



THE UNIVERSITY of TENNESSEE   
Center for Transportation Research

# Survey of Safety Belt and Motorcycle Helmet Usage in Tennessee

## Fiscal Year 2009 Final Report

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## Introduction

Since 1986, the University of Tennessee Center for Transportation Research has conducted a statewide survey once each year during which both safety belt and motorcycle helmet use data are gathered simultaneously. The sample design, data collection techniques, and estimation procedures for the surveys were developed in accordance with the National Highway Traffic Safety Administration's (NHTSA's) "Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use," published in the June 29, 1992, Federal Register with the guideline revisions agreed upon at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta. Detailed information on the sample design (including site selection), survey conduct (including data collection), and statistical procedures for estimation can be found in the August 2008 report "Documentation of Tennessee Observational Surveys of Safety Belt and Motorcycle Helmet Use" and are summarized below.

The 2009 observational survey is the second to utilize a revised survey methodology approved by NHTSA in 2008. For the first time in recent memory, the survey returned to the same observation sites in the same counties in consecutive years. This revised approach eliminates the random effects of roadway conditions, driver populations, and law enforcement techniques introduced by selecting different counties and observation sites each year. A complete description of Tennessee's safety belt survey methodology may be seen in Appendix 1.

## Survey Design

A multi-stage area probability sampling approach is utilized for the survey. In the first stage, an appropriate number of primary sampling units is randomly selected. The primary sampling unit for the Tennessee survey is the "county," and 16 counties are selected for inclusion in the survey.

In the second stage, sampling of individual route segments in each of the counties is performed. All route segments in a county identified in the Tennessee Roadway Information Management System (TRIMS) data files, excluding the rare local road segments included in the database, make up the target population. The qualifying route segments from each of the survey counties are stratified into four groupings using TRIMS functional classification data. For each county, segments are randomly chosen from each of these four strata, with probability of selection proportional to the segment's annual Vehicle Miles Traveled (VMT). At the same time, the direction of travel for belt use observations is also randomly determined. The number of segments chosen from each stratum is generally proportional to the county's estimated annual VMT in each stratum. This assures that the final sample is representative of the traffic mix in the county across the roadway functional types.

A total of 160 roadway segments comprise the sample. This number is large enough to provide a broad sampling of State road conditions and has been shown in other States



to provide belt use estimates well within NHTSA's required level of precision. Forty percent of these sample sites are allocated to the state's four largest counties (64 sites, 16 per county). The remaining 60 percent are evenly divided among the 12 smaller counties in the survey (96 sites, 8 per county).

An observation site is a homogeneous segment of roadway, generally between 0.5 to 5 miles in length. A typical segment is about 1 mile in length. Observers record the belt use/nonuse of outboard front-seat occupants of all passenger vehicles in the travel direction of record for a period of 45 minutes. Data are collected during all daylight hours, generally from 8:00 am to 6:00 pm, and on all days of the week. Vehicles counted include all passenger cars, pickup trucks, vans, and sport utility vehicles. Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, is counted for the motorcycle helmet use survey. The helmet use/nonuse of both motorcycle drivers and passengers is recorded.

The percentages of belt use and helmet use at each site, based on the number using belts or helmets divided by the total number of observed occupants or riders, is computed and reported. These percentages then are combined using weighting formulas to yield statewide estimates of safety belt and motorcycle helmet use. Estimates of one standard error are calculated for the estimated statewide usage rates, and these statistics are used to construct a 95 percent confidence interval for the belt use estimate and helmet use estimate, respectively. A complete description of the methods used in this survey of seatbelt usage may be seen in Appendix 1 of this report.

## **2009 Tennessee Seatbelt Survey Results**

In 2009, the Tennessee highway safety community has continued several important vehicle occupant protection initiatives. The Tennessee Governor's Highway Safety Office (GHSO) continues its partnerships with the National Highway Traffic Safety Administration (NHTSA), the Tennessee Department of Safety (TDOS), local law enforcement agencies, and numerous other public and private entities to promote increased seatbelt usage across the state of Tennessee. Chief among these initiatives is the ninth consecutive year of the Click It or Ticket program. This high visibility education and enforcement campaign, combined with the 2004 enactment of a statewide primary enforcement seatbelt law, has produced an increase in Tennessee's observed seatbelt usage rate in seven of nine years since its implementation in 2001. Other safety campaigns such as Booze It and Lose It, Buckle Up in Your Truck, Hands Across the Border, and 100 Days of Summer Heat have also contributed to continuing progress in safety belt usage. GHSO is also partnering with NHTSA to deliver a focused safety belt camp media and enforcement campaign to roadway users in rural areas. This effort is active in Tennessee, Georgia, and Florida.

For 2009, the final statistically adjusted statewide seatbelt usage rate is 80.64% ( $\pm 0.78\%$ ). By comparison, the final usage rate for 2008 was 81.49% ( $\pm 0.72\%$ ). While



marks the first annual decrease in observed usage rates since 2002, it should be noted that the 2009 rate is still the second highest observed in the State of Tennessee. Also, the difference between the 2008 and 2009 rates is not statistically significant as there is overlap between the 95% confidence intervals. Despite this slight decrease, many historical trends continue. Pickup trucks continue to have the lowest usage rate of any vehicle type. For 2009, pickup trucks occupants were observed to have a seatbelt usage rate of 73.47%, down from 75.15% in 2008. The next lowest rate by vehicle type was 81.77% for passenger cars. Sport utility vehicles and vans returned usage rates of 84.66% and 82.76%, respectively. Table 1 shows the final adjusted usage rates by vehicle type and county, as well as the final statewide usage rate of 80.64% ( $\pm 0.78\%$ ) for all vehicle types. The observed statewide motorcycle helmet usage in 2009 was 100.00%. Table 2 shows the motorcycle helmet usage by county. To further illustrate the recent progress brought about in increasing seatbelt usage across the state of Tennessee by both the Click-It-Or-Ticket campaign and passage of a primary seatbelt enforcement law, Table 3 shows annual usage rates for all vehicles, passenger cars, pickup trucks, vans, and sport utility vehicles since 2000.

