Integrating Safety into the Transportation Management Process

PRISCILLA A. TOBIAS, PE, RSP

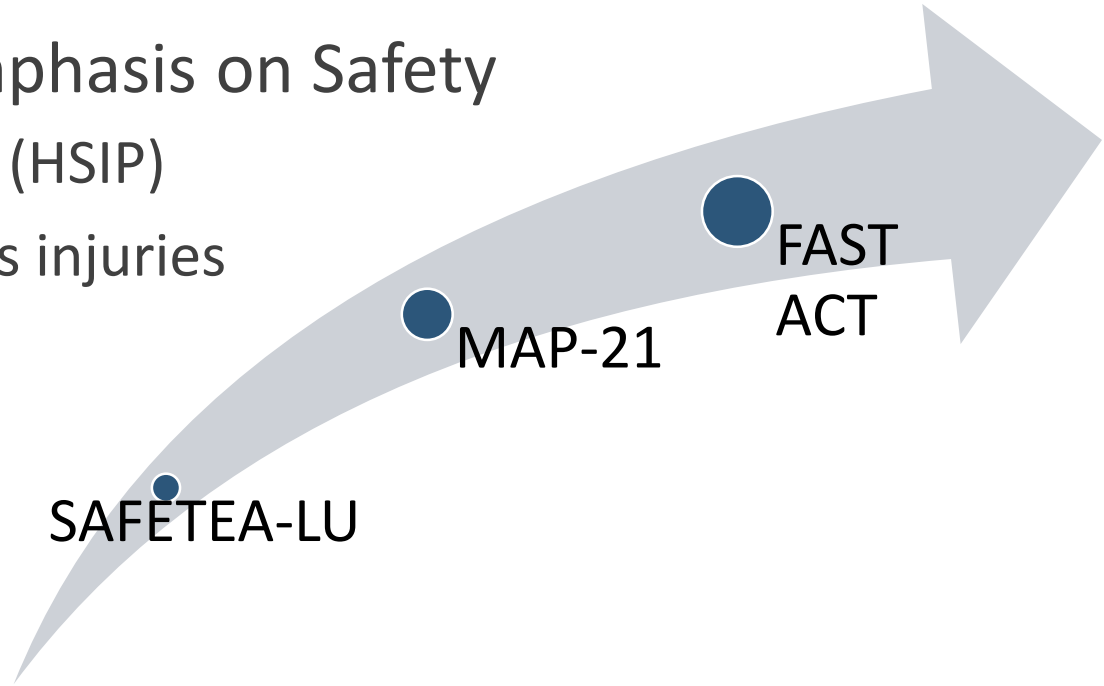
MANAGER, ILLINOIS OPERATIONS

ARORA AND ASSOCIATES, P.C.

Roadway Safety – An Evolution

Federal Transportation Funding/Emphasis on Safety

- Highway Safety Improvement Program (HSIP)
- Reducing roadway fatalities and serious injuries
- Data driven decisions and results
- Strategic Highway Safety Plans (SHSP)
- Performance measures and targets



Strategic Highway Safety Plan

SHSP

- Number of Fatalities & Serious Injuries
- Fatalities & Serious Injury Rate
- Zero Fatality Goal

Emphasis Areas

- State and Local Roadways
- Urban/Rural
- Data Driven Priority 1,2, and 3

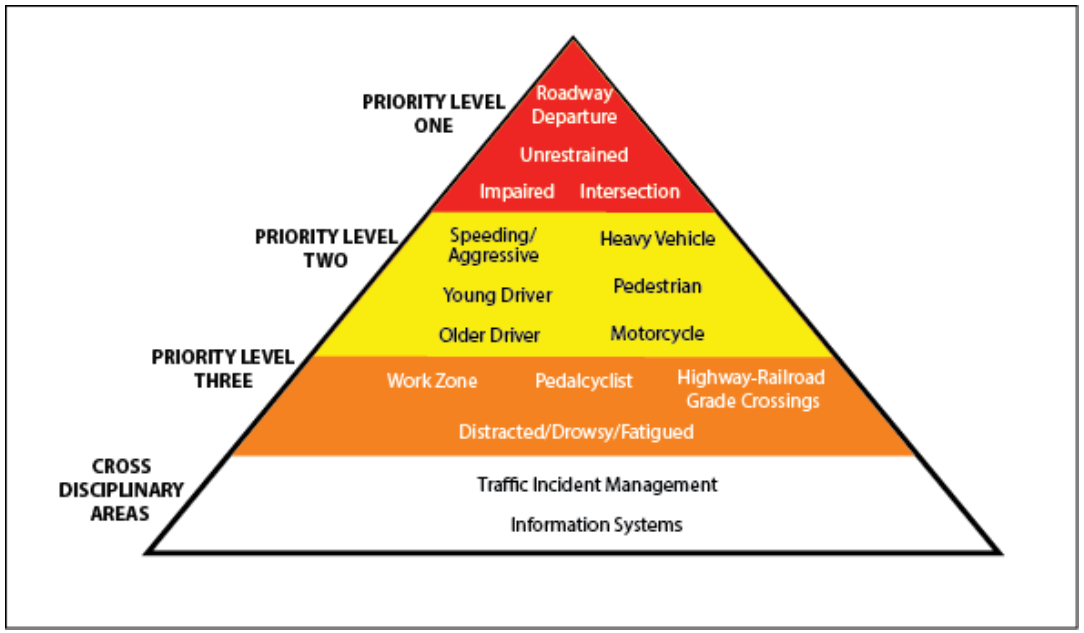
Strategies

- Engineering
- Enforcement
- Education
- EMS

Illinois SHSP Emphasis Areas

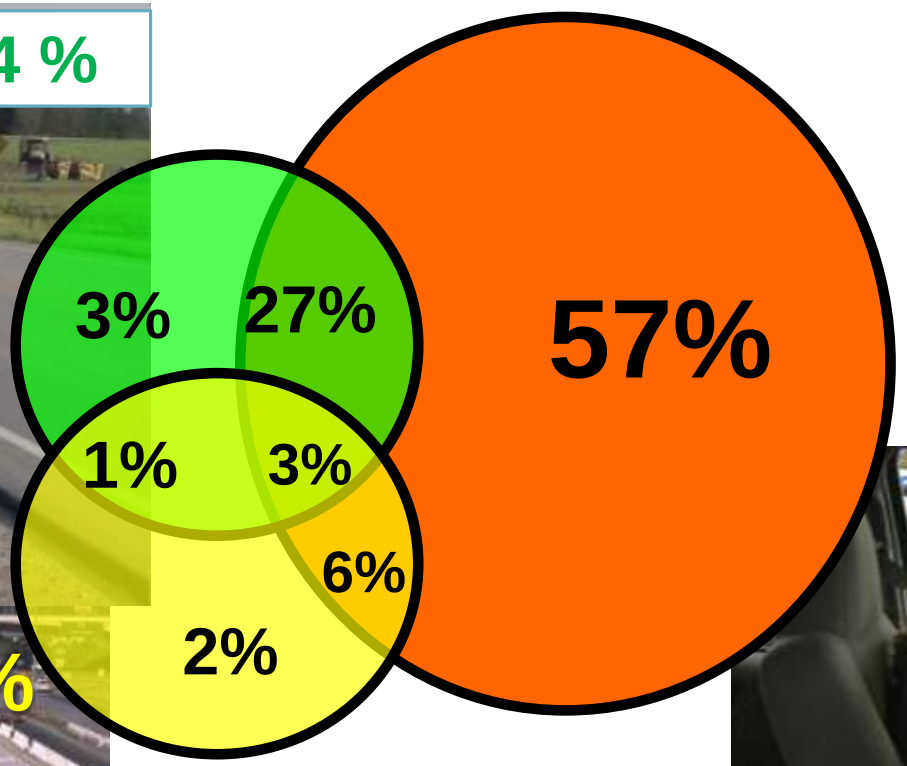
Annual Targets: 2% min Annual Reduction

Priority Level One Emphasis Areas represent fatalities of 25% or greater (based on 2010 to 2014 data)



