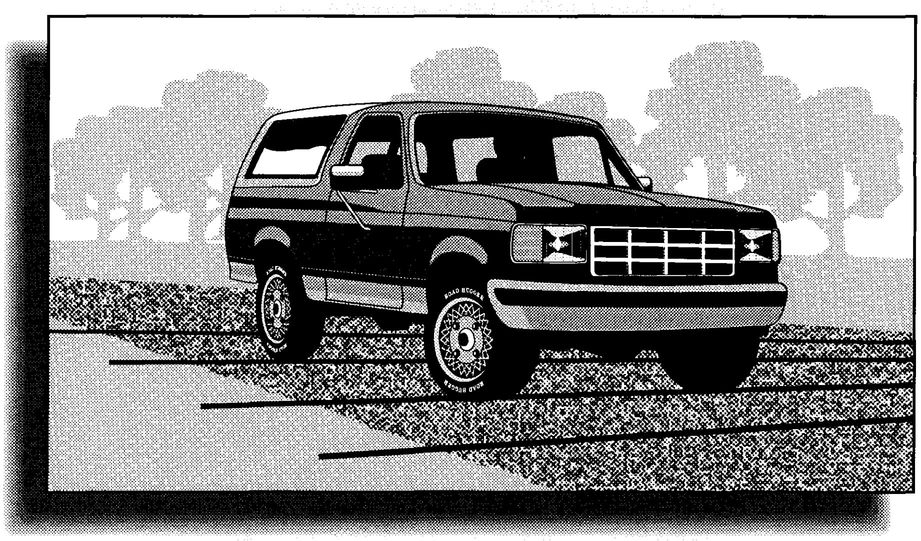
FINAL REPORT

INVESTIGATION OF TRAFFIC COUNT PROCEDURES ON UNPAVED ROADS



S. L. JONES, JR.
Graduate Research Assistant

E. D. ARNOLD, JR.
Senior Research Scientist

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

Standard Title Page — Report on State Project

Report No.	Report Date	No. Pages	Type Report:	Project No.:
VTRC95-R19	April 1995	35	Final Report	9116-030
				Contract No.:

Title and Subtitle

Investigation of Traffic Count Procedures on Unpaved Roads

Author(s)

S. L. Jones, Jr. and E. D. Arnold, Jr.

Performing Organization Name and Address:

Virginia Transportation Research Council
530 Edgemont Road
Charlottesville, Virginia 22903-0817

Sponsoring Agencies' Names and Addresses

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

University of Virginia
Charlottesville
Virginia 22903

Key Words

Low-volume roads
Estimating traffic
Unpaved roads
Traffic counters

Supplementary Notes

Abstract

This report inventoried the current costs and procedures of VDOT's Secondary Count Program, with special attention to costs and procedures for traffic counts on unpaved roads. A survey of VDOT's nine District Traffic Engineers on unpaved road counts, a field evaluation of the accuracy of road tubes on unpaved roads, results of a literature review on alternative procedures for obtaining traffic volumes on unpaved roads, and a survey of the other states that maintain a system of secondary roads, are presented. Of the 9,931 secondary road counts requested in 1993, 2,143 were on unpaved roads. Cost estimates indicated that counting unpaved roads was approximately 17% of the secondary count program expenditure in 1993. The actual field work constituted approximately 10% of the expenditure; the remaining 90% was office work and support services. The District Traffic Engineers were concerned about the accuracy of unpaved road counts, due to local residents tampering with the equipment and the need to apply adjustment factors to the raw counts. Field evaluation of the road tubes indicated that they performed well on unpaved surfaces. However, the programmable counters were more accurate on unpaved roads than the cumulative models currently used by the Department. The literature review indicated that mechanical traffic counts are the most cost-effective way to collect traffic volumes. Trip generation and traffic forecasting methods have no inherent accuracy. Most other states responsible for maintaining a secondary road system do not have specific programs or guidelines for counting unpaved roads, but all of these states use road tubes. Programmable counters can produce hourly counts and provide machine-readable data, which would help identify false counts resulting from tampering with the equipment, reveal possible equipment failures during the counting period, relieve VDOT staff of having to retrieve counters from the field after precisely 24 hours, and reduce the risk of recorder error by downloading the counter directly to a computer. Based on the literature reviews, inventories, surveys, and field tests, all traffic counts on unpaved roads should use programmable, machine-readable counting devices.

FINAL REPORT

INVESTIGATION OF TRAFFIC COUNT PROCEDURES ON UNPAVED ROADS

S. L. Jones, Jr.
Graduate Research Assistant

E. D. Arnold, Jr.
Senior Research Scientist

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

Charlottesville, Virginia

VTRC 95-R19
April 1995

TRAFFIC RESEARCH ADVISORY COMMITTEE

ABSTRACT

This report inventoried the current costs and procedures of VDOT's Secondary Count Program, with special attention to costs and procedures for traffic counts on unpaved roads. A survey of VDOT's nine District Traffic Engineers on unpaved road counts, a field evaluation of the accuracy of road tubes on unpaved roads, results of a literature review on alternative procedures for obtaining traffic volumes on unpaved roads, and a survey of the other states that maintain a system of secondary roads, are presented.

Of the 9,931 secondary road counts requested in 1993, 2,143 were on unpaved roads. Cost estimates indicated that counting unpaved roads was approximately 17% of the secondary count program expenditure in 1993. The actual field work constituted approximately 10% of the expenditure; the remaining 90% was office work and support services. The District Traffic Engineers were concerned about the accuracy of unpaved road counts, due to local residents tampering with the equipment and the need to apply adjustment factors to the raw counts. Field evaluation of the road tubes indicated that they performed well on unpaved surfaces. However, the programmable counters were more accurate on unpaved roads than the cumulative models currently used by the Department.