### **Looking Forward**

The year between the 2008 and 2009 safety belt observations was one of great change for both Tennessee and the nation as a whole. The United States experienced the most severe economic recession in decades. This recession, combined with average fuel prices exceeding \$4.00 per gallon in the fall of 2008, lead to the first recorded annual decrease in vehicle miles of travel on the nation's roadways. At the same time, traffic fatalities are down substantially across much of the country. In Tennessee, traffic fatalities have decreased from 1,339 in 2004 to 1,035 in 2008. If current trends continue, traffic fatalities will fall below 1,000 in 2009. It is difficult to quantify the effects of these influences on safety belt usage, but they certainly play a part in this year's decreased usage rate.

For the third consecutive year, Tennessee's 2010 seatbelt survey will return to the same sites and counties used in the previous year. GHSO will continue its partnership with NHTSA on the Region Four Rural Seat Belt Project. Post-campaign data will be collected in November 2009 and June 2010. While data collected in the rural program counties is not directly incorporated into the statewide observational survey, it will allow GHSO to monitor usage rates in the state's smaller communities and refine its safety belt strategy accordingly.

**Table 1: Final Summary of June 2009 Tennessee Safety Belt Use  
Statewide Observational Survey Results**

County	No. of Sites	Adjusted Usage Rates									
		Passenger					All				
		Cars	Vans	SUVs	SUVs	Trucks	Cars + Vans + SUVs	Trucks	Trucks	Trucks	Vehicles
Davidson	16	88.10%	80.03%	87.44%	86.72%	78.91%	85.23%				
Hamilton	16	87.42%	77.21%	86.06%	85.59%	77.62%	84.02%				
Knox	16	87.62%	84.59%	88.07%	87.12%	75.91%	84.45%				
Shelby	16	79.25%	88.69%	82.61%	80.99%	73.38%	79.59%				
Blount	8	84.59%	83.32%	84.64%	84.30%	73.98%	81.98%				
Bradley	8	88.53%	87.74%	87.83%	88.50%	74.44%	85.13%				
Fayette	8	73.73%	81.03%	81.88%	76.93%	66.42%	73.61%				
Franklin	8	81.17%	82.52%	82.00%	81.91%	65.45%	77.52%				
Jefferson	8	85.99%	85.41%	90.45%	88.69%	78.24%	86.71%				
Montgomery	8	74.08%	78.96%	80.53%	76.87%	67.32%	74.20%				
Rutherford	8	71.49%	83.39%	80.38%	76.21%	67.71%	74.28%				
Sevier	8	82.79%	78.36%	85.32%	82.79%	75.29%	81.01%				
Sullivan	8	82.49%	78.63%	80.97%	81.45%	70.36%	78.88%				
Tipton	8	74.62%	60.14%	81.68%	76.46%	60.54%	70.02%				
Williamson	8	74.30%	85.11%	82.56%	78.71%	76.07%	78.10%				
Wilson	8	80.19%	89.79%	84.30%	83.25%	73.46%	80.64%				
<b>Statewide Totals</b>	<b>160</b>	<b>81.77%</b>	<b>82.76%</b>	<b>84.66%</b>	<b>82.89%</b>	<b>73.47%</b>	<b>80.64%</b>				





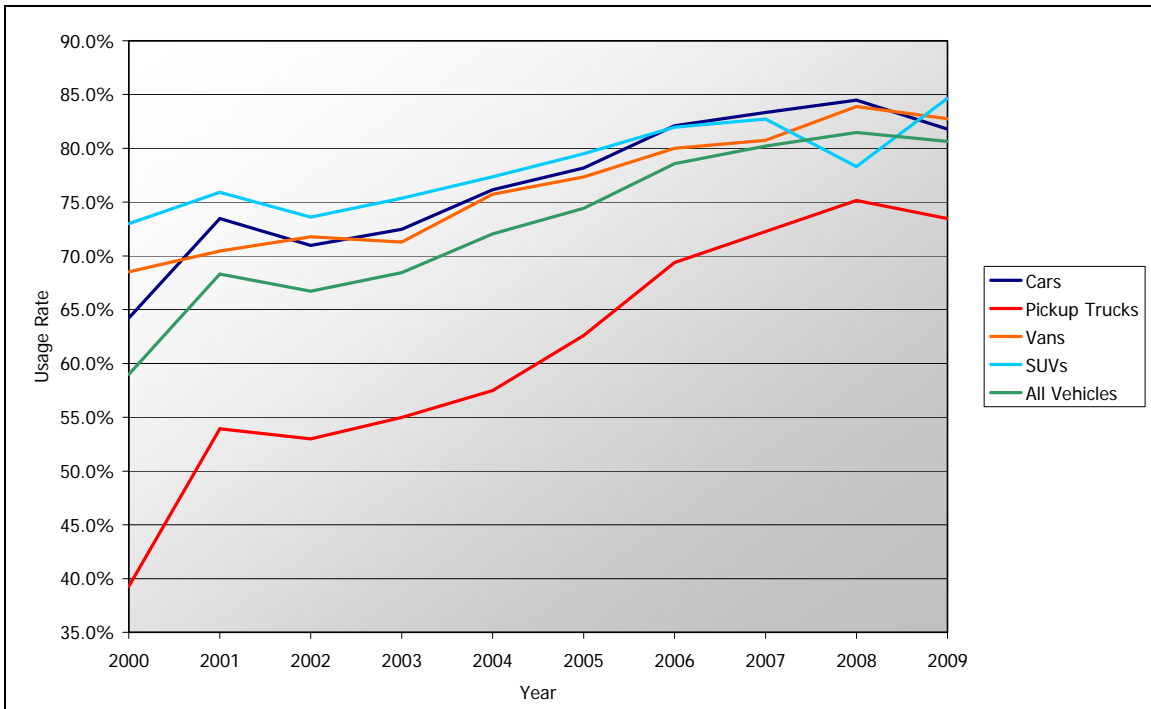
**Table 2: Final Summary of June 2009 Tennessee Motorcycle Helmet Use  
Statewide Observational Survey Results**