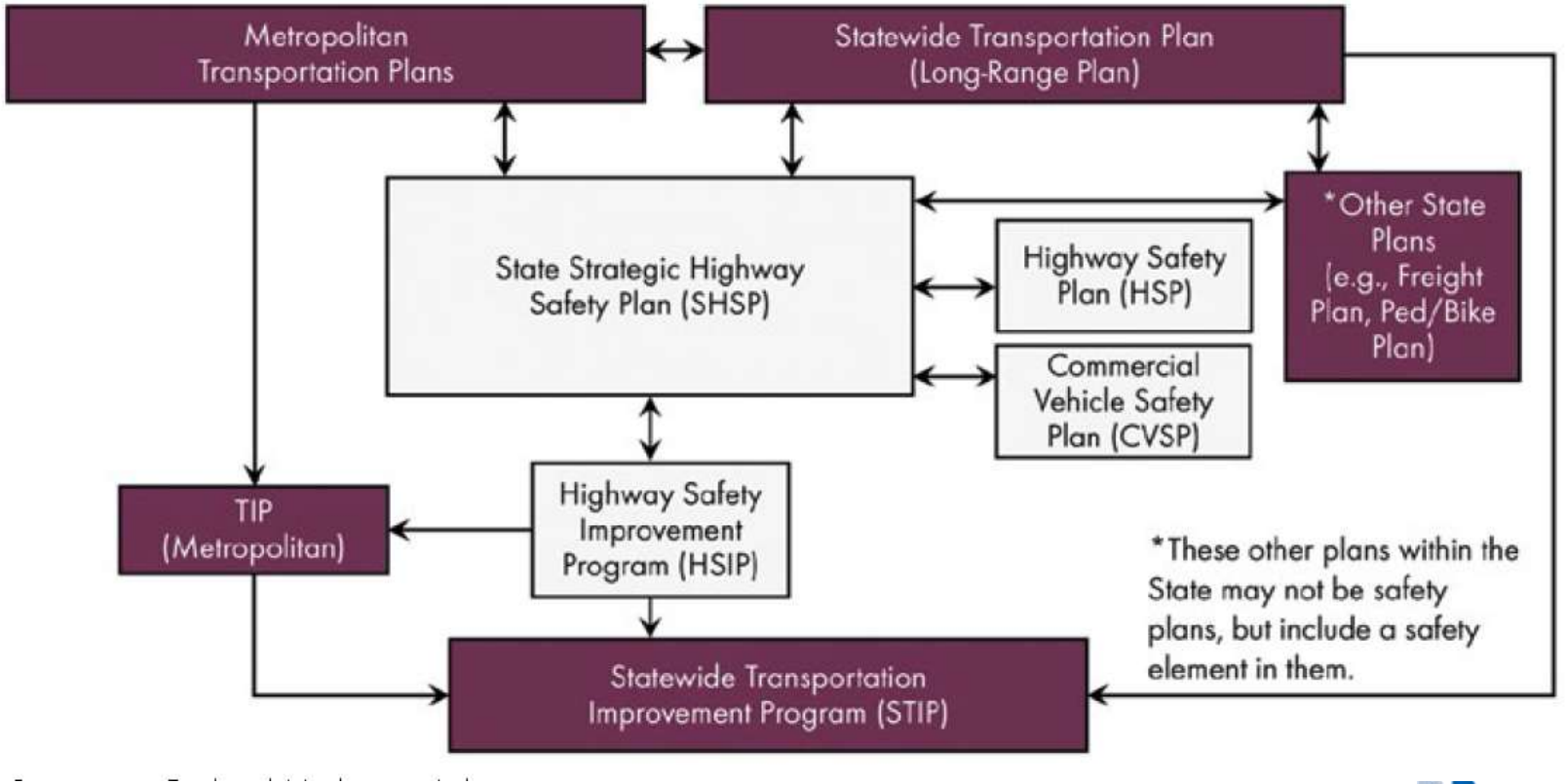
Priority Level	Emphasis Areas	Fatalities	A-Injuries	Fatalities and A-Injuries
PRIORITY LEVEL 1	Roadway Departure	2,483	19,279	21,762
	Impaired Driver	2,088	8,331	10,419
	Unrestrained Occupants	1,377	5,041	6,418
	Intersection Related	1,178	26,397	27,575
PRIORITY LEVEL 2	Speeding/Aggressive Driver	1,108	12,884	13,992
	Older Driver	848	9,593	10,441
	Young Driver	694	12,240	12,934
	Motorcycle	694	5,271	5,965
	Heavy Vehicle	672	4,426	5,098
	Pedestrian	641	4,525	5,166
PRIORITY LEVEL 3	Pedalcyclist	137	2,047	2,184
	Work Zone	133	980	1,113
	Distracted/Fatigued/Drowsy Driver	123	3,264	3,387
	Highway-Railroad Grade Crossings	45	54	99
CROSS DISCIPLINARY AREAS	Traffic Incident Management			
	Information Systems			

Typical Reported Crash Causes

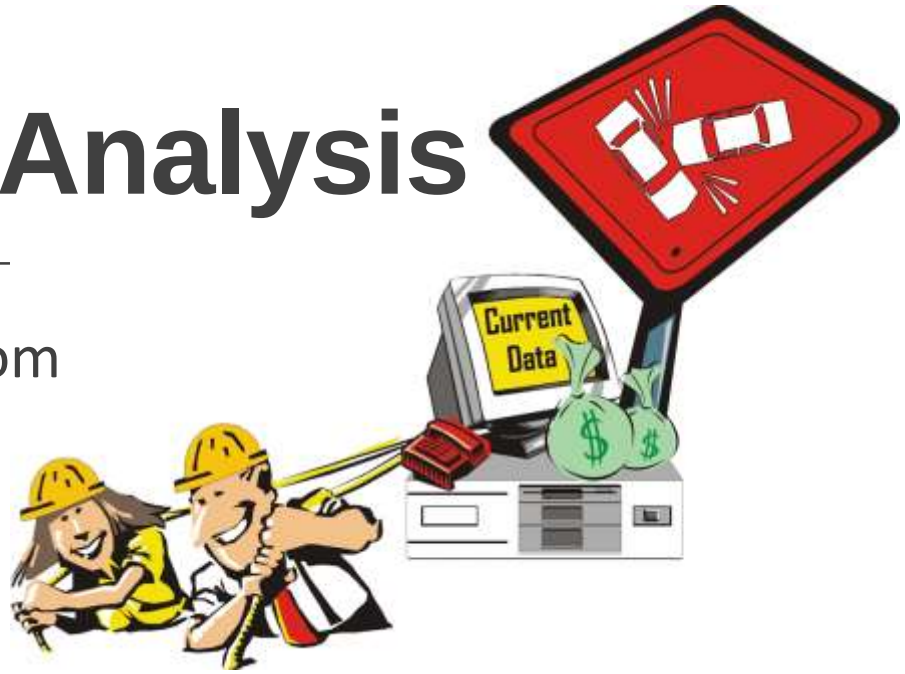


ARORA and ASSOCIATES, P.C

SHSP Linkage to Other Plans/Efforts



Data Driven Safety Analysis



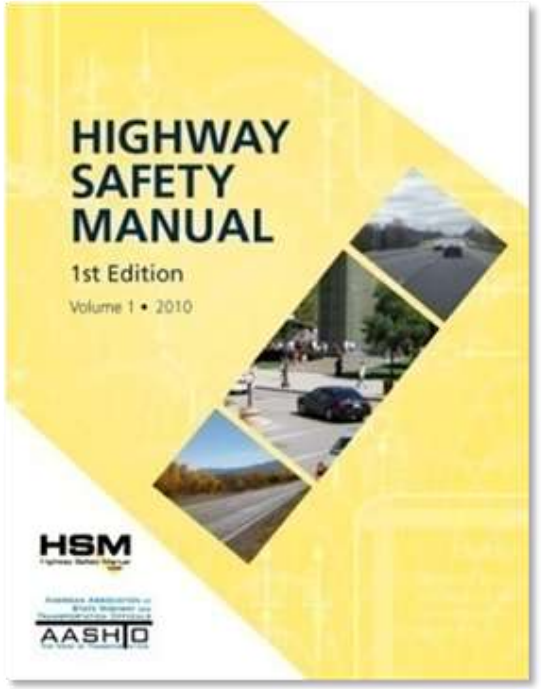
- Fatal and serious injury crashes are rare and random
- Crash severity matters
- Use 3 to 5 years of crash history
- Link “Safety Data”
- Identify trends, over-representation of crash types, contributing factors
- Use robust statistical analysis models and methods
- Key is: Where, What, Why

Data Driven Safety Analysis

Highway Safety Manual (HSM), 1st Edition

- Established Safety Management Process
- Network Screening Methods
- Safety Predictive Methods
- Crash Modification Factors (CMFs)

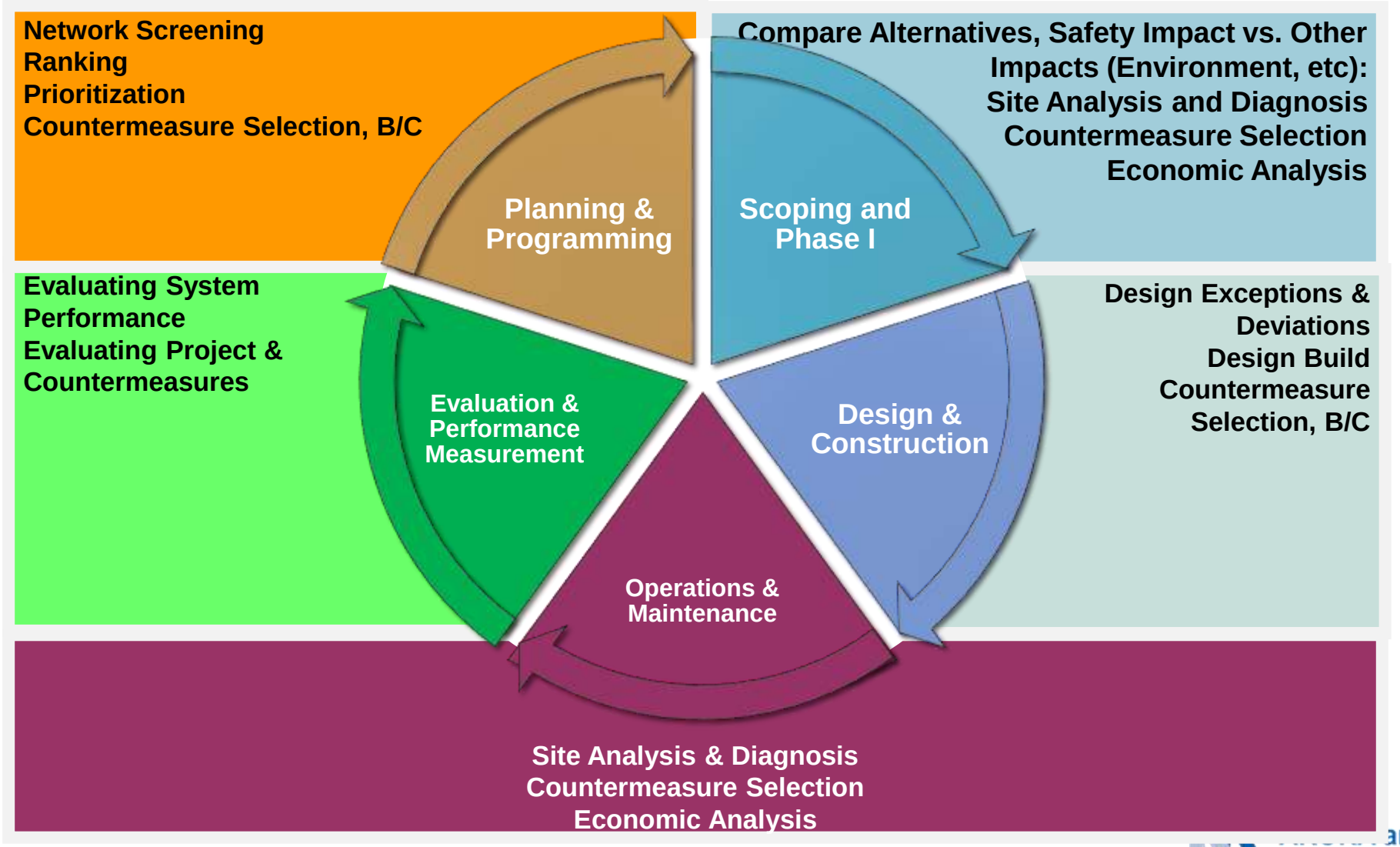
Consider the expected or actual crash frequency and severity for a highway or roadway



