

Safety Applications including the Highway Safety Manual

ODOT Traffic Engineering Conference

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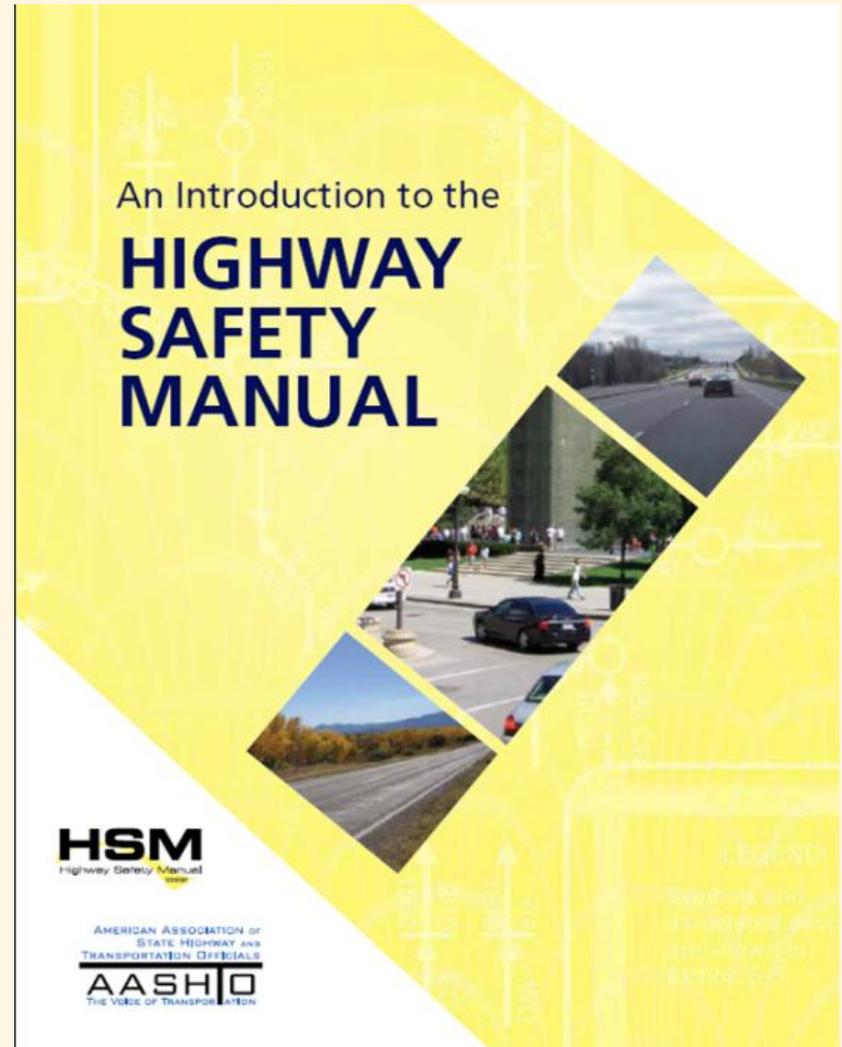
June 7, 2011

Presentation Overview

- › Purpose
- › Key Messages
- › Project Applications Illustrating Messages
- › Closing Remarks

Purpose

- › Demystify Safety
- › Present Tangible Examples
- › Provide Key Points for to help you apply HSM concepts

