TIGER BENEFIT-COST ANALYSIS (BCA) RESOURCE GUIDE

How to Use This Guide

This BCA Resource Guide is a supplement to *Appendix A: Additional Information on Benefit-Cost Analysis,* as found in the January 31, 2012, Federal Register's Notice of Funding Availability (NOFA) for TIGER Grants (http://www.gpo.gov/fdsys/pkg/FR-2012-01-31/pdf/2012-1996.pdf). It provides technical information that Applicants will need for monetizing benefits and costs in their Benefit-Cost Analyses, as well as guidance on methodology and a selection of frequently asked questions from past TIGER grant applicants.

This guide is divided into three sections:

I. **Recommended Monetized Values**
For the purposes of providing as fair an "apples-to-apples" comparison as possible, applicants should use standard monetization values recommended in this section, which represent some of the values that are accepted for common practice at the U.S. Department of Transportation.

II. **Technical Methodologies**
This section provides guidance on the technical details of monetizing carbon dioxide (CO_2) emissions costs according to the Social Cost of Carbon standard developed by Federal agencies, converting nominal dollars into real dollars, and calculating the value of fatalities and injuries from vehicular crashes.

III. **Frequently Asked Questions (FAQs)**
This section provides answers to frequently asked questions from past TIGER applicants, with topics ranging from the logistical to the technical.

Updates to this document will be dated accordingly (with the nature of the updates noted on this cover page) and posted to the TIGER Discretionary Grants website (http://www.dot.gov/tiger).

Updated 2/1/12

I. Recommended Monetized Values

Each project generates unique impacts in its respective community, and the TIGER Evaluation process respects these differences, particularly within the context of benefit-cost analysis. While the impacts may differ from place to place, the Department does recognize certain monetized values (and monetizing methodologies) as standard, such that various projects from across the country may be evaluated on a more equivalent "apples-to-apples" basis of comparison. The following table summarizes key values for various types of benefits and costs that the Department recommends that applicants use in their benefit-cost analyses. However, benefits and costs for any reliable analysis are not limited only to this table. The applicant should provide documentation of sources and detailed calculations for monetized values of additional categories of benefits and costs. Similarly, applicants using different values for the benefit/cost categories presented below below should provide sources, calculations, and rationale for divergence from recommended values.

Table 1. Recommended Monetized Values

<table>
<tr><th>Cost/Benefit Category</th><th>Recommended Monetized Value(s)</th><th>Reference and Notes</th></tr>
<tr><td>Value of Statistical Life (VSL)</td><td>$6,200,000 per fatality ($2011)</td><td>Treatment of the Economic Value of a Statistical Life in Departmental Analyses (2008 revised guidance and 2011 update)
http://ostpxweb.dot.gov/policy/reports.htm</td></tr>
<tr><td>Value of Injuries</td><td><table>
<tr><th>AIS Level</th><th>Severity</th><th>Fraction of VSL</th><th>Unit value ($2011)</th></tr>
<tr><td>AIS 1</td><td>Minor</td><td>0.003</td><td>$ 18,600</td></tr>
<tr><td>AIS 2</td><td>Moderate</td><td>0.047</td><td>$ 291,400</td></tr>
<tr><td>AIS 3</td><td>Serious</td><td>0.105</td><td>$ 651,000</td></tr>
<tr><td>AIS 4</td><td>Severe</td><td>0.266</td><td>$ 1,649,200</td></tr>
<tr><td>AIS 5</td><td>Critical</td><td>0.593</td><td>$ 3,676,600</td></tr>
<tr><td>AIS 6</td><td>Unsurvivable</td><td>1.000</td><td>$ 6,200,000</td></tr>
</table></td><td>Treatment of the Economic Value of a Statistical Life in Departmental Analyses (2008 revised guidance and 2011 update)
http://ostpxweb.dot.gov/policy/reports.htm

NOTE:
Accident data (particularly those provided through law enforcement records) are typically reported as a single number (e.g. "X number of crashes in Year Y") and/or on the KABCO scale of crash severity. Applicants should convert these values to the AIS scale before applying the recommended monetized values. See Part II Section 3 ("Converting Available Accident Data into AIS Data").</td></tr>
</table>

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Property Damage Only (PDO) Crashes	$3,285 per vehicle crash ($2010)	*The Economic Impact of Motor Vehicle Crashes 2000* http://www.nhtsa.gov/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/EconomicImpact2000.pdf **NOTE:** PDO value of $3,285 per vehicle crash is an updated value currently used by NHTSA and based on the methodology and original 2000 dollar value referenced in *The Economic Impact of Motor Vehicle Crashes 2000* source document (Page 62, Table A-1, "Summary of Unit Costs, 2000"). Also, while the cost of PDO crashes is presented here in 2010 dollars, as it was in the source document, applicants should convert this value (along with other monetized values presented in this section) to dollars applicable to whatever base year you are using, using the methodology discussed below in **Part II, Section 2 ("Converting Nominal Dollars into Real (Constant) Dollars").**

