Crash Modification Factor (CMF) Short List WSDOT

Lynn Peterson
Secretary

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Deputy Secretary

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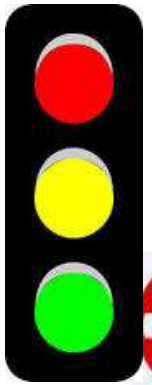
Applying (or misapplying!) CMFs Webinar
December 11, 2014

CMF Working Group Goals

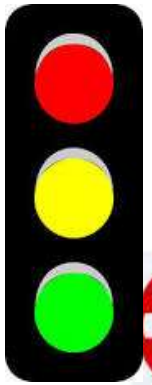
Assist region personnel selection of appropriate CMFs

Create a list of easily identifiable and consistent CMFs.

Represented Business Areas

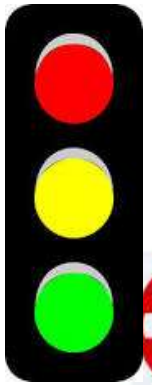


Represented Business Areas



RISK
MGMT

Represented Business Areas



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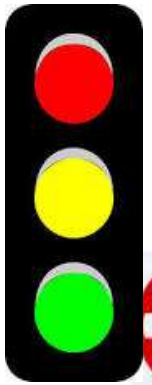

RISK
MGMT

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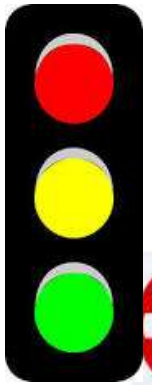

RISK
MGMT

Working Group Resources

The group provides support identifying appropriate CMFs, and interim CMFs where no applicable CMF exists.

CRASH MODIFICATION FACTORS CLEARINGHOUSE

CMF Short List

WSDOT Crash Modification Factor (CMF) "Short List"
Revised March 10, 2014

This list is provided to aid in evaluation of the effectiveness of proposed safety countermeasures in an efficient and consistent manner

Crash Modification Factors (CMFs) must be used within the context shown.

* Interim CMFs may be used for any project.
These CMFs will be replaced with more statistically reliable CMFs matching the context and application for the countermeasure when available.

The short list is not comprehensive. Users are free to explore crash modification factors from other sources.
If CMFs from other sources are identified, concurrence from the funding division must be obtained prior to use.
The CMF Clearinghouse can be a good source of information and is found at: http://www.cmfclearinghouse.org/

WSDOT Reference Number	Category	Countermeasure -- Context	Crash Pattern Affected	CMF	Interim Status*	Std Error	Original Date Discussed	Date Approved	Date -- Study -- Reference	Star Rating	Notes
	Pavement Enhancements	**Shoulder Rumble Strips** New milled in shoulder rumble strips for single vehicle run off the road collisions on:									
CMF #3586			Rural Freeways, **All Severity** Collisions	0.89		0.1	10/23/2013	10/25/2013	NCHRP Report 641: Guidance for the Design and Application of Shoulder and Centerline Rumble Strips pages 1-3 and 80	3	
CMF #3448			Rural Freeways, **Fatal & Injury** Collisions	0.84		0.1	10/23/2013	10/25/2013		4	
CMF #3594			Rural Two-Lane Roads, **All Severity** Collisions	0.85		0.1	10/23/2013	10/25/2013		3	
CMF #3388			Rural Two-Lane Roads, **Fatal and Injury** Collisions	0.71		0.1	10/23/2013	10/25/2013		3	
	Pavement Enhancements	**Friction Surfacing** Install Friction Surfacing in locations with over represented Wet Pavement Crashes and Low **Friction Numbers (32 or less)**									
CMF #195			Reduction of **Wet Pavement Collisions**, All Severities	0.43		0.03	Oct-13	1/8/2014	NCHRP Report 617 Accident Modification Factors for Traffic Engineering and ITS Improvements Pages 22-24 and TRR: Journal of the TRB No. 2068 Safety Effects of Targeted Program to Improve Skid Resistance, pages 135-139	4	
	Pavement Enhancements	**High Friction Surface Treatment** Install HFST in locations with **higher than normal incidence of wet pavement skid type collisions**									
Interim CMF #195			**Ramps - Wet Road Crashes**, All Severities Study CMF 0.22 with Standard Error 0.041	0.40	Interim	N/A	1/8/2014	1/8/2014	Evaluation of Low Cost Improvements - Pooled Fund Study - Phase VI Strategies 2&2-9 Pavement Safety Performance		
Interim CMF #195a			**Curves - Wet Road Crashes**, All Severities	0.48	Interim	0.064	1/8/2014	1/8/2014	Merritt, Lyon, Persaud		
	Intersections	**Roundabout (Signal to Roundabout)** Convert Signal to Roundabout	Urban or Suburban, **Multilane** Roundabout Traffic Volumes 5300 - 52500 ADT								
CMF #4252			All Collision Types - **All Severities (KABCO)**	0.79		0.05	3/6/2014	3/6/2014	NCHRP Report 705 "Evaluation of Safety Strategies at Signalized Intersections"	4	
			For AADT with total entering volumes greater than 18000 use CMF = 1	1.00							
CMF #4253			All Collision types - **Fatal & All Injury** (KABC)	0.34		0.06	3/6/2014	3/6/2014		4	
			Urban or Suburban, **Single Lane** Roundabout Traffic Volumes 5300 - 52500 ADT								
CMF #4256			All Collision Types - **All Severities (KABCO)**	0.74		0.09	3/6/2014	3/6/2014		3	
			For AADT with total entering volumes greater than 18000 use CMF = 1	1.00							
CMF #4257			All Collision types - **Fatal & All Injury** (KABC)	0.45		0.09	3/6/2014	3/6/2014		3	

Notes contained on the Short List

The short list is not comprehensive. Users are free to explore crash modification factors from other sources.