The literature review indicated that mechanical traffic counts are the most cost-effective way to collect traffic volumes. Trip generation and traffic forecasting methods have no inherent accuracy. Most other states responsible for maintaining a secondary road system do not have specific programs or guidelines for counting unpaved roads, but all of these states use road tubes.

Programmable counters can produce hourly counts and provide machine-readable data, which would help identify false counts resulting from tampering with the equipment, reveal possible equipment failures during the counting period, relieve VDOT staff of having to retrieve counters from the field after precisely 24 hours, and reduce the risk of recorder error by downloading the counter directly to a computer. Based on the literature reviews, inventories, surveys, and field tests, all traffic counts on unpaved roads should use programmable, machine-readable counting devices.

FINAL REPORT

INVESTIGATION OF TRAFFIC COUNT PROCEDURES ON UNPAVED ROADS

S.L. Jones, Jr., Graduate Research Assistant, and E.D. Arnold, Jr.,
Senior Research Scientist

INTRODUCTION AND PROBLEM STATEMENT

Virginia is one of five states (Alaska, Delaware, North Carolina, Virginia, West Virginia) that is responsible for maintaining its secondary road system.[1] The Virginia Department of Transportation (VDOT) maintains approximately 74,000 km (46,000 miles) of road within its Secondary Roads System, approximately 15,700 km (10,300 miles) of which are unpaved. Table 1 presents the mileage of the Secondary Road System by surface type in each of VDOT's nine Construction Districts. The Secondary Roads Division of VDOT uses traffic data collected from these unpaved, secondary roads primarily for allocating construction funds in its Unpaved Secondary Roads Fund pursuant to Code of Virginia 33.1-23.1:1. The Code specifies that construction funds "shall be distributed to counties in the secondary system based on the ratio of nonsurface treated roads in each county carrying fifty vehicles or more per day to the total number of such nonsurface treated roads in the Commonwealth." Since traffic counts on unpaved roads are used to determine the eligibility of individual roads for paving with Unpaved Secondary Roads Funds, traffic counts are essential to VDOT and the counties for determining upgrading and paving priorities. The Transportation Planning Division of VDOT also uses these traffic counts for planning purposes.

Traffic counts on unpaved roads are collected by the procedures prescribed in the Secondary Roads Count Program. These procedures require that traffic counts be obtained every four years on all unpaved roads, except for those displaying a previous count between 40 and 49 vehicles. Traffic counts on these roads are currently obtained every two years. A recent consultant study recommended a new procedure for obtaining traffic counts on secondary roads, which would require secondary roads functionally classified as arterials or collectors to be counted every three years. Traffic counts on secondary roads classified as local roads are scheduled every six years, except for unpaved roads where the last count was between 40 and 49 vehicles. Those counts are taken every three years to help the Secondary Roads Division allocate the Unpaved Secondary Roads Funds. The consultant study also recommended restricting cumulative counters to rural minor collectors and phasing out the use of these counters over time.[2] VDOT conducts approximately 11,000 traffic counts each year on secondary roads, approximately one fourth of which are on unpaved roads.

Table 1: Secondary Road System Mileage by Surface Type in Each District.

District	Paved	Unpaved Class II	Unpaved Class III	Unpaved Class IV	Total
Bristol	3,893.25	1,763.12	335.20	41.32	6,032.89
Culpeper	2,677.30	906.49	239.91	6.58	3,830.28
Fredericksburg	3,637.14	338.54	122.20	0.27	4,098.15
Lynchburg	4,631.54	1,141.23	335.25	0.99	6,109.01
NOVA	3,458.76	315.26	98.50	4.72	3,877.24
Richmond	5,212.25	751.55	165.13	4.83	6,133.76
Salem	5,219.89	1,385.73	405.05	35.08	7,045.75
Staunton	3,513.54	1,334.41	197.41	39.81	5,085.17
Suffolk	3,517.91	237.51	69.95	2.07	3,827.44
Total	35,761.58	8,173.84	1,968.60	135.67	46,039.69

Source: VDOT 1993 Mileage Tables.

Unpaved secondary roads typically experience little adjacent development over time, and incur little change in traffic volume. The Department is concerned about committing its resources, even as infrequently as every three or six years, to count traffic on unpaved roads. Reducing the effort needed to obtain traffic volumes for these roads could save time and money, without adversely affecting the allocation processes of the Secondary Roads Division and local jurisdictions.

The current method of obtaining traffic counts on unpaved roads, using road tubes and mechanical counters that provide only a cumulative total of vehicles, introduces two potential sources of error that may result in faulty traffic volume information. Firstly, gravel and uneven road surfaces may affect the performance of the tube. Secondly, since the counter only provides a cumulative volume, VDOT personnel must return to the location precisely 24 hours after the placing the counter to ensure an accurate count.

PURPOSE AND SCOPE

This study assessed the effectiveness of VDOT's current traffic counting procedures for unpaved secondary roads, pursuing the following objectives:

- Determine the accuracy of road tubes for counting traffic on unpaved roads.
- Identify alternative procedures for obtaining traffic volumes on unpaved secondary roads.

- Compare and evaluate these alternative procedures for potential use in VDOT's traffic counting procedures for unpaved roads.

METHODS

1. *Review and analyze existing Secondary Count Program.* An annual inventory of count stations on unpaved roads was obtained from the Traffic Engineering Division (TED). The nine District Traffic Engineers (DTE's) were surveyed and asked to identify procedures and concerns pertaining to the count program. A field trip was conducted to observe actual count installations. Cost estimates for conducting the Secondary Count Program and obtaining unpaved road counts were developed using the annual inventory and financial information from VDOT's Financial Management System (FMS).

