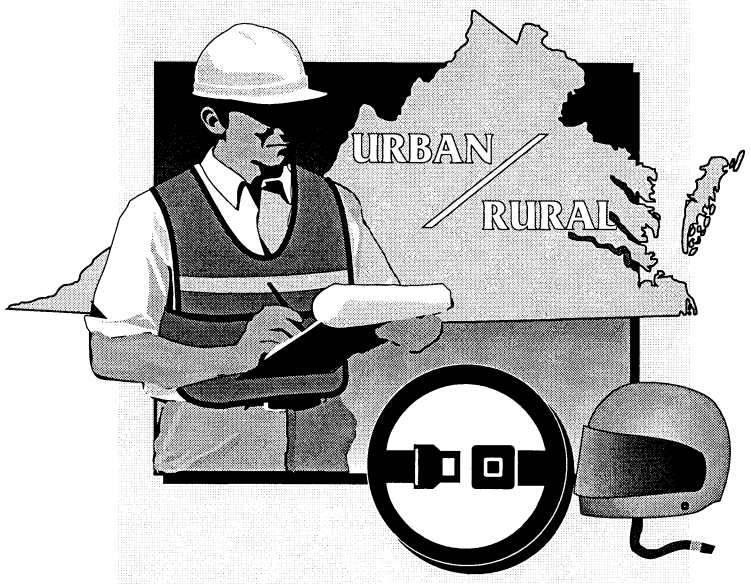
TECHNICAL
ASSISTANCE REPORT

SAFETY BELT AND MOTORCYCLE HELMET USE IN VIRGINIA: RESULTS OF THE 1992 THROUGH 1995 SURVEYS



CHARLES B. STOKE
Senior Research Scientist

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Author(s)
Charles B. Stoke

Performing Organization Name and Address:
Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, Virginia 22903

Sponsoring Agencies' Names and Addresses

Virginia Department of Transportation
1401 E. Broad Street
Richmond, Virginia 23219

University of Virginia
Charlottesville
Virginia 22903

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Virginia Department of Motor Vehicles
P. O. Box 27412
Richmond, Virginia 23269

Abstract

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Even though the funding program ended, the Virginia Department of Motor Vehicles requested that data collection continue and that the same methods, procedures, and sites be used as were used for the Section 153 program.

This report describes the methodology used for data collection and adds the results of the 1995 survey to those for the previous years (1992-1994). The results show that Virginia's 1995 safety belt use rate was 70.2% and the motorcycle helmet use rate was 100.0%. The helmet use rate has been 100% in all 4 years of the study. For the first 3 years the survey was conducted (1992-1994), the safety belt use rates were 71.6%, 73.2%, and 71.8%, respectively.

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(The opinions, findings, and conclusions expressed in this report are those of the author 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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This series of surveys to determine the safety belt and motorcycle helmet use rates in Virginia was initiated to qualify the Commonwealth for incentive funds in accordance with the requirements of the Intermodal Surface Transportation Efficiency Act, Section 153. To receive the funds, states had to meet specified standards with regard to the existence of pertinent statutes as well as safety belt and motorcycle helmet use rates. The National Highway Traffic Safety Administration specified the survey criteria to be used in determining a state's use rate. Over the 3 years the program was in operation (1991-1993), Virginia qualified for approximately $1.6 million in funds.

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INTRODUCTION

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) added a new section (§ 153) to Title 23 of the U.S. Code. This section authorized 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 funds, a state was required to have laws requiring the use of a helmet by all motorcycle riders and the use of a belt or child safety seat by all front-seat occupants in cars. To qualify for second- and third-year funding, a state was required to have mandatory use laws and demonstrate a specified level of compliance. In FY 93, states were required to demonstrate statewide belt usage of at least 55% and helmet usage of at least 70%. For FY 94, the required usage levels increased to 70% for belts and 85% for helmets. Virginia qualified for funding all 3 years of the program. The total amount received exceeded $1.5 million.

On June 29, 1992, the National Highway Traffic Safety Administration (NHTSA) published the final guidelines for the conduct of surveys of belt and helmet use in the states.[1] The guidelines required that the selection of survey samples be based on a single "probability based" survey design and that only direct observational data be used to demonstrate compliance. The sample design had to 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 were to be observed; (5) collecting the observational data; and (6) beginning and concluding an observation period. The guidelines further stated that the relative error of the estimate could be no more than ± 5% and that all drivers, outboard front-seat passengers, and motorcycle drivers and passengers had to be eligible for observation. The guidelines also required that at least 85% of the state's population be eligible for inclusion and that only the smallest counties, based on population, could be eliminated from the sampling frame. Finally, all daylight hours and all days of the week had to be eligible for inclusion in the sample, and the scheduling of the time and day for each sample site had to be done randomly.

