STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

PATRICK L. MCCRORY
GOVERNOR

ANTHONY J. TATA
SECRETARY

November 10, 2014

Memorandum To: Regional and Division Traffic Engineers

FROM: Brad Robinson, PE
Traffic Safety Engineer

SUBJECT: 2013 Standardized Crash Cost Estimates for North Carolina

The Traffic Engineering and Safety Systems Branch periodically updates cost figures associated with traffic crashes for use by branch personnel for cost analyses. Starting with this update (2013), the branch is adopting the Value of a Statistical Life (VSL) to calculate crash costs. The VSL we are using was obtained from the USDOT memo "Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2014 Adjustment" dated June 13, 2014.

In addition to total statewide crashes, 2013 crash costs were also calculated for seven other categories. The 2013 crash cost categories are:

a) Total Crashes
b) Frontal Impact Crashes
c) Lane Departure Crashes
d) Rear End Crashes
e) Pedestrian Crashes
f) Bicycle Crashes
g) Train Crashes
h) Truck Crashes

Please note the crash statistics and costs discussed in the main body of this memo refer only to total crashes-Category *A*. The costs calculated for Categories *B-H* are included in the appendix.

The 2013 North Carolina crash costs include the cost associated with the average number of injuries in each crash type. For example, the average fatal crash in 2013 on North Carolina's roads contained 1.09 fatal injuries, 0.13 A injuries, 0.34 B injuries and 0.29 C injuries. As per the above mentioned memo's guidance, the individual injury costs are calculated based on a fractional value of the VSL. Table 1a shows the cost of crashes by severity.

Table 1a Cost per Crash – Total Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$10,133,000
A Injury Crash	$564,000
B Injury Crash	$176,000
C Injury Crash	$96,000
Property Damage Only Crash	$6,700
Average Crash	$99,000
Injury Crash (F+A+B+C)	$293,000
Non-Fatal Injury Crash (A+B+C)	$128,000
Severe Injury Crash (F+A)	$4,451,000
Moderate Injury Crash (B+C)	$117,000

Rounded to nearest thousand (with exception of PDO)

Table 2a includes only the reportable crashes that occurred on public roads in 2013. Note that for various reasons, many traffic crashes are not reported. A traffic crash in North Carolina is defined as reportable if it involves an injury or total estimated property damage of $1,000 or more. A traffic crash is rated by the most severe injury involved in the incident. If a crash had eight people involved and seven people sustained C type injuries and one person sustained type A injuries, the crash is recorded as an A Injury crash. However, there were eight injuries. A property damage only crash is one in which no people were injured in the incident.

Table 2a Number of Crashes Compared to the Number of Injuries in North Carolina during 2013

	Number of Crashes	Number of Injuries
Fatal	1,172	1,276
A Injury	1,713	2,112
B Injury	17,410	22,383
C Injury	50,503	84,089
Property Damage Only	149,505	--

Source: North Carolina Crash Database

Table 3a shows the average number of each type of injury that occurred in each crash severity category. These numbers were derived by totaling all the individual injuries that occurred in a severity category. The total is then divided by the total number of crashes in that category. For example, there were **1,276 fatalities, 150 A injuries, 400 B injuries, 342 C injuries, and 474 O injuries in 1,172 fatal crashes**. If the number of injuries is divided by the number of crashes, then there was an average of 1.09 fatalities, 0.13 A injuries, 0.34 B injuries, 0.29 C injuries, and 0.40 O injuries in each fatal crash.

Table 3a Average Number of Injuries by Severity Category

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.09	0.13	0.34	0.29	0.40
A Injury Crash	0	1.15	0.34	0.30	0.57
B Injury Crash	0	0	1.23	0.42	0.75
C Injury Crash	0	0	0	1.50	1.37

The cost per injury data was obtained by using the Value of a Statistical Life (VSL) guidelines found in the USDOT memo "Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2014 Adjustment." This memo gives the 2013 VSL as $9.2 million. Other injury costs are given as a fraction of the VSL cost and are shown in Table 4.