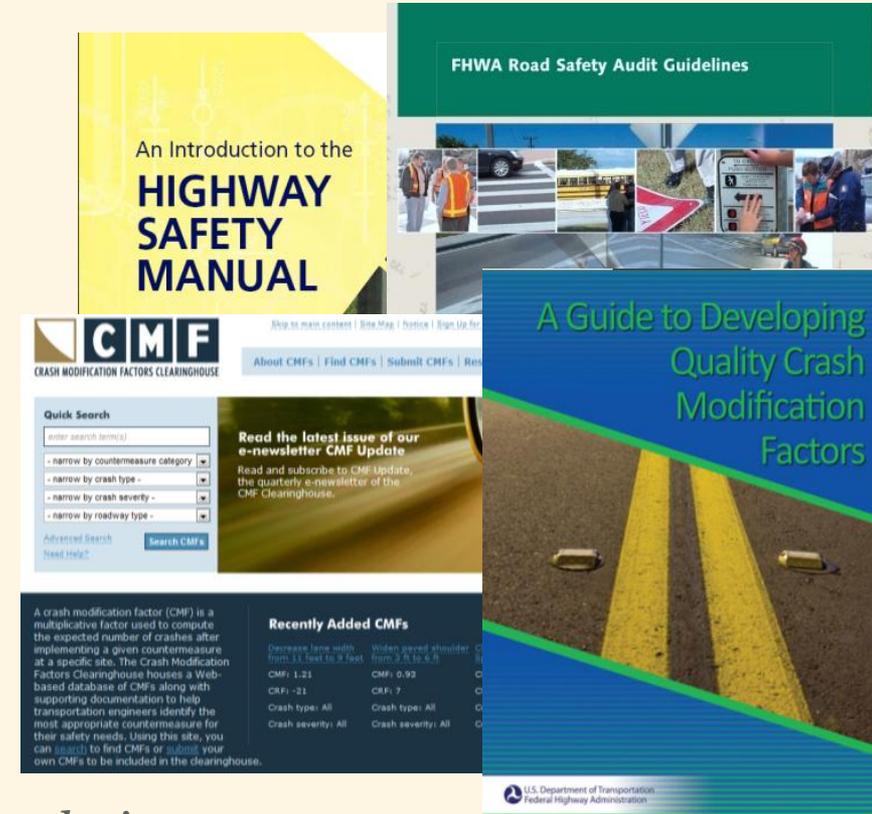


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Key Messages

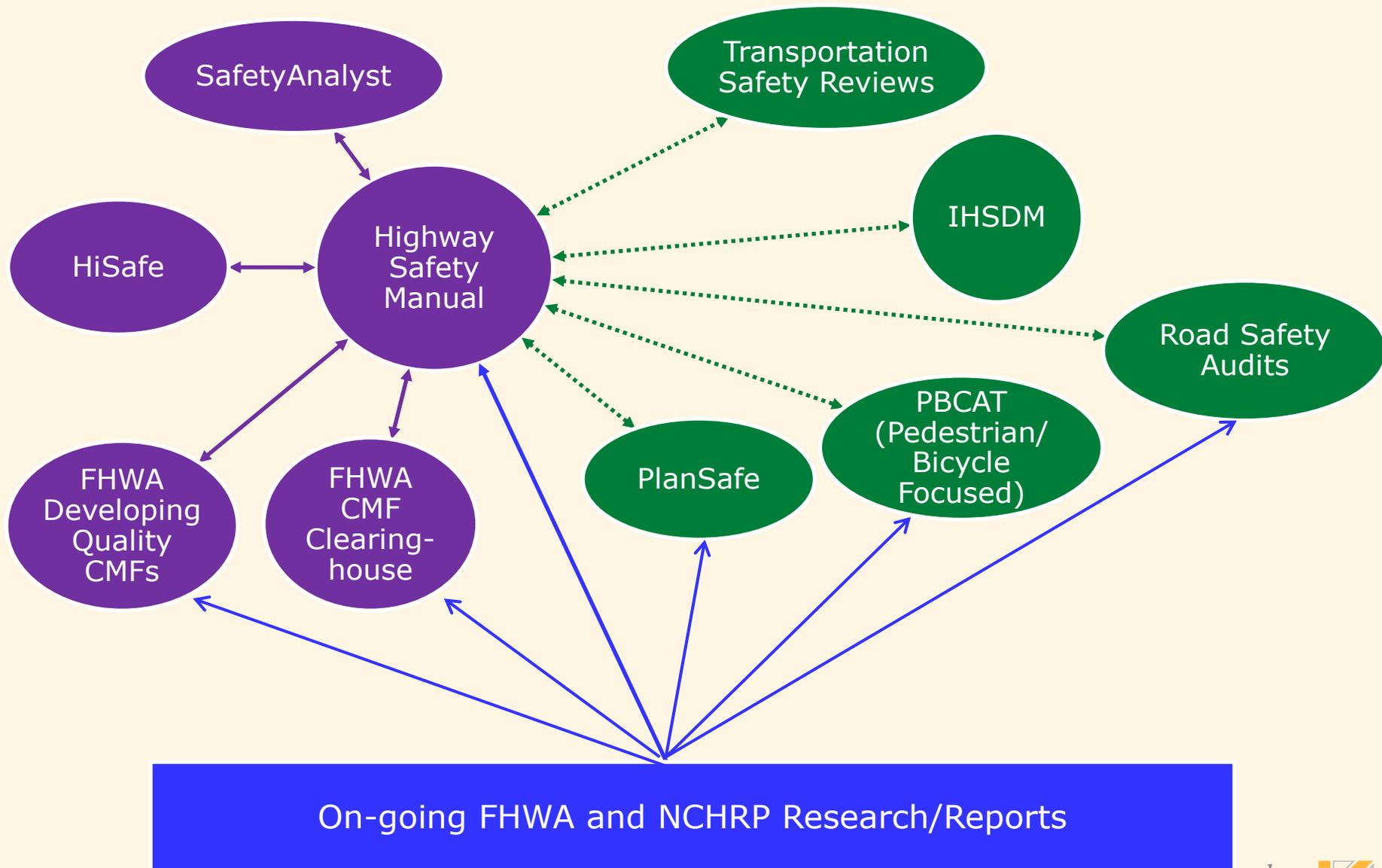
- ▶ We want you to know and understand...
 - *Safety is easy to include in our work; (eventually) we should all be able to do it.*
 - *Safety is more than the HSM.*
 - *Safety integrates into all aspects of the project development process.*
 - *Safety can be a small effort but provide key value.*
 - *Safety can differentiate project development decisions.*
 - *Safety can support Practical Design solutions.*



Quantified Safety integrated in our work:

- › Helps professionals support Practical Design decisions
 - › Are 11 foot lanes different than 12 foot lanes?
- › Helps agency staff communicate with upper management, elected officials and the public.
 - *Why didn't you put a signal there?*
- › Saves money and helps better manage limited budgets.
 - *Do we really need to buy that property to close that driveway?*
- › Safety can be the differentiator between alternative solutions.
- › Safety is a priority federal initiative with increasing attention and increasing amounts of funding associated with it.

Safety is More than the HSM



Here are a few other safety analysis tools

› SafetyAnalyst

- *Roadway safety management tool*
- *Applies HSM Part B procedures*



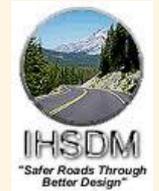
› HiSafe

- *Crash prediction tool*
- *Applies HSM Part C procedures*



› Interactive Highway Safety Design Model (IHSDM)

- *Evaluates safety and operations of geometric design*
- *Crash prediction parallels HSM Part C*



