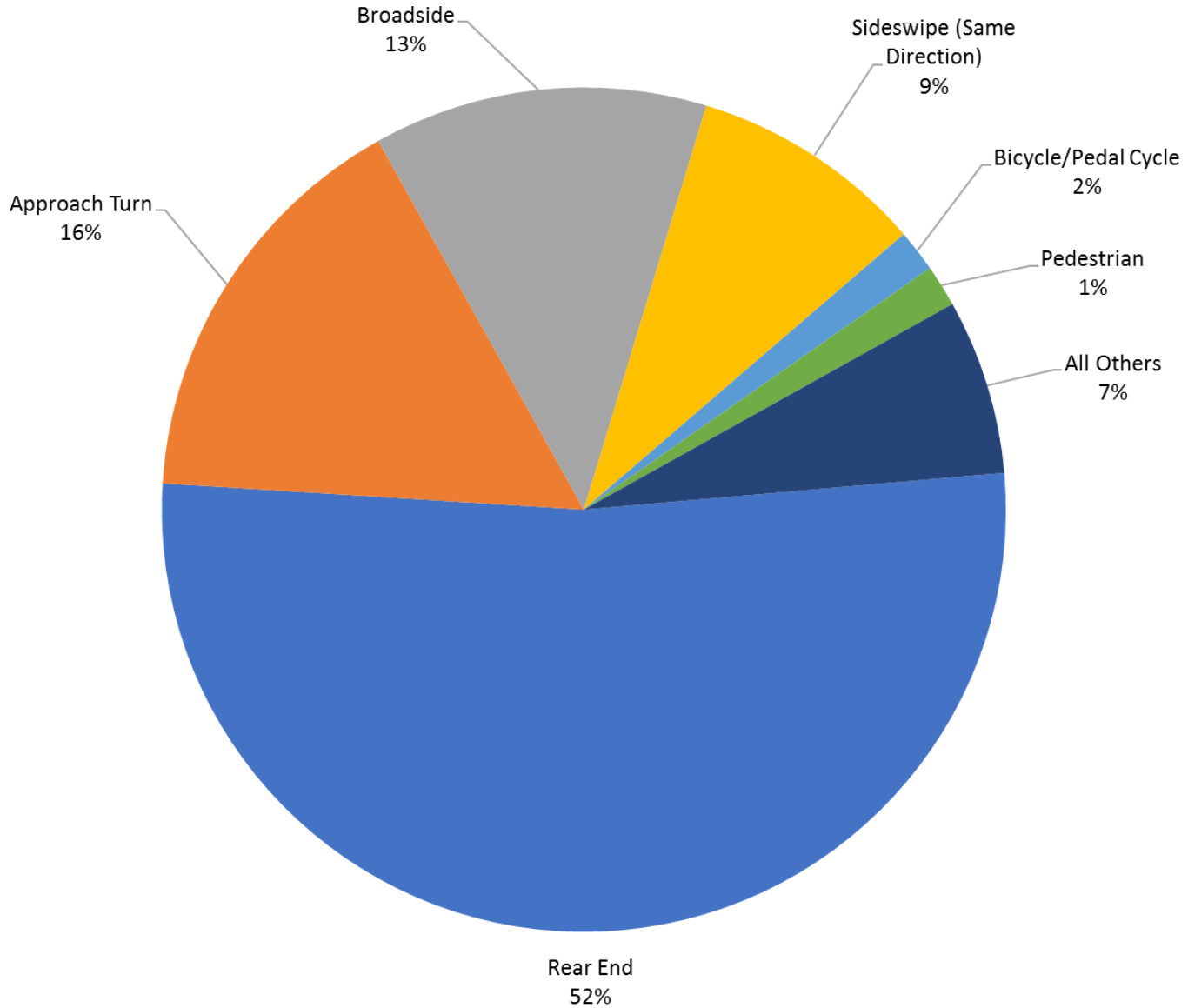
Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection



