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Title and Subtitle

*Safety Belt and Motorcycle Helmet Use in Virginia: Results of the 1992 Survey to Qualify for Incentive Funds Under ISTEA, Section 153*

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Supplementary Notes

Abstract

Section 153 of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) established an incentive grant program to support states in adopting and implementing laws requiring the use of safety belts and motorcycle helmets. Having such laws that applied to all front seat occupants of passenger cars and all motorcycle occupants qualified a state for first-year funding. Second- and third-year funding was dependent upon demonstrating a specified level of compliance with each law.

This report contains the methodology and results of an observational survey conducted in Virginia in September 1992. This survey was conducted according to guidelines established by the National Highway Traffic Safety Administration.

The results show that Virginia's safety belt use rate was 71.6 percent, with a standard error of .001. Motorcycle helmet use was observed to be 100 percent.

TECHNICAL ASSISTANCE REPORT

# SAFETY BELT AND MOTORCYCLE HELMET USE IN VIRGINIA: RESULTS OF THE 1992 SURVEY TO QUALIFY FOR INCENTIVE FUNDS UNDER ISTEA, SECTION 153

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Transportation and the University of Virginia)

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## INTRODUCTION

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) added a new section to Title 23 of the U.S. Code. This section (§153) authorizes the Secretary of Transportation to establish a grant program to support states in adopting and implementing laws governing the use of safety belts and motorcycle helmets. To qualify for first-year funding, a state must have laws requiring the use of a helmet by all motorcycle occupants and the use of a belt or child safety seat by all front-seat occupants in passenger cars. Virginia qualified for first-year funding. However, to qualify for a second- or third-year grant in federal FY 1993 and FY 1994, a state must not only have mandatory use laws but must also demonstrate a specified level of compliance. In FY 93, states are required to demonstrate statewide belt usage of at least 55% and helmet usage of at least 70%. For FY 94, the required usage levels will increase to 70% for belts and 85% for helmets.

On June 29, 1992, the National Highway Traffic Safety Administration (NHTSA) published the final guidelines for the conduct of belt and helmet use surveys in the states.[1] In particular, the guidelines require that the survey samples be selected based on a single "probability-based" survey design and that only direct observational data be used to demonstrate compliance. The sample design must include predetermined protocols for (1) determining sample size; (2) selecting sites; (3) selecting alternate sites when necessary; (4) determining which route, lane, and direction of traffic flow are to be observed; (5) collecting the observational data; and (6) beginning and concluding an observation period. The guidelines further state

that the relative error of the estimate should be no more than ±5% and that all drivers and outboard front-seat passengers must be eligible for observation. Additionally, both motorcycle drivers and passengers must be eligible for observation.

The guidelines require that at least 85% of the state's population be eligible for inclusion and that only the smallest counties, based on population, may be eliminated from the sampling frame. Finally, all daylight hours and all days of the week must be eligible for inclusion in the sample and the scheduling of the time and day for each sample site must be done randomly.

## PURPOSE AND SCOPE

The purpose of this project was to conduct a survey of safety belt and motorcycle helmet use that conformed to NHTSA's guidelines. The project was limited to collecting only the information required by the guidelines.

## METHOD

There were five major steps in preparing the work plan: (1) definition of the population from which the sample was drawn, (2) determination of the sample size, (3) development of the sampling plan, (4) development of the data collection procedures, and (5) determination of how estimates will be weighted to approximate statewide figures.

### Population

According to the federal guidelines, localities in each state making up less than 15% of its total population may be removed from the population from which sites are chosen. In Virginia, determining which localities made up 15% was somewhat complex. In most states, cities are a part of their surrounding counties. In Virginia, although towns are considered to be part of their surrounding counties, the 41 independent cities are not. In order to accommodate this arrangement of political jurisdictions, both counties and independent cities were considered in establishing the sampling population.

In Table 1, the 136 counties and independent cities in Virginia are rank ordered by population. The total population in Virginia is about 6.2 million according to 1990 census figures. However, most of that 6.2 million is located in the four population centers: Northern Virginia, Tidewater, Richmond, and Roanoke. Thus, there is a great disparity between the population size of the rural counties and cities and the more urban ones. For instance, the least populated county, Highland, has fewer than 2,700 residents, and the least populated city, Norton, has fewer than 4,300. Twenty-seven of the 136 political jurisdictions have a population less than