Table 4 Relative Disutility Factors by Injury Severity Level (AIS)

AIS Level	Severity	Fraction of VSL	Cost Per Injury
AIS 1	Minor	.003	$27,600
AIS 2	Moderate	.047	$432,400
AIS 3	Serious	.105	$966,000
AIS 4	Severe	.266	$2,447,200
AIS 5	Critical	.593	$5,455,600
AIS 6	Unsurvivable	1.000	$9,200,000

Source: USDOT Memorandum "Guidance on Treatment of the Economic Value of a Statistical Life (VSL) in U.S. Department of Transportation Analyses – 2014 Adjustment" (June 13, 2014)

As shown in the table above, the VSL guidance lists injuries in terms of the Abbreviated Injury Scale (AIS). Law enforcement officers in North Carolina report injuries using the KABCO Scale. In order to accurately apply the costs in Table 4 to the North Carolina data, a conversion matrix provided by the National Highway Traffic Safety Administration (NHTSA) was applied to the data.

Table 5 KABCO – AIS Data Conversion Matrix

		0 No Injury	C Possible Injury	B Non-Incapacitating	A Incapacitating	K Killed
AIS	0	0.92534	0.23437	0.08347	0.03437	0.00000
	1	0.07257	0.68946	0.76843	0.55449	0.00000
	2	0.00198	0.06391	0.10898	0.20908	0.00000
	3	0.00008	0.01071	0.03191	0.14437	0.00000
	4	0.00000	0.00142	0.00620	0.03986	0.00000
	5	0.00003	0.00013	0.00101	0.01783	0.00000
	Fatality	0.00000	0.00000	0.00000	0.00000	1.00000
	Sum(Prob)	1.00	1.00	1.00	1.00	1.00

Source: National Highway Traffic Safety Administration, July 2011

The matrix is based on probability and the reality that an injury report made by an observation at a crash site does not always end up being accurate. For example, based on the matrix, if a crash report indicates that a driver had an injury of 0 (no injury) there is actually a 7.26% chance that it was an AIS 1 injury (Minor), a 0.198% chance that it was an AIS 2 injury (Moderate), a 0.008% chance that it was an AIS 3 injury (Serious), and a 0.003% chance that it may turn out to be a AIS 5 injury (Critical).

After applying the probabilities from Table 5 to the costs per AIS injury in Table 4, the costs per injury on the KABCO Scale were calculated and are listed in Table 6.

Table 6 2013 Cost Per Injury

Severity (AIS Level)	Cost Per Injury
K	$9,200,000
A	$439,990
B	$119,839
C	$61,194
O	$3,100

.

The cost per crash is calculated by multiplying the cost per injury from Table 6 and the average number of injuries per crash from Table 3a. As an example, Table 7 shows the computations for fatal crashes in 2013. The cost associated with a crash includes the costs associated with each injury involved. The example of the fatal crash shows that the average fatal crash included 1.09 fatalities, 0.13 A injuries, 0.34 B injuries, 0.29 C injuries, and 0.40 O injuries. The same type of calculation was completed for A, B, and C injury Crashes. Table 7 shows the results of these calculations.

Table 7 Computation of Cost Per Fatal Crash

Injury	Number of Injuries (1)	Cost Per Injury (2)	Crash Cost (1) X (2)
Fatal Injury	1.09	$9,200,000	$10,016,380
A Injury	0.13	$439,990	$56,313
B Injury	0.34	$119,839	$40,901
C Injury	0.29	$61,194	$17,857
O Injury	0.40	$3,100	$1,254
TOTAL	**(rounded to nearest thousand)**		**$10,133,000**

The 2013 crash costs were also summarized between urban and rural categories. Rural crashes are usually more severe, making the cost of an average rural crash higher than that of the average urban crash. Table 8 shows the number of crashes broken down by severity category and its respective percentage of total crashes. Notice that there are more severe crashes in rural areas, and a higher percentage of rural crashes fall within the more severe categories.