2. *Determine the accuracy of road tubes for counting traffic on unpaved roads.* Field tests were conducted to check road tube counts against manually collected traffic data. Three types of counting devices, two cumulative models and one programmable model, were tested. Two of each type of counter were tested using vehicles of different weights at three test sites representing Class II, III, and IV unpaved roads as designated by VDOT.

3. *Evaluate alternative procedures for estimating traffic on secondary roads.* The literature on alternative ways to obtain traffic volumes on low-volume roads was reviewed. The other four states responsible for maintaining secondary road systems were surveyed about their procedures for obtaining traffic volumes on unpaved roads, and a summary of the findings from these four states was compiled. The costs, accuracy and feasibility of the alternative procedures identified in the literature review were compared with the procedures currently used in the Secondary Count Program.

RESULTS

Analysis of Existing Secondary Road Count Program

Inventory of Data from 1993 Secondary Count Program. A detailed list of the traffic counts for the 1993 Secondary Count Program obtained from the Traffic Engineering Division (TED) revealed that traffic counts at 9,931 stations on secondary roads were requested, of which 2,143 were on unpaved roads. A summary of the Secondary Road counts requested for each of Virginia's nine construction districts is presented in Table 2.

Survey of District Traffic Engineers. A questionnaire was distributed to the DTE's to learn the procedures and equipment used to obtain counts on unpaved roads in each of the nine construction districts. The survey allowed the DTE's to provide comment on the current procedures for obtaining traffic counts on unpaved roads. All nine construction districts returned the survey. The survey is presented as Appendix A.

Table 2: Summary of the Secondary Road Counts Requested for 1993.

District	Total Number of Secondary Road Count Stations	Total Number of Unpaved Road Count Stations	% Count Stations on Unpaved Roads
Bristol	1,356	250	18
Culpeper	608	199	33
Fredericksburg	843	186	22
Lynchburg	990	289	29
NOVA	631	4	1
Richmond	1,369	321	23
Salem	1,987	432	22
Staunton	1,315	349	27
Suffolk	832	113	14
Total	9,931	2,143	22

The completed DTE surveys indicated that all the districts use cumulative counters to count traffic on secondary roads. Table 3 shows the number of 1993 secondary road counts performed by each district, as estimated in the DTE survey. The estimated number of counts performed in 1993 includes recounts, and is therefore greater than the number of counts requested in 1993. The survey also asked about each district's schedule and resources allocated for obtaining secondary road counts. The number of count personnel and the weekly count schedule for each district appear in Table 4. Each DTE was asked to estimate the number of traffic counters placed in one hour. These estimates ranged between 3 and 12 counters per hour. Several respondents explained that the average number of counters placed per hour was greatly dependent on the distance between count stations. The districts also estimated the hourly cost for personnel and equipment required to conduct the Secondary Count Program. The hourly personnel costs ranged from $8 to $17 and the hourly equipment costs ranged from $4 to $10. Finally, all of the DTE's reported that the road tubes hold up well on unpaved roads.

The survey also allowed the engineers and technicians responsible for the Secondary Count Program to express their opinions about the accuracy of the information obtained from the unpaved road counts. The primary concerns among the district staffs were the possibility of the tubes or counters being tampered with by local residents and the lack of daily and seasonal adjustment factors applied to the 24-hour counts. A summary of the responses to the four survey questions concerning the accuracy of unpaved road counts appears in Table 5.

Table 3: The Estimated Number of 1993 Secondary Road Counts by District.

District	Estimated No. of 1993 Secondary Road Counts
Bristol	1,470
Culpeper	809
Fredericksburg	1,693
Lynchburg	1,772
NOVA	1,185
Richmond	1,406
Salem	1,849
Staunton	1,500
Suffolk	858
Total	12,542

Table 4: Personnel Schedule for the Secondary Count Program.

District	No. of Secondary Road Count Personnel	Weekly Schedule of Count Personnel
Bristol	2	Four-10 hour days
Culpeper	1	Five-8 hour days
Fredericksburg	1	Five-8 hour days
Lynchburg	1	Five - 8 hour days
NOVA	2	Four -10 hour days
Richmond	1	Four -10 hour days
Salem	2	Four-10 hour days
Staunton	1	Four-10 hour days
Suffolk	2	Five-8 hour days

Table 5: Concerns of DTE's about Accuracy

Concern	Number of districts identifying as a concern
Local residents tampering with tubes or counters	7 of 9
Capability of tubes to count on unpaved surfaces	3 of 9
Necessity of returning to the location exactly 24-hours after placement	2 of 9
Obtaining only one count per year (i.e. not considering daily/seasonal variation)	5 of 9

Recognizing that failures of the tubes and counting devices, or human error in recording counts, can lead to inaccurate traffic data, the DTE's reported that recounts are taken when the accuracy of the original counts appears dubious. The Fredericksburg District indicated that, in addition to recounting, inaccurate counts are sometimes estimated. The districts use different methods to identify possibly erroneous counts. In the Bristol, Richmond, Salem, and Suffolk Districts, questionable counts at a particular station are compared with previous counts at that station to determine the probable accuracy of the questionable count. In the Culpeper, Fredericksburg, Lynchburg, and Northern Virginia Districts, DTE's rely on judgement and knowledge of the area to identify inaccurate counts. In the Lynchburg District, factors such as the number of homes, the types of facilities on the road, the day of the week the count was performed, and the road surface are taken into account when possible inaccuracies are suspected. The Staunton District uses both previous counts and local knowledge to determine whether a recount is necessary at a particular station. Staunton District staff explained that if, for instance, a large count on a dead end road was recorded, the site would be recounted and the results from both counts would be compared.