<b>County</b>	<b>No. of Sites</b>	<b>Helmeted Riders</b>	<b>Total Riders Observed</b>	<b>% Helmet Use</b>
Davidson	16	13	13	100.00%
Hamilton	16	52	52	100.00%
Knox	16	70	70	100.00%
Shelby	16	17	17	100.00%
Blount	8	24	24	100.00%
Bradley	8	81	81	100.00%
Fayette	8	8	8	100.00%
Franklin	8	18	18	100.00%
Jefferson	8	17	17	100.00%
Montgomery	8	34	34	100.00%
Rutherford	8	35	35	100.00%
Sevier	8	98	98	100.00%
Sullivan	8	30	30	100.00%
Tipton	8	9	9	100.00%
Williamson	8	40	40	100.00%
Wilson	8	48	48	100.00%
<b>Statewide Totals</b>	<b>160</b>	<b>594</b>	<b>594</b>	<b>100.00%</b>



**Table 3: Tennessee Seatbelt Usage, 2000-2008**

Survey Year	Passenger Cars	Pickup Trucks	Vans	Sport Utility Vehicles	All Vehicles
2000	64.2%	39.3%	68.5%	73.0%	59.0%
2001	73.5%	53.9%	70.4%	75.9%	68.3%
2002	71.0%	53.0%	71.8%	73.6%	66.7%
2003	72.5%	55.0%	71.3%	75.4%	68.4%
2004	76.1%	57.5%	75.7%	77.3%	72.0%
2005	78.2%	62.6%	77.3%	79.5%	74.4%
2006	82.1%	69.4%	80.0%	82.0%	78.6%
2007	83.3%	72.3%	80.8%	82.7%	80.2%
2008	84.5%	75.1%	83.9%	78.3%	81.5%
2009	81.8%	73.5%	82.8%	84.7%	80.6%



**Figure 1: Tennessee Seatbelt Usage, 2000-2008**



## Appendix 1: Survey Methodology

# **DOCUMENTATION OF TENNESSEE OBSERVATIONAL SURVEYS OF SAFETY BELT AND MOTORCYCLE HELMET USE**

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## **Executive Summary**

The University of Tennessee Center for Transportation Research conducts a statewide survey once each year in early summer, at which time both safety belt and motorcycle helmet use data are gathered simultaneously. In recent years, the survey followed a sample design, data collection techniques, and estimation procedures developed in accordance with NHTSA “Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use,” published in the June 29, 1992, Federal Register with revisions agreed upon at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta. To begin with 2008 surveys, a new design is proposed. It follows the basic elements of the previous approach but proposes to meet NHTSA performance criteria with a smaller sample of observation sites, 160 rather than 440.

A multi-stage area probability sampling approach is proposed for the survey. In the first stage, an appropriate number of primary sampling units is randomly selected. The primary sampling unit for the Tennessee survey is the “county,” and 16 counties are selected for inclusion in the survey.

In the second stage, sampling of individual route segments in each of the counties is performed. All route segments in a county identified in the Tennessee Roadway Information Management System (TRIMS) data files, excluding the rare local road segments included in the database, make up the target population. The qualifying route segments from each of the survey counties are stratified into four groupings using TRIMS functional classification data. For each county, segments will be randomly chosen from each of these four strata, with probability of selection proportional to the segment’s annual Vehicle Miles Traveled (VMT). At the same time, the direction of travel for belt use observations will also be randomly determined. The number of segments chosen from each stratum will be generally proportional to the county’s estimated annual VMT in each stratum. This will assure that the final sample is representative of the traffic mix in the county across the roadway functional types.

A total of 160 roadway segments will comprise the sample. This number is large enough to provide a broad sampling of State road conditions and has been shown in other States to provide belt use estimates well within NHTSA’s required level of precision (should the measured precision fail to meet requirements, we will modify the overall design or sampling procedures as needed and as approved by NHTSA). Forty percent of these sample sites will be allocated to the state’s four largest counties (64 sites, 16 per county). The remaining 60 percent will be evenly divided among the 12 smaller counties in the survey (96 sites, 8 per county).

An observation site is a homogeneous segment of roadway, generally between 0.5 to 5 miles in length. A typical segment is about 1 mile in length. Observers record the belt use/nonuse of outboard front-seat occupants of all passenger vehicles in the travel direction of record for a period of 45 minutes. Data are collected during all daylight hours, generally from 8:00 am to 6:00 pm, and on all days of the week. Vehicles to be counted include all passenger cars, pickup trucks, vans, and sport utility vehicles. Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, will

be counted for the motorcycle helmet use survey. The helmet use/nonuse of both motorcycle drivers and passengers is recorded.

