EVALUATION OF THE TRAFFIC COUNT PROGRAM

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ABSTRACT

The purpose of this study was to determine the Department's needs for traffic count data, to relate them to an evaluation of the traffic count programs and procedures, to identify problems and deficiencies with data requirements, and to seek means of improving the programs. In approaching these objectives, interviews were conducted with representatives of the Department who supply and use volume data. The field collection operations were reviewed and the mechanical traffic recorders used by the Department were evaluated for accuracy and reliability. The study concluded that the data provided by the count programs are not sufficient to fulfill the requirements for transportation planning and environmental studies in the urban areas of the state. In the rural areas, an excessive amount of data are acquired and the accuracy of the data is questionable. Specific problems, deficiencies, duplications, etc. in the count programs are identified in the report and recommendations for improvements are presented.

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INTRODUCTION

Traffic counts are the basis for safety, economic, environmental, and engineering considerations by administrators and engineers responsible for the development of highway systems. To obtain these fundamental data, the Virginia Department of Highways and Transportation initiated a formal program consisting of manually taken counts of traffic volumes and classifications on the primary system in the 1930's. As the interstate freeways and arterial bypasses were constructed and opened to traffic, this program was expanded to include them. On the secondary system a count program utilizing mechanical traffic recorders was adopted. Then in 1967, when emphasis was placed on urban transportation planning, an additional program consisting of mechanically taken volume counts was set up for the cities and towns throughout Virginia.

Because of new and expanded requirements in the urban transportation planning process and environmental matters, the Virginia Department of Highways and Transportation now frequently needs detailed data on traffic parameters that are not available from its traffic count programs. In many cases estimated values of the parameters are made without the aid of standardized procedures or factoral basis. In those situations two alternatives are available. First, forecasts can be based on hypothesized assumptions, in which case the accuracy and reliability of the forecasts are only as good as those of the assumptions. The other alternative is to gather detailed data in a study area, an alternative that is very costly and time-consuming.

In view of the fact that the Department is constantly faced with inquiries about the availability of traffic data from programs that now annually cost in excess of $780,000, it desired an evaluation of its traffic counting programs and procedures. There was a need to determine if current data requirements could be met or if some of them were unrealistic and, therefore, should not be met. Subsequently, the Research Council was requested by the Department to review the needs for data and evaluate the traffic count program.

PURPOSE AND SCOPE

The purpose of the study was to determine the Department's needs for traffic count data, to relate them to an evaluation of the traffic count program and procedures, to identify problems and deficiencies with data requirements, and to seek means of improving the program in a order to obtain better traffic data.

The study was concerned primarily with the Department's procedures for collecting, processing, and using data on traffic volumes. It did not include programs involving data on vehicle speeds and delays, highway capacities, truck weights, or trip origins and destinations.

METHODOLOGY

The major activities conducted during the study are described under the following subheadings.

Data Requirements

An inventory was made of the types of data on traffic volumes needed by the Department in its daily operations such as planning, design, programming, preparing environmental impact statements, and designing pavements. Interviews were held with representatives of the Environmental Quality, Planning, Location and Design, Traffic and Safety, Secondary Roads, Programming and Scheduling, and Urban Divisions to find (1) the types and quantities of traffic count data they required, (2) the purposes to which volume data were put, (3) the sources of information used to obtain data, (4) the requirements for data that have not been met, (5) the data requirements which could be simplified or revised, and (6) the data estimates for which there are no standardized computation procedures or factoral basis. Also interviews were conducted with representatives from the Department's district and residency offices.

Program Evaluation

The existing traffic count programs were reviewed to determine the types of data being collected, the cost of data collection, and the disposition made of the data collected. The Traffic and Safety and the Transportation Planning Divisions are responsible for the collection, processing, and dissemination of traffic volume data. Representatives from these divisions were contacted and information gathered about (1) the various types of count programs and their administration, (2) the types of data routinely collected and reported, (3) the types of special data secured, (4) estimates of money and manpower expended in the collection and analysis of data, (5) the procedures and methods used to collect and process data, (6) the types of equipment used, (7) the major uses of traffic volume information, (8) the kinds of requests for data that cannot be met, (9) requests for superfluous data and (10) the data estimates which have no standardized computation procedures or factoral basis.

