

CRASHES VS. CONGESTION

What's the Cost to Society?



CAMBRIDGE SYSTEMATICS

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Crashes vs. Congestion – What's the Cost to Society?

prepared for

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Executive Summary

When American motorists talk about transportation problems, they generally key in on traffic. Snarled highways, epic commutes, and gridlocked business and commercial districts mar our suburban existence, weighing heavily upon our elected leaders, our policymakers, and our families. Yet a more costly problem needs to be addressed on America's roads: motor vehicle crashes. In 2009, traffic crashes killed 33,808 people in the United States – about 93 deaths per day, and nearly four every hour. These figures have been on the decline, in part, due to legislative changes (e.g., state highway safety improvement programs) and advances in the science of safety (e.g., vehicle crash avoidance systems) that have ushered in new approaches for states, regions, and localities to address safety issues and challenges. However, motor vehicle crashes remain the leading cause of death among ages 5-34 in the United States and, in terms of years of life lost, rank third, behind only cancer and heart disease. Most Americans would be surprised to learn the societal costs associated with motor vehicle crashes significantly exceed the costs of congestion.

AAA released a report in 2008 examining the costs of crashes to society. The study, along with recommendations for improvements, was designed to raise awareness among policymakers, departments of transportation, and the public about the magnitude of the safety problem and the importance of transportation investments for reducing the number and severity of crashes. AAA embarked on an update to this study in 2011 to revisit results based on the most recent available data.

■ Methodology

The AAA study compares the costs of crashes to the costs of congestion on a per person level in the same urban areas used by the Texas Transportation Institute (TTI) in the annual *Urban Mobility Report 2010*. The costs of crashes are based on the Federal Highway Administration's (FHWA) comprehensive costs for traffic fatalities and injuries (excluding property damage only crashes), which place a dollar value on 11 components.

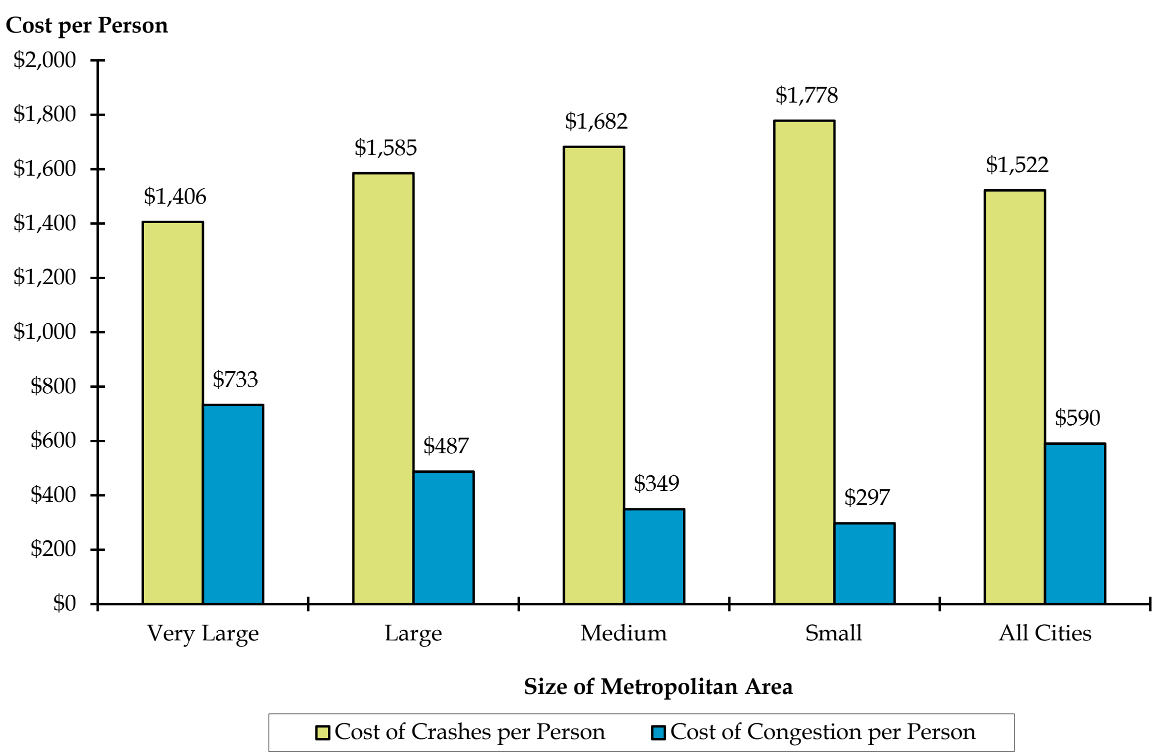
The 11 comprehensive cost components include property damage; lost earnings; lost household production (non-market activities occurring in the home); medical costs; emergency services; travel delay; vocational rehabilitation; workplace costs; administrative costs; legal costs; and pain and lost quality of life. According to FHWA, in 2009 dollars, the cost of a single motor vehicle fatality is $6,000,000. For the purpose of this study, the 2009 cost of an injury is estimated at $126,000. This is based on the most recent estimate provided by FHWA in 2002 and adjusted to maintain the same fatality to injury cost ratio using FHWA's 2009 cost of a fatality estimate. Congestion costs, as reported in the *Urban Mobility Report*, are based on delay estimates combined with value of time and fuel costs.

■ Crash Costs Summary Results

Multiplying the total numbers of reported fatalities and injuries by the estimated costs of a fatality and an injury, the total crash costs in the urbanized areas included in this study in 2009 is $299.5 billion. That figure is over three times the cost of congestion for the same year ($97.7 billion) reported in the Texas Transportation Institute's (TTI) annual *Urban Mobility Report*.

Figure ES.1 compares per person cost of crashes and congestion, in 2009 dollars, for the different metropolitan area sizes studied and an average across cities. The yellow bar graph shows the per person costs of fatal and injury crashes for very large metropolitan areas (population over three million); large urban areas (population of one million but less than three million); medium areas (over 500,000 and less than one million); and small areas (less than 500,000); along with the average for all cities in the study. The blue bar shows the per person costs of congestion as reported by TTI in the annual *Urban Mobility Report.*

Figure ES.1 Annual Cost of Crashes and Congestion per Person
2009



Normalizing the data for a more direct comparison in the urban areas studies, the cost of crashes on a per person basis decreases as the size of the metropolitan area increases, while an increase in the size of the metropolitan area relates to an increase in congestion. However, in every city studied, the crash costs still exceed the congestion costs on a per person basis.

■ Key Findings

- In the urbanized areas in this study, the total cost of traffic crashes is over three times the cost of congestion – $299.5 billion for traffic crashes and $97.7 billion for congestion.
- In every city studied, the crash costs on a per person basis exceed the congestion costs. Overall, crash costs per person is more than two and one-half times the cost of congestion. For very large urban areas, crash costs are nearly double those of congestion. In large urban areas, crash costs are over three times more than congestion; for medium areas, crash costs are over four and one-half times more than congestion; and for small urban areas, crashes are nearly six times more costly than congestion.
- The cost of crashes on a per person basis decreases as the size of the metropolitan area increases. An inverse relationship occurs with the cost of congestion, which increases bases on the size of the metropolitan area.

■ Report Recommendations

While progress has been made to change the culture of traffic safety in the United States, continued improvement is possible and imperative. Such progress will continue to take all the "tools" in the traffic safety toolbox, plus some new thinking about approaches. Complacency regarding safety continues to be a significant challenge. No single action or strategy will bring about a cultural change. Rather, new approaches are needed to enhance public support for increased funding and to help transportation planners focus on areas with the greatest potential for improving safety.

Leadership

- **Make safety a national priority**. Leadership and commitment are needed to make transportation safety a national priority and an integral part of transportation planning. Changing the culture of complacency as it relates to lives lost on the nation's roads should be a guiding principle for all transportation-related discussions going forward. Focusing planning and resources on safety improvements will not only save lives and prevent injuries, but can also reduce congestion.

- **Increase investment in proven safety countermeasures.** By focusing investment on proven countermeasures, we can demonstrate measurable results and show a meaningful return on these investments.

- **Pass good laws and enforce them.** Greater political will is needed to pass legislation and enforce laws having a positive impact on safety, such as primary safety belt requirements, impaired driving countermeasures, and full implementation of graduated driver licensing systems.

- **Ensure implementation and evaluation of state highway safety plans.** Congress and the U.S. Department of Transportation should ensure states follow through on implementation of their strategic highway safety plans and evaluate the results to determine effectiveness. Greater accountability is needed to ensure that states are meeting the goals of their highway safety improvement plans and implementing those strategies that have greatest opportunity for saving lives.

- **Make zero fatalities a national goal.** Achieving zero fatalities should be the national safety goal. AAA recommends convening a White House Conference of Traffic Safety to develop a national strategic plan to put the nation on a course to reach this goal.

Communication and Collaboration

- **Break down silos.** Increased communication and support between federal agencies responsible for transportation safety related issues is critical. Governmental agencies should leverage resources and foster collaboration in order to eliminate duplication and help identify and promote public health programmatic and policy interventions shown to prevent injury and save lives.

- **Communicate the consequences more effectively.** The transportation safety community needs to develop more effective ways of getting the public to understand the impact of traffic crashes, the need for effective countermeasures, and the role their own behavior plays in safety.

- **Increase collaboration between disciplines.** Increased collaboration among traffic safety professionals, public health specialists, and health communications experts is needed to incorporate the best available science on behavior modification.

Research and Evaluation

- **Increase funding for testing and evaluation of safety interventions.** Programs should be based on sound scientific principles rather than "conventional wisdom," populist fervor, or political expediency. Systematic evaluation allows identification and expansion of successful programs and interventions so limited resources can be applied more effectively.

- **Emphasize performance-based planning.** Further testing and implementation of road risk assessment tools (e.g., U.S. Road Assessment Program (usRAP), FHWA's

Systemic Safety Project Selection Tool, SafetyAnalyst, and Vision Zero Suite) should be encouraged to ensure dollars are spent on roads and bridges with the greatest safety problems. Understanding road safety risks will help state DOTs focus on solutions with the greatest safety benefits and should result in broader public support for needed improvements.

- **Increase funding for data collection systems.** Data should meet model minimum uniform standards and should be provided by each state. National data are needed on serious injuries sustained in traffic crashes in order to improve traffic safety research and to foster evidence based decision-making. To achieve this goal states need funding to link crash, emergency department, and trauma registry databases.

Introduction

The American public and elected officials increasingly are concerned about the costs and consequences of congestion. However, each year, over 5.5 million police reported motor vehicle crashes result in more than 30,000 fatalities and two million injuries in the United States alone. These figures have been on the decline, in part, due to legislative changes (e.g., state highway safety improvement programs) and advances in the science of safety (e.g., vehicle crash avoidance systems) that have ushered in new approaches for states, regions, and localities to address safety issues and challenges. This study commissioned by AAA suggests the costs and consequences of these fatalities and injuries greatly exceed the costs of congestion.

The 2008 *Crashes vs. Congestion* study examined the relationship between congestion and crashes to determine the relative *economic* impact. The study, along with recommendations for improvement, was designed to provide elected officials, federal, state, and local agencies with road safety responsibilities, and the public with information on the comparative magnitude and possible interactive effects of the safety and congestion.

This 2011 update to the study, similar to the original report, compares the costs of crashes with the costs of congestion on a per person level in the same 99 urban areas used by the Texas Transportation Institute (TTI) in its annual *Urban Mobility Report 2010* as shown in Table 1.[1] The costs of crashes are based on the Federal Highway Administration's (FHWA) comprehensive costs for traffic fatalities and injuries that assigns a dollar value to 11 components, including property damage; lost earnings; lost household production (non-market activities occurring in the home); medical costs; emergency services; travel delay; vocational rehabilitation; workplace costs; administrative costs; legal costs; and pain and lost quality of life. Based on FHWA estimates, in 2009 dollars, the average cost of a fatality is $6,000,000 and the average cost of an injury is $126,000.