If CMFs from other sources are identified, concurrence from the funding division must be obtained prior to use.

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Crash Modification Factors (CMFs) must be used within the context shown.

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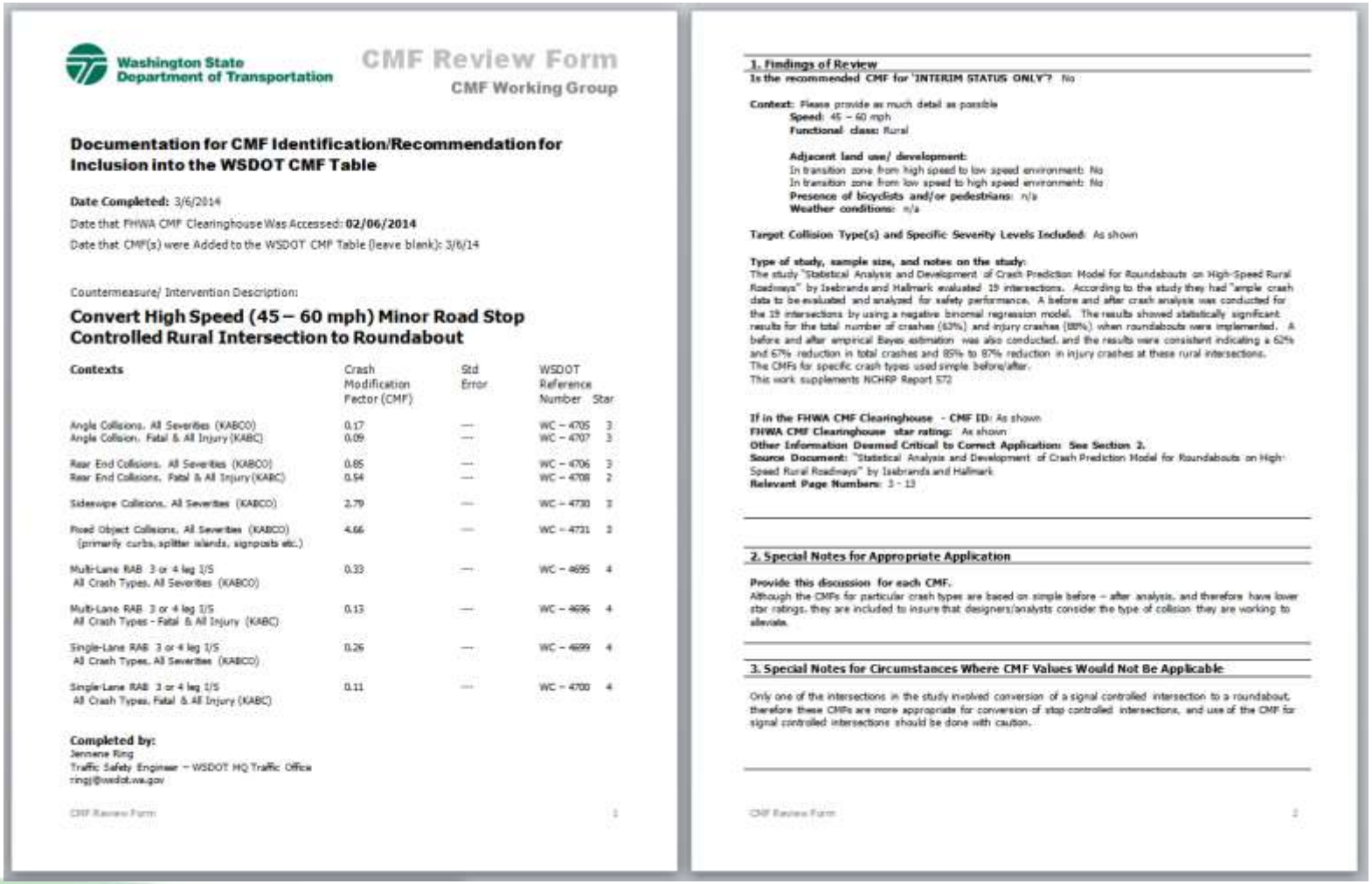
These CMFs will be replaced with more statistically reliable CMFs matching the context and application for the countermeasure when available.

Each Countermeasure is Accompanied by a Review Form



Washington State Department of Transportation

CMF Review Form

CMF Working Group

Documentation for CMF Identification/Recommendation for Inclusion into the WSDOT CMF Table

Date Completed: 3/6/2014

Date that FHWA CMF Clearinghouse Was Accessed: **02/06/2014**

Date that CMF(s) were Added to the WSDOT CMF Table (leave blank): 3/6/14

Countermeasure/ Intervention Description:

Convert High Speed (45 – 60 mph) Minor Road Stop Controlled Rural Intersection to Roundabout

Contexts	Crash Modification Factor (CMF)	Std Error	WSDOT Reference Number	Star
Angle Collisions, All Severities (KABCO)	0.17	—	WC – 4705	3
Angle Collision, Fatal & All Injury (KABC)	0.09	—	WC – 4707	3
Rear End Collisions, All Severities (KABCO)	0.85	—	WC – 4706	3
Rear End Collisions, Fatal & All Injury (KABC)	0.54	—	WC – 4708	2
Sideswipe Collisions, All Severities (KABCO)	2.79	—	WC – 4730	3
Road Object Collisions, All Severities (KABCO) (primarily curbs, splitter islands, signposts etc.)	4.66	—	WC – 4731	3
Multi-Lane RAB 3 or 4 leg I/S All Crash Types, All Severities (KABCO)	0.33	—	WC – 4695	4
Multi-Lane RAB 3 or 4 leg I/S All Crash Types - Fatal & All Injury (KABC)	0.13	—	WC – 4696	4
Single-Lane RAB 3 or 4 leg I/S All Crash Types, All Severities (KABCO)	0.26	—	WC – 4699	4
Single-Lane RAB 3 or 4 leg I/S All Crash Types, Fatal & All Injury (KABC)	0.11	—	WC – 4700	4

