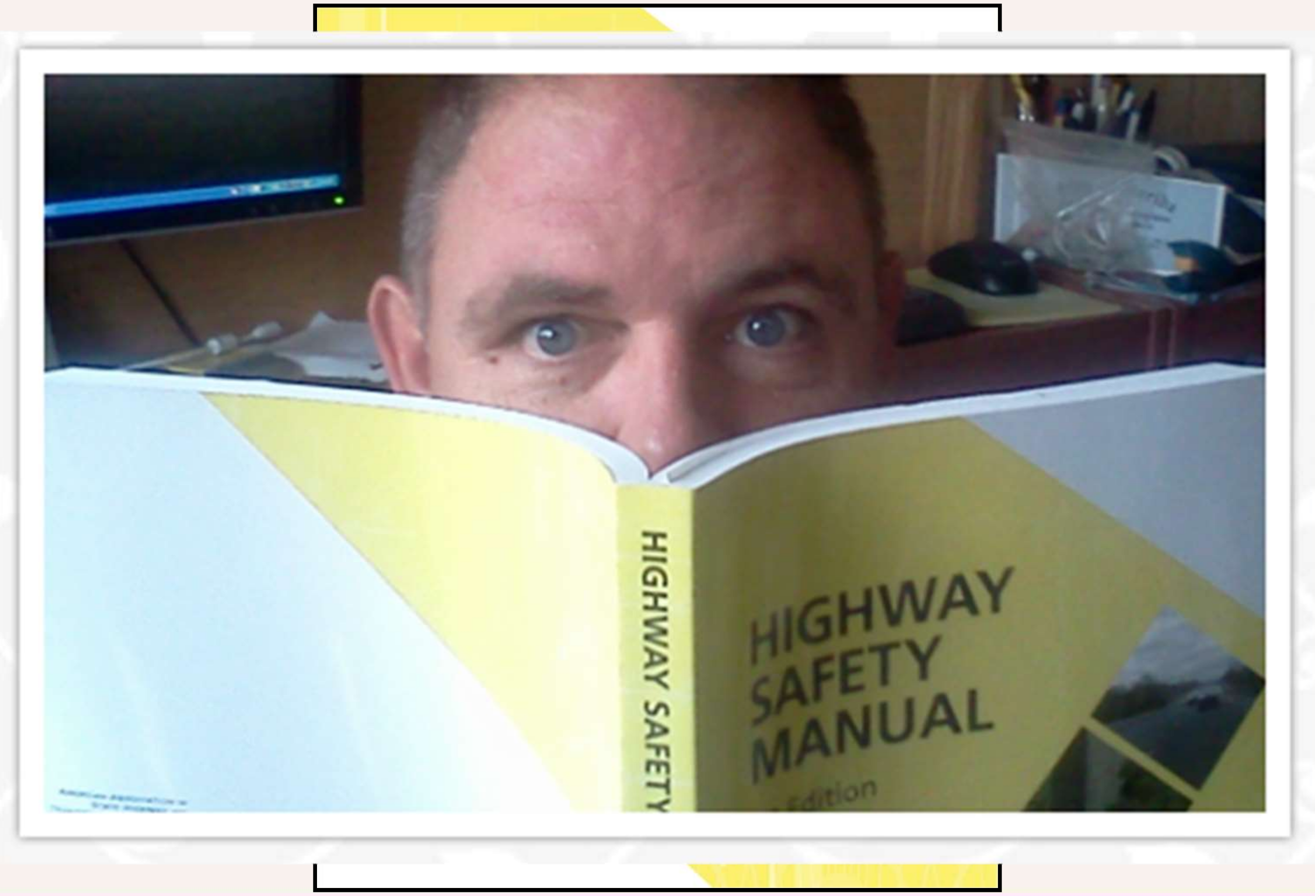
Highway Safety Manual

Applications for Local Agency Safety Projects



Highway Safety Manual

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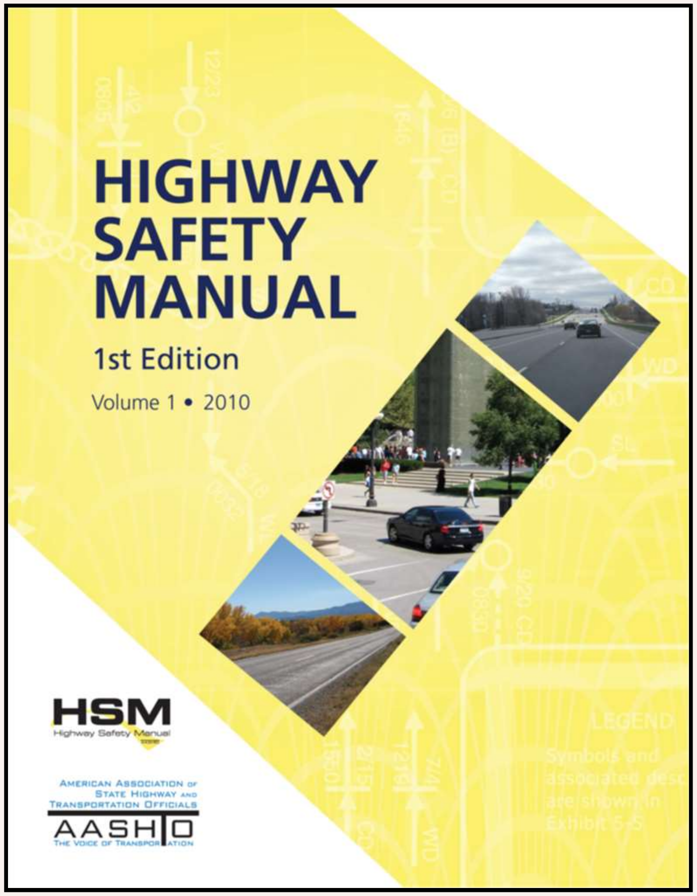
Part 1: Background



HIGHWAY SAFETY MANUAL

1st Edition

Volume 1 • 2010

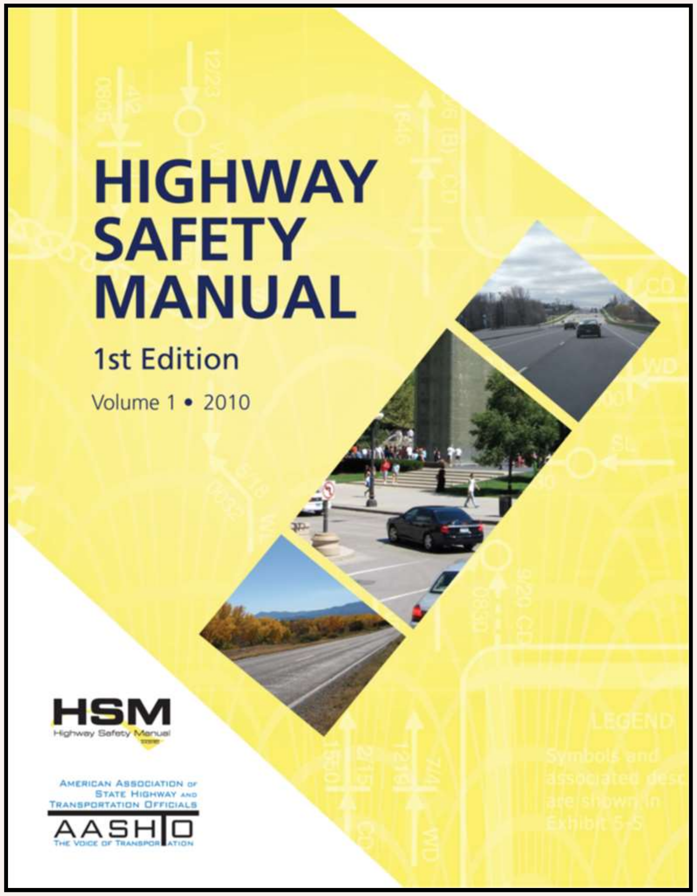
HSM Highway Safety Manual

American Association of State Highway and Transportation Officials

AASHTO

The Voice of Transportation

Part 2: Content



HIGHWAY SAFETY MANUAL

1st Edition

Volume 1 • 2010

HSM
Highway Safety Manual

American Association of State Highway and Transportation Officials
AASHTO
The Voice of Transportation

Introduction to the HSM

- What is the HSM?
- Who should use the HSM?
- When should the HSM be used?
- How to use the HSM?
- Where can we get assistance?
- Why should we use the HSM?

What is the HSM?

An AASHTO Publication that…

- Provides information and tools to conduct quantitative safety analyses.
- Facilitates explicit consideration of safety throughout the project development process.

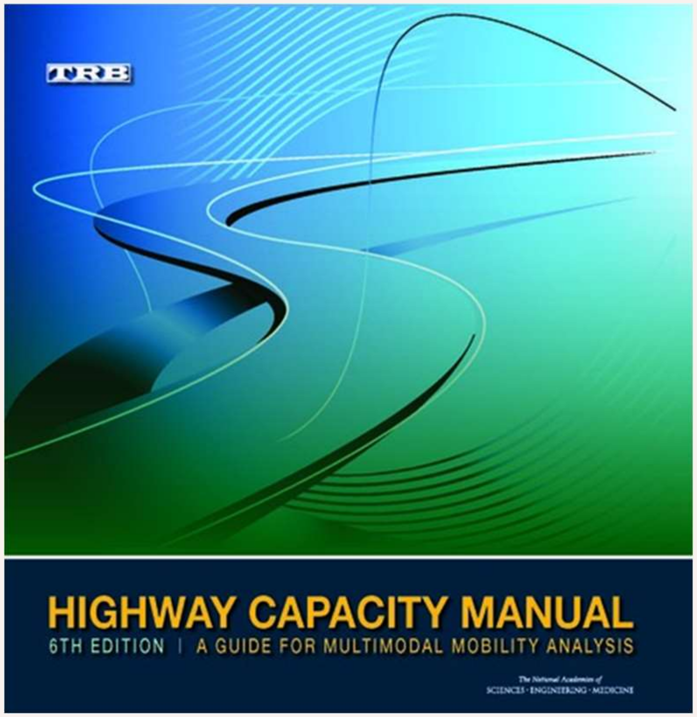
What is the HSM?

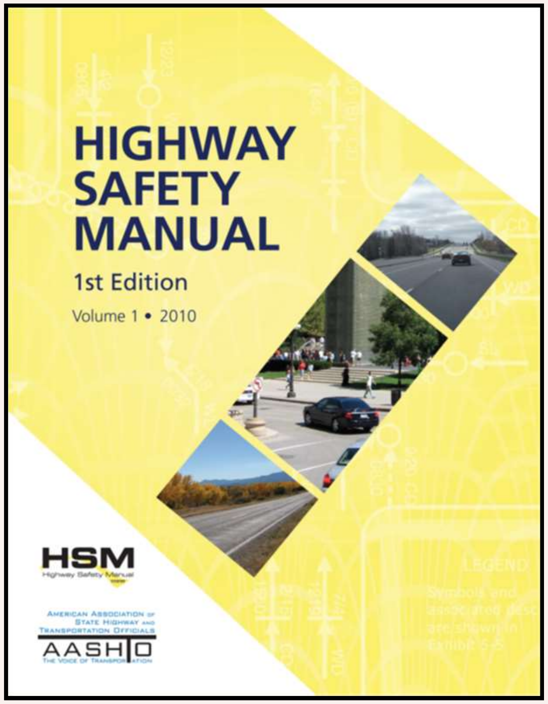
A compilation of:

- Methods for developing an effective roadway safety management program and evaluating its benefits.
- Predictive methods to estimate crash frequency and severity to support project level decision making.
- Catalog of crash modification factors for estimating the effect of a variety of geometric and operational treatments.

The Highway Safety Manual of 2010

- Methodology is like that for assessing and assuring the adequacy of Capacity
- HSM allows the transportation professional to understand and quantify highway safety performance for informed and balanced decision making

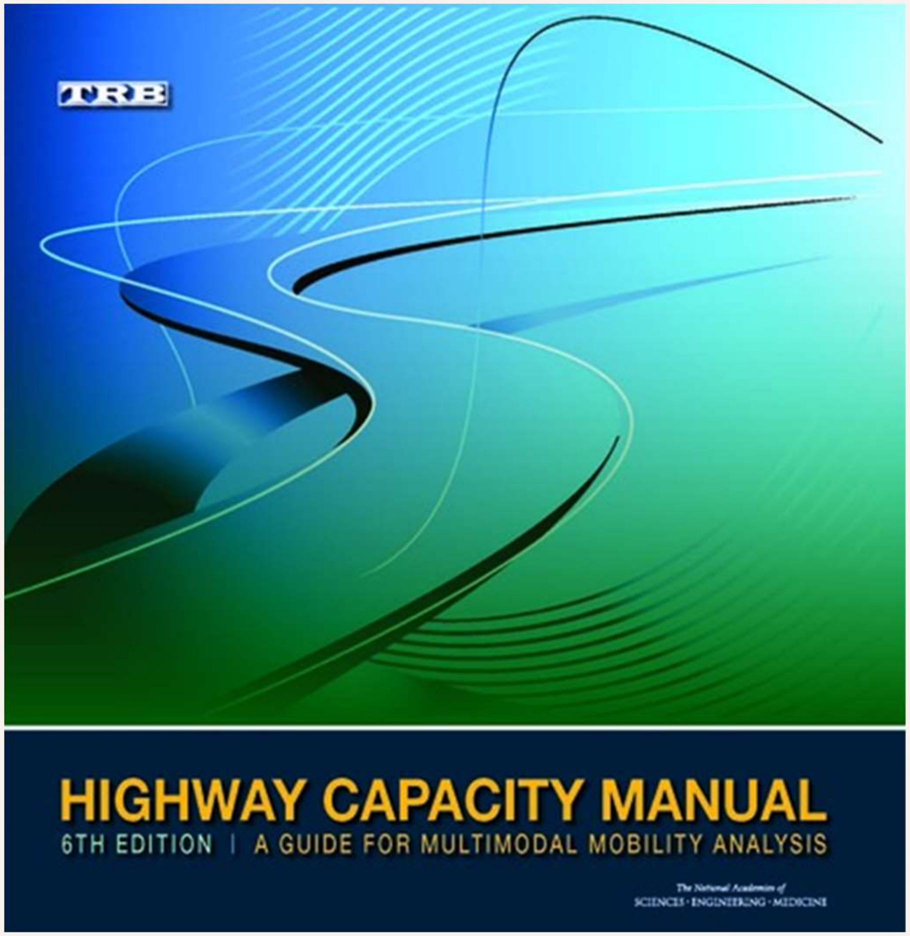




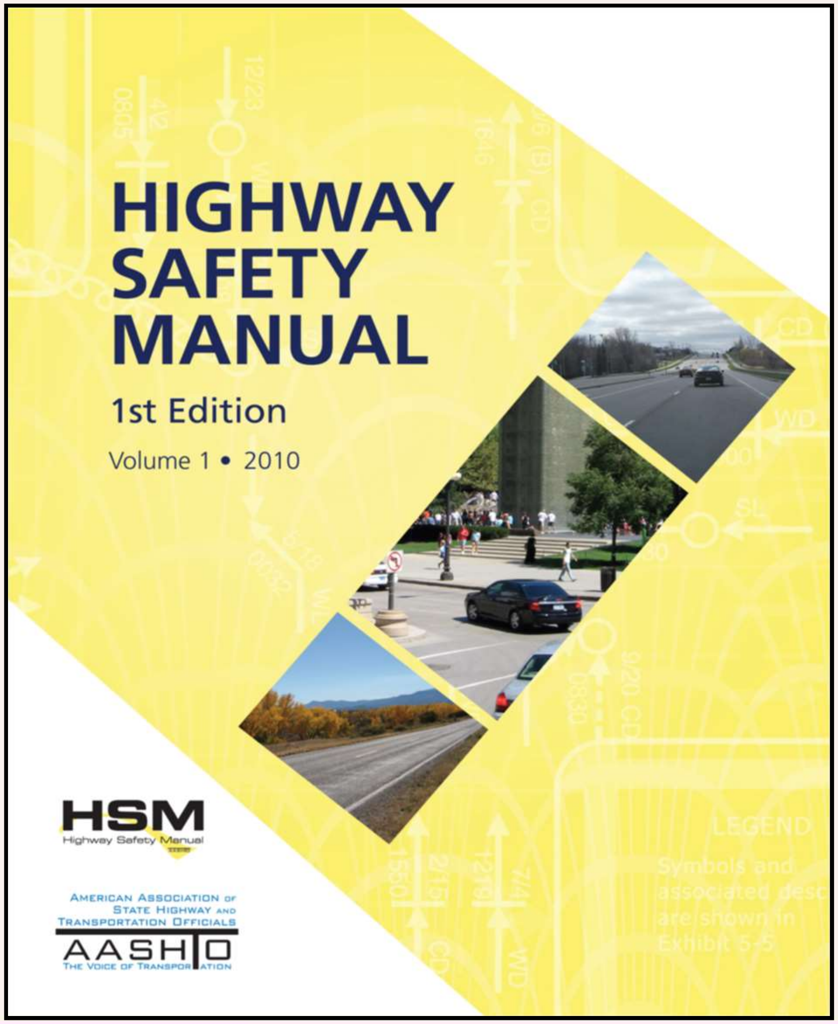
What is the HSM?