## Table 1
## POPULATION BY POLITICAL JURISDICTION

| Jurisdiction | Jurisdiction Population | Cumulative Population | Cumulative Percent | Jurisdiction | Jurisdiction Population | Cumulative Population | Cumulative Percent |
|---|---|---|---|---|---|---|---|
| Highland County | 2,635 | 2,635 | 0.04 | Orange County | 21,421 | 818,373 | 13.23 |
| Norton | 4,247 | 6,882 | 0.11 | Page County | 21,690 | 840,063 | 13.58 |
| Craig County | 4,372 | 11,254 | 0.18 | Winchester | 21,947 | 862,010 | 13.93 |
| Clifton Forge | 4,679 | 15,933 | 0.26 | Hopewell | 23,101 | 885,111 | 14.31 |
| Bath County | 4,799 | 20,732 | 0.34 | Scott County | 23,204 | 908,315 | 14.68 |
| Emporia | 5,306 | 26,038 | 0.42 | Salem | 23,756 | 932,071 | 15.06 |
| Bedford | 6,073 | 32,111 | 0.52 | Staunton | 24,461 | 956,532 | 15.46 |
| Surrey County | 6,145 | 38,256 | 0.62 | Lee County | 24,496 | 981,028 | 15.86 |
| Charles City County | 6,282 | 44,538 | 0.72 | Botetourt County | 24,992 | 1,006,020 | 16.26 |
| King and Queen County | 6,289 | 50,827 | 0.82 | Isle of Wight County | 25,053 | 1,031,073 | 16.66 |
| Buena Vista | 6,406 | 57,233 | 0.92 | Wythe County | 25,466 | 1,056,539 | 17.08 |
| Bland County | 6,514 | 63,747 | 1.03 | Warren County | 26,142 | 1,082,681 | 17.50 |
| Rappahannock County | 6,622 | 70,369 | 1.14 | Carroll County | 26,594 | 1,109,275 | 17.93 |
| Galax | 6,670 | 77,039 | 1.25 | Prince George County | 27,394 | 1,136,669 | 18.37 |
| Manassas Park | 6,734 | 83,773 | 1.35 | Culpeper County | 27,791 | 1,164,460 | 18.82 |
| Lexington | 6,959 | 90,732 | 1.47 | Manassas | 27,957 | 1,192,417 | 19.27 |
| Covington | 6,991 | 97,723 | 1.58 | Amherst County | 28,578 | 1,220,995 | 19.73 |
| South Boston | 6,997 | 104,720 | 1.69 | Russell County | 28,667 | 1,249,662 | 20.20 |
| Richmond County | 7,273 | 111,993 | 1.81 | Halifax County | 29,033 | 1,278,695 | 20.67 |
| Cumberland County | 7,825 | 119,818 | 1.94 | Mecklenburg County | 29,241 | 1,307,936 | 21.14 |
| Franklin | 7,864 | 127,682 | 2.06 | Gloucester County | 30,131 | 1,338,067 | 21.63 |
| Mathews County | 8,348 | 136,030 | 2.20 | Harrisonburg | 30,707 | 1,368,774 | 22.12 |
| Middlesex County | 8,653 | 144,683 | 2.34 | Buchanan County | 31,333 | 1,400,107 | 22.63 |
| Essex County | 8,689 | 153,372 | 2.48 | Shenandoah County | 31,636 | 1,431,743 | 23.14 |
| Amelia County | 8,787 | 162,159 | 2.62 | Accomack County | 31,703 | 1,463,446 | 23.65 |
| Greensville County | 8,853 | 171,012 | 2.76 | Smyth County | 32,370 | 1,495,816 | 24.18 |
| Falls Church | 9,578 | 180,590 | 2.92 | Pulaski County | 34,496 | 1,530,312 | 24.73 |
| Sussex County | 10,248 | 190,838 | 3.08 | James City County | 34,859 | 1,565,171 | 25.30 |
| Greene County | 10,297 | 201,135 | 3.25 | Petersburg | 38,386 | 1,603,557 | 25.92 |
| New Kent County | 10,445 | 211,580 | 3.42 | Franklin County | 39,549 | 1,643,106 | 26.56 |
| Northumberland County | 10,524 | 222,104 | 3.59 | Wise County | 39,573 | 1,682,679 | 27.20 |
| Lancaster County | 10,896 | 233,000 | 3.77 | Charlottesville | 40,341 | 1,723,020 | 27.85 |
| King William County | 10,913 | 243,913 | 3.94 | York County | 42,422 | 1,765,442 | 28.53 |
| Poquoson | 11,005 | 254,918 | 4.12 | Bedford County | 45,656 | 1,811,098 | 29.27 |
| Lunenburg County | 11,419 | 266,337 | 4.30 | Frederick County | 45,723 | 1,856,821 | 30.01 |
| Williamsburg | 11,530 | 277,867 | 4.49 | Washington County | 45,887 | 1,902,708 | 30.75 |
| Charlotte County | 11,688 | 289,555 | 4.68 | Tazewell County | 45,960 | 1,948,668 | 31.49 |
| Madison County | 11,949 | 301,504 | 4.87 | Campbell County | 47,572 | 1,996,240 | 32.26 |
| Floyd County | 12,005 | 313,509 | 5.07 | Fauquier County | 48,741 | 2,044,981 | 33.05 |
| Clarke County | 12,101 | 325,610 | 5.26 | Suffolk | 52,141 | 2,097,122 | 33.89 |
| Appomattox County | 12,298 | 337,908 | 5.46 | Danville | 53,056 | 2,150,178 | 34.75 |
| Fluvanna County | 12,429 | 350,337 | 5.66 | Augusta County | 54,677 | 2,204,855 | 35.63 |
| Nelson County | 12,778 | 363,115 | 5.87 | Pittsylvania County | 55,655 | 2,260,510 | 36.53 |
| Buckingham County | 12,873 | 375,988 | 6.08 | Henry County | 56,942 | 2,317,452 | 37.45 |
| Northampton County | 13,061 | 389,049 | 6.29 | Spotsylvania County | 57,403 | 2,374,855 | 38.38 |
| Alleghany County | 13,176 | 402,225 | 6.50 | Rockingham County | 57,482 | 2,432,337 | 39.31 |
| King George County | 13,527 | 415,752 | 6.72 | Stafford County | 61,236 | 2,493,573 | 40.30 |
| Goochland County | 14,163 | 429,915 | 6.95 | Hanover County | 63,306 | 2,556,879 | 41.32 |
| Nottoway County | 14,993 | 444,908 | 7.19 | Lynchburg | 66,049 | 2,622,928 | 42.39 |
| Powhatan County | 15,328 | 460,236 | 7.44 | Albemarle County | 68,040 | 2,690,968 | 43.49 |
| Westmoreland County | 15,480 | 475,716 | 7.69 | Montgomery County | 73,913 | 2,764,881 | 44.69 |
| Radford | 15,940 | 491,656 | 7.95 | Roanoke County | 79,332 | 2,844,213 | 45.97 |
| Brunswick County | 15,987 | 507,643 | 8.20 | Loudoun County | 86,129 | 2,930,342 | 47.36 |
| Colonial Heights | 16,064 | 523,707 | 8.46 | Roanoke | 96,397 | 3,026,739 | 48.92 |
| Martinsville | 16,162 | 539,869 | 8.73 | Portsmouth | 103,907 | 3,130,646 | 50.60 |
| Grayson County | 16,278 | 556,147 | 8.99 | Alexandria | 111,183 | 3,241,829 | 52.39 |
| Giles County | 16,366 | 572,513 | 9.25 | Hampton | 133,793 | 3,375,622 | 54.56 |
| Prince Edward County | 17,320 | 589,833 | 9.53 | Chesapeake | 151,976 | 3,527,598 | 57.01 |
| Patrick County | 17,473 | 607,306 | 9.82 | Newport News | 170,045 | 3,697,643 | 59.76 |
| Southampton County | 17,550 | 624,856 | 10.10 | Arlington County | 170,936 | 3,868,579 | 62.52 |
| Dickenson County | 17,620 | 642,476 | 10.38 | Richmond | 203,056 | 4,071,635 | 65.81 |
| Rockbridge County | 18,350 | 660,826 | 10.68 | Chesterfield County | 209,274 | 4,280,909 | 69.19 |
| Bristol | 18,426 | 679,252 | 10.98 | Prince William County | 215,686 | 4,496,595 | 72.67 |
| Waynesboro | 18,549 | 697,801 | 11.28 | Henrico County | 217,881 | 4,714,476 | 76.20 |
| Fredericksburg | 19,027 | 716,828 | 11.59 | Norfolk | 261,229 | 4,975,705 | 80.42 |
| Caroline County | 19,217 | 736,045 | 11.90 | Virginia Beach | 393,069 | 5,368,774 | 86.77 |
| Fairfax | 19,622 | 755,667 | 12.21 | Fairfax County | 818,584 | 6,187,358 | 100.00 |
| Louisa County | 20,325 | 775,992 | 12.54 | | | | |
| Dinwiddie County | 20,960 | 796,952 | 12.88 | **Total Population** | 6,187,358 | | |

10,000. On the other hand, 13 jurisdictions have a population of more than 100,000 and account for more than 48% of the total population of the state. Because of this disparity in population, the 74 least populated jurisdictions make up just under 15% of the state's population and, thus, were excluded from sampling according to the federal guidelines. See Figure 1 for a map that shows the jurisdictions that were excluded (the shaded portion). All other locations in the state were equally eligible for inclusion in the sample.

## Sample Size

The next step in the project was to determine the number of statewide sites necessary to fulfill NHTSA's requirement of a relative error of ±5% and 95% confidence. The first consideration in determining sample size was the selection of an appropriate formula. In this case, the sample was designed to ensure that the statewide sample yielded a sample of safety belt and motorcycle helmet use that adequately approximated the true statewide use figure. The formula in Table 2 was designed to yield a sample size for an estimate that approximates the true statewide use figure. (It should be noted that this sample size was not designed to ensure that sample proportions from two or more years could be adequately compared or that sample proportions from two or more sites or regions could be compared.)

