

North Carolina Project Development Crash Reduction Factor Information

Revised May 30, 2007

Countermeasure	Crash Pattern Affected -- Site Specification	Percent Reduction	Date -- Study -- Reference
1. Traffic Signals			
1.1 Install a Traffic Signal	Total Crashes "OR"	22	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	Total Angle Crashes	65	April 01 -- WPRFC Meeting Handout -- Reference 13
	3-leg Urban Intersection (Injury includes fatality and injury crashes)		
	Total Injury Crashes "OR"	14	November 05 -- NCHRP Digest 299 -- Study 4
	Total Right-Angle Injury Crashes	34	November 05 -- NCHRP Digest 299 -- Study 4
	Total Rear-End Injury Crashes	-50	November 05 -- NCHRP Digest 299 -- Study 4
	4-leg Urban Intersection (Injury includes fatality and injury crashes)		
	Total Injury Crashes "OR"	23	November 05 -- NCHRP Digest 299 -- Study 4
	Total Right-Angle Injury Crashes	67	November 05 -- NCHRP Digest 299 -- Study 4
	Total Rear-End Injury Crashes	-38	November 05 -- NCHRP Digest 299 -- Study 4
1.2 Upgraded Traffic Signals	Total Crashes "OR"	22	April 01 -- WPRFC Meeting Handout -- Reference 1, 11
	Total Fatal Crashes	38	April 01 -- WPRFC Meeting Handout -- Reference 1, 11
	Total Non-Fatal Injury Crashes	22	April 01 -- WPRFC Meeting Handout -- Reference 1, 11
	Total PDO Crashes	23	April 01 -- WPRFC Meeting Handout -- Reference 1, 11
1.3 Add Protected Left-Turn Phase	Total Crashes "OR"	25	April 01 -- WPRFC Meeting Handout -- Reference 8
	Total Left-Turn Crashes	70	April 01 -- WPRFC Meeting Handout -- Reference 13
1.4 Add Protected Permissive Left-Turn Phase	Total Crashes "OR"	10	April 01 -- WPRFC Meeting Handout -- Reference 13
	Total Left-Turn Crashes	40	April 01 -- WPRFC Meeting Handout -- Reference 13
1.5 Pretimed to Actuated	Total Crashes	20	April 01 -- WPRFC Meeting Handout -- Reference 8
1.6 Closed Loop Signal System	Total Crashes	15	April 01 -- WPRFC Meeting Handout -- Reference 13
1.7 Improve Signal Timing	Total Crashes	15	March 05 -- WPRFC Email -- ITE Safety Briefs
1.8 Upgrade 8" Signal Heads to 12" Signal Heads	Total Crashes	10	April 01 -- WPRFC Meeting Handout -- Reference 8
1.9 Long Vehicle Detection	Total Crashes	10*	September 06 -- WPRFC Email -- Subjective based on 6 B&A analyses
1.10 Signal Back Plates	Total Crashes "OR"	5*	September 06 -- WPRFC Email -- Subjective based on committee opinion
	Total Right Angle Crashes	20	April 01 -- WPRFC Meeting Handout -- Reference 13
1.11 Queue Detection - Ramp Locations	Total Crashes	30*	April 06 -- WPRFC Email -- Subjective based on committee opinion
2. Flashing Beacons			
2.1 Intersection Warning Flasher	Total Crashes	30	April 01 -- WPRFC Meeting Handout -- Reference 8, 13
	2-lane at 2-lane Rural Intersection		
	Total Crashes "OR"	12	November 06 -- NCDOT Study
	Injury Crashes (Injury crashes are B and C level)	9	November 06 -- NCDOT Study
	Severe Injury Crashes (Severe injury crashes are K and A level) "OR"	40	November 06 -- NCDOT Study
	Frontal Impact Crashes "OR"	9	November 06 -- NCDOT Study
"Ran Stop Sign" Crashes	26	November 06 -- NCDOT Study	
2.2 Upgrade Overhead Warning Flasher Actuated Vehicles Entering	Total Crashes	25*	June 06 -- WPRFC Email -- Subjective based on committee opinion