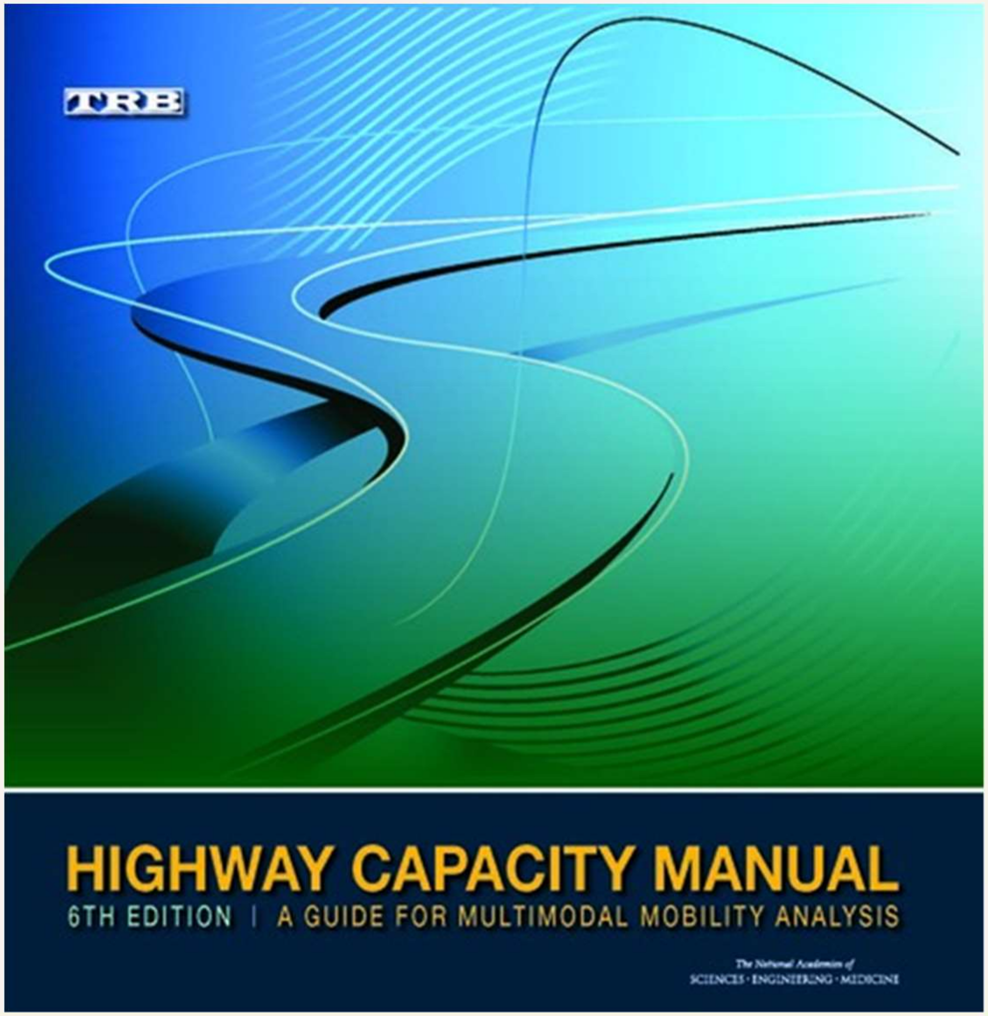
Akin to the HCM, but for safety…

1. Definitive; represents quantitative 'state-of-the-art' information
2. Widely accepted within professional practice of transportation engineering
3. Science-based; updated regularly to reflect research

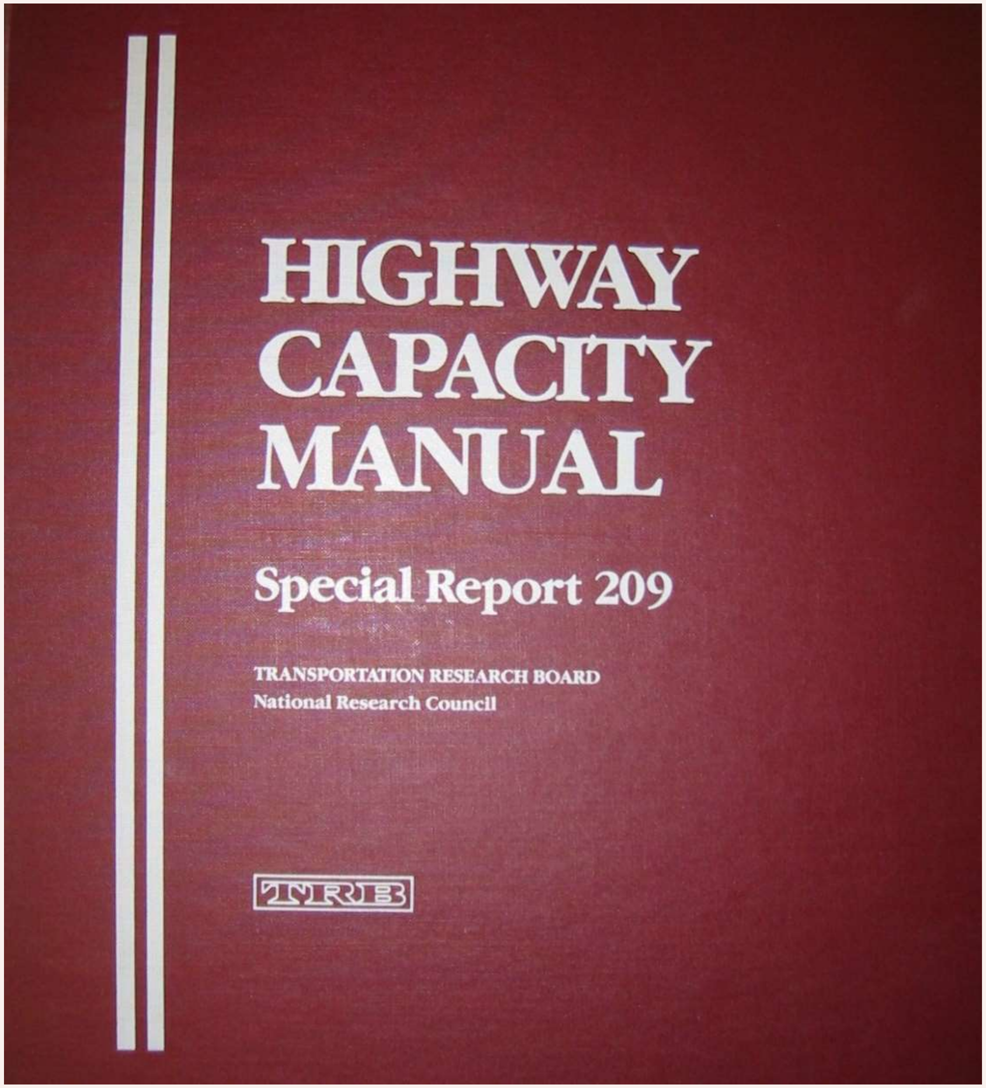


Goal: Make the HSM like the HCM





My Graduate School Years…



HIGHWAY CAPACITY MANUAL

Special Report 209

TRANSPORTATION RESEARCH BOARD
National Research Council

TRB

1985 Highway Capacity Manual

First “modern” Highway Capacity Manual

Worksheet type analysis procedures

Describes “ideal” conditions

Adjustment factors for other than ideal

1985 Highway Capacity Manual

Since then…

Numerous research reports and papers

Updated models and parameters

Updated manuals in 1994, 1997, 2000, 2010

Abandoned worksheet format - SOFTWARE

The LTH Model

1985 HCM greatly over-estimated the capacity of the permitted portion of protected + permitted left turn phasing at signalized intersections

New model for uniform delay for these types of left turn movements

1985 Highway Capacity Manual

First “modern” Highway Capacity Manual

Worksheet type analysis procedures

Describes “ideal” conditions

Adjustment factors for other than ideal

2010 Highway Safety Manual

First EVER Highway Safety Manual

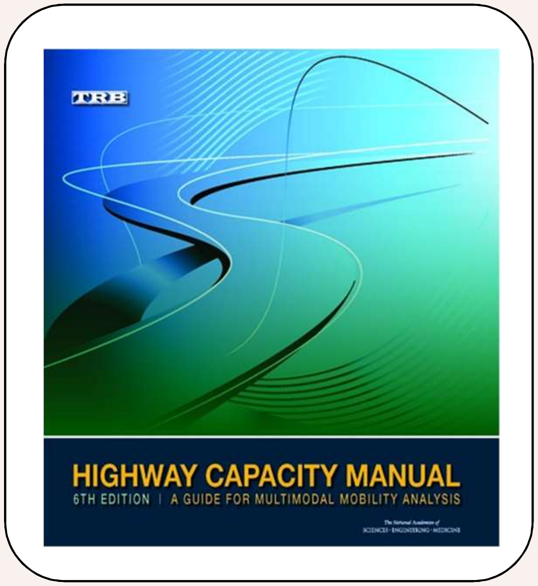
Worksheet type analysis procedures

Describes “ideal” conditions

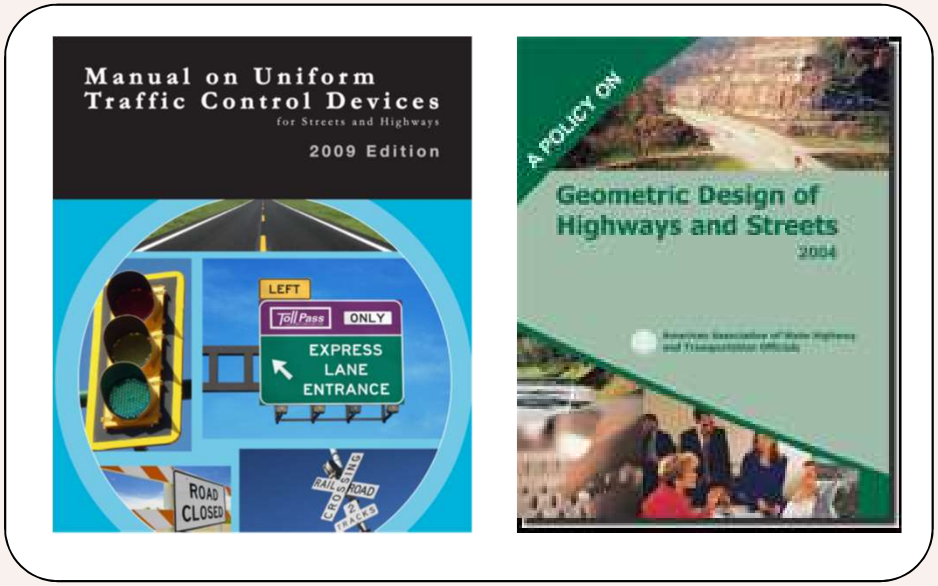
Adjustment factors for other than ideal

WHAT THE HSM IS…….

…Like the HCM



…NOT Like the MUTCD & Green Book



The HSM **describes** the mathematical relationships for safety performance based upon exposure and roadway conditions

The HSM is an **analysis tool only**; just like the HCM

The HSM does **not** have “Standards” nor “Best Practice” guidance

The HSM does **not** supersede other publications that do.

What is the HSM?

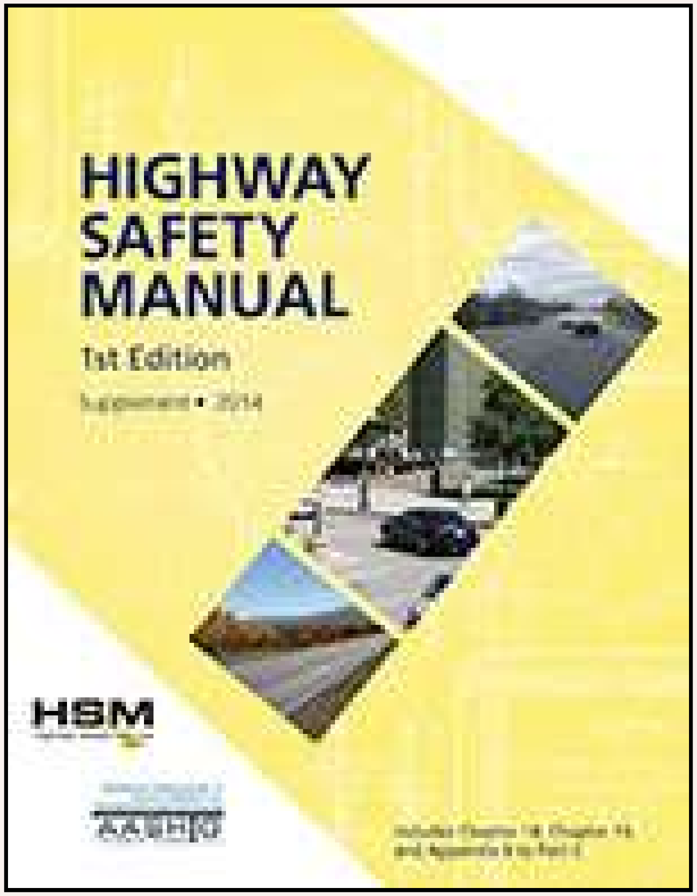
It’s the product of:

- $7 million, 10-year research program funded by NCHRP, AASHTO & FHWA
- Thousands of hours of effort in reviewing the research results:
    - TRB Task Force on Development of the HSM
    - AASHTO Joint Task Force on the HSM, with members from Safety, Design, and Traffic Engineering

What is the HSM?

What is the HSM?

2014
Supplement



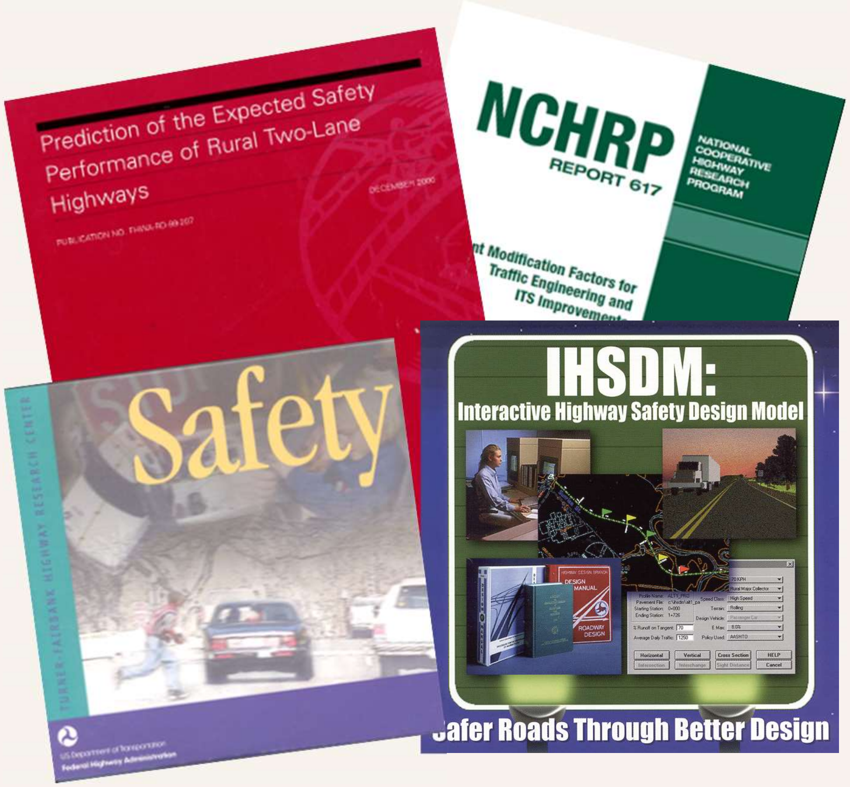
HIGHWAY
SAFETY
MANUAL
1st Edition
Supplement • 2014