Completed by:
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Traffic Safety Engineer – WSDOT HQ Traffic Office
ringj@wsdot.wa.gov

CMF Review Form 1

1. Findings of Review

Is the recommended CMF for 'INTERIM STATUS ONLY'? No

Context: Please provide as much detail as possible
Speed: 45 – 60 mph
Functional class: Rural

Adjacent land use/ development:
In transition zone from high speed to low speed environment: No
In transition zone from low speed to high speed environment: No
Presence of bicyclists and/or pedestrians: n/a
Weather conditions: n/a

Target Collision Type(s) and Specific Severity Levels Included: As shown

Type of study, sample size, and notes on the study:
The study "Statistical Analysis and Development of Crash Prediction Model for Roundabouts on High-Speed Rural Roadways" by Isebrands and Hallmark evaluated 19 intersections. According to the study they had "ample crash data to be evaluated and analyzed for safety performance. A before and after crash analysis was conducted for the 19 intersections by using a negative binomial regression model. The results showed statistically significant results for the total number of crashes (63%) and injury crashes (88%) when roundabouts were implemented. A before and after empirical Bayes estimation was also conducted, and the results were consistent indicating a 62% and 67% reduction in total crashes and 85% to 87% reduction in injury crashes at these rural intersections. The CMFs for specific crash types used simple before/after.
This work supplements NCHRP Report 572

If in the FHWA CMF Clearinghouse - CMF ID: As shown
FHWA CMF Clearinghouse star rating: As shown
Other Information Deemed Critical to Correct Application: See Section 2.
Source Document: "Statistical Analysis and Development of Crash Prediction Model for Roundabouts on High-Speed Rural Roadways" by Isebrands and Hallmark
Relevant Page Numbers: 3 - 13

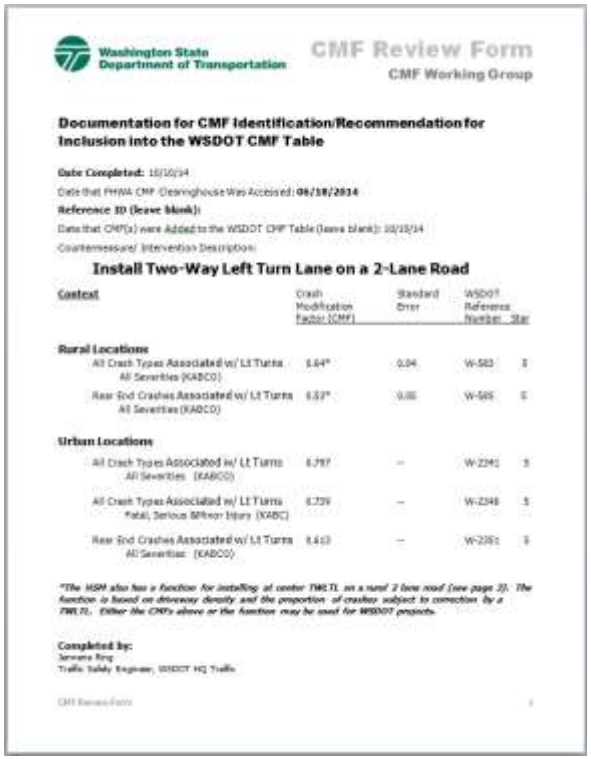
2. Special Notes for Appropriate Application

Provide this discussion for each CMF.
Although the CMFs for particular crash types are based on simple before – after analysis, and therefore have lower star ratings, they are included to insure that designers/analysts consider the type of collision they are working to alleviate.

3. Special Notes for Circumstances Where CMF Values Would Not Be Applicable

Only one of the intersections in the study involved conversion of a signal controlled intersection to a roundabout, therefore these CMFs are more appropriate for conversion of stop controlled intersections, and use of the CMF for signal controlled intersections should be done with caution.

CMF Review Form 2



Washington State Department of Transportation

CMF Review Form

CMF Working Group

Documentation for CMF Identification/Recommendation for Inclusion into the WSDOT CMF Table

Date Completed: 10/10/14

Date that FHWA CMF Clearinghouse Was Accessed: **08/18/2014**

Reference ID (leave blank):

Date that CMF(s) were Added to the WSDOT CMF Table (leave blank): 10/10/14

Countermeasure/ Intervention Description:

Install Two-Way Left Turn Lane on a 2-Lane Road

Context	Crash Modification Factor (CMF)	Standard Error	WSDOT Reference Number	Star
Rural Locations				
All Crash Types Associated w/ Lt Turns All Severities (KABCO)	0.64*	0.04	W-583	5
Rear End Crashes Associated w/ Lt Turns All Severities (KABCO)	0.53*	0.05	W-585	5
Urban Locations				
All Crash Types Associated w/ Lt Turns All Severities (KABCO)	0.797	--	W-2341	5
All Crash Types Associated w/ Lt Turns Fatal, Serious &Minor Injury (KABC)	0.739	--	W-2346	5
Rear End Crashes Associated w/ Lt Turns All Severities (KABCO)	0.613	--	W-2351	5

**The HSM also has a function for installing at center TWLTL on a rural 2 lane road (see page 3). The function is based on driveway density and the proportion of crashes subject to correction by a TWLTL. Either the CMFs above or the function may be used for WSDOT projects.*

Completed by:

Jerrianne Ring

Traffic Safety Engineer, WSDOT HQ Traffic

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1. Findings of Review

Is the recommended CMF for "INTERIM STATUS ONLY"? No

Context:

Speed: Speed Limit less than 45 mph

Functional class: n/a

Adjacent land use/ development: see Section 2

Presence of bicyclists and/or pedestrians: n/a

Weather conditions: n/a

Type of study, sample size, and notes on the study: The study used empirical Bayes for observational before-after studies.