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Value of Travel Time	(see table below)	*Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (Revision 2 – corrected)* http://ostpxweb.dot.gov/policy/reports.htm

Recommended Hourly Values of Travel Time Savings (2009 U.S. $ per person-hour)

Category	Surface Modes* (except High-Speed Rail)	Air and High-Speed Rail Travel
Local Travel		
Personal	$12.00	
Business	$22.90	
All Purposes **	$12.50	
Intercity Travel		
Personal	$16.70	$31.90
Business	$22.90	$62.60
All Purposes **	$18.00	$44.30

Truck Drivers	$23.70
Bus Drivers	$23.60
Transit Rail Operators	$38.90
Locomotive Engineers	$33.00
Airline Pilots and Engineers	$73.30

* Surface figures apply to all combinations of in-vehicle and other transit time. Walk access, waiting, and transfer time in personal travel should be valued at $23.90 per hour for personal travel when actions affect only those elements of travel time.

** These are weighted averages, using distributions of travel by trip purpose on various modes. Distribution for local travel by surface modes: 95.4% personal, 4.6% business. Distribution for intercity travel by conventional surface modes: 78.6% personal, 21.4% business. Distribution for intercity travel by air or high-speed rail: 59.6% personal, 40.4% business. Surface figures derived using annual person-miles of travel (PMT) data from the 2001 National Household Travel Survey. http://nhts.ornl.gov/. Air figures use person-trip data.

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Value of Emissions	<table><tr><th>Emission Type</th><th>$ / long ton ($2007)</th><th>$ / metric ton ($2007)</th></tr><tr><td>Carbon dioxide (CO_2)</td><td>(varies)*</td><td>(varies)*</td></tr><tr><td>Volatile Organic Compounds (VOCs)</td><td>$1,300</td><td>$1,280</td></tr><tr><td>Nitrogen oxides (NOx)</td><td>$5,300</td><td>$5,217</td></tr><tr><td>Particulate matter (PM)</td><td>$290,000</td><td>$285,469</td></tr><tr><td>Sulfur dioxide (SOx)</td><td>$31,000</td><td>$30,516</td></tr></table> * See **"Social Cost of Carbon (3%)"** values below.	*Corporate Average Fuel Economy for MY2012-MY2016 Passenger Cars and Light Trucks* (March 2010), page 403, Table VIII-8, "Economic Values for Benefits Computations (2007 Dollars)" http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2012-2016_FRIA_04012010.pdf **NOTE:** Emissions units are commonly reported as "tons", but there is a distinction between long tons and metric tons. In fact, only carbon dioxide emissions (as reported in the SCC guidance) are typically reported in metric tons, whereas emissions for VOCs, NOx, PMs, and SOx are measured in English (or "long") tons. A metric ton is 2,205 lbs, and a long ton is 2,240 lbs – resulting in a difference of about 1.6% between the monetized values per metric vs long ton.

Cost/Benefit Category	Recommended Monetized Value(s)	Reference and Notes
Social Cost of Carbon (3%)	(see table below)	*Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (February 2010), page 39, Table A-1 "Annual SCC Values 2010-2050 (in 2007 dollars)" http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf **NOTE:** - SCC values are per unit metric ton of carbon dioxide and already discounted forward to the reference year (in 2007 nominal dollars). - See **Part II, Section 1 ("Clarification on the Social Cost of Carbon (SCC) Guidance and the Annual SCC Values")**, for methodology of how to use 3% SCC values in TIGER BCA.

Year	3% SCC (2007$)
2010	21.40
2011	21.90
2012	22.40
2013	22.80
2014	23.30
2015	23.80
2016	24.30
2017	24.80
2018	25.30
2019	25.80
2020	26.30
2021	27.00
2022	27.60
2023	28.30
2024	28.90
2025	29.60
2026	30.20
2027	30.90
2028	31.50
2029	32.10
2030	32.80

Year	3% SCC (2007$)
2031	33.40
2032	34.10
2033	34.70
2034	35.40
2035	36.00
2036	36.70
2037	37.30
2038	37.90
2039	38.60
2040	39.20
2041	39.80
2042	40.40
2043	40.90
2044	41.50
2045	42.10
2046	42.60
2047	43.20
2048	43.80
2049	44.40
2050	44.90

II. Technical Methodologies

1. Clarification on the *Social Cost of Carbon* (SCC) Guidance and the Annual SCC Values

As noted in the recommended emissions values from Section I, there is no longer a fixed unit cost to carbon dioxide (CO_2) emissions. The Federal interagency Social Cost of Carbon (SCC) guidance states that the value of carbon dioxide emissions changes over time and should be discounted at the lower discount rates of 2.5%, 3%, or 5%.

