A Systemic Safety Project Identification Process – Minnesota's County Road Safety Plans

South Dakota Transportation Safety Conference

April 4, 2012

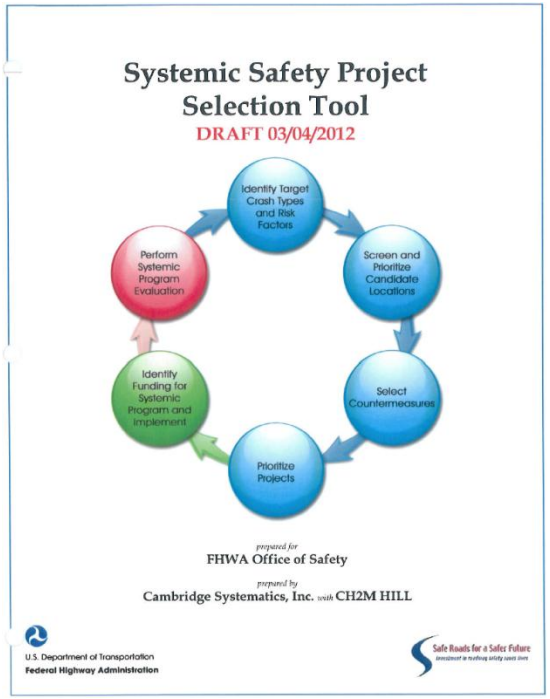
Howard Preston

CH2MHILL

Agenda

- Background & Crash Overview
- Selection of Strategies
- Systemic Approach
  - Segments
  - Curves
  - Intersections
- Project Summary
- Report Outline

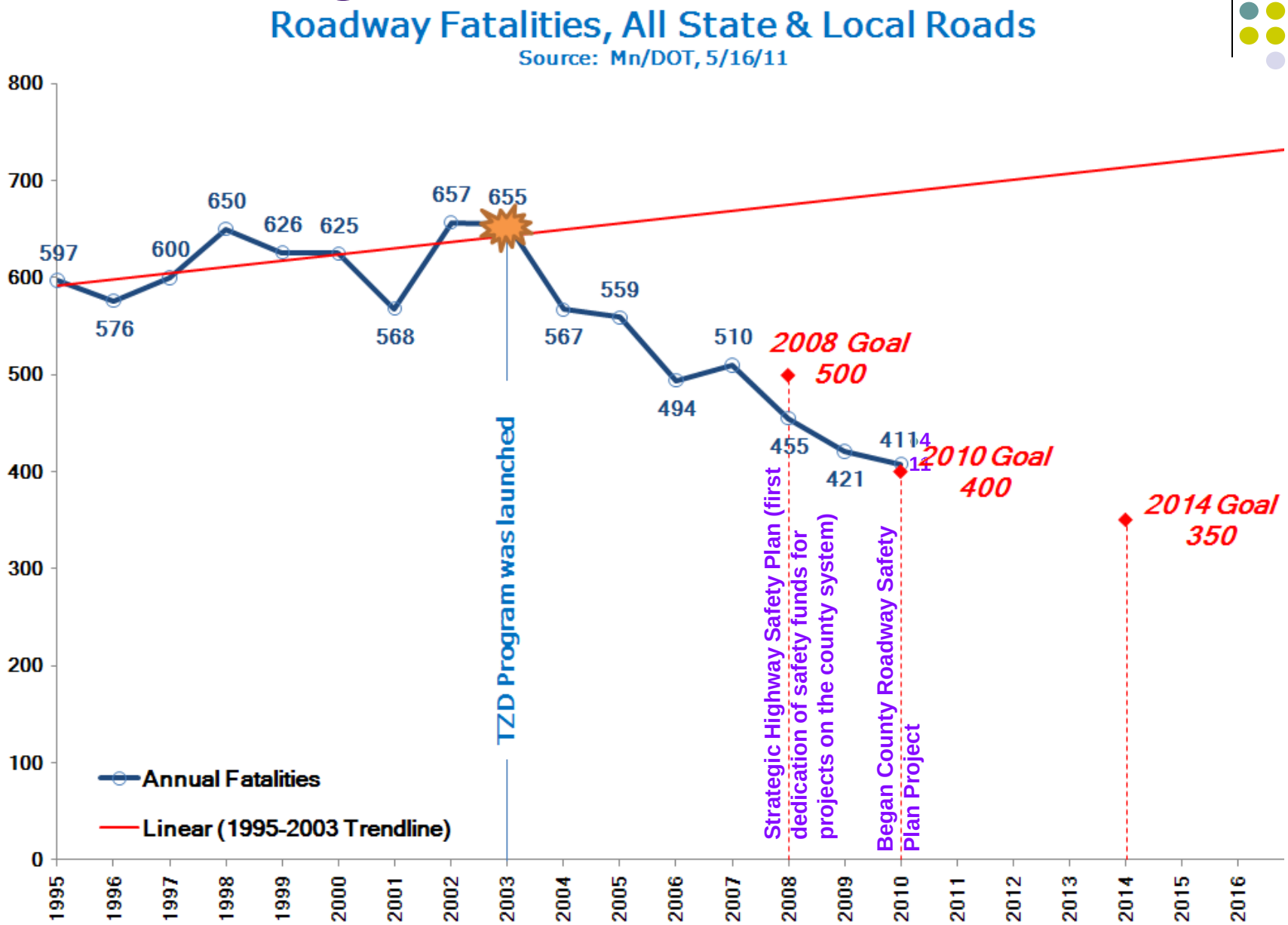
Background



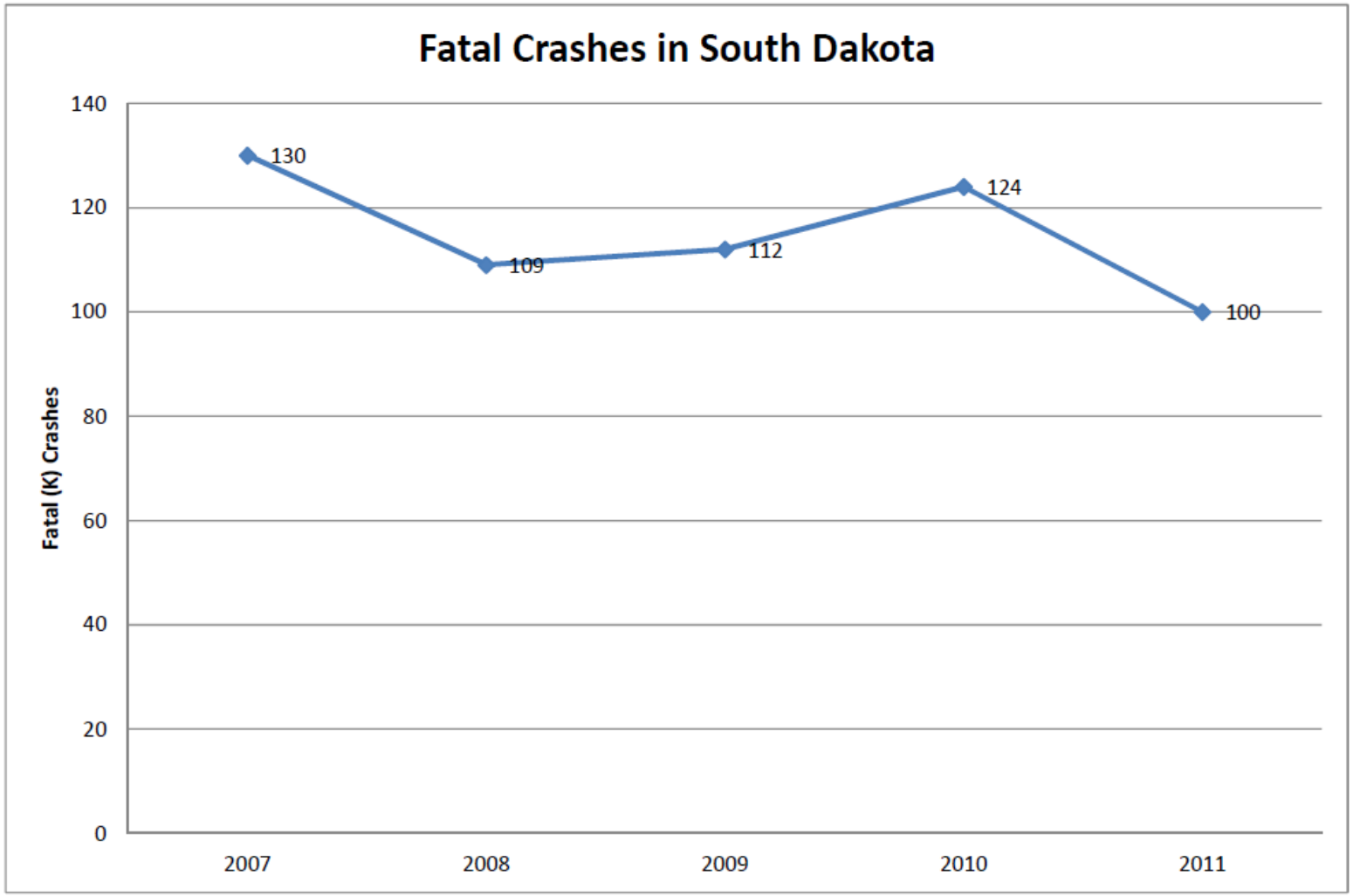
- There is currently an effort underway led by FHWA to develop a systemic safety project selection tool.
- This effort is based on a recognition of the fact that most traditional safety program development has been based on identifying high crash locations – ***but*** this method does not work well when states adopt severe crashes as their safety performance measure.
- Locations with severe crashes have been found to be randomly scattered – primarily along systems of rural roadways

- A new safety analysis method is being developed that is based on using surrogates for crashes – roadway geometry and traffic characteristics – as risk factors.
- This methodology then involves conducting a systemic evaluation of systems of roadways using the risk factors to prioritize locations for safety investment.
- This new methodology is being used to produce Safety Plans for every county in Minnesota