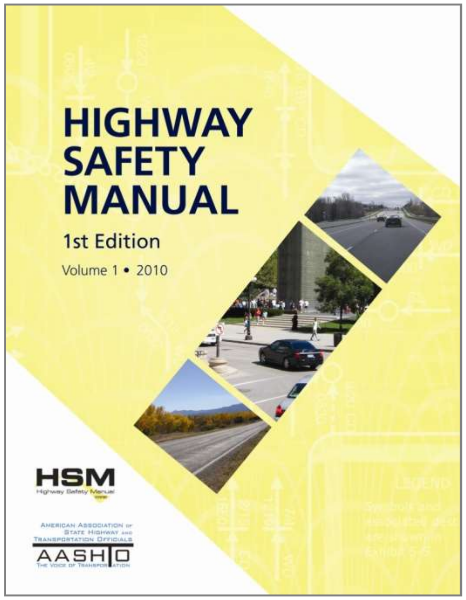
HSM

$175 per copy ☹

The Highway Safety Manual – 1st Edition

Contains Best Science & Research

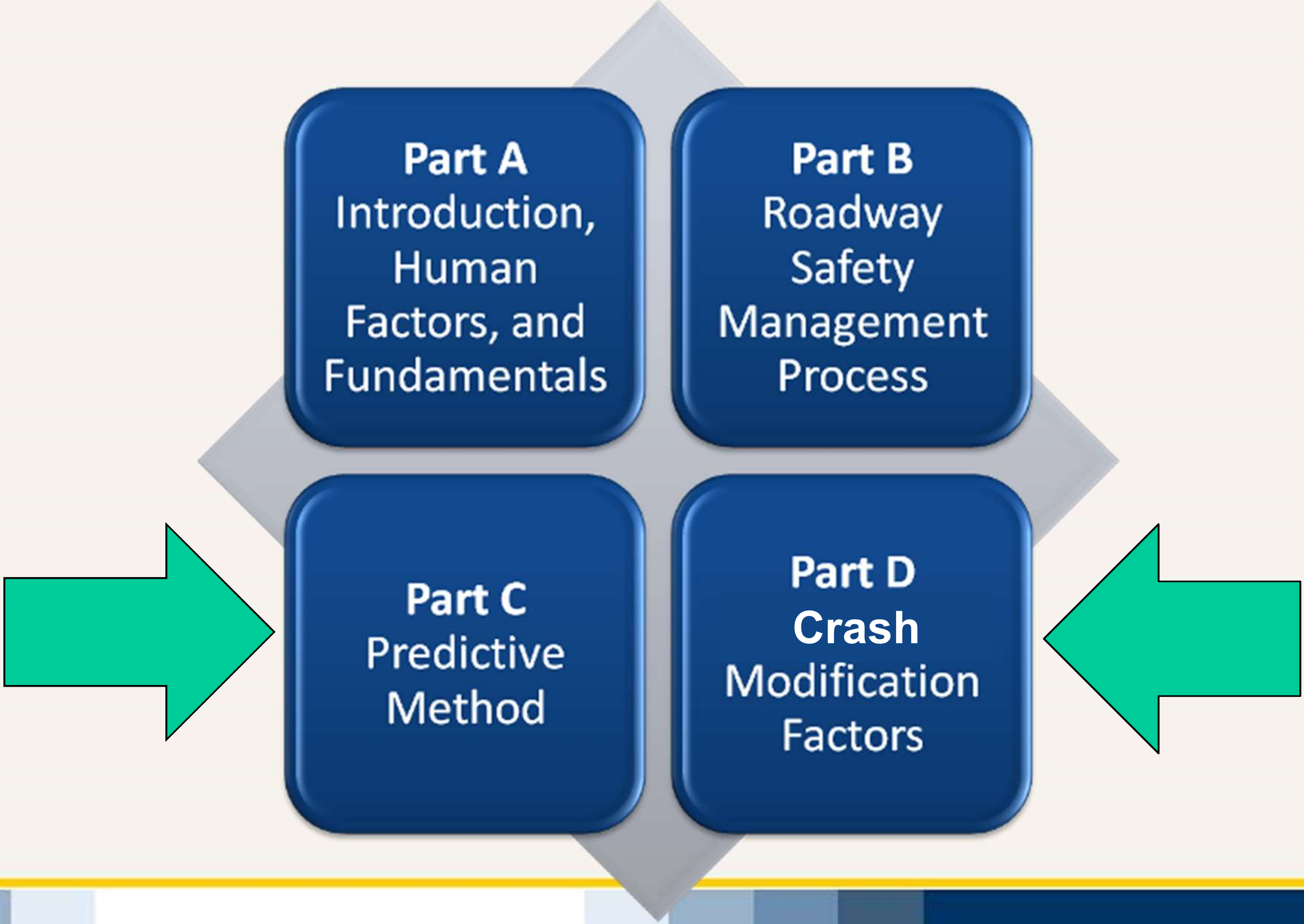




- Synthesis of previous research
- New research commissioned by AASHTO and FHWA

Highway Safety Manual

WHAT IS COVERED IN THE HSM?



Part A
Introduction, Human Factors, and Fundamentals

Part B
Roadway Safety Management Process

Part C
Predictive Method

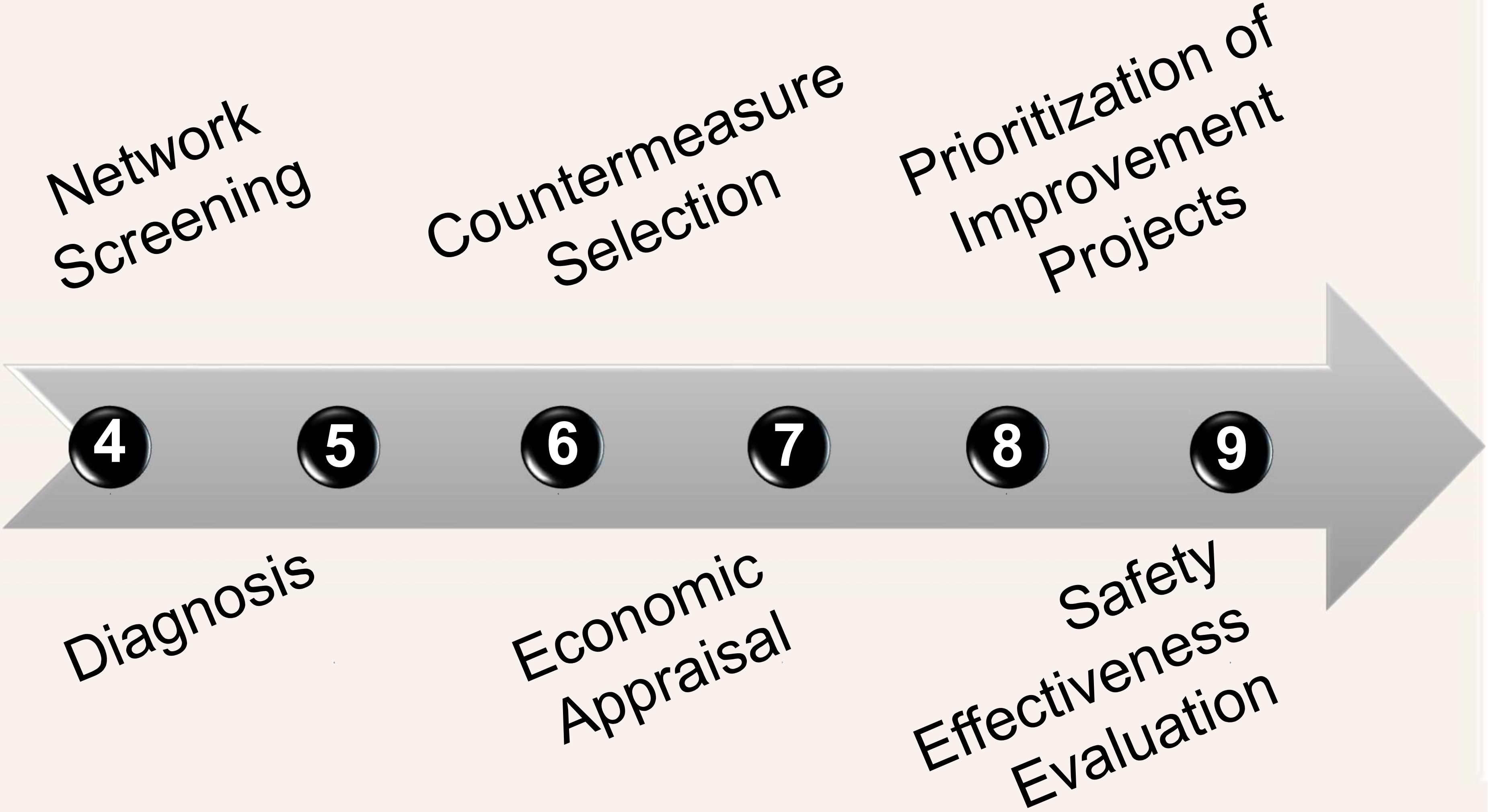
Part D
Crash Modification Factors

Highway Safety Manual

PART A: INTRODUCTION, HUMAN FACTORS, & FUNDAMENTALS

Chapter 1	Introduction and Overview
Chapter 2	Human Factors
Chapter 3	Fundamentals

Highway Safety Manual



Network Screening

Diagnosis

Countermeasure Selection

Economic Appraisal

Prioritization of Improvement Projects

Safety Effectiveness Evaluation

Who should use the HSM?

- Planning
- Design
- Operations
- Maintenance

When should the HSM be used?

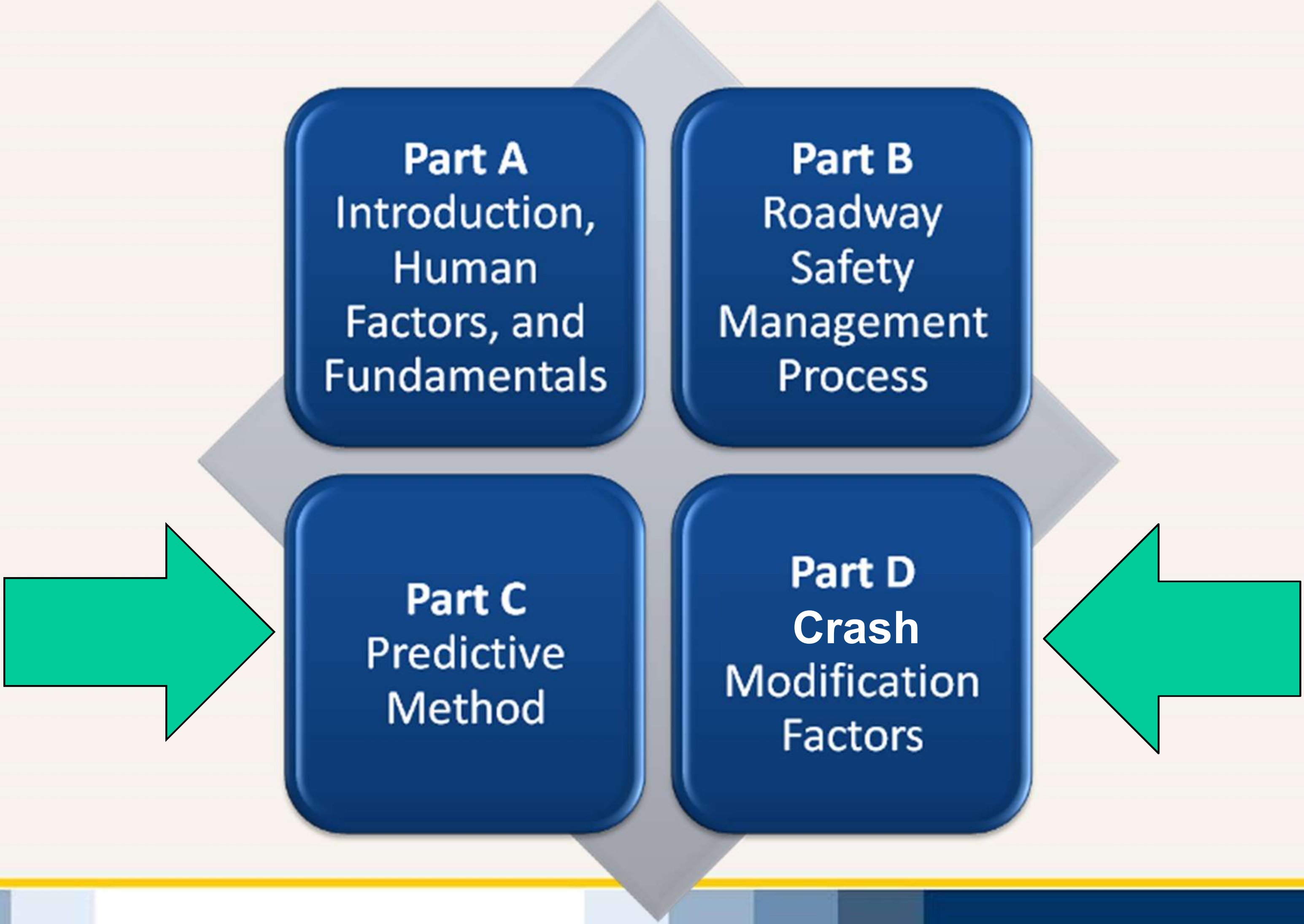
- Planning
- Design
- Operations
- Maintenance

How should we use the HSM?

Very CAREFULLY!

Highway Safety Manual

WHAT IS COVERED IN THE HSM?



Part A
Introduction, Human Factors, and Fundamentals

Part B
Roadway Safety Management Process

Part C
Predictive Method

Part D
Crash Modification Factors

Highway Safety Manual - Part C

Chapter 10		**Two-Lane Rural Roads**
Chapter 11		**Rural Multilane Highways**
Chapter 12		**Urban/ Suburban Arterial Highways**

Part C
Common Procedures

- Safety Performance Functions
- Crash Modification Factors
- Calibration for local conditions

Highway Safety Manual - Part C

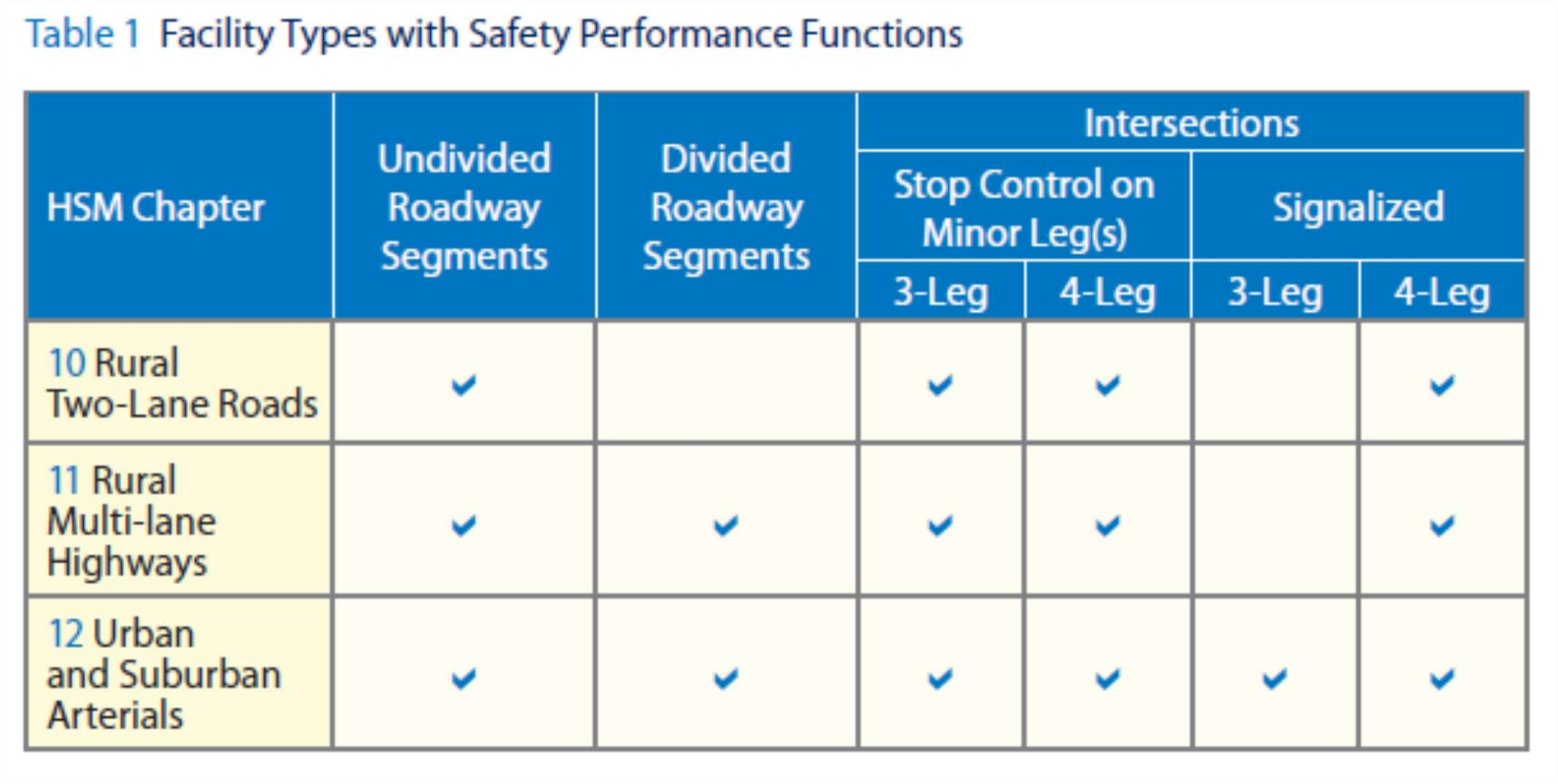


Table 1 Facility Types with Safety Performance Functions

HSM Chapter	Undivided Roadway Segments	Divided Roadway Segments	Intersections			
			Stop Control on Minor Leg(s)		Signalized	
			3-Leg	4-Leg	3-Leg	4-Leg
10 Rural Two-Lane Roads	✓		✓	✓		✓
11 Rural Multi-lane Highways	✓	✓	✓	✓		✓
12 Urban and Suburban Arterials	✓	✓	✓	✓	✓	✓

Highway Safety Manual - Part C

What are Safety Performance Functions?