However, the lack of 7% SCC values does not mean that applicants should ignore 7% discounting for the BCA. The document and its findings imply that carbon emissions are valued differently from other benefits and costs from the perspective of discount rate. Applicants should continue to calculate discounted present values for all benefits and costs (that *exclude* carbon dioxide emissions) at 7% and 3%, as recommended by OMB Circular A-94[1]. To these non-carbon NPV benefits, the Applicant should then add the corresponding net value of carbon dioxide emissions, as calculated from the 3% SCC value. The methodology for calculating this net value of carbon dioxide emissions is described below:

i. Determine your base year and the life cycle years for the project. Look up the corresponding 3% average value for each corresponding year in which the carbon dioxide emissions occur. The TIGER Program recommends the use of the 3% average values as provided in the document *Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (February 2010)[2], on page 39 in Table A-1 "Annual SCC Values 2010-2050 (in 2007 dollars)".

   a. **Example:** Our project has base year 2012, with project life through 2020. We want to know how to value a carbon dioxide emissions reduction of 100 metric tons in 2020.

   b. **[NOTE]** The SCC values are given in 2007 dollars. You should convert these to your base year dollars by multiplying by the corresponding GDP deflator or CPI ratio.

ii. Multiply the quantity of tons reduced in 2020 by the 3% SCC value in that same year.

   a. **Example:** 100 tons x $26.30 = $2630.00 benefits in 2020.

iii. Discount forward the 2020 carbon dioxide benefits *only* to the base year (2012) present value at the same SCC discount rate (3%). Recall that

$$PV = \frac{FV}{(1+i)^t}$$

Where
PV= Present discounted value of a future payment from year *t*
FV = Future Value of payment in year *t*
i = Discount rate applied
t = Years in the future for payment (where base year of analysis is *t* = 0)

   a. **Example:** NPV in 2012 (for year 2020 benefits) = $2630.00 / [(1.03)^8] = $2076.10

iv. Add the sum of these yearly NPV SCC values to the calculated net present value of all other benefits (which will exclude carbon emissions).

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[1] White House Office of Management and Budget, Circular A-94 *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs* (October 29, 1992) (http://www.whitehouse.gov/sites/default/files/omb/assets/a94/a094.pdf).

[2] Interagency Working Group on Social Cost of Carbon, United State Government, *Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866* (February 2010) (http://www.epa.gov/oms/climate/regulations/scc-tsd.pdf).

a. **Example:** Add $2076.10 to the non-Carbon net benefits (discounted at 7% and 3%) for year 2020 to get the total NPV benefits for year 2020.

The spreadsheet on the following page demonstrates what the methodology would look like for a sample multi-year analysis.

Table 2. Sample Calculation for Applying Social Cost of Carbon to TIGER Benefit-Cost Analysis

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)
Year	**Calendar Year**	**Non-CO2 Benefits (2007$)**	**Non-CO2 Costs (2007$)**	**Net non-CO2 Benefits [C+D]**	**7% NPV Non-CO2 Benefits [E/(1.07^A)]**	**3% NPV Non-CO2 Benefits [E/(1.03^A)]**	**CO2 Reduced (Metric Tons)**	**3% SCC (2007$)**	**Undiscounted CO2 Costs @ 3% Avg SCC [H*I]**	**NPV CO2 Costs @ 3% Avg SCC [J/(1.03^A)]**	**7% NPV Total Benefits [F+K]**	**3% NPV Total Benefits [G+K]**
0	2012	$0	$500,000	($5,000,000)	($5,000,000)	($5,000,000)	-25	$22.40	($560.00)	($560.00)	($5,000,560)	($5,000,560)
1	2013	$0	($1,500,000)	($1,500,000)	($1,401,869)	($1,456,311)	-25	$22.80	($570.00)	($553.40)	($1,402,423)	($1,456,864)
2	2014	$0	($1,500,000)	($1,500,000)	($1,310,158)	($1,413,894)	-25	$23.30	($582.50)	($549.06)	($1,310,707)	($1,414,443)
3	2015	$5,000,000	($150,000)	$4,850,000	$3,959,045	$4,438,437	100	$23.80	$2,380.00	$2,178.04	$3,961,223	$4,440,615
4	2016	$5,000,000	($150,000)	$4,850,000	$3,700,042	$4,309,162	100	$24.30	$2,430.00	$2,159.02	$3,702,201	$4,311,321
5	2017	$5,000,000	($150,000)	$4,850,000	$3,457,983	$4,183,653	100	$24.80	$2,480.00	$2,139.27	$3,460,122	$4,185,792
6	2018	$5,000,000	($150,000)	$4,850,000	$3,231,760	$4,061,799	100	$25.30	$2,530.00	$2,118.84	$3,233,879	$4,063,917
7	2019	$5,000,000	($150,000)	$4,850,000	$3,020,336	$3,943,494	100	$25.80	$2,580.00	$2,097.78	$3,022,434	$3,945,592
8	2020	$5,000,000	($150,000)	$4,850,000	$2,822,744	$3,828,635	100	$26.30	$2,630.00	$2,076.15	$2,824,820	$3,830,711
				TOTALS	**$12,479,882**	**$16,894,975**			**$13,318**	**$11,107**	**$12,490,989**	**$16,906,081**

2. Converting Nominal Dollars into Real (Constant) Dollars

In providing the recommended monetized values from Section I, this Guide provides numbers from their original source documents whenever possible. This means that the various values provided (and any other additional figures found in the general BCA literature) are monetized in several different years' dollars. However, establishing an "apples-to-apples" comparison of monetized benefits and costs requires a comparison of dollar values for a single base year. Conversion from nominal dollars into real (constant) dollars is a necessary task for Applicants. Two methods for conversion are discussed below.