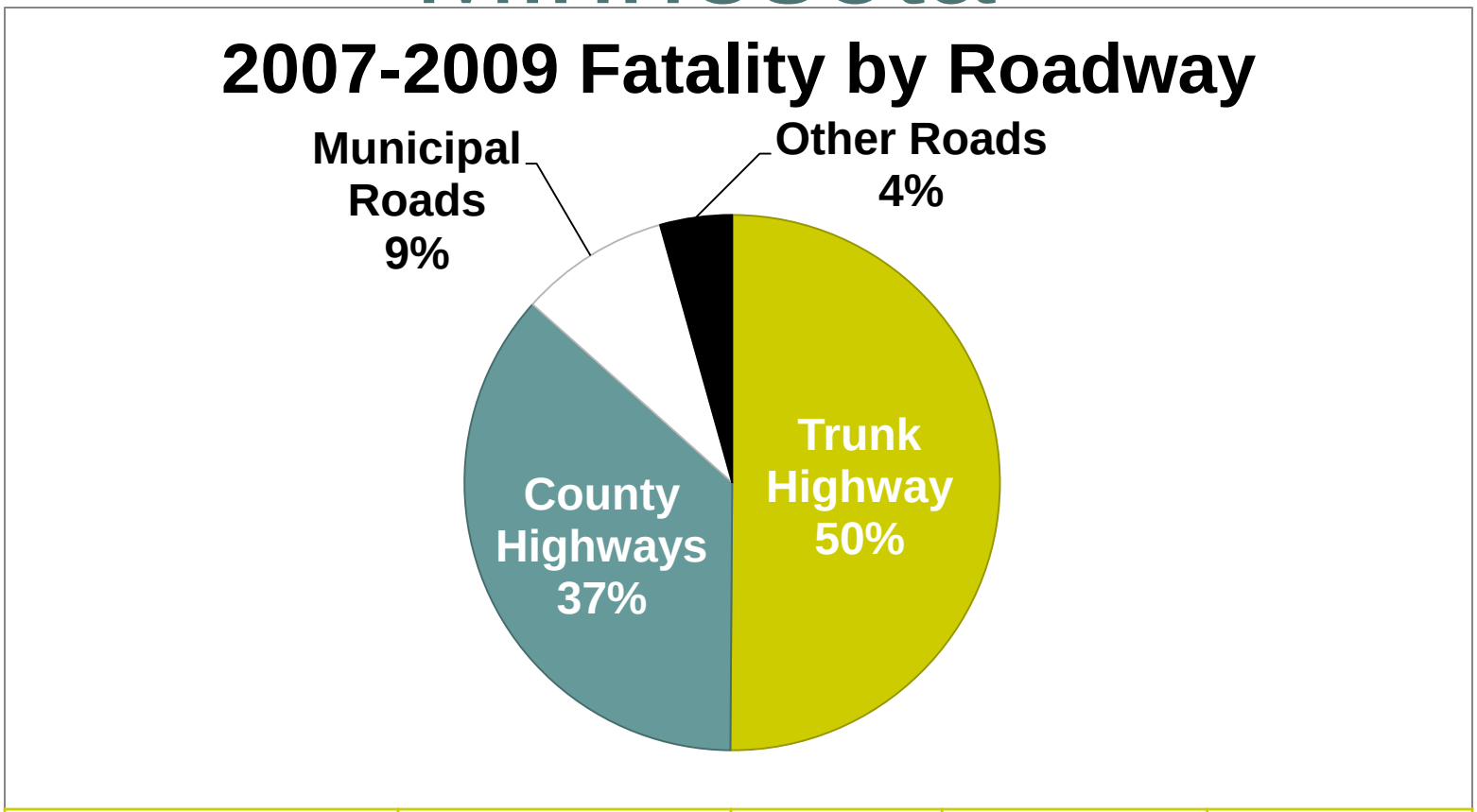
Reversing the trend in Minnesota



Reversing the trend in South Dakota

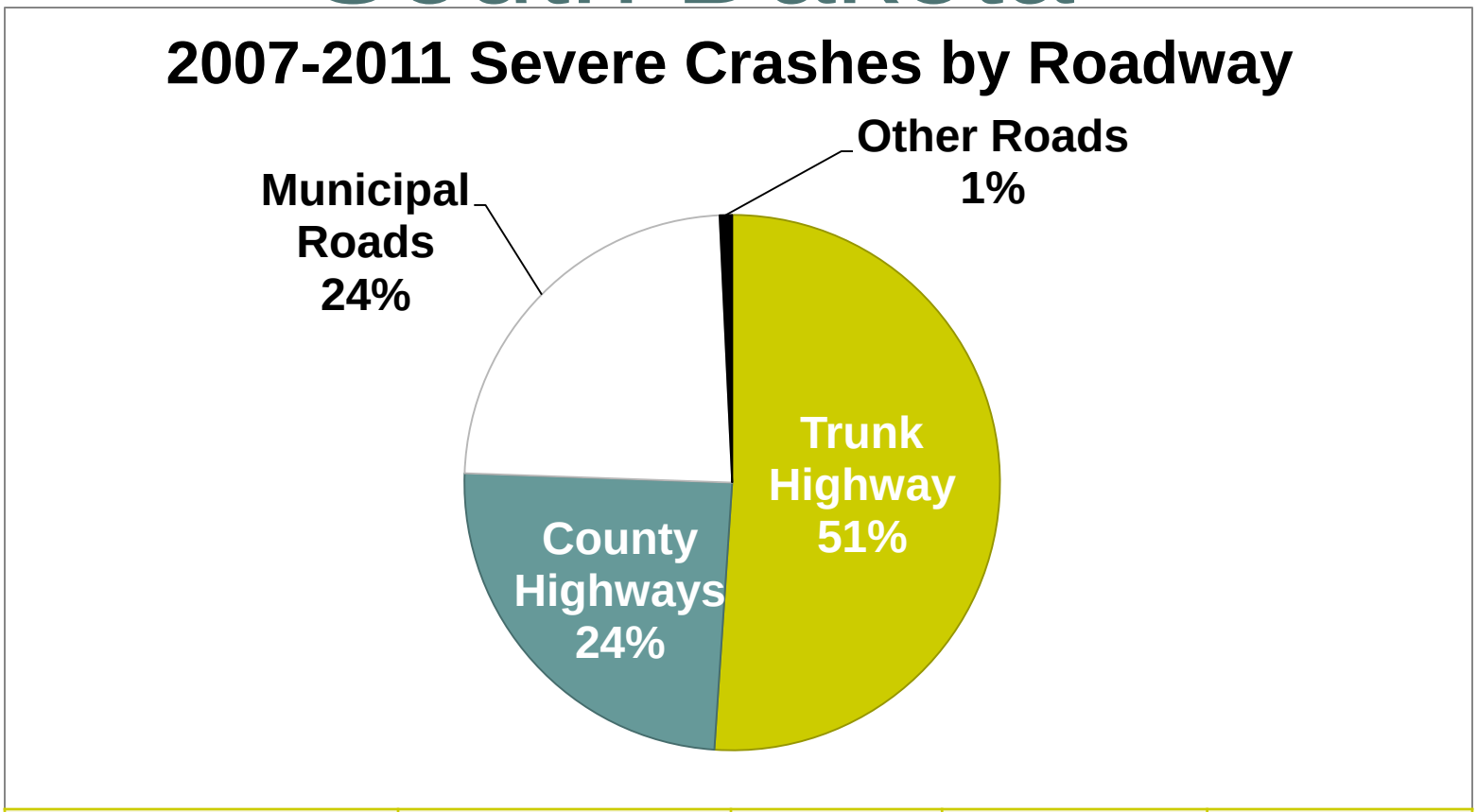


Minnesota



Roadway	# Killed: 2009	% Killed	# Rural	% Rural
Trunk Highway	191	46%	140	48%
County Highways	169	40%	132	45%
City Streets	42	10%	5	2%
Other Roads	16	4%	16	5%

South Dakota



Roadway	# Severe Crashes	% Severe Crashes	# Rural	% Rural
Trunk Highway	1970	51%	1617	82%
County Highways	945	24%	910	96%
City Streets	914	24%	1	0%
Other Roads	29	1%		

Minnesota HSIP Program

- Challenge to determine where to focus safety funds
  - Black spots are infrequent on local roads
  - Fatal and Severe injury crashes are random on local rural roads

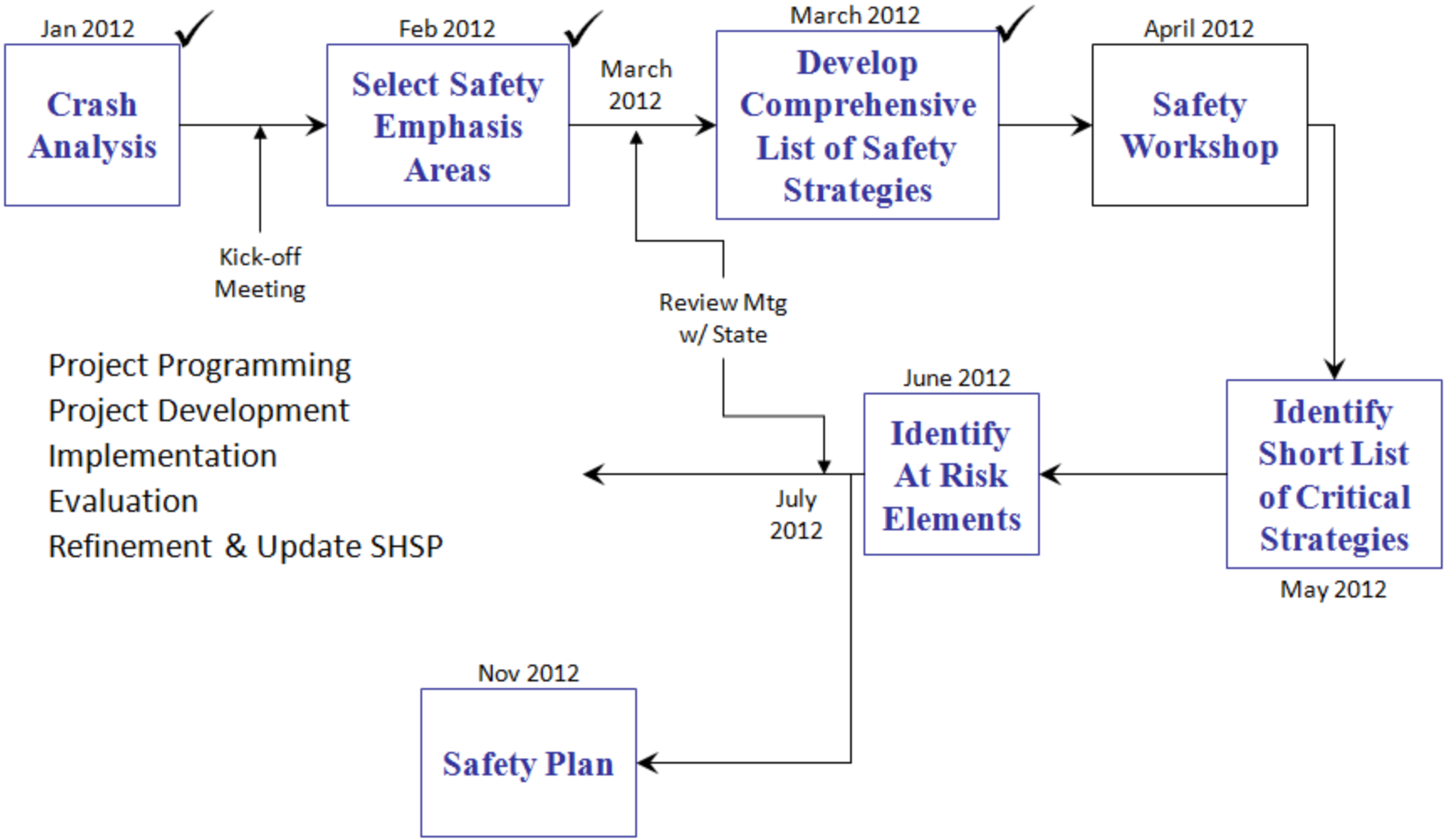
County Roads

- 2,089 Severe Crashes
- 45,000 miles of road
- 0.05 severe crashes per mile

Trunk Highway

- 2,168 Severe Crashes
- 12,000 miles of road
- 0.18 severe crashes per mile

South Dakota Safety Plan Development Process



Minnesota – Safety Emphasis Areas

Emphasis Area		Statewide Percentage	ATP 4 Interstate, US & TH	ATP 4 CSAH & CR	ATP 4 Twnshp & Other	ATP 8 Interstate, US & TH	ATP 8 CSAH & CR	ATP 8 Twnshp & Other
Total Fatal and Serious Injury Crashes		9,122	249	230	94	202	219	110
Drivers	Young drivers (under 21)	26%	26% (65)	16% (36)	29% (27)	27% (55)	30% (65)	25% (27)
	Unlicensed drivers	8%	6% (16)	7% (16)	9% (8)	5% (10)	6% (14)	5% (5)
	Older drivers (over 64)	13%	24% (60)	15% (34)	10% (9)	21% (43)	16% (35)	11% (12)
	Aggressive driving and speeding-related	21%	20% (50)	27% (62)	22% (21)	11% (22)	24% (53)	20% (22)
	Drug and alcohol-related	26%	20% (51)	39% (89)	32% (30)	20% (40)	33% (72)	25% (28)
	Inattentive, distracted, asleep drivers	20%	23% (58)	19% (43)	17% (16)	18% (36)	16% (36)	14% (15)
	Safety awareness	- -	- -	- -	- -	- -	- -	- -
	Unbelted vehicle occupants	26%	31% (78)	38% (87)	31% (29)	33% (67)	43% (95)	44% (48)
Special Users	Pedestrians crashes	8%	4% (10)	3% (7)	7% (7)	3% (7)	3% (6)	6% (7)
	Bicycle crashes	4%	0% (0)	2% (5)	6% (6)	2% (4)	0% (0)	5% (5)
Vehicles	Motorcycles crashes	15%	9% (23)	18% (41)	18% (17)	9% (19)	10% (22)	10% (11)
	Heavy vehicle crashes	9%	19% (47)	7% (16)	2% (2)	25% (50)	6% (14)	11% (12)
	Safety enhancements	- -	- -	- -	- -	- -	- -	- -
Highways	Train-vehicle collisions	0%	1% (2)	0% (0)	6% (6)	0% (0)	0% (0)	2% (2)
	Road departure crashes	27%	28% (69)	49% (113)	31% (29)	24% (48)	51% (111)	32% (35)
	Consequences of leaving road	- -	- -	- -	- -	- -	- -	- -
	Intersection crashes	42%	34% (84)	36% (82)	37% (35)	42% (85)	34% (74)	45% (50)
	Head-On and Sideswipe (opposite) crashes	15%	22% (54)	23% (54)	13% (12)	22% (45)	21% (45)	7% (8)
	Work zone crashes	1%	1% (3)	1% (2)	0% (0)	0% (1)	1% (3)	0% (0)
EMS	Enhancing Emergency Capabilities	- -	- -	- -	- -	- -	- -	- -
Management	Information and decision support systems	- -	- -	- -	- -	- -	- -	- -
	More effective processes	- -	- -	- -	- -	- -	- -	- -

DPS Crash Data Records, 2005 to 2009

Top 5 Emphasis Areas by Jurisdiction

Note: Numbers are not additive, as one crash may involve a young driver at an intersection.