Crash Modification Factors (CMFs)

ARORA and ASSOCIATES, P.C

Safety &Transportation Management Process



IDOT Network Screening

PSI (Potential for Safety Improvements)

How much a site's safety performance exceeds the predicted

- Roadway Segments: PSI represents the excess losses per mile for 5 yr period
- Intersection: PSI represents the excess losses at given intersection for 5 yr period

Weighted PSI:

Default values of weights: Fatal-K(25), Injury-A (10), and Injury-B (1)

Empirical Bayesian (EB) Method:

Find a weighted average of the predicted and observed numbers of crashes

IDOT Network Screening

Roadway Segment Mileage Analyzed by Peer Group

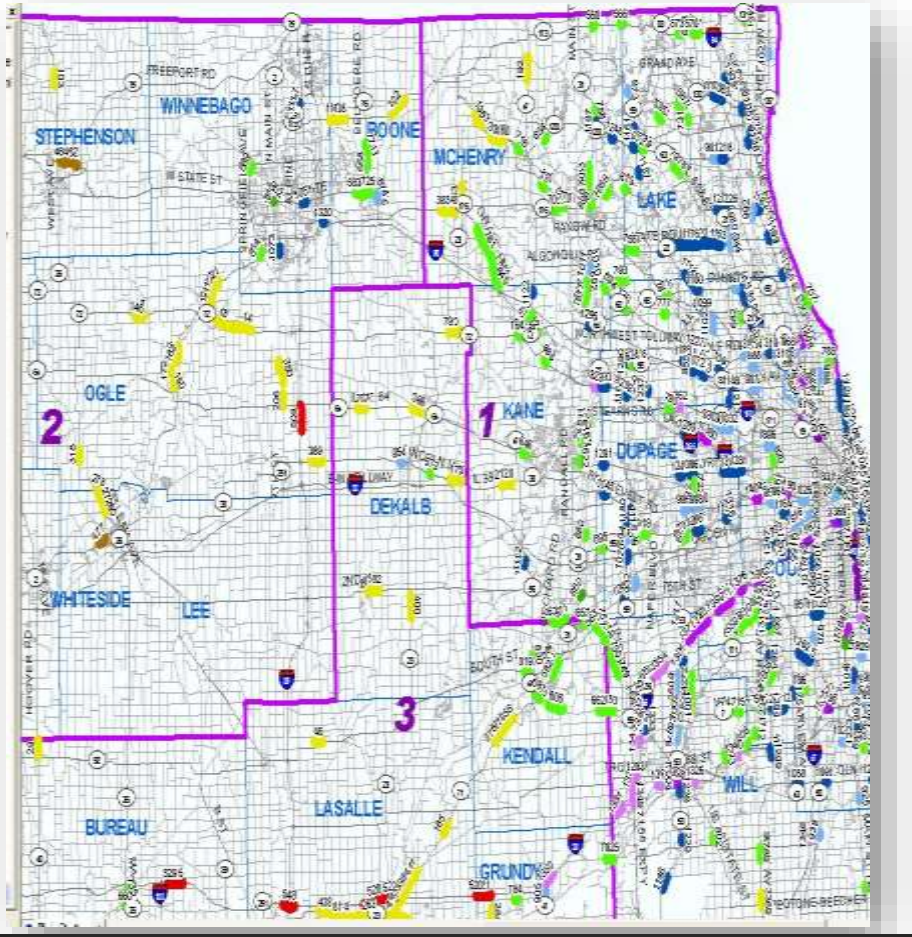
Roadway Segment Peer Groups	Mileage Analyzed By Peer Group
1. Rural 2-Lane Highway	9,586
2. Rural Multilane Undivided Highway	40
3. Rural Multilane Divided Highway	341
4. Rural Freeway, 4-Lanes	1,429
5. Rural Freeway, 6+ Lanes	32
6. Urban 2-Lane Highway	2,000
7. Urban One-Way Arterial	187
8. Urban Multilane Undivided Highway	771
9. Urban Multilane Divided Highway	1,247
10. Urban Freeway, 4-Lanes	441
11. Urban Freeway, 6-Lanes	282
12. Urban Freeway 8+ Lanes	64
Total	**16,421**

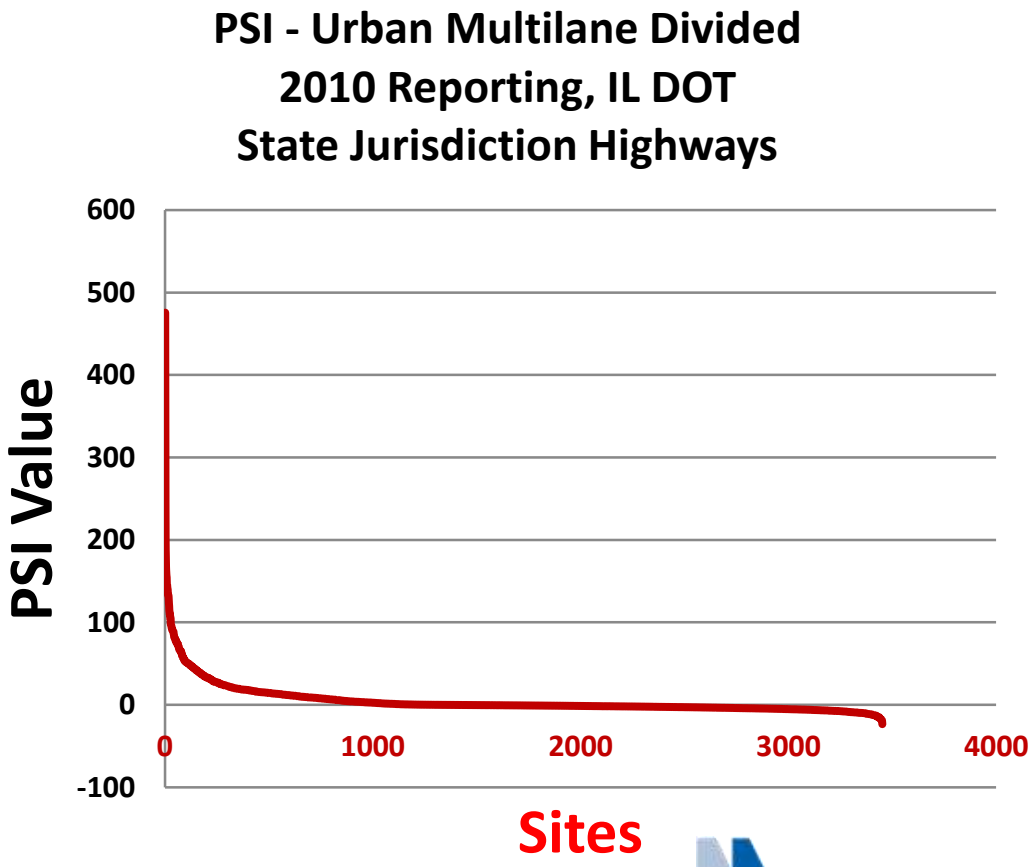
Number of Intersections Analyzed by Peer Group

Intersection Peer Groups	Number of Intersections Analyzed by Peer Group
1. Rural Minor Leg Stop Control	16,498
2. Rural All-Way Stop Control	369
3. Rural Signalized Intersection	202
4. Rural Undetermined Intersection	7,361
5. Urban Minor Leg Stop Control	17,737
6. Urban All-Way Stop Control	242
7. Urban Signalized Intersection	6,057
8. Urban Undetermined Intersection	6,414
Total	**54,880**

*Now expanded to all 145,000 Miles of Public Roads

High Potential for Safety Improvement





ARORA and ASSOCIATES, P.C

Five Percent Reporting

TABLE D-9a Selected Segment Crash Experience—State and US Highways

Peer Group 9—Urban Multilane Divided Highway

SegmentID	District	Length	Total Crashes	Crashes per Mile	PSI	Crashes by Severity			Crash Type							
									Head-On and Opposite Direction		Fixed Object and Overturned		Angle and Turning		Rear End and Same Direction Sideswipe	
						K	A	B	Number	Percent	Number	Percent	Number	Percent	Number	Percent
09-0686	1	0.40	14	35.26	219.19	2	4	8	1	7%	2	14%	3	21%	8	57%
09-0687	1	0.26	26	99.04	216.10		7	19		0%	19	73%	2	8%	4	15%
09-0689	1	0.44	23	51.86	200.64	1	7	15	1	4%		0%	14	61%	6	26%
09-0690	1	0.49	46	94.13	188.29		14	32	1	2%	5	11%	19	41%	19	41%
09-0691	1	0.39	49	125.57	188.07		17	32		0%	3	6%	29	59%	12	24%
09-0692	1	0.31	25	81.12	184.27		11	14	1	4%		0%	15	60%	9	36%
09-0693	1	0.51	33	64.15	169.96		10	23	1	3%	5	15%	8	24%	18	55%
09-0694	1	0.72	33	45.99	167.70		9	24		0%	1	3%	16	48%	4	12%
09-0697	1	0.48	64	133.72	160.83	1	13	50	1	2%			35	55%		
09-0698	1	0.31	55	177.59	152.35	1	7	47	1	2%	28	51%	6	11%	19	35%