GDP Price Deflators. In order to convert nominal dollars from one year to another, one can simply multiply by the ratio of annual GDP price deflators, as reported by the US Department of Commerce's Bureau of Economic Analysis.[3]

In order to convert Year Y dollars into Year Z dollars, conduct the following calculation:

(Year Z \$) = (Year Y \$) x [(Year Z GDP Price Deflator)/(Year Y GDP Price Deflator)]

i. **Example:** What is the 2010 real value of \$1,000,000 earned in 2000 using annual GDP price deflators?

(2010 Real Value of \$1,000,000) = (\$1,000,000) x (110.992/88.723)
= \$1,250,994.67

Consumer Price Index (CPI). Another similar method of converting dollars is to multiply by the ratio of annual average Consumer Price Indices (CPIs), as reported by the US Department of Labor's Bureau of Labor Statistics,[4] as in the following calculation:

(Year Z \$) = (Year Y \$) x [(Year Z CPI)/(Year Y CPI)]

ii. **Example:** What is the 2010 real value of \$1,000,000 earned in 2000 using annual average urban CPIs?

(2010 Real Value of \$1,000,000) = (\$1,000,000) x (218.056/172.2)
= \$1,266,295

It is worth noting that the CPI in the above example (and its corresponding hyperlink) is for urban areas only, and that BLS does provide CPI numbers for specific expenditure categories (see http://www.bls.gov/cpi/ for more comprehensive CPI data).

The differences between using the GDP price deflator and CPI are sufficiently small that either methodology is acceptable for the TIGER BCA. For the purposes of transparency, it would be useful for Applicants to note which method they used, if applicable.

[3] U.S. Department of Commerce, Bureau of Economic Analysis, National Income and Product Accounts Table, Table 1.1.9. Implicit Price Deflators for Gross Domestic Product (http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=13&Freq=Qtr&FirstYear=2009&LastYear=2011).

[4] U.S. Department of Labor, Bureau of Labor Statistics, Consumer Price Index – All Urban Consumers (CPI-U), U.S. City Average, All Items (ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt).

3. Converting Available Accident Data into AIS Data

As indicated by the information in Section I, this Guide recommends monetizing the value of injuries according to the maximum Abbreviated Injury Scale (AIS).[5] However, the Department does recognize that accident data that are available to Applicants may not be reported as AIS numbers. Law enforcement data may use the KABCO Scale, which is a measure of the observed severity of the victim's functional injury at the crash scene. In some cases, the Applicant may only have a single reported number of accidents on a particular project site, but have no injury and/or injury severity data for any of those accidents. With accidents reported in KABCO-scale or with unknown injury/severity information, it is necessary for the Applicant to convert the available data into AIS.

Table 3. Comparison of Injury Severity Scales (KABCO vs AIS vs Unknown)

Reported Accidents (KABCO or # Accidents Reported)		Reported Accidents (AIS)	
O	No injury	**0**	No injury
C	Possible Injury	**1**	Minor
B	Non-incapacitating	**2**	Moderate
A	Incapacitating	**3**	Serious
K	Killed	**4**	Severe
U	Injured (Severity Unknown)	**5**	Critical
# Accidents Reported	Unknown if Injured	**6**	Unsurvivable

The National Highway Traffic Safety Administration (NHTSA) provides a conversion matrix (Table 4) that allows KABCO-reported and generic accident data to be re-interpreted as AIS data. The premise of the matrix works in this way: it is understood that an injury observed and reported at the crash site may actually end up being more/less severe than the KABCO scale indicates. Similarly, any accident can – statistically speaking – generate a number of different injuries for the parties involved. Each column of the conversion matrix represents a probability distribution of the different AIS-level injuries that are statistically associated with a corresponding KABCO-scale injury or a generic accident.

[5] The maximum Abbreviated Injury Scale is also sometimes represented by the acronym "MAIS." For the purposes of this Guide, any reference to "MAIS" is equivalent to "AIS".

Table 4. KABCO/Unknown – AIS Data Conversion Matrix

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	O *No injury*	**C** *Possible Injury*	**B** *Non-incapacitating*	**A** *Incapacitating*	**K** *Killed*	**U** *Injured Severity Unknown*	**# Non-fatal Accidents** *Unknown if Injured*
AIS 0	0.92534	0.23437	0.08347	0.03437	0.00000	0.21538	0.43676
1	0.07257	0.68946	0.76843	0.55449	0.00000	0.62728	0.41739
2	0.00198	0.06391	0.10898	0.20908	0.00000	0.10400	0.08872
3	0.00008	0.01071	0.03191	0.14437	0.00000	0.03858	0.04817
4	0.00000	0.00142	0.00620	0.03986	0.00000	0.00442	0.00617
5	0.00003	0.00013	0.00101	0.01783	0.00000	0.01034	0.00279
Fatality	0.00000	0.00000	0.00000	0.00000	1.00000	0.00000	0.00000
Sum(Prob)	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***	***1.00***

Source: National Highway Traffic Safety Administration, July 2011.