The numbers represent severe crashes (Fatal and A-type Injury crashes)

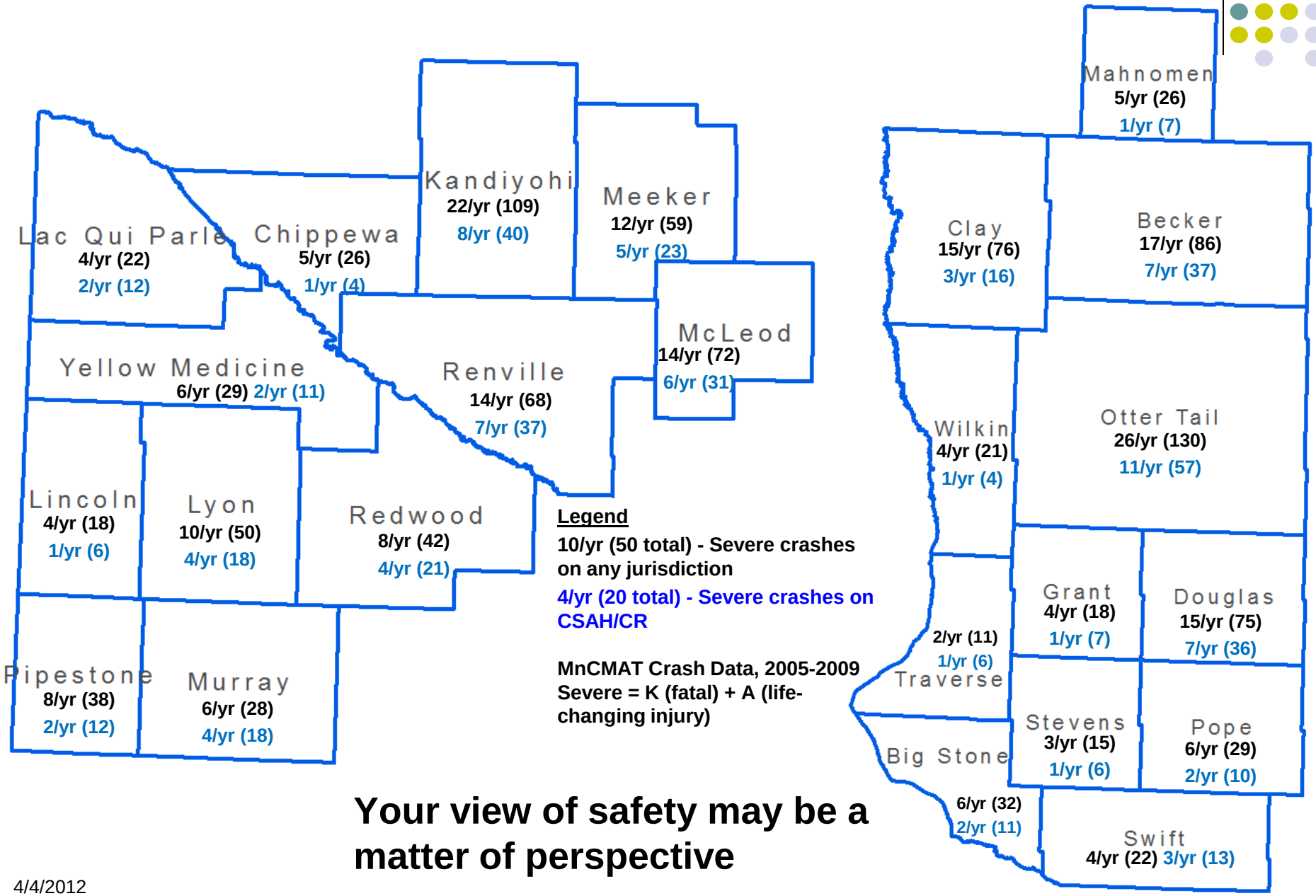
South Dakota - Safety Emphasis Areas

South Dakota -- Severe (K + A) Crashes *DRAFT* *2007 - 2011 SDARS Crash Data*

Emphasis Areas		State (All Roads)		State Roads (Interstate, U.S., SD)		County Roads		City Streets		Other	
		Percent	#	Percent	#	Percent	#	Percent	#	Percent	#
Drivers	Young Drivers (under 21)	23%	899	18%	350	27%	257	31%	286	21%	6
	Unlicensed Drivers	12%	470	9%	183	19%	175	12%	108	14%	4
	Older Drivers (over 64)	15%	592	19%	373	10%	96	13%	121	7%	2
	Aggressive Driving and Speeding-Related	28%	1,080	29%	573	28%	267	25%	227	45%	13
	Drug and Alcohol-Related	24%	926	20%	386	37%	345	20%	184	38%	11
	Inattentive, Distracted and Asleep Drivers	13%	508	14%	271	12%	109	14%	125	10%	3
	Safety Awareness	-	-	-	-	-	-	-	-	-	-
	Unbelted Vehicle Occupants*	37%	1,440	36%	706	50%	475	27%	251	28%	8
Other Users	Pedestrian Crashes	5%	188	3%	53	2%	19	12%	114	7%	2
	Bicycle Crashes	1%	57	1%	14	0%	1	5%	42	0%	0
Vehicles	Motorcycle Crashes	21%	825	26%	504	19%	175	15%	134	41%	12
	Heavy Vehicle Crashes	8%	312	12%	236	5%	50	3%	26	0%	0
	Safety Enhancements	-	-	-	-	-	-	-	-	-	-
Highways	Train-Vehicle Collisions	0%	18	0%	7	1%	6	1%	5	0%	0
	Run-off-the Road Crashes	52%	2,021	53%	1,048	76%	721	25%	231	72%	21
	Consequences of leaving the road (run-off-the-road crashes involving a fixed object or overturn)	*52%*	*1,994*	*53%*	*1,036*	*75%*	*713*	*25%*	*225*	*69%*	*20*
	Head-On and Sideswipe-Opposing Crashes	5%	190	6%	127	5%	46	2%	17	0%	0
	Roadway Departure Subtotal = Run-off-theRoad and Head-On / Sideswipe-Opposing Crashes	57%	2,211	60%	1,175	81%	767	27%	248	72%	21
	Intersection Crashes	27%	1,041	21%	419	14%	137	52%	477	28%	8
	Work Zone Crashes	2%	93	4%	75	1%	7	1%	11	0%	0
EMS	Enhancing Emergency Capabilites	-	-	-	-	-	-	-	-	-	-
Management	Information and Decisions Support Systems	-	-	-	-	-	-	-	-	-	-
	More Effective Processes	-	-	-	-	-	-	-	-	-	-
Totals		3,858		1,970		945		914		29	

--Numbers are not additive, as there could be a young and distracted driver for example.

Minnesota - ATP 4 & 8 County Severe Crash Numbers



Legend

10/yr (50 total) - Severe crashes on any jurisdiction

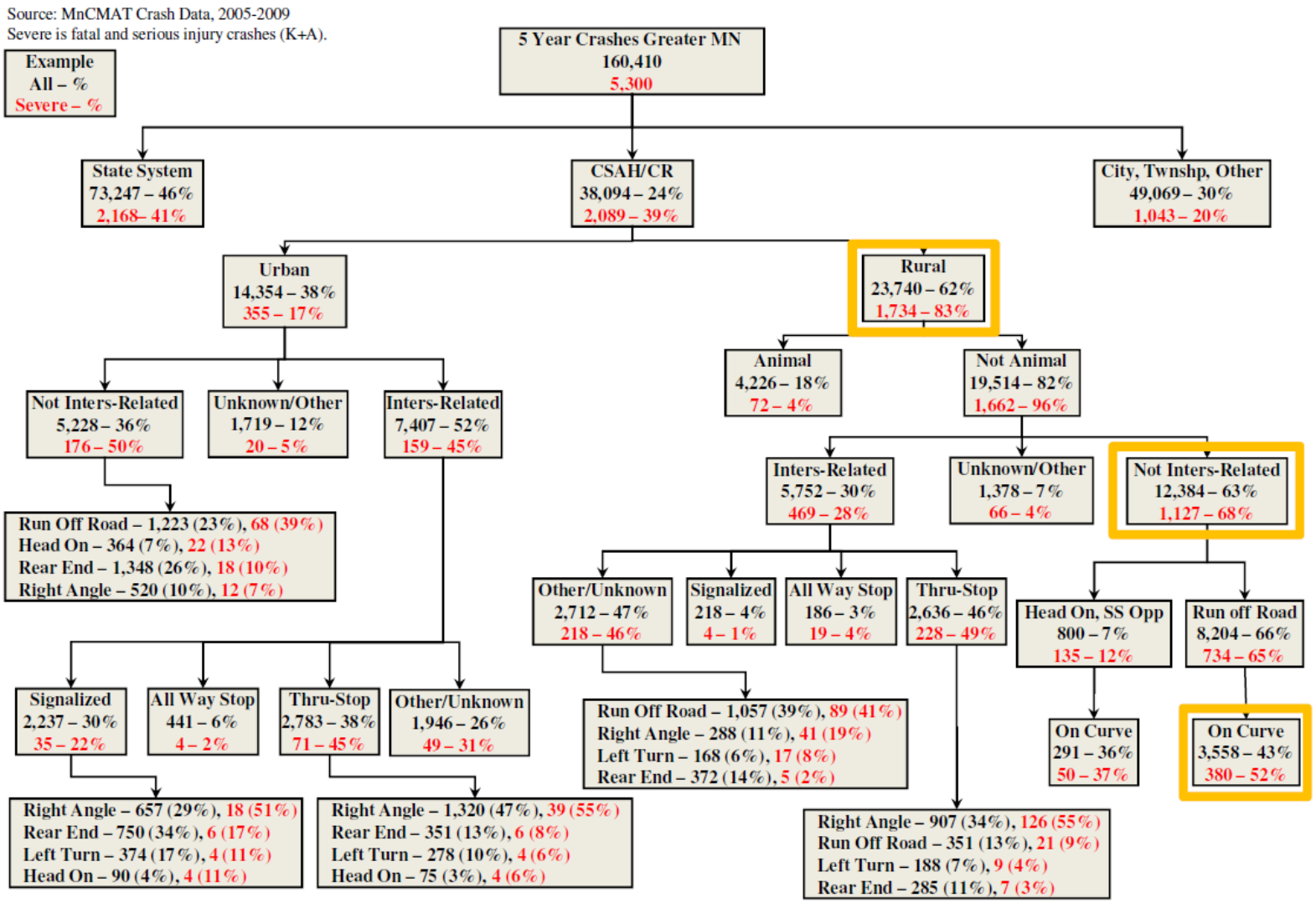
4/yr (20 total) - Severe crashes on CSAH/CR

MnCMAT Crash Data, 2005-2009
Severe = K (fatal) + A (life-changing injury)