The variance estimate used was based on the estimates of use that were found in a survey of safety belt use in Virginia in 1991. The between site variance

**Table 2**
**CALCULATION OF MINIMUM SAMPLE SIZE**

$$n = \frac{\left(Z^2_{1-a} + Z^2_{1-b}\right) \cdot (sd)^2}{(M_1 - M_0)^2}$$

$$\text{corrected } n = \frac{\text{Population size} \times n}{\text{Population size} + n}$$

where $n$ = the calculated minimum sample size

$a, b$ = alpha and beta error levels; in this case, 0.05 and 0.20, respectively

$Z_{1-a}, Z_{1-b}$ = normal values for the alpha and beta errors

$sd^2$ = variance estimate

$M_1 - M_0$ = smallest detectable difference between the mean and the true mean or standard

Population size = estimated total number of intersections

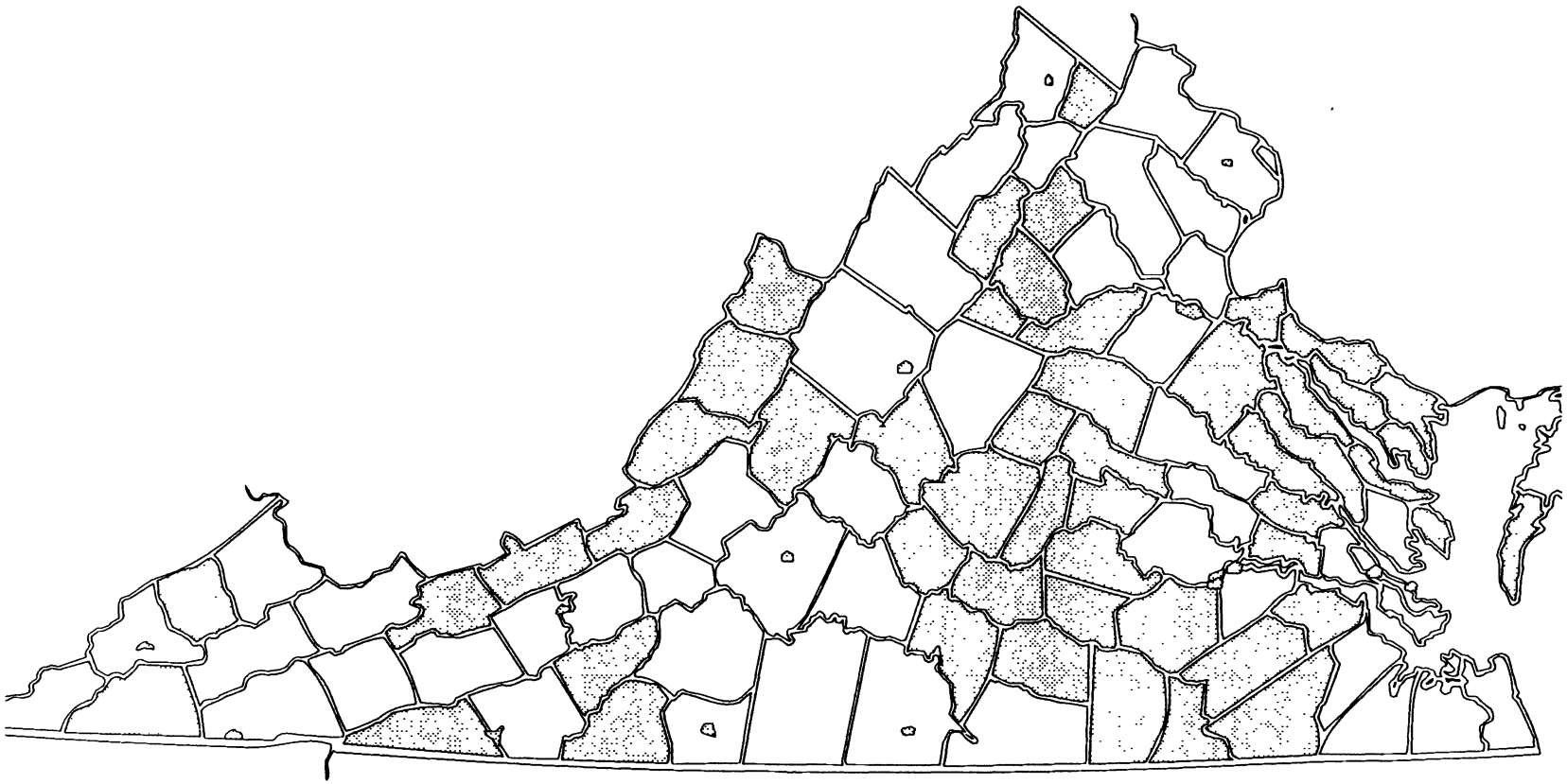

**Figure 1. AREAS EXCLUDED FROM SAMPLING PROCEDURES (SHADED).**

in proportion of usage was calculated based on the 50 sites at which data were taken across the state. The minimum detectable difference is based on a 5% relative error of the statewide mean safety belt use found in the 1991 survey. The following figures were entered into the formula for drivers and outboard passengers:

| | | |
|---|---|---|
| $Z_{1-a}$ | = | 1.96 |
| $Z_{1-b}$ | = | 0.85 |
| $sd$ | = | 9.44 |
| $M_1 - M_0$ | = | 3.02 |
| Population size | = | 250,000 |

Uncorrected sample size = 77.151210.

Corrected sample size = 77.127408.

Thus, a random sample of 78 sites was deemed adequate to determine Virginia's safety belt use within ±5%. Observing safety belt use at 6 sites per day for 13 days would, therefore, provide data with the relative error required by NHTSA's guidelines. In order to minimize the relative error of the estimate further, the project work plan initially proposed to observe safety belt use at 84 sites across 14 days. However, because of comments received from NHTSA on 4 September 1992 suggesting that additional sites would be needed to ensure that the required precision was reached, data were collected at 120 sites.

## Sampling Plan

In order to select the sample of sites, a grid with 1/4-in by 1/4-in sections was placed over a standard map of Virginia issued by the Virginia Department of Transportation (VDOT) and drawn to a scale of 1 in = 13 miles. See Figure 2 for a sample section of the map. Thus, each grid box contained approximately 10.5 square miles. This procedure produced a system of 144 sections across the horizontal axis of Virginia and 63 sections across the vertical axis. However, because Virginia is not perfectly rectangular and because political jurisdictions representing Virginia's smallest 15% of the population were excluded from the sample, some boxes fell outside the geography of Virginia or wholly within areas that were excluded. So that these boxes would not affect the random nature of the sample, they were not defined as part of the population to be studied. To accomplish this, each valid grid box containing at least one intersection in an included part of Virginia was numbered. Random numbers were generated to select 120 of the 2,572 valid grid boxes, without replacement, from which specific intersections were selected.

Another comment from NHTSA dealt with the sample design for selecting intersections. To accommodate the concern of having an overrepresentation of local road intersections, we used an urban/rural division. Excluding the lowest 15% of the state's population, the urban areas have about 68% of the remaining population and the rural areas have about 32%. Of the 120 total sites, 82 were randomly selected from the four metropolitan areas and 38 were randomly selected from the remainder of the state.