PURPOSE AND SCOPE

The purpose of this project was to conduct a survey of safety belt and motorcycle helmet use in accordance with NHTSA's guidelines. Even though the § 153 funding program has ended, safety belt and motorcycle helmet data have continued to be collected at the request of the

Virginia Department of Motor Vehicle's Transportation Safety Administration. The methods and procedures that qualified the state for incentive funds were used in all the surveys. In this way, longitudinal data can be compared between years and over a period of years. When methods of data collection change, the making of comparisons is compromised to the extent that differences in collection procedures affect the results.

METHODS

This survey included five major tasks: (1) defining the population from which the sample was drawn, (2) determining the number of survey sites, (3) developing the sampling plan, (4) developing procedures and collecting data, and (5) determining how estimates would be weighted to approximate statewide figures.

Population

According to federal guidelines, localities with the smallest populations and making up less than 15% of the state's total population could be removed from the study population. In Virginia, determining which localities made up 15% of the population was complex. In most states, a city is a part of its surrounding county. In Virginia, although towns are considered to be a part of their surrounding county, 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.

Table 1 shows the 136 counties and independent cities in Virginia ordered by population. According to 1990 census figures, Virginia's total population is about 6.2 million. However, most of the population 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 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; thus, they were excluded from sampling. Figure 1 is 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.

Number of Survey Sites

The next step in the project was to determine the number of statewide sites necessary to fulfill NHTSA's requirements of a relative error of ± 5% and 95% confidence. When

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	Glouchester 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		