Geometric, traffic, and crash data were obtained for 78 sites (21.3 mi) in North Carolina, 10 sites (6 mi) in Illinois, 21 sites (6.8 mi) in California and 26 sites (10.2 mi) in Arkansas. There was a statistically significant reduction in fatal and rear-end crashes in each of the four states. Rural installations were found to be more effective in reducing crashes than urban ones in each of the four states.

Segment AADTs ranged from a minimum of 500 veh/day to a maximum of 25,877 veh/day.

If in the FHWA CMF Clearinghouse - CMF ID: 2341, 2346, 2351, 583, & 585

FHWA CMF Clearinghouse star rating: 5

Other Information Deemed Critical to Correct Application: See Section 2.

Source Document: Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads

Relevant Page Numbers: 1 - 28

2. Special Notes for Appropriate Application

The report provided the following logical consideration:

"...locations with a high frequency of rear-end collisions, especially those involving a lead vehicle desiring to make a turn, would experience a greater safety benefit from the treatment and would be prime candidates for installing TWLTLs."

Evaluation of Installing Center Two-Way Left Turn Lanes on Two-Lane Roads pg.28

3. Special Notes for Circumstances Where CMF Values Would Not Be Applicable

N/A

4. List All Source Documents that Were Reviewed

Documents:

Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads FHWA-HRT-09-042 pages 1-28

CMF ID	Study Title	Countermeasure	CMF	Crash Type	Crash Severity	Roadway Type	Area Type	Publication Year	Star Quality Rating	Adjusted Standard Error of CMF	Unadjusted Standard Error of CMF	Included in First Edition of Highway Safety Manual	Type of Study Methodology	State	Sample Size Unit Type	Before Sample Size	After Sample Size	Begin Year of Data	End Year of Data
583	Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads	Introduce TWLTL (two-way left turn lanes) on rural two lane roads	0.64	All	All	Not specified	Rural	2008	5	0.04	0.03	no	Before/after using empirical Bayes or full Bayes						
585	Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads	Introduce TWLTL (two-way left turn lanes) on rural two lane roads	0.53	Rear end	All	Not specified	Rural	2008	5	0.05	0.04	no	Before/after using empirical Bayes or full Bayes						
2341	Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads	Install TWLTL (two-way left turn lane) on two lane road	0.797	All	All	Not Specified	All	2008	5		0.03	no	Before/after using empirical Bayes or full Bayes	AR,CA,IL, NC	Mile-years	582	582	1990	2004
2346	Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads	Install TWLTL (two-way left turn lane) on two lane road	0.739	All	Fatal,Serious injury,Minor injury	Not Specified	All	2008	5		0.068	no	Before/after using empirical Bayes or full Bayes	AR,CA,IL, NC	Mile-years	582	582	1990	2004
2351	Safety Evaluation of Installing Center Two-Way Left-Turn Lanes on Two-Lane Roads	Install TWLTL (two-way left turn lane) on two lane road	0.613	Rear end	All	Not Specified	All	2008	5		0.04	no	Before/after using empirical Bayes or full Bayes	AR,CA,IL, NC	Mile-years	582	582	1990	2004

$$CMF = 1.0 - (0.7 \times P_{dwy} \times P_{LT/D}) \quad (16\text{-}3)$$

$$P_{dwy} = \frac{(0.0047 * DD) + (0.0024 * DD^2)}{1.199 + (0.0047 * DD) + (0.0024 * DD^2)} \quad (16\text{-}3A)$$

Where:

P_{dwy} = driveway-related crashes as a proportion of total crashes;

DD = driveway density (driveways per mile); and

$P_{LT/D}$ = left-turn crashes subject to correction by a TWLTL as a proportion of driveway-related crashes (can be estimated to be 0.5).