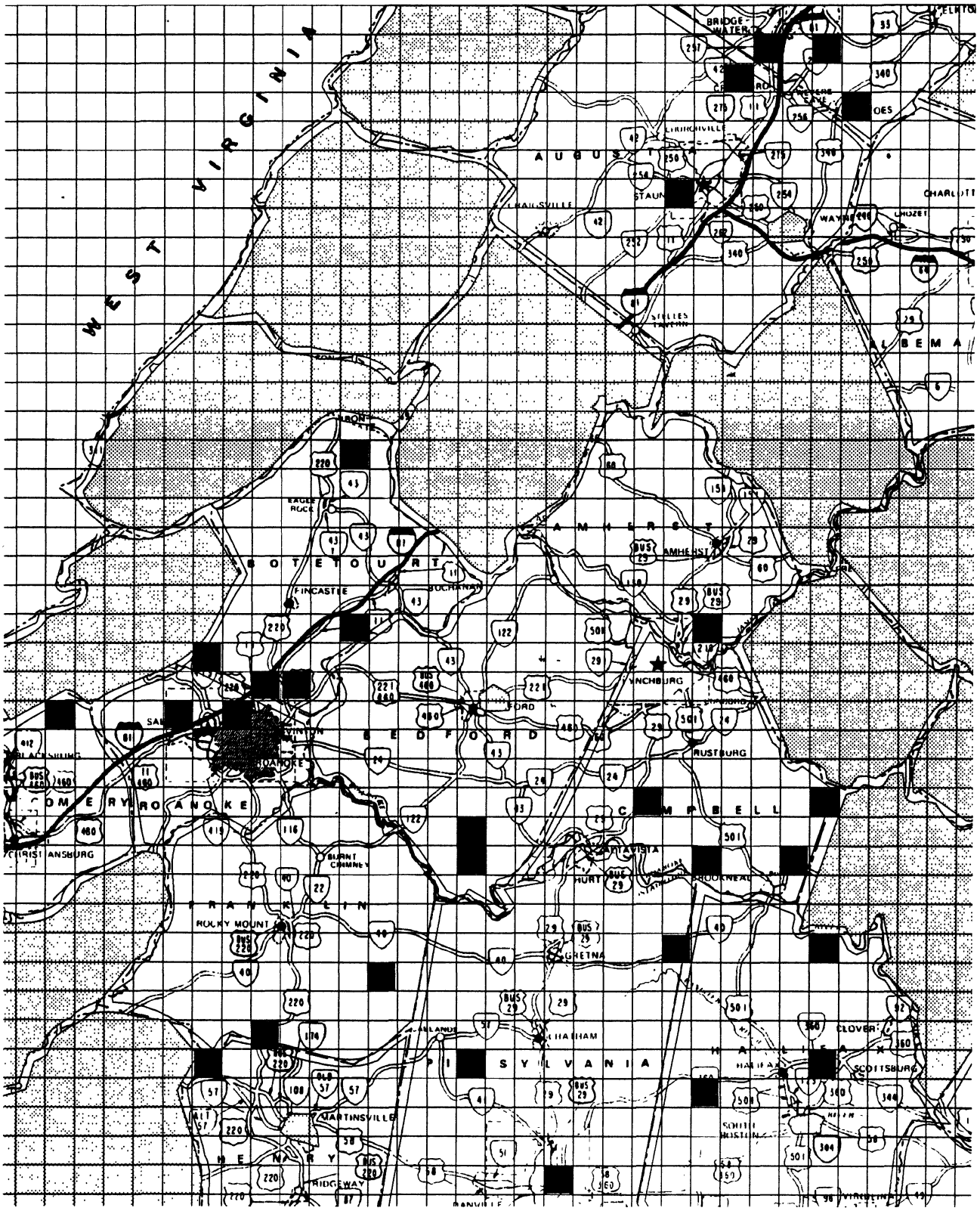


**Figure 2. SAMPLE SECTION OF STATE MAP SHOWING GRID BOXES.**

By the use of detailed maps of urban areas available in book form from ADC map publishers,[2–6] and county maps prepared by VDOT, each intersection in a selected grid box was numbered and a random number generated to select the specific intersection to be sampled. First and second alternate sites were also selected randomly from in the box. Likewise, for each primary and alternate site, random numbers were used to select the route observed at the selected intersection, the direction of travel observed, and whether traffic entering or exiting the intersection was to be observed. See Figures 3 and 4 for examples of urban and rural grid boxes and potential sites.

Members of the study team visited and evaluated each site prior to the beginning of the observation period to determine whether data could be safely and adequately collected at the site. The safety of the observer was the primary criterion for judging each site, followed by the ability to observe traffic. If the intersection was found to be inadequate, attempts were made to find an adequate observation point downstream if traffic exiting the intersection was to be observed and upstream if entering traffic was to be observed. In either case, if an adequate site could not be found before the next intersection was reached, an alternate site was investigated. Choosing a point before the next intersection ensured that the same traffic characteristics would be present at the upstream or downstream site as would have been present at the original intersection. Very few original sites were discarded in favor of alternates. Those that were discarded had no safe area for the observer to stand or park or placed the observer below the level of the roadway, thus making observation of the occupants impossible.

After selection, the sites were sorted geographically into seven groups. The days of the week were randomly assigned, without replacement, to each geographic group. For each site, data were collected for 1 hr. Accordingly, for each day, the sites in a geographic group were assigned a random hour to begin, without replacement, from 7 a.m. to 6 p.m.. When inclement weather precluded the collection of data at a site, data were collected at that site on the next available day at the originally specified time.

## Data Collection Procedures

All passenger cars in the curb lane were observed for shoulder belt use. (Dedicated turning lanes were not considered to be curb lanes for the purpose of this study.) All observations began precisely on the hour and ended on the hour. Once observations were begun, they continued throughout the hour. If a momentary interruption occurred, the observer was instructed to resume observing vehicles, but in order to ensure that the beginning observation was not a nonrandom selection by the observer, data collection resumed with the fifth vehicle to pass the site after the observer was ready.

Observations were recorded using eight counters mounted on a hand-held board. A "yes" or a "no" count was made for shoulder belt use for drivers and