The percentages of belt use and helmet use at each site, based on the number using belts or helmets divided by the total number of observed occupants or riders, will be computed and reported. These percentages then will be combined using weighting formulas to yield statewide estimates of safety belt and motorcycle helmet use. Estimates of one standard error are calculated for the estimated statewide usage rates, and these statistics are used to construct a 95 percent confidence interval for the belt use estimate and helmet use estimate, respectively.

## **Introduction**

Following is a detailed description of the methodology proposed for use for 2008 and subsequent years in the State of Tennessee observational surveys of safety belt and motorcycle helmet use. The sample design, data collection techniques, and estimation procedures for the surveys have been developed in accordance with NHTSA “Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use,” published in the June 29, 1992, Federal Register and revised at the June 1998 Region IV Workshop on Safety Belt Use Surveys held in Atlanta. The number of sites in this proposed plan has been reduced from the previous plan based on experiences in other States, which has shown that belt use estimates based on approximately 120-150 sites can be well within NHTSA’s required level of precision. Under the Tennessee plan, a statewide survey is conducted once each year in the summer, at which time both safety belt and motorcycle helmet use data are gathered simultaneously. This annual survey is designed and is currently administered, analyzed, and documented by the University of Tennessee Center for Transportation Research. The primary contact person at the Center is Mr. Matthew Cate (865/974-5255, [mcate@utk.edu](mailto:mcate@utk.edu)).

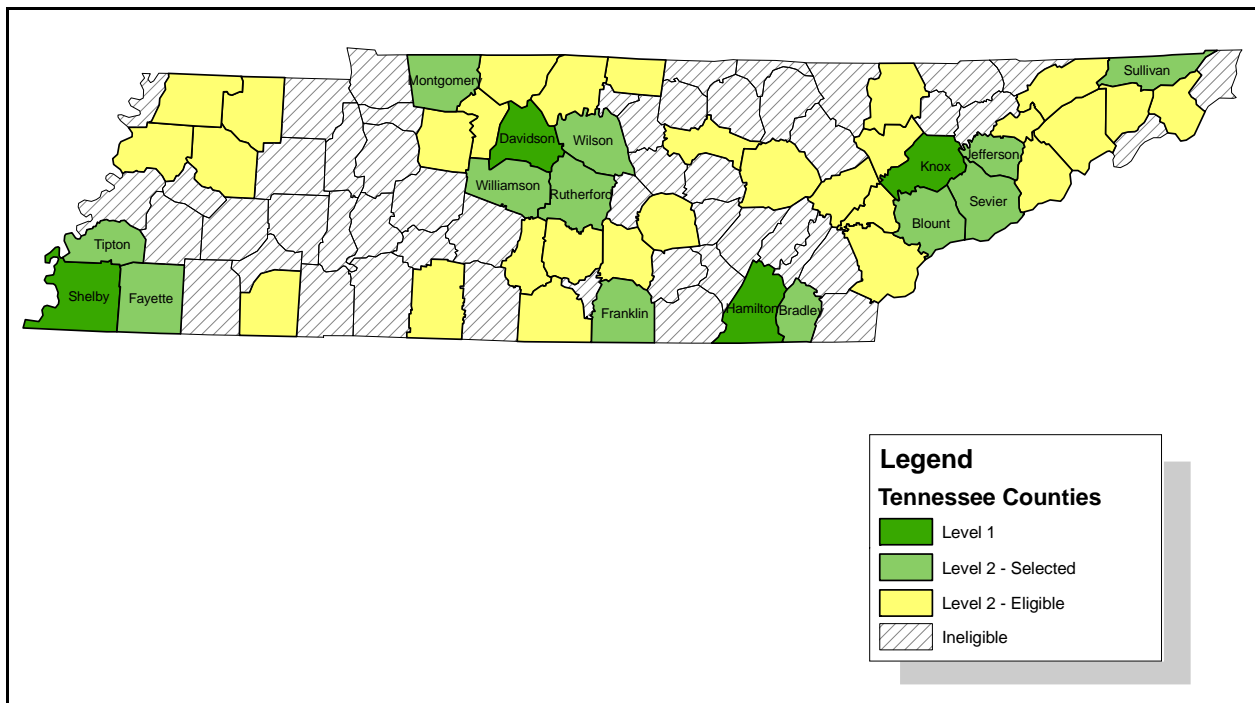
The sampling procedures described herein utilize current data from the Tennessee Roadway Information Management System (TRIMS) compiled by the Tennessee Department of Transportation (TDOT), and the U.S. Census Bureau. The TRIMS files include estimates of Average Daily Traffic (ADT) and Vehicle Miles of Travel (VMT) for each road segment and by road class and county, and the Census Bureau provides current population estimates by county.

The TRIMS files also provide a “population” of observation sites for the surveys. TRIMS contains data on the entire 91,000-mile road system in Tennessee, including Interstate Highways and Expressways, Principal and Minor Arterials, Major and Minor Collectors, and a small sample of Local Roads. As part of these data, each roadway is broken down into several “control-sections,” or segments, which vary from less than a mile to a few miles in length. These route segments tend to be homogeneous with regard to traffic volumes, land use, function, speeds, etc. Segment beginning and ending termini, road functional classification, location of intersecting roadways, and an ADT estimate are recorded in the TRIMS files for each control-section.

## **Sample Design**

A multi-stage area probability sampling approach is proposed for the survey. In the first stage, an appropriate number of primary sampling units is randomly selected. The primary sampling unit for the Tennessee survey is the county. Tennessee has a total of 95 counties; however, the least populated counties which collectively comprise approximately 15 percent of the State’s population are excluded from the sampling process (county population is the measure of sampling unit size for the purpose of defining the initial set of sampling units to be considered). Table 1 shows a listing of Tennessee’s 95 counties ranked using July 1, 2006, U.S. Census Bureau estimates, the most recent available, from most to least populated. The 45 counties which have been included in the sampling population as per the above criterion are identified in Table 1, as well as the 50 least populated counties which have been excluded from the sampling population.