Development of Cost Estimates for the Secondary Count Program. One of the primary purposes of the DTE survey was to obtain an approximate annual cost of the Secondary Count Program. Although some cost estimates were provided in the survey responses, a more accurate estimate was obtained from VDOT's Financial Management System (FMS). The FMS provided expenditure information on the Secondary Count Program for all districts. The amounts spent on the Secondary Count Program in FY '93 and FY '94 were similar for all but the Fredericksburg, Staunton, and Suffolk Districts, where FY '94 expenditures were significantly greater than FY '93 expenditures. The DTE surveys revealed that those three districts simply obtained a larger number of counts in calendar year 1993 than in calendar year 1992, accounting for the differences in expenditures. The FMS expenditures for FY '93 and FY '94 appear in Appendix B. Since traffic counts are generally obtained between April and September, the amount expended in calendar year 1993 on the Secondary Count Program was estimated by averaging the amounts expended in FY '93 and 'FY 94 as reported in the FMS. Table 6 shows these amounts for each district.

Table 6: Actual Cost of the Secondary Count Program for Calendar Year 1993.

District	Cost ($1,000)
Bristol	35.7
Culpeper	18.7
Fredericksburg	39.0
Lynchburg	28.1
NOVA	26.4
Richmond	80.4
Salem	65.8
Staunton	22.9
Suffolk	9.5
Total	326.5

The DTE survey estimated the number of secondary road counts obtained by each district. This estimate included the counts requested by TED in 1993, as well as any necessary recounts. An estimate of the "actual" cost per secondary road count was obtained by dividing the FMS expenditure by the total number of counts in each district. The calculated actual cost per count varied considerably among the districts, ranging from $11 to $57 per count. The actual cost per count is presented in Table 7 for each district.

Table 7. Calculated Actual Costs Per Secondary Road Count for Calendar Year 1993.

District	Actual Cost Per Count ($)
Bristol	24
Culpeper	21
Fredericksburg	23
Lynchburg	16
NOVA	22
Richmond	57
Salem	28
Staunton	15
Suffolk	11
Average	24

The DTE survey also revealed that personnel cost ranged from $8 to $17 per hour and the equipment costs ranged from approximately $4 to $10 per hour. Only seven of the nine districts provided the hourly costs in their survey responses. A field cost of conducting a count was then determined based on the hourly costs and the estimated number of counters placed in an hour by each district. This cost ranged from $1.64 to $3.92 among the districts. The field cost of conducting a count and the actual cost per count are shown for each district in Figure 1.

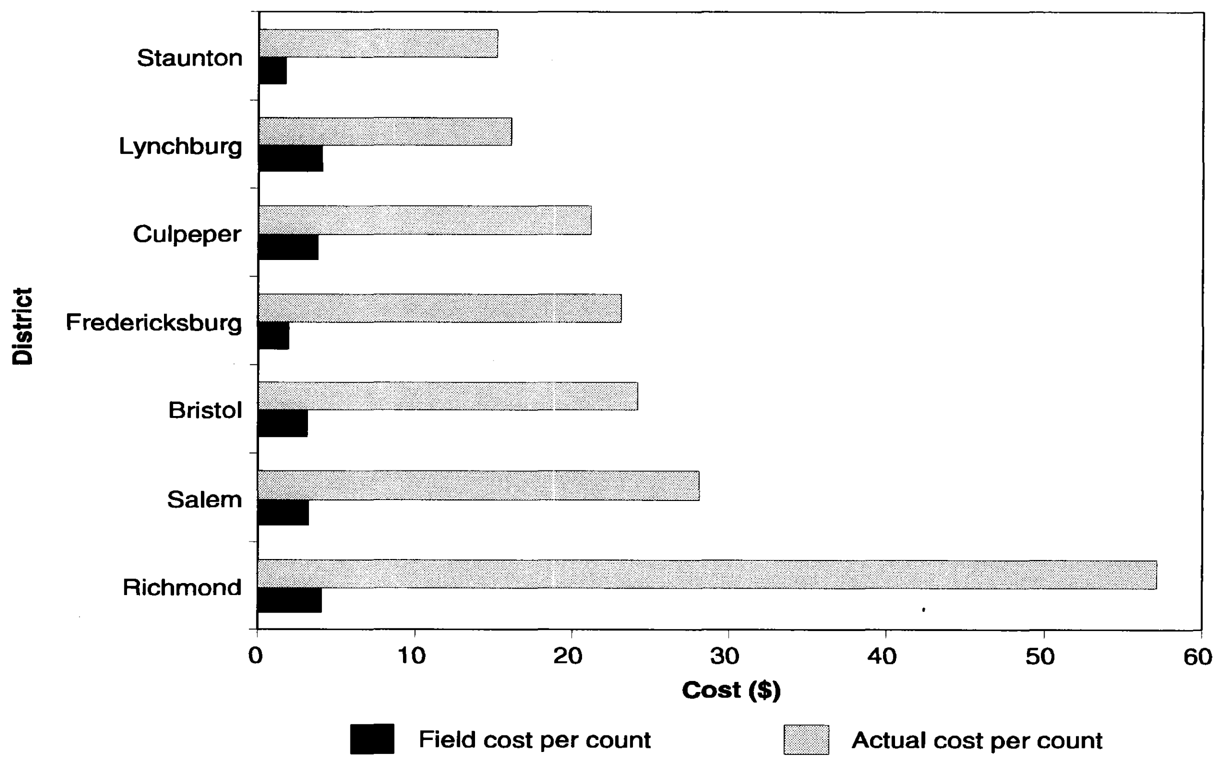


Figure 1. Comparison of field costs and the FMS-based actual costs per count.