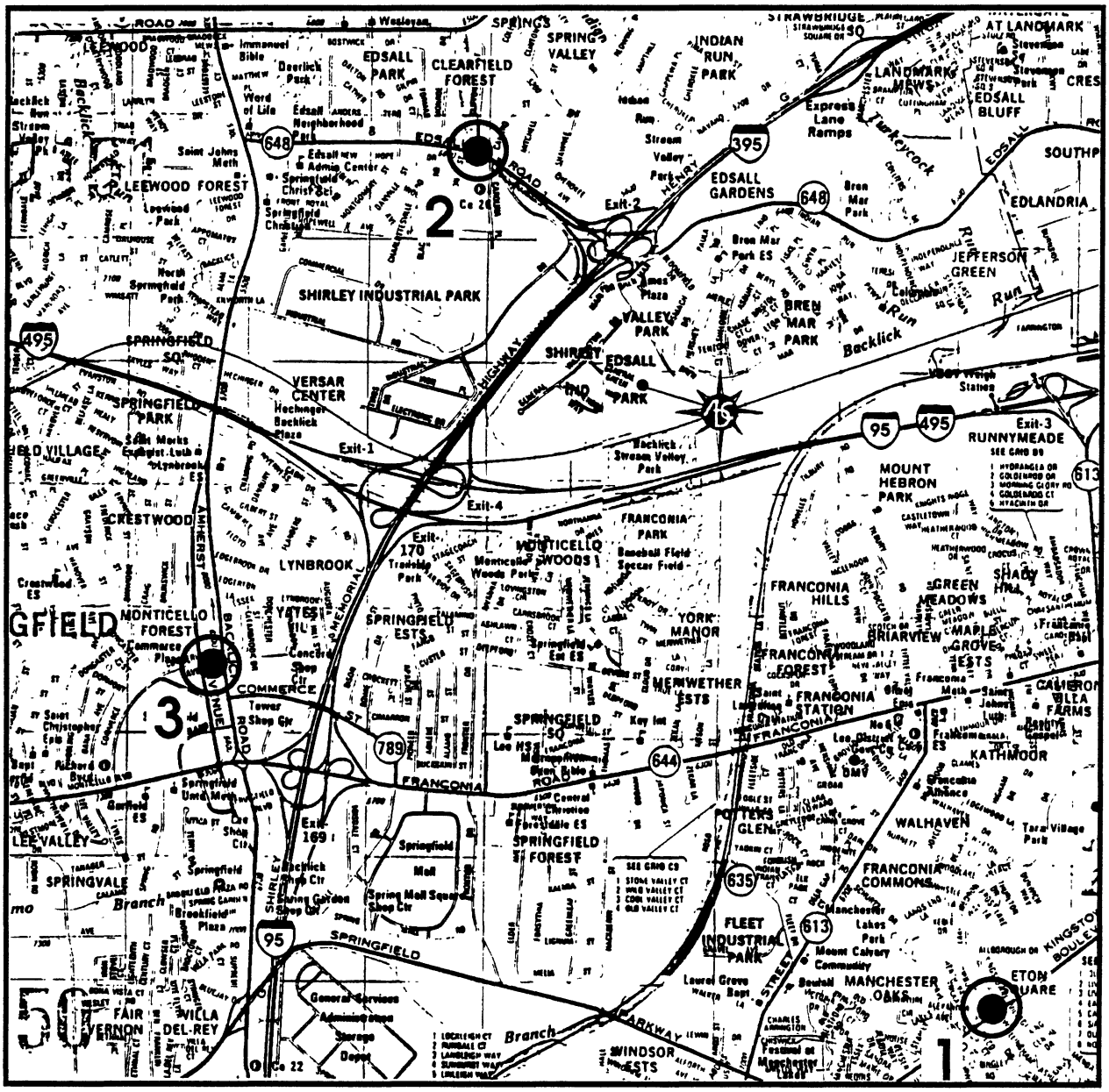


**Figure 3. DETAIL OF URBAN GRID SHOWING INTERSECTION CHOICES.**

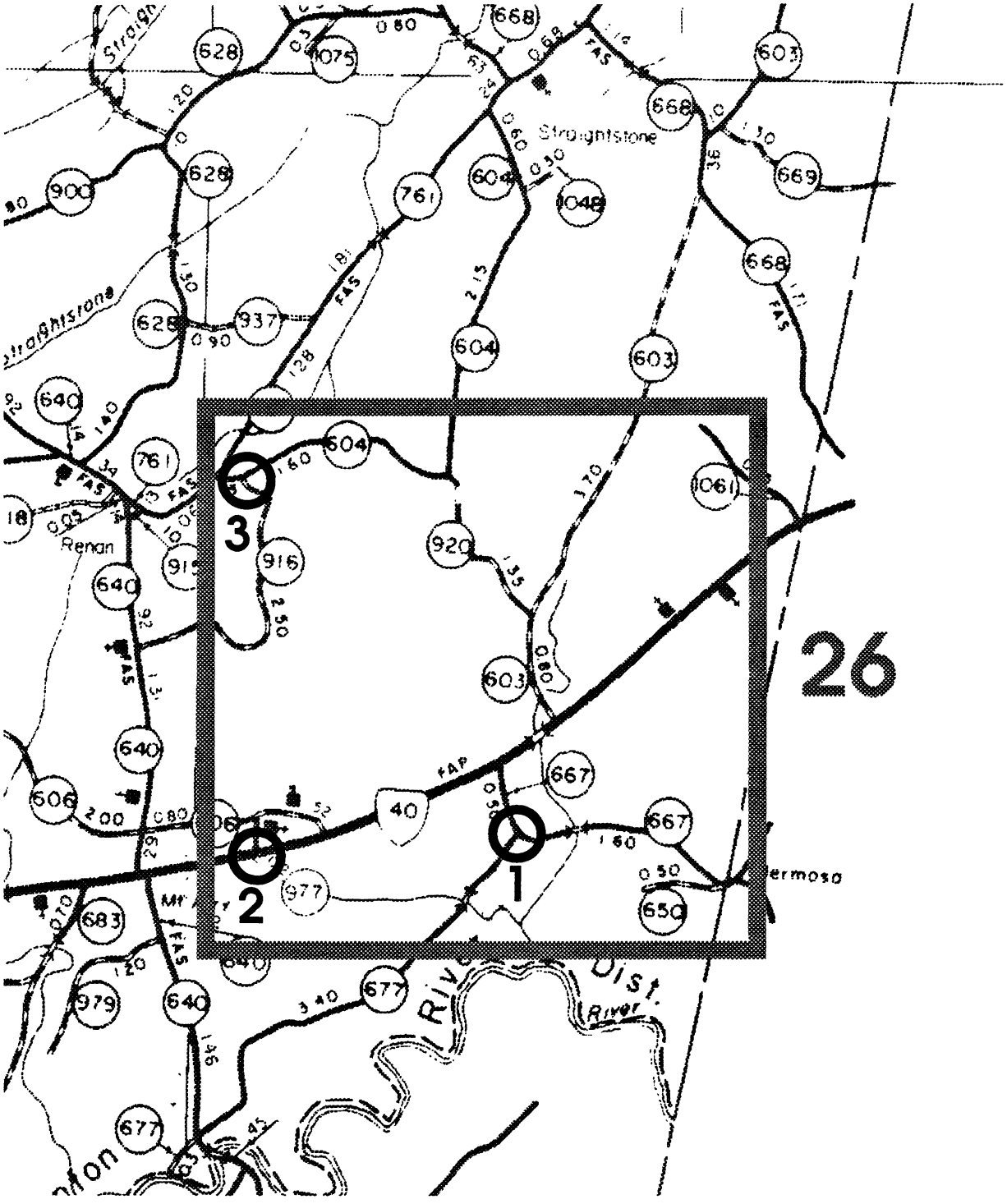


**Figure 4. DETAIL OF RURAL GRID SHOWING INTERSECTION CHOICES.**

outboard front passengers for each passenger car in the curb travel lane and for motorcycle driver or passenger helmet use in any lane in the appropriate direction of travel. To assist data collectors in moving from one vehicle or occupant classification to another (e.g., from drivers to passengers), all "yes" tallies were made by pressing a clicker on the right and all "no" tallies by pressing a clicker on the left. The data collectors were required to complete a training program on the use of the counter board and on how the data were to be collected and recorded. The data collectors were checked for interrater reliability in training sessions prior to the beginning of the survey. Since observation points were preselected at each site, the data collectors were instructed to use intersection diagrams and photographs to locate the point at which observations were to be made (see Figures 5 and 6).

## Calculation of Use and Error Rates

Because safety belt use was observed only in the curb lane, it was necessary to weight the observations taken on multilane highways. However, no such weighting was necessary for motorcycles, which were observed in all lanes of travel. For passenger cars at each site, the number of driver and passenger observations was multiplied by the number of lanes in the observed direction of travel. Thus, at a site with two lanes in the travel direction, the number of observations would be doubled to estimate the total number of drivers and passengers that crossed the site.

At NHTSA's suggestion, the selection of sites was stratified to represent the urban and rural areas of the Commonwealth in proportion to their populations. Thus, more than two thirds of the sites were from the urban areas of Virginia.