From the sampling population, a sample of 16 counties will be selected. The number of counties (16) in the survey sample is based on the fact that Tennessee has a total of 45 counties in its sampling unit population. According to NHTSA guidelines to this number of sampling units, 16 is an appropriate number to achieve the desired level of accuracy in belt use estimation. The 16-county sample is chosen using a two-step procedure. First, the four largest counties (Shelby, Davidson, Knox and Hamilton), which comprise approximately 37 percent of the state’s population, are automatically placed into the 16-county sample. Then, 12 additional counties are selected from the remaining 41 counties to complete the survey sample, with probability for selection proportional to the population of the county. “Population weighting” is used together with random number generation to select the 12 smaller counties into the 16-county sample; the selection is done without replacement. The population values used for selection are Census estimates for July 1, 2006, the most current ones available. A random sample selected using this methodology and proposed for use in the new survey design is shown in Table 1 with the 16 counties in bold type. Additionally, these 16 counties are shown on a map of Tennessee in Figure 1.



**Figure 1:** Tennessee Counties Selected for Inclusion in 2008 Safety Belt Observational Survey

Once the 16 survey counties have been chosen, second stage sampling of individual route segments in each of the counties will be performed. The qualifying route segments comprising the sampling population are identified from the TRIMS files. All route segments except the very small number of local roads in the TRIMS files are eligible for selection (of the 22,401 segments in the files, just 206 are local road segments, less than 1% of all segments; they contribute less

**Table 1: 2006 Census Population**

County	Population	% Total	Cumulative % Total
<b>Shelby</b>	<b>911,438</b>	<b>15.09%</b>	<b>15.09%</b>
<b>Davidson</b>	<b>578,698</b>	<b>9.58%</b>	<b>24.68%</b>
<b>Knox</b>	<b>411,967</b>	<b>6.82%</b>	<b>31.50%</b>
<b>Hamilton</b>	<b>312,905</b>	<b>5.18%</b>	<b>36.68%</b>
<b>Rutherford</b>	<b>228,829</b>	<b>3.79%</b>	<b>40.47%</b>
<b>Williamson</b>	<b>160,781</b>	<b>2.66%</b>	<b>43.13%</b>
<b>Sullivan</b>	<b>153,239</b>	<b>2.54%</b>	<b>45.67%</b>
Sumner	149,416	2.47%	48.14%
<b>Montgomery</b>	<b>147,114</b>	<b>2.44%</b>	<b>50.58%</b>
<b>Blount</b>	<b>118,186</b>	<b>1.96%</b>	<b>52.54%</b>
Washington	114,316	1.89%	54.43%
<b>Wilson</b>	<b>104,035</b>	<b>1.72%</b>	<b>56.15%</b>
Marshall	95,894	1.59%	57.74%
<b>Bradley</b>	<b>93,538</b>	<b>1.55%</b>	<b>59.29%</b>
<b>Sevier</b>	<b>81,382</b>	<b>1.35%</b>	<b>60.64%</b>
Mcnairy	78,309	1.30%	61.93%
Anderson	73,579	1.22%	63.15%
Putnam	68,284	1.13%	64.28%
Greene	65,945	1.09%	65.37%
Robertson	62,187	1.03%	66.40%
Hamblen	61,026	1.01%	67.42%
Carter	59,157	0.98%	68.39%
<b>Tipton</b>	<b>57,380</b>	<b>0.95%</b>	<b>69.34%</b>
Hawkins	56,850	0.94%	70.29%
Roane	53,293	0.88%	71.17%
Cumberland	52,344	0.87%	72.04%
Macon	52,020	0.86%	72.90%
Coffee	51,625	0.85%	73.75%
<b>Jefferson</b>	<b>49,372</b>	<b>0.82%</b>	<b>74.57%</b>
Gibson	48,461	0.80%	75.37%
Dickson	46,583	0.77%	76.14%
Loudon	44,566	0.74%	76.88%
Monroe	44,163	0.73%	77.61%
Bedford	43,413	0.72%	78.33%
<b>Franklin</b>	<b>41,319</b>	<b>0.68%</b>	<b>79.02%</b>
Lawrence	40,934	0.68%	79.69%
Campbell	40,848	0.68%	80.37%
Warren	40,016	0.66%	81.03%
Cheatham	39,018	0.65%	81.68%
Dyer	37,886	0.63%	82.31%
<b>Fayette</b>	<b>36,102</b>	<b>0.60%</b>	<b>82.90%</b>
Cocke	35,220	0.58%	83.49%
Weakley	33,357	0.55%	84.04%
Lincoln	32,728	0.54%	84.58%
Obion	32,184	0.53%	85.11%
Henry	31,837	0.53%	85.64%
Claiborne	31,347	0.52%	86.16%
Rhea	30,347	0.50%	86.66%