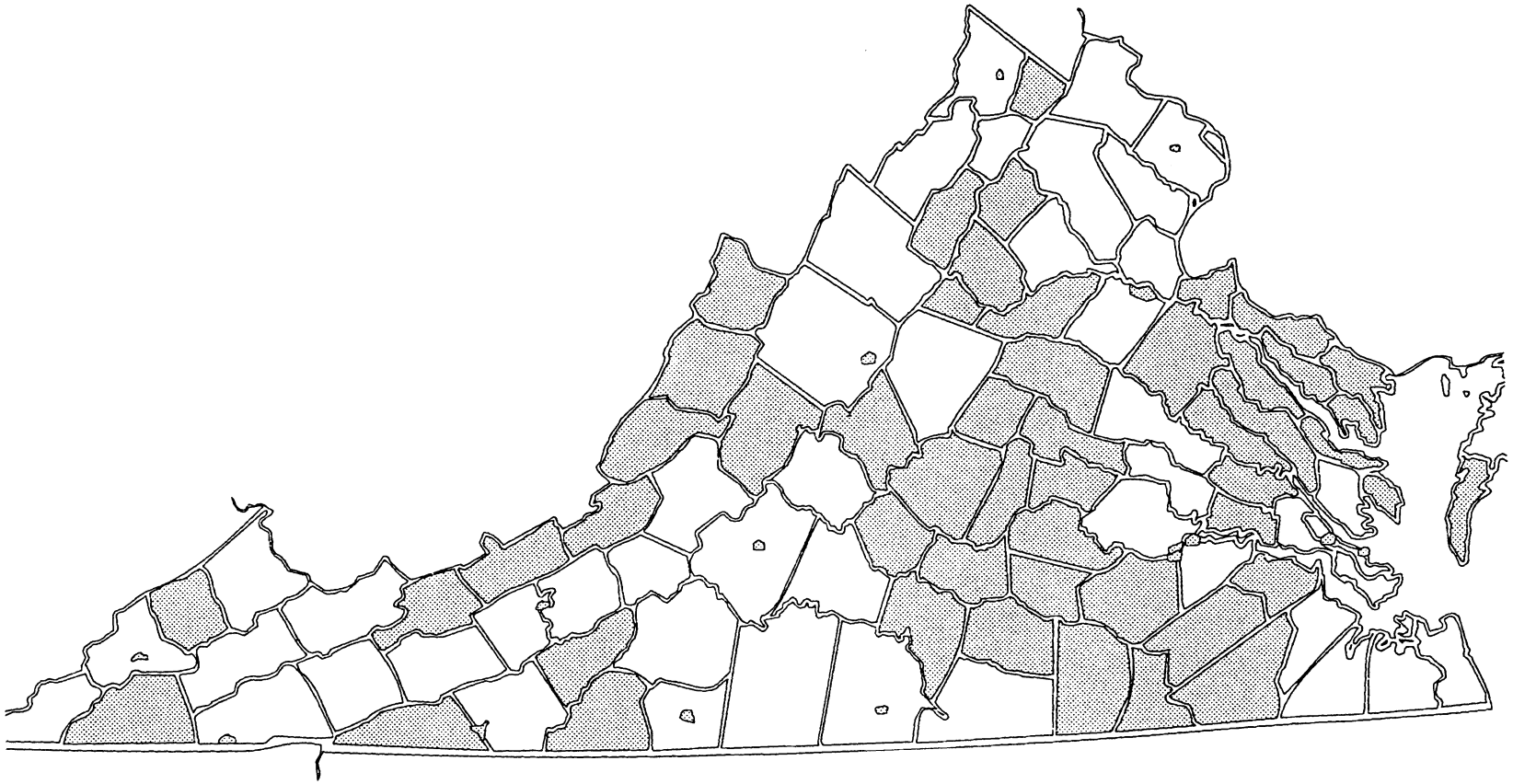

Figure 1. Areas excluded from sampling procedures (shaded).

computations were carried out to determine the number of sites necessary to meet these requirements, it was found that 78 sites would be adequate. After reviewing the project work plan, NHTSA wrote (September 4, 1992) that they would require Virginia to use 120 sites. The same 120 sites have been used every year the survey has been conducted. In addition, data were collected on the same day of the week and the same hour of the day at each site during the 4 years.

Sampling Plan

To select the sample of sites, a grid with 0.64-cm by 0.64-cm (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 2.54 cm = 20.92 km (1 in = 13 miles). Figure 2 is a sample section of the map. Each grid box contained approximately 27.19 km^2 (10.5 square miles). This procedure produced a system of 144 sections across the horizontal axis 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 or were wholly within excluded areas. To keep these boxes from affecting the random nature of the sample, they were not defined as part of the study population. 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.

To respond to a concern expressed by NHTSA that a pure statewide random sample of 120 sites would overrepresent the nonurban areas of Virginia, the originally proposed procedures were changed. The selection of sites was based on the proportion of the population in the urban and rural areas of the state. 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, 84 were randomly selected from the four metropolitan areas and 36 were randomly selected from the remainder of the state.

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 was generated to select the specific intersection to be sampled. Two alternate sites were also selected randomly from the box. For each primary and alternate site, random numbers were used to select which route and direction of travel and whether traffic entering or exiting the selected intersection would be observed. Figures 3 and 4 are examples of urban and rural grid boxes and potential sites.

Members of the study team visited and evaluated each site to determine whether data could be safely and adequately collected. The safety of the observer was the primary criterion for evaluating 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.