Mathematical Regression Models for Roadway Segments and Intersections:

- Developed from data for a number of similar sites
- Developed for specific site types and "base conditions"
- Function of only a few variables, primarily AADT
- Used to calculate the expected crash frequency (crashes/year) for a set of base geometric and traffic control conditions

Purpose of Crash Modification Factors

- Adjusts the calculated SPF predicted value for base conditions to actual or proposed conditions
- Accounts for the difference between base conditions and site specific conditions

Highway Safety Manual - Part C

Crash Modification Factors - CMFs

CMFs are used to adjust the calculated SPF predicted value for base conditions to actual or proposed conditions

- **CMF = 1.0:** Meets base conditions or the treatment has no effect on the expected crash frequency
- **CMF < 1.0:** The treatment reduces the expected crash frequency
- **CMF > 1.0:** The treatment increases the expected crash frequency

CRF = 1 - CMF

Highway Safety Manual - Part C

IMPORTANT NOTE:

The CMFs from Part C are used to adjust the calculated SPF predicted value for base conditions to actual or proposed conditions. These are **NOT** the same as the CMFs in Part D or those that you get from the CMF Clearinghouse.

Highway Safety Manual - Part C

SPF Prediction Model for Base Conditions:

Rural Two-Lane Roadway Segments

$$\boxed{N_{spf\text{-}rs} = AADT \times L \times 365 \times 10^{-6} \times e^{(-0.312)}}$$

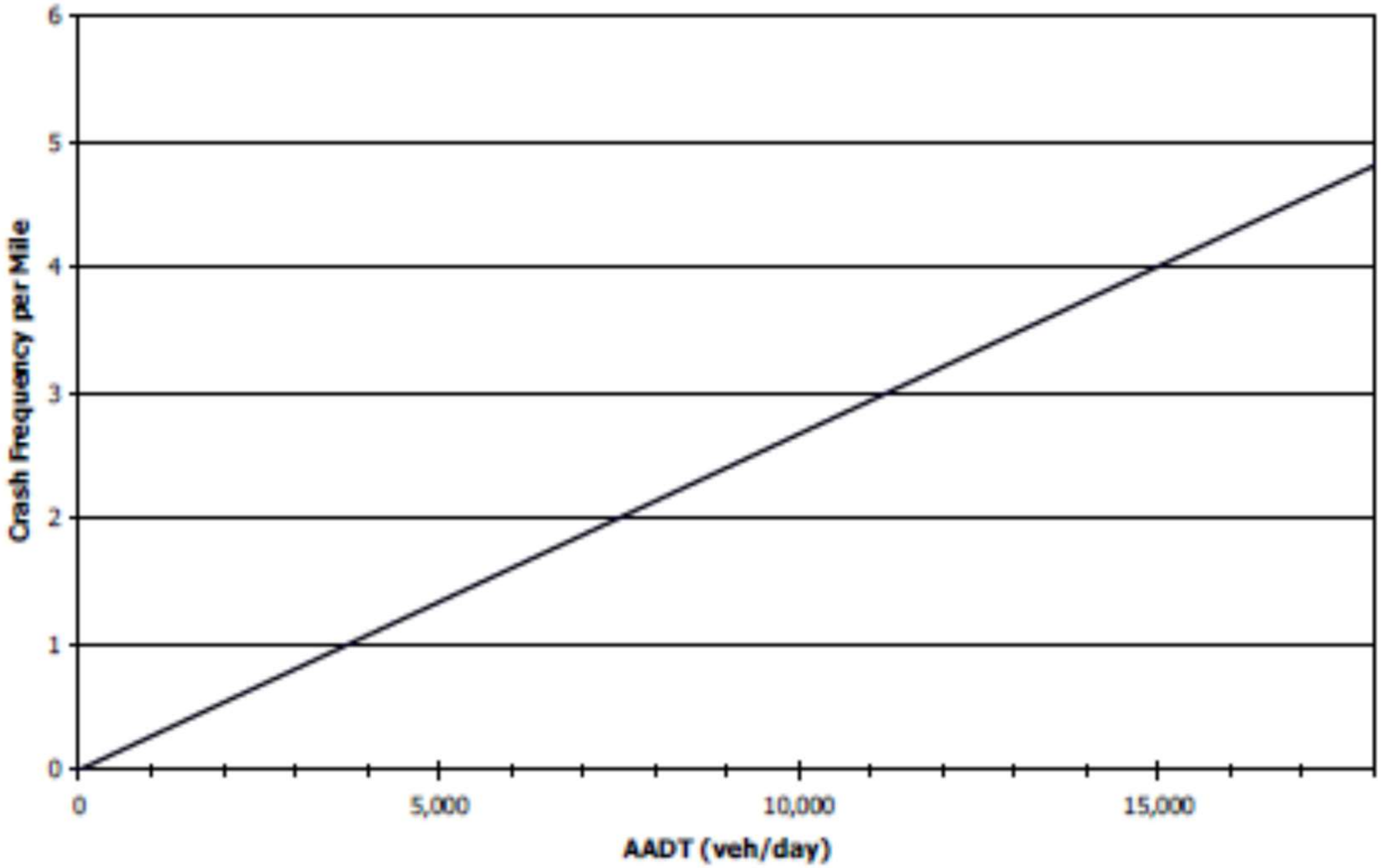
$N_{spf\text{-}rs}$ = predicted total crash frequency for roadway segment base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

L = length of roadway segment (miles)

Highway Safety Manual - Part C

Exhibit 10-5: Graphical Form of SPF for Rural Two-Lane Two-Way Roadway Segments (Equation 10-6)



Highway Safety Manual - Part C

SPF Prediction Model for Base Conditions:

Rural Two-Lane Roadway Segments

$$N_{spf\text{-}rs} = AADT \times L \times 365 \times 10^{-6} \times 0.732$$

$N_{spf\text{-}rs}$ = predicted total crash frequency for roadway segment base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

L = length of roadway segment (miles)

Highway Safety Manual - Part C

Base Conditions for Rural Two-Lane Roadway Segments:

Lane Width:	12 feet
Shoulder Width:	6 feet
Shoulder Type:	Paved
Roadside Hazard Rating:	3
Driveway Density:	≤5 driveways/mile
Grade:	0%
Horizontal Curvature:	None
Vertical Curvature:	None
Centerline rumble strips:	None
TWLTL, climbing, or passing lanes:	None
Lighting:	None
Automated Speed Enforcement:	None

Highway Safety Manual - Part C

Apply CMFs to the SPF Base Model

$$\boxed{N_{predicted\text{-}rs} = N_{spf\text{-}rs} \ \text{x} \ (CMF_{1r} \ldots CMF_{xr})\ C_r}$$

Where:

$N_{predicted\text{-}rs}$ = predicted average crash frequency for an individual roadway for a specific year (crashes per year)

$N_{spf\text{-}rs}$ = predicted average crash frequency for base conditions for an individual roadway segment (crashes per year)

CMF_{1r} ... CMF_{xr} = Crash Modification Factors for individual design elements

C_r = calibration factor

Highway Safety Manual - Part C

Base Conditions for Rural Two-Lane Roadway Segments:

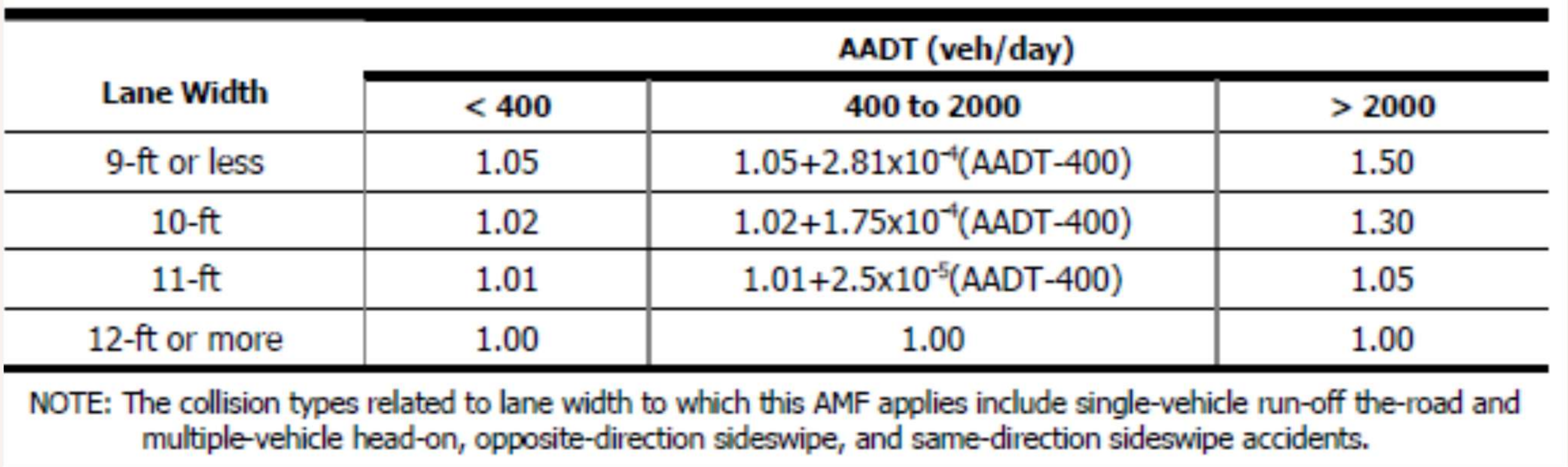
Lane Width:	12 feet
Shoulder Width:	6 feet
Shoulder Type:	Paved
Roadside Hazard Rating:	3
Driveway Density:	≤5 driveways/mile
Grade:	0%
Horizontal Curvature:	None
Vertical Curvature:	None
Centerline rumble strips:	None
TWLTL, climbing, or passing lanes:	None
Lighting:	None
Automated Speed Enforcement:	None

Highway Safety Manual - Part C

Crash Modification Factor- Lane Width

$$CMF_{1r} = (CMF_{ra} - 1.0)p_{ra} + 1.0$$

CMF for Lane Width on Roadway Segments (CMF_{ra})



Lane Width	AADT (veh/day)		
	< 400	400 to 2000	> 2000
9-ft or less	1.05	$1.05+2.81x10^{-4}(AADT-400)$	1.50
10-ft	1.02	$1.02+1.75x10^{-4}(AADT-400)$	1.30
11-ft	1.01	$1.01+2.5x10^{-5}(AADT-400)$	1.05
12-ft or more	1.00	1.00	1.00

NOTE: The collision types related to lane width to which this AMF applies include single-vehicle run-off the-road and multiple-vehicle head-on, opposite-direction sideswipe, and same-direction sideswipe accidents.

P_{ra} = proportion of related crashes. Default value = 0.574

District 7 has good data: use CDMS to get factors

Highway Safety Manual - Part C

But what about the intersections?

Highway Safety Manual - Part C

SPF Models for Rural Two-Lane Intersections:

1) 3-Leg <u>Stop Controlled</u> Intersection (3ST):

$$N_{spf\text{-}3ST}=\exp[-9.86 + 0.79\ \ln(AADT_{maj}) + 0.49\ \ln(AADT_{min})]$$

2) 4-Leg 2-Way <u>Stop Controlled</u> Intersection (4ST):

$$N_{spf\text{-}4ST}=\exp[-8.56 + 0.60\ \ln(AADT_{maj}) + 0.61\ \ln(AADT_{min})]$$

3) 4-Leg <u>Signalized</u> Intersection (4SG):

$$N_{spf\text{-}4SG} = \exp[-5.13 + 0.60\ \ln(AADT_{maj}) + 0.20\ \ln(AADT_{min})]$$

Base Conditions for Rural Two-Lane Intersections:

Intersection Skew Angle:	0 degrees
Presence of Left-Turn Lanes:	None
Presence of Right-Turn Lanes:	None
Lighting:	None

Predicting Safety Performance

Total predicted crashes within the limits of the roadway being analyzed:

$$\boxed{N_{\text{total crashes}} = \sum N_{\text{predicted-rs}} + \sum N_{\text{predicted-int}}}$$

$$\begin{array}{cc} \uparrow & \uparrow \\ \text{Roadway Segments} & \text{Intersections} \end{array}$$

- **Combine predicted roadway segment and intersection related crashes to obtain the total predicted crashes for the entire segment**

Highway Safety Manual - Part C

Safety Performance Functions
and
Crash Modification Factors
for
Rural Multilane Highway Segments

Highway Safety Manual - Part C

SPF Prediction Model for Base Conditions:

Rural Multilane Highway Segments

$$\boxed{N_{spf\text{-}ru} = e^{(a + b \times \ln(AADT) + \ln(L))}}$$

Undivided roadway sections

$N_{spf\text{-}ru}$ = predicted total crash frequency for roadway segment base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

L = length of roadway segment (miles)

a & b = regression coefficients

Highway Safety Manual - Part C

SPF Prediction Model for Base Conditions:

Rural Multilane Highway Segments

$$N_{spf\text{-}rd} = e^{(a + b \times \ln(AADT) + \ln(L))}$$

Divided roadway sections

$N_{spf\text{-}rd}$ = predicted total crash frequency for roadway segment base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

L = length of roadway segment (miles)

a & b = regression coefficients

Highway Safety Manual - Part C

SPF Coefficients for Undivided Rural Multilane

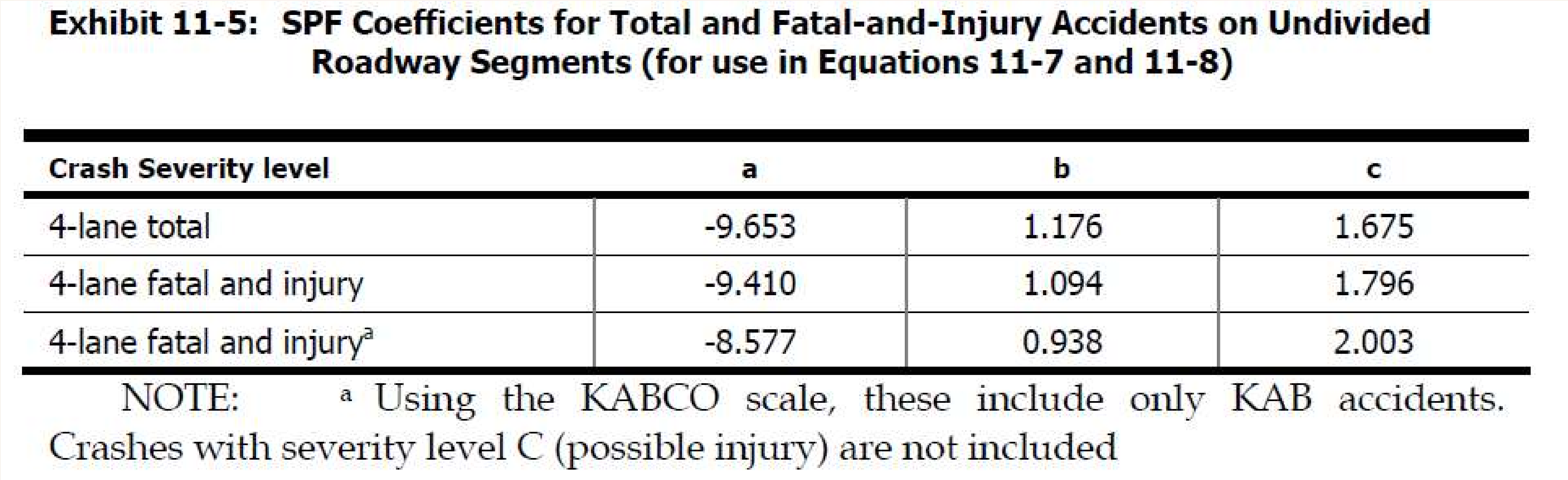


Exhibit 11-5: SPF Coefficients for Total and Fatal-and-Injury Accidents on Undivided Roadway Segments (for use in Equations 11-7 and 11-8)