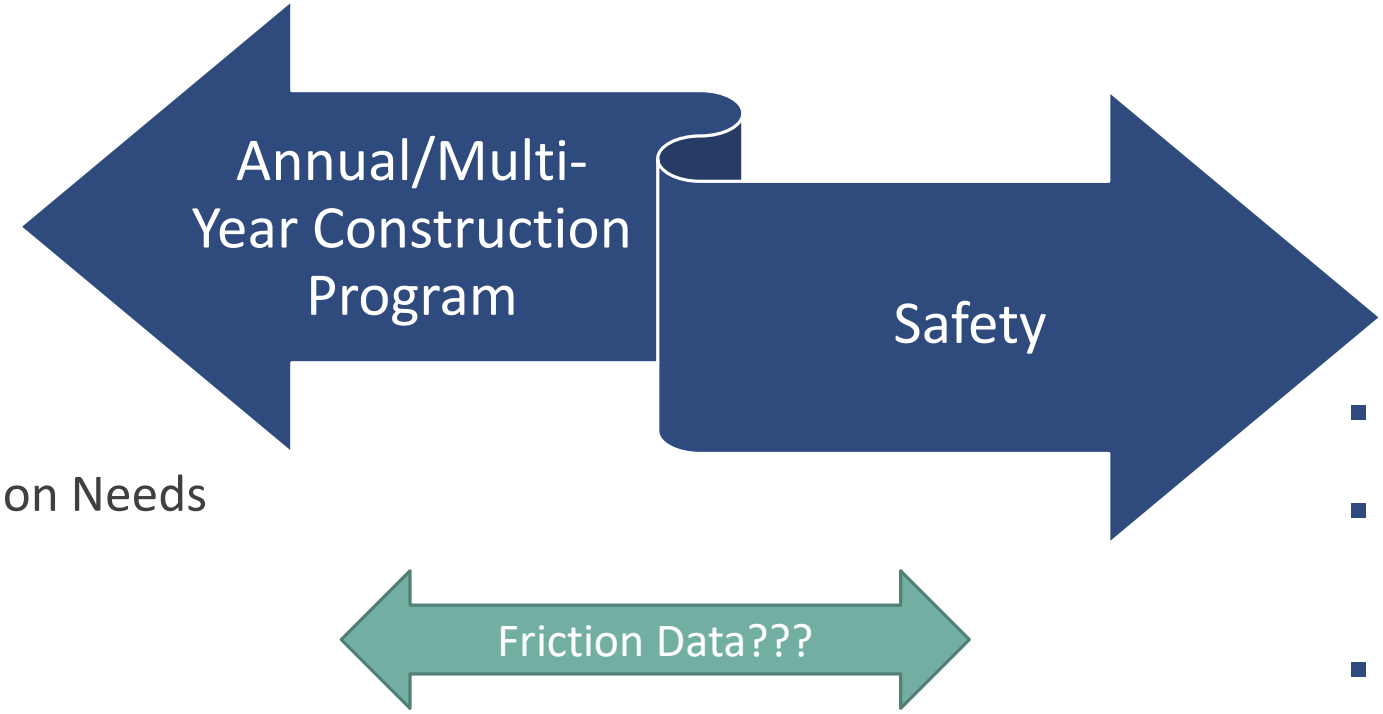
PSI = 152

Fixed Object & Overturn = 51%

Rear End & Same Direction Sideswipe = 35%

ARORA and ASSOCIATES, P.C

Project Development



- Pavement Condition Needs
- Capacity

- Safety Issues
- Network Screening (5%/100% list)
- Problem Identification
- Countermeasure Selection

How do you impact safety performance????

- Safety performance targets
- Asset management—people are assets
- Leverage all resources
- Integrate data

Safer Roads Index (SRI) & Safety Tiers

- Five (5) Tier Designations
  - Based on Potential for Safety Improvement (PSI)
  - Fatal and A-Injury crashes
  - Critical (Top 5% PSI)
  - High (Top 6-10% PSI)
  - Medium (10%-25% PSI)
  - Low (25-50% PSI)
  - Minimal (Lowest 50% PSI)
- Performance metric for programming process/project selection—Used like construction management & pavement, bridge, infrastructure condition evaluation and maintenance
- Goes beyond the simple Yes/No answer of being a FIVE PERCENT location

IDOT Performance Measures

Condition Rating System (CRS)

Structural:

Loss of load carrying capacity or structural breakdown

International Roughness Index (IRI)

Functional/Surface:

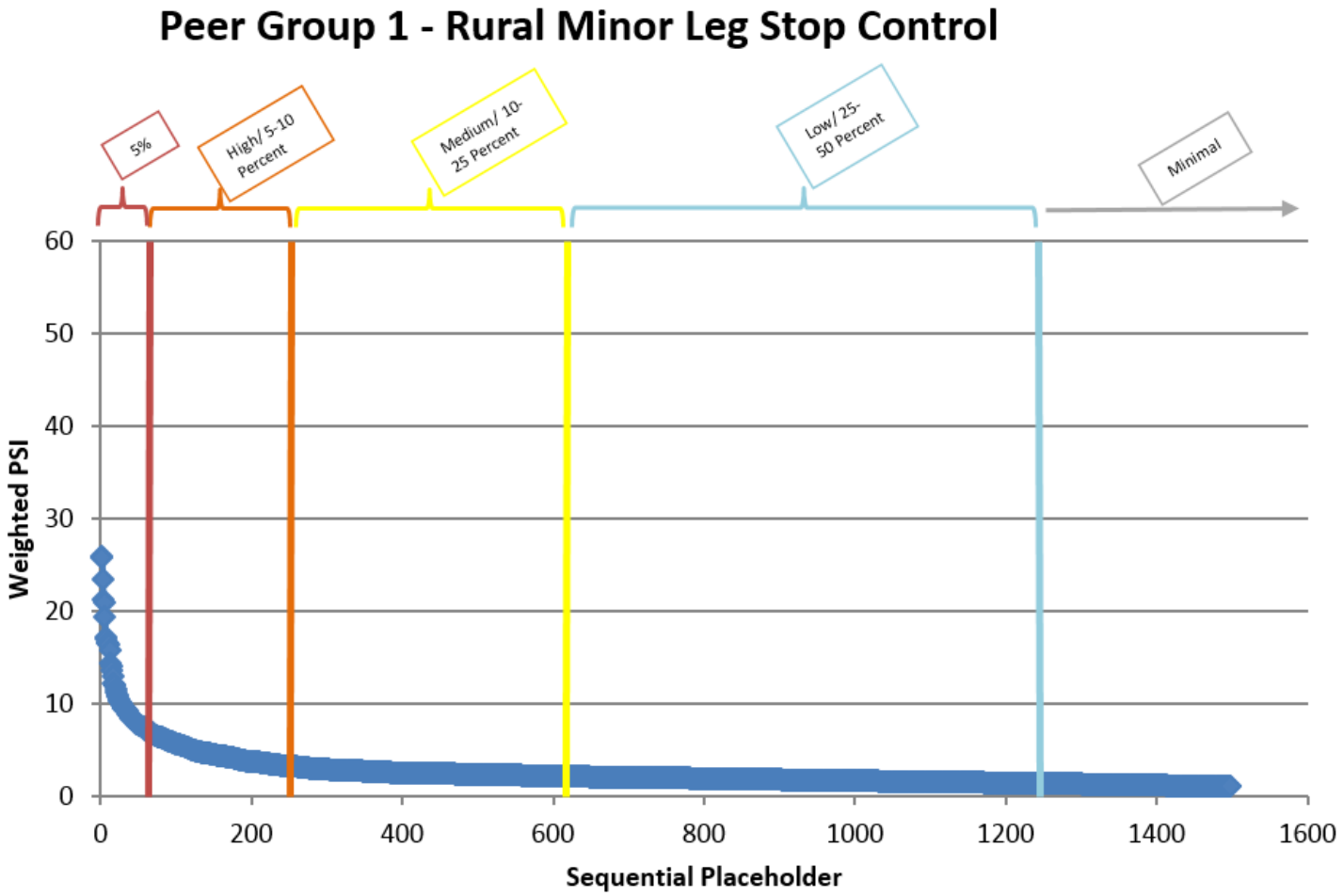
Excessive roughness impacting functional usability and causing drive discomfort

Safer Roads Index (SRI)

Safety Performance (PSI):