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[1] The TTI report lists 101 urbanized areas. In this study, the costs of congestion for Lancaster-Palmdale, California and Indio-Cathedral City-Palm Springs, California have been added to the Los Angeles-Long Beach-Santa Ana, California and Riverside-San Bernardino, California Metropolitan Statistical Areas (MSA) respectively. The crash statistics for Los Angeles-Long Beach-Santa Ana, California and Riverside-San Bernardino, California MSAs already include the data for Lancaster-Palmdale, California and Indio-Cathedral City-Palm Springs, California. Hence, no double counting is included.

Table 1. Metropolitan Areas Analyzed

Akron, *Ohio*	Eugene-Springfield, *Oregon*	Phoenix-Mesa-Scottsdale, *Arizona*
Albany-Schenectady-Troy, *New York*	Fresno, *California*	Pittsburgh, *Pennsylvania*
Albuquerque, *New Mexico*	Grand Rapids-Wyoming, *Michigan*	Portland-Vancouver-Beaverton, *Oregon-Washington*
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*	Greensboro-High Point, *North Carolina*	Poughkeepsie-Newburgh-Middletown, *New York*
Anchorage, *Alaska*	Hartford-West Hartford-East Hartford, *Connecticut*	Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*
Atlanta-Sandy Springs-Marietta, *Georgia*	Honolulu, *Hawaii*	Provo-Orem, *Utah*
Austin-Round Rock, *Texas*	Houston-Baytown-Sugar Land, *Texas*	Raleigh-Cary, Durham, *North Carolina*
Bakersfield, *California*	Indianapolis, *Indiana*	Richmond, *Virginia*
Baltimore-Towson, *Maryland*	Jackson, *Mississippi*	Riverside-San Bernardino-Ontario, *California*
Baton Rouge, *Louisiana*	Jacksonville, *Florida*	Rochester, *New York*
Beaumont-Port Arthur, *Texas*	Kansas City, *Missouri-Kansas*	Sacramento-Arden-Arcade-Roseville, *California*
Birmingham-Hoover, *Alabama*	Knoxville, *Tennessee*	Salem, *Oregon*
Boise City-Nampa, *Idaho*	Laredo, *Texas*	Salt Lake City, *Utah*
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*	Las Vegas-Paradise, *Nevada*	San Antonio, *Texas*
Boulder, *Colorado*	Little Rock-North Little Rock, *Arkansas*	San Diego-Carlsbad-San Marcos, *California*
Bridgeport-Stamford-Norwalk, *Connecticut*	Los Angeles-Long Beach-Santa Ana, *California*	San Francisco-Oakland-Fremont, *California*
Brownsville-Harlingen, *Texas*	Louisville, *Kentucky-Indiana*	San Jose-Sunnyvale-Santa Clara, *California*
Buffalo-Niagara, *New York*	Madison, *Wisconsin*	San Juan-Caguas-Guaynabo, *Puerto Rico*
Cape Coral-Fort Myers, *Florida*	McAllen-Edinburg-Mission, *Texas*	Sarasota-Bradenton-Venice, *Florida*
Charleston-North Charleston, *South Carolina*	Memphis, *Tennessee-Mississippi-Arkansas*	Seattle-Tacoma-Bellevue, *Washington*
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*	Miami-Fort Lauderdale-Miami Beach, *Florida*	Spokane, *Washington*
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*	Milwaukee-Waukesha-West Allis, *Wisconsin*	Springfield, *Massachusetts*
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*	Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*	St. Louis, *Missouri-Illinois*
Cleveland-Elyria-Mentor, *Ohio*	Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*	Stockton, *California*
Colorado Springs, *Colorado*	New Haven-Milford, *Connecticut*	Tampa-St. Petersburg-Clearwater, *Florida*
Columbia, *South Carolina*	New Orleans-Metairie-Kenner, *Louisiana*	Toledo, *Ohio*
Columbus, *Ohio*	New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	Tucson, *Arizona*
Corpus Christi, *Texas*	Oklahoma City, *Oklahoma*	Tulsa, *Oklahoma*
Dallas-Fort Worth-Arlington, *Texas*	Omaha-Council Bluffs, *Nebraska-Iowa*	Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*
Dayton, *Ohio*	Orlando, *Florida*	Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*
Denver-Aurora-Broomfield, *Colorado*	Oxnard-Thousand Oaks-Ventura, *California*	Wichita, *Kansas*
Detroit-Warren-Livonia, *Michigan*	Pensacola-Ferry Pass-Brent, *Florida*	Winston-Salem, *North Carolina*
El Paso, *Texas*	Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*	Worcester, *Massachusetts*

To ensure the accuracy of the study, results were not provided for Boston-Cambridge-Quincy, Massachusetts-New Hampshire urbanized area due to insufficient crash data.

The cost of crashes exceeds the cost of congestion in each of the TTI urban areas compared. Results from the study show large cities incur the largest total crash costs because the number of fatalities and injuries is larger than in smaller cities. However, if the total cost of crashes is calculated on a per person basis (necessary for a comparison with the costs of congestion), smaller cities have greater per person costs.

As with the total cost of crashes, the total cost of congestion increases as city size increases. However, on a per person basis, an inverse relationship occurs: while crash costs per person increase according to the declining size of the city, the cost of congestion per person declines along with declining city size. This indicates the relative cost of crashes is greater than the cost of congestion in smaller cities.

A complex relationship exists between congestion and crashes. Although the evidence is mixed, less congested roadways appear to lead to fewer, but more severe, crashes. This relationship is especially strong in the case of crash severity; that is, more severe crashes occur on less congested roadways due in large part to faster speeds. On more congested roadways, the number of crashes may increase, but they may be primarily minor crashes reflecting the increased weaving and access/egress movements often occurring on congested road segments. Crashes may also lead to severe, unexpected congestion in an otherwise congestion-free roadway, reducing the level of service.

This report includes sections discussing: the methodology for data collection and the technical approach used to determine crash costs; final tabulated crash costs as compared to congestion costs; key findings; and recommendations. Appendix A provides detailed results on crash and congestion costs by urbanized area included in this study. Appendix B provides a review of the conventional wisdom on the relationship between crashes and congestion.

Methodology

The 2011 update to the *Crashes vs. Congestion* study uses a data analysis methodology similar to that used in the original report. The process involved four key steps:

- Collecting fatality and injury data;
- Assembling data with respect to metropolitan area boundaries;
- Monetizing fatalities and injuries to determine total costs; and
- Comparing crash costs to congestion costs.

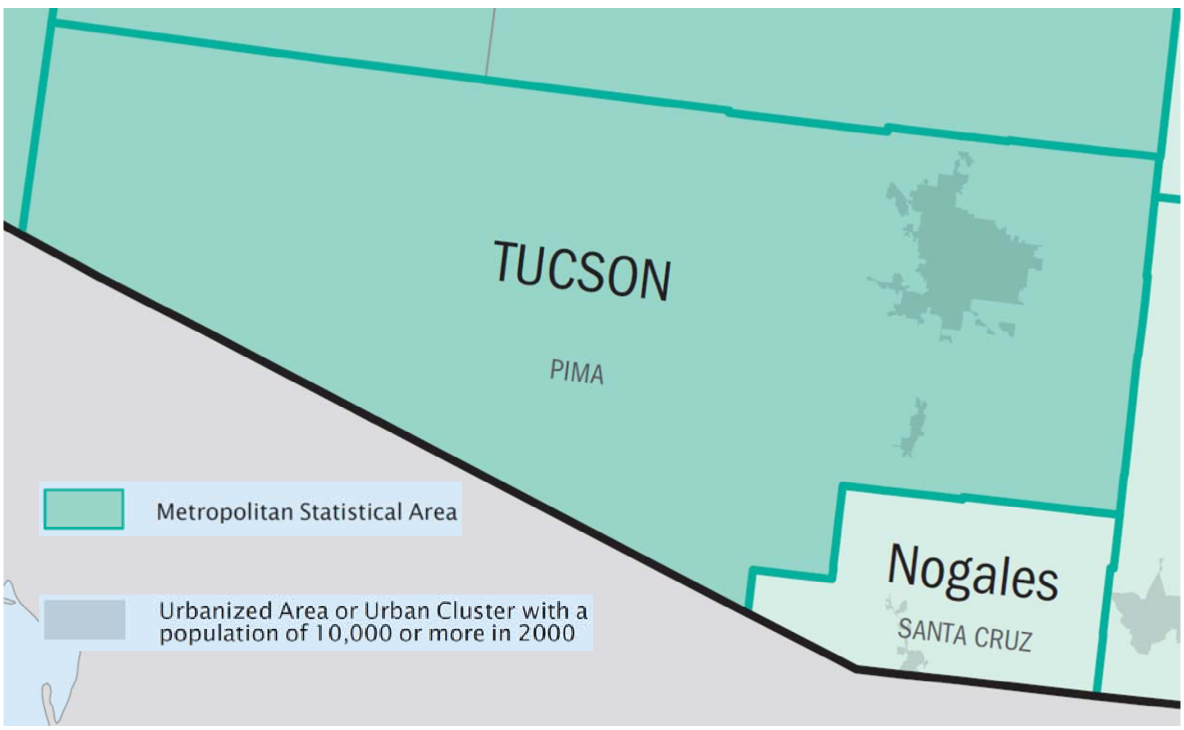
The key components in determining estimates for crash costs for this study were the numbers of fatalities and injuries. Fatality and injury statistics are primarily summarized at the county level; therefore, it was determined analyses would be conducted at the metropolitan statistical area (MSA) level as MSAs are defined based on county boundaries. As a result, it was necessary to assemble crash data for all constituent counties in an MSA. Steps were taken to contact all appropriate state agencies to obtain fatality and injury data. The inclusion of Property Damage Only (PDO) crashes was considered; however, data for such crashes is inconsistent. PDO crashes are reported only if they meet a certain damage threshold level, which differs from state to state. Because of the thresholds, about half of all PDO crashes are unreported. Thus, PDO crashes were excluded from this study.

The definition of an MSA differs from the definition of an urbanized area used in the Urban Mobility Report (UMR). The UMR provides information on congestion based on data collected from the Highway Performance Monitoring System (HPMS). Since the UMR is focused on roadways within urban areas, a filter is used to isolate specific roadways in the HPMS database for the analysis. Filtering uses the urban or nonurban variable coded for each roadway in the HPMS dataset. The classification of urban or non-urban is based on "urbanized area" definitions provided by the Bureau of the Census. Such definitions are provided for hundreds of urban agglomerations across the country, many more than those covered in the UMR. Urbanized areas are density-based, and include census blocks in the urban core with a population density exceeding 1,000 persons per square mile, and census blocks in the surrounding areas with a population density exceeding 500 persons per square mile.

Crash data is coded with sufficient location information to identify the urban or rural location of the crash; however, to obtain and process database information from all the states and to juxtapose this information with urbanized area definitions would have been extremely costly and difficult to process. As a result, the study used the MSA definitions provided by the Bureau of the Census as an appropriate method of determining the size of a metropolitan area. Unlike the urbanized area definitions, which are based on density, MSAs are based on county boundaries. A county is grouped with an MSA if it has a high degree of social and economic integration with the urban core of the MSA.

Using MSA definitions is beneficial because crash data are summarized at the county level by all states. The drawback of using MSA definitions is a direct geographical comparison of crash statistics with the congestion statistics based on the urbanized area definitions used by TTI cannot be made. Figure 1 provides a comparison of urbanized area and MSA definitions for Tucson, Arizona. The grey shape at the northeastern corner of Pima County is the urbanized area definition used by TTI. The MSA of Tucson is Pima County, which is colored green in the figure. As the figure clearly shows, the MSA covers additional area that would not be classified as urban; therefore, the safety statistics covered within the MSA would overestimate the cost of crashes in a direct comparison with the TTI statistics. It should be noted, however, more vehicular travel in an MSA is located in urbanized areas than in rural areas.

Figure 1. Urbanized Area versus Metropolitan Statistical Area in Tucson



Source: U.S. Bureau of the Census, 2009.

Because MSAs differ in size due to the sprawl and population of a metropolitan area and the size of counties, a normalization procedure of dividing the cost of crashes on a per person basis was conducted.