Crash Severity level	a	b	c
4-lane total	-9.653	1.176	1.675
4-lane fatal and injury	-9.410	1.094	1.796
4-lane fatal and injury[a]	-8.577	0.938	2.003

NOTE: [a] Using the KABCO scale, these include only KAB accidents. Crashes with severity level C (possible injury) are not included

Highway Safety Manual - Part C

SPF Coefficients for Divided Rural Multilane

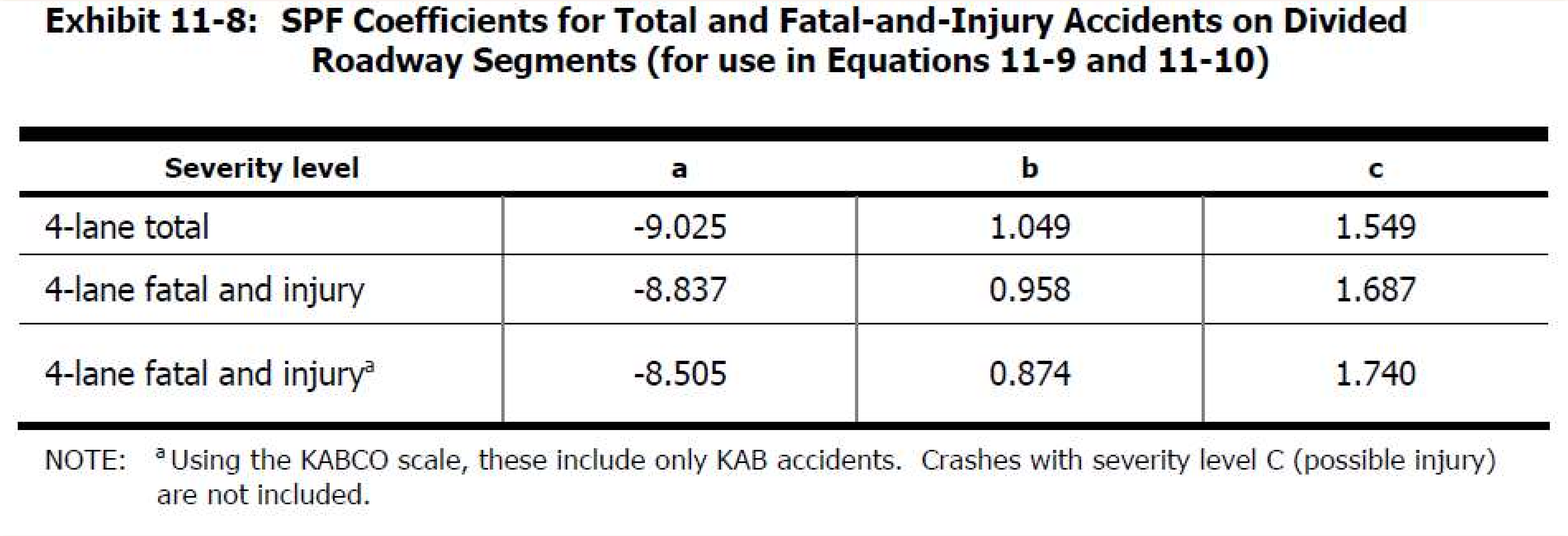


Exhibit 11-8: SPF Coefficients for Total and Fatal-and-Injury Accidents on Divided Roadway Segments (for use in Equations 11-9 and 11-10)

Severity level	a	b	c
4-lane total	-9.025	1.049	1.549
4-lane fatal and injury	-8.837	0.958	1.687
4-lane fatal and injury[a]	-8.505	0.874	1.740

NOTE: [a] Using the KABCO scale, these include only KAB accidents. Crashes with severity level C (possible injury) are not included.

Highway Safety Manual - Part C

Base Conditions for Undivided Rural Multilane

- Lane Width: 12 feet
- Shoulder Width: 6 feet
- Shoulder Type: Paved
- Sideslope: 1V:7H or flatter
- Lighting: None
- Automated Speed Enforcement: None

Highway Safety Manual - Part C

Base Conditions for Divided Rural Multilane

- Lane Width: 12 feet
- Right Shoulder Width: 8 feet
- Median Width: 30 feet
- Lighting: None
- Automated Speed Enforcement: None

Highway Safety Manual - Part C

Important note: the HSM says the following:

The term “multilane” refers to facilities with four through lanes.

Facilities with six or more lanes are not covered in Chapter 11.

Highway Safety Manual - Part C

Safety Performance Functions
and
Crash Modification Factors
for
Rural Multilane Highway Intersections

Highway Safety Manual - Part C

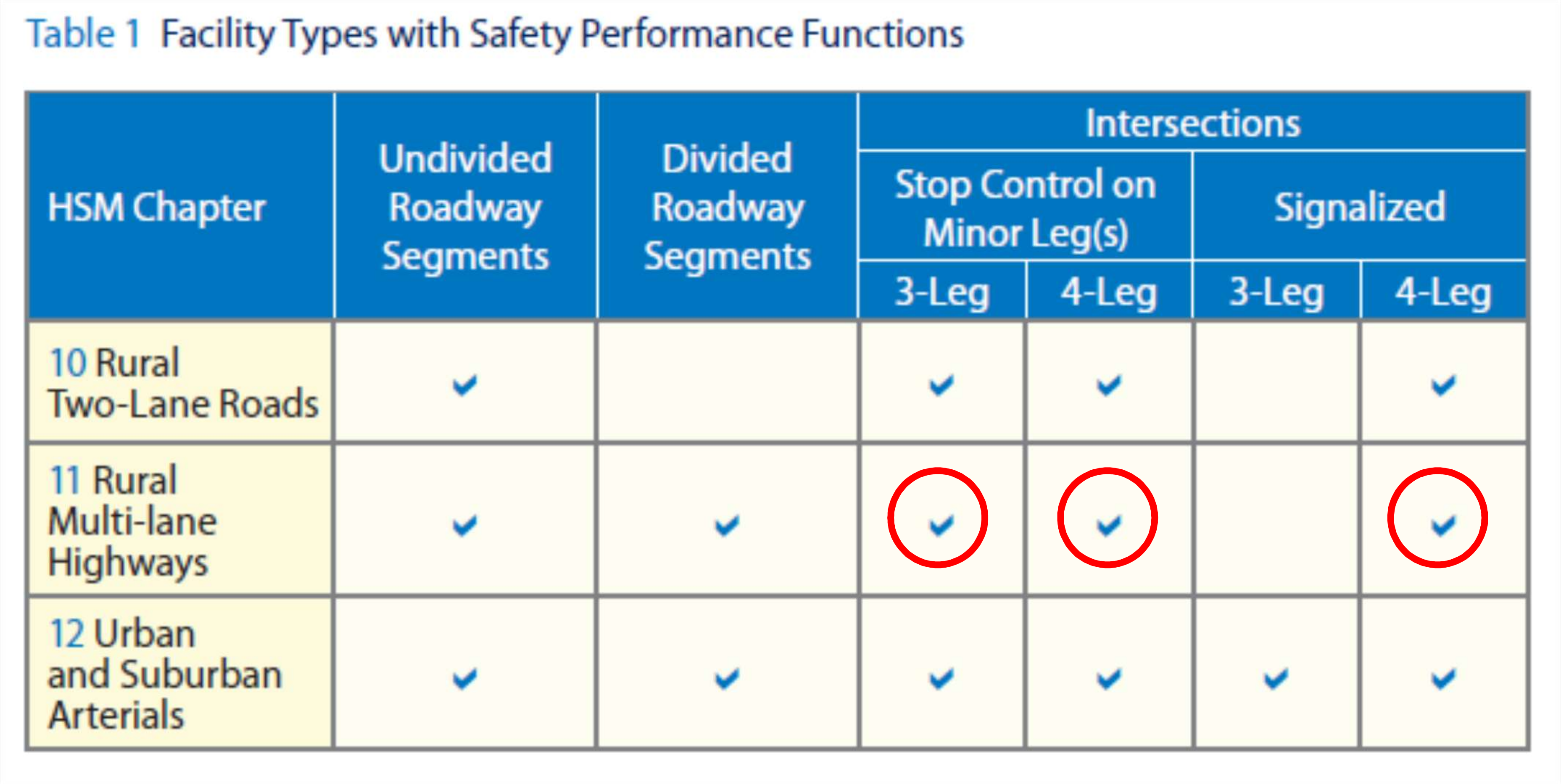


Table 1 Facility Types with Safety Performance Functions

HSM Chapter	Undivided Roadway Segments	Divided Roadway Segments	Intersections			
			Stop Control on Minor Leg(s)		Signalized	
			3-Leg	4-Leg	3-Leg	4-Leg
10 Rural Two-Lane Roads	✓		✓	✓		✓
11 Rural Multi-lane Highways	✓	✓	✓	✓		✓
12 Urban and Suburban Arterials	✓	✓	✓	✓	✓	✓

From the HSM:

The SPF’s for four-leg signalized intersections (4SG) on rural multilane highways have no specific base conditions and therefore, can only be applied for general predictions. **No CMF’s are provided for 4SG intersections and predictions of average crash frequency cannot be made for intersections with specific geometric design and traffic control features.**

Highway Safety Manual - Part C

Rural Multilane Highway Intersections

$$\boxed{N_{\text{spf int}} = e^{(a + b \times \ln(AADT_{maj}) + c \times \ln(AADT_{min}))}}$$

or

$$\boxed{N_{\text{spf int}} = e^{(a + d \times \ln(AADT_{total}))}}$$

$N_{\text{spf int}}$ = predicted total crash frequency for intersection base conditions (crashes/year)

AADT = average annual daily traffic volume (vpd)

a b c d = regression coefficients

Note: bottom equation form only used for four-leg signalized intersection fatal and injury crashes.

Highway Safety Manual - Part C

SPF Coefficients for STOP Controlled Intersections

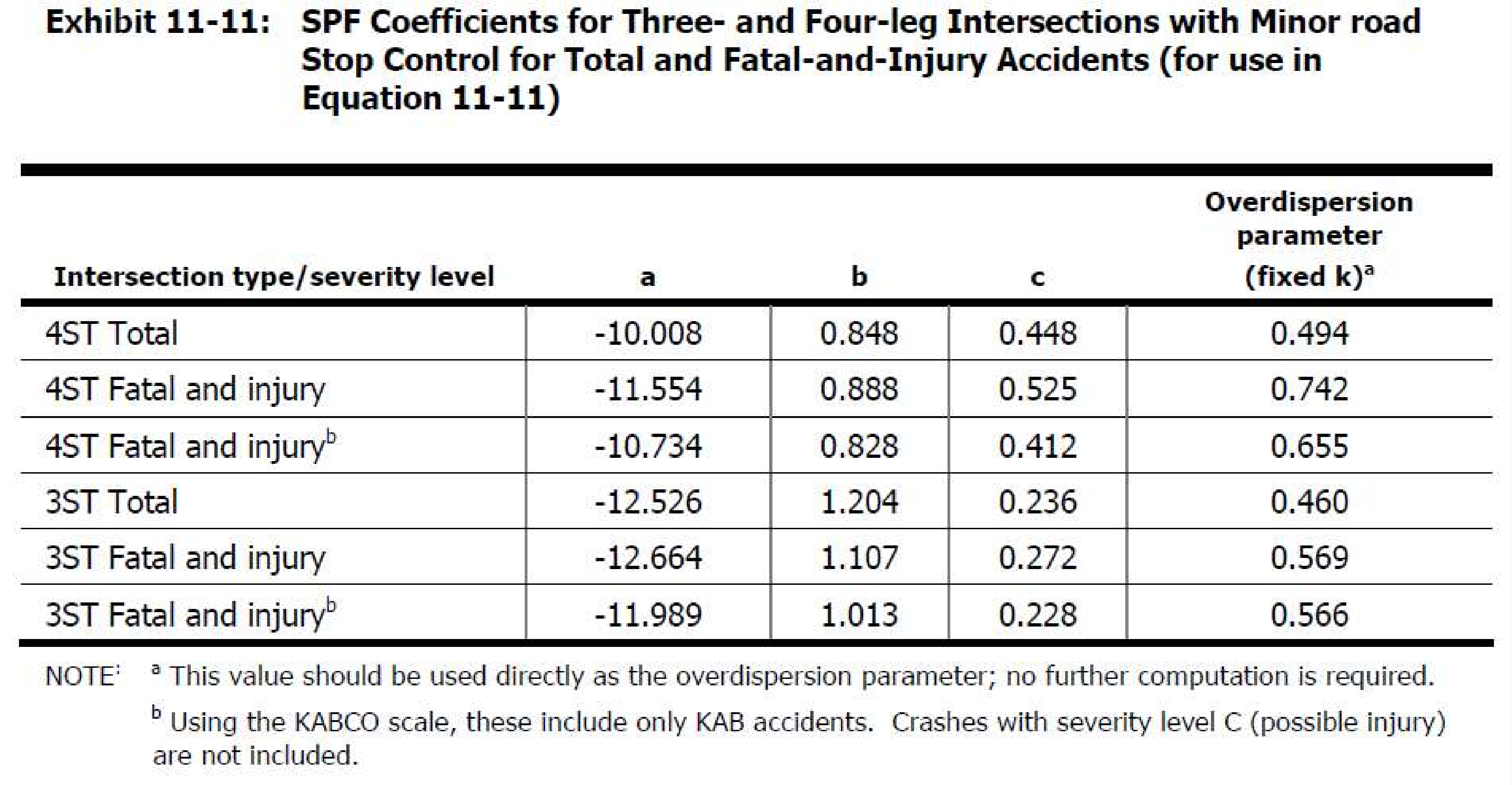


Exhibit 11-11: SPF Coefficients for Three- and Four-leg Intersections with Minor road Stop Control for Total and Fatal-and-Injury Accidents (for use in Equation 11-11)

Intersection type/severity level	a	b	c	Overdispersion parameter (fixed k)[a]
4ST Total	-10.008	0.848	0.448	0.494
4ST Fatal and injury	-11.554	0.888	0.525	0.742
4ST Fatal and injury[b]	-10.734	0.828	0.412	0.655
3ST Total	-12.526	1.204	0.236	0.460
3ST Fatal and injury	-12.664	1.107	0.272	0.569
3ST Fatal and injury[b]	-11.989	1.013	0.228	0.566

NOTE: [a] This value should be used directly as the overdispersion parameter; no further computation is required.

[b] Using the KABCO scale, these include only KAB accidents. Crashes with severity level C (possible injury) are not included.

Highway Safety Manual - Part C

SPF Coefficients for Signalized Intersections

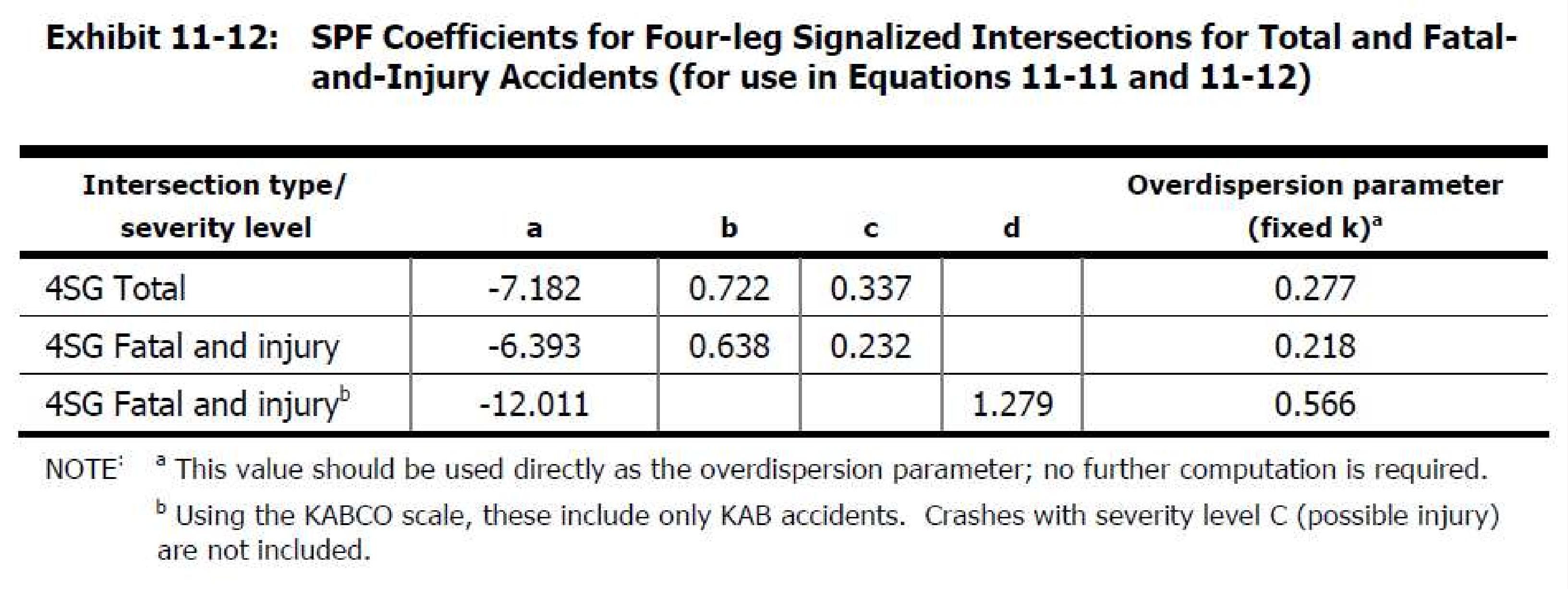


Exhibit 11-12: SPF Coefficients for Four-leg Signalized Intersections for Total and Fatal-and-Injury Accidents (for use in Equations 11-11 and 11-12)

Intersection type/ severity level	a	b	c	d	Overdispersion parameter (fixed k)[a]
4SG Total	-7.182	0.722	0.337		0.277
4SG Fatal and injury	-6.393	0.638	0.232		0.218
4SG Fatal and injury[b]	-12.011			1.279	0.566

NOTE: [a] This value should be used directly as the overdispersion parameter; no further computation is required.