Establishes safety risk based on historical severe crashes and exposure

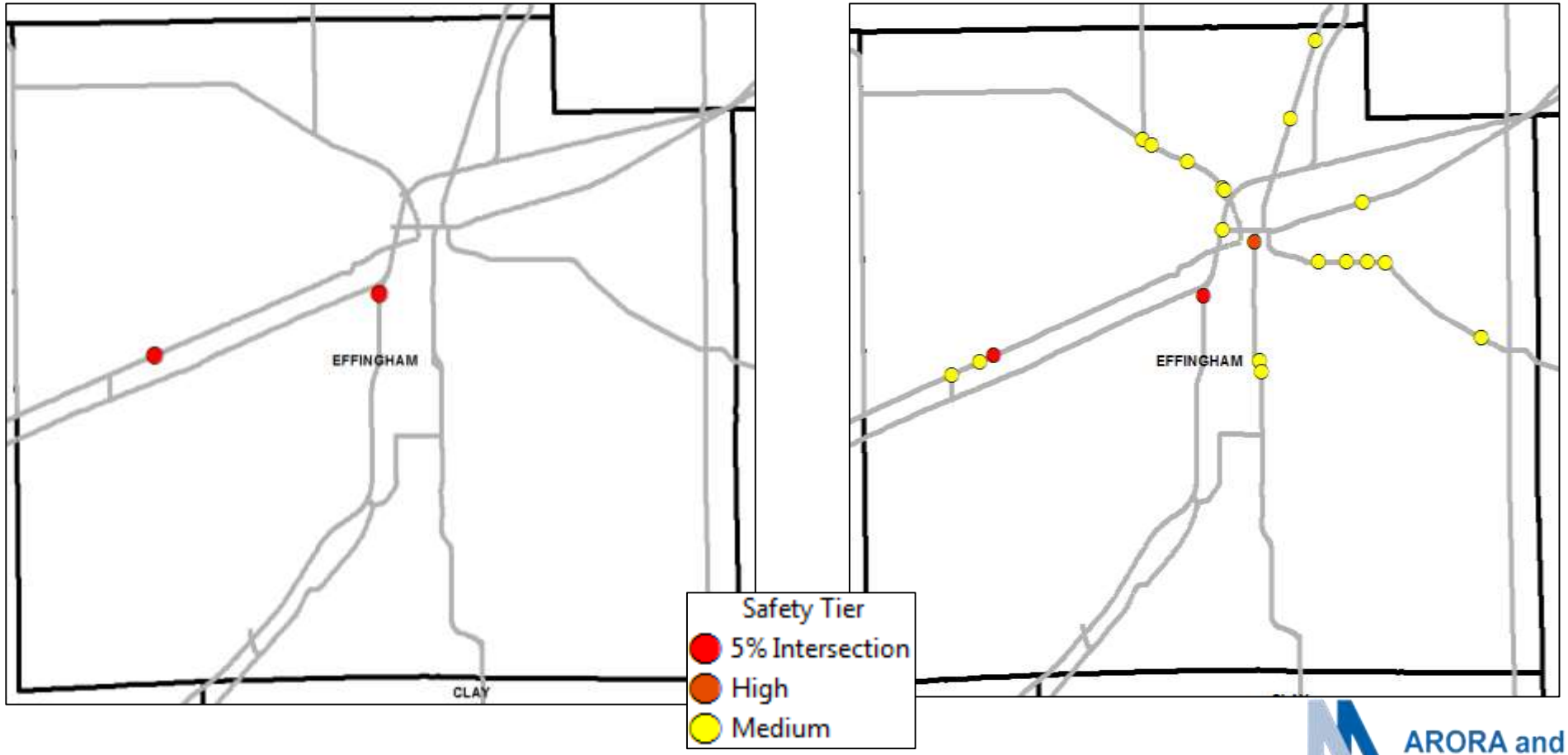
	State of Repair
CRS Range	
9.0 to 7.6	Excellent
7.5 to 6.1	Good
6.0 to 4.6	Fair
4.5 to 1.0	Poor
IRI Range (in/mi)	
1 to 94	Good
95 to 177	Fair
> 177	Poor
SRI Range	
Minimal	Good
Low	Minor
Medium	Moderate
High	Severe
5%	5%



Intersections and Safety Tiers

Intersections Before

Intersections After



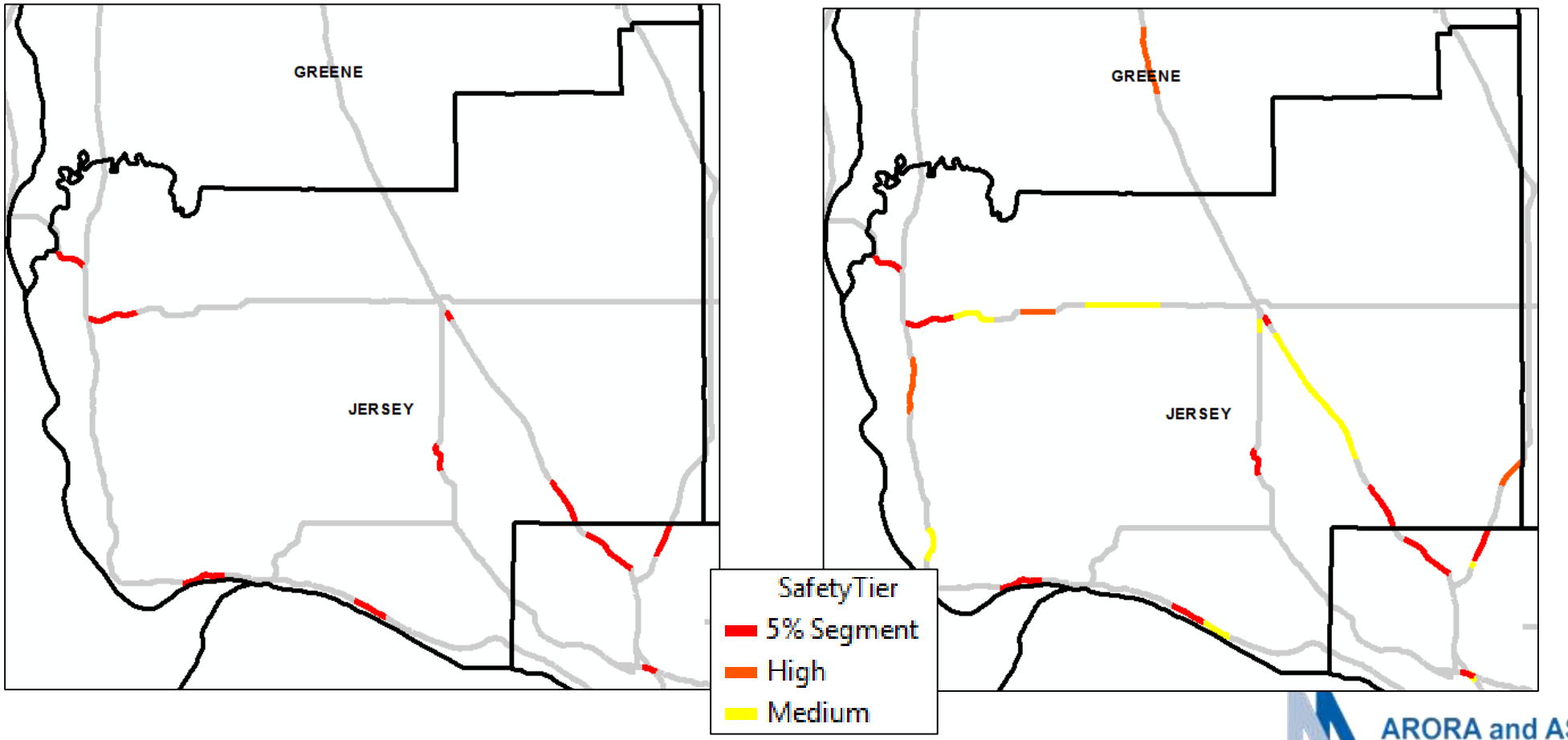
Roadway Segments and Safety Tiers

2015 FIVE PERCENT Report: Segment Safety Tiers									
Peer Group	Tier	Max. PSI	K+A	Σ K+A	Σ K+A %	Tier Mileage	Tier Mileage %	Σ Mileage	Σ Mileage %
1: Rural 2-Lane	5%	70.0	748	748	25.9%	422	5.1%	422	5.1%
	High	40.5	128	876	30.3%	431	5.2%	853	10.2%
	Medium	14.0	348	1,224	42.3%	1,281	15.3%	2,134	25.5%
4: Rural Freeway 4 Lanes	5%	54.0	457	457	15.8%	76	5.1%	76	5.1%
	High	24.0	221	678	23.4%	73	4.9%	149	10.1%
	Medium	16.0	111	789	27.3%	224	15.2%	373	25.2%