After compiling data for each MSA, a cost was applied to monetize fatalities and injuries. The *Treatment of the Economic Value of a Statistical Life in Departmental Analyses* memoranda by the United States Department of Transportation (U.S. DOT) in 2008 and 2009 were used as a basis to determine the Value of Statistical Life (VSL) from motor vehicle traffic crashes. The memoranda indicate:

> *"… potential damage associated with accidents includes both the personal disutility of death or injury and a variety of purely economic losses (to both the victims and others), including property damage, traffic delay, lost productivity, and the costs of police, investigation, medical, legal, and insurance services. In general, the benefit of preventing economic losses to society, apart from victims and their families, should also be accounted for in analyses."*

By definition, the VSL is the estimated monetary benefit of a reduction by one in the expected number of fatalities. The estimated values have changed over time with statistical techniques, model specifications, and sources of data continuing to evolve. The U.S. DOT's 2009 memoranda estimated $6 million for the average cost of a fatality, however, the economic value for statistical injury is still under review at the time of this study. Therefore, this 2011 *Crashes versus Congestion* update estimates $126,000 for the average cost of an injury in 2009, which reflects the same fatality to injury cost ratio from the last time FHWA provided estimates of both in the same year ($3 million and $63,000, respectively, in 2002).

The number of fatalities and injuries in 2009 for each MSA was then multiplied by these 2009 VSL and injury costs to determine the total cost of crashes. The cost of crashes was tabulated for all cities and compared with congestion costs reported in the UMR. As with the UMR, data also were summarized according to metropolitan area population size: very large metropolitan areas (population over three million); large urban areas (population of one million but less than three million); medium areas (over 500,000 and less than one million); and small areas (less than 500,000).

Table 2 shows the metropolitan area groupings by population size.

Table 2. Metropolitan Area Groupings by Population Size

Very Large (Over three million)
Atlanta-Sandy Springs-Marietta, *Georgia*
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*
Dallas-Fort Worth-Arlington, *Texas*
Detroit-Warren-Livonia, *Michigan*
Houston-Baytown-Sugar Land, *Texas*
Los Angeles-Long Beach-Santa Ana, *California*
Miami-Fort Lauderdale-Miami Beach, *Florida*
New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*
Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*

Table 2. Metropolitan Area Groupings by Population Size (continued)

Very Large (Over three million) (continued)
Phoenix-Mesa-Scottsdale, *Arizona*
San Diego-Carlsbad-San Marcos, *California*
San Francisco-Oakland-Fremont, *California*
Seattle-Tacoma-Bellevue, *Washington*
Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*
Large (One million to less than three million)
Austin-Round Rock, *Texas*
Baltimore-Towson, *Maryland*
Buffalo-Niagara, *New York*
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*
Cleveland-Elyria-Mentor, *Ohio*
Columbus, *Ohio*
Denver-Aurora-Broomfield, *Colorado*
Indianapolis, *Indiana*
Jacksonville, *Florida*
Kansas City, *Missouri-Kansas*
Las Vegas-Paradise, *Nevada*
Louisville, *Kentucky-Indiana*
Memphis, *Tennessee-Mississippi-Arkansas*
Milwaukee-Waukesha-West Allis, *Wisconsin*
Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*
Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*
New Orleans-Metairie-Kenner, *Louisiana*
Orlando, *Florida*
Pittsburgh, *Pennsylvania*
Portland-Vancouver-Beaverton, *Oregon-Washington*
Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*
Raleigh-Cary, Durham, *North Carolina*
Riverside-San Bernardino-Ontario, *California*
Sacramento-Arden-Arcade-Roseville, *California*
San Antonio, *Texas*
San Jose-Sunnyvale-Santa Clara, *California*
San Juan-Caguas-Guaynabo, *Puerto Rico*
St. Louis, *Missouri-Illinois*
Tampa-St. Petersburg-Clearwater, *Florida*
Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*

Table 2. Metropolitan Area Groupings by Population Size (continued)

Medium (500,000 to less than one million)
Akron, *Ohio*
Albany-Schenectady-Troy, *New York*
Albuquerque, *New Mexico*
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*
Bakersfield, *California*
Baton Rouge, *Louisiana*
Birmingham-Hoover, *Alabama*
Bridgeport-Stamford-Norwalk, *Connecticut*
Charleston-North Charleston, *South Carolina*
Colorado Springs, *Colorado*
Dayton, *Ohio*
El Paso, *Texas*
Fresno, *California*
Grand Rapids-Wyoming, *Michigan*
Hartford-West Hartford-East Hartford, *Connecticut*
Honolulu, *Hawaii*
McAllen-Edinburg-Mission, *Texas*
New Haven-Milford, *Connecticut*
Oklahoma City, *Oklahoma*
Omaha-Council Bluffs, *Nebraska-Iowa*
Oxnard-Thousand Oaks-Ventura, *California*
Poughkeepsie-Newburgh-Middletown, *New York*
Richmond, *Virginia*
Rochester, *New York*
Salt Lake City, *Utah*
Sarasota-Bradenton-Venice, *Florida*
Springfield, *Massachusetts*
Toledo, *Ohio*
Tucson, *Arizona*
Tulsa, *Oklahoma*
Wichita, *Kansas*
Small (Under 500,000)
Anchorage, *Alaska*
Beaumont-Port Arthur, *Texas*
Boise City-Nampa, *Idaho*
Boulder, *Colorado*
Brownsville-Harlingen, *Texas*

Table 2. Metropolitan Area Groupings by Population Size (continued)

Small (Under 500,000) (continued)
Cape Coral-Fort Myers, *Florida*
Columbia, *South Carolina*
Corpus Christi, *Texas*
Eugene-Springfield, *Oregon*
Greensboro-High Point, *North Carolina*
Jackson, *Mississippi*
Knoxville, *Tennessee*
Laredo, *Texas*
Little Rock-North Little Rock, *Arkansas*
Madison, *Wisconsin*
Pensacola-Ferry Pass-Brent, *Florida*
Provo-Orem, *Utah*
Salem, *Oregon*
Spokane, *Washington*
Stockton, *California*
Winston-Salem, *North Carolina*
Worcester, *Massachusetts*

Costs of Crashes and Congestion

Note: Complete results can be found in Appendix A.

Total Cost of Crashes

In the 99 urbanized areas studied, the total cost of crashes, involving 16,032 fatalities and 1,613,236 injuries, stands at $299.5 billion. The value of each statistical life was estimated at $6,000,000 and the cost of an injury was evaluated at $126,000. Table 3 shows the range of total crash costs by metropolitan area population category. Data were summarized according to metropolitan area population size: very large metropolitan areas (population over three million); large urban areas (population of one million but less than three million); medium areas (over 500,000 and less than one million); and small areas (less than 500,000). The key finding here is the larger the city, the larger the total cost of crashes.

Table 3. Ranges in the Total Cost of Crashes by Population Category

	Very Large	Cost (Millions)	Large	Cost (Millions)	Medium	Cost (Millions)	Small	Cost (Millions)
High Cost City	New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	$29,516	Tampa-St. Petersburg-Clearwater, *Florida*	$6,654	Baton Rouge, *Louisiana*	$2,948	Little Rock-North Little Rock, *Arkansas*	$1,722
Low Cost City	San Diego-Carlsbad-San Marcos, *California*	$3,030	San Jose-Sunnyvale-Santa Clara, *California*	$1,393	Colorado Springs, *Colorado*	$387	Boulder, *Colorado*	$203

Source: Cambridge Systematics, Inc., 2011.

Cost of Crashes per Person

When total crash costs are examined on a per person basis, figures for smaller cities are greater than those in larger cities. Table 4 shows crash costs on a per person basis for the highest-cost and lowest-cost city, as well as the average, in each metropolitan area category.

Table 4. Ranges in the Cost of Crashes on a per Person Basis by Population Category

	Very Large	Cost	Large	Cost	Medium	Cost	Small	Cost
High Cost City	Miami-Fort Lauderdale-Miami Beach, *Florida*	$2,016	Raleigh-Cary, *North Carolina*	$2,694	Baton Rouge, *Louisiana*	$3,747	Beaumont-Port Arthur, *Texas*	$2,787
Low Cost City	San Francisco-Oakland-Fremont, *California*	$796	Denver-Aurora-Broomfield, *Colorado*	$614	Colorado Springs, *Colorado*	$618	Boulder, *Colorado*	$670
Average		$1,406		$1,585		$1,682		$1,778

Source: Cambridge Systematics, Inc., 2011.

Cost of Crashes and Cost of Congestion

The cost of congestion (excluding Boston-Cambridge-Quincy metropolitan area), as reported by the TTI in its *Urban Mobility Report 2010*, was estimated at $97.7 billion. The cost of crashes ($299.5 billion) is more than three times the cost of congestion in the same urban areas.

For an even-scale analysis, the average per person cost of crashes is compared to the average per person cost of congestion. Figure 2 shows the relationship between the two per person costs. In Figure 2, the yellow bars show the cost per person of fatal and injury crashes and the blue bars show the cost per person of congestion. As shown, the cost of crashes on a per person basis decreases as the size of the metropolitan area increases, while an increase in the size of the metropolitan area relates to a increase in congestion. However, in every city studied, the crash costs on a per person basis exceed the congestion costs.