4. Pavement Widening			
4.1 Widening for an Additional Lane	Total Crashes	10*	March 07 -- WPRFC Meeting -- Subjective based on committee opinion
4.2 Pavement Widening	Total Crashes	22	April 01 -- WPRFC Meeting Handout -- Reference 2
	"OR"		
	Total Fatal Crashes	40	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	15	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	25	April 01 -- WPRFC Meeting Handout -- Reference 2
4.3 Widen or Improve Shoulder	Total Crashes	8	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	"OR"		
	Total Fatal Crashes	22	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	Total Non-Fatal Injury Crashes	13	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	Total PDO Crashes	12	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	<u>Rural 2-lane</u>		
	Total Crashes	18	April 01 -- WPRFC Meeting Handout -- Reference 2
	"OR"		
	Total Fatal Crashes	48	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	8	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	23	April 01 -- WPRFC Meeting Handout -- Reference 2
	<u>Urban 2-lane</u>		
Total Crashes	26	April 01 -- WPRFC Meeting Handout -- Reference 2	
4.4 Add Passing Lanes (Two-Lane Roads)	<u>One-Way</u> (single direction of travel)		
	Total Crashes	25	November 05 -- NCHRP Digest 299 -- Study 11
	<u>Two-Way</u> (short four-lane sections)		
	Total Crashes	35	November 05 -- NCHRP Digest 299 -- Study 11
5. Pavement Enhancements			
5.1 Shoulder Rumble Strips	Total Crashes	29	April 01 -- WPRFC Meeting Handout -- Reference 3
	<u>Rural and Urban Freeways</u> (Injury includes fatality and injury crashes)		
	Total Single-Vehicle Run-Off-Road Crashes	18	November 05 -- NCHRP Digest 299 -- Study 17
	"OR"		
	Total Injury Single-Vehicle Run-Off-Road Crashes	13	November 05 -- NCHRP Digest 299 -- Study 17
	<u>Rural Freeways</u> (Injury includes fatality and injury crashes)		
	Total Single-Vehicle Run-Off-Road Crashes	21	November 05 -- NCHRP Digest 299 -- Study 17
"OR"			
Total Injury Single-Vehicle Run-Off-Road Crashes	7	November 05 -- NCHRP Digest 299 -- Study 17	
5.2 Add Centerline Rumble Strips	<u>Rural 2-lane Roads</u> (Injury includes fatality and injury crashes)		
	Total Crashes	14	November 05 -- NCHRP Digest 299 -- Study 18
	"OR"		
	Total Frontal/Opposing-Direction Sideswipe Crashes	21	November 05 -- NCHRP Digest 299 -- Study 18
	"OR"		
Total Injury Crashes	15	November 05 -- NCHRP Digest 299 -- Study 18	
"OR"			
Total Injury Frontal/Opposing-Direction Sideswipe Crashes	25	November 05 -- NCHRP Digest 299 -- Study 18	
5.3 Skid Treatments (overlay)	Total Crashes	27	April 01 -- WPRFC Meeting Handout -- Reference 2
	"OR"		
	Total Fatal Crashes	29	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	16	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	32	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Wet Crashes	63	April 01 -- WPRFC Meeting Handout -- Reference 10
	"OR"		
Total Wet Injury Crashes (Injury includes fatality and injury crashes)	57	April 01 -- WPRFC Meeting Handout -- Reference 9	
5.4 Skid Treatments (groove pavement)	Total Crashes	14	April 01 -- WPRFC Meeting Handout -- Reference 2
	"OR"		
	Total Non-Fatal Injury Crashes	12	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	15	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Wet Injury Crashes (Injury includes fatality and injury crashes)	61	April 01 -- WPRFC Meeting Handout -- Reference 9