ARORA and ASSOCIATES, P.C

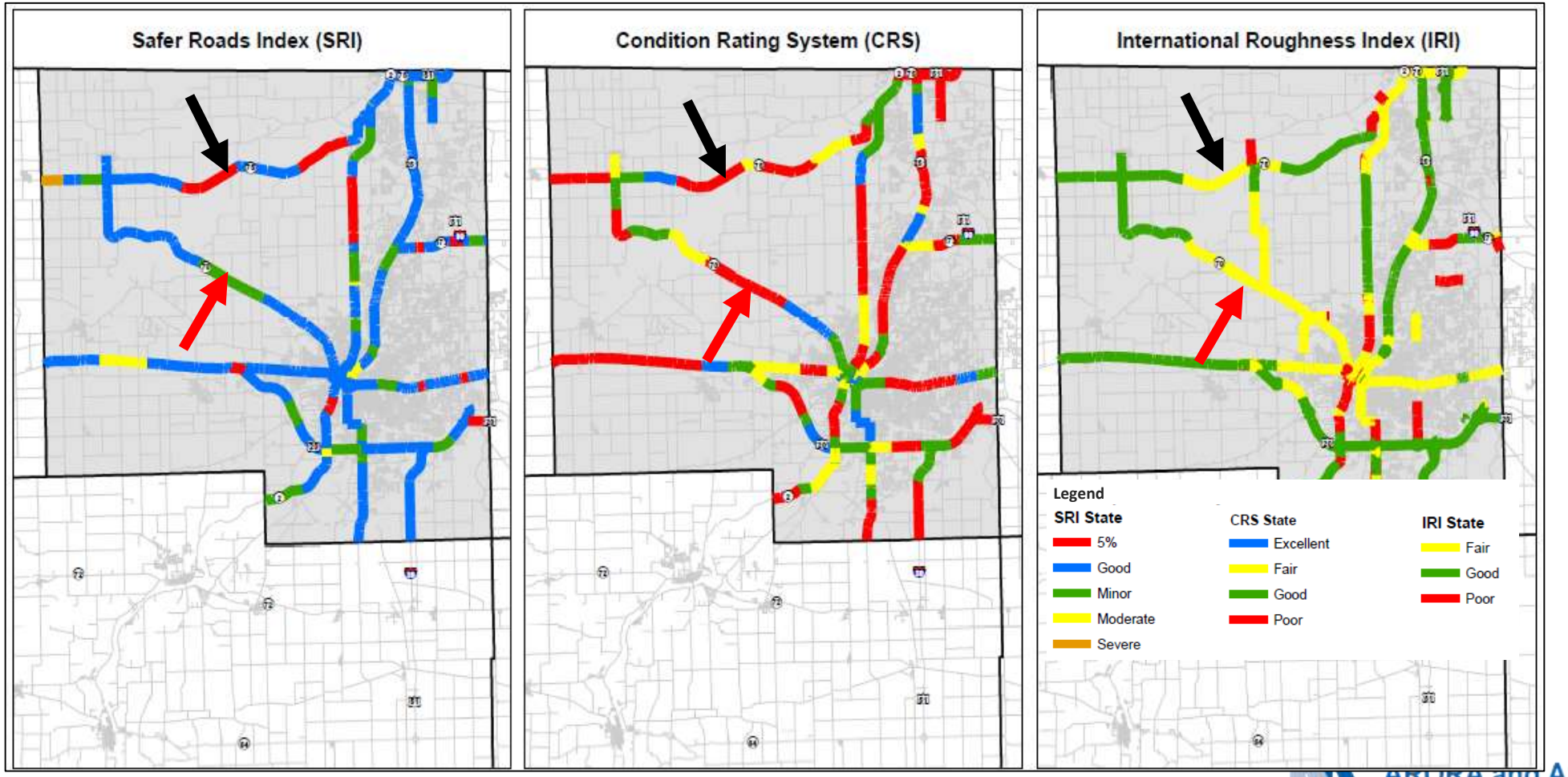
Segments Before...

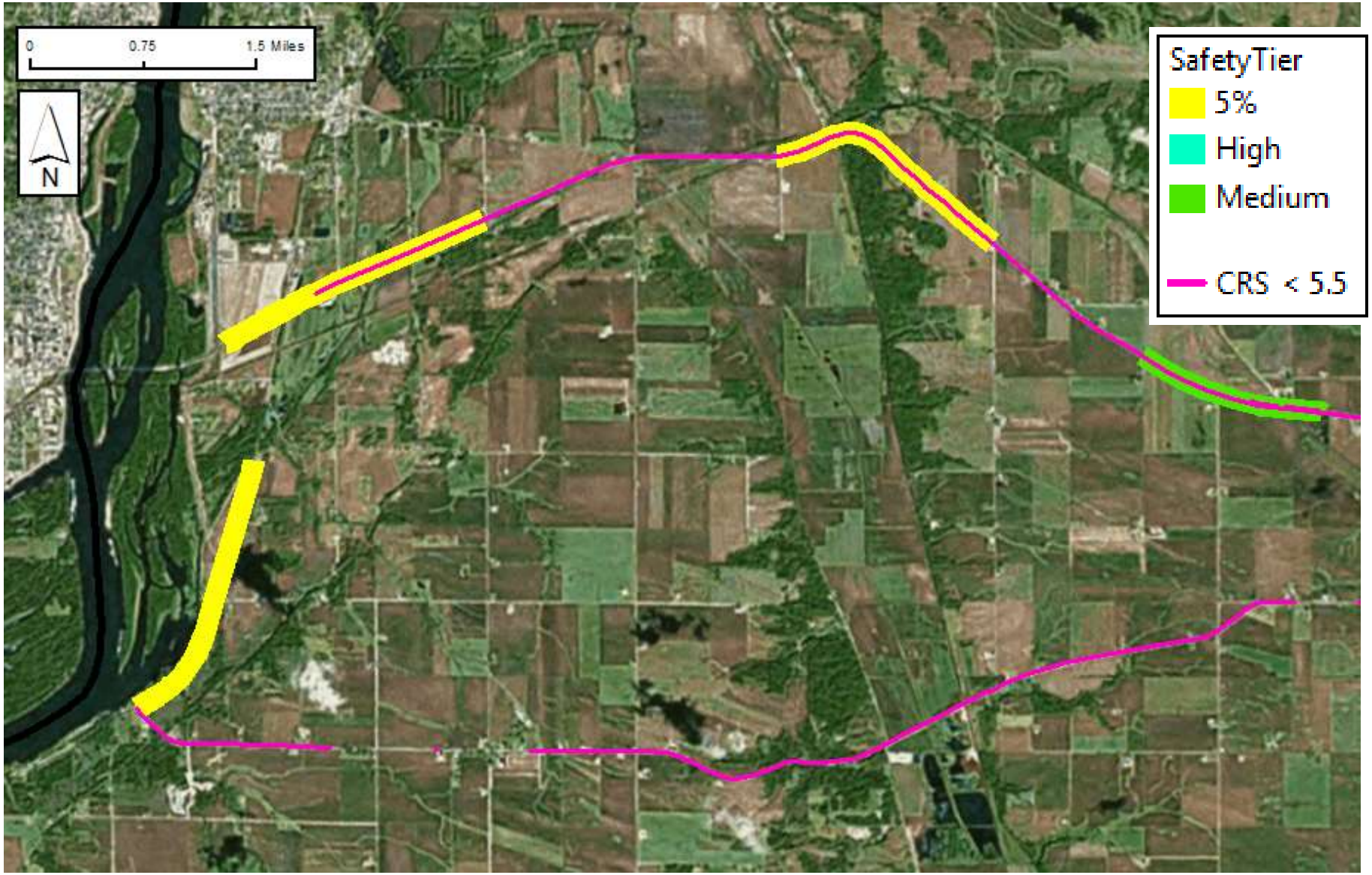
Segments After...