Figure 2. Annual Cost of Crashes and Congestion per Person
2009

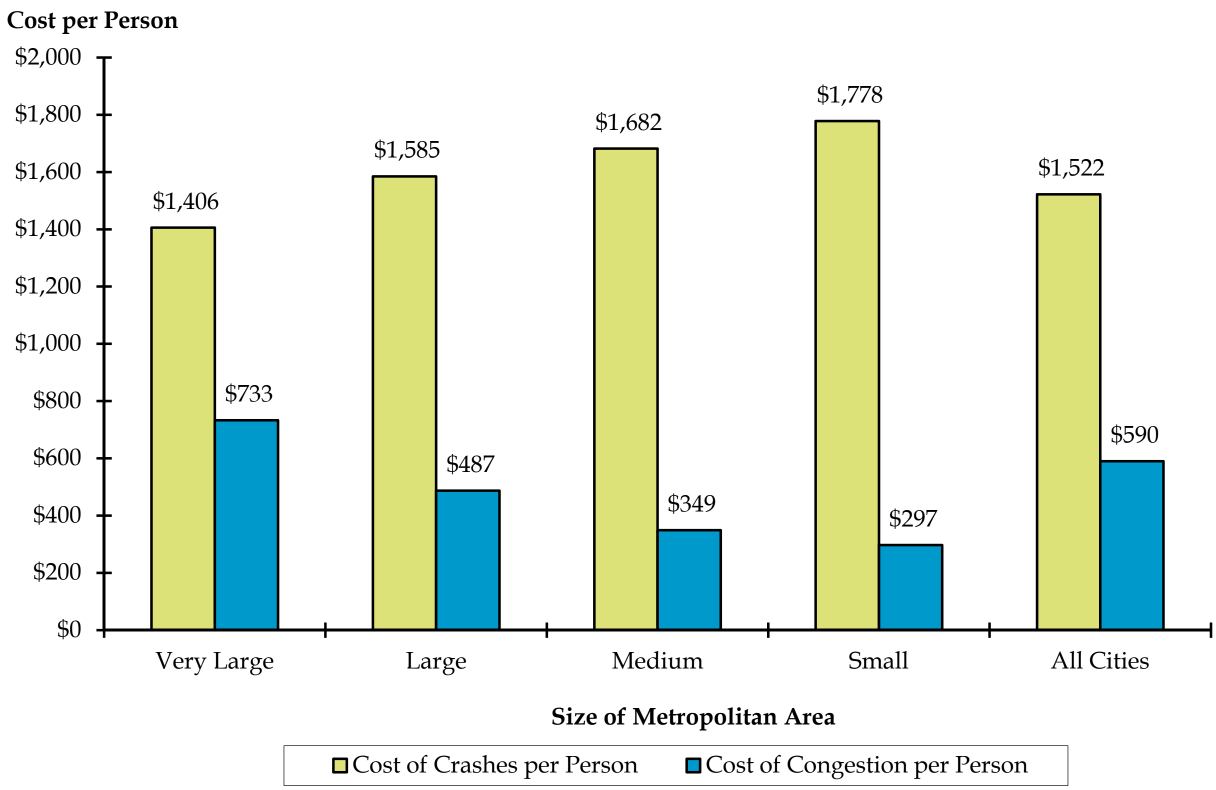


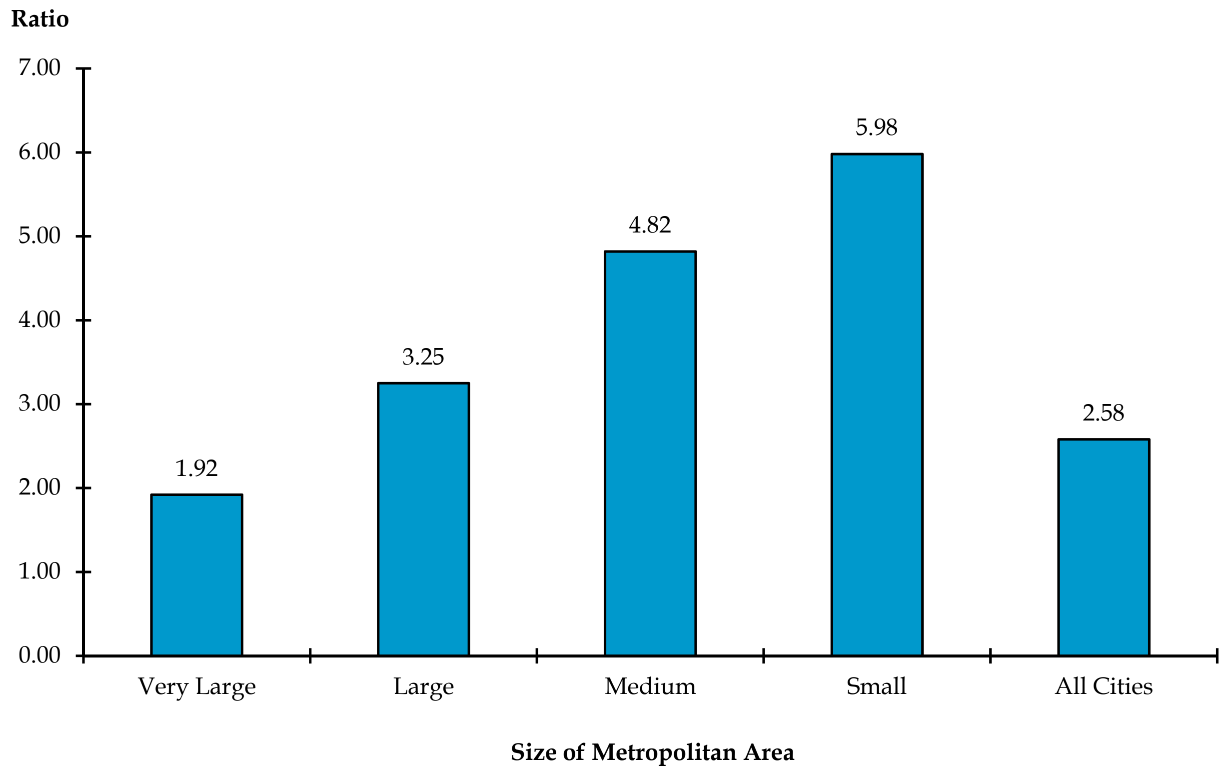
Table 5 and Figure 3 show the ratio between the per person cost of crashes and the per person cost of congestion. For very large urban areas, crash costs are nearly double those of congestion. In other words, for every dollar spent on congestion in very large urban areas, $1.92 is spent on crashes. In large urban areas, crash costs are nearly three times more than congestion; for medium areas, crash costs are over four and one-half times more than congestion; and for small urban areas, crashes are six times more costly than congestion.

Table 5. Crash Cost versus Congestion Cost per Person Ratios

	Very Large	Ratio	Large	Ratio	Medium	Ratio	Small	Cost
High Cost City	Miami-Fort Lauderdale-Miami Beach, *Florida*	3.30	Columbus, *Ohio*	6.69	McAllen-Edinburg-Mission, *Texas*	18.55	Corpus Christi, *Texas*	11.92
Low Cost City	Chicago-Naperville-Joliet, *Illinois*	1.06	Denver-Aurora-Broomfield, *Colorado*	0.81	Colorado Springs, *Colorado*	1.26	Worcester, *Massachusetts*	2.99
Average		1.92		3.25		4.82		5.98

Source: Cambridge Systematics, Inc., 2011.

Figure 3. Ratio of Cost of Crashes per Person to Cost of Congestion per Person
2009



Comparison between 2008 and 2011 Studies

Even though the number of fatalities and injuries continue to decrease, the overall cost of crashes has increased dramatically reflecting the significant rise in costs of the components associated with these types of crashes. Figure 4 shows the cost of crashes and cost of congestion for the years 2005 and 2009. The overall cost of crashes for the areas studied increased 1.82 times from $164.2 billion in 2005 to $299.5 billion in 2009. In the same duration, the total cost of congestion escalated 1.71 times from $57.0 billion in 2005 to $97.7 billion in 2009. While all costs have increased between the two studies, the ratios indicate a similar order of magnitude of the absolute cost of crashes over the absolute cost of congestion (2.88 in 2005 and 3.07 in 2009).

Figure 4. Cost of Crashes and Cost of Congestion (in Billions)
2005 versus 2009

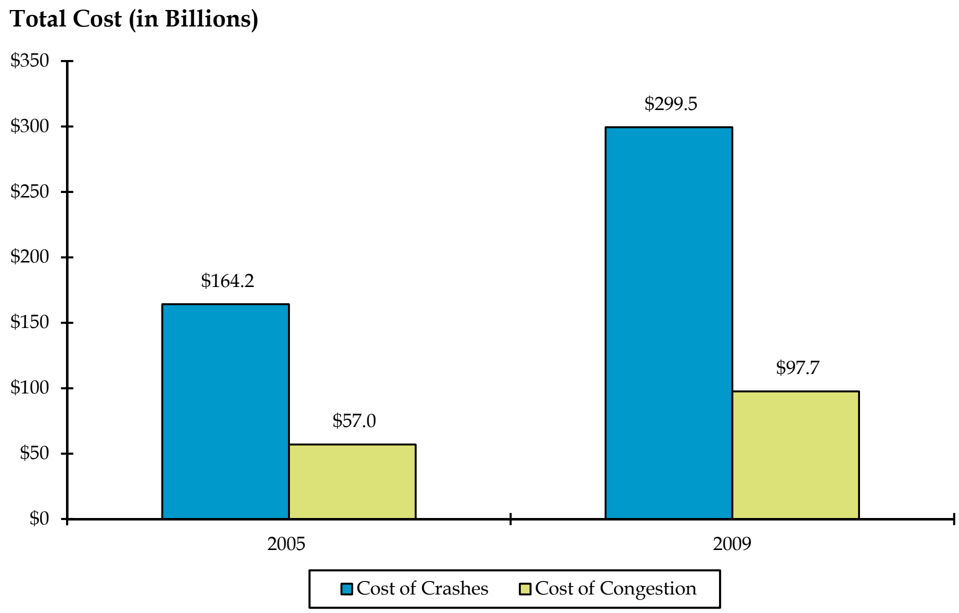
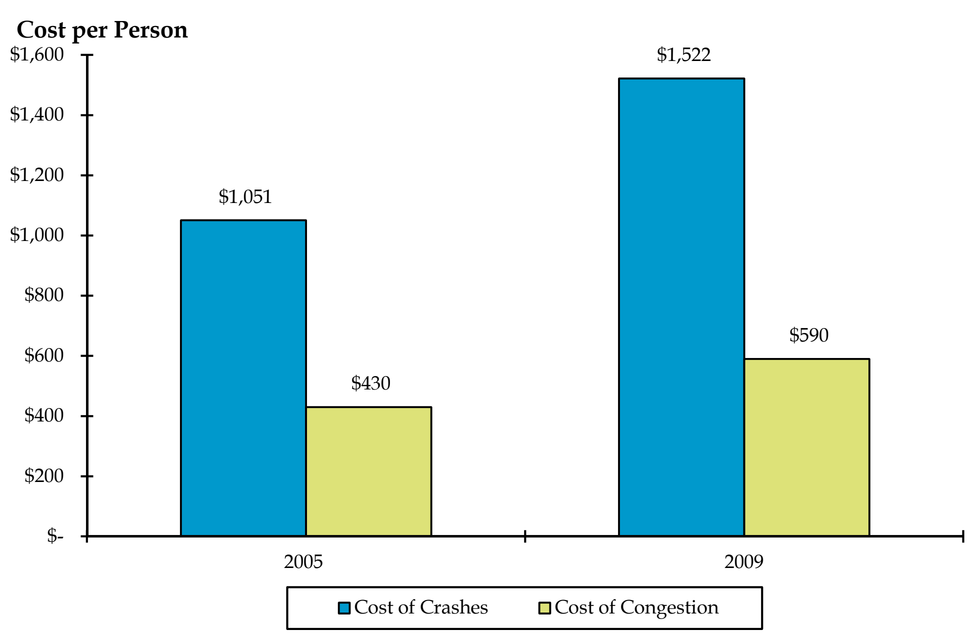


Figure 5 compares the cost of crashes (per person) to cost of congestion (per person) for 2005 and 2009. The per person ratio of crashes to congestion increased from 2.44 in 2005 to 2.58 in 2009.

Figure 5. Cost of Crashes per Person and Cost of Congestion per Person
2005 versus 2009



Key Findings

Several results from this study offer significant insight regarding the cost of crashes versus the cost of congestion:

- In the urbanized areas in this study, the total cost of traffic crashes is over three times the cost of congestion – $299.5 billion for traffic crashes and $97.7 billion for congestion.

- In every city studied, the crash costs on a per person basis exceed the congestion costs. Overall, crash costs per person is more than two and one-half times the cost of congestion. For very large urban areas, crash costs are nearly double those of congestion. In large urban areas, crash costs are over three times more than congestion; for medium areas, crash costs are over four and one-half times more than congestion; and for small urban areas, crashes are nearly six times more costly than congestion.

- The cost of crashes on a per person basis decreases as the size of the metropolitan area increases. An inverse relationship occurs with the cost of congestion, which increases based on the size of the metropolitan area.

Report Recommendations

While progress has been made to change the culture of traffic safety in the United States, continued improvement is possible and imperative. Such progress will continue to take all the "tools" in the traffic safety toolbox, plus some new thinking about approaches. Complacency regarding safety continues to be a significant challenge. No single action or strategy will bring about a cultural change. Rather, new approaches are needed to enhance public support for increased funding and to help transportation planners focus on areas with the greatest potential for improving safety.

Leadership

- **Make safety a national priority**. Leadership and commitment are needed to make transportation safety a national priority and an integral part of transportation planning. Changing the culture of complacency as it relates to lives lost on the nation's roads should be a guiding principle for all transportation-related discussions going forward. Focusing planning and resources on safety improvements will not only save lives and prevent injuries, but can also reduce congestion.

- **Increase investment in proven safety countermeasures.** By focusing investment on proven countermeasures, we can demonstrate measurable results and show a meaningful return on these investments.

- **Pass good laws and enforce them.** Greater political will is needed to pass legislation and enforce laws having a positive impact on safety, such as primary safety belt requirements, impaired driving countermeasures, and full implementation of graduated driver licensing systems.

- **Ensure implementation and evaluation of state highway safety plans.** Congress and the U.S. Department of Transportation should ensure states follow through on implementation of their strategic highway safety plans and evaluate the results to determine effectiveness. Greater accountability is needed to ensure that states are meeting the goals of their highway safety improvement plans and implementing those strategies that have greatest opportunity for saving lives.

- **Make zero fatalities a national goal.** Achieving zero fatalities should be the national safety goal. AAA recommends convening a White House Conference of Traffic Safety to develop a national strategic plan to put the nation on a course to reach this goal.

Communication and Collaboration

- **Break down silos.** Increased communication and support between federal agencies responsible for transportation safety related issues is critical. Governmental agencies should leverage resources and foster collaboration in order to eliminate duplication and help identify and promote public health programmatic and policy interventions shown to prevent injuries and save lives.

- **Communicate the consequences more effectively.** The transportation safety community needs to develop more effective ways of getting the public to understand the impact of traffic crashes, the need for effective countermeasures, and the role their own behavior plays in safety.

- **Increase collaboration between disciplines.** Increased collaboration among traffic safety professionals, public health specialists, and health communications experts is needed to incorporate the best available science on behavior modification.