Two substudies were conducted as part of the research.[1, 2] In one, the field personnel who collect traffic volume data were questioned on their duties and responsibilities. Their opinions on the importance and use of the data collected, working schedules and conditions, type and maintenance of equipment, etc. were noted. The second tested the accuracy and reliability of the mechanical traffic recorders used by the Department.

Identification to Needs for Improvements

In an attempt to identify problems, deficiencies, duplications, needs for improvements, etc. in the traffic count programs a comparison of the data requirements and the data provided was conducted. In the following sections of this report the findings of the study along with the suggested improvements in the traffic count programs are discussed in detail.

DATA REQUIREMENTS

The interviews with representatives of the divisions revealed that a variety of traffic count data is needed in the planning, programming, design, construction, and operational stages of the Department's transportation system. As shown in Table 1 the average daily traffic (ADT) is the measurement most used by highway engineers, planners, and administrators. Table 1 lists many of the types of studies conducted by the various divisions along with the types of volume data used. The requirements directly related to the traffic count program are presented. The use of traffic count data is not limited to the Department. Many governmental agencies, businesses, and individuals use traffic statistics in their daily activities. Table 2 lists some of the agencies that request traffic data from the Department.

Table 1

Data Requirements
Virginia Department of Highways and Transportation

Division	Data Use	Type
Traffic and Safety	Traffic forecasts	ADT
	Accident studies and rates	ADT, classification, VMT
	Safety improvement studies	ADT, peak, classification
	Travel and traffic surveys	ADT, peak, classification
	Preparation of allocation factors	VMT
	TA-1 Reports	VMT
	TF-1 Reports	VMT
	18-kip (8.1 tonnes) axle loading	ADT, classification
	Additions or deletions to hwy. system	ADT, classification
	Signing and signalization studies	ADT, peak
	Capacity analyses	ADT, peak, classification
	Railroad grade crossing studies	ADT, peak, classification
	Highway illumination	ADT
	Public information releases	ADT, peak, classification
	Flow maps	ADT
Transportation Planning	Traffic forecasts	ADT
	Calibration and validation of models	ADT, peak, classification
	Surveillance of changes in traffic	ADT, peak, classification
	Evaluation of network	ADT, peak, classification
	Traffic and travel surveys	ADT, peak, classification
	Capacity analyses	ADT, peak, classification
	Priority strategies	ADT, peak
	Needs estimates	ADT, peak, classification
	Public information releases	ADT, peak, classification
Location and Design	Location of facilities	ADT
	Design of facilities	ADT, peak, classification

Table 1 (Continued)

Division	Data Use	Type
Environmental Quality	Environmental impact statements	ADT, peak, classification
	Air studies	ADT, peak, classification
	Noise studies	ADT, peak, classification
Secondary Roads	Construction projects and priorities	ADT, classification
	Planning for improvements	ADT, classification
	Allocation of funds	VMT
Urban	Route improvement studies	ADT
	Project selection and priorities	ADT
Construction	Traffic control	ADT, peak, classification
	Project programming	ADT
	Project personnel assignments	ADT
Maintenance	Maintenance schedules	ADT
	Snow removal routings and priorities	ADT
Material	Pavement design	ADT, classification
Bridge	Bridge records	ADT
Transportation Coordination	Airport access route studies	ADT, classification
Research	Research studies	ADT, classification
Field offices	Maintenance schedules	ADT
	Planning improvements	ADT
	Public information releases	ADT, peak, classification

Table 2

Other Agencies Having Data Requirements

Federal Highway Administration
Virginia Regional Planning Districts
Virginia Air Pollution Control Board
Virginia County Board of Supervisors
Virginia Division of Motor Vehicles
Virginia Department of State Police
Virginia Department of Transportation Safety
Traffic Consultants
Virginia City Planning Offices
Virginia Chamber of Commerce
Virginia State Travel Service
Travel Associations
Virginia Department of Industrial Development
Virginia Colleges
Virginia Libraries
Automobile Association of Virginia
Banks, Realtors, Developers, Businessmen
Citizens

Tables 1 and 2 demonstrate the magnitude of traffic data requirements within the Commonwealth. Several divisions within the Department use more data than others and in the following sections the traffic count needs of those divisions are discussed in detail.