[b] Using the KABCO scale, these include only KAB accidents. Crashes with severity level C (possible injury) are not included.

Predicting Safety Performance

Total predicted crashes within the limits of the roadway being analyzed:

$$\boxed{N_{\text{total crashes}} = \sum \underset{\substack{\uparrow \\ \text{Roadway Segments}}}{N_{\text{predicted-rs}}} + \sum \underset{\substack{\uparrow \\ \text{Intersections}}}{N_{\text{predicted-int}}}}$$

- **Combine predicted roadway segment and intersection related crashes to obtain the total predicted crashes for the entire segment**

Highway Safety Manual - Part C

Safety Performance Functions
and
Crash Modification Factors
for
Urban and Suburban Arterial Highway Segments

Highway Safety Manual - Part C

Important note: the HSM says the following:

> “Chapter 12 does not address arterial facilities with six or more lanes.”

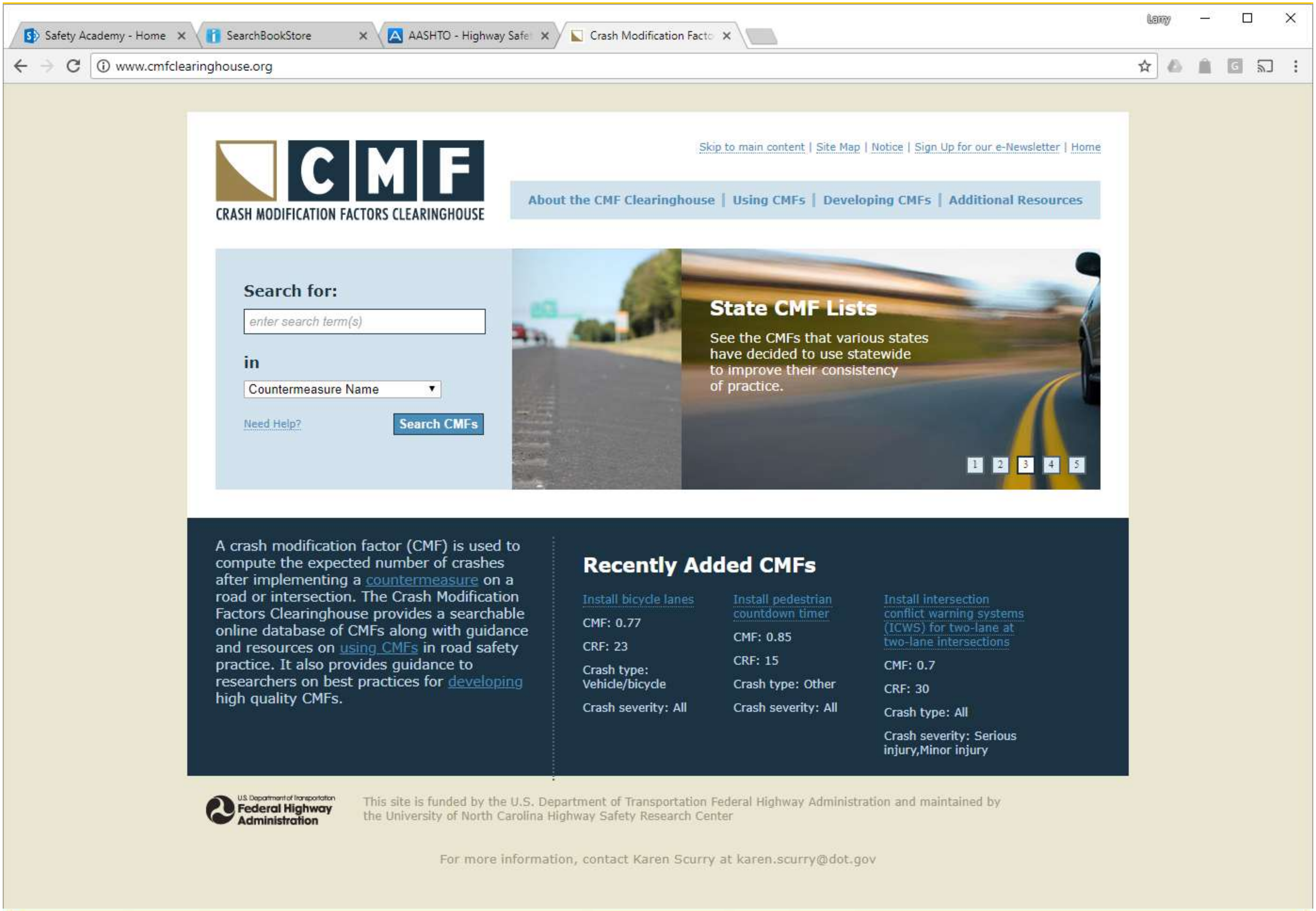
Highway Safety Manual - Part C

2014 Supplement to 1st Edition

Chapter 18	Predictive Method for Freeways
Chapter 19	Predictive Method for Ramps

Highway Safety Manual - Part D

CHAPTER 13	Roadway Segments
CHAPTER 14	Intersections
CHAPTER 15	Interchanges
CHAPTER 16	Special Facilities and Geometric Situations
CHAPTER 17	Road Networks



Search for:

enter search term(s)

in

Countermeasure Name

State CMF Lists

See the CMFs that various states have decided to use statewide to improve their consistency of practice.

A crash modification factor (CMF) is used to compute the expected number of crashes after implementing a countermeasure on a road or intersection. The Crash Modification Factors Clearinghouse provides a searchable online database of CMFs along with guidance and resources on using CMFs in road safety practice. It also provides guidance to researchers on best practices for developing high quality CMFs.

Recently Added CMFs

Install bicycle lanes
CMF: 0.77
CRF: 23
Crash type: Vehicle/bicycle
Crash severity: All

Install pedestrian countdown timer
CMF: 0.85
CRF: 15
Crash type: Other
Crash severity: All

Install intersection conflict warning systems (ICWS) for two-lane at two-lane intersections
CMF: 0.7
CRF: 30
Crash type: All
Crash severity: Serious injury,Minor injury

U.S. Department of Transportation Federal Highway Administration

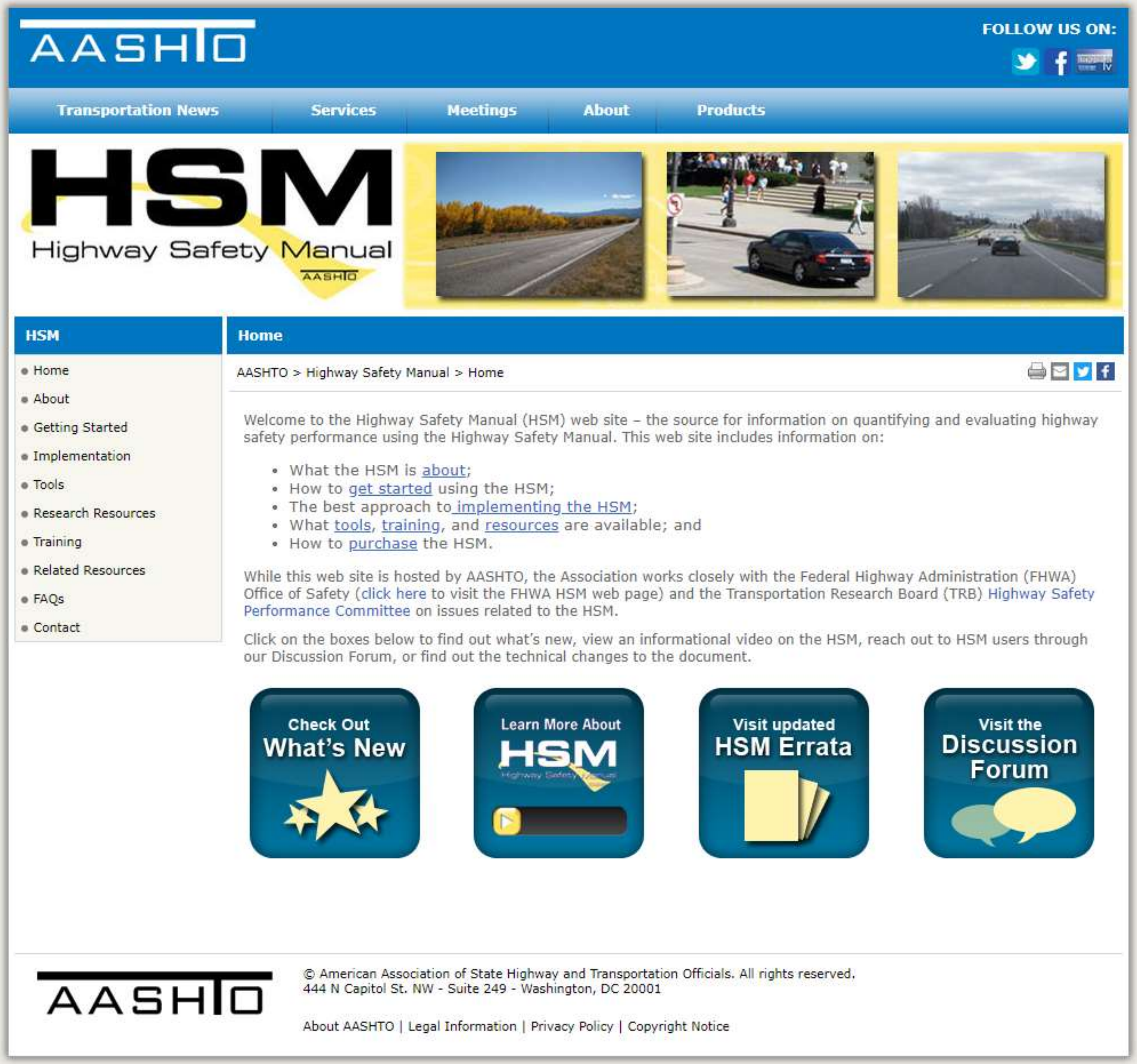
This site is funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center

For more information, contact Karen Scurry at karen.scurry@dot.gov

Where do we get help on the HSM?

www.**HighwaySafetyManual**.org

- Online training (webinar series videos)
- Links to related tools (SafetyAnalyst, IHSDM)
- User discussion forum



Welcome to the Highway Safety Manual (HSM) web site – the source for information on quantifying and evaluating highway safety performance using the Highway Safety Manual. This web site includes information on:

- What the HSM is about;
- How to get started using the HSM;
- The best approach to implementing the HSM;
- What tools, training, and resources are available; and
- How to purchase the HSM.

While this web site is hosted by AASHTO, the Association works closely with the Federal Highway Administration (FHWA) Office of Safety (click here to visit the FHWA HSM web page) and the Transportation Research Board (TRB) Highway Safety Performance Committee on issues related to the HSM.

Click on the boxes below to find out what's new, view an informational video on the HSM, reach out to HSM users through our Discussion Forum, or find out the technical changes to the document.

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Why should we use the HSM?

- We need quantitative estimates of safety performance for many planning and project development decisions.
- More reliable estimates lead to more safety cost-effective decision making.
- The estimation methods in the HSM are based upon good science/research and improve upon much of current practice.

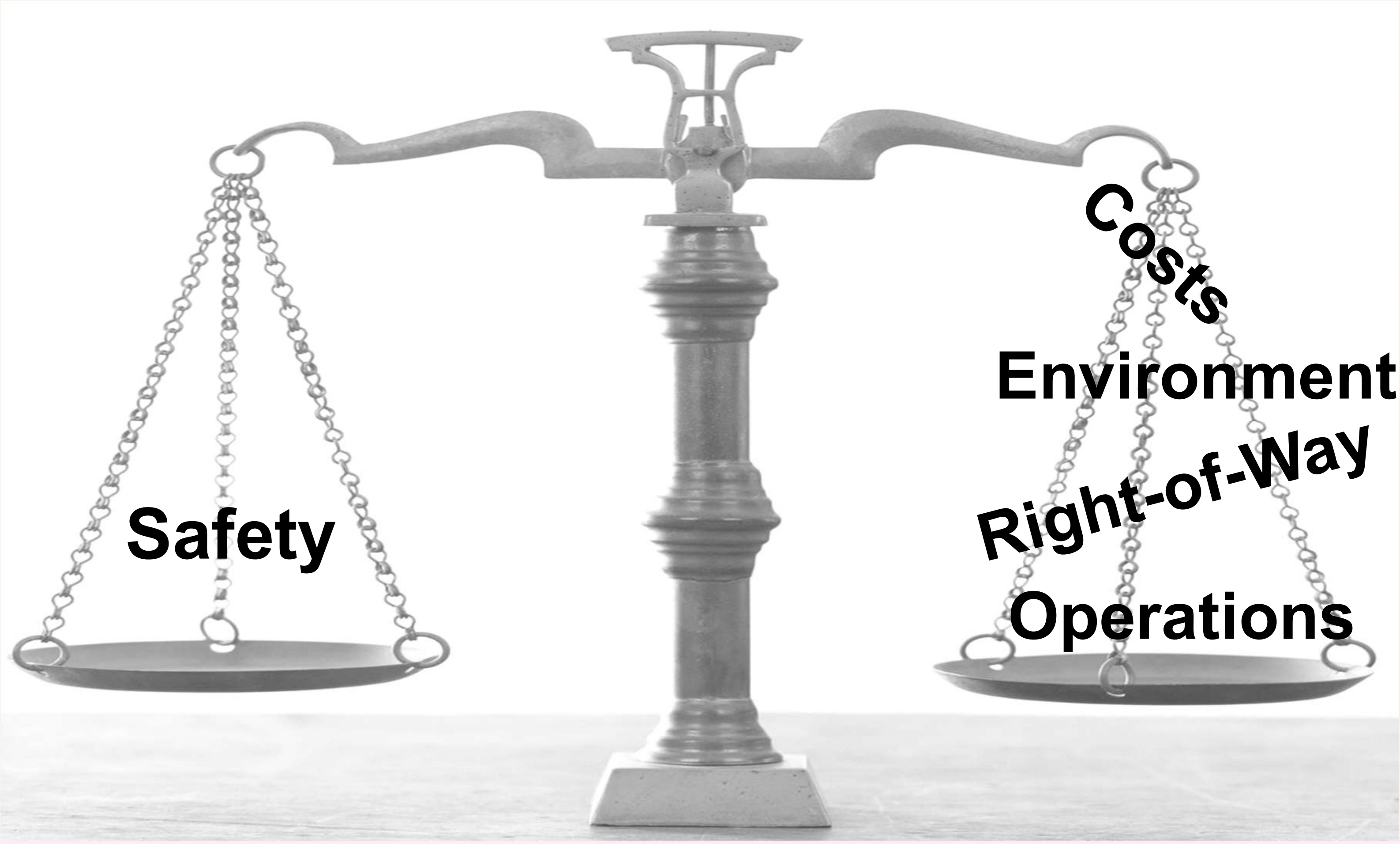
Why should we use the HSM?