For example, if an injury is recorded as "O" on the KABCO scale at the crash site, there is about a 92.5% probability that it is indeed a "No injury" (AIS 0). But there is a 7.26% chance that it is a Minor injury (AIS 1), a 0.198% chance that it may turn out to be a Moderate injury (AIS 2), a small 0.008 chance that it is a Serious injury (AIS 3), and an even smaller 0.003% chance that it is actually a Critical injury (AIS 5). Recalling the Value of Injuries from Table 1, this would mean that one "O" reported injury is valued at about $2,089 (interpreted as a willingness-to-pay to avoid the accident). This value results from multiplying the "O" accident's associated AIS-level probabilities by the recommended unit Value of Injuries, and then summing the products.

Table 5. KABCO– AIS Data Conversion for KABCO "O" Accident

AIS Level	"O" Distribution of AIS Level	Recommended Unit Value	Unit Value of "O" Distribution
AIS 0	0.92534	$ -	$ -
AIS 1	0.07257	$ 18,600	$ 1,349.80
AIS 2	0.00198	$ 291,400	$ 576.97
AIS 3	0.00008	$ 651,000	$ 52.08
AIS 4	0.00000	$ 1,649,200	$ -
AIS 5	0.00003	$ 3,676,600	$ 110.30
AIS 6	0.00000	$ 6,200,000	$ -
		TOTAL	**$ 2,089.15**

Tables 6 and 7 provide sample calculations for the monetization of fatalities and injuries from accidents. By converting KABCO data into AIS and then monetizing according to the recommended values, the Applicant represented in Table 6 may be providing a baseline value of fatalities and injuries caused by 27 accidents reported in the most recent calendar year.[6] The same Applicant may have calculated the values in Table 7 to estimate their benefits of their project, which they anticipate may reduce accident rates (by at least one fatal accident and 5 non-fatal accidents per year).

[6] Accident data may not be presented on an annual basis when it is provided to Applicants (i.e. an available report requested in Fall 2011 may record total accidents from 2005-2010). For the purposes of the BCA, is important to annualize data when possible.

Table 6. Sample Calculation for Monetizing Value of 27 Reported KABCO-scaled Accidents (O=15, C-=5, B=5, A=3, K=2, U=2)

	(1)	(2)		(3)		(4)		(5)		(6)		(7)	
		O *No injury*		C *Possible Injury*		B *Non-incapacitating*		A *Incapacitating*		K *Killed*		U *Injured Severity Unknown*	
	Accident Counts by KABCO Level	**15**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]	**5**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]	**5**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]	**3**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]	**2**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]	**2**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]
AIS	**0**	13.88010	$ -	1.17185	$ -	0.41735	$ -	0.10311	$ -	0.00000	$ -	0.43076	$ -
	1	1.08855	$ 20,247.03	3.44730	$ 64,119.78	3.84215	$ 71,463.99	1.66347	$ 30,940.54	0.00000	$ -	1.25456	$ 23,334.82
	2	0.02970	$ 8,654.58	0.31955	$ 93,116.87	0.54490	$ 158,783.86	0.62724	$ 182,777.74	0.00000	$ -	0.20800	$ 60,611.20
	3	0.00120	$ 781.20	0.05355	$ 34,861.05	0.15955	$ 103,867.05	0.43311	$ 281,954.61	0.00000	$ -	0.07716	$ 50,231.16
	4	0.00000	$ -	0.00710	$ -	0.03100	$ -	0.11958	$ -	0.00000	$ -	0.00884	$ -
	5	0.00045	$ 1,654.47	0.00065	$ 2,389.79	0.00505	$ 18,566.83	0.05349	$ 196,661.33	0.00000	$ -	0.02068	$ 76,032.09
	Fatality	0.00000	$ -	0.00000	$ -	0.00000	$ -	0.00000	$ -	2.00000	$12,400,000.00	0.00000	$ -
	SUBTOTALS	**15.00**	**$ 31,337.28**	**5.00**	**$ 194,487.49**	**5.00**	**$ 352,681.73**	**3.00**	**$ 692,334.22**	**2.00**	**$12,400,000.00**	**2.00**	**$ 210,209.26**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 13,881,049.99**

Table 7. Sample Calculation for Monetizing Accident Reduction (1 Fatal Accident, 5 Non-fatal Accidents)

	(1)	(2)		(3)	
		Fatal Accidents *# Fatalities at Crash Site*		**# Non-fatal Accidents** *Unknown if Injured*	
	Accident Counts	**1**	**$ Value** Fatalities * VSL	**5**	**$ Value** [Pr(AIS_x)*Value(AIS_x)]
AIS	**0**	0.00000	$ -	2.18380	$ -
	1	0.00000	$ -	2.08695	$ 38,817.27
	2	0.00000	$ -	0.44360	$ 129,265.04
	3	0.00000	$ -	0.24085	$ 156,793.35
	4	0.00000	$ -	0.03085	$ 50,877.82
	5	0.00000	$ -	0.01395	$ 51,288.57
	Fatality	1.00000	$ 6,200,000.00	0.00000	$ -
	SUBTOTALS	**1.00**	**$ 6,200,000.00**	**5.00**	**$ 427,042.05**