Typical Intersection Pie Chart

Urban 4-Lane Divided Signalized 4-Leg Intersection



Urban 4-Lane Divided Signalized 4-Leg Intersections



Colorado Department of Transportation
 DiExSys™ Roadway Safety Systems
 Diagnostics Comparison Percentages Baselines

04/30/2015

Job #: 20150430134425

Highway Class: CO - Urban 4-Lane Divided Signalized 4-Leg Intersections (2002)

Baseline Statistics

Statewide Average

CATEGORY	# ACC's	%
Property Damage Only (PDO)	35,506	68.78%
Injury (INJ)	15,982	30.96%
Fatal (FAT)	138	0.27%
Persons Injured	24,351	
Persons Killed	142	
Single Vehicle Accidents	3,443	6.67%
Two Vehicle Accidents	41,898	81.16%
Three or More Vehicle Accidents	6,120	11.85%
Unknown Number of Vehicles	165	0.32%
On Road	49,405	95.70%
Off Road	2,096	4.06%
Off Road Left	770	1.49%
Off Road Right	1,294	2.51%
Off Road at Tee	18	0.03%
Off Road in Median	14	0.03%
Unknown Road Location	125	0.24%
Overturning	205	0.40%
Other Non Collision	218	0.42%
Vehicle Cargo or Debris	0	0.00%
Pedestrian	909	1.76%
Broadside	7,963	15.42%
Head On	299	0.58%
Rear End	23,351	45.23%
Sideswipe (Same Direction)	3,994	7.74%
Sideswipe (Opposite Direction)	311	0.60%
Approach Turn	10,014	19.40%
Overtaking Turn	553	1.07%

Baseline Statistics

Statewide Average

CATEGORY	# ACC's	%
Tree	44	0.09%
Large Boulders or Rocks	5	0.01%
Rocks in Roadway	4	0.01%
Barricade	24	0.05%
Wall or Building	44	0.09%
Crash Cushion	0	0.00%
Mailbox	7	0.01%
Other Fixed Object	140	0.27%
Involving Other Object	110	0.21%
Road Maintenance Equipment	16	0.03%
Unknown Accident Type	124	0.24%
Total Fixed Objects	1,989	3.85%
Total Other Objects	130	0.25%
Daylight	37,009	71.69%
Dawn or Dusk	1,743	3.38%
Dark - Lighted	11,218	21.73%
Dark - Unlighted	702	1.36%
Unknown Lighting	954	1.85%
No Adverse Weather	45,689	88.50%
Rain	2,548	4.94%
Snow or Sleet or Hail	2,093	4.05%
Fog	71	0.14%
Dust	5	0.01%
Wind	185	0.36%
Unknown Weather	1,035	2.00%
Dry Road	43,642	84.53%
Wet Road	4,454	8.63%