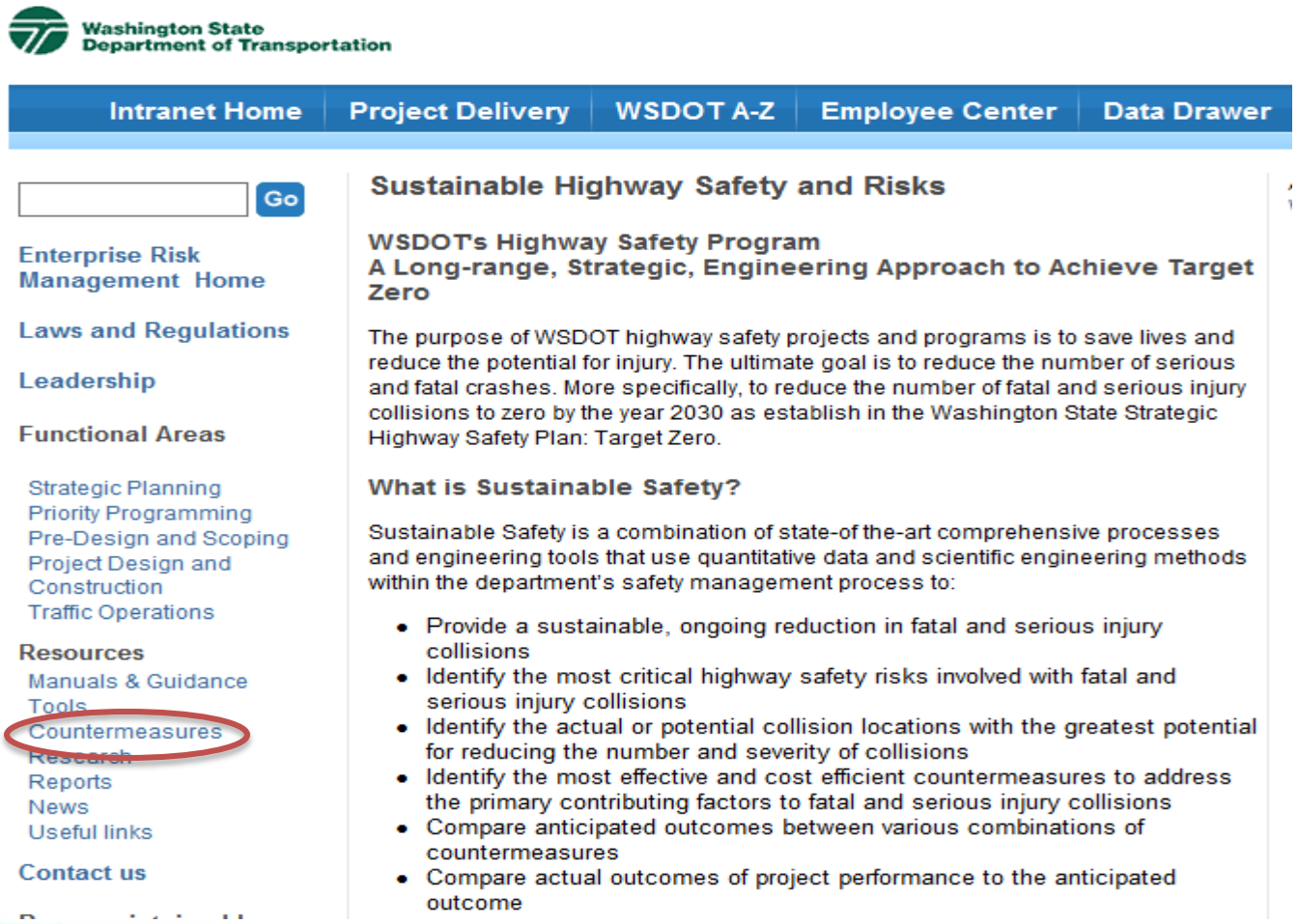
Rural Locations

All Crash Types Associated w/ Lt Turns All Severities (KABCO)	0.64*
Rear End Crashes Associated w/ Lt Turns All Severities (KABCO)	0.53*

Urban Locations

All Crash Types Associated w/ Lt Turns All Severities (KABCO)	0.797
All Crash Types Associated w/ Lt Turns Fatal, Serious &Minor Injury (KABC)	0.739
Rear End Crashes Associated w/ Lt Turns All Severities (KABCO)	0.613

The short list is housed on the Sustainable Safety Intranet Site



Go

Sustainable Highway Safety

Laws and Regulations

Leadership

Functional Areas

Strategic Planning
Priority Programming
Pre-Design and Scoping
Project Design and Construction
Traffic Operations

Resources

Manuals & Guidance
Tools
Research
Reports
News
Useful links

Sustainable Highway Safety Countermeasures

AASHTO Resources

- Crash Modification Factor Clearinghouse
- Combining_Multiple_CMFs_Final.pdf (pdf 395 kb)
- CMF Newsletter
- Star Quality Rating explanation

Crash Modification Factor (CMF) Review Forms

Form template (doc 59 kb)

- Shoulder Rumble Strips (doc 76 kb)
- Convert Signal to Roundabout (doc 70 kb)
- Friction Surfacing (doc 65 kb)
- Convert Stop Control to Roundabout (doc 68 kb)
- High Speed Roundabouts (doc 65 kb)
- J-Turn (doc 300 kb)
- TWLTL Added to 2-lane Rural Road (doc 177 kb)
- High Friction Surface Treatment (doc 61 kb)

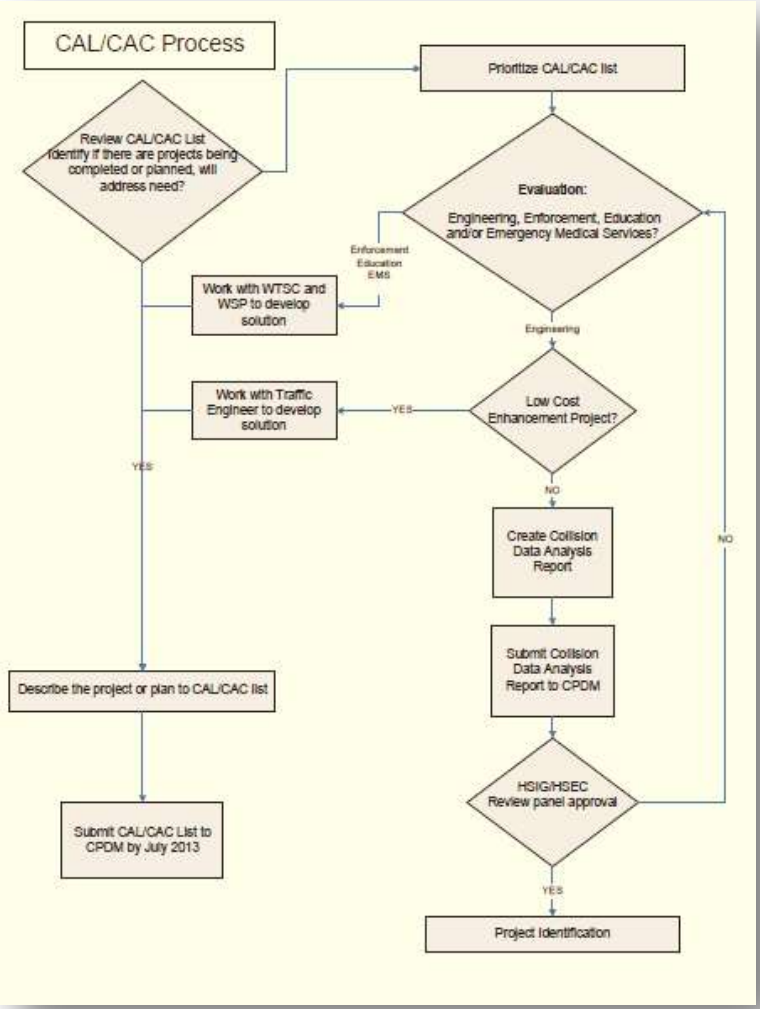
CMF Short List (xls 23 kb)

Capital Safety Prioritization

HQ Capital Program Development and Management office (CPDM) runs a network screening statewide.