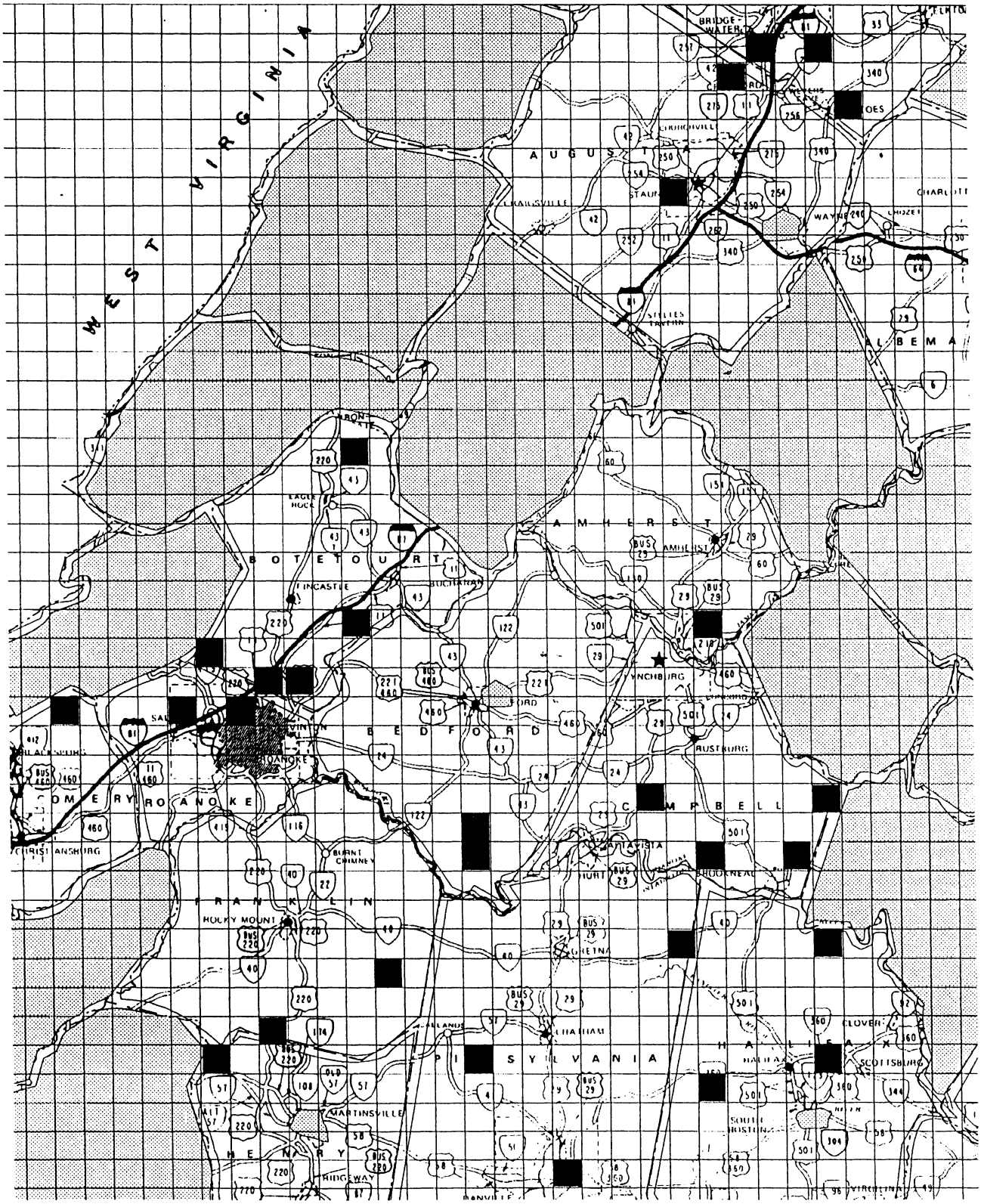

Figure 2. Sample section of state map showing grid boxes.

Figure 3. Detail of urban grid showing intersection choices.