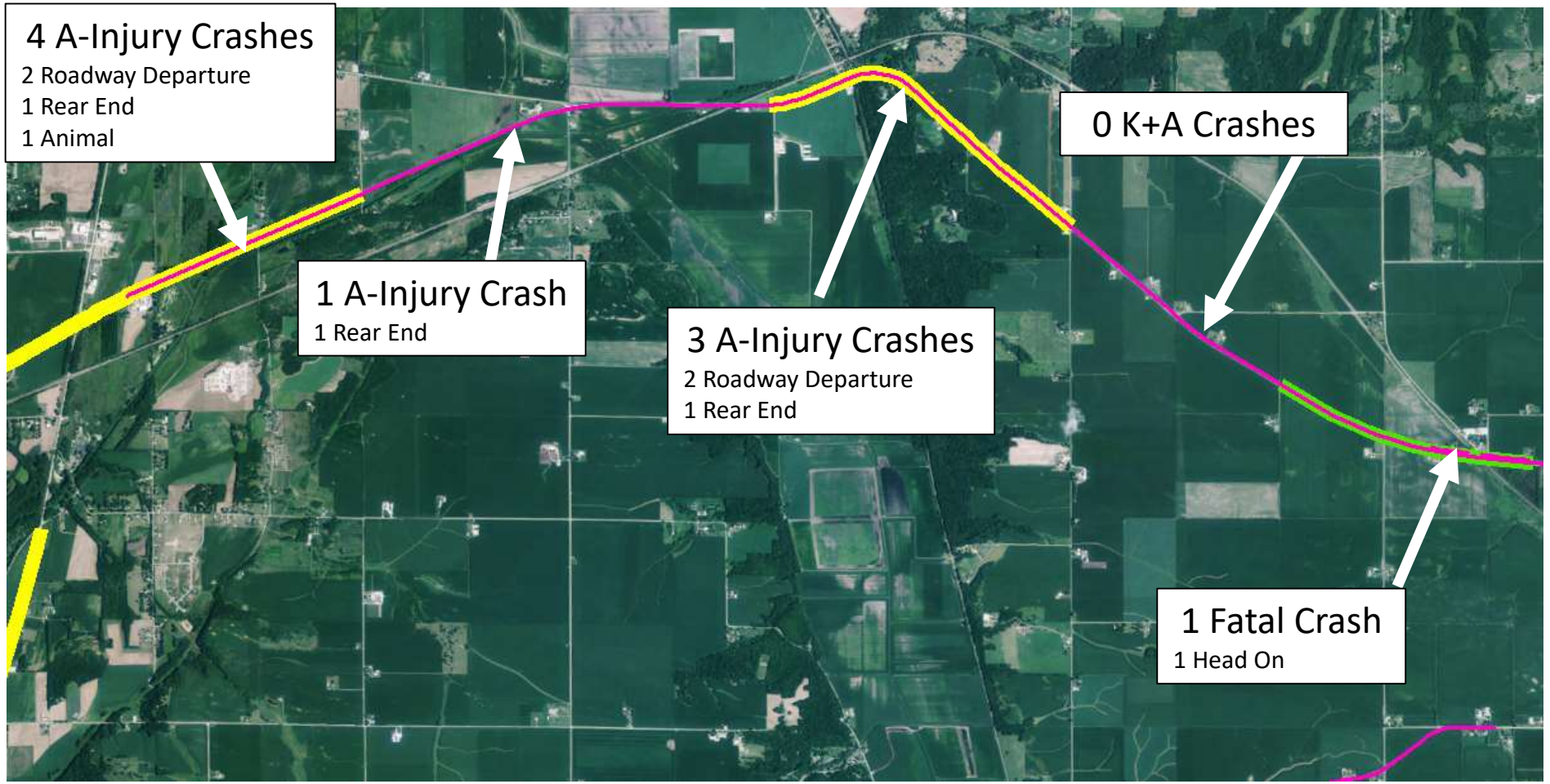
ARORA and ASSOCIATES, P.C

Transportation System & Performance Measures

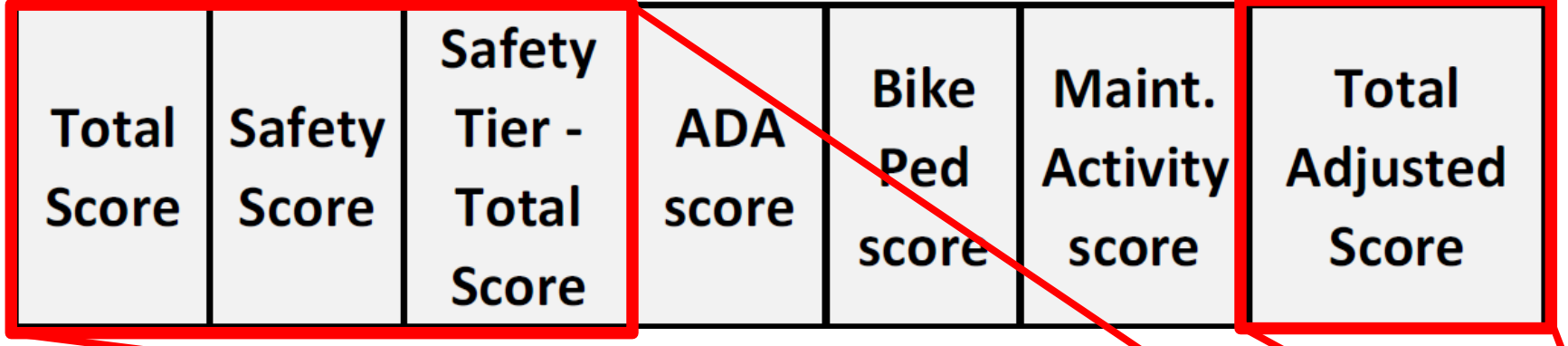




ARORA and ASSOCIATES, P.C



ARORA and ASSOCIATES, P.C

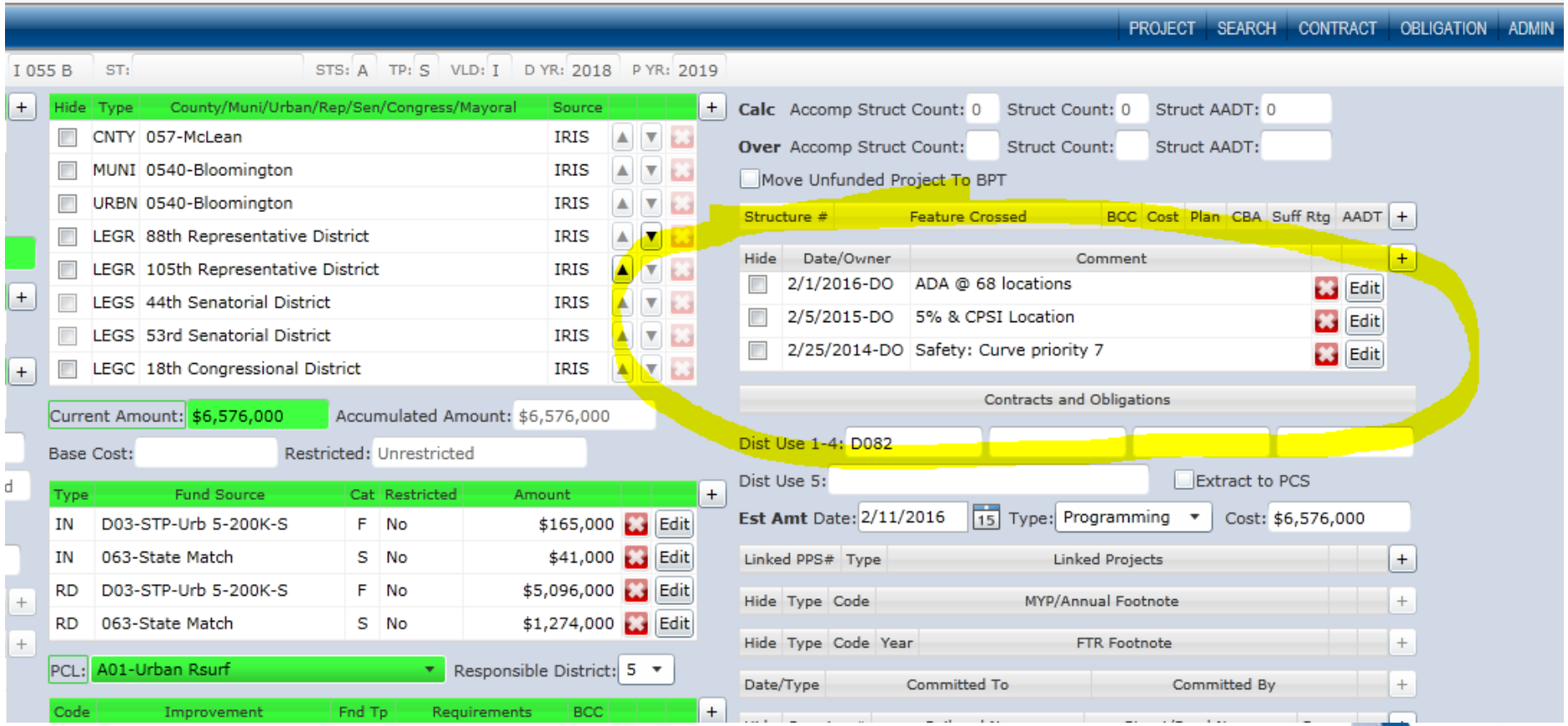


PPS Number	Marked Route	Street Name	Location	Program Cost	AADT Score	FC Score	NHS Score	CRS Score	Truck % Score	IRI Score	Rut Depth Score	Distress Score	Backlog Score	Total Score	Safety Score	Safety Tier - Total Score	ADA score	Bike Ped score	Maint. Activity score	Total Adjusted Score	Surface Year	Comments
5530240000	US 150	PROSPECT AVE	BLOOMINGTON RD TO SPRINGFIELD AVE IN CHAMPAIGN	1,125,000	2000	1250	500	2000	0	500	0	550	1250	8050	1500	0	100	0	0	9650	2014	Intermittent Inlay
5529990000	US 45	NEIL ST	SPRINGFIELD AVE IN CHAMPAIGN TO CURTIS RD IN SAVOY	3,491,000	2000	1250	500	1250	0	250	0	300	1000	6550	2000	0	100	0	750	9400	2007	**Worksheet Complete**
5530270000	US 150		PROSPECT AVE TO UNIVERSITY AVE IN CHAMPAIGN	1,050,000	1500	1250	500	0	0	0	0	0	2500	5650	2000	350	100	100	750	8950	2005	Need estimate
5530430000	I 55 BUS	VETERANS PKWY	CLEARWATER AVE TO I-55	6,125,000	2000	1250	500	500	0	250	1000	0	1250	6750	1500	0	100	0	0	8350	1998	**Worksheet Complete**
5529740000	ILL 9		ILL 122 TO I-74 IN BLOOMINGTON	3,100,000	1250	1250	500	500	0	0	0	300	2000	6150	1000	1000	0	0	0	8150	2003	Worksheet Complete
5539430000	US 45		US 36 AT TUSCOLA TO COLES CO LINE	3,666,000	500	500	0	1250	0	250	0	0	1250	5700	1000	500	100	100	750	8150	2010	**Worksheet Complete**
5535300000	US 150		MANSFIELD TO MAHOMET	2,350,000	500	250	0	2000	0	250	0	250	2500	5350	1000	1000	100	100	0	7550	2002	Worksheet Complete
5530080000	US 51 BUS	CENTER ST	US 51 BYP (N) TO US 51 BYP (S) IN CLINTON	1,330,000	1000	1250	500	500	0	250	0	1200	1250	5950	1000	200	100	100	0	7350	2004	Worksheet Complete

Safety Scoring

Safety Mark C = Critical H = High M = Medium	Safety Score	Safety Tier - Shldr mark 1, 2,	Safety Tier Shldr score	Safety Tier - Centerline mark 1, 2, or 3	Safety Tier - Centerline score	Safety Tier - Curve score mark 500	Safety Tier - Pedestrian score mark 500	Safety Tier - Total Score	Mark x if ADA	ADA score	Mark x if Bike/Ped	Bike/Ped score2	Mark x if LOS = D,E, or F	LOS score	Enter Maint. Activity	Maint. Activity score	Total Adjusted Score
h	1500		0		0			0	x	100		0		0		0	9650
	0	2	250	3	100			350		0		0		0		0	7700
	0	2	250	3	100			350	x	100		0		0		0	7550
h	1500		0		0			0	x	100		0		0		0	8350