6. Sight Distance			
6.1 Horizontal Realignment	Total Fatal Crashes	66	April 01 -- WPRFC Meeting Handout -- Reference 1
	Total Non-Fatal Injury Crashes	43	April 01 -- WPRFC Meeting Handout -- Reference 1
6.2 Vertical Realignment	Total Crashes	40	April 01 -- WPRFC Meeting Handout -- Reference 13
6.3 Improve Skew Angle	Total Crashes	40	April 01 -- WPRFC Meeting Handout -- Reference 13
6.4 Improve Sight Distance Triangles - Remove Objects	Total Crashes	25	February 2005 -- WPRFC Phone Call -- Low Cost Workshop
	"OR"		
	Total Fatal Crashes	66	February 2005 -- WPRFC Phone Call -- Low Cost Workshop
	Total Non-Fatal Injury Crashes	20	February 2005 -- WPRFC Phone Call -- Low Cost Workshop
6.5 Channelization - Parking Area Sight Distance Issues	Total Crashes	25*	April 06 -- WPRFC Email -- Subjective based on committee opinion
7. Guardrail			
7.1 New or Upgraded Guardrail	Total Injury Crashes (Injury includes fatality and injury crashes)	47	November 05 -- NCHRP Digest 299 -- Study 19
	Total PDO Crashes	-50*	March 06 -- WPRFC Email -- Subjective based on committee opinion
	<u>Rural 2-lane</u>		
	Total Fatal Crashes	50	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	12	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	18	April 01 -- WPRFC Meeting Handout -- Reference 2
	<u>Rural 4-lane Undivided</u>		
	Total Fatal Crashes	44	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	23	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total PDO Crashes	44	April 01 -- WPRFC Meeting Handout -- Reference 2
	<u>Rural 4-lane Divided</u>		
	Total Fatal Crashes	46	April 01 -- WPRFC Meeting Handout -- Reference 2
	Total Non-Fatal Injury Crashes	13	April 01 -- WPRFC Meeting Handout -- Reference 2
	7.2 New Median Barrier	Total Fatal Crashes	63
Total Non-Fatal Injury Crashes		10	April 01 -- WPRFC Meeting Handout -- Reference 1
Total PDO Crashes		-25*	April 01 -- WPRFC Meeting -- Subjective based on committee opinion
<u>Rural 4-lane Divided</u>			
Total Fatal Crashes		93	April 01 -- WPRFC Meeting Handout -- Reference 2
<u>Rural</u>			
Total Fatal Crashes		75	April 01 -- WPRFC Meeting Handout -- Reference 2
<u>Urban 4-lane Undivided</u>			
Total Non-Fatal Injury Crashes		63	April 01 -- WPRFC Meeting Handout -- Reference 2
<u>Urban 4-lane Divided</u>			
Total Fatal Crashes		84	April 01 -- WPRFC Meeting Handout -- Reference 2
<u>Urban</u>			
Total Fatal Crashes	72	April 01 -- WPRFC Meeting Handout -- Reference 2	
7.3 Bridge Guardrail	<u>Bridge Approach Guardrail</u>		
	Total Fatal Crashes	55	April 01 -- WPRFC Meeting Handout -- Reference 4
	Total Non-Fatal Injury Crashes	20	April 01 -- WPRFC Meeting Handout -- Reference 4
	Total PDO Crashes	-50	April 01 -- WPRFC Meeting Handout -- Reference 4
7.4 Bridge Replacements	Total Crashes per Year	22	November 02 -- NCDOT Study
	"OR"		
	Total Injury Crashes per Year (Injury includes fatality and injury crashes)	32	November 02 -- NCDOT Study
	PDO Crashes per Year	13	November 02 -- NCDOT Study

8. Delineation			
8.1 Markings & Delineation	Total Crashes	21	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	"OR"		
	Total Fatal Crashes	15	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	Total Non-Fatal Injury Crashes	6	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
	Total PDO Crashes	26	April 01 -- WPRFC Meeting Handout -- Reference 1, 2
8.2 Warning Signs - General	Total Crashes	25	April 01 -- WPRFC Meeting Handout -- Reference 13
9. Intersection Enhancements			
9.1 Limited Movement Crossovers	Total Crashes	37*	April 07 -- WPRFC Email -- Subjective based on 12 B&A analyses
9.2 Concrete Island - Channelization	Total Crashes	25	March 07 -- NCDOT Project Development Webpage -- Reference 13
9.3 Remove Crossover	Total Crashes	90*	March 07 -- WPRFC Meeting on 030107 -- Subjective based on committee opinion
9.4 Roundabout	<u>All Conversions</u> (Injury includes fatality and injury crashes)		
	Total Crashes	40	November 05 -- NCHRP Digest 299 -- Study 1
	"OR"		
	Total Injury Crashes	80	November 05 -- NCHRP Digest 299 -- Study 1
9.5 Splitter Island with Additional Stop Sign	Total Crashes	11	April 05 -- WPRFC Email -- Low Cost Workshop
	"OR"		
	Total Right Angle Crashes	36	April 05 -- WPRFC Email -- Low Cost Workshop
9.6 Transverse Rumble Strips	Total Crashes	30	May 05 -- WPRFC Email -- Low Cost Workshop
9.7 4-Way Stop Installation	Total Crashes	47	November 05 -- NCHRP Digest 299 -- Study 7
	"OR"		
	Total Right-Angle Crashes	72	November 05 -- NCHRP Digest 299 -- Study 7
	Total Rear-End Crashes	13	November 05 -- NCHRP Digest 299 -- Study 7
	Total Left-Turn Crashes	20	November 05 -- NCHRP Digest 299 -- Study 7
	Total Pedestrian Crashes	39	November 05 -- NCHRP Digest 299 -- Study 7
	"OR"		
	Total Injury Crashes (Injury includes fatality and injury crashes)	71	November 05 -- NCHRP Digest 299 -- Study 7
9.8 Grade Separation - Flyover	Total Crashes	90*	March 06 -- WPRFC Email -- Subjective based on committee opinion
10. Pedestrian Enhancements			
10.1 Pedestrian Structure	Pedestrian	85	April 01 -- WPRFC Meeting Handout -- Reference 12
10.2 Crosswalk	Total Pedestrian Crashes	25	April 01 -- WPRFC Meeting Handout -- Reference 13
10.3 Crosswalk - Multiple Improvements	Total Pedestrian Crashes	50*	March 06 -- WPRFC Email -- Subjective based on committee opinion
10.4 Install Raised Medians at Crosswalks	<u>Urban and Suburban Multilane Roads - Marked Crosswalks</u>		
	Total Pedestrian Crashes	46	November 05 -- NCHRP Digest 299 -- Study 20
	<u>Urban and Suburban Multilane Roads - Unmarked Crosswalks</u>		
	Total Pedestrian Crashes	39	November 05 -- NCHRP Digest 299 -- Study 20