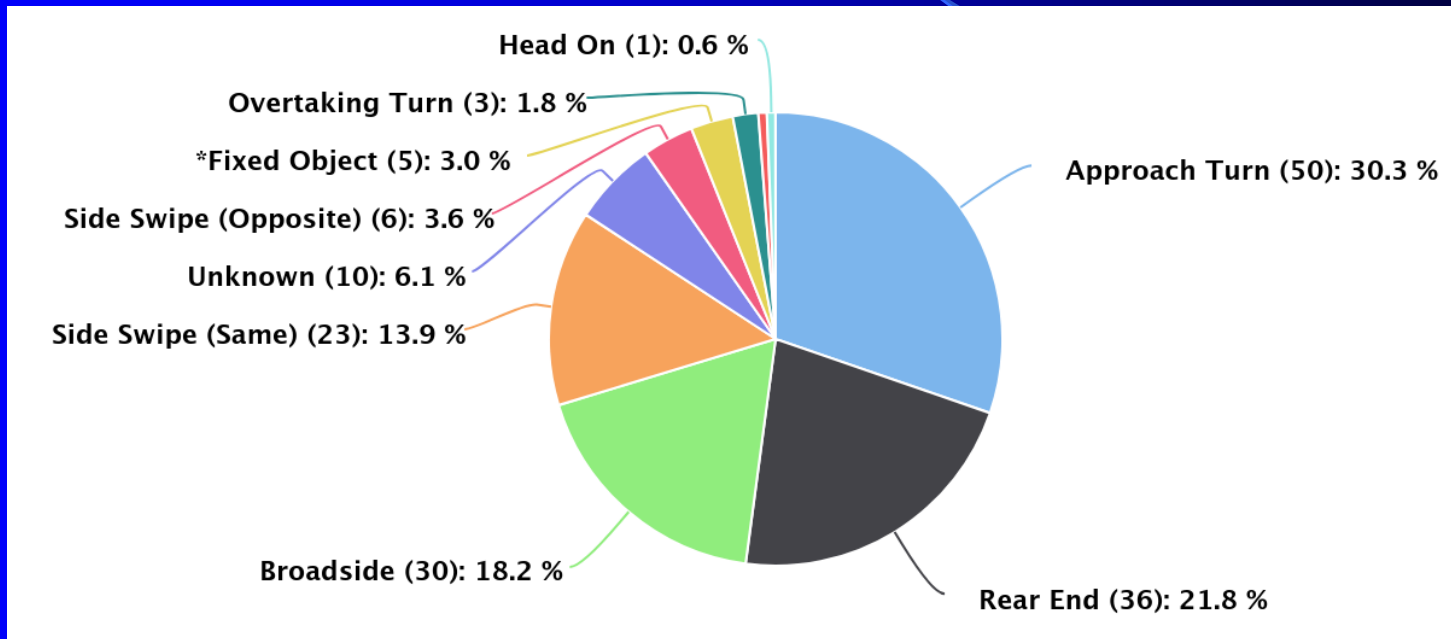
Signalized Intersection Roosevelt and I-30 E Frontage



Roosevelt and I-30 E Frontage Rd
ADT1=15,000/ADT2=8,700

Signalized Intersection Roosevelt and I-30 E Frontage

Crash Type Distribution



Signalized Intersection Roosevelt and I-30 E Frontage

Diagnostic Report



Arkansas DOT
DiExSys™ Vision Zero Suite
Diagnostics Report

10/13/2025

I-30 and Roosevelt E FR diagnostics

Cutoff: 5 Acc's @ 95

Category/Trait	Statewide Average %	# Crashes	This Location %	Probability
Crash Severity				
Injury (INJ)	24.6%	64	38.79%	100%
Number Of Vehicles				
Single Vehicle Accidents	6.56%	17	10.3%	97.61%
Crash Type				
Broadside	12.92%	30	18.18%	97.97%
Approach Turn	15.84%	50	30.3%	100%