The west side of the state and east side of the state are evaluated separately for prioritization.

The flowchart is followed for prioritization of projects.



Collision Data Analysis Guide
for Countermeasure and Design Element Selection

SR XXX, Project Title

Prepared by:
Washington State Department of Transportation
Region
Region Address
City, WA Zip

Month, YEAR

Example Vicinity Map

1. **INTRODUCTION**

1-1. General location/corridor description
1-2. Describe geometric general characteristics of the facility including:
- 1-21 Location Geometrics
- 1-22 Traffic Volume/Truck Percentage
- 1-23 Posted Speed
- 1-24 Urban/Rural
- 1-25 Roadway Functional Class (match design manual language)
- 1-26 Roadside Fixed Objects (RFIP)
- 1-27 Other key location specific characteristics (e.g., environmental, R/W conditions, access issues, etc.)

1-3. Conditional Diagram

2. **DIAGNOSTICS**
Diagnostic can be performed using the SafetyAnalyst tool.

2-1. Collision Frequency (number of collisions in analysis period)
2-2. Collision Type Table
2-3. Descriptive Crash Statistics Contributing Circumstances – can be performed using Safety Analyst. SafetyAnalyst provides summary statics for 29 data elements.
- Human Factors
  - Speeding
  - Inattentive
  - DUI
  - Roadway Location(Roadway, Shoulder, Left, Right, Roadside)
  - Vehicle Type
  - Light Conditions
  - Environmental conditions
  - Other Descriptors

2-4. Summarizing Crash by Location -Collision Diagram

3. COUNTERMEASURE SELECTION

3-1. Alternative Evaluation

- 3-1.1 Human Factors (If there is no Engineering solution)
  - a. Education
  - b. Enforcement
  - c. Emergency Medical Services
- 3-1.2 Engineering
  - a. Operations (Program Q-Low Cost Enhancements)
  - b. Roadway (Systematic, Spot, Corridor)
  - c. Roadside (Systematic, Spot, Corridor)
  - d. Intersection/Access (Systematic, Spot, Corridor)
- 3-1.3 Description of Counter Measure Assumptions (CMF selection)
- 3-1.4 How CM Addresses Contributing Circumstances
- 3-1.5 Basis for Selection (Counter Measure)
- 3-1.6 Basis for CMF Value Used
- 3-1.7 Cost Assumptions

3-2. DESIGN EVALUATION OF COUNTER MEASURE

This section is required to calculate Predicted Average Crash Frequency and Expected Average Crash Frequency

The EB Method should be applied for the following

- No Build Option (e.g., " do-nothing)
- # of through lanes consistent (e.g., the roadway cross section is modified but the basic number of through lanes remains the same)
- Minor alignment changes
- Passing lanes
- Any combination of above

The EB Method should NOT be applied for the following

- New Alignment
- Change in # intersection legs
- Change in traffic control

Therefore,

- If your proposed solution is such that the EB method is applicable, then you could use the EB method for both the existing and proposed solutions.
- If your proposed solutions are such that the EB method is not applicable to any segment or intersection, then you can still use the EB method for the existing conditions. For the proposed, you would apply the Part C predictive method without EB.

*For roundabout, please use "Interim Predictive Method" HCM section 12.9.

3-2.1 Detailed Design Analysis (Part C)
Highway Safety Manual (Chapter 10, 11 and 12)

3-2.2 Crash Frequency Estimate

Crash Frequencies (crashes/year)	Base	Alternative 1	Alternative 2
Total Predicted Average			
Fatal and Injury (FI) Predicted Average			
Property Damage Only (PDO) Predicted Average			
Total Vehicle Expected Average			
Fatal and Injury (FI) Vehicle Expected Average			
Property Damage Only (PDO) Vehicle Expected Average			
Total Vehicle-Pedestrian Expected Average			
Total Vehicle-Bicycle Expected Average			

3-2.3 Adoption or Modification to Counter Measure DESIGN ELEMENT(S) SELECTION

3-2.4 Design Elements Affected by Selected CM

- a. DEAT
  - i. Select Design Level

3-2.5 ECONOMIC APPRAISAL

Alternative	Years of service	Crash Modification Factor (CMF)	Cost Estimate	Present Value of Estimated Change in Crash Frequency	Benefit/ Cost

4. PROPOSED COUNTER MEASURE(S)

Description of Counter Measure Selection

Collision Data Analysis

Countermeasure and Design Element Selection

Under 23 United States Code – Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT or the State of Washington.