Table 8 Urban and Rural Crash Summary by Severity Category

	Rural		Urban	
Severity	**Number of Crashes**	**% Of Total**	**Number of Crashes**	**% Of Total**
K	763	0.93%	409	0.30%
A	1,006	1.22%	707	0.51%
B	8,370	10.19%	9,040	6.54%
C	16,531	20.13%	33,972	24.59%
PDO	55,461	67.53%	94,044	68.06%

Table 9 shows the 2013 crash costs for rural and urban areas. The 2013 combined (urban and rural) crash costs are also presented for comparison. The crash cost for each severity category is very similar across the board for urban, rural, and combined categories. There is little change because the number of injuries per crash for each severity category changes very little when looking at rural and urban crashes. The big difference comes in the average costs. The average rural crash costs are higher because severe crashes make up a higher percentage of the total rural crashes when compared to the urban crash costs.

Table 9 Crash Costs for Urban and Rural Areas

	Combined	Rural	Urban
	Cost Per Crash	**Cost Per Crash**	**Cost Per Crash**
Fatal Crash	$10,133,000	$10,132,000	$10,135,000
A Injury Crash	$564,000	$580,000	$542,000
B Injury Crash	$176,000	$172,000	$179,000
C Injury Crash	$96,000	$92,000	$98,000
Property Damage Only Crash	$6,700	$6,700	$6,700
Average Crash	$99,000	$142,000	$73,000
Injury Crash (F+A+B+C)	$293,000	$423,000	$215,000
Non-Fatal Injury Crash (A+B+C)	$128,000	$137,000	$122,000
Severe Injury Crash (F+A)	$4,451,000	$4,700,000	$4,057,000
Moderate Injury Crash (B+C)	$117,000	$119,000	$115,000

If you have any questions regarding 2013 crash costs, please contact Brad Robinson, PE at (919) 773-2966.

BDR/bdr

Appendix

Crash Costs for Frontal Impact Crashes (Category B)

(Frontal impact crashes are considered Angle, Left turn same road, Left turn different road, Right turn same road, Right turn different road, and Head on crashes)

Table 1b Cost per Crash – Frontal Impact Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$10,588,000
A Injury Crash	$640,000
B Injury Crash	$210,000
C Injury Crash	$107,000
Property Damage Only Crash	$6,700
Average Crash	$130,000
Injury Crash (F+A+B+C)	$313,000
Non-Fatal Injury Crash (A+B+C)	$147,000
Severe Injury Crash (F+A)	$4,544,000
Moderate Injury Crash (B+C)	$134,000

Rounded to nearest thousand (with exception of PDO)

Table 2b Number of Frontal Impact Crashes Compared to the Number of Injuries in North Carolina during 2013

	Number of Crashes	Number of Injuries
Fatal	345	389
A Injury	534	741
B Injury	5,484	7,989
C Injury	15,354	30,027
Property Damage Only	32,168	--

Source: North Carolina Crash Database

Table 3b Average Number of Injuries by Severity Category for Frontal Impact Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.13	0.23	0.66	0.51	0.58
A Injury Crash	0	1.24	0.51	0.51	0.92
B Injury Crash	0	0	1.37	0.71	1.08
C Injury Crash	0	0	0	1.67	1.54

Crash Costs for Lane Departure Crashes (Category C)

(Lane departure crashes are considered Run off road straight, Run off road right, Run off road left, Fixed object, Overturn/Rollover, Sideswipe opposite direction, Parked motor vehicle, and Head on crashes)