› FHWA CMF Clearinghouse

- *Broader range of CMFs than HSM*
- *Web-based, continually updated*



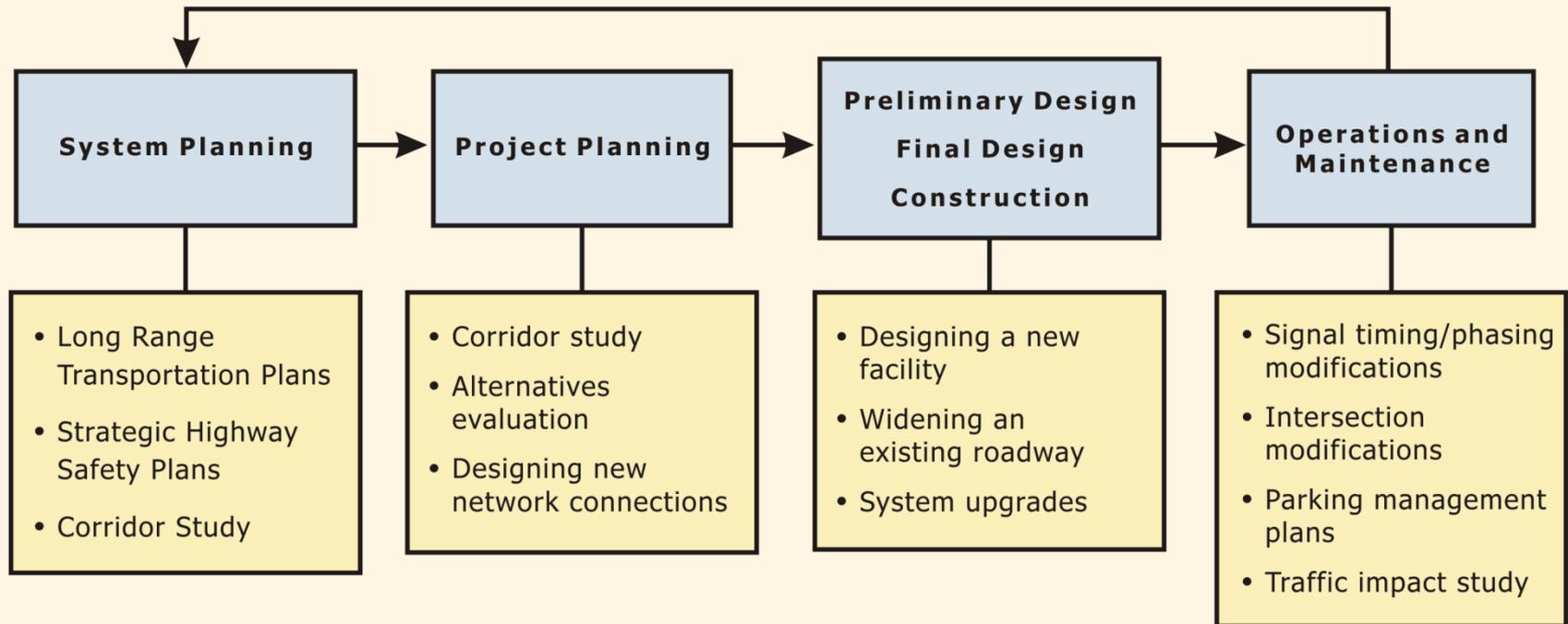
› FHWA Guide to Developing Quality CMFs

- *Provides direction for formulating CMFs*
- *Supplements HSM for local and/or timely treatments*

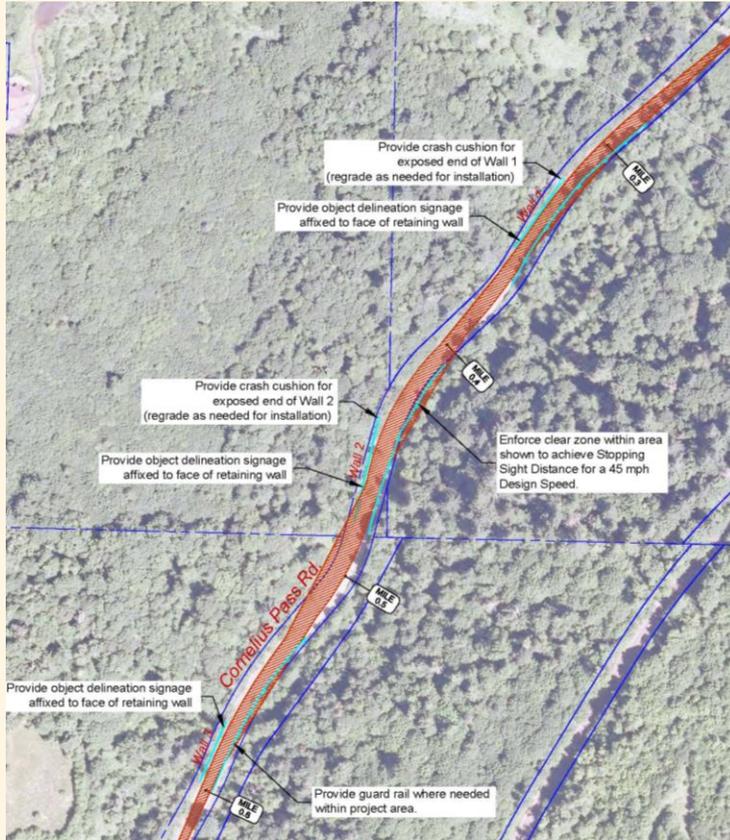


Safety integrates throughout project development

- › Quantify safety performance
- › Comprehensively address safety issues
- › Cost-effectively reduce crashes

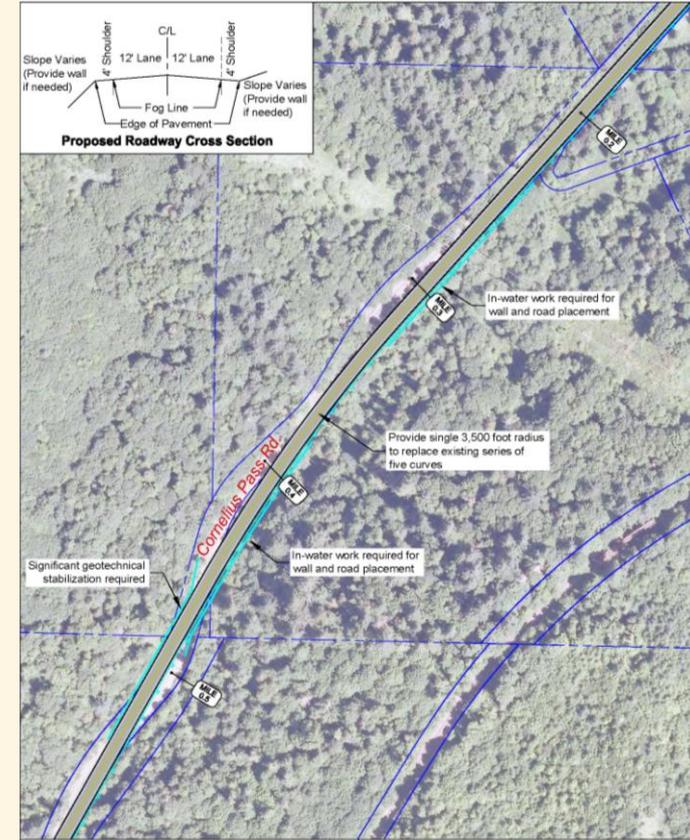


Safety can help differentiate project choices



Project #1:

- › Estimated cost: \$1.4 million
- › Safety cost-benefit ratio: 0.56



Project #2:

- › Estimated cost: \$7.5 million
- › Safety cost-benefit ratio: 0.53

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Quick side track...