TOTAL VALUE OF FATALITIES & INJURIES	**$ 6,627,042**

III. *Frequently Asked Questions (FAQs)*

1. **Are all applicants required to submit a benefit-cost analysis with their TIGER application? We are proposing only a small project and have very limited resources to conduct a full benefit-cost analysis.**

   A Benefit-Cost Analysis (BCA) is required of all applicants. The TIGER team is sensitive to the fact that different applicants have different resource constraints, and that complex forecasts and analyses are not always a cost-effective option. However, given the quality of BCAs received in previous rounds of TIGER from applicants of all sizes, we also believe that a transparent, reproducible, thoughtful and reasonable BCA is possible for all projects. The goal of a well-produced BCA is to provide a more objective assessment of a project, and why a project sponsor has prioritized that specific project over other alternatives and proposals. An Applicant's evaluative process of assessing benefits and costs can only help to support an already complete application.

2. **Where can I find information on how to develop my TIGER application's benefit-cost analysis?**

   The final Notice of Funding Availability contains a special appendix (*Appendix A: Additional Information on Benefit-Cost Analysis*) which provides general information and guidance on conducting a benefit-cost analysis for TIGER grant applications.

   In addition to the NOFA Appendix, the Department has previously sponsored several informational sessions with regard to benefit-cost analysis:

   - DOT held an eight-hour workshop to offer technical assistance in developing benefit-cost analyses in 2010. That session can be viewed here: http://mediasite.yorkcast.com/webcast/Viewer/?peid=48d006182cf5438680a75b7c6dfc2c9e
   - An archive of the 2011 90-minute webinar on TIGER benefit-cost analysis can be found here: http://fhwa.adobeconnect.com/p2evpxuzqrm/?launcher=false&fcsContent=true&pbMode=normal
   - The Department also partnered with Smart Growth America to provide assistance for rural communities as they develop benefit-cost analyses. An archive of the 2-hour webinar can be found here: http://www.smartgrowthamerica.org/2011/09/02/tiger-and-rural-america-part-2-webinar-materials-now-online/

3. **Please explain Discounting in the Benefit-Cost Analysis section.**

   The Notice requires discounting future benefits at a real discount rate of 7% following guidance from OMB in Circulars A-4 and A-94 (http://www.whitehouse.gov/omb/circulars/). Applicants should also provide an alternative analysis with a real discount rate of 3%.

The formula for present discounted value is:

$$PV = \frac{FV}{(1+i)^t}$$

Where *PV*= Present discounted value of a future payment from year *t*
FV = Future Value of payment in year *t*
i = Discount rate applied
t = Years in the future for payment (where base year of analysis is *t* = 0)

An example of the present value formula in action (at the 7% and 3% discount rates) is Columns F and G of the *Sample Calculation for Applying Social Cost of Carbon to TIGER Benefit-Cost Analysis* spreadsheet provided under Section II.1 of this guide.

4. Could you clarify how the benefit-cost analysis differs from an economic impact analysis?

A benefit-cost analysis measures the dollar value of the benefits and costs to all the members of society. The benefits, for example, are the dollar value of what all the people in society would be willing to pay to have the project built. If people would be willing to pay more than the project actually costs, then the project has positive net benefits (benefits minus costs).

An economic impact analysis, on the other hand, measures "impacts," which are not the same thing as benefits. Impacts, for example, include the dollar value of all jobs created by a project. While jobs are a good thing, the benefit of a job is not measured by how much we pay the person who has a job, but by the increase in the productivity of that person compared with what the person would have been producing if the project were not funded. Economic impact analysis also generally measures local effects of a project, not overall effects on society as a whole. Some projects create positive effects on one community but negative effects on other communities. The "impacts" simply look at the positive effects, while the benefits consider negative effects as well as positive effects.

5. For TIGER transit project applicants, would it be appropriate to use the cost-effectiveness measure (as calculated under New Starts guidance) instead of calculating travel time savings using the TIGER recommended guidance?

Please note that the value of time (VOT) as referenced in the context of TIGER Grants is an actual value of time – that is, a monetized value assigned to each hour of travel time saved by users of the transportation system. The calculation prescribed by the New Starts process that is commonly referenced as value of travel time savings is actually a Cost-Effectiveness value, a measure of what the value of travel time savings would have to be to equal the level of estimated capital and operating costs. This is essentially more of an adjusted program value – not the actual transportation consumer's dollar valuation of time saved or lost through use of the transportation system, and therefore we would not recommend the use of this number in the proposed project TIGER BCA.