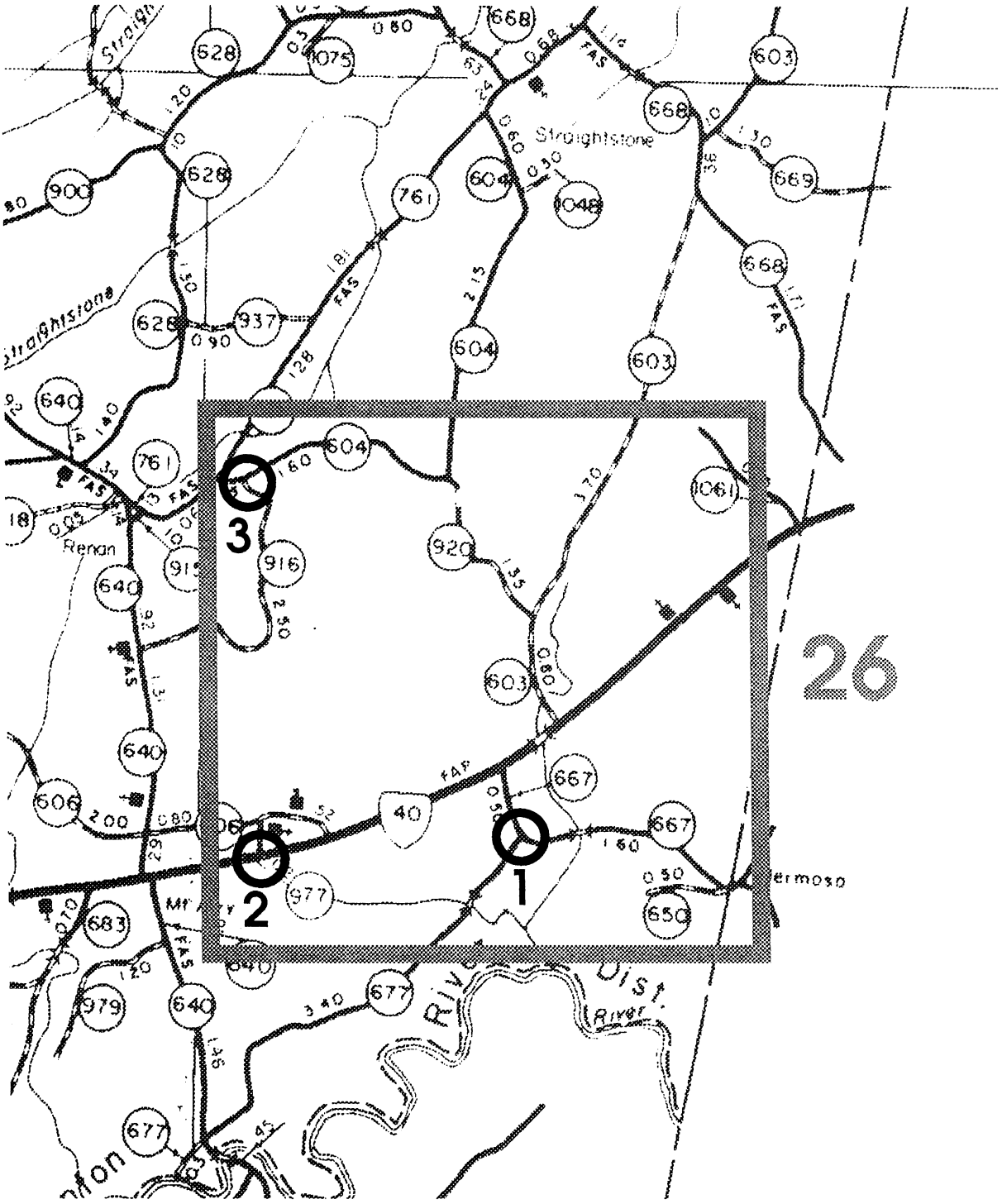

Figure 4. Detail of rural grid showing intersection choices.

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 sites 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 required the observer to be below the level of the roadway, making observation 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. Data were collected for 1 hr at each site all 4 years. 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 at a later date but at the originally specified time and on the same day of the week.

Data Collection Procedures

All passenger cars in the curb lane were observed for shoulder belt use by the specified passengers. (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. If a momentary interruption occurred, the observer was instructed to resume observing vehicles, but 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 "no" count was made for shoulder belt use for drivers and outboard front-seat passengers for each passenger car in the curb travel lane and for motorcycle driver and passenger helmet use in any lane at the intersection. The data collectors were required to complete a training program on the use of the counter board and how the data were to be collected and recorded. The data collectors were checked for inter-rater reliability in training sessions before they began 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).

In 1992, 1993, and 1994, college students were hired for data collection as summer employees of the Virginia Transportation Research Council (VTRC). Because of a mandate from the Governor's office to reduce the number of employees on the state payroll, a contract was executed with the Weldon Cooper Center for Public Service at the University of Virginia (the Center) for 1995 data collection. The Center hired personnel who collected the data in accordance with previously established procedures and furnished VTRC with the data formatted for use in the formula for computing the statewide use rate. Although VTRC was responsible for all training and scheduling, it had no role in the hiring of the employees and only a partial role in their supervision and quality assurance checks.