HSM Safety Fundamentals

HSM Content Reminder

› **Part A – Introduction and Fundamentals**

- *1: Introduction*
- *2: Human Factors*
- *3: Fundamentals*

› **Part B – Roadway Safety Management Process**

- *4: Network Screening*
- *5: Diagnosis*
- *6: Select Countermeasures*
- *7: Economic Evaluation*
- *8: Prioritization*
- *9: Safety Effectiveness Evaluation*

› **Part C – Predictive Method**

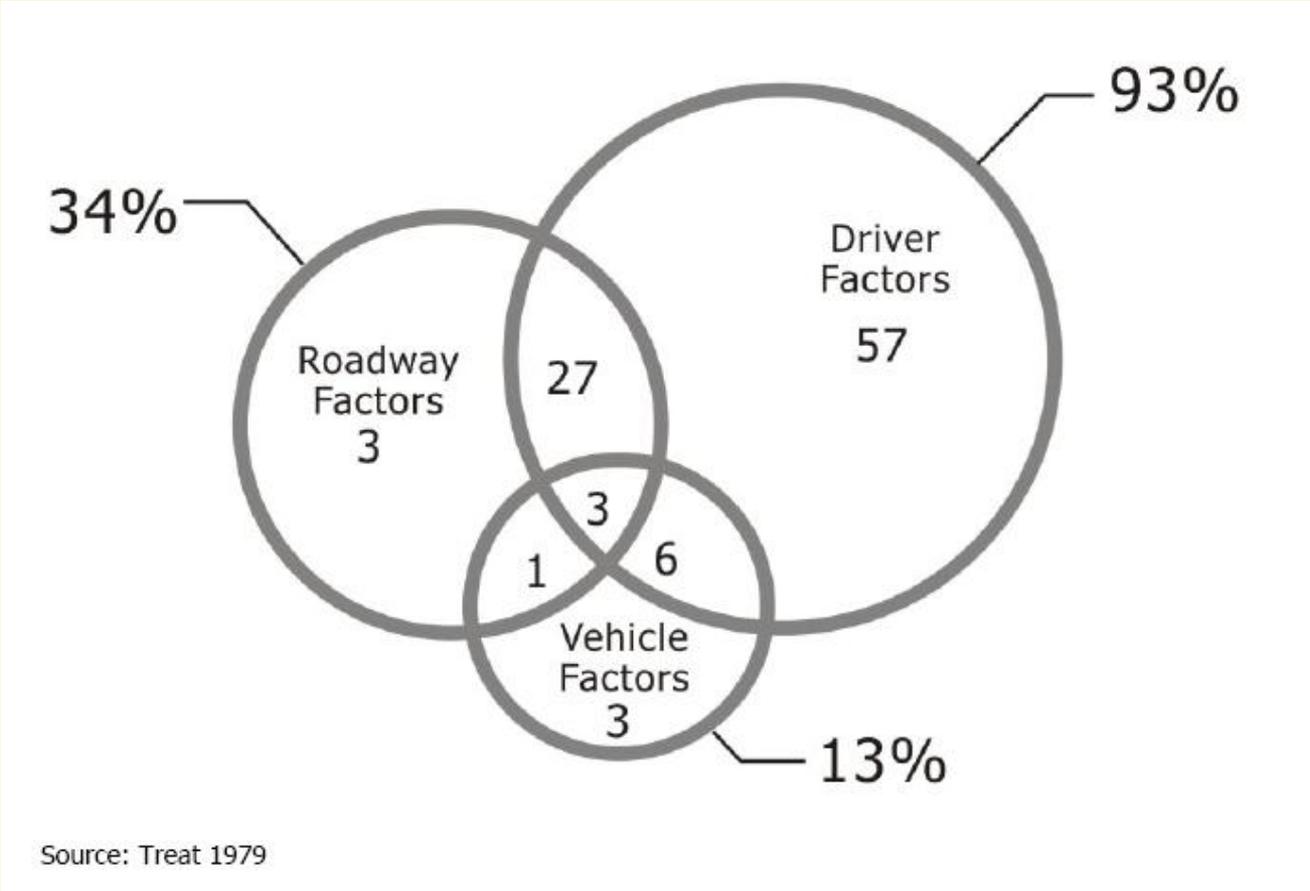
- *10: Two-Lane Rural Highways*
- *11: Multilane Rural Highways*
- *12: Urban and Suburban Arterials*

› **Part D – Crash Modification Factors**

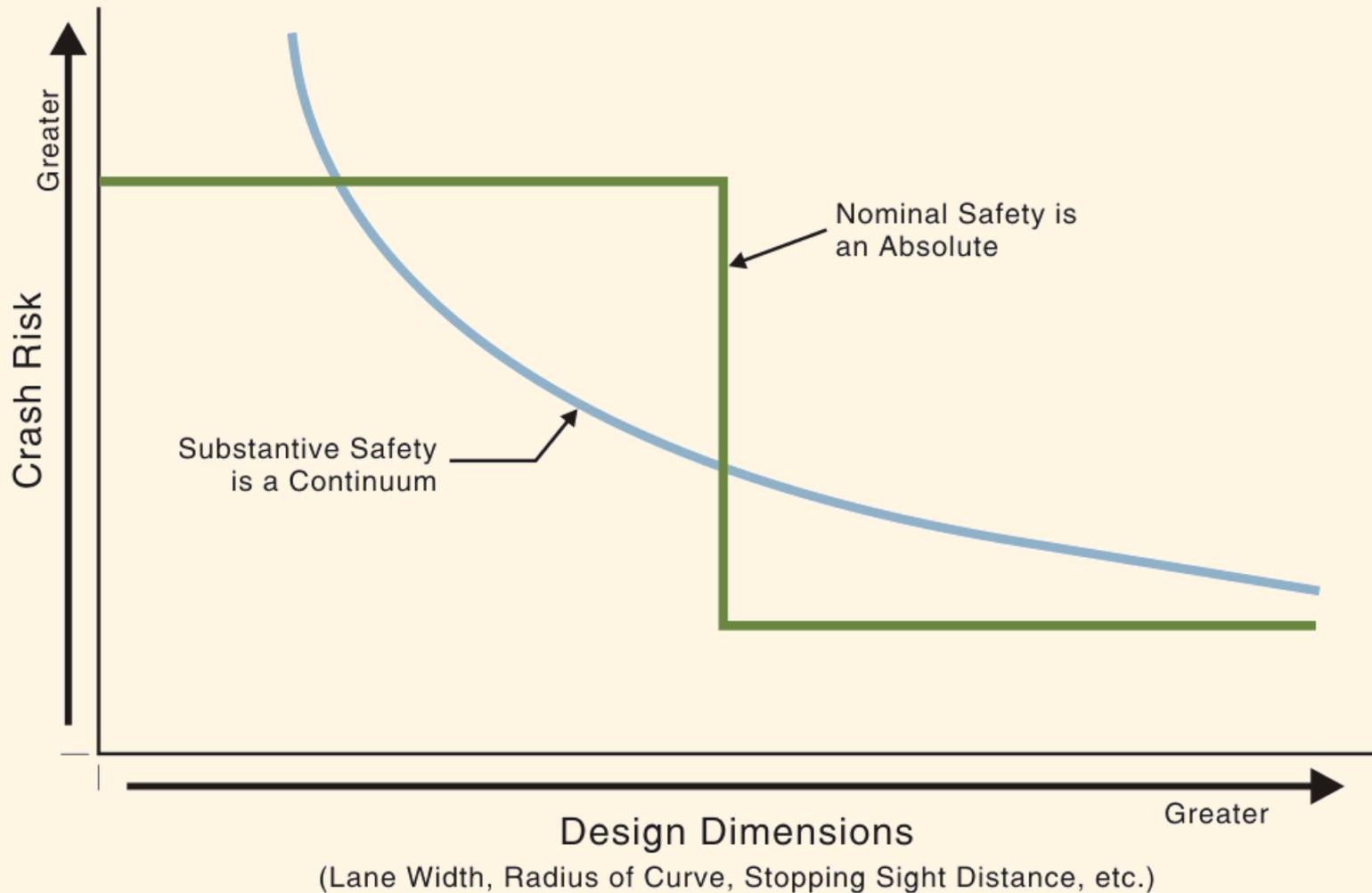
- *13: Roadway Segments*
- *14: Intersections*
- *15: Interchanges*
- *16: Special Facilities*
- *17: Networks*