The use rate was calculated by the formula:

$$P_B = \frac{\sum_{t=1}^{2} \frac{N_t}{n_t} \sum_{i=1}^{n_t} N_{ti} B_{ti}}{\sum_{t=1}^{2} \frac{N_t}{n_t} \sum_{i=1}^{n_t} N_{ti} O_{ti}} \qquad [1]$$

where $P_B$ = estimated proportion of drivers and passengers using safety belts in Virginia

$t$ = stratum, 1 = urban, 2 = rural

$ti$ = each site within a stratum

$N_t$ = total number of grid boxes within stratum $t$

$n_t$ = number of grid boxes selected from each stratum $t$

$N_{ti}$ = total number of intersections within each sampled grid box

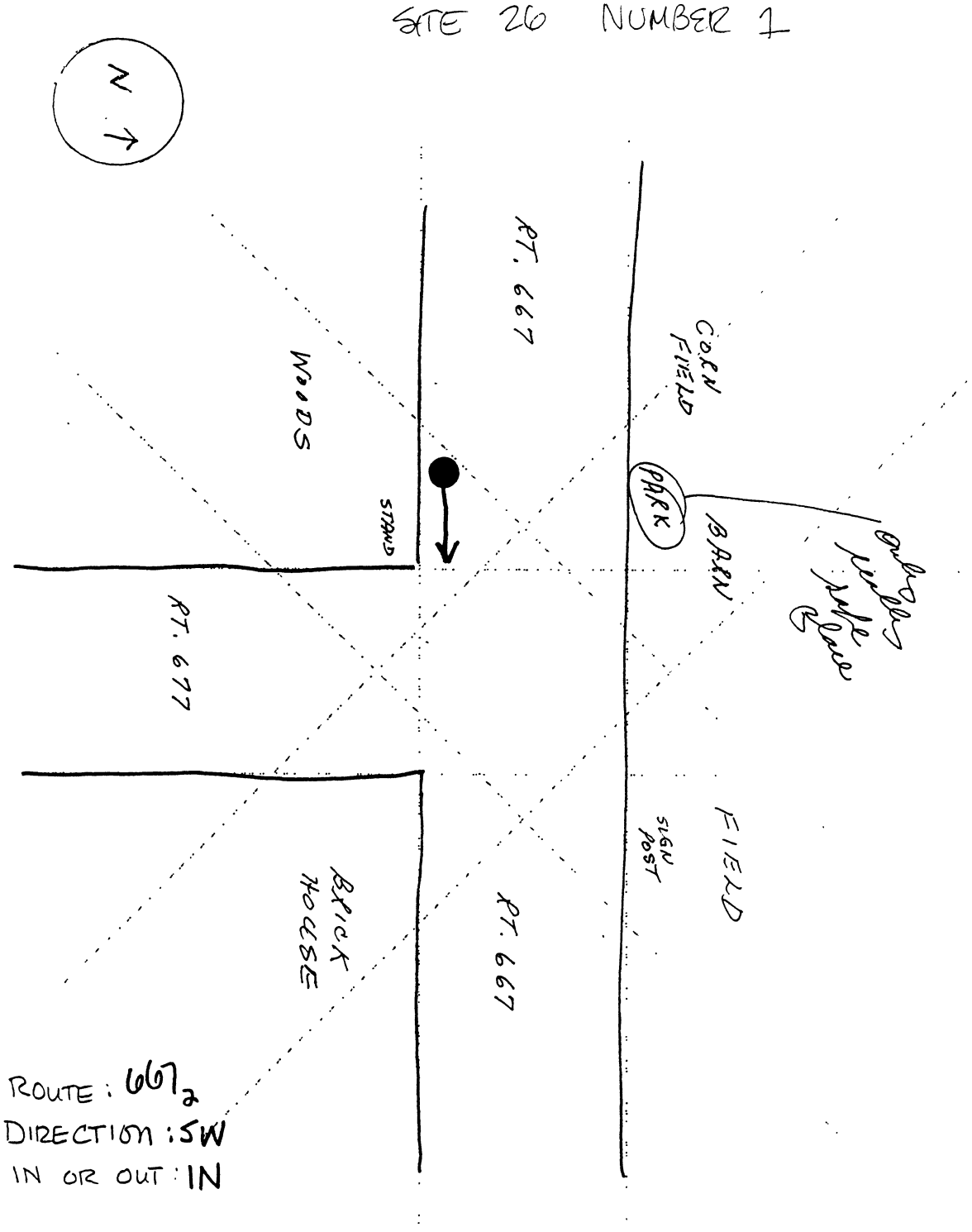


**Figure 5. URBAN SITE INTERSECTION DIAGRAM.**

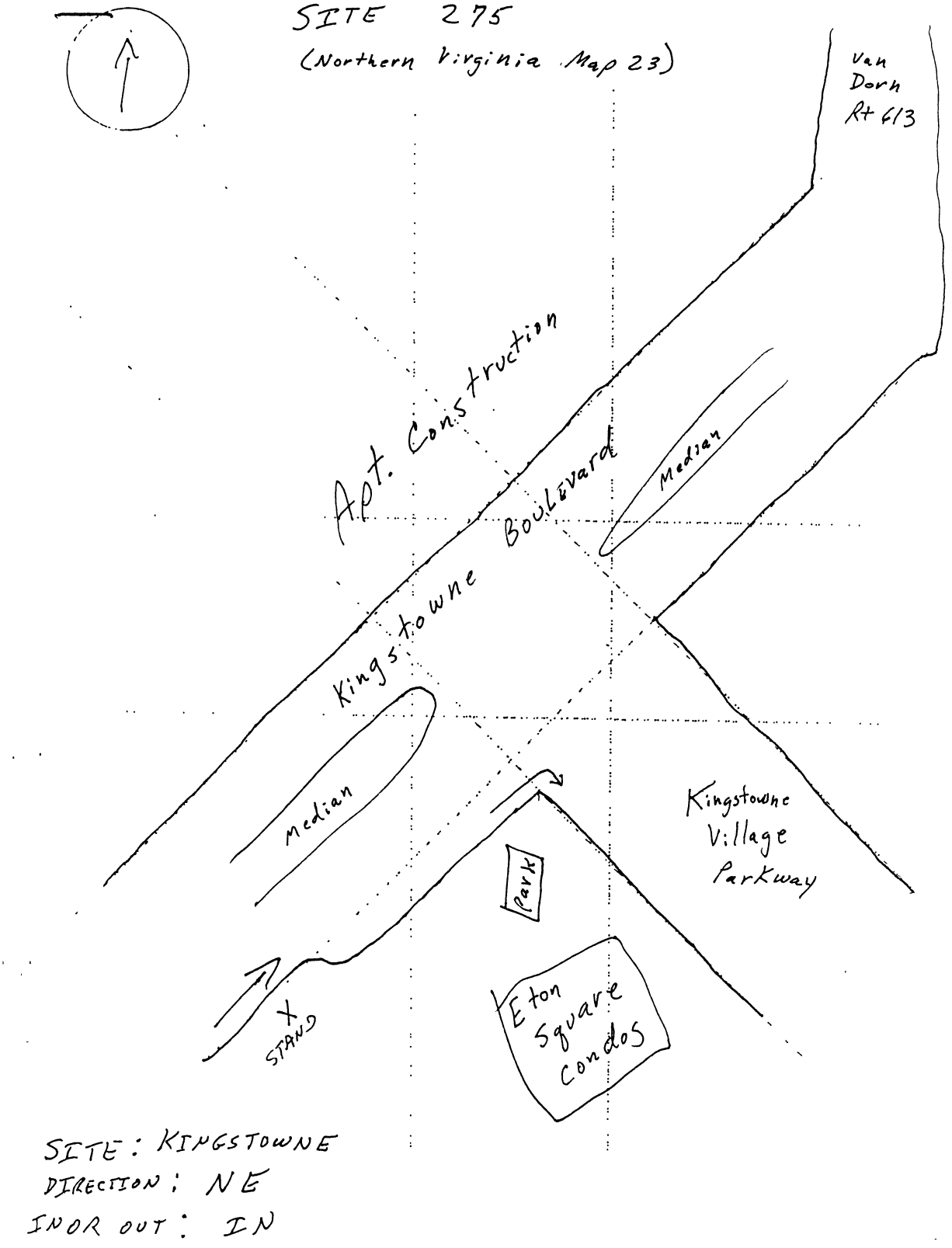


**Figure 6. RURAL SITE INTERSECTION DIAGRAM.**

$B_{ti}$ = number of belted occupants observed at site $ti$, weighted by lanes

$O_{ti}$ = total number of occupants observed at site $ti$, weighted by lanes.