Research and Evaluation

- **Increase funding for testing and evaluation of safety interventions.** Programs should be based on sound scientific principles rather than "conventional wisdom," populist fervor, or political expediency. Systematic evaluation allows identification and expansion of successful programs and interventions so limited resources can be applied more effectively.

- **Emphasize performance-based planning.** Further testing and implementation of road risk assessment tools (e.g., U.S. Road Assessment Program (usRAP), FHWA's Systemic Safety Project Selection Tool, SafetyAnalyst, and Vision Zero Suite) should be encouraged to ensure dollars are spent on roads and bridges with the greatest safety problems. Understanding road safety risks will help state DOTs focus on solutions with the greatest safety benefits and should result in broader public support for needed improvements.

- **Increase funding for data collection systems.** Data should meet model minimum uniform standards and should be provided by each state. National data are needed on serious injuries sustained in traffic crashes in order to improve traffic safety research and to foster evidence based decision-making. To achieve this goal states need funding to link crash, emergency department, and trauma registry databases.

Appendix A – Complete Statistics

Table A.1 Fatalities and Injuries by City in Alphabetical Order

Metropolitan Area	Metro Area Size	Number of Fatalities	Number of Injuries	Cost of Fatalities (Millions)	Cost of Injuries (Millions)	Total Cost of Crashes (Millions)
Akron, *Ohio*	Med	44	6,309	$264	$ 795	$1,059
Albany-Schenectady-Troy, *New York*	Med	48	7,746	$288	$ 976	$1,264
Albuquerque, *New Mexico*	Med	98	9,205	$588	$1,160	$1,748
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*	Med	79	6,573	$474	$ 828	$1,302
Anchorage, *Alaska*	Sml	35	3,939	$210	$ 496	$706
Atlanta-Sandy Springs-Marietta, *Georgia*	Vlg	498	62,263	$2,988	$7,845	$10,833
Austin-Round Rock, *Texas*	Lrg	167	14,966	$1,002	$1,886	$2,888
Bakersfield, *California*	Med	157	3,061	$942	$ 386	$1,328
Baltimore-Towson, *Maryland*	Lrg	245	23,082	$1,470	$2,908	$4,378
Baton Rouge, *Louisiana*	Med	156	15,971	$936	$2,012	$2,948
Beaumont-Port Arthur, *Texas*	Sml	70	5,037	$420	$ 635	$1,055
Birmingham-Hoover, *Alabama*	Med	163	7,489	$978	$ 944	$1,922
Boise City-Nampa, *Idaho*	Sml	51	2,994	$306	$ 377	$683
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*	Vlg					
Boulder, *Colorado*	Sml	19	709	$114	$89	$203
Bridgeport-Stamford-Norwalk, *Connecticut*	Med	42	9,501	$252	$1,197	$1,449
Brownsville-Harlingen, *Texas*	Sml	34	3,601	$204	$ 454	$658
Buffalo-Niagara, *New York*	Lrg	80	11,522	$480	$1,452	$1,932
Cape Coral-Fort Myers, *Florida*	Sml	80	4,574	$480	$ 576	$1,056
Charleston-North Charleston, *South Carolina*	Med	112	7,357	$672	$ 927	$1,599
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*	Lrg	158	20,005	$948	$2,521	$3,469
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*	Vlg	512	65,376	$3,072	$8,237	$11,309
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*	Lrg	162	18,794	$972	$2,368	$3,340
Cleveland-Elyria-Mentor, *Ohio*	Lrg	120	18,268	$720	$2,302	$3,022
Colorado Springs, *Colorado*	Med	44	978	$264	$ 123	$387
Columbia, *South Carolina*	Sml	116	7,904	$696	$ 996	$1,692
Columbus, *Ohio*	Lrg	156	17,187	$936	$2,166	$3,102
Corpus Christi, *Texas*	Sml	49	5,135	$294	$ 647	$941
Dallas-Fort Worth-Arlington, *Texas*	Vlg	479	55,124	$2,874	$6,946	$9,820
Dayton, *Ohio*	Med	73	7,456	$438	$ 939	$1,377
Denver-Aurora-Broomfield, *Colorado*	Lrg	144	5,577	$864	$ 703	$1,567
Detroit-Warren-Livonia, *Michigan*	Vlg	303	30,873	$1,818	$3,890	$5,708
El Paso, *Texas*	Med	70	6,868	$420	$ 865	$1,285
Eugene-Springfield, *Oregon*	Sml	40	2,185	$240	$ 275	$515
Fresno, *California*	Med	121	3,179	$726	$ 401	$1,127
Grand Rapids-Wyoming, *Michigan*	Med	83	5,480	$498	$ 690	$1,188
Greensboro-High Point, *North Carolina*	Sml	81	9,437	$486	$1,189	$1,675

Key:

Cities with insufficient crash data.

Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Table A.1 Fatalities and Injuries by City in Alphabetical Order (continued)

Metropolitan Area	Metro Area Size	Number of Fatalities	Number of Injuries	Cost of Fatalities (Millions)	Cost of Injuries (Millions)	Total Cost of Crashes (Millions)
Hartford-West Hartford-East Hartford, *Connecticut*	Med	67	12,564	$402	$1,583	$1,985
Honolulu, *Hawaii*	Med	53	3,670	$318	$ 462	$780
Houston-Baytown-Sugar Land, *Texas*	Vlg	587	53,898	$3,522	$6,791	$10,313
Indianapolis, *Indiana*	Lrg	137	8,649	$822	$1,090	$1,912
Jackson, *Mississippi*	Sml	103	4,922	$618	$ 620	$1,238
Jacksonville, *Florida*	Lrg	184	14,418	$1,104	$1,817	$2,921
Kansas City, *Missouri-Kansas*	Lrg	190	15,555	$1,140	$1,960	$3,100
Knoxville, *Tennessee*	Sml	95	6,801	$570	$ 857	$1,427
Laredo, *Texas*	Sml	21	2,334	$126	$ 294	$420
Las Vegas-Paradise, *Nevada*	Lrg	144	22,595	$864	$2,847	$3,711
Little Rock-North Little Rock, *Arkansas*	Sml	110	8,425	$660	$1,062	$1,722
Los Angeles-Long Beach-Santa Ana, *California*	Vlg	742	64,190	$4,452	$8,088	$12,540
Louisville, *Kentucky-Indiana*	Lrg	137	10,776	$822	$1,358	$2,180
Madison, *Wisconsin*	Sml	48	4,034	$288	$ 508	$796
McAllen-Edinburg-Mission, *Texas*	Med	71	7,829	$426	$ 986	$1,412
Memphis, *Tennessee-Mississippi-Arkansas*	Lrg	213	13,874	$1,278	$1,748	$3,026
Miami-Fort Lauderdale-Miami Beach, *Florida*	Vlg	599	60,230	$3,594	$7,589	$11,183
Milwaukee-Waukesha-West Allis, *Wisconsin*	Lrg	91	12,467	$546	$1,571	$2,117
Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*	Lrg	176	19,374	$1,056	$2,441	$3,497
Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*	Lrg	204	16,856	$1,224	$2,124	$3,348
New Haven-Milford, *Connecticut*	Med	58	9,826	$348	$1,238	$1,586
New Orleans-Metairie-Kenner, *Louisiana*	Lrg	138	17,060	$828	$2,150	$2,978
New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	Vlg	917	190,584	$5,502	$24,014	$29,516
Oklahoma City, *Oklahoma*	Med	148	12,823	$888	$1,616	$2,504
Omaha-Council Bluffs, *Nebraska-Iowa*	Med	65	8,016	$390	$1,010	$1,400
Orlando, *Florida*	Lrg	257	21,737	$1,542	$2,739	$4,281
Oxnard-Thousand Oaks-Ventura, *California*	Med	62	3,421	$372	$ 431	$803
Pensacola-Ferry Pass-Brent, *Florida*	Sml	65	5,797	$390	$ 730	$1,120
Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*	Vlg	441	48,219	$2,646	$6,076	$8,722
Phoenix-Mesa-Scottsdale, *Arizona*	Vlg	382	33,924	$2,292	$4,274	$6,566
Pittsburgh, *Pennsylvania*	Lrg	216	14,176	$1,296	$1,786	$3,082
Portland-Vancouver-Beaverton, *Oregon-Washington*	Lrg	120	15,996	$720	$2,015	$2,735
Poughkeepsie-Newburgh-Middletown, *New York*	Med	61	7,226	$366	$ 910	$1,276
Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*	Lrg	120	14,514	$720	$1,829	$2,549
Provo-Orem, *Utah*	Sml	29	4,088	$174	$ 515	$689
Raleigh-Cary, Durham, *North Carolina*	Lrg	168	16,073	$1,008	$2,025	$3,033
Richmond, *Virginia*	Med	150	10,991	$900	$1,385	$2,285
Riverside-San Bernardino-Ontario, *California*	Lrg	464	14,315	$2,784	$1,804	$4,588
Rochester, *New York*	Med	60	9,084	$360	$1,145	$1,505
Sacramento-Arden-Arcade-Roseville, *California*	Lrg	169	10,369	$1,014	$1,306	$2,320
Salem, *Oregon*	Sml	35	3,125	$210	$ 394	$604

Key:
- (blue) Cities with insufficient crash data.
- (green) Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Table A.1 Fatalities and Injuries by City in Alphabetical Order (continued)

Metropolitan Area	Metro Area Size	Number of Fatalities	Number of Injuries	Cost of Fatalities (Millions)	Cost of Injuries (Millions)	Total Cost of Crashes (Millions)
Salt Lake City, *Utah*	Med	67	10,082	$402	$1,270	$1,672
San Antonio, *Texas*	Lrg	233	23,318	$1,398	$2,938	$4,336
San Diego-Carlsbad-San Marcos, *California*	Vlg	232	12,998	$1,392	$1,638	$3,030
San Francisco-Oakland-Fremont, *California*	Vlg	224	16,625	$1,344	$2,095	$3,439
San Jose-Sunnyvale-Santa Clara, *California*	Lrg	92	6,675	$552	$ 841	$1,393
San Juan-Caguas-Guaynabo, *Puerto Rico*	Lrg	229	24,315	$1,374	$3,064	$4,438
Sarasota-Bradenton-Venice, *Florida*	Med	77	6,119	$462	$ 771	$1,233
Seattle-Tacoma-Bellevue, *Washington*	Vlg	169	26,379	$1,014	$3,324	$4,338
Spokane, *Washington*	Sml	44	3,429	$264	$ 432	$696
Springfield, *Massachusetts*	Med	41	2,930	$246	$ 369	$615
St. Louis, *Missouri-Illinois*	Lrg	278	24,432	$1,668	$3,078	$4,746
Stockton, *California*	Sml	63	3,333	$378	$ 420	$798
Tampa-St. Petersburg-Clearwater, *Florida*	Lrg	353	36,000	$2,118	$4,536	$6,654
Toledo, *Ohio*	Med	59	7,211	$354	$ 909	$1,263
Tucson, *Arizona*	Med	92	7,926	$552	$ 999	$1,551
Tulsa, *Oklahoma*	Med	163	9,989	$978	$1,259	$2,237
Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*	Lrg	124	14,095	$744	$1,776	$2,520
Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*	Vlg	350	42,566	$2,100	$5,363	$7,463
Wichita, *Kansas*	Med	67	5,313	$402	$ 669	$1,071
Winston-Salem, *North Carolina*	Sml	47	5,122	$282	$ 645	$927
Worcester, *Massachusetts*	Sml	42	3,829	$252	$ 482	$734

Source: Cambridge Systematics, Inc., 2011.

Key:
Cities with insufficient crash data.
Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Tables A.2 through A.5 show the total cost of crashes and cost per person sorted in order of declining total crash costs.