Notes:

Please use all crashes of the correctable type occurring at the location unless otherwise noted.

* Subjective data agreed upon by the Crash Reduction Factor Committee until empirical data is established. The subjective data is based off of small samples of Simple Before and After Analyses or are compiled from the experiences and opinions of the Crash Reduction Factor Committee members.

References:

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| April 01 -- WPRFC Handout -- Reference 1 | FHWA, (1996). The 1996 Annual Report on Highway Safety Improvement Programs. Publication No. FHWA-SA-96-040. USDOT. FHWA. Washington, DC. |
| April 01 -- WPRFC Handout -- Reference 2 | Highway Safety Evaluation System, FHWA Office of Highway Safety, 1982. |
| April 01 -- WPRFC Handout -- Reference 3 | "Predicting Accident Reduction Factors for Safety Improvements in the State of Kansas", Mulinazzi, Lee; Kansas University Transportation Center, August 1981. |
| April 01 -- WPRFC Handout -- Reference 4 | "Assessment of Techniques for Cost-Effectiveness of Highway Accident Countermeasures", McFarland, et. Al., TTI; Report No. FHWA-RD-79-53, January 1979. |
| April 01 -- WPRFC Handout -- Reference 8 | "Development of Accident Reduction Factors", Kentucky Transportation Research Program, March 1985 |
| April 01 -- WPRFC Handout -- Reference 9 | "1981 Annual Report, Pennsylvania Highway Safety Improvement Program, Pennsylvania DOT, September 1981. |

April 01 -- WPRFC Handout -- Reference 10
April 01 -- WPRFC Handout -- Reference 11
April 01 -- WPRFC Handout -- Reference 12
April 01 -- WPRFC Handout -- Reference 13

"Annual Safety Report, FY 1981", New Jersey DOT, August 1981.
"Evaluation and Report on the Highway Safety Construction Program", Illinois DOT, August 1981.
"Synthesis of Safety Research - Pedestrians", Zeeger, FHWA, June 1991.
"Development of Accident Reduction Factors", Kentucky Transportation Center, June 1996.

(WPRFC -- W-Project Reduction Factor Committee)

November 05 -- NCHRP Digest 299 -- Study 1
November 05 -- NCHRP Digest 299 -- Study 2
November 05 -- NCHRP Digest 299 -- Study 3
November 05 -- NCHRP Digest 299 -- Study 4
November 05 -- NCHRP Digest 299 -- Study 7
November 05 -- NCHRP Digest 299 -- Study 11
November 05 -- NCHRP Digest 299 -- Study 17
November 05 -- NCHRP Digest 299 -- Study 18
November 05 -- NCHRP Digest 299 -- Study 19
November 05 -- NCHRP Digest 299 -- Study 20

Install Roundabout -- Persaud, Retting, Garder, and Lord; 2001
Add Exclusive Left-Turn Lane -- Harwood, Bauer, Potts, Torbic, Richard, Kohlman-Rabbani, Hauer, and Elefteriadou; 2002
Add Exclusive Right-Turn Lane -- Harwood, Bauer, Potts, Torbic, Richard, Kohlman-Rabbani, Hauer, and Elefteriadou; 2002
Install a Traffic Signal -- McGee, Taori, and Persaud; 2003
Convert to All-Way Stop Control -- Lovell and Hauer; 1986
Add Passing Lanes (Two-Lane Roads) -- Harwood, Council, Hauer, Hughes, and Vogt; 2000
Add Shoulder Rumble Strips -- Griffith; 1999
Add Centerline Rumble Strips -- Persaud, Retting, and Lyon; 2003
Install/Upgrade Guardrail -- Elvik and Vaa; 2004
Install Raised Medians at Crosswalk -- Zeeger, Stewart, Huang, and Lagerwey; 2001

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