Your view of safety may be a matter of perspective

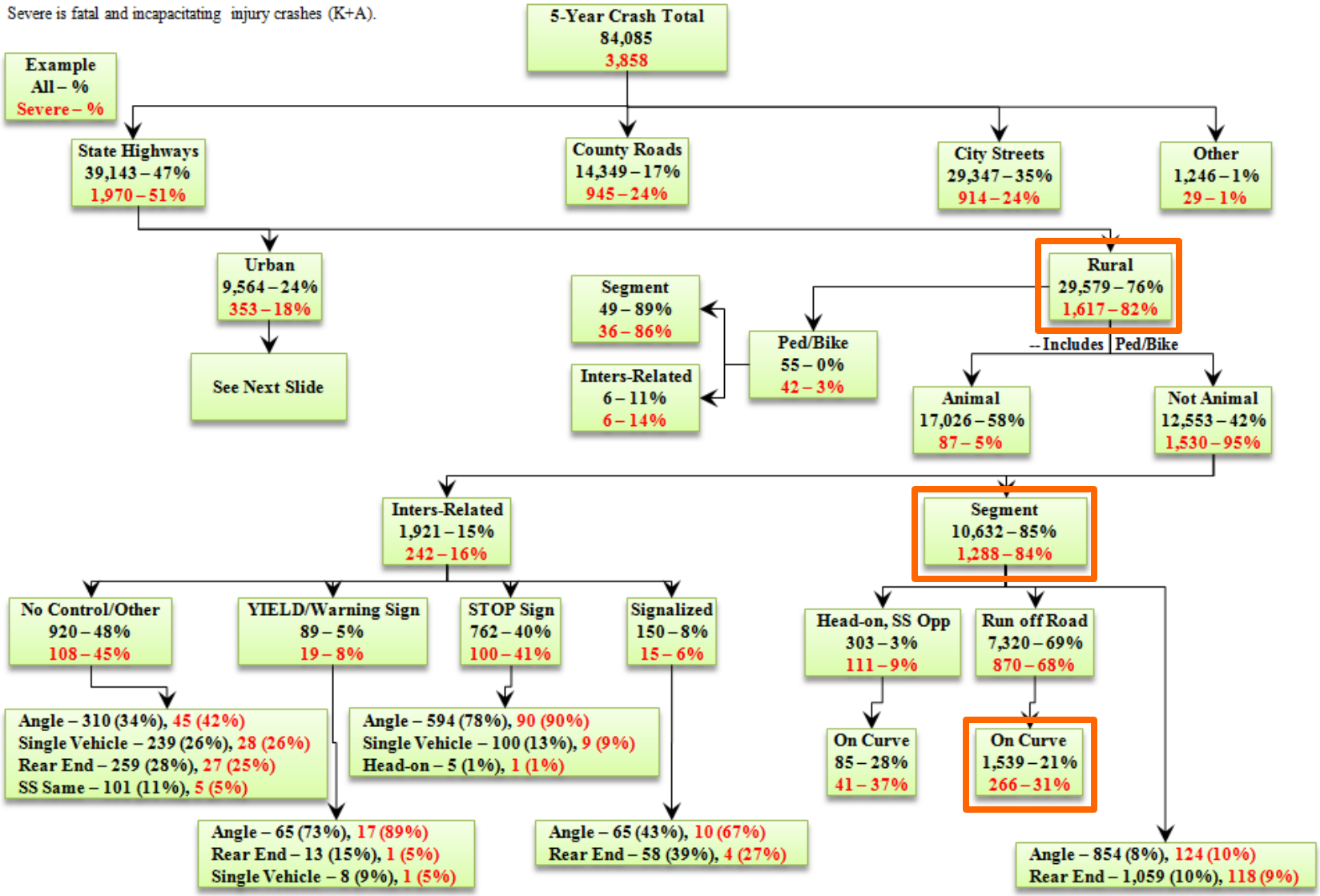
Greater MN County Crash Data Overview

-ATP's 1, 2, 3, 4, 6, 7, and 8 – *NO* Metro



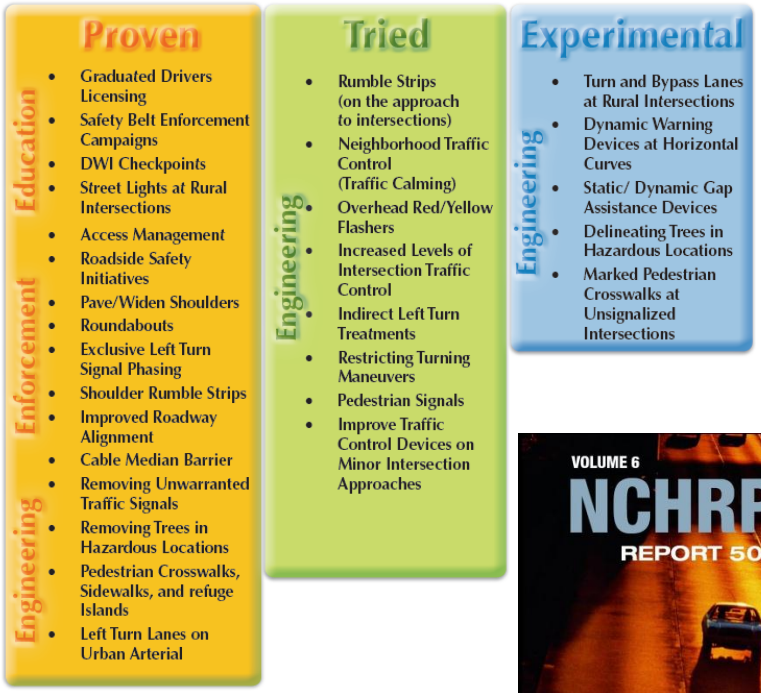
South Dakota Crash Data Overview

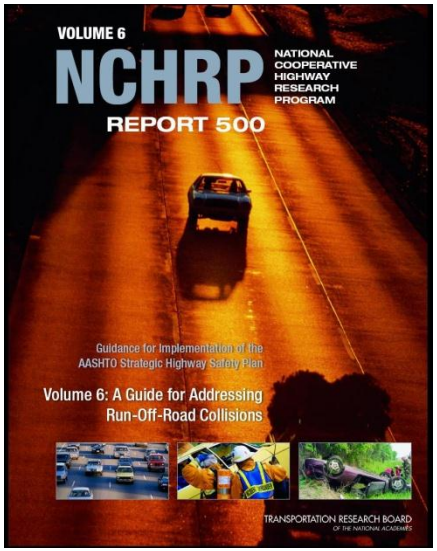
Source: 2007-2011 SDARS Crash Data
Severe is fatal and incapacitating injury crashes (K+A).



Safety Strategies Overview NCHRP Report 500

- A series of guides to assist state and local agencies in reducing injuries and fatalities in targeted emphasis areas
- The guides correspond to the emphasis areas outlined in the AASHTO Strategic Highway Safety Plan.
- Each guide includes a brief introduction, a general description of the problem, the strategies/ countermeasures to address the problem, and a model implementation process.





List of Road Departure Strategies

List of Road Departure Strategies

Objectives	Strategies	Relative Cost to Implement and Operate	Effectiveness	Typical Timeframe for Implementation
15.1 A -- Keep vehicles from encroaching on the roadside	15.1 A1 -- Install shoulder rumble strips	Low	Proven*	Short
	15.1 A2 -- Install enhanced pavement markings, edgeline rumble strips or modified shoulder rumble strips on section with narrow or no paved shoulders	Low	Experimental/ Tried	Short
	15.1 A3 -- Install centerline rumble strips	Low	Proven*	Short
	15.1 A4 -- Provide enhanced shoulder or delineation and marking for sharp curves	Low	Tried / Proven	Short
	15.1 A5 -- Provide improved highway geometry for horizontal curves	High*	Proven	Long
	15.1 A8 -- Apply shoulder treatments *Eliminate shoulder drop-offs *Shoulder edge *Widen and/or pave shoulders	Moderate*	Experimental/ Proven	Medium
15.1 B -- Minimize the likelihood of crashing into an object or overturning if the vehicle travels off the shoulder	15.1 B1 -- Design safer slopes and ditches to prevent rollovers	Moderate to High*	Proven	Medium
	15.1 B2 -- Remove/relocate objects in hazardous locations	Moderate to High	Proven	Medium

Source: NCHRP 500 Series (2003)

Short (<1 year)	Low (<$10,000/mile)
Medium (1-2 years)	Moderate ($10,000-$100,000/mile)
Long (>2 years)	High (>$100,000/mile)

*Updated by CH2M HILL

Example – Typical Run-Off Road Strategies

Lane Departure Crashes

Key Objectives:
Keep Vehicles in Their Lane

Key Strategies:

- Improved curve delineation
- Improved lane markings

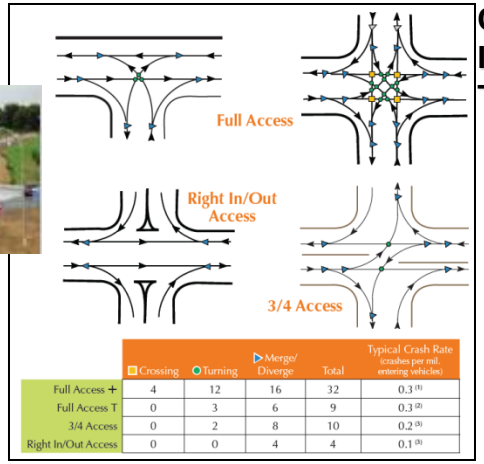
Key Objectives:
Improve Shoulders

Key Strategies:

- Safety edge
- Paved shoulders
- Shoulder rumble strips

Example – Typical Intersection Strategies

Included Strategies:

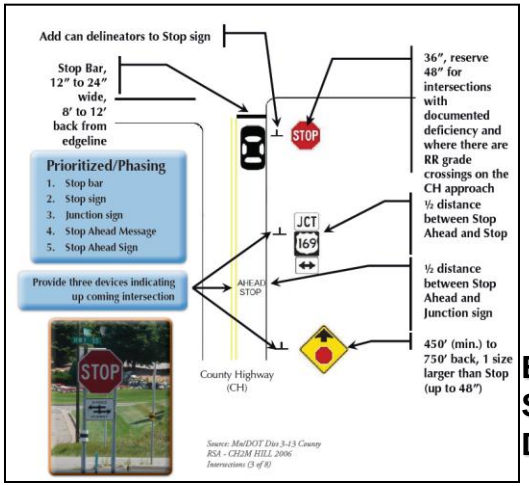


	Crossing	Turning	Merge/ Diverge	Total	Typical Crash Rate (crashes per mil. entering vehicles)
Full Access +	4	12	16	32	0.3 (1)
Full Access T	0	3	6	9	0.3 (2)
3/4 Access	0	2	8	10	0.2 (3)
Right In/Out Access	0	0	4	4	0.1 (3)

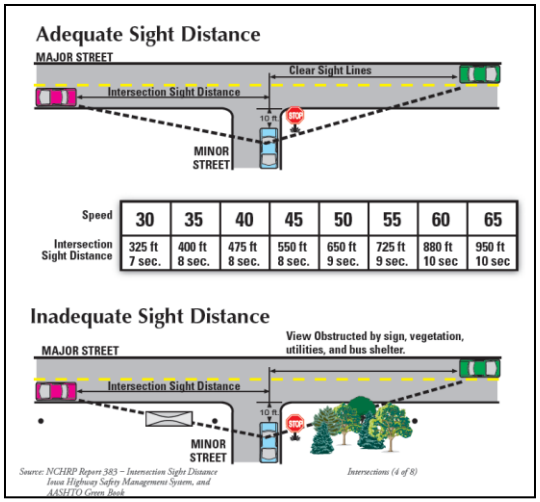
Change Intersection Type

Street Lighting

Dynamic Warning Signs

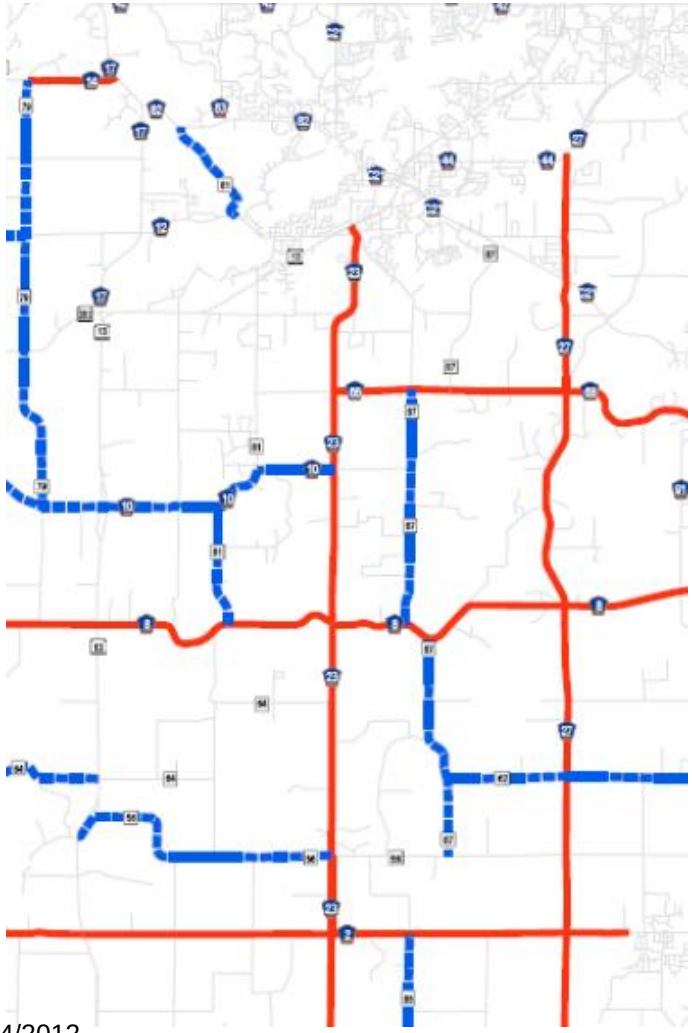


Enhanced Signing and Delineation



Improve Sight Distance

A Systemic Approach



- The average county in Minnesota includes:
  - 500 miles of county highway
  - 400 horizontal curves
  - 180 controlled intersections
- The key questions:
- Is every element of the county system equally at risk?
- Where to Start?
- A new approach to safety planning

<u>Old Approach</u>

Crashes = Risk & No Crashes = No Risk

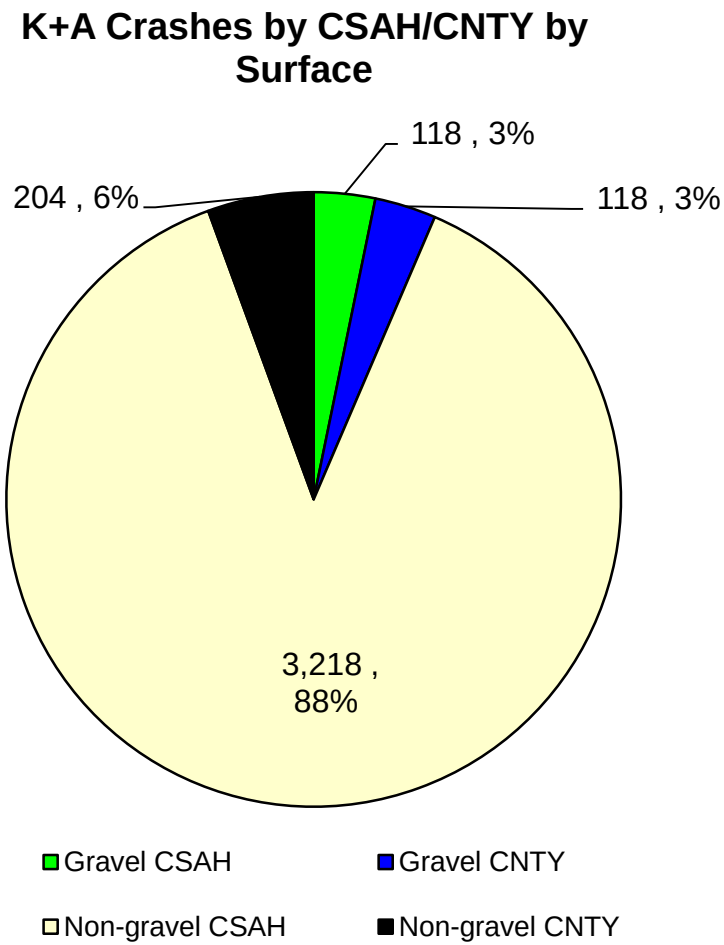
<u>New Approach</u>

No Crashes ≠ No Risk

Use surrogates of crashes (roadway and traffic characteristics) to identify risk and prioritize – the 5 ★ (or 6) Ranking System