Table A.2 Total Cost of Crashes and Cost per Person
Very Large Metropolitan Areas

Metropolitan Area	MSA Population	Total Cost of Crashes (Millions)	Total Cost of Crashes Per Person
New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	19,069,796	$29,516	$1,548
Los Angeles-Long Beach-Santa Ana, *California*	12,874,797	$12,540	$974
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*	9,580,567	$11,309	$1,180
Miami-Fort Lauderdale-Miami Beach, *Florida*	5,547,051	$11,183	$2,016
Atlanta-Sandy Springs-Marietta, *Georgia*	5,475,213	$10,833	$1,979
Houston-Baytown-Sugar Land, *Texas*	5,867,489	$10,313	$1,758
Dallas-Fort Worth-Arlington, *Texas*	6,447,615	$9,820	$1,523
Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*	5,968,252	$8,722	$1,461
Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*	5,476,241	$7,463	$1,363
Phoenix-Mesa-Scottsdale, *Arizona*	4,364,094	$6,566	$1,505
Detroit-Warren-Livonia, *Michigan*	4,403,437	$5,708	$1,296
Seattle-Tacoma-Bellevue, *Washington*	3,407,848	$4,338	$1,273
San Francisco-Oakland-Fremont, *California*	4,317,853	$3,439	$796
San Diego-Carlsbad-San Marcos, *California*	3,053,793	$3,030	$992
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*	4,588,680		

Source: Cambridge Systematics, Inc., 2011.

Key:

Cities with insufficient crash data.

Table A.3 Total Cost of Crashes and Cost per Person
Large Metropolitan Areas

Metropolitan Area	MSA Population	Total Cost of Crashes (Millions)	Total Cost of Crashes Per Person
Tampa-St. Petersburg-Clearwater, *Florida*	2,747,272	$6,654	$2,422
St. Louis, *Missouri-Illinois*	2,828,990	$4,746	$1,678
Riverside-San Bernardino-Ontario, *California*	4,143,113	$4,588	$1,107
San Juan-Caguas-Guaynabo, *Puerto Rico*	2,617,089	$4,438	$1,696
Baltimore-Towson, *Maryland*	2,690,886	$4,378	$1,627
San Antonio, *Texas*	2,072,128	$4,336	$2,093
Orlando, *Florida*	2,082,421	$4,281	$2,056
Las Vegas-Paradise, *Nevada*	1,902,834	$3,711	$1,950
Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*	3,269,814	$3,497	$1,070
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*	1,745,524	$3,469	$1,987
Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*	1,582,264	$3,348	$2,116
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*	2,171,896	$3,340	$1,538
Columbus, *Ohio*	1,801,848	$3,102	$1,721
Kansas City, *Missouri-Kansas*	2,067,585	$3,100	$1,499
Pittsburgh, *Pennsylvania*	2,354,957	$3,082	$1,309
Raleigh-Cary, Durham, *North Carolina*	1,125,827	$3,033	$2,694
Memphis, *Tennessee-Mississippi-Arkansas*	1,304,926	$3,026	$2,319
Cleveland-Elyria-Mentor, *Ohio*	2,091,286	$3,022	$1,445
New Orleans-Metairie-Kenner, *Louisiana*	1,189,981	$2,978	$2,502
Jacksonville, *Florida*	1,328,144	$2,921	$2,199
Austin-Round Rock, *Texas*	1,705,075	$2,888	$1,694
Portland-Vancouver-Beaverton, *Oregon-Washington*	2,241,841	$2,735	$1,220
Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*	1,600,642	$2,549	$1,592
Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*	1,674,498	$2,520	$1,505
Sacramento-Arden-Arcade-Roseville, *California*	2,127,355	$2,320	$1,091
Louisville, *Kentucky-Indiana*	1,258,577	$2,180	$1,732
Milwaukee-Waukesha-West Allis, *Wisconsin*	1,559,667	$2,117	$1,357
Buffalo-Niagara, *New York*	1,123,804	$1,932	$1,719
Indianapolis, *Indiana*	1,743,658	$1,912	$1,096
Denver-Aurora-Broomfield, *Colorado*	2,552,195	$1,567	$614
San Jose-Sunnyvale-Santa Clara, *California*	1,839,700	$1,393	$757

Source: Cambridge Systematics, Inc., 2011.

Table A.4 Total Cost of Crashes and Cost per Person
Medium Metropolitan Areas

Metropolitan Area	MSA Population	Total Cost of Crashes (Millions)	Total Cost of Crashes Per Person
Baton Rouge, *Louisiana*	786,947	$2,948	$3,747
Oklahoma City, *Oklahoma*	1,227,278	$2,504	$2,040
Richmond, *Virginia*	1,238,187	$2,285	$1,845
Tulsa, *Oklahoma*	929,015	$2,237	$2,408
Hartford-West Hartford-East Hartford, *Connecticut*	1,195,998	$1,985	$1,660
Birmingham-Hoover, *Alabama*	1,131,070	$1,922	$1,699
Albuquerque, *New Mexico*	857,903	$1,748	$2,037
Salt Lake City, *Utah*	1,130,293	$1,672	$1,480
Charleston-North Charleston, *South Carolina*	659,191	$1,599	$2,426
New Haven-Milford, *Connecticut*	848,006	$1,586	$1,870
Tucson, *Arizona*	1,020,200	$1,551	$1,520
Rochester, *New York*	1,035,566	$1,505	$1,453
Bridgeport-Stamford-Norwalk, *Connecticut*	901,208	$1,449	$1,608
McAllen-Edinburg-Mission, *Texas*	741,152	$1,412	$1,906
Omaha-Council Bluffs, *Nebraska-Iowa*	849,517	$1,400	$1,648
Dayton, *Ohio*	835,063	$1,377	$1,650
Bakersfield, *California*	807,407	$1,328	$1,644
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*	816,012	$1,302	$1,596
El Paso, *Texas*	751,296	$1,285	$1,711
Poughkeepsie-Newburgh-Middletown, *New York*	677,094	$1,276	$1,885
Albany-Schenectady-Troy, *New York*	857,592	$1,264	$1,474
Toledo, *Ohio*	672,220	$1,263	$1,878
Sarasota-Bradenton-Venice, *Florida*	845,078	$1,233	$1,459
Grand Rapids-Wyoming, *Michigan*	778,009	$1,188	$1,528
Fresno, *California*	915,267	$1,127	$1,231
Wichita, *Kansas*	612,683	$1,071	$1,749
Akron, *Ohio*	699,935	$1,059	$1,513
Oxnard-Thousand Oaks-Ventura, *California*	802,983	$803	$1,000
Honolulu, *Hawaii*	907,574	$780	$860
Springfield, *Massachusetts*	698,903	$615	$880
Colorado Springs, *Colorado*	626,227	$387	$618

Source: Cambridge Systematics, Inc., 2011.

Key:

Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Table A.5 Total Cost of Crashes and Cost per Person
Small Metropolitan Areas

Metropolitan Area	MSA Population	Total Cost of Crashes (Millions)	Total Cost of Crashes Per Person
Little Rock-North Little Rock, *Arkansas*	685,488	$1,722	$2,511
Columbia, *South Carolina*	744,730	$1,692	$2,272
Greensboro-High Point, *North Carolina*	714,765	$1,675	$2,344
Knoxville, *Tennessee*	699,247	$1,427	$2,041
Jackson, *Mississippi*	540,866	$1,238	$2,289
Pensacola-Ferry Pass-Brent, *Florida*	455,102	$1,120	$2,462
Cape Coral-Fort Myers, *Florida*	586,908	$1,056	$1,800
Beaumont-Port Arthur, *Texas*	378,477	$1,055	$2,787
Corpus Christi, *Texas*	416,095	$941	$2,262
Winston-Salem, *North Carolina*	484,921	$927	$1,912
Stockton, *California*	674,860	$798	$1,182
Madison, *Wisconsin*	570,025	$796	$1,397
Worcester, *Massachusetts*	803,701	$734	$914
Anchorage, *Alaska*	374,553	$706	$1,886
Spokane, *Washington*	468,684	$696	$1,485
Provo-Orem, *Utah*	555,551	$689	$1,240
Boise City-Nampa, *Idaho*	606,376	$683	$1,127
Brownsville-Harlingen, *Texas*	396,371	$658	$1,659
Salem, *Oregon*	396,103	$604	$1,524
Eugene-Springfield, *Oregon*	351,109	$515	$1,468
Laredo, *Texas*	241,438	$420	$1,740
Boulder, *Colorado*	303,482	$203	$670

Source: Cambridge Systematics, Inc., 2011.

Tables A.6 through A.9 show the total cost of congestion and cost per person sorted in order of declining total congestion costs.

Table A.6 Total Cost of Congestion and Cost per Person
Very Large Metropolitan Areas

Metropolitan Area	Urbanized Area Population (Thousands)	Cost of Congestion (Millions)	Cost of Congestion Per Person
Los Angeles-Long Beach-Santa Ana, *California*	13,633	$12,158	$892
New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	18,768	$10,878	$580
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*	8,519	$9,476	$1,112
Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*	4,454	$4,066	$913
Dallas-Fort Worth-Arlington, *Texas*	5,013	$3,649	$728
Houston-Baytown-Sugar Land, *Texas*	3,921	$3,403	$868
Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*	5,337	$3,274	$613
Miami-Fort Lauderdale-Miami Beach, *Florida*	5,350	$3,272	$612
San Francisco-Oakland-Fremont, *California*	4,000	$2,791	$698
Atlanta-Sandy Springs-Marietta, *Georgia*	4,200	$2,727	$649
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*	4,252	$2,691	$633
Phoenix-Mesa-Scottsdale, *Arizona*	3,538	$2,161	$611
Seattle-Tacoma-Bellevue, *Washington*	3,187	$2,119	$665
Detroit-Warren-Livonia, *Michigan*	3,900	$2,032	$521
San Diego-Carlsbad-San Marcos, *California*	3,048	$1,672	$549

Source: Texas Transportation Institute, 2010.

Key:
Cities with insufficient crash data.

Table A.7 Total Cost of Congestion and Cost per Person
Large Metropolitan Areas

Metropolitan Area	Urbanized Area Population (Thousands)	Cost of Congestion (Millions)	Cost of Congestion Per Person
Baltimore-Towson, *Maryland*	2,500	$2,024	$810
Denver-Aurora-Broomfield, *Colorado*	2,256	$1,711	$758
Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*	2,697	$1,689	$626
Tampa-St. Petersburg-Clearwater, *Florida*	2,344	$1,239	$529
St. Louis, *Missouri-Illinois*	2,330	$1,238	$531
San Juan-Caguas-Guaynabo, *Puerto Rico*	2,305	$1,190	$516
Riverside-San Bernardino-Ontario, *California*	2,522	$1,116	$443
Pittsburgh, *Pennsylvania*	1,760	$965	$548
Orlando, *Florida*	1,429	$962	$673
Portland-Vancouver-Beaverton, *Oregon-Washington*	1,861	$958	$515
San Jose-Sunnyvale-Santa Clara, *California*	1,783	$937	$526
Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*	1,550	$714	$461
Austin-Round Rock, *Texas*	1,250	$691	$553
Las Vegas-Paradise, *Nevada*	1,400	$673	$481
Sacramento-Arden-Arcade-Roseville, *California*	1,850	$671	$363
San Antonio, *Texas*	1,528	$664	$435
Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*	1,100	$624	$567
Milwaukee-Waukesha-West Allis, *Wisconsin*	1,485	$570	$384
Kansas City, *Missouri-Kansas*	1,547	$538	$348
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*	1,700	$525	$309
New Orleans-Metairie-Kenner, *Louisiana*	1,010	$511	$506
Indianapolis, *Indiana*	1,200	$503	$419
Cleveland-Elyria-Mentor, *Ohio*	1,710	$489	$286
Raleigh-Cary, Durham, *North Carolina*	1,094	$472	$431
Jacksonville, *Florida*	1,059	$445	$420
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*	1,005	$437	$435
Memphis, *Tennessee-Mississippi-Arkansas*	1,045	$430	$411
Louisville, *Kentucky-Indiana*	1,065	$389	$365
Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*	1,236	$343	$278
Columbus, *Ohio*	1,255	$323	$257
Buffalo-Niagara, *New York*	1,050	$280	$267

Source: Texas Transportation Institute, 2010.