Figure 1 reveals that in 1993 the survey-based field cost per secondary road count was considerably less than the cost based on the FMS data. This difference implies that actual data collection activities are only a small portion (about 10% on average) of the actual cost per count. Follow-up calls to survey respondents revealed that there is a considerable amount of office-related work involved in the Secondary Count Program. For example, in three districts, count personnel work five 8-hour days, one of which is spent in the office transcribing the data. In other districts, count personnel work four 10-hour days, with some amount of time allotted for office work related to the count program. The DTE survey indicated that the recorded traffic counts are inspected in the office for possible errors. In addition, count personnel from two Districts indicated that count equipment (counters, batteries, tubes, etc.) is thoroughly checked each time before counts are taken.

Costs of Counting Unpaved Roads. The total cost of obtaining the requested traffic data for unpaved roads in 1993 was calculated by multiplying the total number of unpaved road counts by the FMS-based actual cost per count. It was assumed that the costs associated with counting paved and unpaved roads are the same. Table 8 presents these costs for each District. The total cost of obtaining all of the requested traffic volumes on unpaved roads in 1993 was $56,040, which represented approximately 17% of the entire amount spent on the Secondary Count Program that year.

Table 8: Costs of obtaining traffic volume information on unpaved roads in 1993.

District	1993 Cost of Unpaved Road Counts ($)
Bristol	6,000
Culpeper	4,179
Fredericksburg	4,278
Lynchburg	4,624
NOVA	88
Richmond	18,297
Salem	12,096
Staunton	5,235
Suffolk	1,243
Total	56,040

Road Tube Accuracy on Unpaved Roads

A field test was conducted to check the accuracy of collecting data with road tubes on unpaved surfaces by comparing tube counts with manual counts. The experiment was conducted using three types of counting devices, all requiring road tubes for input. Two brands of cumulative counters and one brand of programmable counter were used. Each device was tested using a relatively light and a heavy automobile at three test sites selected to represent Class II, III and IV roads, as classified by TED in 1993. Appendix C shows the worksheets used in the field tests.

Both vehicles were driven over tubes connected to each of the six counters (two of each type). Two sets of thirty passes were made at speeds between 15 - 20 mph and between 25 - 35 mph on each of the three road types. Figure 2 shows the setup of the counters and the tubes. Figures 3 and 4 show passes being made with light and heavy vehicles, respectively.

Figure 2. Set up of counters used in field test.

Figure 3. Pass of a light vehicle over the counters used in field test.

Figure 4. Pass of a heavy vehicle over the counters used in field test.

The experiments revealed no observable trend of inaccuracy. Discrepancies between counts were largely attributable to the quality of the counting devices used. The tubes and installations were inspected after each run and no obstructions were found. There were small, random errors in the range of 1.7% to 13.0% among the different types of counters, and there were a few scattered large errors. For instance, thirty passes were made between 25 - 35 mph on the Class III road with the light vehicle and one of the cumulative counters displayed a count of 147 vehicles. For the same run, two of the counters counted 1 axle too many and displayed a count of 30.5, while the remaining three counters indicated the correct count of 30. A separate run with the light vehicle on a Class II road resulted in a different cumulative counter showing zero after thirty passes. One counter showed 30.5, indicating that one extra axle was falsely registered, but the other four counters showed the correct number of passes.

The cumulative counters produced errors of varying degrees during 58% of the runs performed during the field test. These counters produced large errors ($\geq$ 10%) during 17% of the runs. In all but three of the runs the programmable counters performed without error. Two of the errors resulted from the counter registering one extra vehicle during two separate runs. In a separate run, two extra vehicles were counted.

The programmable counters can produce hourly counts in a machine-readable format. The ability of programmable counters to record hourly counts would make it easier to identify possibly inaccurate counts. For example, if a station registered an unlikely high count, the counts could be inspected on an hourly basis to determine whether or not the counters had been tampered with. Programmable counters would also reveal whether or not a counter failed during the 24-hour counting period. In addition, a programmable counter that provides machine-readable data reduces recorder error, as the counts are directly downloaded from the counter to a computer.

Alternative Procedures for Estimating Traffic Volumes

Literature Review. The literature review identified current practices and procedures used to obtain traffic data on unpaved roads. Trip generation and other estimating procedures were included in this review as possible alternatives to traffic counts. Several different methods of obtaining traffic volume information were identified. Of the various methods and procedures, three analytical techniques were determined to be most relevant to the present study.

One of the more interesting traffic prediction methods reviewed was an analytical technique to forecast Average Annual Daily Traffic (AADT) on rural state highways in Indiana developed by Purdue University and the Indiana Department of Transportation (INDOT).[3] The method models future traffic volumes based on: present traffic volumes, population, households, vehicle registrations, employment, and fuel prices. The general form of the equation for the model is:

$$AADT_f = AADT_b + \left[1.0 + \sum_{j-1}^{n}\left(e_j \frac{(x_{jf} - x_{j,b})}{x_{j,b}}\right)\right]$$

where

$AADT_f$ = AADT in future year,

$AADT_b$ = AADT in base year,

$x_{j,f}$ = value of variable x_j in future year,

$x_{j,b}$ = value of variable x_j in base year,

e_j = elasticity of AADT with respect to x_j,

n = number of associated variables.