The variance of the estimate $P_B$ was approximated by the formula:

$$V(P_B) \doteq \frac{1}{\overline{O}^2}[V(B) + P_B^2 V(O) - 2P_B COV(B,O)] \qquad [2]$$

where $V(P_B)$ = the approximate variance of the estimate $P_B$

$\overline{O}$ = weighted average number of occupants observed per site

$$= \frac{1}{2}\sum_{t=1}^{2}\frac{\sum_{i=1}^{n_t} N_{ti}O_{ti}}{n_t}$$

$V(B)$ = variance of the number of belted occupants

$$= \frac{1}{(N_1+N_2)^2}\sum_{t=1}^{2}\frac{N_t^2}{n_t(n_t-1)}\sum_{i=1}^{n_t}(N_{ti}B_{ti}-\overline{B}_t)^2$$

$$\text{where } \overline{B}_t = \frac{\sum_{i=1}^{n_t} N_{ti}B_{ti}}{n_t}$$

$V(O)$ = variance of the number of observed occupants

$$= \frac{1}{(N_1+N_2)^2}\sum_{t=1}^{2}\frac{N_t^2}{n_t(n_t-1)}\sum_{i=1}^{n_t}(N_{ti}O_{ti}-\overline{O}_t)^2$$

$$\text{where } \overline{O}_t = \frac{\sum_{i=1}^{n_t} N_{ti}O_{ti}}{n_t}$$

$COV(B, O)$ = covariance of the number of belted and observed occupants

$$= \frac{1}{(N_1 + N_2)^2} \sum_{t=1}^{2} \frac{N_t^2}{n_t(n_t - 1)} \sum_{i=1}^{n_t} (N_{ti}B_{ti} - \overline{B}_t)(N_{ti}O_{ti} - \overline{O}_t).$$

The standard error of the estimate was calculated by the formula:

$$SE = \frac{\sqrt{V(P_B)}}{n - 1} \qquad [3]$$

where $SE$ = standard error of the estimate

$n$ = total number of sites sampled.

The relative error of the estimate was calculated by the formula:

$$RE = \frac{SE}{P_B} \qquad [4]$$

where $RE$ = relative error of the estimate.

## RESULTS

As can be seen in Table 3, there were 26,320 weighted observations of occupants in passenger cars and 53 motorcycle rider observations. Passenger car occupants had a safety belt use rate of 71.6%. The relative error of the estimate was 0.12%.

Only 53 motorcycle riders were observed, but every rider was protected by a helmet, thereby producing a 100% use rate. The relative error of the estimate, which had no variance, was 0.

**Table 3**
**SUMMARY OF SURVEY RESULTS**

| | Weighted Observations | Drivers Protected | Passengers Protected | Use Rate | Variance | Standard Error | Relative Error |
|---|---|---|---|---|---|---|---|
| Passenger cars | 26,320 | 14,701 | 4,233 | 71.6% ($p$ = .716) | 0.011124 | 0.000886 | 0.001238 |
| Motorcycles | 53 | 47 | 6 | 100% ($p$ = 1) | 0 | 0 | 0 |

## REFERENCES


1. *Federal Register*, Docket No. 92-12, Notice No. 02, Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use, Monday June 29, 1992.

2. ADC of Alexandria, Inc., "Street Map of Northern Virginia," 34th Edition, Alexandria, Va., 1992.

3. ADC of Alexandria, Inc., "Street Map of Prince William County," 17th Edition, Alexandria, Va., 1992.

4. ADC of Alexandria, Inc., "Street Map of Richmond and Vicinity," 9th Edition, Alexandria, Va., 1991.

5. ADC of Alexandria, Inc., "Street Map of Tidewater," 15th Edition, Alexandria, Va., 1991.

6. ADC of Alexandria, Inc., "Street Map of Virginia Peninsula," 14th Edition, Alexandria, Va., 1991.

# Appendix

**Table A-1**
**URBAN SAFETY BELT AND MOTORCYCLE HELMET USE: RAW DATA BY SITE**

| Site ID | Lanes | $N_{ti}$ | $B_{ti}$ | $O_{ti}$ | MC $B_{ti}$ | MC $O_{ti}$ |
|---|---|---|---|---|---|---|
| 2 | 1 | 10 | 11 | 13 | 0 | 0 |
| 7 | 1 | 408 | 141 | 194 | 0 | 0 |
| 8 | 1 | 7 | 2 | 4 | 0 | 0 |
| 11 | 1 | 82 | 4 | 6 | 0 | 0 |
| 15 | 3 | 6 | 447 | 597 | 5 | 5 |
| 17 | 3 | 115 | 312 | 486 | 1 | 1 |
| 19 | 1 | 10 | 49 | 80 | 0 | 0 |
| 20 | 1 | 7 | 13 | 25 | 0 | 0 |
| 21 | 1 | 148 | 43 | 58 | 0 | 0 |
| 28 | 1 | 3 | 3 | 5 | 0 | 0 |
| 30 | 2 | 3 | 220 | 320 | 0 | 0 |
| 32 | 1 | 244 | 23 | 35 | 0 | 0 |
| 40 | 3 | 254 | 693 | 1083 | 1 | 1 |
| 41 | 1 | 211 | 234 | 285 | 0 | 0 |
| 42 | 1 | 36 | 8 | 12 | 0 | 0 |
| 46 | 1 | 5 | 12 | 17 | 0 | 0 |
| 49 | 1 | 6 | 2 | 2 | 0 | 0 |
| 54 | 2 | 504 | 850 | 1130 | 2 | 2 |
| 58 | 1 | 15 | 90 | 125 | 0 | 0 |
| 67 | 1 | 5 | 3 | 5 | 0 | 0 |
| 68 | 1 | 24 | 3 | 4 | 0 | 0 |
| 69 | 3 | 721 | 1053 | 1311 | 0 | 0 |
| 81 | 1 | 6 | 16 | 26 | 0 | 0 |
| 86 | 2 | 7 | 86 | 148 | 0 | 0 |
| 90 | 1 | 17 | 53 | 80 | 0 | 0 |
| 92 | 3 | 142 | 678 | 867 | 5 | 5 |
| 105 | 1 | 24 | 74 | 89 | 1 | 1 |
| 118 | 1 | 7 | 24 | 36 | 0 | 0 |
| 119 | 3 | 32 | 1332 | 1551 | 2 | 2 |
| 120 | 1 | 546 | 30 | 43 | 0 | 0 |
| 121 | 1 | 7 | 87 | 114 | 0 | 0 |
| 136 | 1 | 23 | 43 | 57 | 1 | 1 |
| 140 | 3 | 3 | 726 | 987 | 1 | 1 |
| 154 | 1 | 8 | 39 | 42 | 0 | 0 |
| 169 | 2 | 4 | 168 | 304 | 1 | 1 |
| 170 | 1 | 19 | 11 | 19 | 0 | 0 |
| 173 | 2 | 331 | 530 | 702 | 0 | 0 |
| 183 | 1 | 8 | 10 | 12 | 0 | 0 |
| 202 | 1 | 59 | 47 | 62 | 0 | 0 |
| 206 | 1 | 17 | 5 | 10 | 0 | 0 |
| 210 | 2 | 73 | 236 | 314 | 1 | 1 |
| 211 | 1 | 253 | 160 | 234 | 0 | 0 |
| 213 | 1 | 376 | 410 | 571 | 1 | 1 |
| 234 | 1 | 197 | 3 | 6 | 0 | 0 |
| 236 | 1 | 87 | 60 | 91 | 0 | 0 |
| 250 | 1 | 16 | 1 | 2 | 0 | 0 |
| 259 | 3 | 532 | 486 | 639 | 0 | 0 |
| 275 | 2 | 526 | 36 | 50 | 0 | 0 |
| 280 | 1 | 104 | 10 | 13 | 0 | 0 |