Table A.8 Total Cost of Congestion and Cost per Person
Medium Metropolitan Areas

Metropolitan Area	TTI Population Group	Urbanized Area Population (Thousands)	Cost of Congestion (Millions)	Cost of Congestion Per Person
Bridgeport-Stamford-Norwalk, *Connecticut*	Med	925	$507	$548
Salt Lake City, *Utah*	Med	992	$415	$418
Baton Rouge, *Louisiana*	Med	600	$387	$645
Birmingham-Hoover, *Alabama*	Med	850	$380	$447
Oklahoma City, *Oklahoma*	Med	950	$376	$396
Honolulu, *Hawaii*	Med	709	$326	$460
Hartford-West Hartford-East Hartford, *Connecticut*	Med	899	$321	$357
Tucson, *Arizona*	Med	700	$317	$453
Albuquerque, *New Mexico*	Med	613	$286	$467
New Haven-Milford, *Connecticut*	Med	615	$285	$463
Richmond, *Virginia*	Med	954	$279	$292
Colorado Springs, *Colorado*	Med	540	$266	$493
El Paso, *Texas*	Med	712	$242	$340
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*	Med	628	$237	$377
Charleston-North Charleston, *South Carolina*	Med	510	$227	$445
Oxnard-Thousand Oaks-Ventura, *California*	Med	697	$216	$310
Tulsa, *Oklahoma*	Med	700	$202	$289
Sarasota-Bradenton-Venice, *Florida*	Med	678	$198	$292
Grand Rapids-Wyoming, *Michigan*	Med	606	$193	$318
Albany-Schenectady-Troy, *New York*	Med	612	$190	$310
Omaha-Council Bluffs, *Nebraska-Iowa*	Med	630	$184	$292
Springfield, *Massachusetts*	Med	625	$183	$293
Dayton, *Ohio*	Med	744	$170	$228
Fresno, *California*	Med	669	$165	$247
Wichita, *Kansas*	Med	500	$160	$320
Akron, *Ohio*	Med	620	$148	$239
Rochester, *New York*	Med	746	$140	$188
Bakersfield, *California*	Med	527	$119	$226
Poughkeepsie-Newburgh-Middletown, *New York*	Med	544	$107	$197
Toledo, *Ohio*	Med	519	$102	$197
McAllen-Edinburg-Mission, *Texas*	Med	545	$ 56	$103

Source: Texas Transportation Institute, 2010.

Key:
(shaded green) Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Table A.9 Total Cost of Congestion and Cost per Person
Small Metropolitan Areas

Metropolitan Area	Urbanized Area Population (Thousands)	Cost of Congestion (Millions)	Cost of Congestion Per Person
Columbia, *South Carolina*	473	$202	$427
Cape Coral-Fort Myers, *Florida*	464	$183	$394
Little Rock-North Little Rock, *Arkansas*	450	$179	$398
Knoxville, *Tennessee*	495	$170	$343
Jackson, *Mississippi*	418	$161	$385
Worcester, *Massachusetts*	442	$135	$305
Pensacola-Ferry Pass-Brent, *Florida*	356	$108	$303
Spokane, *Washington*	375	$106	$283
Provo-Orem, *Utah*	453	$102	$225
Winston-Salem, *North Carolina*	379	$102	$269
Salem, *Oregon*	238	$100	$420
Greensboro-High Point, *North Carolina*	339	$ 93	$274
Boise City-Nampa, *Idaho*	304	$ 91	$299
Beaumont-Port Arthur, *Texas*	241	$ 86	$357
Madison, *Wisconsin*	390	$ 79	$203
Stockton, *California*	399	$ 73	$183
Anchorage, *Alaska*	297	$ 72	$242
Corpus Christi, *Texas*	332	$ 63	$190
Laredo, *Texas*	225	$ 54	$240
Brownsville-Harlingen, *Texas*	204	$ 52	$255
Eugene-Springfield, *Oregon*	252	$ 39	$155
Boulder, *Colorado*	146	$ 32	$219

Source: Texas Transportation Institute, 2010.

Tables A.10 through A.13 show the total cost of crashes versus Cost of Congestion sorted in order of declining total cost ratios. Ratios are determined by dividing the absolute cost of crashes by the cost of congestion for a total cost ration, and dividing the per person cost of crashes by the cost of congestion for the per person cost ratio.

Table A.10 Cost of Crashes versus Cost of Congestion
Very Large Metropolitan Areas

Metropolitan Area	Total Cost Ratio	Per Person Cost Ratio
Atlanta-Sandy Springs-Marietta, *Georgia*	3.97	3.05
Miami-Fort Lauderdale-Miami Beach, *Florida*	3.42	3.30
Phoenix-Mesa-Scottsdale, *Arizona*	3.04	2.46
Houston-Baytown-Sugar Land, *Texas*	3.03	2.03
Detroit-Warren-Livonia, *Michigan*	2.81	2.49
New York-Northern New Jersey-Long Island, *New York-New Jersey-Pennsylvania*	2.71	2.67
Dallas-Fort Worth-Arlington, *Texas*	2.69	2.09
Philadelphia-Camden-Wilmington, *Pennsylvania-New Jersey-Delaware-Maryland*	2.66	2.38
Seattle-Tacoma-Bellevue, *Washington*	2.05	1.91
Washington-Arlington-Alexandria, *D.C.-Virginia-Maryland-West Virginia*	1.84	1.49
San Diego-Carlsbad-San Marcos, *California*	1.81	1.81
Boston-Cambridge-Quincy, *Massachusetts-New Hampshire*	1.60	1.48
San Francisco-Oakland-Fremont, *California*	1.23	1.14
Chicago-Naperville-Joliet, *Illinois-Indiana-Wisconsin*	1.19	1.06
Los Angeles-Long Beach-Santa Ana, *California*	1.03	1.09

Source: Cambridge Systematics, Inc., 2011.

Key:
Cities with insufficient crash data.

Table A.11 Cost of Crashes versus Cost of Congestion
Large Metropolitan Areas

Metropolitan Area	Total Cost Ratio	Per Person Cost Ratio
Columbus, *Ohio*	9.60	6.69
Charlotte-Gastonia-Rock Hill, *North Carolina-South Carolina*	7.94	4.57
Providence-New Bedford-Fall River, *Rhode Island-Massachusetts*	7.43	5.74
Memphis, *Tennessee-Mississippi-Arkansas*	7.04	5.64
Buffalo-Niagara, *New York*	6.90	6.45
Jacksonville, *Florida*	6.56	5.23
San Antonio, *Texas*	6.53	4.82
Raleigh-Cary, Durham, *North Carolina*	6.43	6.24
Cincinnati-Middletown, *Ohio-Kentucky-Indiana*	6.36	4.98
Cleveland-Elyria-Mentor, *Ohio*	6.18	5.05
New Orleans-Metairie-Kenner, *Louisiana*	5.83	4.95
Kansas City, *Missouri-Kansas*	5.76	4.31
Louisville, *Kentucky-Indiana*	5.60	4.74
Las Vegas-Paradise, *Nevada*	5.51	4.06
Tampa-St. Petersburg-Clearwater, *Florida*	5.37	4.58
Nashville-Davidson-Murfreesboro-Franklin, *Tennessee*	5.37	3.73
Orlando, *Florida*	4.45	3.05
Austin-Round Rock, *Texas*	4.18	3.06
Riverside-San Bernardino-Ontario, *California*	4.11	2.50
St. Louis, *Missouri-Illinois*	3.83	3.16
Indianapolis, *Indiana*	3.80	2.62
San Juan-Caguas-Guaynabo, *Puerto Rico*	3.73	3.28
Milwaukee-Waukesha-West Allis, *Wisconsin*	3.71	3.54
Virginia Beach-Norfolk-Newport News, *Virginia-North Carolina*	3.53	3.27
Sacramento-Arden-Arcade-Roseville, *California*	3.46	3.01
Pittsburgh, *Pennsylvania*	3.19	2.39
Portland-Vancouver-Beaverton, *Oregon-Washington*	2.86	2.37
Baltimore-Towson, *Maryland*	2.16	2.01
Minneapolis-St. Paul-Bloomington, *Minnesota-Wisconsin*	2.07	1.71
San Jose-Sunnyvale-Santa Clara, *California*	1.49	1.44
Denver-Aurora-Broomfield, *Colorado*	0.92	0.81

Source: Cambridge Systematics, Inc., 2011.

Table A.12 Cost of Crashes versus Cost of Congestion
Medium Metropolitan Areas

Metropolitan Area	Total Cost Ratio	Per Person Cost Ratio
McAllen-Edinburg-Mission, *Texas*	25.22	18.55
Toledo, *Ohio*	12.38	9.56
Poughkeepsie-Newburgh-Middletown, *New York*	11.93	9.58
Bakersfield, *California*	11.16	7.28
Tulsa, *Oklahoma*	11.07	8.34
Rochester, *New York*	10.75	7.74
Richmond, *Virginia*	8.19	6.31
Dayton, *Ohio*	8.10	7.22
Baton Rouge, *Louisiana*	7.62	5.81
Omaha-Council Bluffs, *Nebraska-Iowa*	7.61	5.64
Akron, *Ohio*	7.15	6.34
Charleston-North Charleston, *South Carolina*	7.04	5.45
Fresno, *California*	6.83	4.99
Wichita, *Kansas*	6.70	5.46
Oklahoma City, *Oklahoma*	6.66	5.15
Albany-Schenectady-Troy, *New York*	6.65	4.75
Sarasota-Bradenton-Venice, *Florida*	6.23	5.00
Hartford-West Hartford-East Hartford, *Connecticut*	6.18	4.65
Grand Rapids-Wyoming, *Michigan*	6.16	4.80
Albuquerque, *New Mexico*	6.11	4.37
New Haven-Milford, *Connecticut*	5.57	4.04
Allentown-Bethlehem-Easton, *Pennsylvania-New Jersey*	5.49	4.23
El Paso, *Texas*	5.31	5.03
Birmingham-Hoover, *Alabama*	5.06	3.80
Tucson, *Arizona*	4.89	3.36
Salt Lake City, *Utah*	4.03	3.54
Oxnard-Thousand Oaks-Ventura, *California*	3.72	3.23
Springfield, *Massachusetts*	3.36	3.01
Bridgeport-Stamford-Norwalk, *Connecticut*	2.86	2.93
Honolulu, *Hawaii*	2.39	1.87
Colorado Springs, *Colorado*	1.46	1.26

Source: Cambridge Systematics, Inc., 2011.

Key:
(green shading) Cities utilizing 2008 data in lieu of unavailable 2009 crash data.

Table A.13 Cost of Crashes versus Cost of Congestion
Small Metropolitan Areas

Metropolitan Area	Total Cost Ratio	Per Person Cost Ratio
Greensboro-High Point, *North Carolina*	18.01	8.54
Corpus Christi, *Texas*	14.94	11.92
Eugene-Springfield, *Oregon*	13.21	9.48
Brownsville-Harlingen, *Texas*	12.65	6.51
Beaumont-Port Arthur, *Texas*	12.26	7.81
Stockton, *California*	10.93	6.46
Pensacola-Ferry Pass-Brent, *Florida*	10.37	8.12
Madison, *Wisconsin*	10.08	6.90
Anchorage, *Alaska*	9.81	7.78
Little Rock-North Little Rock, *Arkansas*	9.62	6.31
Winston-Salem, *North Carolina*	9.09	7.11
Knoxville, *Tennessee*	8.39	5.94
Columbia, *South Carolina*	8.38	5.32
Laredo, *Texas*	7.78	7.25
Jackson, *Mississippi*	7.69	5.94
Boise City-Nampa, *Idaho*	7.51	3.76
Provo-Orem, *Utah*	6.76	5.51
Spokane, *Washington*	6.57	5.25
Boulder, *Colorado*	6.35	3.06
Salem, *Oregon*	6.04	3.63
Cape Coral-Fort Myers, *Florida*	5.77	4.56
Worcester, *Massachusetts*	5.44	2.99

Source: Cambridge Systematics, Inc., 2011.

Appendix B – Crashes and Congestion – The Conventional Wisdom

Traffic congestion is not only exasperating, it is costly. According to the Texas Transportation Institute's *Urban Mobility Report*, which examines the costs of congestion in America's 101 largest urban areas, an astronomical 4.8 billion hours of people's time and 3.9 billion gallons of fuel were wasted in 2009 because of congestion. The cost of these squandered resources is a staggering $97.7 billion, the report noted. In the American Association of State Highway Transportation Officials (AASHTO) report *Optimizing the System,* the question of safety is brought to the attention of the reader: "But as bad as (congestion) is, there's an immeasurably more costly and tragic measure of the system's performance: the human toll" (1). In 2009, more than 33,000 people were killed and over two million were injured in crashes on roads and highways in the United States.