Gravel Roads

- Gravel roads make up approximately 44% of Minnesota's 45,000 mile County Highway system.
- Almost one-half of Minnesota's counties have NO fatal crashes on their gravel roads and only ONE county averages one fatal crash per year.
- Severe RD Crash Density
  - Gravel Roads: 0.001 crashes/mi/year
  - Paved Roads: 0.006 crashes/mi/year
- Statewide, 94% of crashes and 88% of severe crashes occur on the 56% of the county system that is paved.
- Gravel roads have been removed from further detailed analysis



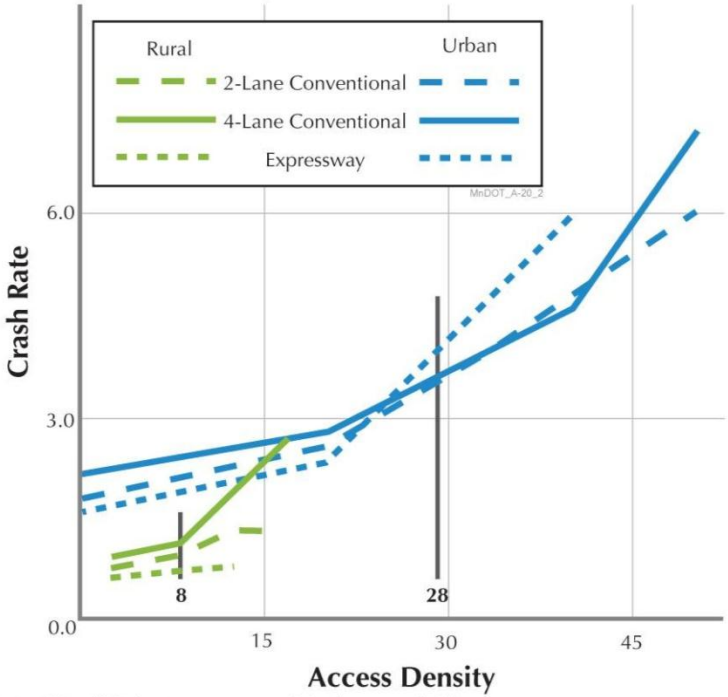
Note: Some counties removed gravel roads from segments lists

Rural Paved Segments

- 47 counties in ATP 3, 4, 6 & 8
- 13,813 rural paved miles
  - Rural Road Departure Crashes
    - 21,611 total, 1,464 severe, 637 Severe RD
    - Average Density of Sev RD Crashes= 0.009 crashes/mi/year
- Risk Rating Criteria
  - Density of Road Departure Crashes (based on County data)
  - Traffic Volume (based on ATP data)
  - Curve (Critical Radius) Density (based on County data)
  - Access Density (based on County data)
  - Edge Risk Assessment (based on County data)

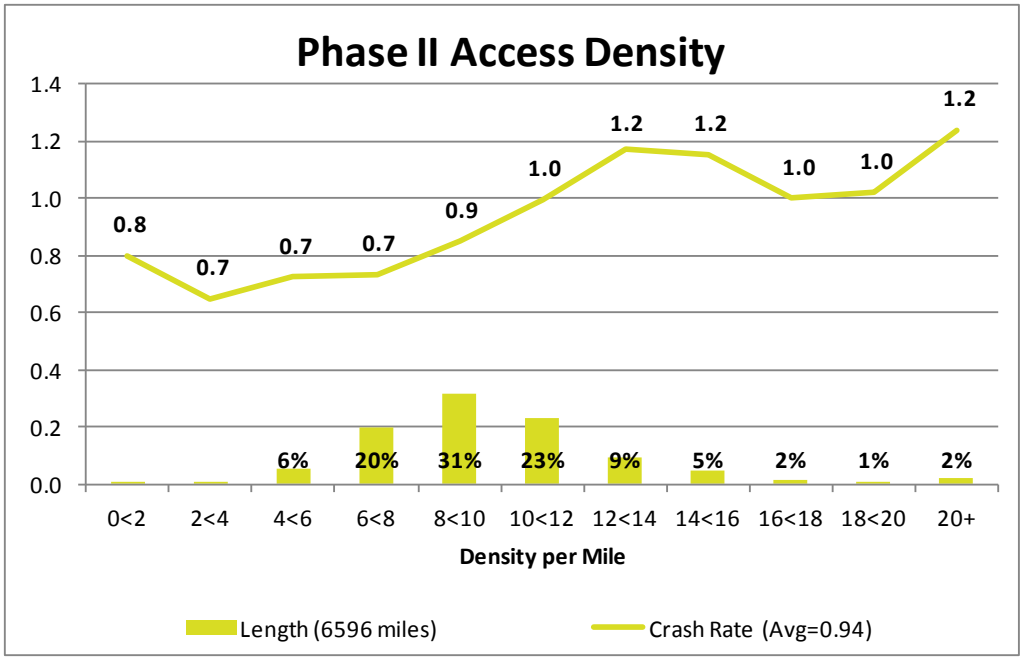
ATP	Segments	Mileage	Severe RD Crashes
ATP 3	1404	5,486	284
ATP 4	747	3,434	99
ATP 6	626	1,731	159
ATP 8	671	3,162	95
Grand Total	**3,448**	**13,813**	**637**

Access Density



Note: "Rural" Refers to a non–municipal area and cities with a population less than 5,000.

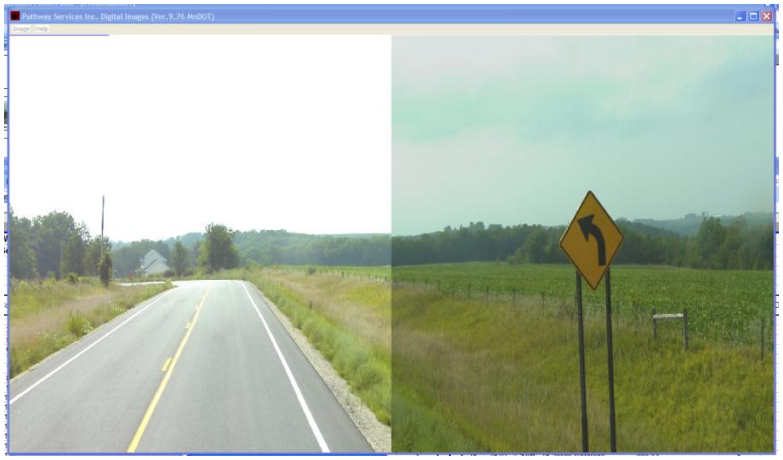
Source: Mn/DOT Research Report 1998-27 "Statistical Relationship between Vehicular Crashes and Highway Access"

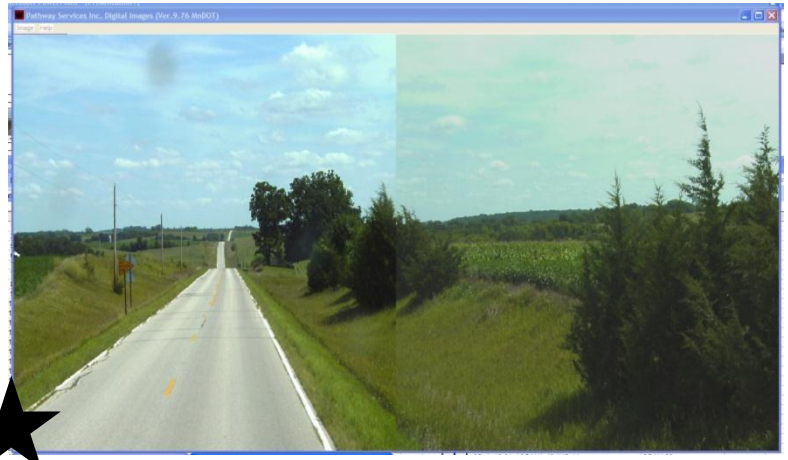


- Previous research has demonstrated that on State Highways in Minnesota, there is a statistically significant relationship between Access Density and Crash Rates – the greater the number of access points the higher the crash rate.
- Phase II of the County Roadway Safety Plans has produced information that proves that the same access effect is present along the County Highway system – as the access density increases, the crash and severity rates also increase.