› **Glossary**

Roadway Factors Contribute to about 1/3 of Crashes



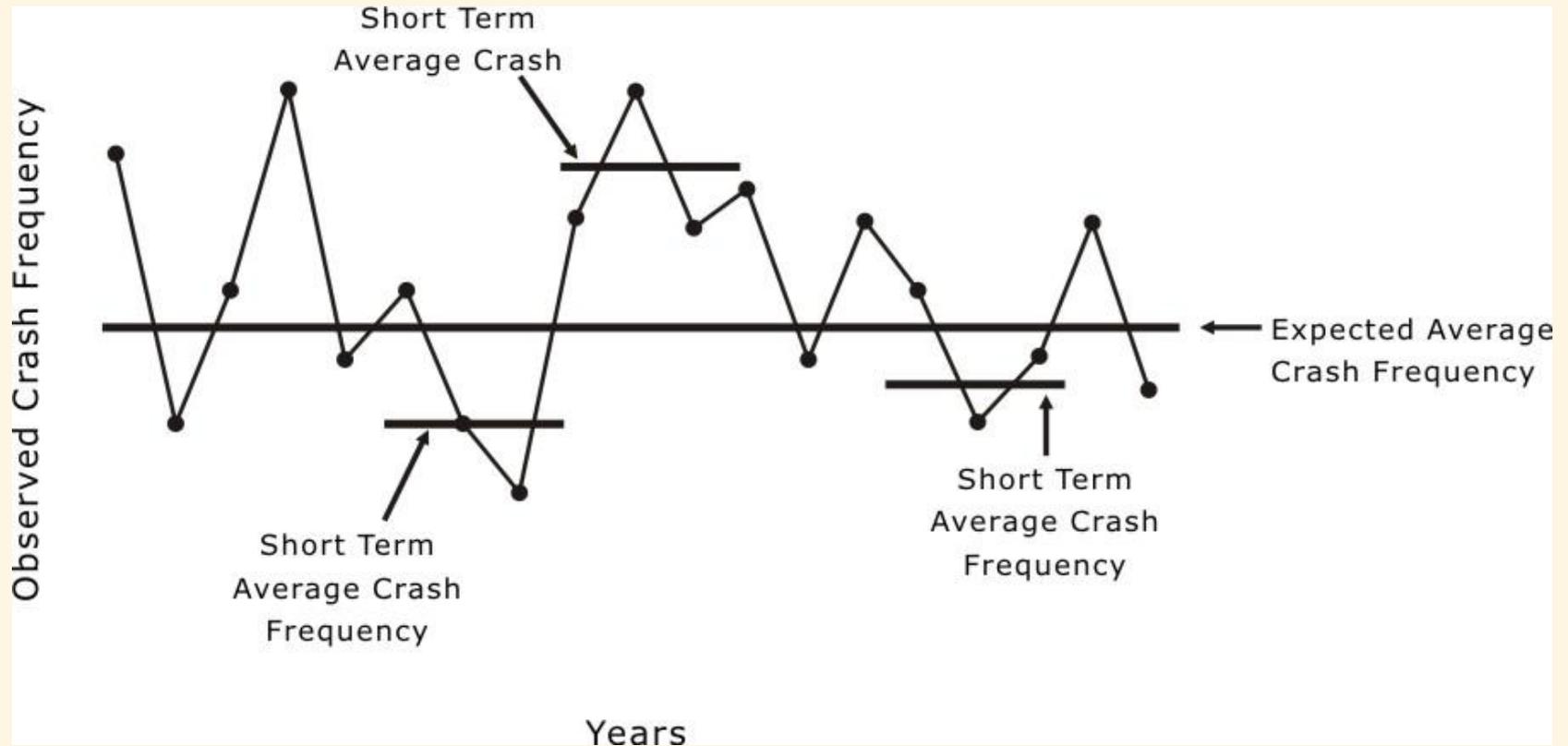
Safety is a continuum not an absolute



Source: NCHRP 480

Crashes are Rare and Random Events

- › Crashes regress to a long-term average
- › Short-term crash frequencies can be misleading



Compensating for the Randomness in Crashes

- › HSM contains tools for calculating **long-term average crash frequency**
- › Key tools and methods in the HSM
 - *Safety Performance Functions (SPFs)*
 - *Empirical Bayes Method (EB Method)*
 - *Crash Modification Factors (CMFs)*
- › Primarily comprised of equations with multiplicative factors
- › Calculations involve increased data, “look-ups” in the HSM, and algebraic math (e.g., addition, subtraction, multiplication, exponents)