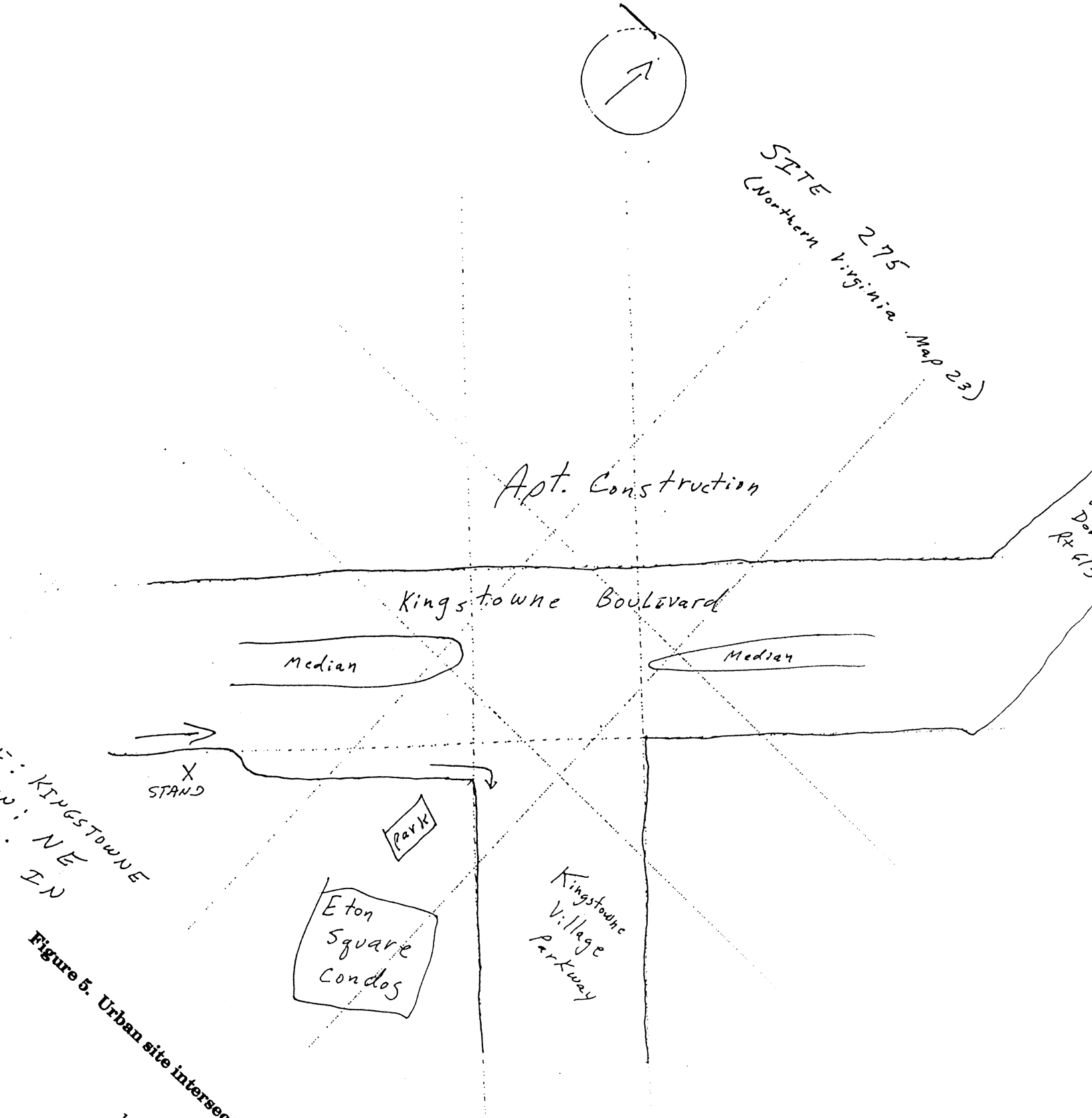

Figure 5. Urban site intersection diagram.