*continues*

**Table A-1 (continued)**

| Site ID | Lanes | $N_{ti}$ | $B_{ti}$ | $O_{ti}$ | MC $B_{ti}$ | MC $O_{ti}$ |
|---|---|---|---|---|---|---|
| 290 | 1 | 3 | 198 | 259 | 0 | 0 |
| 300 | 1 | 110 | 2 | 3 | 0 | 0 |
| 306 | 1 | 12 | 0 | 1 | 0 | 0 |
| 313 | 3 | 186 | 492 | 741 | 0 | 0 |
| 315 | 1 | 9 | 74 | 94 | 0 | 0 |
| 317 | 2 | 444 | 108 | 162 | 0 | 0 |
| 322 | 1 | 1 | 32 | 50 | 0 | 0 |
| 324 | 2 | 82 | 158 | 206 | 0 | 0 |
| 330 | 1 | 16 | 17 | 18 | 0 | 0 |
| 332 | 3 | 8 | 1782 | 2385 | 3 | 3 |
| 353 | 1 | 11 | 65 | 94 | 0 | 0 |
| 359 | 1 | 9 | 48 | 64 | 1 | 1 |
| 371 | 2 | 64 | 68 | 96 | 0 | 0 |
| 372 | 3 | 5 | 696 | 1032 | 3 | 3 |
| 374 | 1 | 26 | 14 | 21 | 0 | 0 |
| 375 | 1 | 12 | 181 | 248 | 6 | 6 |
| 385 | 3 | 30 | 225 | 351 | 1 | 1 |
| 388 | 1 | 10 | 7 | 8 | 0 | 0 |
| 400 | 1 | 385 | 9 | 13 | 0 | 0 |
| 403 | 2 | 341 | 410 | 580 | 4 | 4 |
| 406 | 2 | 374 | 616 | 972 | 0 | 0 |
| 411 | 1 | 19 | 100 | 124 | 0 | 0 |
| 420 | 1 | 223 | 69 | 94 | 0 | 0 |
| 425 | 1 | 365 | 41 | 51 | 0 | 0 |
| 426 | 2 | 626 | 340 | 536 | 1 | 1 |
| 434 | 1 | 25 | 1 | 5 | 0 | 0 |
| 450 | 1 | 15 | 58 | 74 | 0 | 0 |
| 458 | 2 | 180 | 64 | 88 | 0 | 0 |
| 464 | 1 | 21 | 21 | 43 | 0 | 0 |
| 471 | 1 | 13 | 2 | 5 | 1 | 1 |
| 476 | 1 | 13 | 186 | 236 | 0 | 0 |
| 477 | 1 | 11 | 25 | 35 | 0 | 0 |
| 483 | 1 | 2 | 91 | 116 | 1 | 1 |
| 508 | 2 | 628 | 520 | 852 | 4 | 4 |
| 512 | 1 | 15 | 77 | 97 | 1 | 1 |

Site ID = identifier of site sampled.
Lanes = number of lanes in sampled direction at site.
$N_{ti}$ = total number of intersections within sampled grid .
$B_{ti}$ = number of belted occupants observed at site.
$O_{ti}$ = total number of occupants observed at site.
MC $B_{ti}$ = number of motorcycle occupants with helmets at site.
MC $O_{ti}$ = total number of motorcycle occupants observed at site.

**Table A-2**
**RURAL SAFETY BELT AND MOTORCYCLE HELMET USE: RAW DATA BY SITE**

| Site ID | Lanes | $N_{ti}$ | $B_{ti}$ | $O_{ti}$ | MC $B_{ti}$ | MC $O_{ti}$ |
|---|---|---|---|---|---|---|
| 1 | 1 | 15 | 36 | 45 | 0 | 0 |
| 4 | 1 | 9 | 18 | 26 | 0 | 0 |
| 5 | 1 | 9 | 1 | 6 | 0 | 0 |
| 6 | 1 | 16 | 25 | 32 | 0 | 0 |
| 9 | 1 | 6 | 12 | 18 | 0 | 0 |
| 10 | 1 | 5 | 4 | 9 | 0 | 0 |
| 12 | 1 | 4 | 318 | 525 | 0 | 0 |
| 13 | 1 | 17 | 6 | 14 | 0 | 0 |
| 16 | 1 | 4 | 12 | 14 | 0 | 0 |
| 18 | 1 | 8 | 0 | 0 | 0 | 0 |
| 22 | 1 | 12 | 6 | 10 | 0 | 0 |
| 23 | 1 | 7 | 69 | 90 | 0 | 0 |
| 25 | 1 | 6 | 23 | 30 | 0 | 0 |
| 26 | 1 | 9 | 8 | 16 | 0 | 0 |
| 27 | 1 | 13 | 4 | 6 | 0 | 0 |
| 29 | 1 | 6 | 0 | 3 | 0 | 0 |
| 31 | 1 | 7 | 7 | 14 | 0 | 0 |
| 33 | 1 | 15 | 13 | 19 | 0 | 0 |
| 35 | 1 | 9 | 30 | 48 | 0 | 0 |
| 36 | 1 | 12 | 2 | 4 | 0 | 0 |
| 37 | 1 | 1 | 26 | 39 | 0 | 0 |
| 39 | 1 | 10 | 37 | 58 | 1 | 1 |
| 44 | 1 | 7 | 2 | 4 | 0 | 0 |
| 45 | 1 | 7 | 79 | 138 | 0 | 0 |
| 47 | 3 | 18 | 897 | 1,191 | 4 | 4 |
| 48 | 1 | 15 | 1 | 2 | 0 | 0 |
| 50 | 1 | 8 | 38 | 67 | 0 | 0 |
| 51 | 1 | 11 | 1 | 3 | 0 | 0 |
| 52 | 1 | 3 | 30 | 50 | 0 | 0 |
| 53 | 1 | 2 | 12 | 16 | 0 | 0 |
| 55 | 1 | 12 | 28 | 37 | 0 | 0 |
| 56 | 2 | 5 | 130 | 224 | 0 | 0 |
| 57 | 1 | 13 | 8 | 22 | 0 | 0 |
| 59 | 1 | 7 | 11 | 21 | 0 | 0 |
| 62 | 2 | 13 | 598 | 794 | 0 | 0 |
| 63 | 1 | 15 | 68 | 105 | 0 | 0 |

Site ID = identifier of site sampled.
Lanes = number of lanes in sampled direction at site.
$N_{ti}$ = total number of intersections within sampled grid.
$B_{ti}$ = number of belted occupants observed at site.
$O_{ti}$ = total number of occupants observed at site.
MC $B_{ti}$ = number of motorcycle occupants with helmets at site.
MC $O_{ti}$ = total number of motorcycle occupants observed at site.