**Table 1 Continued: 2006 Census Population**

County	Population	% Total	Cumulative % Total
Giles	29,269	0.48%	87.15%
Carroll	29,096	0.48%	87.63%
Mcminn	28,884	0.48%	88.11%
Hardeman	28,176	0.47%	88.57%
Maury	27,942	0.46%	89.04%
Henderson	26,750	0.44%	89.48%
Lauderdale	26,732	0.44%	89.92%
Hardin	26,089	0.43%	90.36%
Madison	25,722	0.43%	90.78%
White	24,482	0.41%	91.19%
Hickman	23,812	0.39%	91.58%
Grainger	22,453	0.37%	91.95%
Scott	21,926	0.36%	92.32%
Marion	21,726	0.36%	92.68%
Overton	20,740	0.34%	93.02%
Morgan	20,108	0.33%	93.35%
Haywood	19,405	0.32%	93.67%
Union	19,086	0.32%	93.99%
Smith	18,753	0.31%	94.30%
Humphreys	18,394	0.30%	94.60%
Dekalb	18,360	0.30%	94.91%
Johnson	18,043	0.30%	95.21%
Unicoi	17,663	0.29%	95.50%
Fentress	17,480	0.29%	95.79%
Wayne	16,828	0.28%	96.07%
Benton	16,378	0.27%	96.34%
Chester	16,043	0.27%	96.60%
Polk	15,939	0.26%	96.87%
Grundy	14,499	0.24%	97.11%
Crockett	14,392	0.24%	97.35%
Cannon	13,448	0.22%	97.57%
Bledsoe	13,030	0.22%	97.79%
Sequatchie	13,002	0.22%	98.00%
Stewart	12,998	0.22%	98.22%
Meigs	11,698	0.19%	98.41%
Lewis	11,588	0.19%	98.60%
Decatur	11,426	0.19%	98.79%
Jackson	10,918	0.18%	98.97%
Houston	8,076	0.13%	99.11%
Clay	8,055	0.13%	99.24%
Trousdale	7,811	0.13%	99.37%
Perry	7,653	0.13%	99.50%
Lake	7,406	0.12%	99.62%
Hancock	6,713	0.11%	99.73%
Moore	6,070	0.10%	99.83%
Van Buren	5,448	0.09%	99.92%
Pickett	4,855	0.08%	100.00%
Tennessee	6,038,803		

than 0.3% of the total VMT). The qualifying route segments from the 16 counties collectively constitute the set of observation sites from which the survey sites are then selected. The qualifying route segments from the 45 counties collectively will constitute the “target population” of observation sites.

The qualifying route segments from each of the survey counties are stratified into the following four groupings using TRIMS functional classification data:

1. All Interstates, Freeways or Expressways;
2. Other Principal Arterials;
3. Minor Arterials; and,
4. Collectors.

For a given county, segments will be randomly chosen from each of these four strata. The number of segments chosen from each stratum will be generally proportional to the county’s estimated annual VMT in each stratum though providing a minimum of two sites in each stratum-county. The proportional allocation of the segments across the various roadway groupings assures that the final sample is representative of the urban and rural mix in the county, as well as the mix of roadway functional types. The proposed allocation of sites, for the 16 counties identified in Table 1, is shown in Table 2.

In order to achieve the required level of precision, a total of 160 roadway segments will comprise the sample. In safety belt observation designs for other States, this number has yielded results well within NHTSA’s reliability requirement of 5% relative error. Should the measurement for safety belt use not meet this standard, however, additional observations will be conducted as recommended by NHTSA in order to achieve the necessary reliability.

Forty percent of these sample sites (64 sites) will be allocated to the state’s four largest counties, with each of these counties receiving one-fourth of this total number, or 16 sites. The remaining 60 percent (96 sites) will evenly divided among the 12 smaller counties in the survey, i.e., eight sample sites per county. In addition, one alternate site per county per roadway classification will be identified (this represents an additional 80 sites which can be used as substitute sites in the event that a primary site is unusable, e.g., closed for road work). The sample sites within each stratum are to be selected without replacement.

**Table 2: Proposed Site Allocation by County and Road Class Stratum**

County	Sites Allocated	County VMT (excl. local)	Road Class Stratum	Road Class VMT	Number of Sites if Allocated by VMT	Adjusted Number of Sites
Shelby	16	21,707,688	1	7,411,421	5.46	6
			2	6,110,646	4.50	4
			3	6,441,313	4.75	4
			4	1,744,308	1.29	2
Davidson	16	18,528,430	1	10,249,296	8.85	6
			2	3,581,238	3.09	4
			3	3,616,214	3.12	4
			4	1,081,682	0.93	2
Knox	16	11,318,599	1	5,584,194	7.89	6
			2	2,721,922	3.85	4
			3	1,872,610	2.65	4
			4	1,139,873	1.61	2
Hamilton	16	8,930,615	1	3,984,258	7.14	6
			2	2,088,215	3.74	4
			3	2,333,200	4.18	4
			4	524,942	0.94	2
Rutherford	8	6,231,299	1	2,381,636	3.06	2
			2	1,632,711	2.10	2
			3	1,330,927	1.71	2
			4	886,025	1.14	2
Williamson	8	4,849,437	1	1,858,847	3.07	2
			2	1,017,887	1.68	2
			3	1,177,728	1.94	2
			4	794,975	1.31	2
Sullivan	8	3,816,581	1	1,152,546	2.42	2
			2	1,338,460	2.81	2
			3	960,607	2.01	2
			4	364,968	0.77	2
Montgomery	8	3,189,595	1	725,244	1.82	2
			2	1,073,206	2.69	2
			3	998,797	2.51	2
			4	392,348	0.98	2
Blount	8	2,375,406	1	85,741	0.29	2
			2	1,269,771	4.28	2
			3	520,081	1.75	2
			4	499,813	1.68	2
Wilson	8	3,663,739	1	1,620,422	3.54	2
			2	882,859	1.93	2
			3	619,552	1.35	2
			4	540,906	1.18	2
Bradley	8	2,504,115	1	1,061,431	3.39	2
			2	566,935	1.81	2
			3	560,284	1.79	2
			4	315,465	1.01	2
Sevier	8	2,709,465	1	305,523	0.90	2
			2	1,175,787	3.47	2
			3	673,271	1.99	2
			4	554,884	1.64	2
Tipton	8	981,522	1	0	0.00	0
			2	478,988	3.90	3
			3	214,826	1.75	2
			4	287,708	2.34	3
Jefferson	8	2,137,837	1	1,204,100	4.51	2
			2	171,320	0.64	2
			3	418,907	1.57	2
			4	343,510	1.29	2
Franklin	8	834,019	1	0	0.00	0
			2	379,252	3.64	3
			3	163,419	1.57	2
			4	291,348	2.79	3
Fayette	8	1,543,165	1	565,778	2.93	2
			2	409,204	2.12	2
			3	306,157	1.59	2
			4	262,026	1.36	2
<b>Totals</b>	<b>160</b>	<b>95,321,512</b>	1	38,190,437	55.26	44
			2	24,898,401	46.25	42
			3	22,207,893	36.22	40
			4	10,024,781	22.26	34