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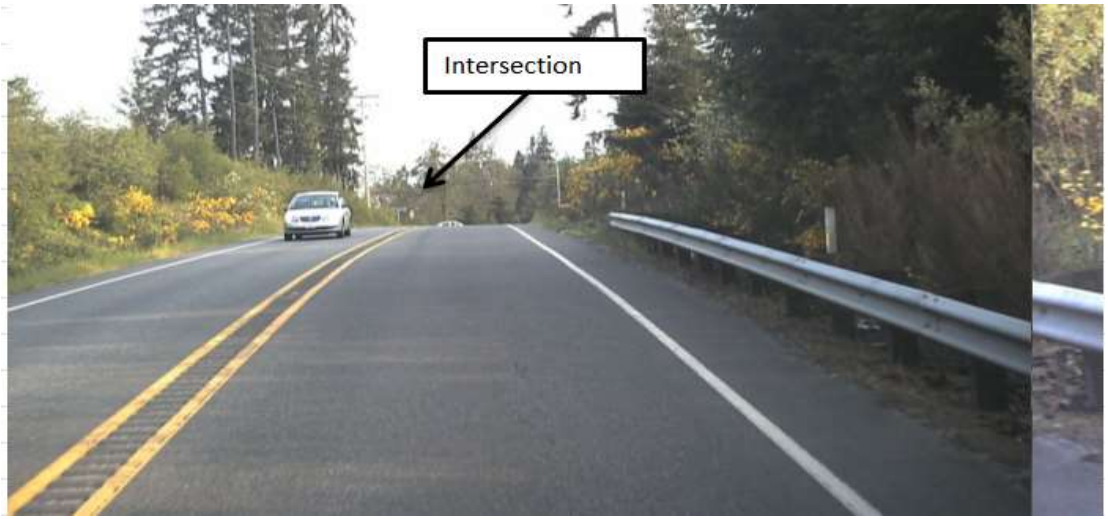

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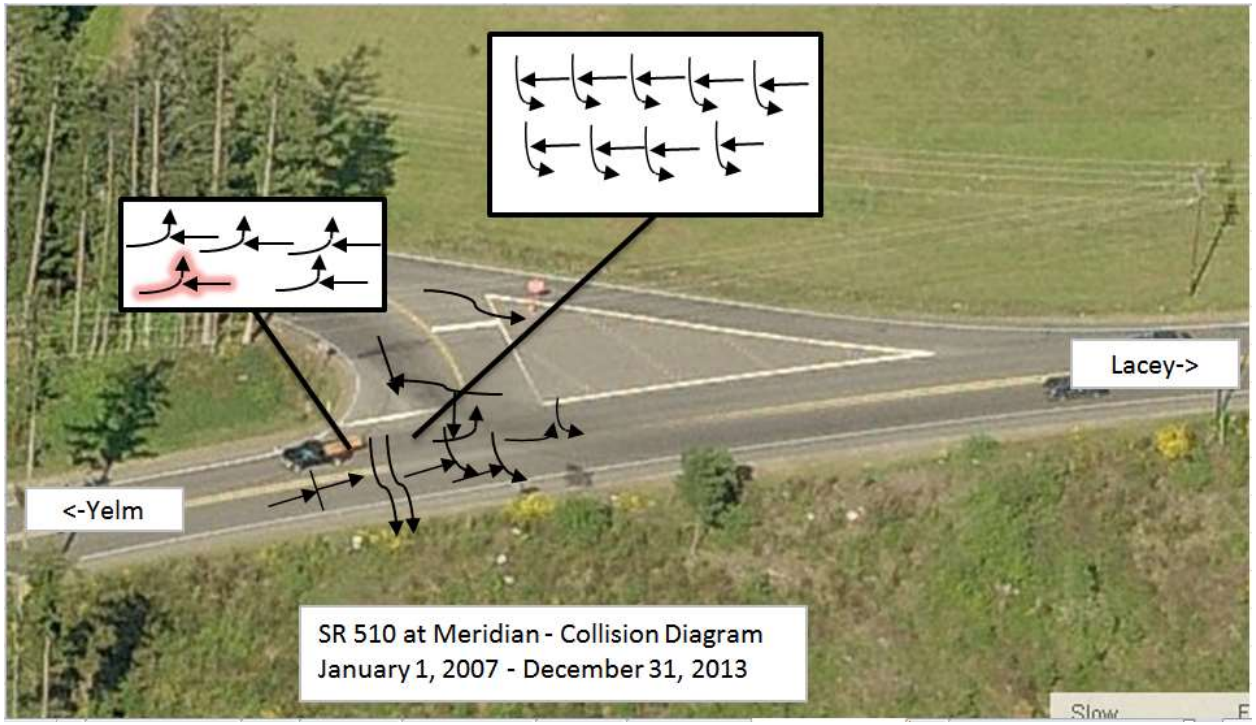

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Countermeasures Evaluated

- Realign intersection and install left turn channelization
- Install Roundabout
- Install Signal and left turn channelization
- Install left turn channelization without realigning the intersection.

- *CMF - Increase Triangle Sight Distance (CMF ID #307) –* ***CMF = 0.53*** *(3-star rating)*
- This CMF is for 4 – leg intersection, all roadway types, serious injury and minor injury collisions. While not directly related to the proposed improvement, the improvements do improve sight distance, and thus the CMF should be in the ball park.
- Rural CMF = 0.53 *(CMF ID #307)*
- Urban CMF = 0.53 *(CMF ID #307)*

- *CMF – Installation of Left-Turn Lanes on Intersection Approaches – Table 10-13 HSM* ***CMF = 0.56***
- This is for a 3 leg intersection, stop control on minor leg
- Rural CMF = 0.56 (Table 10-13)
- Urban CMF = 0.67 (table 12-24)

- *CMF – Conversion of Rural Minor Stop Controlled Intersection into Modern Roundabout (CMF ID #230)* ***CMF = 0.13*** for all fatal and injury crashes *(5-star rating)*
- Rural CMF = 0.13 *(CMF ID #230)*
- Urban CMF = 0.22 (CMF ID #234)

- *CMF – Install a traffic signal (CMF ID #325)* ***CMF = 0.56*** *(5-star rating)*
- This is for rural, stop controlled intersection, 3 or 4 legs, all collision types, all collision severity

- *CMF – Installation of Left-Turn Lanes on Intersection Approaches – Table 10-13 HSM* ***CMF = 0.56***
- This is for a 3 leg intersection, stop control on minor leg

- *CMF – Installation of Left-Turn Lanes on Intersection Approaches – Table 10-13 HSM* ***CMF = 0.56***
- This is for a 3 leg intersection, stop control on minor leg