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Roadway Safety Management Program

Clackamas County Transportation Safety Action Plan (TSAP)



TSAP Purpose and Vision

- › Create a Safety Culture in Clackamas County
- › Align and Coordinate Efforts
- › Focus on Injury/Fatality Prevention
 - *Transportation focused*
- › Develop an *Action Plan*
 - *Data driven, but not data focused*
 - *All 5 E's, not just engineering*

Clackamas County: TSAP Goals

- › Zero fatalities on County roadways

- *Consistent with national goal*

- › Holistic approach

- *Multiple disciplines*

- *Considering full range of activities*

- › Framework for the future

- *Building on past successes*

- *Further nurturing and developing a safety culture*

- *Identifying near-term next steps and goals*

- *Setting the stage for longer-term goals as well as evolution in analysis procedures and activities*



Photo: Joe Marek,
Clackamas County

Crash Data Review – Informs the TSAP

- › Identify overarching crash trends
 - *Young Drivers; Run off the Road Crashes; Aggressive Driving*
- › Improve data management
 - *Connect Crash, Traffic Volume, and Roadway Data*
- › Evolve Data Analysis
 - *Applying More Robust HSM Performance Measures*
- › Integrate 911 and hospital records
- › Inform non-engineering activities
 - *Education; Enforcement Emergency Response*



Photo: Joe Marek, Clackamas County

TSAP Near-Term Actions

- › Identify Modifications to Plans, Policies, Design Standards, and Development Review Process
- › Identify and Implement Incremental Improvements to Data Management
- › Identify Overarching Programmatic Countermeasures to Address Crash Trends
- › Develop a Framework for Evaluating Progress

TSAP Longer-Term Opportunities

- › Implement Modifications to Plans, Policies, Design Standards and Development Review Process
- › Improve Data Management
- › Integrate Multiple Sources of Data
- › Evolve to using Robust HSM Performance Measures
- › Establish and Implement Evaluation Process
- › Expand Interagency Cooperation and Coordination

TSAP Summary

- › Comprehensively and Proactively Addressing Safety
- › Coordinating Efforts among Stakeholders and Safety Interest Groups
- › Nurturing and Growing a Holistic Safety Culture
- › Integrating Safety in Planning, Design, Operations, and Maintenance
- › Reaching Safety Goals (e.g., Zero Transportation Fatalities)



Intersection Study

Maryland State Highway Administration
MD 144/MD 910

MD 144/MD 910 Intersection Study

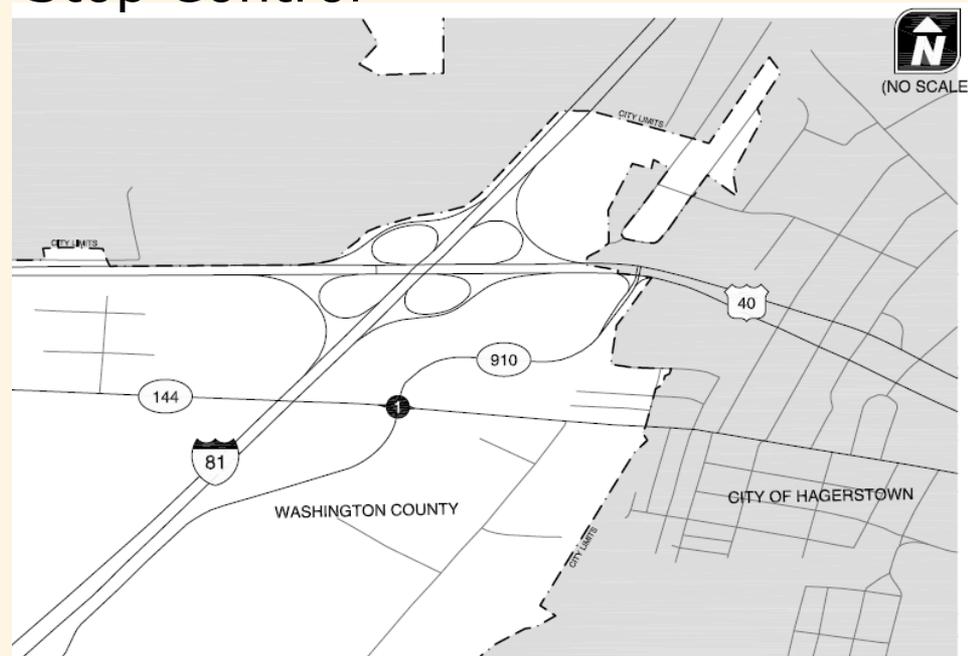
› Study motivations

- *Targeted family-wage employment area—partially developed*
- *MD 144 programmed for corridor improvements*
- *Increased numbers of crashes*
- *Political pressure on SHA*