Table 1c Cost per Crash – Lane Departure Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$10,317,000
A Injury Crash	$559,000
B Injury Crash	$157,000
C Injury Crash	$80,000
Property Damage Only Crash	$6,700
Average Crash	$175,000
Injury Crash (F+A+B+C)	$453,000
Non-Fatal Injury Crash (A+B+C)	$130,000
Severe Injury Crash (F+A)	$4,745,000
Moderate Injury Crash (B+C)	$110,000

Rounded to nearest thousand (with exception of PDO)

Table 2c Number of Lane Departure Crashes Compared to the Number of Injuries in North Carolina during 2013

	Number of Crashes	Number of Injuries
Fatal	680	753
A Injury	905	1,151
B Injury	7,806	9,863
C Injury	12,050	17,560
Property Damage Only	35,418	--

Source: North Carolina Crash Database

Table 3c Average Number of Injuries by Severity Category for Lane Departure Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.11	0.17	0.35	0.21	0.15
A Injury Crash	0	1.15	0.34	0.23	0.20
B Injury Crash	0	0	1.19	0.22	0.26
C Injury Crash	0	0	0	1.28	0.43

Crash Costs for Rear End Crashes (Category D)

(Rear end crashes are considered Rear end slow or stop and Rear end turn crashes)

Table 1d Cost per Crash – Rear End Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$10,569,000
A Injury Crash	$607,000
B Injury Crash	$200,000
C Injury Crash	$101,000
Property Damage Only Crash	$6,700
Average Crash	$53,000
Injury Crash (F+A+B+C)	$142,000
Non-Fatal Injury Crash (A+B+C)	$117,000
Severe Injury Crash (F+A)	$3,086,000
Moderate Injury Crash (B+C)	$113,000

Rounded to nearest thousand (with exception of PDO)

Table 2d Number of Rear End Crashes Compared to the Number of Injuries in North Carolina during 2013

	Number of Crashes	Number of Injuries
Fatal	52	59
A Injury	157	194
B Injury	2,558	3,290
C Injury	18,696	31,080
Property Damage Only	40,895	--

Source: North Carolina Crash Database

Table 3d Average Number of Injuries by Severity Category for Rear End Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.13	0.10	0.37	0.67	1.17
A Injury Crash	0	1.20	0.36	0.50	1.38
B Injury Crash	0	0	1.26	0.72	1.63
C Injury Crash	0	0	0	1.56	1.86

Crash Costs for Pedestrian Crashes (Category E)

Note: Due to having a relatively small yearly sample size, the costs for pedestrian crashes were calculated based on five years of crash data (2009-2013)

Table 1e Cost per Crash – Pedestrian Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$9,356,000
A Injury Crash	$474,000
B Injury Crash	$131,000
C Injury Crash	$66,000
Property Damage Only Crash	$6,700
Average Crash	$945,000
Injury Crash (F+A+B+C)	$964,000
Non-Fatal Injury Crash (A+B+C)	$134,000
Severe Injury Crash (F+A)	$5,077,000
Moderate Injury Crash (B+C)	$99,000

Rounded to nearest thousand (with exception of PDO)

Table 2e Number of Pedestrian Crashes Compared to the Number of Injuries in North Carolina from 2009 through 2013 (5 Years)

	Number of Crashes	Number of Injuries
Fatal	840	851
A Injury	781	835
B Injury	3,931	4,307
C Injury	3,782	4,563
Property Damage Only	182	--

Source: North Carolina Crash Database

Table 3e Average Number of Injuries by Severity Category for Pedestrian Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.01	0.03	0.10	0.15	0.28
A Injury Crash	0	1.03	0.10	0.11	0.21
B Injury Crash	0	0	1.06	0.07	0.15
C Injury Crash	0	0	0	1.08	0.08

Crash Costs for Bicycle Crashes (Category F)

Note: Due to having a relatively small yearly sample size, the costs for bicycle crashes were calculated based on five years of crash data (2009-2013)