The data for the independent variables used in the equations were found in several sources, including census data and the Indiana Bureau of Motor Vehicles files. The selection of independent variables for the equations was based on statistical analysis and subjective criteria developed by the researchers, such as the cost and ease of obtaining the required data. The rural state highways in Indiana were divided into four categories. Different combinations of independent variables were used to develop four separate aggregate models for each of the categories of highway. The equation developed for highways in the *rural major collector* category is presented below.

$$AADT_f = AADT_b \, [1.0 + 3.77379 \, (\Delta \text{ in County Households})]$$

Similar aggregate equations were developed for the other three categories using the appropriate independent variables. Disaggregate models were developed on a site specific basis at some of the permanent count stations. When used together, the aggregate and dissaggregate models provided acceptable R^2 values and a simple inexpensive method of forecasting traffic volumes.

A second analytical method for forecasting traffic volumes on rural roads was developed by the New York State Department of Transportation (NYSDOT) as part of a study to develop a quick-response procedure for forecasting rural traffic.[4] The method was developed using data from the State's continuous count stations. Several models and nomographs were developed to forecast traffic on roads carrying urban-to-rural and rural-to-rural traffic. The equation developed for rural-to-rural traffic is presented below.

$$\text{FORECAST TRAFFIC} = \text{Present traffic} \, (1 + 0.314 \times \% \text{ change in town households})$$

A similar equation was developed for the urban-to-rural category of traffic. The percent change in town households variable represents the development expected between the present year and the year in which the traffic is being forecasted. The method is considered by NYSDOT to be reasonably accurate and easy to use.

Cambridge Systematics, a consulting firm in the Boston area, is currently involved in a trip generation study in the Northeast. An interview with a representative of the firm revealed that the planned study is an origin-destination (O-D) survey in small urban and rural areas. Sites in New Hampshire have been identified and more sites in Maine are being considered as candidate locations for the surveys. The results of the surveys will be used to develop trip generation factors for small urban and rural locations.[5]

Other publications revealed further interesting information. One, *Estimating Average Daily Traffic on Low-Volume Roads,* provided an overview of techniques commonly used to obtain traffic volumes on rural roads. The article compared mechanical traffic counts with the approaching vehicle method, estimation from aerial photography, and trip generation procedures. The study concluded that mechanical counts using road tubes were the most cost effective means of obtaining traffic volumes. The article also stated that trip generation is cost effective when basic land use information is readily available, but it becomes expensive when extensive research and field work is necessary to select and derive trip generation factors. In addition the article pointed out that unlike physical counts, trip generation has no inherent accuracy.[6]

A survey of traffic counting procedures in all 50 states conducted by the New Mexico State Highway and Transportation Department in 1990 described several methods used to identify and estimate inaccurate traffic counts. The survey, which assessed general monitoring practices and did not specifically address unpaved roads, indicated that in the case of a failed counter, 44 states recount the site and 13 estimate the missing data. Seven states recount and estimate missing data in the event of a failed counter.[7] Techniques applicable to unpaved roads in Virginia include estimates from historical counts on similarly classified roads, and estimates from historical counts at the same site.

In addition to correcting inaccurate counts, many states apply various factors to raw traffic count data to more accurately represent traffic. The Highway Capacity Manual (HCM), referring to the AADT,[8] noted examples from traffic data collected in Minnesota and Illinois that indicate:

- monthly variations in traffic are greater on rural roads than other types of roads;
- monthly variations are most pronounced on recreational rural routes;
- variation in daily traffic volumes is inversely proportional to traffic volume.

These concepts apply directly to unpaved roads in Virginia. These roads provide access to homes, churches, summer camps, hunting facilities, and even schools. The very fact that the threshold for paving unpaved roads is set at fifty vehicles per day implies that unpaved roads in Virginia have low traffic volumes. The HCM explains that low volume roads typically experience considerable variation in traffic from day to day and seasonally. The fact that unpaved roads in Virginia experience monthly and seasonal variations is not currently accounted for in the treatment of traffic counts on unpaved roads.

Survey of Other States. A telephone survey of the other four states responsible for maintaining a secondary road system was conducted. The level of detail of the response varied greatly. A survey questionnaire (Appendix D) was used as a guideline during the interviews, although not all the items were applicable to each state.

The representative from the Alaska Department of Transportation (AKDOT) said that traffic counts are performed at selected sites around the state every three years. Road tubes are used to collect traffic data on paved and unpaved roads. AKDOT does not use trip generation or any forecasting methods to obtain traffic volumes on unpaved roads. The representative stated that due to the unique nature of the transportation system in Alaska, paving priorities are determined subjectively. He explained that there are relatively few roads connecting population centers and that local roads are paved as needed.

The representative from the Delaware Department of Transportation (DelDOT) stated that less than 4% of the total roadway mileage in Delaware is unpaved. DelDOT intends to eventually pave all of the roads in the State, but unpaved roads have not been prioritized and are thus paved on an as-needed basis. DelDOT uses road tubes to obtain traffic counts on unpaved roads. Unpaved road counts are taken irregularly and as infrequently as every six years.

The North Carolina Department of Transportation (NCDOT) maintains approximately 17,700 km (11,000 miles) of unpaved roads. Several years ago, NCDOT established a policy to pave all unpaved roads in the state. The schedule for paving these roads is dependent on annual budget constraints. When the policy was established, conditions and development on all unpaved roads were assessed and the unpaved roads were assigned a paving priority. NCDOT keeps abreast of new development or changes in conditions on these roads, and the priority ranking is reassessed if necessary. NCDOT performs traffic counts with road tubes on unpaved roads every 2 years, depending on present priorities. Where an unpaved road is a dead end or serves only as access to homes, the Department estimates the traffic volumes based on a trip generation rate of 6 trips/day/household.