If you have a cost-effectiveness measure, you should still calculate the VOT as recommended in Section I of this document ("Recommended Monetized Values"). You should take the estimated travel time savings (hours of personal and business travel saved, as referenced in Section I, Table 1, "Value of Travel Time") from the proposed transit project and multiply by the national hourly values of travel time for each type of travel. The dollar value of benefits other than travel time savings directly generated by the project (highway congestion reduction, economic development, environmental, other indirect benefits) should be calculated separately. Please be sure to include clear documentation of assumptions and calculations in your BCA for all calculated benefits and costs.

6. Must costs of externalities created during construction be included in the benefit-cost analysis?

Yes, any external costs incurred during construction phases (especially if that construction phase is lengthy) should be included in the BCA. In general, the calculation of costs for a BCA should not merely be the estimated dollars paid to deliver the project – they should include costs over the entire life cycle of the project (operations and maintenance, scheduled rehabilitation, etc.) as well as external costs (noise, travel time delay, etc.). Appendix A from the January 31, 2012, Notice of Funding Availability (NOFA) addresses these topics specifically under the "Other" section (page 4878). Specifically, the section states that "applicants should include, to the extent possible, costs to users during construction, such as delays and increased vehicle operating costs associated with work zones or detours."

7. Our proposed TIGER grant transit project would have multiple impacts in our community beyond travel-time savings – specifically on property values, low-income wages, and automobile operating costs. Do you have any specific sources of information regarding these benefits and how our agency may calculate them?

The impacts of transit investment vary depending on geographic location and are largely dependent on the travel demand data generated for the proposed project. The TIGER Team assumes that the sponsoring agency and their technical team have developed the most appropriate model for estimating realistic travel demand changes resulting from the proposed project (and its alternatives) and will use the outcomes of that usership model to estimate the direct and indirect benefits and costs for the analysis. It is important to provide a clear explanation of the underlying assumptions, values, and calculations as part of the transparent documentation of the BCA.

Specifically addressing the topics above:

- **Property Values:** Change in property value is one of the benefits generally attributed to transit investment. The topic – along with other benefits and costs considered in transit investments – is discussed well within TCRP Report 78: *Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners* (2002).[7] Please note that the issue of double-counting is an important consideration when calculating economic development benefits for any proposed project. The TIGER NOFA Appendix discusses economic development benefits on page 4878. It is important, when estimating expected property value increases in one metropolitan area based on actual increases in another area, to make sure that the transit improvements in the two areas are comparable. For example, you should not estimate property value increases for a light rail system in one city based on experience with a heavy rail system in another city.

[7] Transportation Research Board – National Research Council, TCRP Report 78 – *Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practioners* (TCRP Report 78), 2002 (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp78/guidebook/tcrp78.pdf).

- **Low-income wages and job creation:** A BCA focus on low-income wage earners is relevant when a transportation project can potentially increase the wages of an affected population. In general, wages from project-induced job creation are considered transfer payments and should not be included in a typical benefit-cost analysis. However, the January 31, 2012, TIGER NOFA Appendix (Page 4878) makes the important distinction of increased wages as a reflection of higher labor productivity benefits and leaves its calculation to the discretion of the Applicant. Applicants need to demonstrate rigorously how such productivity benefits are estimated and the exact period of time over which the productivity benefits occur. Simply asserting these gains is inadequate. To this end, Applicants should make sure that productivity benefits from higher-paying jobs are not double-counted with other benefits and are *net* societal estimates (i.e., the productivity benefits are newly generated and not simply transferred from another jurisdiction).

- **Auto operating cost savings:** Any savings from private automobile operating costs would presumably be generated from reduced auto traffic estimated by the travel demand model. The TIGER NOFA's BCA Appendix does not provide a specific value of auto operating cost, but such estimates (on a per mile basis) do exist. The AAA publishes annual data on per-mile driving cost that incorporates costs for fuel, maintenance, tires, insurance, fees (license and registration) and taxes, depreciation, and financing.[8]

8. Our agency is proposing to construct the Applicant Project either with TIGER grant funding or toll revenues. Would the toll-funded option be considered an "alternative" in the benefit-cost analysis?

Within the context of the TIGER grants, "alternatives" are generally intended to mean projects that significantly differ from the proposed project in technology, alignment/location, design and/or construction schedule. Alternative projects would generate different levels of benefits and costs in the various societal benefit/cost categories such as travel time savings, emissions, safety, life cycle costs, externalities, etc. Financing a project with a TIGER grant versus toll financing is not really an alternative project, though the difference in financing could affect the travel demand on the project and hence affect the benefits. We would consider alternative financing approaches to be a variation within the same basic project.

A benefit-cost analysis is expected to minimally compare the benefits and costs of the proposed project against the most realistic base case (what would be the most likely scenario if the project were not built) and any viable alternatives under consideration. The BCA should demonstrate why the proposed project is better than all other alternatives.

9. For reference, is there an accepted ratio for short-term and long-term job creation as a function of the project costs? This would help establish a starting point for more detailed assessment.