Planning & Programming System



ARORA and ASSOCIATES, P.C

Curves

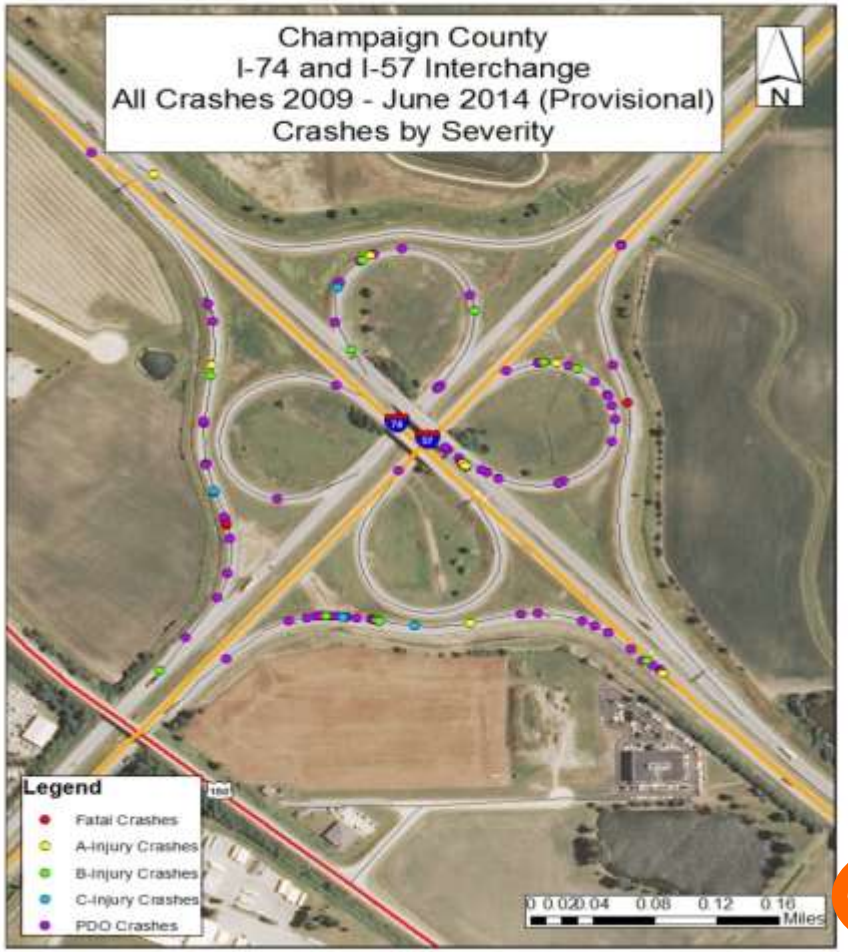
More than 25 percent of fatal crashes are associated with a horizontal curve, and the vast majority of these crashes are roadway departures.

Crash Rate: 3X higher than any other crash type.

Illinois:

- Curves represent 10% of total fatal and serious injury crashes and 30% of roadway departure.
- Identified the top 450 curves statewide (included Interstate Ramps)
- Further analysis completed to identify potential safety strategies
  - ✓ Super-elevation correction
  - ✓ Shoulders & chevrons
  - ✓ **HFST Candidates**

Ramps



Collision Type	Total	Fatal	A-Injuries	B-Injuries	C-Injuries	PDs
Fixed Object	79	2	3	3	3	71
Overturned	21	0	3	7	1	11
Angle	5	0	3	0	0	2
Sideswipe Same Direction	5	0	0	0	0	5
Rear End	3	0	0	2	0	1
Other Non-Collision	3	0	0	0	0	3
TOTAL:	116	2	9	12	4	93

Roadway Departure Crash Totals	
Collision Type	Total
Fixed Object	79
Overturned	21
TOTAL:	100

Road Surface		
Wet	78	67%
Dry	28	24%
Ice	7	6%
Snow or Slush	3	3%
Total:	116	

I-57 and I-74 Interchange Crash Totals – Crash Data Comparison of 08-13 thru 01-14 to 08-14 thru 01-15

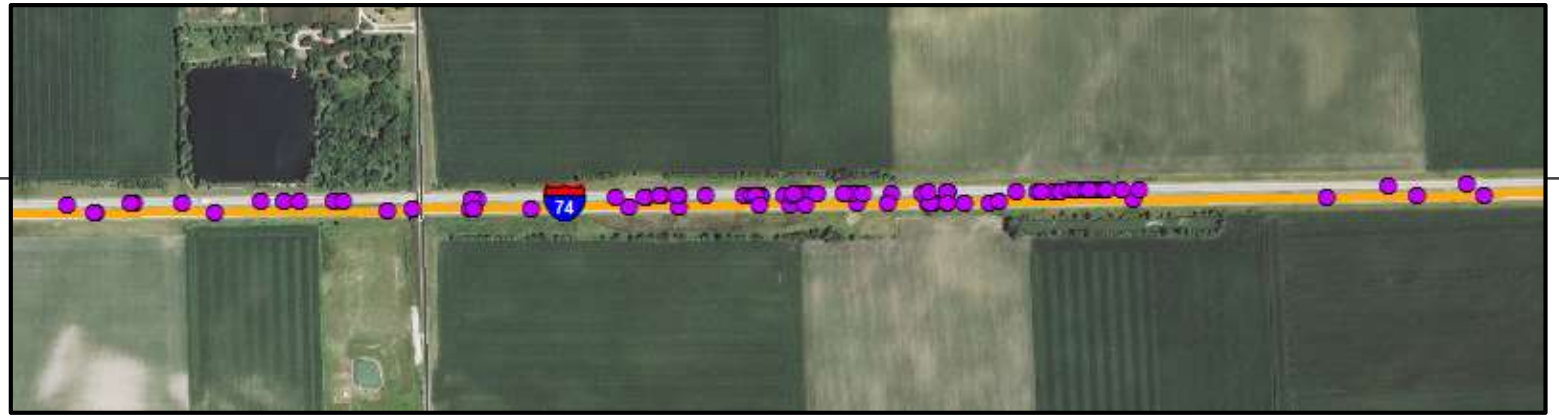
- Pre – HFST: 7 Total Crashes Reported (Aug 2013 – Jan 2014)
- Post – HFST: 0 Total Crashes Reported (Aug 2014 – Janu 2015)

Pre- and Post- HFST Friction

Friction Data for I-57/74 Interchange Ramps - Contract 70A52

Ramp	Pre-HFST						Post-HFST						Increase			
	Treaded			Smooth			Treaded			Smooth			Treaded		Smooth	
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg	FN_{AVG}	%	FN_{AVG}	%
I 57 SB on-ramp from I 74 WB	32	49	38	24	38	29	71	73	72	70	73	71	43	89.5	42	144.8
I 74 WB on-ramp from I 57 NB	33	50	41	31	22	43	75	80	77	75	76	76	34	87.8	33	76.7
I 57 NB on-ramp from I 74 EB	44	60	54	42	65	50	76	80	78	76	78	77	28	44.4	27	54.0
I 74 EB on-ramp from I 57 SB	38	58	45	31	42	36	79	80	80	79	80	80	44	77.8	44	122.2
I 74 WB on-ramp from I 57 SB	48	60	56	42	54	48	83	88	85	75	84	71	37	51.8	23	47.9
I 57 NB on-ramp from I 74 WB	38	57	48	27	49	37	77	85	81	79	85	83	44	68.8	46	124.3
I 74 EB on-ramp from I 57 NB	33	46	40	27	43	34	74	80	78	78	81	79	44	95.0	45	132.4
I 57 SB on-ramp from I 74 EB	30	55	44	21	42	30	77	85	81	75	77	76	51	84.1	46	153.3

I-74 Mainline Crash Data



COLL_TYPE	Total	Fatal	A-Injury	B-Injury	C-Injury	PDO
Fixed Object	54	0	1	2	2	49
Other Non-Collision	21	0	0	1	0	20
Sideswipe Same Direction	9	0	1	3	0	5
Rear End	8	0	0	3	0	5
Animal	6	0	0	0	0	6
Overturned	6	0	1	2	0	3
Pedestrian	1	0	0	1	0	0
Turning	0	0	0	0	0	0
Total	105	0	3	12	2	88

ROADWAY DEPARTURE CRASHES TOTALS						
COLL_TYPE	Total	Fatal	A-Injury	B-Injury	C-Injury	PDO
Fixed Object	54	0	1	2	2	49
Other Non-Collision	21	0	0	1	0	20
Overturned	6	0	1	2	0	3
Total	81	0	2	5	2	72

Vehicle Type	
Tractor With Semi-Trailer	56
Passenger	26
SUV	9
Pickup	8
Truck Single Unit	2
Other	1
N/A	1
Other Vehicle With Trailer	1
Tractor Without Semi-Trailer	1
Total	105

SURF_COND	
Wet	59
Dry	27
Snow or slush	13
Ice	5
Unknown	1
Total	105

I-74 Mainline Friction

Initial Friction Numbers for I-74: Very Low--SMOOTH
Wind/Wet Pavement Related Severe Crashes

Friction Data for I-74 Mainline - Contract 70B12						
Location	Post-HFST 6/22/2015					
	Treaded			Smooth		
	Min	Max	Avg	Min	Max	Avg
Eastbound Passing Lane	78	82	81	81	85	83
Westbound Passing Lane	80	83	81	80	82	81
Eastbound Traveling Lane	73	81	78	74	78	76
Westbound Traveling Lane	74	79	77	73	78	76

Considerations

- Curves are an issue—Chevrons, Superelevation, Friction Treatment
- Ramps can be an issue—Commercial Motor Vehicles have greater friction demand than available; in-sufficient funds to reconstruct interchanges/ramps
- Limited resources = Leverage those resources
- Better integration of data = better decisions = better use of resources
- Link Safety Performance to Friction
  - Help you identify contributing factors to crashes
  - Address safety and friction at the same time
  - Develop a Crash Modification Factor (CMF) or Adjustment Factor (AF) for friction

Questions

PRISCILLA A. TOBIAS, P.E., RSP
ARORA AND ASSOCIATES, P.C.
217-655-6601
PTOBIAS@ARORAPC.COM