SIGNAL EB VIEW



E ROOSEVELT AT EAST I-30 E FRONTAGE

RURAL 2 LANE INTERSECTION, ADT1=2,730, ADT2=1,400

Intersection - General


jake.kononov@diexsys.com - RT 163, 5_31,
3.11-3.15, APT AR

Search Dates Range(s): +

1/1/2015 - 12/31/2019 

 **Crash Filters** Intersection/Segment

Highway and MP Search

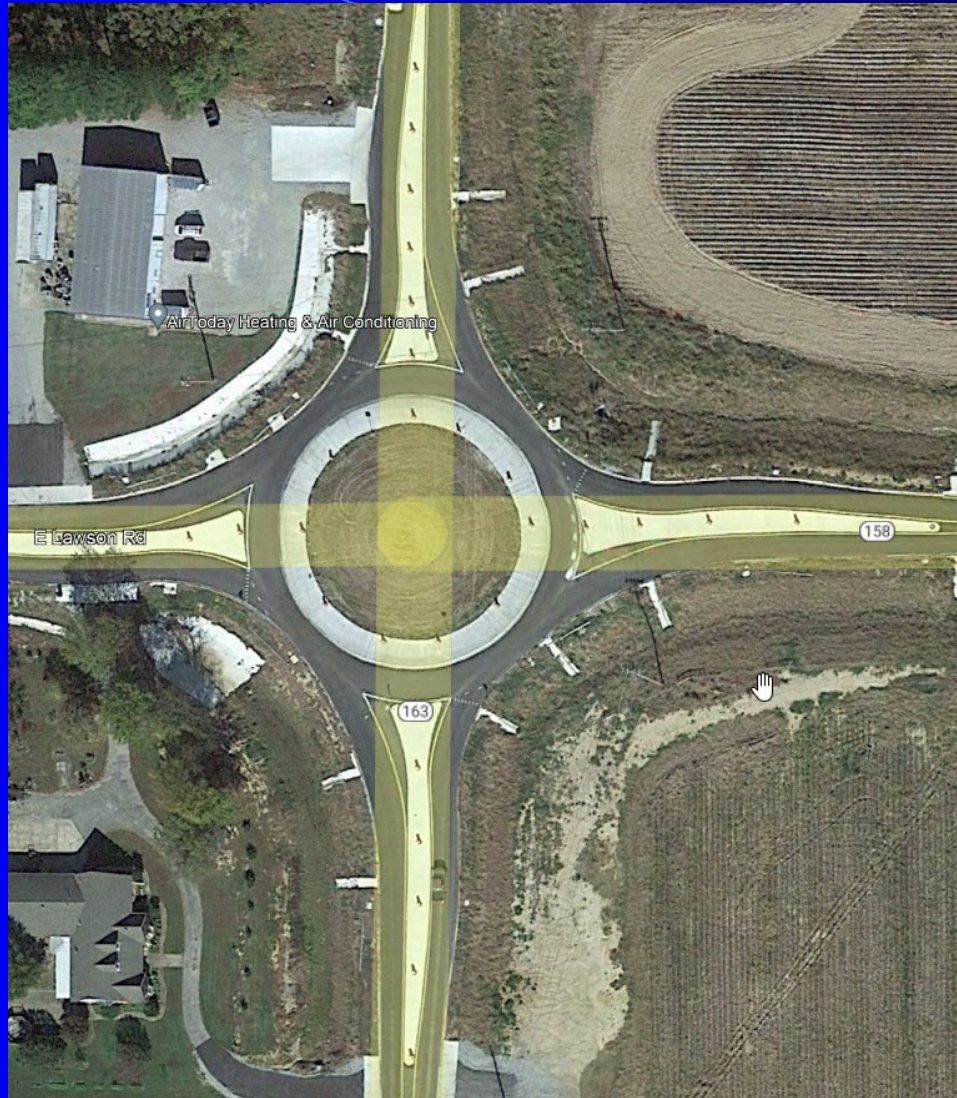
Rt: 163 Section: 5_31 MM: 
[3.11 - 3.15]

[View LRS Data](#)