› Existing Condition: Two-Way Stop Control

› Potential Countermeasures

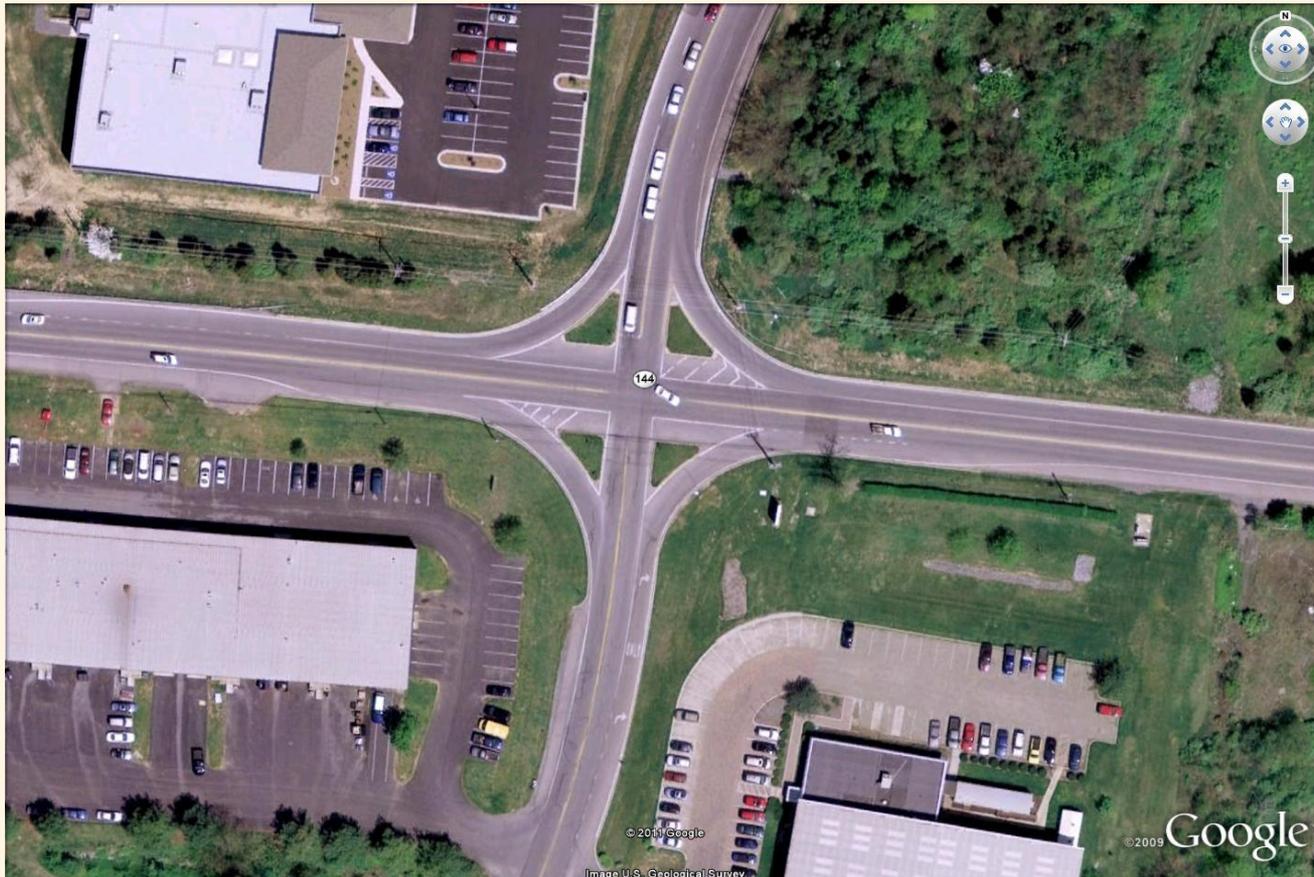
- *4-Way Stop Control*
- *Traffic Signal*
- *Roundabout*



MD 144/MD 910 Intersection Study

In addition to conducting “traditional” analyses...

- › Signal warrant analysis
- › Traffic operations (Volume/Capacity, Delay, Queuing)



MD 144/MD 910 Intersection Study

...We Applied the HSM to:

- › Estimate long-term average crash performance for existing conditions (HSM Part C)
- › Estimate changes in crashes for each countermeasure (HSM Part D)
- › Compute the **estimated change in crashes** between existing conditions and the potential alternatives
- › Compare the annual monetary benefit of change in crashes for each alternative

MD 144/MD 910 Intersection Study

Change in crashes summary

– *Roundabout alternative estimated to provide highest crashes reduction*

Estimated Change in the Number of Crashes/Year	Existing Two-Way Stop	Four-Way Stop	Traffic Signal	Roundabout
Injury/Fatal	-	N/A	N/A	0.24 to 0.41
PDO	-	N/A	N/A	0.49 to 0.50
Total	-	0.46 to 0.64	0.43 to 0.57	0.73 to 0.91

Crash monetary benefits summary

– *Roundabout alternative to have the highest monetary benefits*

Estimated Annual Monetary Benefit Based on Severity	Existing Two-Way Stop	Four-Way Stop	Traffic Signal	Roundabout
Total per Year	-	\$11,200 to \$15,600	\$10,500 to \$13,900	\$41,600 to \$68,600

MD 144/MD 910 Summary

- › Relatively easy to incorporate crash analysis and augment traditional evaluations
- › Helped mid-level SHA staff communicate more effectively with higher level staff
- › Meaningful analysis results allowed decision makers to:
 - *Construct a temporary roundabout in the interim*
 - *Accelerate funding for permanent roundabout construction*
- › Safety component highlighted the value of quantitatively assess safety