Decisions requiring quantitative safety estimates:

- Identifying sites with the most potential for crash frequency or severity reduction
- Identifying crash patterns and treatments to address those patterns
- Conducting economic appraisals of projects
- Evaluating the crash reduction benefits of implemented treatments
- Estimating the effects of design decisions on crash frequency and severity

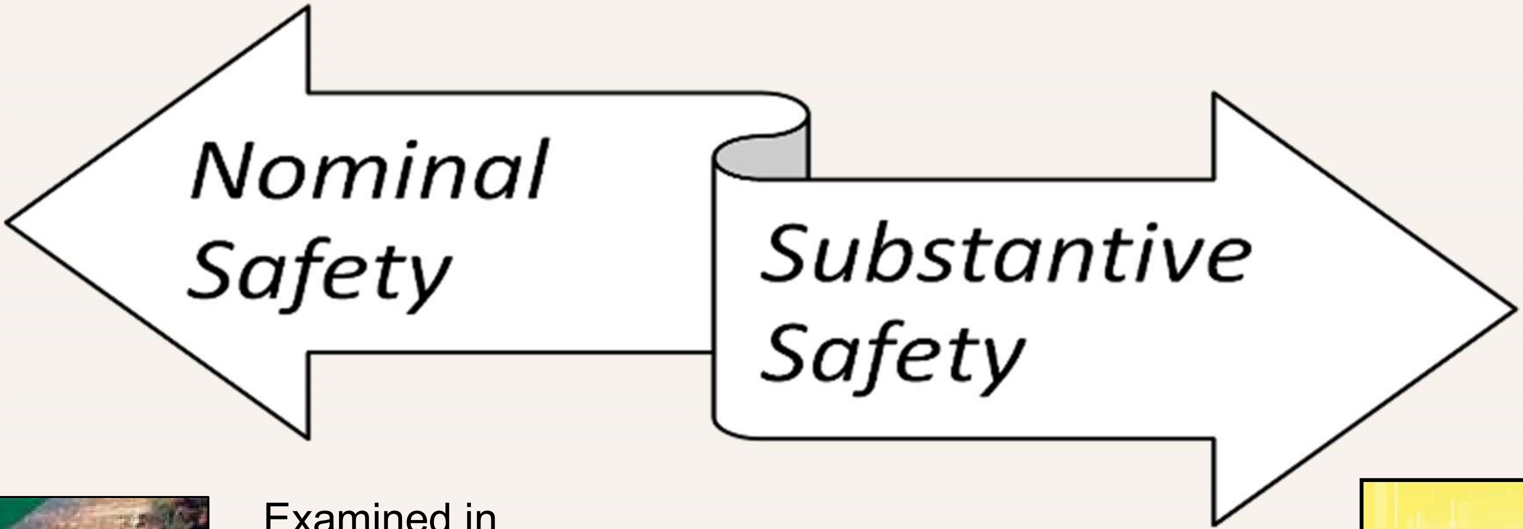
Why should we use the HSM?

Quantifying safety facilitates tradeoff analysis…



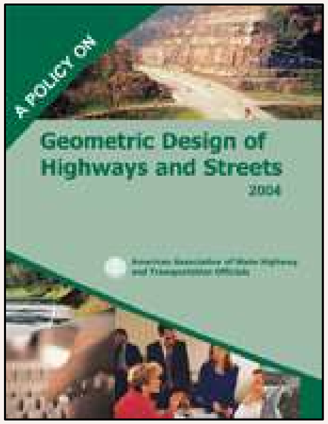
Why should we use the HSM?

HSM methods complement design guidelines…



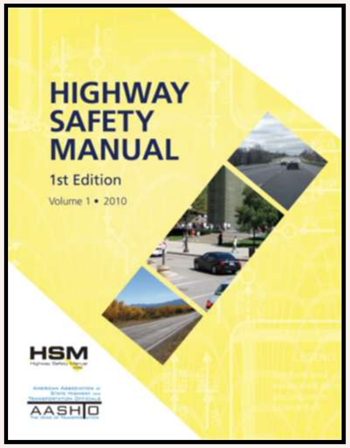
Nominal Safety

Substantive Safety



Examined in reference to compliance with standards, warrants, guidelines and sanctioned design procedures

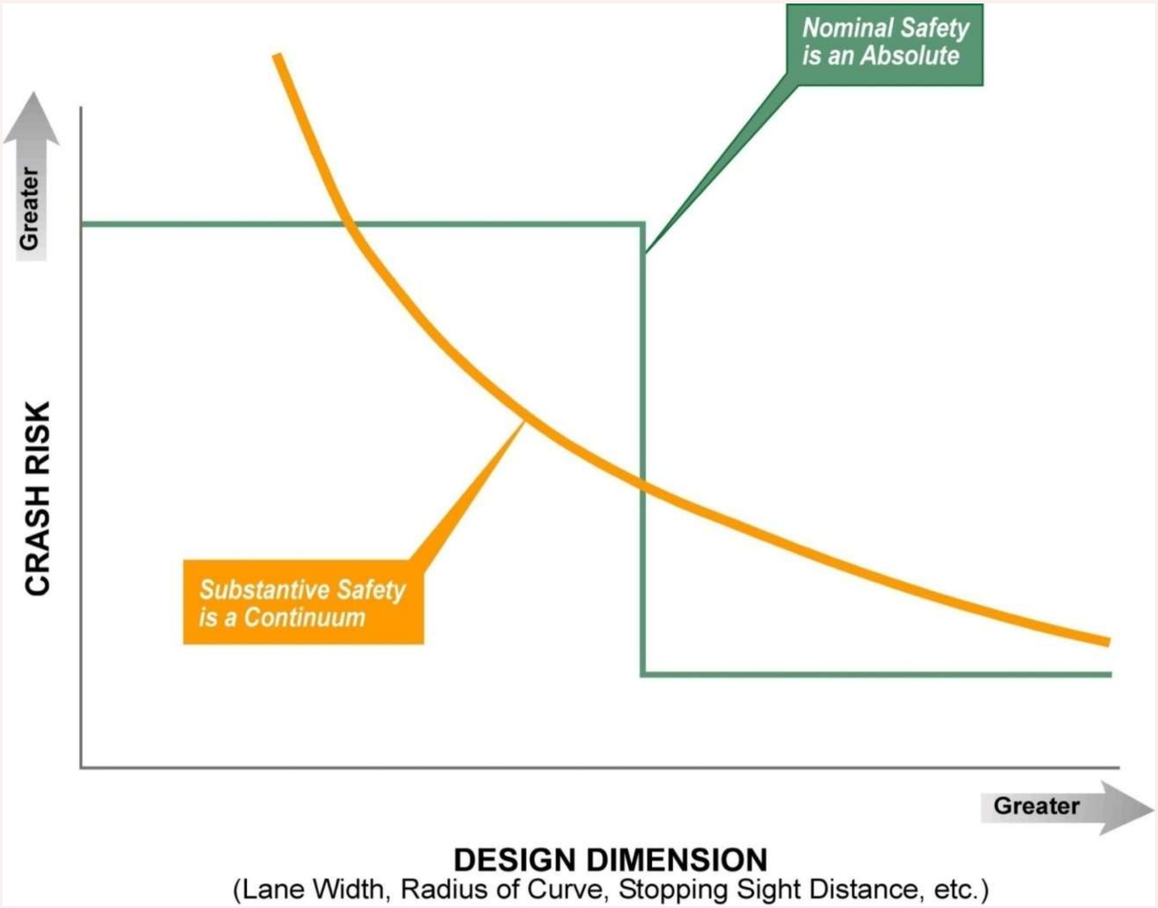
The expected or actual crash frequency and severity for a highway or roadway



**Ezra Hauer, ITE Traffic Safety Toolbox Introduction, 1999*

Why should we use the HSM?

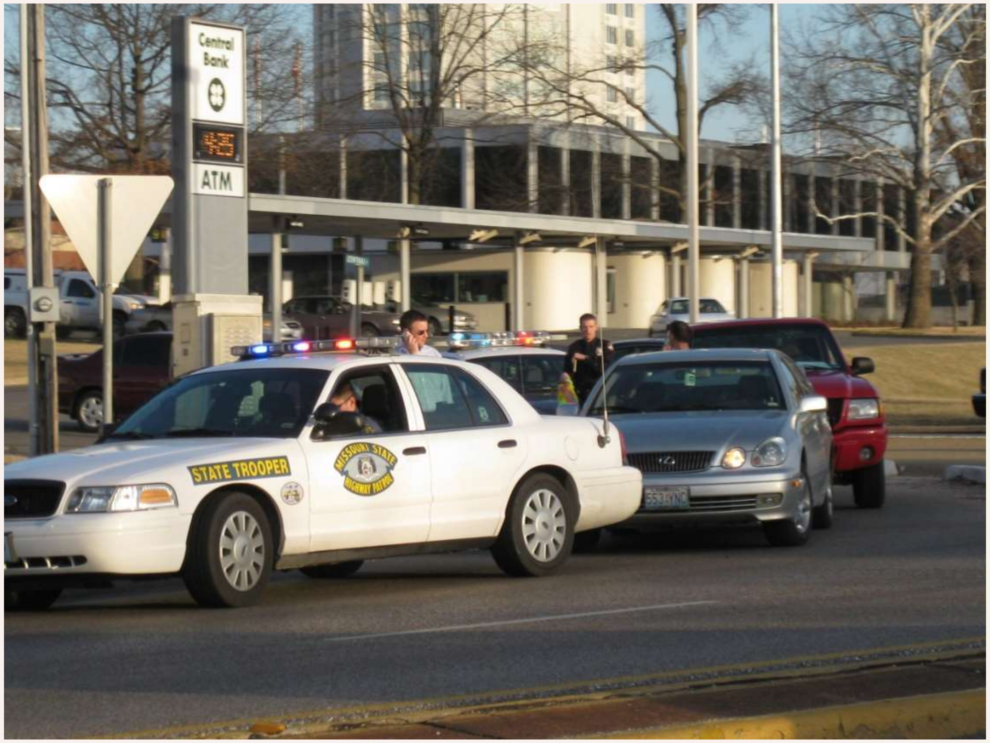
HSM estimates the safety effects of design decisions…



Key Safety Principles and Design

Knowledge is imprecise, judgment is essential

- ☐ Meeting standards does not necessarily make a highway safe
- ☐ Some Important features of highways not determined by standards
  - e.g., “large” radius right turn lanes



Role of Road Design in Crash Prevention

Design can reduce:

- →Incidents of human error
- →Chance of human error resulting in crash
- →Severity of the consequences of crashes

- How a particular section of highway or an intersection is built (Engineering) and how it is operated impact both the number and severity of crashes

Why should we use the HSM?

Better methods improve the "bottom line"

- Better safety analysis tools to support decision making
- More cost-effective safety investments
- More lives saved and injuries avoided per dollar invested

Why should we use the HSM?

HSM methods improve upon current practice:

- Safety is measured in terms of expected (long-term) average crash frequency
- Alternative ways to estimate:
  - Crash counts
  - Statistical (predictive) methods
  - Combination of crash counts and predictive methods (Empirical Bayes method)

Why should we use the HSM?

HSM predictive methods:

- Apply appropriate statistical methods to:
  - Model the variability in crash data
  - Compensate for regression to the mean
  - Account for changes in traffic volumes
- Include the following components:
  - Safety performance functions (SPFs)
  - Crash modification factors (CMFs)
  - State/local calibration factors
  - Empirical Bayes weightings

Why should we use the HSM?

HSM <u>predictive</u> methods

PROactive

rather than

REactive

Why should we use the HSM?

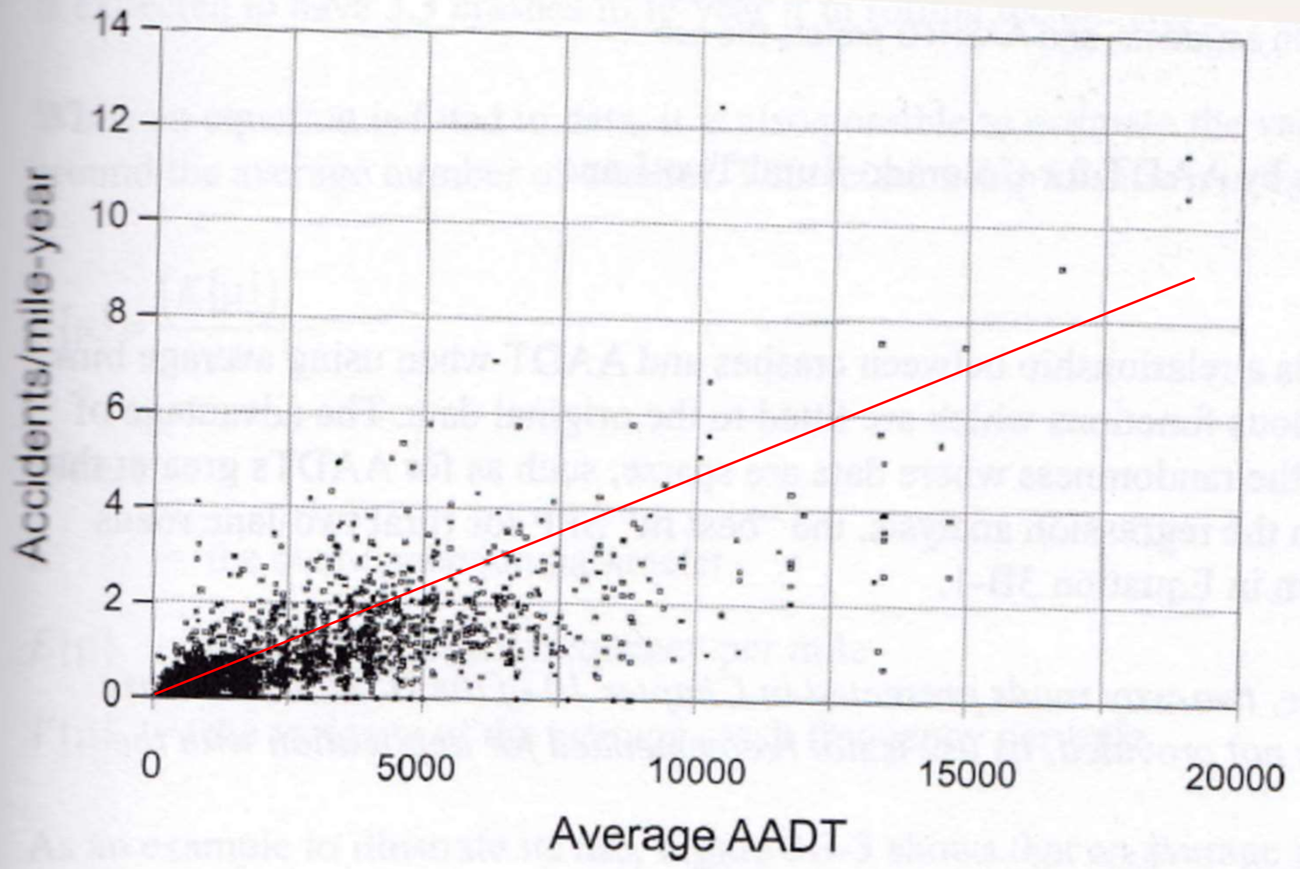
In summary:

- We need quantitative estimates of safety performance for many planning and project development decisions.
- More reliable estimates lead to more safety cost-effective decision making.
- The estimation methods in the HSM are based upon good science/research and improve upon much of current practice.

Why should we use the HSM?

- Safety considerations should be a part of every transportation project
- See Your Mission Statement
- We can reduce crashes and save lives
- We need to start thinking proactively about safety

How good are the regression equations?