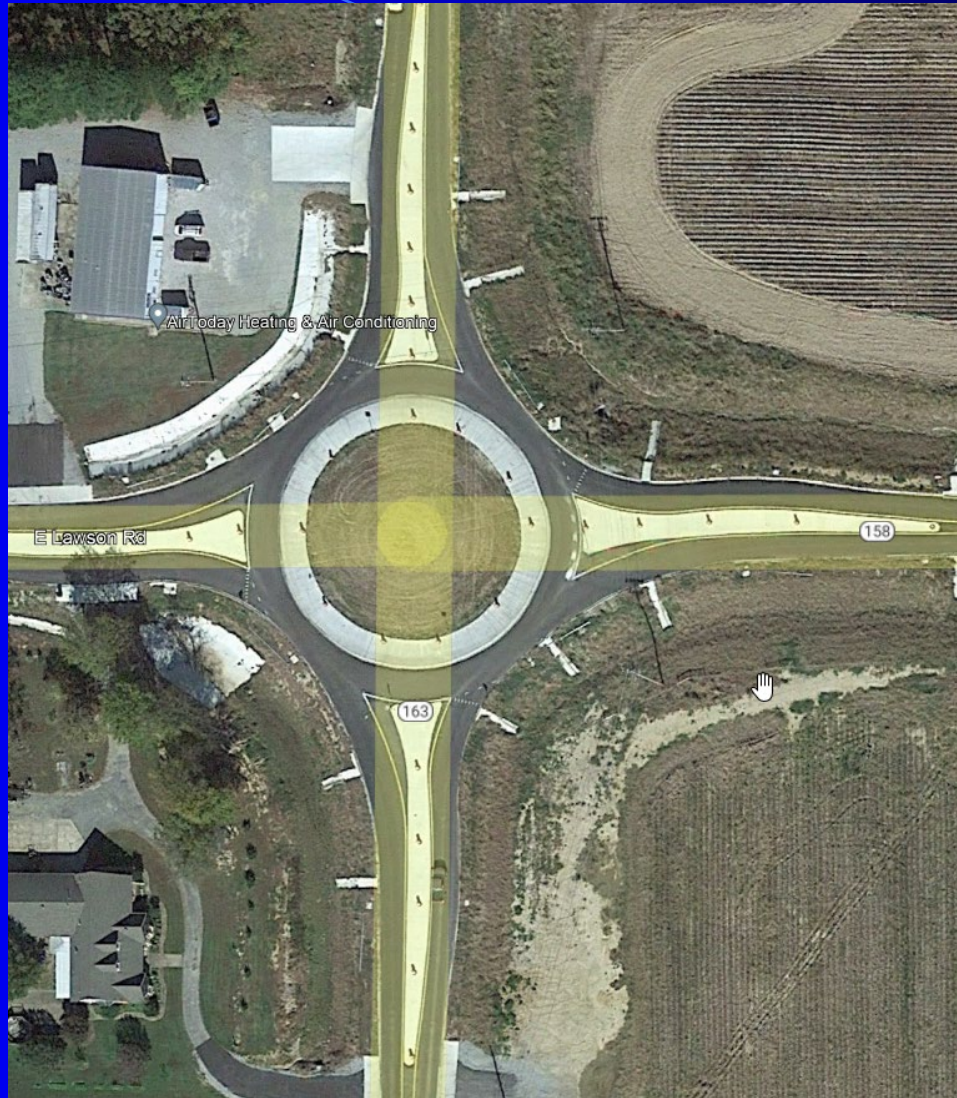
RURAL 2 LANE INTERSECTION BEFORE



RURAL 2 LANE INTERSECTION AFTER



RURAL 2 LANE INTERSECTION AFTER



BEFORE / AFTER SEVERE CRASH SPF

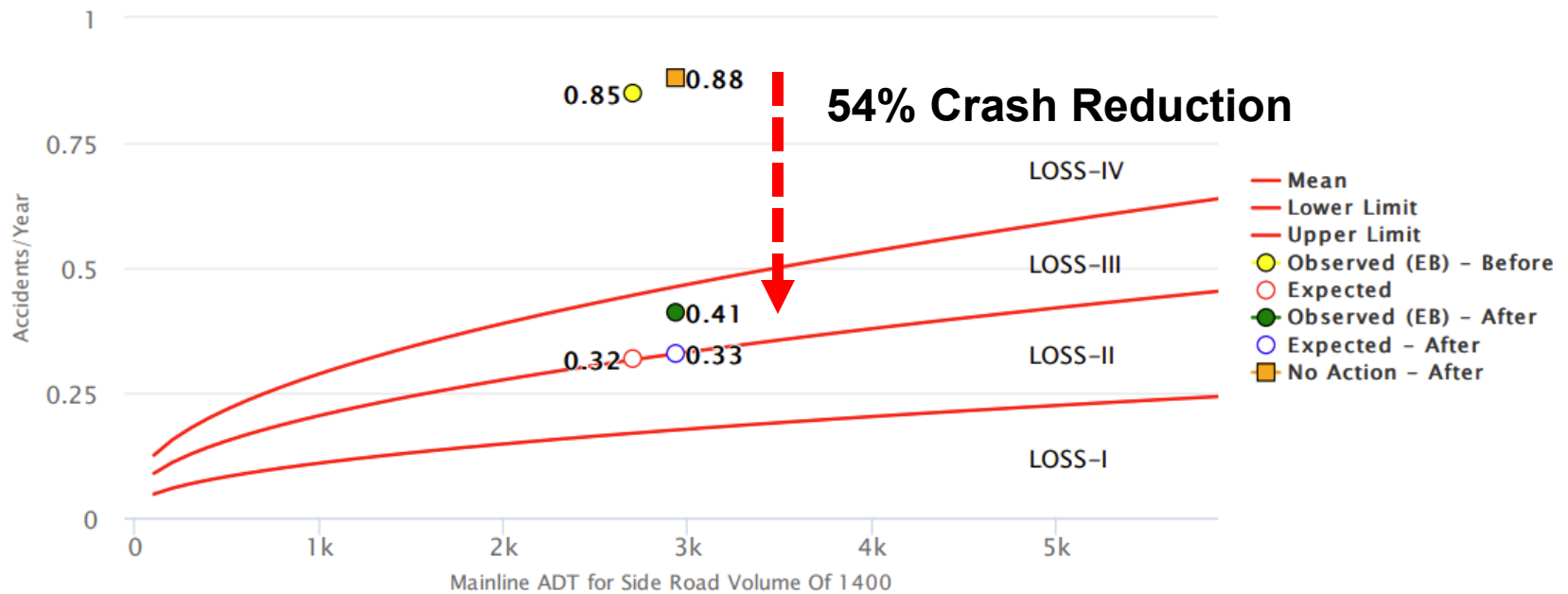


Arkansas DOT DiExSys™ Vision Zero Suite

10/13/2025

AR 163 and 168 roundabout spfba

Type: Intersection Search Name: Rt: 163 Section: 5_16 MM: [3.11 - 3.15] From: 1/1/2015 To: 12/31/2019



RETROACTIVE BENEFIT/COST CALCULATION



Arkansas DOT DiExSys™ Vision Zero Suite Economic Analysis Report

10/13/2025

AR 163 and 168 roundabout bc

Loc: 163_5_16 Begin: 3.11 End: 3.15 From: 1/1/2015 To: 12/31/2019

Benefit Cost Ratio Calculations

Crashes

PDO: 6
INJ C: 5
INJ B: 5
INJ A: 1
FAT: 0

11 :Injured C
7 :Injured B
2 :Injured A
0 :Killed

Crash Reduction Factors (Composite)

CRF for PDO: 54%
CRF for INJ C: 54%
CRF for INJ B: 54%
CRF for INJ A: 54%
CRF for FAT: 54%

Other Information

Cost of PDO: \$9,918
Cost of INJ C: \$263,987
Cost of INJ B: \$263,987
Cost of INJ A: \$4,657,879
Cost of FAT: \$4,657,879
Interest Rate: 5%
AADT Growth Factor: 2%
Service Life: 20
Capital Recovery Factor: 0.080
Annual Maintenance/Delay Cost: \$0

Improvement Cost: \$3,000,000

Years in Crash Search: 5

Benefit/Cost Ratio: 7.79

RURAL 2-LANE CURVED SEGMENT



- Highway 5 in Saline County near log mile 11.8
- 2021 project realigned the curve (~360' radius to ~870')

RURAL 2-LANE CURVED SEGMENT



- Rural 2-Lane Undivided Highway
- 4,400 AADT (minimal change over time)

BEFORE / AFTER SEVERE CRASH SPF



Arkansas DOT
DiExSys™ Vision Zero Suite

10/13/2025

AR 5 sect 7 LM 11.8 curve b-a

Type: Segment Search Name: Rt: 5 Section: 7_62 MM: [11.5 - 12.1] From: 1/1/2017 To: 12/31/2021