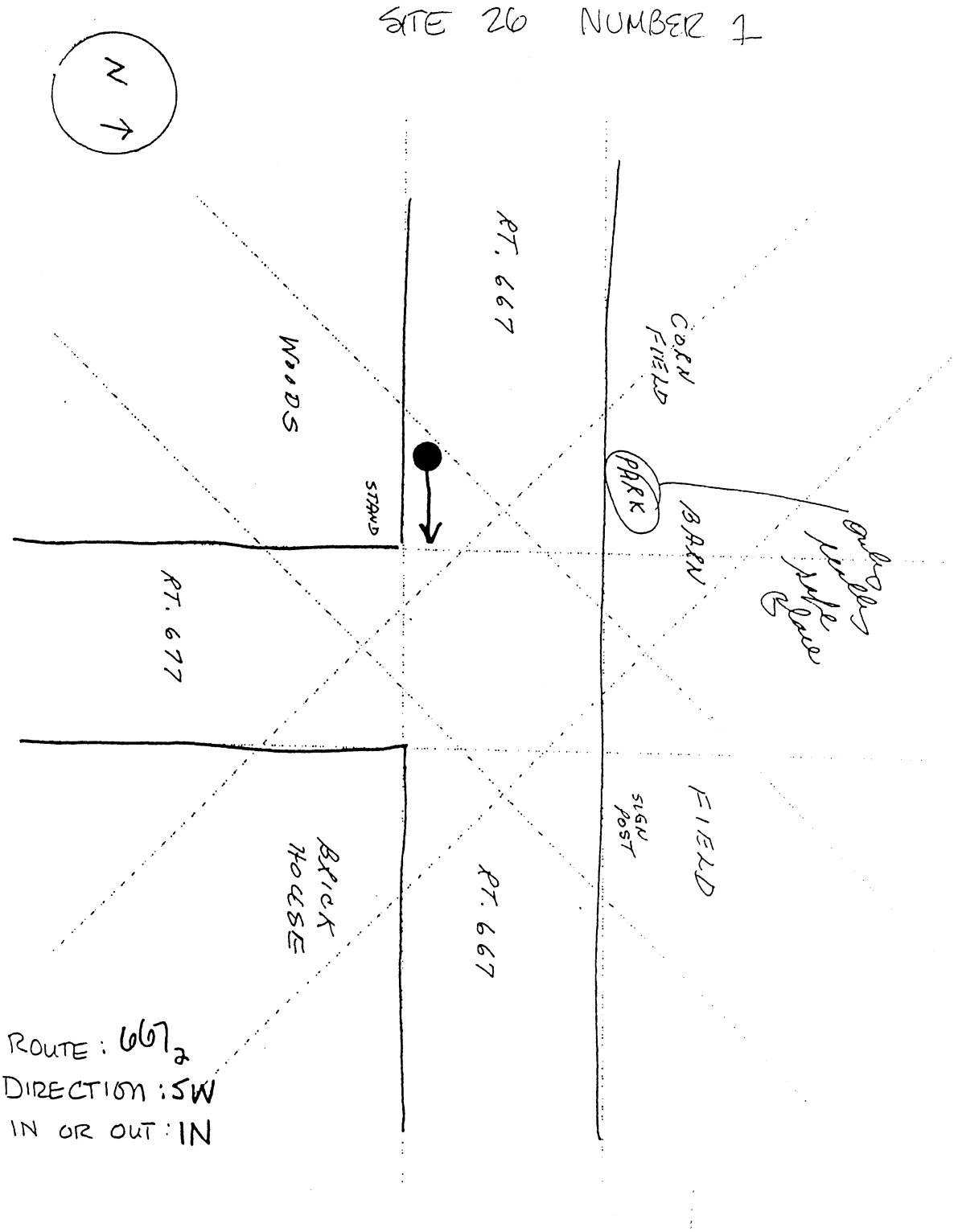

Figure 6. Rural site intersection diagram.

Calculation of Use and Error Rates

Because safety belt use was observed only in the curb lane, the NHTSA guidelines required that the observations taken on multilane highways be weighted by the number of lanes of travel. 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 was doubled to estimate the total number of drivers and passengers who crossed the site.

As previously discussed, the selection of sites was stratified to represent urban and rural areas in proportion to their populations. Thus, more than two thirds of the sites were in urban areas.

The use rate, P_B, is the estimated proportion of drivers and passengers using safety belts and is 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 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
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 estimated belt use, $V(P_B)$, was approximated by the formula:

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

where $\bar{O}$ is the weighted average number of occupants observed per site and is computed by the formula:

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

and where *V(B)* is the variance of the number of belted occupants and is computed by the formula:

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

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

and where *V(O)* is the variance of the number of observed occupants and is computed by the formula:

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

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

and where *COV(B, O)* is the covariance of the number of belted and observed occupants and is computed by the formula:

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

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

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

where SE = standard error of the estimate
n = total number of sites sampled.

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

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

where RE = relative error of the estimate.

RESULTS

As can be seen from the data in Table 2, there were 29,584 weighted observations of occupants in passenger cars. Of these, there were 15,632 drivers and 4,521 right-front passengers who were observed to be using a shoulder belt. Passenger car occupants had a weighted safety belt use rate of 70.2%. The relative error of the estimate was 0.15%.

Table 2

Summary of 1995 Survey Results

	Weighted Observations	Drivers Protected	Passengers Protected	Use Rate	Variance	Standard Error	Relative Error
Passenger cars	29,584	15,632	4,521	70.2% (p = .702)	0.01523	0.001037	0.001477
Motor-cycles	247	208	39	100% (p = 1)	0	0	0

There were 247 motorcycle riders observed (208 drivers and 39 passengers), and the rate of helmet use was 100%. The relative error of the estimate, which had no variance, was 0.

The results from the fall 1992 survey are shown in Table 3, and those from the summers of 1993 and 1994 are shown in Tables 4 and 5. In each of the 4 years (1992-1995), 100% of the motorcycle drivers and passengers observed were using a helmet. For the passenger car drivers and right-front passengers observed, use rates were 71.6%, 73.2%, 71.8%, and 70.2% over these 4 years. As a practical matter, there is little difference in the rates of use.

Table 3

Summary of 1992 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
Motor-cycles	53	47	6	100% ($p = 1$)	0	0	0

Table 4

Summary of 1993 Survey Results

	Weighted Observations	Drivers Protected	Passengers Protected	Use Rate	Variance	Standard Error	Relative Error
Passenger cars	24,299	13,045	4,396	73.2% ($p = .732$)	0.008885	0.000792	0.001083
Motor-cycles	236	208	28	100% ($p = 1$)	0	0	0

Table 5

Summary of 1994 Survey Results

	Weighted Observations	Drivers Protected	Passengers Protected	Use Rate	Variance	Standard Error	Relative Error
Passenger cars	25,291	14,146	4,271	71.8% ($p = .718$)	0.00743	0.000724	0.001009
Motor-cycles	105	90	15	100% ($p = 1$)	0	0	0

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REFERENCES

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

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

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

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

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

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

APPENDIX

1995 Raw Data by Site

Table A-1

Urban Raw Data by Site[a]