## Data Collection

An observation site is a homogeneous segment of roadway, generally ranging in length from 0.5 to 5 miles. A typical segment is approximately 1 mile in length (the longer segments tend to be in rural areas where there are few intersections or driveways). For each observation site, at the time the site is initially selected a direction of travel will be randomly selected to be the travel direction of record. Proceeding in this direction from the beginning point of the segment, the observer is instructed to position himself or herself at the first intersection (preferably the first controlled intersection) within the segment.

The observer is to find a safe spot to stand just beyond the edge of the roadway at or very near the intersection. From this vantage point the observer records the belt use/nonuse of occupants of all passenger vehicles in the travel direction of record. If there are multiple through lanes in the travel direction of record, the first preference is to record all vehicles in all through lanes. If traffic is too heavy, then observers will split the observation time into a number of periods equal to the number of through lanes and then record belt use for one through lane at a time, beginning with the outermost lane. In the rare event that traffic is too heavy to count every vehicle in the survey lane, observers are instructed to identify a point down the road such that, when they complete recording data for the current vehicle, they can look up and select the next vehicle passing the point in that lane as the next one for observing.

Vehicles included in the survey data shall include all passenger cars, pickup trucks, vans, and sport utility vehicles. The shoulder belt use/nonuse of all front seat, outboard occupants of passenger vehicles is recorded. Children in child restraint seats are not counted, but children not in such devices are counted, and if they are wearing a shoulder belt, they are counted as “belted.” Since motorcycle traffic volumes are relatively low, all motorcycle traffic visible from the observation site, regardless of direction or lane of travel, is counted for the motorcycle helmet use survey. The helmet use and nonuse of both motorcycle drivers and any passengers are recorded.

The observation period at each site is 45 minutes. There are eight observation periods per day, scheduled to begin at the following times: 8:00 am; 9:15 am; 10:30 am; 11:45 am; 1:00 pm; 2:15 pm; 3:30 pm; and 4:45 pm. Actual observation time periods will begin at these times or as close as practical to these times, i.e., as soon the observer can get positioned at the site. Observers are instructed to commence counting with the first vehicle which arrives at the site after the time period begins, and to cease counting at the precise end of the 45-minute time period.

Data are collected during all daylight hours from 8:00 am to 6:00 pm and on all days of the week. When observation time periods are assigned to individual sites, the sites are first clustered according to travel time proximity. Those sites within a reasonable driving range, i.e., approximately 25 minutes, are grouped together. A cluster is then randomly assigned to a day or days of the week. Then, the sites within the cluster are randomly assigned to the consecutive observation time periods within that day or days, balancing within and between clusters time of day for sites by road functional class strata. It is expected that the sites within a county will make up a cluster (or two clusters, for the certain-selection counties). Clusters will be assigned days of the week to balance the type of county (e.g., urban/rural, part of the state) across weekdays and weekends.

If an observation site cannot be surveyed because of construction activities, safety concerns, or another legitimate reason, the site is abandoned. The observer is instructed to travel to the next alternative site of the same function-class stratum, observe at that site as quickly as possible, then go to the next assigned site and resume the survey as scheduled, staying as close as possible to the scheduled order and time of sites. As noted previously, alternate sites are selected during the initial sampling process.

The surveys will continue during mild inclement weather. In the event of severe inclement weather, the surveys are discontinued until such time as the weather eases. Then, the surveys are resumed according to the original schedule. After the remaining sites in a cluster have been surveyed, the observer returns to the missed site(s), and he/she surveys the site(s) beginning in the next consecutive time period.

## Estimation

### Calculation of Overall Safety Belt Usage Rate

Safety belt use rates will be calculated using formulas based on the proportion of the state's total VMT (excluding local-road VMT) "represented" by the site. Safety belt use rate calculations will follow a four-step process.

First, estimated rates will be calculated for each of the road strata within each county. Observed use rates for all of the sites within each stratum-county combination will be combined by simple averaging, as shown in formula (1). (Since the sites' original probability of inclusion in the sample was proportional to their VMT, averaging their use rates makes use of that sampling probability to reflect their different VMTs.)

$$P_{i(j)k} = \frac{\sum_{l=1}^{n_{i(j)k}} P_{i(j)kl}}{n_{i(j)k}} \quad (1)$$

where  $i(j)$  = county  $i$  within category  $j$  (where category 1 = the 4 certain-selection counties and category 2 = the 12 random-selection counties),  $k$  = road functional category stratum,  $l$  = site within stratum and county,  $n_{i(j)k}$  = number of sites within the stratum-county combination, and  $P_{i(j)kl}$  = the observed safety belt use rate at site  $i(j)kl = B_{i(j)kl}/O_{i(j)kl}$ , where  $B_{i(j)kl}$  = total number of belted occupants (drivers and outboard front-seat passengers) observed at the site and  $O_{i(j)kl}$  = total number of occupants whose belt use was observed at the site.