After discussions with the White House Council of Economic Advisers, the USDOT estimates that there are 13,000 short-term job-years created per one billion dollars of government investment (or $76,900 per job-year). Previous guidance had stated that every $92,000 of investment is equivalent to one job-

[8] AAA Exchange, "Your Driving Costs", (http://www.aaaexchange.com/Main/Default.asp?CategoryID=16&SubCategoryID=76&ContentID=353). The 2011 edition of the *Your Driving Costs* guide is available at http://www.aaaexchange.com/Assets/Files/201145734460.DrivingCosts2011.pdf.

year. These estimates include direct on-site jobs, indirect jobs in supplier industries, and jobs that are induced in consumer goods and services industries as workers with direct and indirect jobs spend their increased incomes. These or any other well-documented and reasonable estimates of short-term job creation would be acceptable values to use. Since all projects create about the same number of short-term jobs per million dollars spent, the most important information about short-term job creation is how quickly these jobs are created, so applicants should provide quarter-by-quarter estimates of the timing of short-term job creation, showing how many jobs they expect to create in each quarter. Long-term job creation will vary greatly depending on the nature of the project, so there are no accepted ratios for long-term job creation. Applicants should attempt to measure the level of long-term economic activity induced by the project, and the level of labor-intensity associated with that economic activity. Analysis of such long-term economic activity and job creation should be estimated on a year-by-year basis. Applicants can share their estimated numbers of jobs produced in the qualitative portions of the application.

While we are interested in the short-term economic impact of job creation caused by a TIGER project, these impacts should not be included in the benefit-cost analysis. The benefit-cost analysis should include only the short- and long-term increases in labor productivity associated with the jobs created by the project. The Notice of Funding Availability reminds applicants that job creation is primarily just a transfer payment – the benefits gained by the employee are costs to the employer, and therefore net benefits are zero. New jobs only yield net benefits if the jobs created actually increase the overall productivity of workers. Applicants should fully understand these distinctions before including job creation effects as part of net benefits.

10. Are there specific worksheets, forms, or formats that are required for the BCA?

There is no "specific worksheet" or format that is required for submittal, but the NOFA Appendix does ask that Applicants "make every effort to make the results of their analyses as *transparent* and *reproducible* as possible". This means that spreadsheets should be accompanied by a narrative describing all of the basic assumptions, methods, and data underlying the analysis – in addition to any narrative text from the BCA and Application themselves. Appendix A also provides a sample of a potential layout of how this information can be presented.

11. We have a project where buses, pedestrians, and bikers cannot go through a tunnel, with no reasonable alternative. Are there standard methods for monetizing these benefits?

When beginning any BCA, it is necessary to think about at least two different scenarios: one in which the proposed project is built and a second scenario in which is described the most realistic scenario if the project is not built (a base case, or "no-build" alternative). If there were an alternative route that buses, pedestrians, and bicycles could take to avoid the tunnel, then the benefits of the project would be the value of the delays avoided by not having to take that alternative route. If there is no alternative route, then it becomes impossible for bus riders, pedestrians, and bicyclists to travel to destinations served by the tunnel, and the benefits are the value to riders of being able to access those destinations. Measuring the dollar value of these accessibility benefits is difficult – they are analytically equal to the toll that bus riders, pedestrians, and bicyclists would be willing to pay to use the tunnel. It may be possible to gather such information through survey data. The bus fare that passengers would be willing to pay to access these points is one indicator of the value that passengers place on being able to travel on these routes.

12. Regarding ports and harbors, is it fair to include benefits to the US economy that would be diverted from other nations, say, Canada and Mexico?

Yes. The benefits to be counted are benefits to U.S. residents. Hence, benefits resulting from diversion of port activity to the U.S. can be considered without deducting any costs associated with loss of port activity in Canada or Mexico. Remember, however, that the dollar value of port activity is not a benefit – it is a payment for a service provided, and hence is a transfer payment, not a net benefit. Benefits would include only the cost savings or increases in productivity associated with the port activity created.

13. If a project has already been funded for preliminary design and land purchase from a different funding source, yet is seeking construction funds through this program, would the land purchase and preliminary design be included in the benefit-cost analysis?

Yes. The entire cost of the proposed project (including land purchase, preliminary design, and any other relevant components not funded by TIGER, as well as any indirect costs) must be included in the BCA.

14. Would you explain more about what might be included in agglomeration benefits and what methodologies might be used to estimate them?

Methodologies for determining agglomeration benefits are not yet well-established. It is generally agreed that agglomeration benefits can be significant, but it is also agreed that the significance of these benefits falls as the distance between the points joined by a transportation project increases. Agglomeration benefits are therefore generally more significant within the context of a metropolitan area than they are in an intercity context. In general, the methodology for estimating agglomeration benefits involves examining wage rates and output and productivity levels in locations that are well-connected to other populations, and comparing these measures of income and output to locations that are not well-connected to other populations. This can allow estimation of coefficients that measure the impact of connectedness to incomes and output. A summary of recent literature on agglomeration benefits can be found in Daniel J. Graham, "Agglomeration, Productivity, and Transport Investment," *Journal of Transport Economics and Policy*, v. 41, Part 3 (September 2007), pp. 317-343.