Site ID	Lanes	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	Mc O_{ti}
2	1	10	4	10	0	0
7	1	408	110	158	0	0
8	1	7	2	3	0	0
11	1	82	3	4	0	0
15	3	6	447	654	5	5
17	3	115	204	354	1	1
19	1	10	104	158	0	0
20	1	7	6	15	0	0
21	1	148	39	47	1	1
28	1	3	5	8	0	0
30	2	3	214	394	1	1
32	1	244	47	66	0	0
40	3	254	777	1065	0	0
41	1	211	198	271	1	1
42	1	36	13	20	0	0
46	1	5	23	38	0	0
49	1	6	0	0	0	0
54	2	504	890	1062	0	0
58	1	15	38	61	0	0
67	1	5	0	4	0	0
68	1	24	6	13	0	0
69	3	721	1383	1809	3	3
81	1	6	25	49	2	2
86	2	7	148	298	7	7

Table A-1

90	1	17	73	111	1	1
92	3	142	516	657	11	11
105	1	24	60	69	1	1
118	1	7	35	52	0	0
119	3	32	1068	1584	2	2
120	1	546	32	45	0	0
121	1	7	198	259	4	4
136	1	23	31	52	0	0
140	3	3	1629	2025	3	3
154	1	8	52	69	2	2
169	2	4	108	218	3	3
170	1	19	2	2	0	0
173	2	331	552	728	6	6
183	1	8	13	18	0	0
202	1	59	50	79	1	1
206	1	17	9	11	0	0
210	2	73	312	420	8	8
211	1	253	205	322	4	4
213	1	376	221	312	1	1
234	1	197	0	0	0	0
236	1	87	39	57	0	0
250	1	16	0	2	5	5
259	3	532	1218	1569	1	1
275	2	526	128	188	1	1
280	1	104	12	12	0	0
290	1	3	144	206	2	2
300	1	110	4	4	0	0
306	1	12	2	2	0	0
313	3	186	615	924	1	1

Table A-1

315	1	9	95	158	0	0
317	2	444	90	190	0	0
322	1	1	27	40	0	0
324	2	82	164	248	0	0
330	1	16	7	16	1	1
332	3	8	963	1446	49	49
353	1	11	81	127	6	6
359	1	9	42	49	2	2
371	2	64	30	38	0	0
372	3	5	1200	1686	15	15
374	1	26	16	27	2	2
375	1	12	173	290	4	4
385	3	30	597	1005	2	2
388	1	10	2	7	0	0
400	1	385	8	14	0	0
403	2	341	332	500	4	4
406	2	374	218	368	2	2
411	1	19	55	85	2	2
420	1	223	84	111	0	0
425	1	365	45	65	0	0
426	2	626	496	834	12	12
434	1	25	5	6	0	0
450	1	15	111	153	1	1
458	2	180	152	256	0	0
464	1	21	35	55	2	2
471	1	13	2	4	0	0
476	1	13	434	614	5	5
477	1	11	7	16	0	0
483	1	2	73	99	0	0

Table A-1

508	2	628	534	920	4	4
512	1	15	93	126	0	0

[a]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 Raw Data by Site[a]

Site ID	Lanes	N_{ti}	B_{ti}	O_{ti}	MC B_{ti}	Mc O_{ti}
1	1	15	28	57	1	1
4	1	9	12	28	2	2
5	1	9	3	3	0	0
6	1	16	25	50	1	1
9	1	6	1	9	2	2
10	1	5	0	0	0	0
12	2	4	422	694	0	0
13	1	17	22	33	0	0
16	1	4	3	7	0	0
18	1	8	0	1	0	0
22	1	12	6	20	0	0
23	1	7	44	91	1	1
25	1	6	28	42	0	0
26	1	9	2	9	0	0
27	1	13	2	3	17	17
29	1	6	3	9	0	0
31	1	7	5	11	0	0
33	1	15	70	94	3	3
35	1	9	38	51	2	2
36	1	12	3	3	0	0
37	1	1	29	53	0	0
39	1	10	8	17	0	0
44	1	7	3	13	3	3
45	1	7	50	106	5	5
47	3	18	624	1074	13	13
48	1	15	1	4	0	0
50	1	8	34	65	2	2

Table A-2

51	1	11	0	3	0	0
52	1	3	5	16	0	0
53	1	2	13	21	0	0
55	1	12	19	60	0	0
56	2	5	52	140	0	0
57	1	13	0	3	0	0
59	1	7	0	0	0	0
62	2	13	344	566	4	4
63	1	15	69	117	0	0

[a]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.