Second, a county-by-county safety belt use rate,  $P_{i(j)}$ , will be obtained by combining county-stratum safety belt use rates across strata within counties, weighted by the class's relative contribution to total county VMT:

$$P_{i(j)} = \frac{\sum_k VMT_{i(j)k} P_{i(j)k}}{\sum_k VMT_{i(j)k}} \quad (2)$$

where  $VMT_{i(j)k}$  = VMT of all roads in stratum  $k$  in county  $i(j)$ , and  $P_{i(j)k}$  = safety belt use rate for stratum  $k$  in county  $i(j)$ .

In the third step, category-weighted safety belt use rates will be obtained by combining and weighting the rates from the sampled counties in each category by their VMT values and probabilities of being selected:

$$P_j = \frac{\sum_i VMT_{i(j)} W_{i(j)} P_{i(j)}}{\sum_i VMT_{i(j)} W_{i(j)}} \quad (3)$$

where  $VMT_{i(j)}$  = total VMT for county  $i$  in region  $j$  and  $W_{i(j)}$  = the inverse of the probability of the county's selection:  $W_{i(1)} = 1$  for the certainty counties and  $W_{i(2)} = \frac{\sum_{l=1}^{41} Pop_{l(2)}}{12 * Pop_{i(2)}}$  where 41 = the

number of high population counties in category 2, 12 = the number of those counties to be selected, and  $Pop_{l(2)}$  are 2006 Census county population estimates.

Finally, the statewide belt use proportion will be calculated by combining the category proportions weighted by their proportion of statewide (45-county) VMT:

$$p = \frac{\sum_{j=1}^2 VMT_j p_j}{\sum_{j=1}^2 VMT_j} \quad (4)$$

The result will be a weighted combination of the individual site safety belt use rates. Estimates of subgroups of occupants, such as male drivers, female passengers, male drivers of pickup trucks, etc., will be calculated in the same way.

#### *Calculation of the Standard Error of the Overall Safety Belt Use Rate*

Standard error of estimate values will be estimated through a jackknife approach, based on the general formula:

$$\hat{\sigma}_{\hat{p}} = \left[ \frac{n-1}{n} \sum_{i=1}^n (\hat{p}_i - \hat{p})^2 \right]^{1/2} \quad (5)$$

where  $\hat{\sigma}_{\hat{p}}$  = standard deviation (standard error) of the estimated statewide safety belt use proportion  $\hat{p}$  (equivalent to  $p$  in the notation of formulas 1-4),  $n$  = the number of sites, i.e., 160, and  $\hat{p}_i$  = the estimated statewide belt use proportion with site  $i$  excluded from the calculation.

The relative error rate, i.e.,  $\hat{\sigma}_{\hat{p}} / \hat{p}$ , will also be calculated, as will the 95% confidence interval, i.e.,  $\hat{p} \pm 1.96\hat{\sigma}_{\hat{p}}$ . These values will be reported for the overall statewide seatbelt use rate. Should the calculated relative error rate fail to meet NHTSA's 5% criterion, additional data observations, or other remedies agreeable to NHTSA, will be undertaken to achieve the necessary reliability.

#### *Calculation of Overall Motorcycle Helmet Usage Rate and Standard Error of the Usage Rate*

Motorcycle helmet use rates will be calculated using a three-step process. The process proposed is different than that to be used for safety belt use calculations because one of the two weighting factors, VMT, is primarily a passenger vehicle and truck measure. Because there is no comparable motorcycle VMT measure, we propose using simple averages up to the level of county helmet use. County values will then be combined using the population factors used for calculating safety belt use rates.

First, a county-by-county helmet use rate,  $m_{i(j)}$ , will be obtained by dividing the number of helmet-wearing riders observed across all sites in the county by the total number of riders observed:

$$m_{i(j)} = \sum_{k,l} H_{i(j)kl} / \sum_{k,l} R_{i(j)kl} \quad (M1)$$

where  $H_{i(j)kl}$  = the number of helmeted riders observed at site  $l$  in stratum  $k$  in county  $i(j)$ , and  $R_{i(j)kl}$  = the total number of riders observed at site  $l$  in stratum  $k$  in county  $i(j)$ .

In the second step, category-weighted helmet use rates will be obtained by combining the rates from the sampled counties in each category by their probabilities of being selected:

$$m_j = \frac{\sum_i U_{i(j)} m_{i(j)}}{\sum_i U_{i(j)}} \quad (M2)$$

where  $U_{i(j)}$  = the inverse of the probability of the county's selection:  $U_{i(1)} = 1$  for the certainty counties and  $U_{i(2)} = \frac{\sum_{l=1}^{41} Pop_{l(2)}}{12 * Pop_{i(2)}}$  where 41 = the number of high population counties in category 2 and 12 = the number of those counties selected.

Finally, the statewide helmet proportion will be calculated by combining the category proportions weighted by their proportion of statewide population:

$$m = \frac{\sum_{j=1}^2 U_j m_j}{\sum_{j=1}^2 U_j} \quad (M3)$$

where  $U_j$  = the proportion of the State's population in category  $j$ . Estimates of subgroups of riders, such as male drivers, female passengers, etc., will be calculated in the same way.

Standard error of estimate values will be calculated using a jackknife procedure analogous to that used in the safety belt use calculations, as will relative error rates.