Federal and state departments of transportation (DOT) publicly refer to congestion management and road safety as their stated goals, as do metropolitan planning organizations (MPO), and other local transportation agencies. Safety is nearly always a goal in transportation planning at any level, particularly because of the federal transportation bills TEA-21, and SAFETEA-LU, which establish safety as a priority transportation planning factor. Given the unacceptable number of deaths and injuries, safety is increasingly stated as "the most important goal." On the other hand, congestion receives very high levels of attention in the national media, as well as in government circles, as one of the most critical challenges facing urban America.

After the goal statements in transportation plans, safety is likely to receive less attention than congestion except for temporary interest following highly publicized crashes or when high-visibility enforcement campaigns are launched, e.g., Click It or Ticket, the national safety belt campaign, etc. Except for these events, safety generally does not receive the same level of public or political attention and concern as does the annual release of a congestion index in the Texas Transportation Institute's (TTI) *Urban Mobility Report*. This is not surprising when considering the increase in new highway capacity has not kept up with the growth in travel. According to FHWA, between 1980 and 1999, route-miles of highways increased 1.5 percent while vehicle-miles of travel increased 76 percent. While congestion is often associated with large cities, delays have become common in smaller cities and in some rural communities (2).

The obvious reason is elected and appointed officials frequently hear concerns expressed by their constituents and the media about congestion. Safety, on the other hand, receives far less attention despite the fact that millions of crashes occur each year. Crashes occur randomly and usually affect only a few people each time they do occur. Studies show the vast majority of Americans think they are good drivers; hence, they do not believe they will cause a crash. A recent survey indicated nearly two-thirds (64 percent) of American drivers rate themselves as "excellent" or "very good" drivers (3).

The purpose of this section is to provide a brief overview of the conventional wisdom regarding the relationship between safety and congestion. Literature examining the congestion-safety relationship remains sparse. A search of the Transportation Research International Documentation (TRID) on the keywords "safety congestion management system" produces nearly 1,600 references. Generally, research examines the impact of incident management on safety and not the direct interaction effect of crashes and congestion. Overall, the research is almost always about something other than an examination of the statistical relationship between crashes and congestion. Furthermore, the statements below reflect a lack of consensus on the most frequently suggested hypotheses:

- Congested roadways lead to a decrease in crashes;
- Congested roadways lead to an increase in crashes; and
- Congested roadways lead to an increase in crashes but severity is reduced.

B.1 Crashes, Congestion, and System Performance

Little research is available on the relationship between crashes and congestion as it relates to the performance of the transportation system. The existing research can be organized into four categories: congestion-related crashes, nonrecurring congestion crashes, secondary crashes, and volume-related crashes.

Congestion-Related Crashes

The evidence is mixed on the degree to which congestion reduces the number of crashes occurring on congested road segments. In some cases, crash statistics show the number of crashes is reduced when the road is less congested. A study by the Victoria Transport Policy Institute examined the relationships among safety, congestion, and system performance by focusing on mode shift as a method for reducing congestion. The study found:

- Safety impacts depend on types of travel changes that occur. Reductions in total vehicle mileage are likely to cause proportionate or greater reductions in crashes. The safety impact of mode shifting depends on the relative risks of each mode. Shifting vehicle travel from congested roads to less congested conditions tends to reduce crashes but increases crash severity. Strategies that reduce trip distance and traffic speed can provide significant safety benefits (4).

The conventional wisdom seems to be increasing mobility, e.g., adding lane-miles, results in safety improvement. The argument frequently is made to stimulate more interest and funding to support capacity increases. Research on Nevada's future mobility needs concluded at least $2 billion in additional funding is needed for highway projects due to the tremendous growth in population and vehicle-miles of travel in that state. According to The Road Information Program and the Nevada Highway Users Alliance, "These projects would help relieve traffic congestion, *improve traffic safety*, and improve pavement quality statewide" (5). There is little doubt congestion and pavement quality would be improved. However, the scientific literature supporting such a statement is not as clear. Recent research has attempted to provide an insight into what happens when lanes are added on freeways. The additional lanes briefly alleviate the safety problem as extra capacity lowers the density of vehicles on the facility. However, as the congestion, or vehicle density, increases, the total as well as the injury and fatal crash rates escalate (6). When vehicle density reaches a certain level, research suggests safety deteriorates and offsets any gains which may be achieved by building the additional lanes. The conflict opportunities increase with additional lanes and more lanes tend to increase the average speed and the speed differential, two major contributing factors for crash occurrence. In simple terms, we cannot build our way out of congestion without compromising safety on the roadways.

In summary, although the evidence is mixed, less congested roadways appear to lead to fewer, but more severe, crashes. On more congested roadways, the number of crashes may increase, but they may be primarily minor crashes reflecting the increased weaving and access/egress movements often occurring on congested road segments.

Nonrecurring Congestion Crashes

Urban road congestion is caused by two phenomena:

- Recurring congestion reflecting the normal, day-to-day delays caused by bottlenecks and large volumes; and
- Nonrecurring congestion caused when something unexpected happens. According to FHWA:

> *… Nonrecurring congestion includes the development and deployment of strategies designed to mitigate traffic congestion due to nonrecurring causes, such as crashes, disabled vehicles, work zones, adverse weather events, and planned special events. About half of congestion is caused by temporary disruptions that take away part of the roadway from use – or "nonrecurring" congestion. The three main causes of nonrecurring congestion are: incidents ranging from a flat tire to an overturned hazardous material truck (25 percent of congestion), work zones (10 percent of congestion), and weather (15 percent of congestion). Nonrecurring events dramatically reduce the available capacity and reliability of the entire transportation system. This is the type of congestion that surprises us. We plan for a trip of 20 minutes and we experience a trip of 40 minutes. Travelers and shippers are especially sensitive to the unanticipated disruptions to tightly scheduled personal activities and manufacturing distribution procedures* (7).

Although national data suggest approximately 25 percent of nonrecurring congestion is due to crashes, it may be underreported.

Secondary Crashes

Strong evidence exists indicating the number of upstream crashes increases when congestion occurs downstream. This is not surprising especially on high-speed roads. Suddenly approaching stopped traffic can lead to rear-end collisions. According to FHWA's *Freeway Management and Operations Handbook*:

- Although the problems most often associated with traffic incidents are congestion and associated traveler delay, increased fuel consumption, and reduced air quality, the most serious problem is the occurrence of secondary crashes. Another related issue is the danger posed by traffic incidents to the response personnel serving the public at the scene (8).

In severe crash-induced congestion, this phenomenon can result in more than one additional secondary crash. For example, in a study of freeway secondary crashes conducted by the Eno Foundation for Transportation, 60 percent occurred within 600 feet of the original crash (9). For this reason, many DOTs have instituted incident management programs and freeway service patrols. These programs are designed to notify drivers as quickly as possible of crash-related congestion ahead and to manage the incident using methods that restore normal traffic conditions as quickly as possible. The phenomenon of secondary crashes also is one that is important for urban arterial roads (10). Several journal articles make the case improved incident management leads to safety improvements due to reductions in secondary crashes and lessening of harm to incident management personnel (11 to 19).

Volume-Related Crashes

At intersections in particular, volume of traffic (especially turning traffic) has a significant relationship to the number of crashes. Higher volumes usually correspond with a larger number of crashes simply because the probability of a crash occurring is greater when more vehicles are present. However, higher volumes do not necessarily equate to increased congestion, and little research is available on the relationship between congested intersection conditions and crash incidents.

Summary

The conventional wisdom related to the operational relationship between congestion and safety indicates the relationship depends on the geometric design of the road, the types of vehicle operations occurring on the road, and the volume of traffic. It is fair to conclude congestion *is* related to safety, but it is often understated and misunderstood.

B.2 Crashes, Congestion, and Institutional Capacity

The manner in which states organize their transportation programs is often an indication of the underlying assumptions upon which the program is structured. In some cases, for example, state transportation safety programs are closely tied to the state DOT traffic operations unit, which is the group primarily responsible for managing congestion through road management and operations. For many state transportation agencies, it was assumed following the standards established by the AASHTO Policy on Geometric Design of Highways and Streets (Green Book) and the Manual on Uniform Traffic Control Devices (MUTCD) automatically resulted in safety improvements. However, only in recent years have engineers, researchers, statisticians, and others realized a comprehensive safety program includes more than just engineering solutions. The real problem is limited funding available to rebuild roads many of which existed before any reasonable design standards existed and many of the local roads never had a design standard applied but were built to provide access to property. The FHWA and AASHTO, through multi-year/multi-million dollar research efforts, will soon be publishing a highway safety manual which will allow designers to more definitively predict the safety outcomes from design modifications.

To what extent do DOT and MPO transportation planners address safety in the traditional planning process and documents? The findings in several studies that addressed this question have suggested this has occurred in only a limited way. Safety was often noted in the vision and perhaps in a goals statement, but the subject was rarely addressed beyond that point in the plan development process. This is primarily because the transportation planning process traditionally dealt with only large scale capital projects such as additional lanes or new access controlled facilities, which are inherently safer than the facilities the traffic used before. Only in recent times has the planning process addressed smaller scale improvements and operational type actions.

An interesting institutional relationship, however, between congestion and safety could be developed. Every metropolitan area with a population over 200,000 (referred to as a "transportation management area") must have a congestion management process identifying the most congested roads in the region. This road network is then part of the prioritization process for investment decision-making. In many cases, the defined network for the congestion management process also includes those roads with the largest number of crashes. A substantial percentage (40-50 percent) of non-recurring congestion is caused by one-time incidents, including traffic crashes. Thus, a potential database in many metropolitan areas could be tapped showing the congested roads and corresponding crash statistics.

Also, as mandated by the federal transportation bill, SAFETEA-LU, State DOTs are required to identify the most hazardous locations based on a data review of crashes, fatalities, and injuries as part of their Highway Safety Improvement Program (HSIP). States must submit an annual report to the federal government describing not less than five percent of these locations exhibiting the most severe safety needs to raise public awareness of the highway safety needs and challenges in the states. Unfortunately, most of the state reports are limited to state road systems since crash data on other public roads is often unavailable or unreliable. Provisions in SAFETEA-LU require the hazardous location designation apply to "all public roads" (state and local) to ensure resources are targeted at the state's most serious transportation safety problems regardless of where they occur.

Several additional federal, state, and local agencies other than DOTs or MPOs, have specific responsibilities for safety including, the police agencies, the motor vehicle agencies, the court systems, and the state highway safety offices managed by the governors' highway safety representatives. In some cases, these offices are located in the DOT, but they may be independent or part of other agencies such as Departments of Public Safety, Motor Vehicles, or the State Police. These offices focus mainly on behavioral safety and seek to reduce traffic-related crashes, fatalities, and injuries through law enforcement, education, and prevention initiatives.

To that end, the federal mandate for states to develop Strategic Highway Safety Plans (SHSP) as part of their Highway Safety Improvement Program (HSIP) was, to a large extent, designed to get the various elements of the state highway transportation agencies and departments to collaborate by jointly developing common goals and objectives from a broader "4E" perspective, i.e., engineering, education, enforcement, and emergency response. AASHTO began this more collaborative approach in 1997 with approval of a strategic plan recommending action in 22 emphasis areas to reduce fatalities, and in 2007 AASHTO adopted an aggressive national goal of halving fatalities over the next two decades.

Research by Hendren and Niemeier shows the relationship between safety and congestion is complex, and missing variables from congestion and safety models provide an incomplete picture. In their study, which attempted to link performance measures to resource allocation, the authors concluded transportation system performance is clearly influenced by factors besides government expenditure categories. For example, between 1985 and 2000, safety belt use increased, saving approximately 133,549 lives (23). Increasing safety belt use may not reduce crashes, but it effectively reduces severity. A study of the relationship between safety and congestion over time would have to take this phenomenon and others into account.

Congestion, like safety, is a public issue and is repeatedly ranked as number one or two in urban polls. The public expects the DOTs to address the issue and judges their effectiveness on its ability to alleviate congestion; therefore, substantial funding is aimed at strategies to reduce congestion. The results of this study suggest the public needs to understand better the societal costs associated with crashes and to demand safety become as important a policy issue.

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