The West Virginia Department of Transportation (WVDOT) maintains approximately 24,000 km (15,000 miles) of unpaved roads. Although WVDOT has no formal count program, counts are obtained on a three year cycle, with roughly one third of the State's road system (highway, primary, secondary) collected each year. Traffic counts on unpaved roads are obtained using road tubes and cumulative counters. The Department performs 48-hour counts and applies seasonal and vehicle factors to obtain AADT's. In some cases, the traffic volumes on certain unpaved roads are estimated and not counted. Paving priorities in West Virginia are determined at the district level and there is no fixed percentage of transportation funds devoted specifically to unpaved roads.

FINDINGS AND CONCLUSIONS

- There were 9,931 secondary counts requested in calendar year 1993, 2,143 of which were on unpaved roads. Although the number of counts varies from year to year, the number of 1993 counts was deemed to be a reasonable estimate of the number of secondary road counts obtained annually.

- The cost of the Secondary Count Program for the 1993 calendar year was estimated at $326,500, of which approximately $56,000 was for unpaved roads. Estimates of the field costs revealed that actual data collection constituted only 10% of the total costs of obtaining secondary road counts. The remaining 90% of the costs were associated with such support services as count scheduling, equipment inspection, transcribing the count data, and reviewing the data for possible errors. By employing trip generation and forecasting methods, VDOT would only save the cost of obtaining the field counts, because these alternative methods would also require considerable office-related work. Since the literature indicates that trip generation and traffic forecasting techniques have no inherent accuracy and are largely subjective, such methods appear to be inappropriate for predicting traffic volumes on unpaved roads in Virginia.

- As noted, VDOT conducts approximately the same number of unpaved road counts each year. Under the current program unpaved roads are counted every four years, except for those with a previous 24-hour count between 40 and 49 vehicles, for which counts are taken every two years. A study conducted by Cambridge Systematics recommended that counts on unpaved roads carrying less than 40 vehicles in a 24-hour period be performed every six years and that counts on roads carrying between 40 and 49 vehicles be performed every three years.[2]

- Road tubes are appropriate for counting traffic on unpaved surfaces. Field tests performed using three types of mechanical counters revealed no significant factors affecting the accuracy of the tubes. However, the tests indicated that high-quality programmable counters are more accurate than the cumulative counters currently used by VDOT to count unpaved roads. Programmable counters can communicate in a machine-readable format, help VDOT staff identify errors in the traffic counting process, and obviate mistakes in transcribing the data. The Cambridge Systematics study recommended that cumulative counters be restricted to rural minor collectors and that these counters be phased out.[2]

- Five of the DTE's surveyed thought seasonal adjustment factors were needed for the traffic data collected on unpaved roads. Application of adjustment factors is a standard practice in most states. Low-volume rural roads have a propensity to display considerable seasonal variations.[8] Adjusting the raw traffic counts for seasonal variations would result in a more accurate representation of traffic, since unpaved roads in Virginia serve many purposes. Adjustment factors would improve VDOT's credibility with the public, and adopting a standard procedure for applying seasonal variations would reduce the risk of contention. There are several methods for obtaining adjustment factors. However, developing and applying seasonal and daily adjustment factors would significantly increase the effort associated with the current program. The Cambridge Systematics study recommended that adjustment factors be applied to all roads in Virginia except those that are functionally classified as local.[2] It would not be an efficient use of Department resources to develop and apply adjustment factors to counts obtained on unpaved roads. Instead, the DTE's should continue to coordinate with the Residencies in their district to ensure that any roads that require special counts because of the type of adjacent development, be given proper attention.

- Seven DTE's were concerned about errors resulting from local residents tampering with the tubes and counters. Programmable counters can produce hourly counts, which would facilitate the identification of false counts resulting from tampering with the equipment. Hourly counts would also reveal a counter or tube failure during the counting period. Programmable counters that provide hourly count reports also preclude errors occurring because counters were left in place longer than 24 hours. Programmable counters capable of providing hourly counts are the most appropriate device for counting traffic on unpaved roads.

RECOMMENDATIONS

Based on the literature reviews, inventories, surveys, and field tests conducted during this investigation, all traffic counts on unpaved roads should be performed using programmable, machine-readable counting devices. This study expands upon the previous Cambridge Systematics Study by recommending that cumulative counters be phased out as rapidly as budgetary constraints allow.

REFERENCES

1. Walzer, N., and McFadden, C. 1989. *Linking America: the county highway system.* p. 29. National Association of Counties.

2. Cambridge Systematics. 1994. *Traffic monitoring systems development studies. Task 2: Review and evaluation of the current TMS and preliminary recommendations*. Washington, D. C.: Cambridge Systematics.

3. Fricker, J. D., and Saha, S. K. 1987. *Traffic volume forecasting methods for rural state highways*. FHWA/IN/JHRP-86-20. Washington, D. C.

4. Local Road Classification Task Force. 1988. *Guidelines for rural town and county roads (draft).* New York State Department of Transportation.

5. Cambridge Systematics. 1994. *Statewide planning study.* New Hampshire Department of Transportation.

6. ITE Committee 6A-1. 1974. *Estimating average daily traffic on low-volume roads.* Traffic Engineering.

7. New Mexico State Highway and Transportation Department. 1990. *1990 Survey of traffic monitoring practices among state transportation agencies of the United States.* FHWA-HPR-NM-90-05. Washington, D. C.

8. Transportation Research Board. 1985. *Highway capacity manual.* TRB Special Report 209. Washington, D. C.: National Research Council.

APPENDIX A

Survey of District Traffic Engineers

I N T E R O F F I C E   M E M O R A N D U M

Date Created: 12-Jul-1994 04:17 DST
From: Gene Arnold
ARNOLD_ED
Title: Sr. Research Scientist
Dept:
Tel No:

TO: See Below

Subject: Unpaved Road Counts

TO: DISTRICT TRAFFIC ENGINEERS

FROM: Gene Arnold

The Council has initiated a research project (described at the recent TRAC meeting in Salem) to assess the effectiveness of the current traffic counting procedures for unpaved roads. In addition to conducting an inventory of the existing procedures, the study will investigate and compare alternative procedures for obtaining traffic volume information on unpaved, secondary roads. The alternatives, including the current procedures, will be evaluated on the basis of costs, feasibility and accuracy. The study will include a final recommendation to VDOT regarding the most effective procedure.