SAFETY BENEFITS Cost Analysis worksheet for Safety Scoping for 2015-2017

SR	510			**Posted Speed:**	50
Project Title:	Meridian Road - Install Roundabout				
Subject Section:	**MP**	6.95	**to**	**MP**	

1a. Initial Project Cost, I	$ 1,820,000	
2. Annual Op. Costs, H	$ 500	(if there are annual benefits, enter as a negative value)

Existing Conditions

Site Subtype: Urban and Suburban Arterials-3-Leg Intersection /Stop Control on Minor

Expected Average Crash Frequency (Fatal and All Injury): 1.164

Proposed Conditions

Site Subtype: Roundabouts

Expected Average Crash Frequency (Fatal and All Injury): 0.256 (Used CMF of 0.22)

Applied a CMF of 0.22 (CMF #234) to the $N_{expected}$(FI) = 1.164*0.22 = 0.256

	Existing Conditions		Proposed Conditions		
Collision Severity Type	Distribution for Crash Severity Level: Table1	Expected Average Crash Frequency by Crash Severity Level (crash/year)	Distribution for Crash Severity Level: Table1	Predicted Average Crash Frequency by Crash Severity Level (crash/year)	Ann. Benefit
Fatality (K)	1%	0.01	0%	0.00	0.01
Serious Injury (A)	6%	0.07	0%	0.00	0.07
Evident Injury (B)	26%	0.31	36%	0.05	0.25
Possible Injury (C)	67%	0.78	64%	0.09	0.68

Costs Per Collision	
Collision Type	Costs
a) Fatality	$2,000,000
b) Disabling injury	$1,000,000
c) Evident Injury	$100,000
d) Possible Injury	$70,000

Annual Safety Benefits by Costs of Collisions

a)	Annual Benefit*Cost=	$19,223
b)	Annual Benefit*Cost=	$72,085
c)	Annual Benefit*Cost=	$25,478
d)	Annual Benefit*Cost=	$47,922
f)	Total, (B) =	$164,707

7. Salvage Value, T (Optional)

Feature	Cost		Factor		
a) Right of Way	$ 185,000.00	(from estimate) x	0.45	=	$ 83,250.00
b) Grading & Drainage	$ -	(from estimate) x	0.40	=	$ -
c) Structures	$ -	(from estimate) x	0.43	=	$ -
			d) Total, T		$ 83,250.00

Service Life,(n) = 20 (1-20)

Interest Rate, (i) 4%

Present Worth Factor, of a Uniform Service, SPWin 13.59

Present Worth of Cost, PWOC:

PWOC= I + .68J + SPWin x H - T $1,743,545

Present Worth of Benefits, PWOB = B (SPWin) $2,238,370

B/C = 1.283803957

SAFETY BENEFITS Cost Analysis worksheet for Safety Scoping for 2015-2017

SR	510			**Posted Speed:**	50
Project Title:	Meridian Road - Install Roundabout				
Subject Section:	**MP**	6.95	**to**	**MP**	

1a. Initial Project Cost, I	$ 1,820,000	
2. Annual Op. Costs, H	$ 500	(if there are annual benefits, enter as a negative value)

Existing Conditions

Site Subtype: Rural Two-Lane, Two-Way Roads -3-Leg Intersection/ Stop Control on M

Expected Average Crash Frequency (Fatal and All Injury): 1.544

Proposed Conditions

Site Subtype: Roundabouts

Expected Average Crash Frequency (Fatal and All Injury): 0.2 (Used CMF of 0.13)

Applied a CMF of 0.13 (CMF #230) to the $N_{expected}$ (FI) = 1.544*0.13 = 0.20

	Existing Conditions		Proposed Conditions		
Collision Severity Type	Distribution for Crash Severity Level: Table1	Expected Average Crash Frequency by Crash Severity Level (crash/year)	Distribution for Crash Severity Level: Table1	Predicted Average Crash Frequency by Crash Severity Level (crash/year)	Ann. Benefit
Fatality (K)	4%	0.06	0%	0.00	0.06
Serious Injury (A)	10%	0.15	0%	0.00	0.15
Evident Injury (B)	40%	0.62	36%	0.04	0.58
Possible Injury (C)	46%	0.71	64%	0.07	0.64
				Total	1.43

Costs Per Collision	
Collision Type	Costs
a) Fatality	$2,000,000
b) Disabling injury	$1,000,000
c) Evident Injury	$100,000
d) Possible Injury	$70,000

Annual Safety Benefits by Costs of Collisions

a) Annual Benefit*Cost=	$126,496
b) Annual Benefit*Cost=	$148,819
c) Annual Benefit*Cost=	$57,717
d) Annual Benefit*Cost=	$45,017
f) Total, (B) =	$378,049

7. Salvage Value, T (Optional)

Feature	Cost		Factor		
a) Right of Way	$ 60,000.00	(from estimate) x	0.45	=	$ 27,000.00
b) Grading & Drainage	$ -	(from estimate) x	0.40	=	$ -
c) Structures	$ -	(from estimate) x	0.43	=	$ -
			d) Total, T		$ 27,000.00

Service Life,(n) = 20 (1-20)

Interest Rate, (i) 4%

Present Worth Factor, of a Uniform Service, SPWin 13.59

Present Worth of Cost, PWOC:

PWOC= I + .68J + SPWin x H - T $1,799,795

Present Worth of Benefits, PWOB = B (SPWin) $5,137,693

B/C = 2.85459883

Under 23 United States Code – Section 409, this data cannot be used in discovery or as evidence at trial in any action for damages against the WSDOT or the State of Washington.

Existing Roundabouts

Proposed Roundabout

Washington State Department of Transportation

For more information on the

WSDOT Crash Modification Factor Short List

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