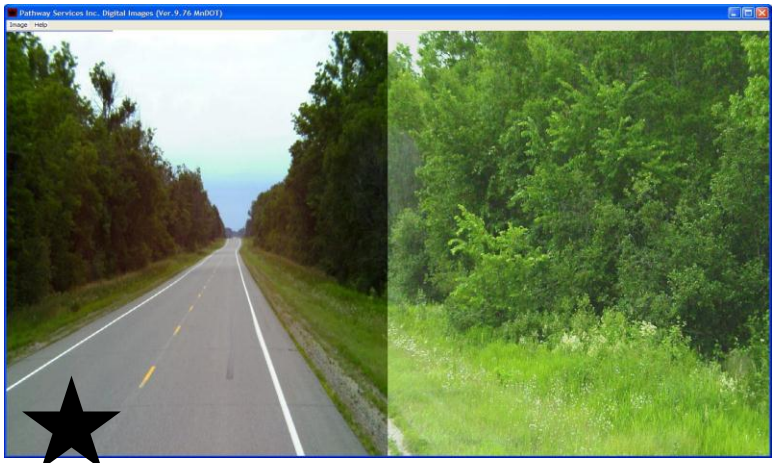
Edge Risk Assessment

1 – Usable Shoulder, Reasonable Clear Zone

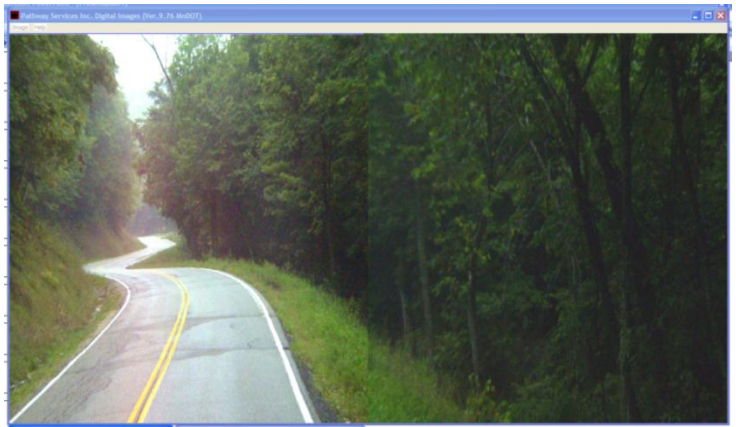




2 – No Usable Shoulder, Reasonable Clear Zone



2 – Usable Shoulder, Roadside with Fixed Obstacles



3 – No Usable Shoulder, Roadside with Fixed Obstacles

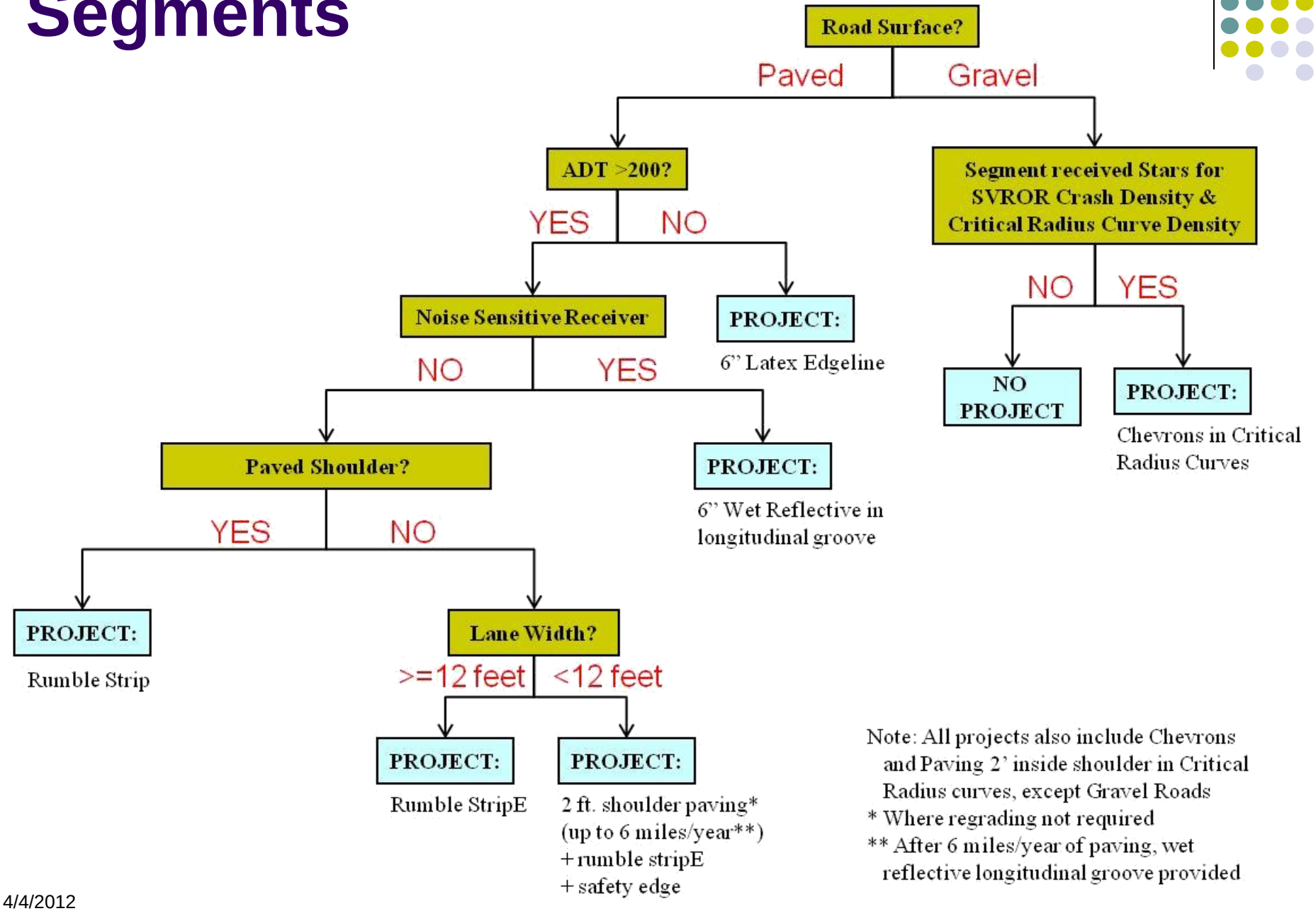
Sample County Segment Prioritization

Rank	Corridor	Route	#	Start	End	Length	ADT	ADT Range	RD Density	Access Density	Curve Critical Radius Density	Edge Risk	Totals	Tiebreakers Edge Risk	Tiebreakers RD Density
1	144.01	CNTY	89	CSAH-30	CSAH-30	1.4	480	★	★	★	★	★	★★★★★	3	0.28
2	40.04	CSAH	40	NEW LONDON CORP LIM	CSAH-2	5.9	450	★	★	★	★	★	★★★★★	2	0.17
3	131.01	CNTY	89	CSAH-30	MNTH-23	0.7	145		★	★	★	★	★★★★	2	0.29
4	9.02	CSAH	9	CR-90 , WILLMAR CORP LIM	CSAH-10	5.6	940	★	★	★	★		★★★★	1	0.14
5	5.06	CSAH	5	150TH AVE NW CSAH-29	CSAH-1	10.1	628	★	★	★	★		★★★★	1	0.14
6	31.02	CSAH	31	NEW LONDON CORP LIM	MNTH-23	1.6	920	★	★	★	★		★★★★	1	0.13
7	8.01	CSAH	8	RENVILLE COUNTY LINE	LAKE LILLIAN CORP LIM	3.6	750	★	★			★	★★★	2	0.33
8	4.01	CSAH	4	CSAH-8	CSAH-20	6.7	320		★	★		★	★★★	2	0.09
9	2.05	CSAH	2	CSAH-10	MNTH-23	9.8	385			★	★	★	★★★	2	0.04
10	4.04	CSAH	4	CR-98	CSAH-40	2.4	290			★	★	★	★★★	2	0.00
11	38.01	CSAH	38	CSAH-40	CSAH-48	2.1	130			★	★	★	★★★	2	0.00
12	132.01	CNTY	89	CSAH-8	CSAH-8	2.2	190			★	★	★	★★★	2	0.00
13	42.01	CSAH	42	CSAH-7	COUNTY LINE	0.5	120			★	★	★	★★★	2	0.00
14	9.03	CSAH	9	CSAH-10	CSAH-40 , REDWOOD ST	4.9	1,800		★	★	★		★★★	1	0.45
15	25.01	CSAH	25	CSAH-5	USTH-71	3.2	1,315		★	★	★		★★★	1	0.25
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
…	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…
74	1.03	CSAH	1	MNTH-23	PENNOCK CORP LIM	7.0	333							1	0.03
75	116.02	CNTY	89	CSAH-3	MNTH-40	7.0	98							1	0.03
76	2.04	CSAH	2	ATWATER CORP LIM	CSAH-10	6.7	1,018							1	0.00
77	28.02	CSAH	28	CSAH-2	COUNTY LINE	2.0	315							1	0.00
						Total Stars --		26	33	34	33	22			
						% That Gets Star --		36%	46%	47%	46%	31%			

- Is the County's entire system at-risk?
  - No – about 25% of their system is High Priority

	Totals #	%	Mileage	%
★★★★★	2	3%	7.4	2%
★★★★	4	5%	17.9	4%
★★★	16	21%	75.3	19%
★★	28	36%	150.6	38%
★	20	26%	108.0	27%
-	7	9%	41.4	10%
	77	100%	400.6	100%

Project Development – High Priority Segments



Note: All projects also include Chevrons and Paving 2' inside shoulder in Critical Radius curves, except Gravel Roads

* Where regrading not required

** After 6 miles/year of paving, wet reflective longitudinal groove provided

Sample County Segment

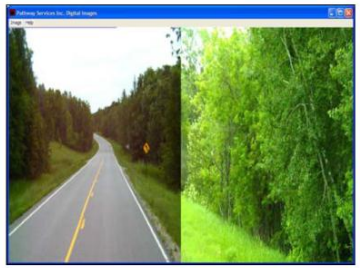
- CSAH 26 Segment Project Form
  - Roadway Data –ADT, Lane Width, Shoulder Width/Type
  - Crash Data – Total & RD Crashes, Density, Rate
  - Deficiencies – Risk Ranking
  - Strategies Considered
  - Selected Strategy

CSAH 37 from MNTH 34 to CSAH 26 Project

DRAFT

Roadway Data

	Verbal	Ref. Point
Type:	CSAH	
Number:	37	
Start:	MNTH 34	-
End:	CSAH 26	-
City/Rural:	Rural	
County:		
ATP:	6	
ADT:	634	
Facility Type:	2-Lane	
Lane Width:	12	
Shoulder Width:	2	
Shoulder Type:	Gravel	
Length (miles):	8.0	
Rumble Installed:	none	



Crash Data

2005-2009 MnCMAT Crash Data 5 years

	Total	Road Dept	K+A
Crashes	15	11	1
Density (per mile per year)	0.38	0.28	0.03
Rate (per MVM)	1.62	1.19	0.11

Ranking Factors

	Value	Critical	Star Ranking
ADT Range	634	600 to 1200	★
RD Density	0.28	0.08	★
Access Density	8.88	4.30	★
Curve Critical Radius Density	0.75	0.59	★
Edge Risk	3	2 or 3	★
			★★★★★

Short List of Strategies Considered

Description	Type	Cost per mi	Mileage	Cost	Notes - Noise sensitive area adjacent to Shell Lake
2' Shoulder Pave+RS+Safety Wedge	Proactive	$40,000	0.0	$0	
Rumble Strip	Proactive	$3,000	0.0	$0	
Rumble StripE	Proactive	$3,500	6.0	$21,000	
6" edgelines	Proactive	$650	0.0	$0	
Ground In Wet-Reflective Markings	Proactive	$8,500	2.0	$17,000	

Implementation Cost

Federal Funds	$34,200
Local Match (10% of Total project cost)	$3,800
Total Project Cost	**$38,000**

Page:	1
Segment ID:	37.01
Date:	2/12/2011

Segments Project Summary (Projects Measured in Miles)

ATP	2' Shoulder Pave+RS+Safety Wedge	Rumble Strip	Rumble StripE	6 inch edgelines	Ground In Wet-Reflective Markings	Total Project Value
ATP 3	180	373	673	50	636	$16,106,107
ATP 4	151	147	560	210	180	$10,095,868
ATP 6	153	91	332	46	306	$10,196,428
ATP 8	106	139	758	200	85	$8,158,210
Total	591	749	2323	505	1207	$44,556,613

Rural Curves

- 11,660 total curves in ATP 3, 4, 6 & 8
  - 9,592 (82%) curves with no crashes
  - Crashes
    - 3,061 total, 326 severe crashes
    - 4 curves with multiple fatal crashes (5 years)
    - 33 curves with multiple severe crashes
    - 0.006 severe crashes/curve/year

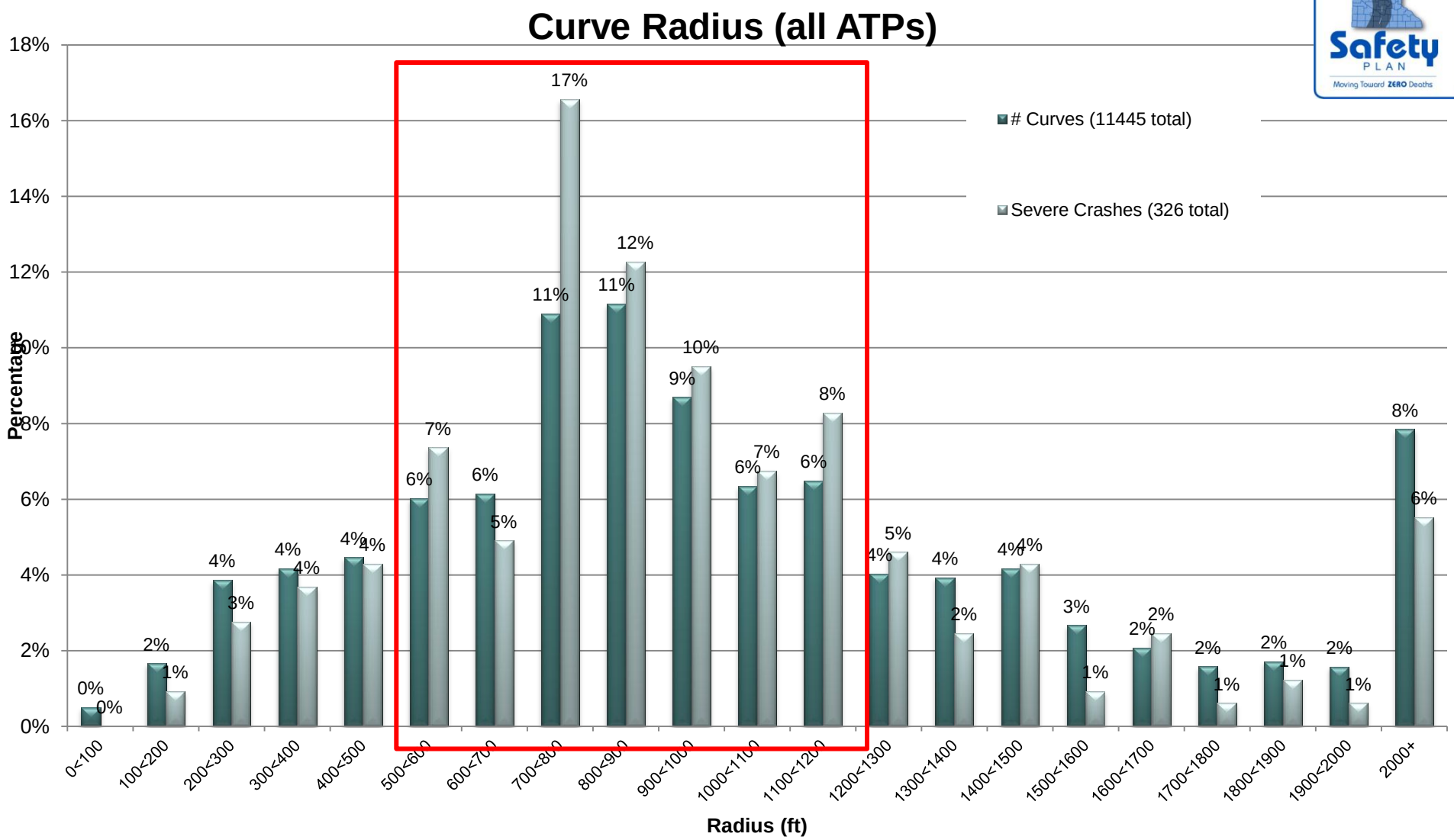
ATP	Curve Count	Severe Crashes	Total Crashes	Chevrons Installed
ATP 3	4297	141	1267	597
ATP 4	2494	51	501	1172
ATP 6	3699	102	962	449
ATP 8	1170	32	331	472
Grand Total	**11660**	**326**	**3061**	**2690**

Curve-Related Roadway Departure

- In ATP 4, 61% of roadway departure crashes are curve related (39% in ATP 8)
- Are all curves equally at-risk?
  - No