In this regard, it would be very much appreciated if you would complete the attached survey by July 22, if at all possible. Please note, as you probably are aware, the survey can be completed "on-screen" by editing this document, refiling it, and E-mailing it back to me.

If you have any questions, please call me at (804) 293-1931.

Thank you very much for your help.

Gene

SURVEY OF DISTRICT TRAFFIC ENGINEERS

1) Please complete as much of the following table as possible:

	No. of Secondary Road counts	No. of unpaved road counts
1991 -		
1992 -		
1993 -		
1994 -		

2) What type of counter do you use on unpaved roads? (Please indicate make and model).

3) How many of each type of counter do you have?

4) How many people do you have assigned to counting traffic on secondary roads?

____

5) What is your schedule for performing traffic counts?

6) Approximately how many counters do your people place in one hour?

____

7) How well do the tubes hold up on unpaved roads? Do some tubes perform better than others?

8) Do you have any concerns over the accuracy of traffic counts on unpaved

_____ YES
_____ NO

If yes, which of the following do you think affects the accuracy? (check all that apply).

___ locals tampering with the tubes or counters

___ capability of tubes to accurately count on an unpaved surface

___ necessity of returning to the location exactly 24-hours after placement

___ obtaining only one count per year (i.e. not considering daily/seasonal variation).

___ other, please explain.

9) How do you identify possible inaccuracies?

10) How do you correct inaccuracies?

11) Do you have any ideas for alternative counting procedures?

12) We are attempting to develop cost estimates. Please provide the following information if at all possible.

a. Annual cost of conducting secondary road counts program:

____

b. Approximate hourly salary cost of count personnel, including overhead:

____

c. Approximate hourly cost of equipment used in collecting counts:

____

d. Other financial information that might be useful. Please elaborate.

13) Comments?

APPENDIX B

Secondary Count Program FMS Expenditures for FY '93 and FY '94

FY '93 and FY '94 Secondary Count Program FMS Expenditures.

District	FY '93 Expenditures ($1,000)	FY '94 Expenditures ($1,000)
Bristol	37.6	33.7
Culpeper	19.0	18.5
Fredericksburg	32.3	45.8
Lynchburg	27.7	28.6
NOVA	29.3	23.4
Richmond	75.8	85.1
Salem	67.1	64.5
Staunton	16.3	29.5
Suffolk	6.8	12.2
Total	311.9	341.3

APPENDIX C

Worksheets for Field Evaluation of Accuracy of Road Tubes on Unpaved Roads

INVESTIGATION OF TRAFFIC COUNTS ON UNPAVED ROADS

FIELD EVALUATION OF THE ACCURACY OF ROAD TUBES ON UNPAVED SURFACES

SPEED: SLOW (<20)

ROAD / VEHICLE	COUNTER					
	# 1	# 2	# 3	# 4	# 5	# 6
CLASS II						
SMALL	30	30	30	30	30	30
LARGE	30	33	27	29.5	27.5	30
CLASS III						
SMALL	30	30	30	31	30	30
LARGE	30	31	30	31.5	30	31
CLASS IV						
SMALL	30	31.5	30.5	37	30.5	30
LARGE	31	30	32.5	42	32.5	33

INVESTIGATION OF TRAFFIC COUNTS ON UNPAVED ROADS

FIELD EVALUATION OF THE ACCURACY OF ROAD TUBES ON UNPAVED SURFACES

SPEED: FAST (25 < v < 35)

ROAD / VEHICLE	COUNTER					
	# 1	# 2	# 3	# 4	# 5	# 6
CLASS II						
SMALL	30	30	0	30.5	30	30
LARGE	30	30	29.5	30	30	30
CLASS III						
SMALL	30	30.5	30	30.5	147	30
LARGE	30	30	30	31	30	30
CLASS IV						
SMALL	30	33	31	36.5	30.5	30
LARGE	30	22.5	28.5	26	29.5	30

APPENDIX D

Questionnaire of Other States that Maintain Secondary Road Systems

UNPAVED ROADS SURVEY

1. Approximately how many miles of unpaved roads does your organization maintain?

_ < 5,000 _ 5,000 - 10,000 _ 10,000 - 15,000 _ 15,000 - 20,000 _ > 20,000

2. Does your organization use any alternative methods to obtain traffic information on unpaved roads (e.g. trip generation, forecasting, etc.)?

__ no __ yes

if yes, please describe briefly ____
____
____
____

3. Traffic data is collected from these unpaved roads once every:

__ 1 year __ 2 years __ 3 years __ 4 years __ 5 years __ 6 years __ > 6 years, please specify ____

4. Approximately how many traffic counts does your organization perform per year?

_ < 5,000 _ 5,000 - 10,000 _ 10,000 - 15,000 _ 15,000 - 20,000 _ > 20,000

5. Does your organization perform manual or mechanical traffic counts on these roads?

__ manual __ mechanical __ both __ other, please specify ____

6. At what level of traffic do the unpaved roads in your jurisdiction become eligible for paving?

__ 25 vpd __ 50 vpd __ 75 vpd __ 100 vpd __ 125 vpd
__ other, please specify ____
____

7. Approximately what percentage of your transportation budget is set aside for paving unpaved roads?

__ < 1% __ 1-3% __ 3-5% __ 5-7% __ > 7%