Table 1f Cost per Crash – Bicycle Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$9,415,000
A Injury Crash	$464,000
B Injury Crash	$125,000
C Injury Crash	$64,000
Property Damage Only Crash	$6,700
Average Crash	$366,000
Injury Crash (F+A+B+C)	$376,000
Non-Fatal Injury Crash (A+B+C)	$118,000
Severe Injury Crash (F+A)	$3,350,000
Moderate Injury Crash (B+C)	$96,000

Rounded to nearest thousand (with exception of PDO)

Table 2f Number of Bicycle Crashes Compared to the Number of Injuries in North Carolina from 2009 through 2013 (5 Years)

	Number of Crashes	Number of Injuries
Fatal	98	100
A Injury	206	215
B Injury	1,696	1,752
C Injury	1,537	1,654
Property Damage Only	94	--

Source: North Carolina Crash Database

Table 3f Average Number of Injuries by Severity Category for Bicycle Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.02	0.01	0.09	0.16	0.51
A Injury Crash	0	1.04	0.03	0.04	0.27
B Injury Crash	0	0	1.02	0.03	0.26
C Injury Crash	0	0	0	1.03	0.23

Crash Costs for Train Crashes (Category G)

Note: Due to having a relatively small yearly sample size, the costs for train crashes were calculated based on five years of crash data (2009-2013)

Table 1g Cost per Crash – Train Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$9,856,000
A Injury Crash	$444,000
B Injury Crash	$184,000
C Injury Crash	$85,000
Property Damage Only Crash	$60,000
Average Crash	$801,000
Injury Crash (F+A+B+C)	$1,862,000
Non-Fatal Injury Crash (A+B+C)	$173,000
Severe Injury Crash (F+A)	$6,582,000
Moderate Injury Crash (B+C)	$138,000

Rounded to nearest thousand (with exception of PDO)

Table 2g Number of Train Crashes Compared to the Number of Injuries in North Carolina from 2009 through 2013 (5 Years)

	Number of Crashes	Number of Injuries
Fatal	15	16
A Injury	8	9
B Injury	34	43
C Injury	29	57
Property Damage Only	123	--

Source: North Carolina Crash Database

Table 3g Average Number of Injuries by Severity Category for Train Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries	Average Number of O Injuries
Fatal Crash	1.07	0.07	0.07	0.07	0.33
A Injury Crash	0	1.00	0.00	0.00	1.25
B Injury Crash	0	0	1.24	0.53	1.00
C Injury Crash	0	0	0	1.31	1.69

Crash Costs for Heavy Truck Crashes (Category H)

(Heavy truck crashes are considered those that involve a unit coded as Vehicle Style 12, 13, 14, 15, or 16 on the crash report)

Table 1h Cost per Crash – Truck Crashes

Crash Type	Cost Per Crash 2013 Dollars
Fatal Crash	$10,506,000
A Injury Crash	$535,000
B Injury Crash	$154,000
C Injury Crash	$86,000
Property Damage Only Crash	$6,700
Average Crash	$184,000
Injury Crash (F+A+B+C)	$601,000
Non-Fatal Injury Crash (A+B+C)	$123,000
Severe Injury Crash (F+A)	$6,059,000
Moderate Injury Crash (B+C)	$106,000

Rounded to nearest thousand (with exception of PDO)

Table 2h Number of Truck Crashes Compared to the Number of Injuries in North Carolina during 2013

	Number of Crashes	Number of Injuries
Fatal	77	87
A Injury	62	78
B Injury	459	560
C Injury	1,075	1,581
Property Damage Only	3,948	--

Source: North Carolina Crash Database

Table 3h Average Number of Injuries by Severity Category for Train Crashes

Crash Type	Average Number of Fatal Injuries	Average Number of A Injuries	Average Number of B Injuries	Average Number of C Injuries
Fatal Crash	1.13	0.12	0.30	0.35
A Injury Crash	0	1.11	0.23	0.26
B Injury Crash	0	0	1.14	0.24
C Injury Crash	0	0	0	1.33