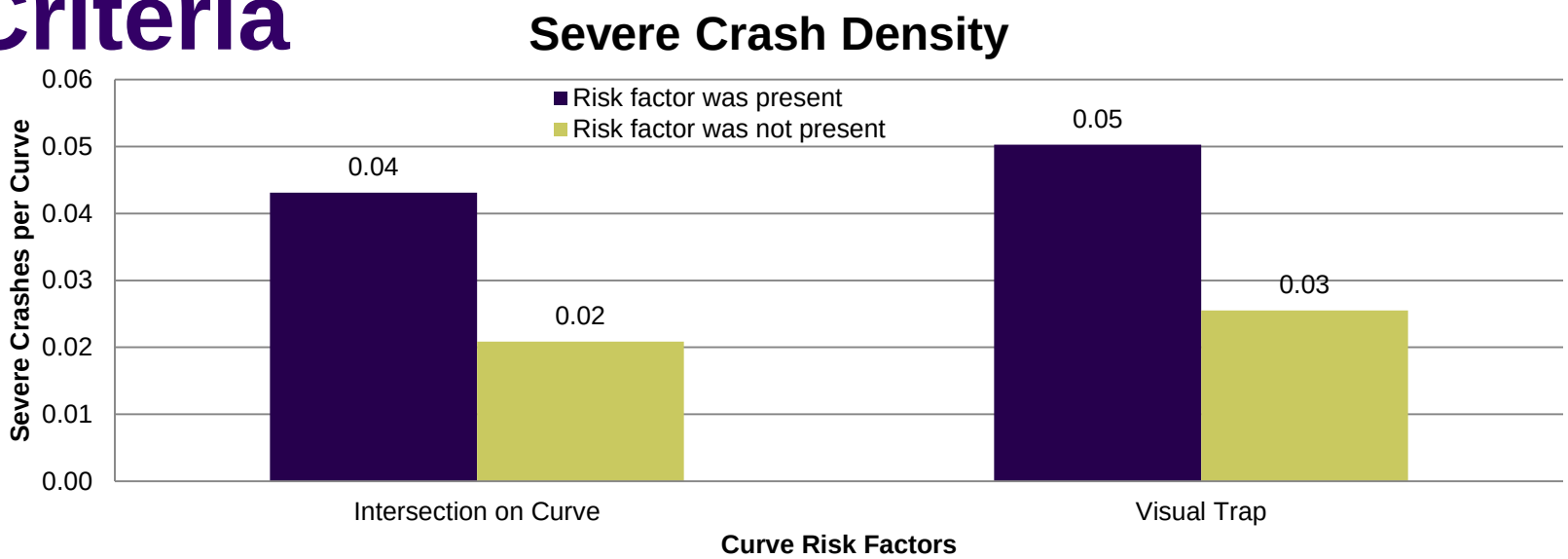
- Risk Rating Criteria:
  - ADT Range
  - Radius Range
  - Severe Crash on curve
  - Intersection on curve
  - Visual Trap on curve

Curve Radius

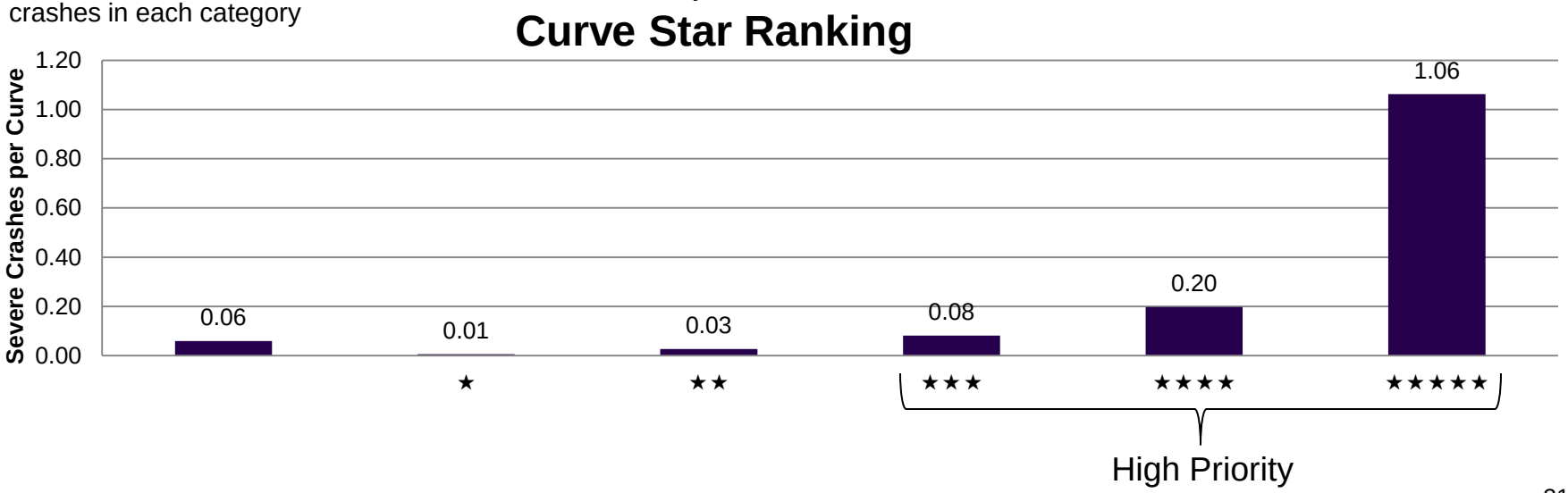


- The majority of severe crashes occurred on curves with 500’-1,200’ radii.

Horizontal Curve Risk Rating Criteria



- There was a higher severe crash density at curves where risk factors are present.
- Phase I and II intersections – 3,990 curves included in analysis of each risk factor. Minimum of 1,500 curves and 76 severe crashes in each category



Sample Curve Prioritization

Curve Count	ID	Corridor	Segment	Start	End	Crashes Total	Crashes K	Crashes A	Radius (ft)	ADT	Intersection on Curve	Chevrons	Visual Trap	Notes	Rank	High Priority Segment + Radius	Proximity	Chevron Candidate
1	001A	1.01	CSAH 1	CR-75	PRINSBERG CORP LIM	2	-	-	1084	600	Yes		Yes	Removed from analysis - Urban Segment				
2	001B	1.01	CSAH 1	CR-75	PRINSBERG CORP LIM	0	-	-	1082	600	Yes	Yes	Yes	Removed from analysis - Urban Segment				
3	001C	1.03	CSAH 1	MNTH-23	PENNOCK CORP LIM	0	-	-	1077	333	No	Yes	No		★	-	x	Installed
4	001D	1.03	CSAH 1	MNTH-23	PENNOCK CORP LIM	0	-	-	1088	333	Yes	Yes	Yes		★★★	-	-	Installed
5	001E	1.03	CSAH 1	MNTH-23	PENNOCK CORP LIM	0	-	-	2482	333	Yes		No		★	-	-	-
6	001F	1.04	CSAH 1	PENNOCK CORP LIM	PENNOCK CORP LIM	0	-	-	1141	650	No		No	Removed from analysis - Urban Segment				
7	001G	1.04	CSAH 1	PENNOCK CORP LIM	PENNOCK CORP LIM	0	-	-	860	650	No		No	Removed from analysis - Urban Segment				
8	001H	1.05	CSAH 1	PENNOCK CORP LIM	CSAH-29	0	-	-	1140	534	Yes	Yes	Yes		★★★★	-	-	Installed
9	001I	1.05	CSAH 1	PENNOCK CORP LIM	CSAH-29	0	-	-	1186	534	No		No		★★	-	x	Yes
10	001J	1.05	CSAH 1	PENNOCK CORP LIM	CSAH-29	0	-	-	1078	534	Yes		No		★★★	-	-	Yes
11	001K	1.05	CSAH 1	PENNOCK CORP LIM	CSAH-29	0	-	-	1160	534	No		No		★★	-	-	-
12	001L	1.05	CSAH 1	PENNOCK CORP LIM	CSAH-29	0	-	-	1135	534	Yes		No		★★★	-	-	Yes
13	001M	1.07	CSAH 1	MNTH-9	STEARNS COUNTY LINE	0	-	-	725	333	Yes	Yes	No		★★	-	-	Installed
14	001N	1.07	CSAH 1	MNTH-9	STEARNS COUNTY LINE	0	-	-	1198	333	No		No		★	-	-	-
15	001O	1.07	CSAH 1	MNTH-9	STEARNS COUNTY LINE	0	-	-	710	333	No	Yes	No		★	-	-	Installed
16	002A	2.02	CSAH 2	CSAH-20	ATWATER CORP LIM	0	-	-	829	1,040	Yes	Yes	Yes		★★★★	-	-	Installed
17	002B	2.02	CSAH 2	CSAH-20	ATWATER CORP LIM	0	-	-	1289	1,040	Yes	Yes	No		★★	-	-	Installed
18	002C	2.02	CSAH 2	CSAH-20	ATWATER CORP LIM	0	-	-	1098	1,040	No	Yes	No		★★	-	-	Installed
19	002D	2.02	CSAH 2	CSAH-20	ATWATER CORP LIM	0	-	-	1455	1,040	No	Yes	No		★	-	-	Installed
20	002E	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1498	385	No		No			-	-	-
21	002F	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1420	385	Yes		No		★	-	-	-
22	002G	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	4595	385	No		No	Removed from further analysis - radius > 3,000'				
23	002H	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1007	385	No		No		★	x	-	Yes
24	002I	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1068	385	No		No		★	x	-	Yes
25	002J	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1141	385	Yes	Yes	Yes		★★★	x	-	Installed
26	002K	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	1101	385	Yes	Yes	Yes		★★★	x	-	Installed
27	002L	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	3605	385	No		No	Removed from further analysis - radius > 3,000'				
28	002M	2.05	CSAH 2	CSAH-10	MNTH-23	0	-	-	6704	385	No		No	Removed from further analysis - radius > 3,000'				

- Complete census of 490 curves
- 50 High Priority Curves (10%)

Stars	Total #	Total %	Chevroned #	Chevroned %
★★★★★	1	0%	1	1%
★★★★	7	1%	7	8%
★★★	42	9%	16	19%
★★	78	16%	23	28%
★	120	24%	15	18%
-	242	49%	21	25%
	490	100%	83	100%

Project Development – High Priority Curves

- Three ways for a Curve to receive a project

All Curves on Roadways*

Curves w/ Existing Chevrons

High Priority Curves
and those in close proximity

High Priority Segments & Critical Curve Radius

PROJECT:

Install/upgrade Chevrons
+2' Shoulder Paving
+Rumble Strip

Note: Gravel roads were considered if the segment experienced a high frequency of severe curve-related crashes.

Curve Project Summary (Number of Curves)

ATP	Currently Installed Chevrons	★Ranking	Proximity	HP Seg + Crit Rad	Total Project Value
ATP 3	695	546	871	373	$19,794,813
ATP 4	760	445	612	743	$9,749,702
ATP 6	393	300	860	430	$15,933,618
ATP 8	428	292	97	433	$5,012,430
Total	2276	1583	2440	1979	$50,490,563

Rural Intersections

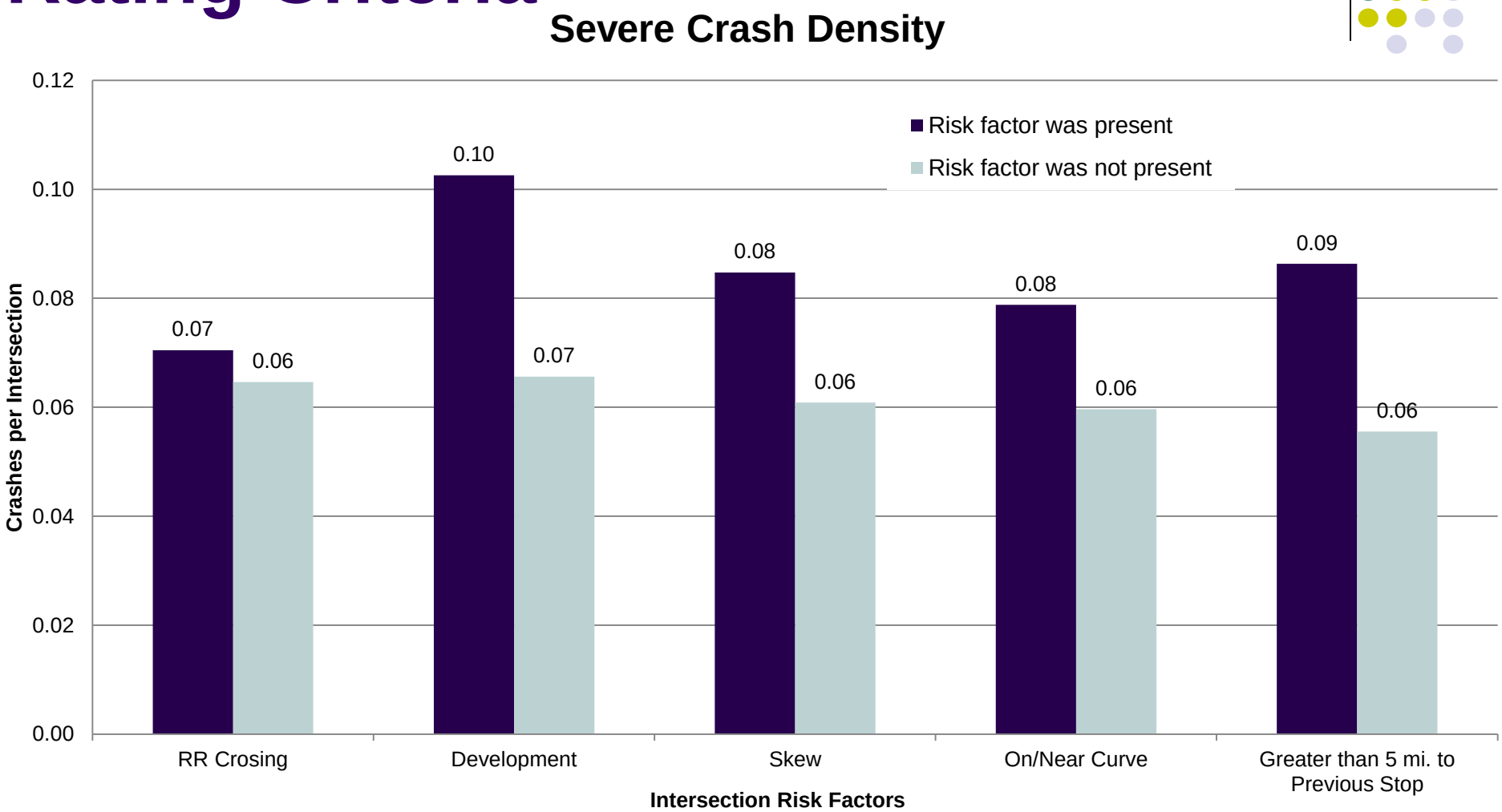
- 5,725 rural thru/stop (yield) intersections in ATP 3, 4, 6 & 8
  - 4,794 total crashes
  - 373 Severe Crashes
    - 172 severe right angle
  - Intersections with Multiple Severe Crashes: 28 (8 had 2 Fatals)
  - 0.17 crashes/intersection/year
  - 0.01 severe crashes/intersection/year