“Temporary” Roundabout Example



Considering Potential Cross Section Changes

State Highway Bridge Project

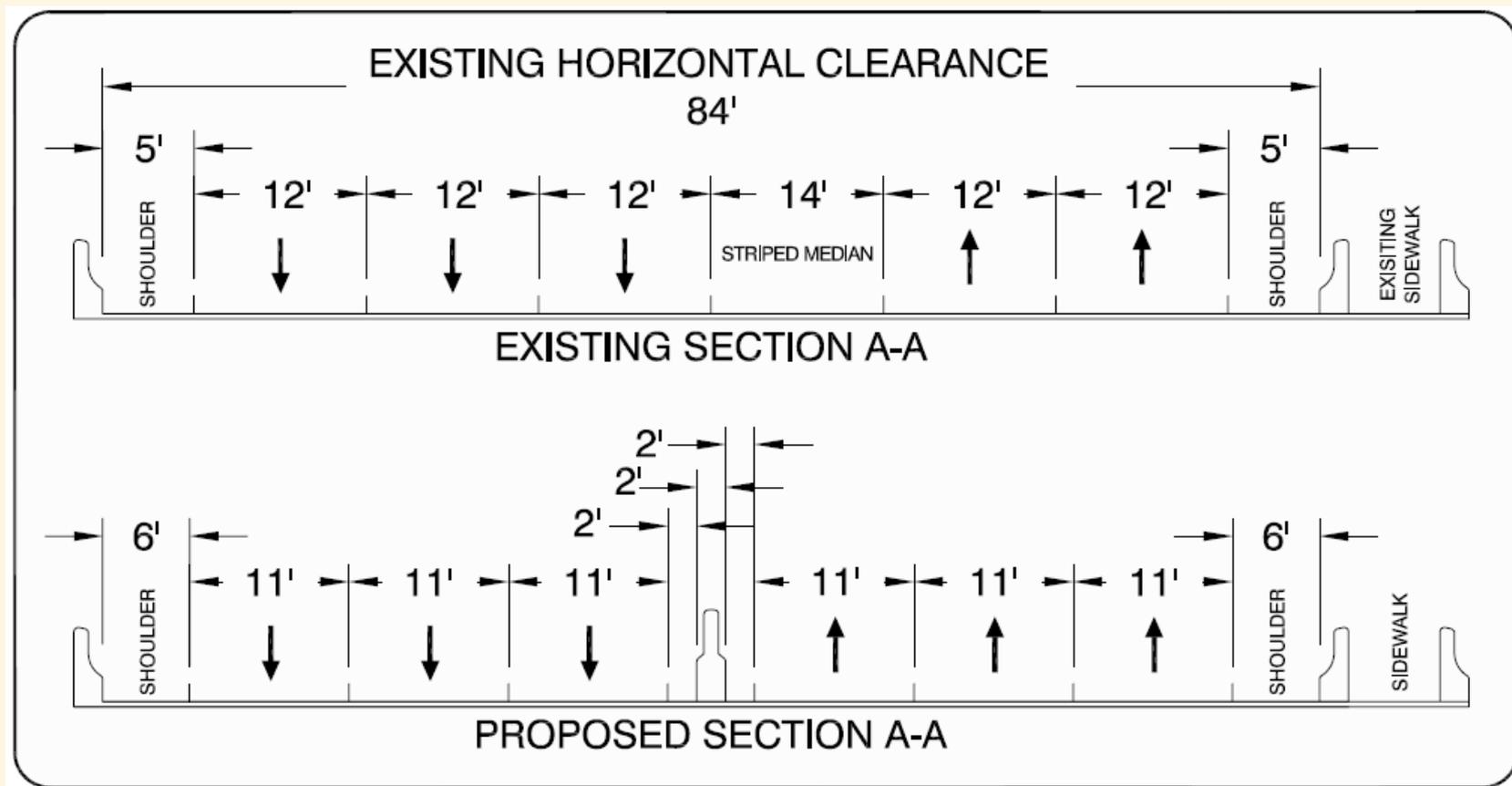
State Highway Bridge Project

- › Typical project where we have to reallocate cross section dimensions
- › Any project that requires design dimensions differing from agency standard dimensional values
- › Practical Design solutions
- › Opportunities to support design variance documentation and general project decisions



State Highway Bridge Project

- › Reallocate cross section to add a north bound lane
- › Reduce project costs by using existing bridge



State Highway Bridge Project

...We Applied the HSM to:

- › Evaluated existing crash history
- › Investigated potential Crash Modification Factors for the various elements of the cross section change (HSM Part D)
- › Considered other countermeasures and their influence on crashes
- › Summarized the changes potential changes of crashes based on the proposal and identified additional countermeasures for consideration

State Highway Bridge Project: Potential Crashes

- › Crash Modification Factors (CMF)
 - *Adding lanes to a freeway by narrowing existing lanes and shoulders, and maintaining existing right-of-way*

Condition	Crash Severity	CMF	Standard Deviation (std. dev.)
Five to six lane conversion	All types All severities	1.03*	0.08

*The treatment could result in benefit, disbenefit, or no safety effect based on standard deviation

- › 2 Crashes/year under existing conditions:
- › Impact to yearly crashes
 - *Decrease to 1.7 crashes per year OR increase to 2.4 crashes per year*

State Highway Bridge Project: Other potential mitigations

- › Median Barrier
 - *“Positive benefit” – no specific CMF*
- › Roadway illumination
 - $CMF = 0.72$ ($SE=0.06$)
- › Continuous rolled-in shoulder rumble strips on shoulder
 - $CMF = 0.82$ ($SE = 0.10$)

State Highway Bridge Project Summary

- › Determined Alternative 2 would not definitively change the number of crashes (i.e., quantifying safety)
- › Identified additional cost-effective safety mitigation strategies to reduce crashes
- › Provided information and clear documentation to select the most cost-effective solution
 - *Near Term – Modify bridge cross-section*
 - *Potential Long Term – Reconstruct bridge*

Corridor Study

ODOT US 26 (Powell Boulevard)

US 26 (Powell Boulevard) Corridor Study

- › Corridor considering cross section changes
 - *Access management study*
 - *Pedestrian/bike facilities*
 - *Rural roadway evolving to urbanized features*
 - *Basic corridor capacity improvement*
- › Project where traffic operations are not clear differentiators
 - *High volume considerations*
 - *Low volume considerations*
- › Safety and Multi Modal Level of Service are supplemental performance measures to traditional vehicular operational evaluations

US 26 (Powell Boulevard) Corridor Study

Arterial Context



US 26 (Powell Boulevard) Corridor Study

- › Originally had 22 specific alternatives
- › Organized alternatives into five primary groups
- › Tested alternatives using the HSM predictive method

Group	Description
1	Access Management and Intersection Modifications at 122nd
2	Different locations of left-turn lanes along SE Powell Boulevard
3	Three-lane (TWLTL) roadway with different roadway element widths
4	Three-lane (raised median) roadway with different roadway elements
5	Existing conditions with different pedestrian features

US 26 (Powell Boulevard) Corridor Study

- › Originally had 22 specific alternatives
- › Organized alternatives into five primary groups
- › Tested alternatives using the HSM predictive method

Alt Group	Description	% Crash Reduction
1	Access management and intersection modifications near 122nd	0% ¹
2	Varying locations of left-turn lanes along US 26	1-3% ²
3	Three-lane (TWLTL) roadway with varying roadway element widths	21%
4	Three-lane (raised median) roadway with varying roadway elements	19-27% ³
5	Existing conditions with different pedestrian features	0% ¹

US 26 (Powell Boulevard) Summary

- › Allowed ODOT to consider quantified safety information in their selection process.
- › Comprehensive assessment of alternatives created a better understanding of tradeoffs.
- › Allowed ODOT to communicate to the public the benefit of doing more than sidewalks.

Closing Remarks

› Remember....

- *Safety is easy to include in our work; (eventually) we should all be able to do it.*
- *Safety is more than the HSM.*
- *Safety integrates into any aspect of our projects.*
- *Safety can be a small effort but provide key value.*

› Value potential...

- *Helps agency staff **communicate with elected officials and the public.***
- *Saves money and helps better **manage limited budgets.***
- *Safety can be the **differentiator** between alternative solutions.*
- *Safety as a priority is a federal initiative with increasing attention and **increasing amounts of funding** associated with it.*