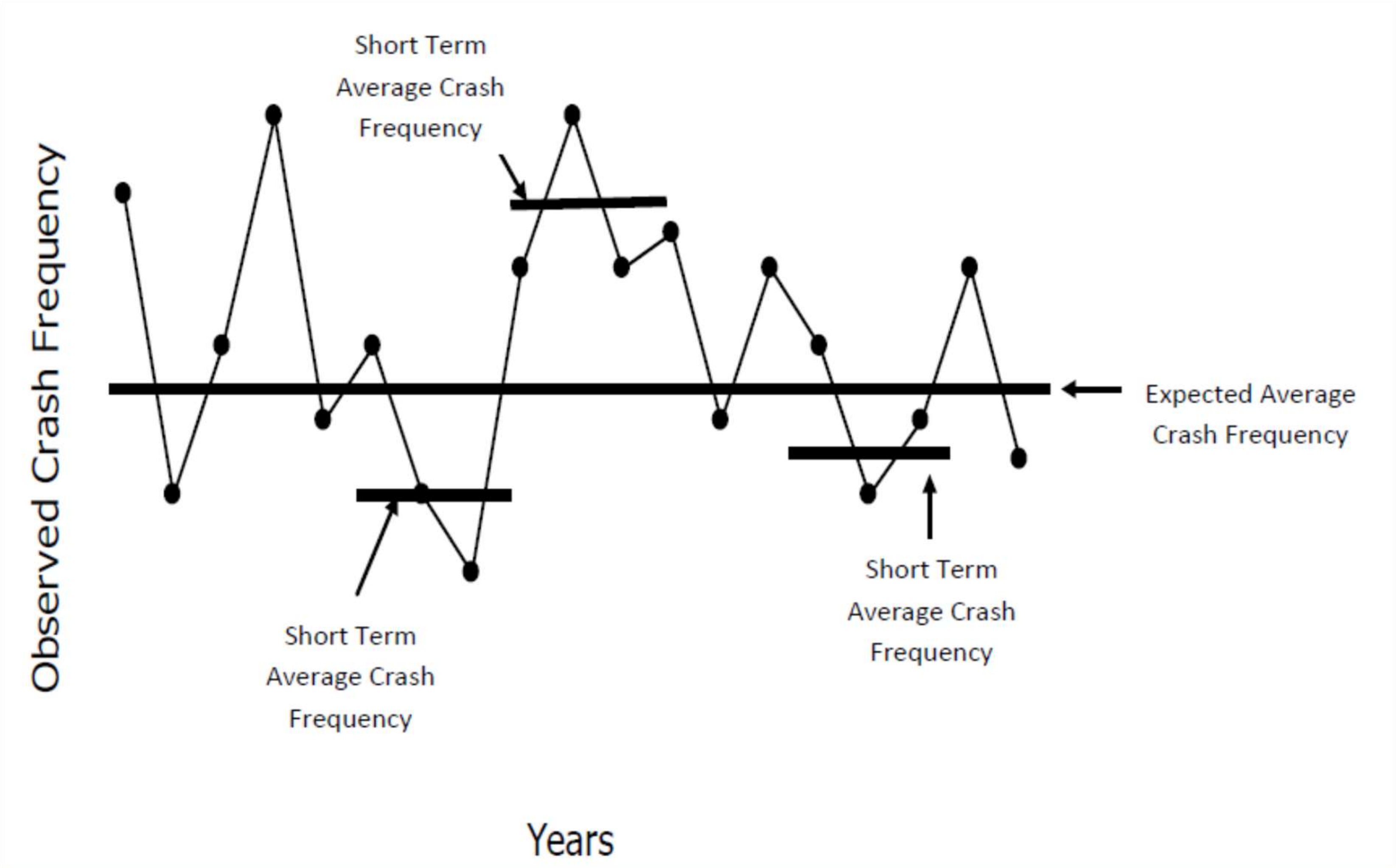


Note: The term *accidents* is used in this graphic to remain consistent with the original source. The HSM does not use the term *accidents*, and AASHTO prefers the use of the term *crashes*.

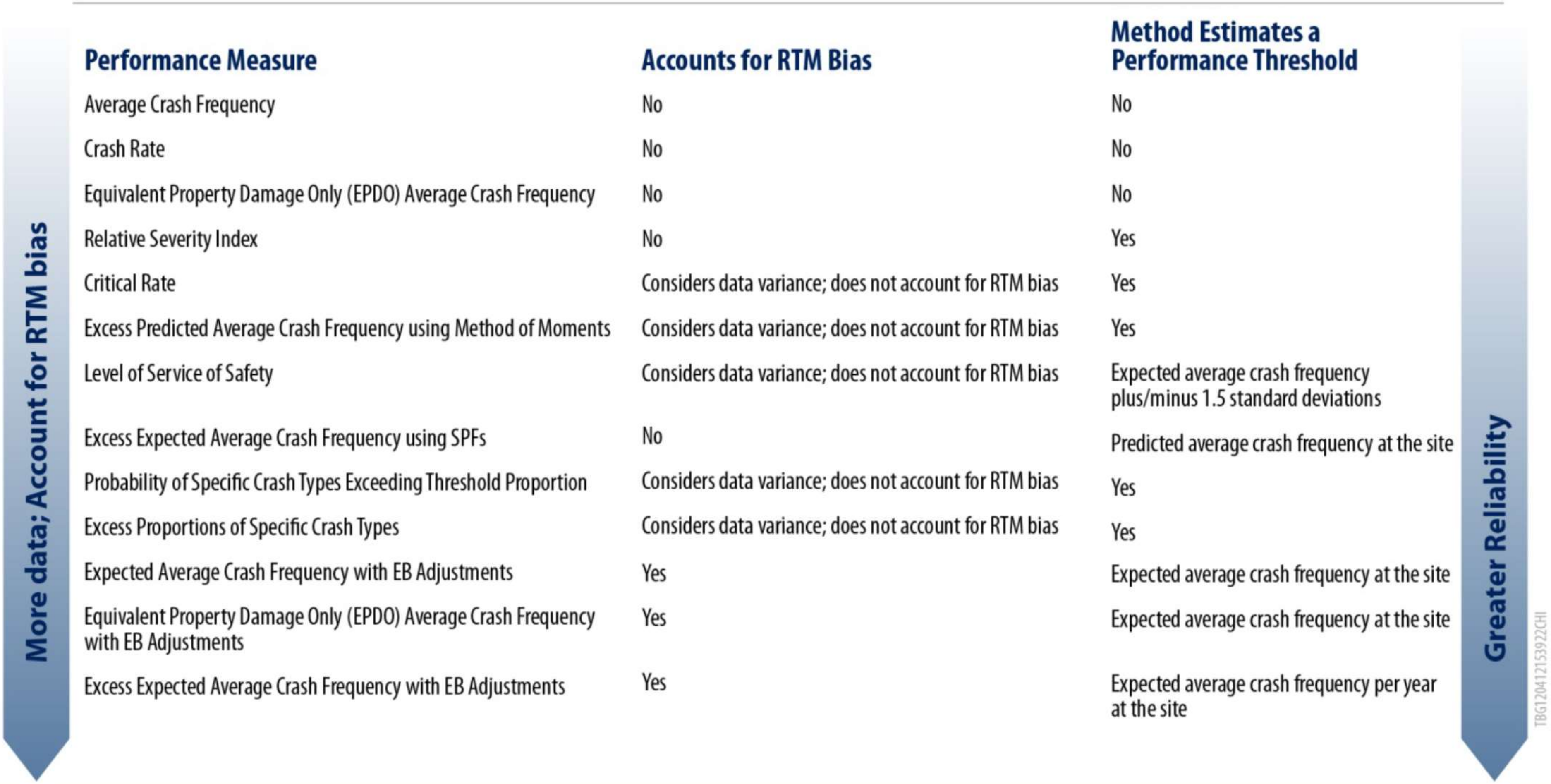
What does regression-to-the-mean mean?

Regression-to-the-mean (RTM) or selection bias refers to the bias created by the natural fluctuation of crash frequencies, which may lead one to draw incorrect conclusions about countermeasure effectiveness or sites with potential for improvement.

What does regression-to-the-mean mean?

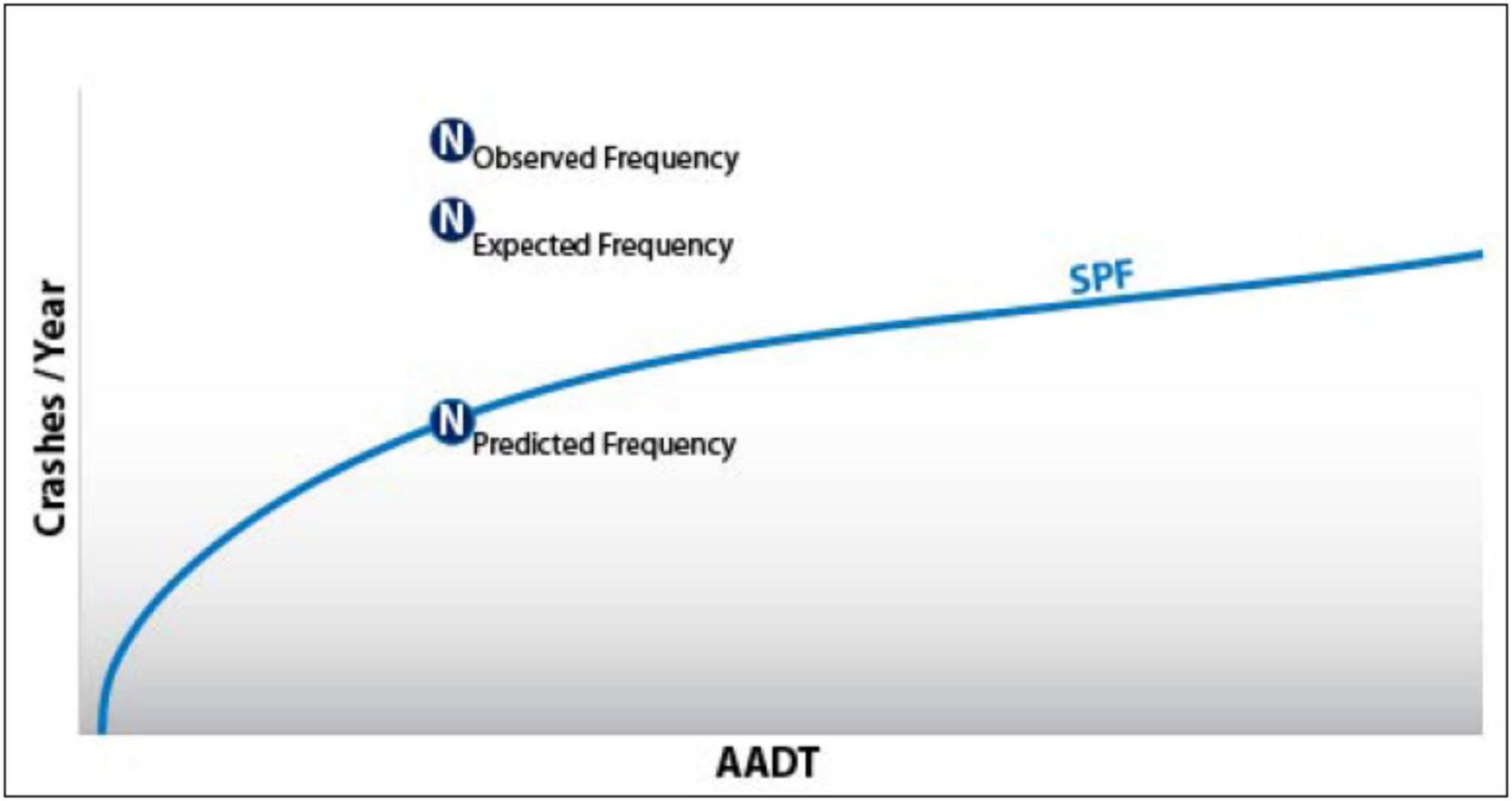


What is Empirical Bayes?



Performance Measure	Accounts for RTM Bias	Method Estimates a Performance Threshold
Average Crash Frequency	No	No
Crash Rate	No	No
Equivalent Property Damage Only (EPDO) Average Crash Frequency	No	No
Relative Severity Index	No	Yes
Critical Rate	Considers data variance; does not account for RTM bias	Yes
Excess Predicted Average Crash Frequency using Method of Moments	Considers data variance; does not account for RTM bias	Yes
Level of Service of Safety	Considers data variance; does not account for RTM bias	Expected average crash frequency plus/minus 1.5 standard deviations
Excess Expected Average Crash Frequency using SPFs	No	Predicted average crash frequency at the site
Probability of Specific Crash Types Exceeding Threshold Proportion	Considers data variance; does not account for RTM bias	Yes
Excess Proportions of Specific Crash Types	Considers data variance; does not account for RTM bias	Yes
Expected Average Crash Frequency with EB Adjustments	Yes	Expected average crash frequency at the site
Equivalent Property Damage Only (EPDO) Average Crash Frequency with EB Adjustments	Yes	Expected average crash frequency at the site
Excess Expected Average Crash Frequency with EB Adjustments	Yes	Expected average crash frequency per year at the site

What is Empirical Bayes?

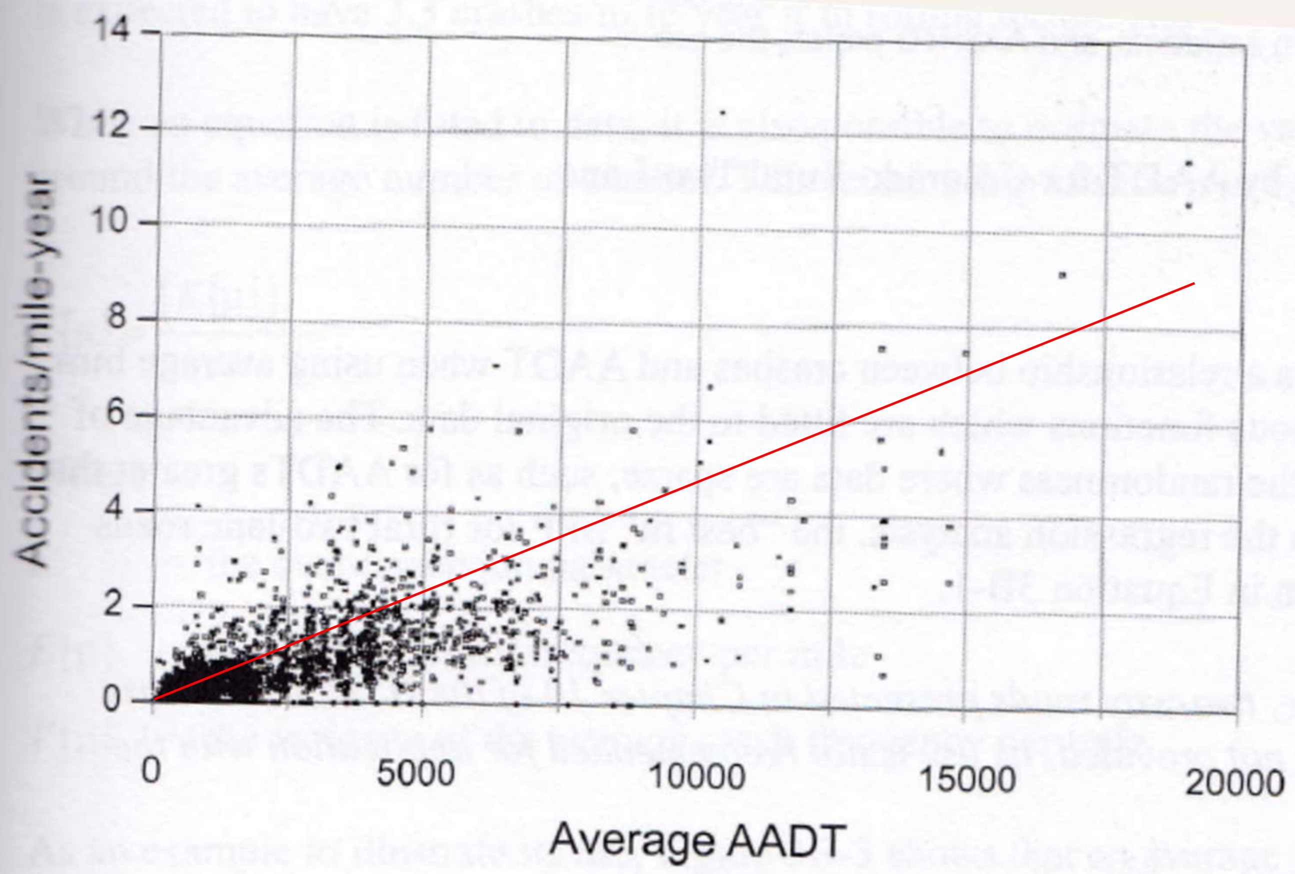


What is the underlying assumption?

The BIG Assumption:

Average Crash Rate For 100 Years = Average Crash Rate For 1 Year At 100 Similar Sites

How good are the regression equations?



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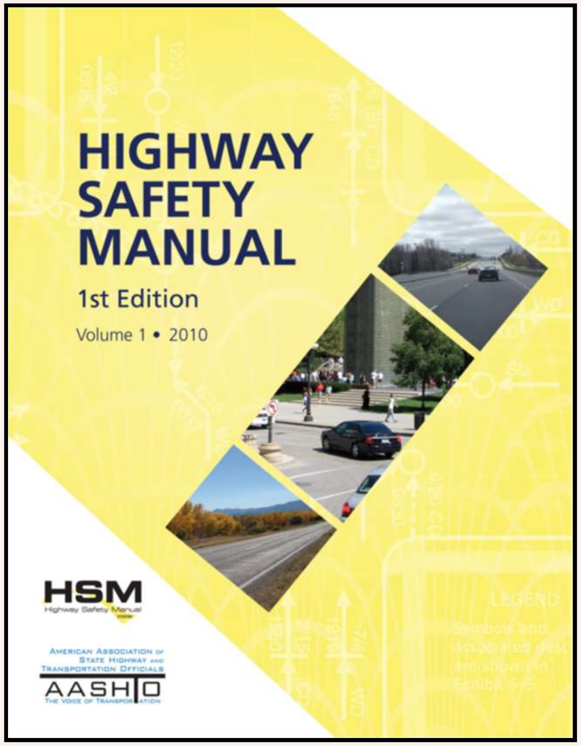
Introduction to the HSM

- What is the HSM?
- Who should use the HSM?
- When should the HSM be used?
- How to use the HSM?
- Where can we get assistance?
- Why should we use the HSM?

Highway Safety Manual

Applications for Local Agency Safety Projects



Questions?

Larry@TrafficSafetyGuru.com