ATP	Intersections	Severe Right Angle Crashes	Severe Crashes
ATP 3	1,293	63	121
ATP 4	1,912	28	71
ATP 6	1,033	36	90
ATP 8	1,487	45	91
Grand Total	**5,725**	**172**	**373**

Rural Thru STOP Proactive Risk Rating Criteria

- Geometry
  - Skewed minor leg approach
  - Intersection on/near horizontal curve
- Volume
  - Minor ADT/Major ADT ratio
- Proximity
  - Previous STOP sign
  - Railroad crossing
- Intersection Related Crashes
- Commercial Development in quadrants

Rural Thru STOP Proactive Risk Rating Criteria



- There was a higher severe crash density at intersections where risk factors are present.
- Phase I and II intersections - 5,725 intersections included in analysis of each risk factor. Minimum of 150 intersections and 16 severe crashes in each category

Sample Rural Inters Prioritization

Rank	Int #	Sys	#	Intersection Description	Skew	On/Near Curve	Development	RR Xing	Previous STOP (>5mi)	Total Crashes	Ratio (Min/Maj)	Priority	Crash Cost
1	9.08	CSAH	9	CSAH 9 and CSAH-10 EAST	★	★	★		★	★	★	★★★★★★	$ 12,000
2	5.06	CSAH	5	CSAH 5 and MNTH-23	★	★			★	★	★	★★★★★	$ 2,483,000
3	9.09	CSAH	9	CSAH 9 and CSAH-10 WEST	★	★	★			★	★	★★★★★	$ 584,000
4	4.04	CSAH	4	CSAH 4 and CSAH-20 WEST	★	★			★	★	★	★★★★★	$ 412,000
5	15.01	CSAH	15	CSAH 15 and 30TH ST SW (CSAH-47)		★	★	★		★	★	★★★★★	$ 230,000
6	1.07	CSAH	1	CSAH 1 and MNTH-23	★			★	★	★		★★★★	$ 1,202,000
7	2.19	CSAH	2	CSAH 2 and CSAH-31, CR-103		★			★	★	★	★★★★	$ 412,000
8	2.21	CSAH	2	CSAH 2 and MNTH-23 EAST	★		★		★	★		★★★★	$ 342,000
9	5.17	CSAH	5	CSAH 5 and MNTH-9 EAST	★	★				★	★	★★★★	$ 148,000
10	9.04	CSAH	9	CSAH 9 and CSAH-26	★	★	★			★		★★★★	$ 136,000
11	92.01	CNTY	92	CNTY 92 and 75TH ST NW (CR-116)	★	★				★	★	★★★★	$ 136,000
12	25.01	CNTY	25	CSAH 25 and CSAH-41	★	★				★	★	★★★★	$ 24,000
13	3.09	CSAH	3	CSAH 3 and CSAH-8	★	★			★	★		★★★★	$ 12,000
14	10.01	CSAH	10	CSAH 10 and USTH-71	★	★				★	★	★★★★	$ 12,000
15	4.05	CSAH	4	CSAH 4 and CSAH-20 EAST	★	★			★		★	★★★★	$ -
16	9.02	CSAH	9	CSAH 9 and USTH-12		★	★			★		★★★	$ 981,000
17	4.09	CSAH	4	CSAH 4 and USTH-12				★	★	★		★★★	$ 927,000
18	7.09	CSAH	7	CSAH 7 and USTH-12	★			★		★		★★★	$ 478,000
19	65.01	CNTY	65	CNTY 65 and USTH-12	★			★		★		★★★	$ 478,000
20	9.16	CSAH	9	CSAH 9 and CSAH-33	★					★	★	★★★	$ 424,000
21	5.02	CSAH	5	CSAH 5 and MNTH-7		★				★	★	★★★	$ 273,000
22	30.05	CNTY	30	CSAH 30 and MNTH-23 S	★		★			★		★★★	$ 251,000
23	40.03	CNTY	40	CSAH 40 and USTH-71					★	★	★	★★★	$ 239,000
24	116.02	CNTY	116	CNTY 116 and MNTH-23	★			★		★		★★★	$ 239,000
25	4.11	CSAH	4	CSAH 4 and CSAH-28					★	★	★	★★★	$ 148,000
26	9.07	CSAH	9	CSAH 9 and CSAH-27, CR-127					★	★	★	★★★	$ 148,000
27	4.07	CSAH	4	CSAH 4 and CSAH-23 SOUTH					★	★	★	★★★	$ 136,000
28	5.19	CSAH	5	CSAH 5 and CSAH-34	★	★				★		★★★	$ 103,000
29	1.14	CSAH	1	CSAH 1 and CSAH-29					★	★	★	★★★	$ 91,000
30	7.07	CSAH	7	CSAH 7 and CSAH-42	★	★				★		★★★	$ 91,000
31	116.04	CNTY	116	CNTY 116 and USTH-12	★			★		★		★★★	$ 91,000
32	29.03	CNTY	29	CSAH 29 and USTH-71		★			★	★		★★★	$ 24,000
33	148.01	CNTY	148	CNTY 148 and MNTH-9	★	★				★		★★★	$ 24,000
34	4.14	CSAH	4	CSAH 4 and CSAH-30		★				★	★	★★★	$ 12,000
35	48.01	CNTY	48	CSAH 48 and MNTH-9	★	★				★		★★★	$ 12,000
36	9.11	CSAH	9	CSAH 9 and CSAH-40 WEST		★	★				★	★★★	$ -

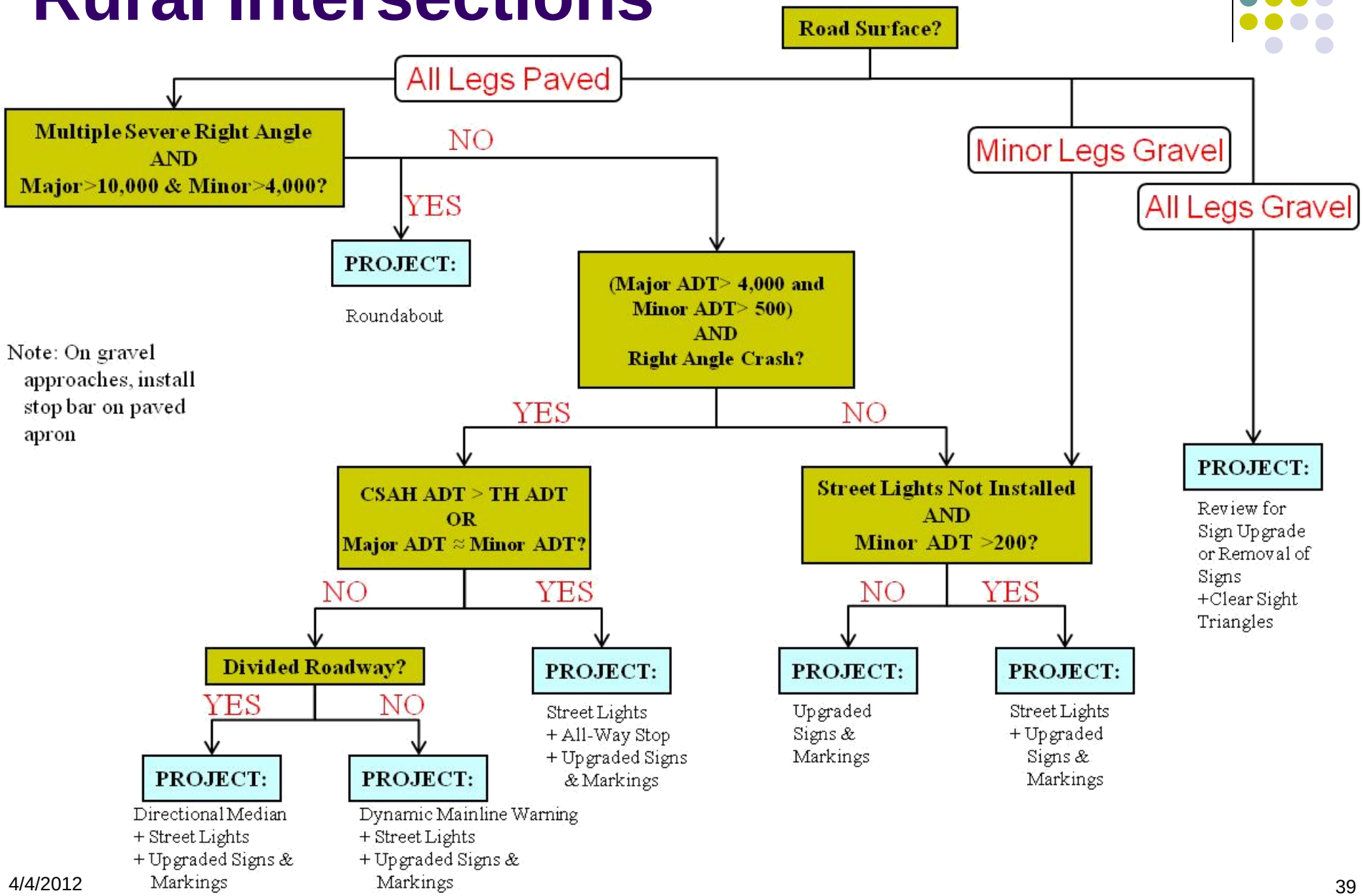
- Is the County's entire system at-risk?
  - No – about 1/3 of their system

Totals

	#	%
★★★★★★	0	0%
★★★★★★	1	0%
★★★★★	4	2%
★★★★	10	4%
★★★	28	12%
★★	57	25%
★	70	31%
-	56	25%
	226	100%

Considered for projects

Project Development – High Priority Rural Intersections



Intersection Project Summary (Number of Intersections)

ATP	Roundabout	All-Way STOP	Directional Median	Dynamic Warning Sign	Street Lights	Upgraded Signs &/or Markings	Review Signs & CST	Total Project Value
ATP 3	0	1	17	61	328	483	0	$7,972,400
ATP 4	0	0	4	15	219	443	23	$4,827,500
ATP 6	0	1	6	14	199	137	0	$2,666,800
ATP 8	0	0	1	11	174	342	28	$3,561,850
Total	0	2	28	101	920	1405	51	$19,028,550

Proactive Project Summary

ATP Totals	Intersections	Segments	Curves	Total
ATP 3	$7,972,400	$16,106,107	$19,794,813	$43,873,320
ATP 4	$4,547,000	$9,802,628	$9,749,702	$24,099,330
ATP 6	$2,666,800	$10,196,428	$15,933,618	$28,796,846
ATP 8	$3,561,850	$8,088,124	$5,012,430	$16,662,404
Total	$18,748,050	$44,193,287	$50,490,563	$113,431,900

Average Per County	Intersections	Segments	Curves	Total
ATP 3	$664,367	$1,342,176	$1,649,568	$3,656,110
ATP 4	$378,917	$816,886	$812,475	$2,008,278
ATP 6	$296,311	$1,132,936	$1,770,402	$3,199,650
ATP 8	$296,821	$674,010	$417,703	$1,388,534
Average	$416,623	$982,073	$1,122,013	$2,520,709

- MnDOT has concluded that the systematic safety methodology works – the method has successfully identified candidates for safety investment at locations where crash densities are very low and has identified low cost mitigations that can be widely deployed.

Questions?