Traffic and Safety Division

Although three of the primary duties of the Traffic and Safety Division are the collection, processing and dissemination of traffic count data (which will be discussed in the evaluation of the count program), other duties necessitate the use of that data. Numerous traffic studies such as accident, signalization, signing, capacity analysis, railroad grade crossings, level of service, pedestrian, bicycle, parking, out-of-state visitors and economic are conducted by the Division. Most of the required data relate to ADT, classification of vehicles, hourly volumes and short period counts during the peak hours. Many of the studies utilize data from the routine count program; however, many require special traffic data that must be collected by the Division's engineering and economics section. A review of the section's weekly activity sheets showed that during the 180-day period ending March 28, 1978, there were 26 requests for special traffic counts that originated within the Division. The majority of the special counts consisted of directional turning movements. Although the special data requirements will be discussed in detail later in this report, most traffic and safety studies requiring short period (hourly, 15-minute, etc.) and directional turning volume counts necessitate special data not available from the routine count programs. Therefore, in Table 1 most of the data needs that require "peak" type information necessitate special data collection.

The Traffic and Safety Division is one of two divisions that indicated vehicle miles of travel (VMT) data were needed. The Division prepares and submits the TA-1 reports to the FHWA annually.

Traffic and Safety is also responsible for forecasting travel in the rural areas. In the urban areas the Transportation Planning Division makes the forecast for travel as a part of the urban transportation planning process. The Traffic and Safety Division receives 75 to 100 requests for traffic forecasts annually and 90% to 95% of these are made using data gathered through the routine count program.

Traffic and Safety conducts studies to determine if a particular road should be added to or deleted from the highway system. It is reported that these studies always require the collection of special data such as percentage of out-of-state vehicles, and trip length by type of vehicle; limited use is made of the ADT data available through the count programs.

The equivalent 18-kip (8.1 tonnes) axle loading reports for pavement thickness design are prepared by Traffic and Safety. These studies require ADT and classification statistics, and utilize those that are published in the count program documents.

Transportation Planning Division

As previously mentioned, the Transportation Planning Division processes and disseminates much traffic count data on streets and highways in urban areas; however, the Traffic and Safety Division collects all of the data that the Transportation Planning Division routinely uses. During interview sessions, the Division's needs for traffic volume data both at locations where counts are routinely conducted and where special traffic data are required for projects were discussed. Basically, the Division is responsible for meeting the federal and state requirements for transportation planning programs in approximately 47 urban study areas. In these areas the Division is responsible for providing the current and projected traffic data.

Forecasting travel in urban areas is much more complicated than it is in the case of rural areas; therefore, elaborate modeling techniques are employed. The models require much volume data including ADT, vehicle classification, direction distribution, and hourly traffic patterns. It was reported that most of the forecast studies require special data, although the routinely collected data are beneficial in establishing travel trends. It should be pointed out that the count program in urban areas consists of 24-hour mechanical counts taken at selected locations each year. Although these counts cannot be considered as ADT, they are used to monitor travel patterns in each of the urban areas to determine if previous forecasts of social, economic, and land use parameters are valid. Significant changes usually lead to an update of the base plan. It was noted that the traffic counts are needed along the screen line and cordon line in the urban areas to adequately monitor the travel trends. Also classification data are required.

The Division is also required to monitor several facilities which have been constructed for high occupancy vehicles (buses, vanpools, carpools, etc.). Special data studies are required as none of the current count programs include occupancy counts. As greater emphasis is placed on the movement of people rather than the movement of vehicles along urban corridors, the requirements for occupancy counts increase. In the near future they will be essential to assist the Division in planning and monitoring processes.

The Transportation Planning Division conducts numerous traffic and travel surveys in urban areas. These studies, similar to those conducted by Traffic and Safety, include capacity analysis, level of service, parking, pedestrian, bicycle, traffic flow, etc. and require ADT, classification, and peak period data. Some of the studies utilize existing data from the urban count program but usually special data are required because the urban program does not provide comprehensive coverage.

As previously mentioned, many of the data needs of the Division require special data collection studies usually involving directional turning movements, vehicle classification counts, and 24-hour volume counts. These are necessary for complete, up-to-date, and accurate information. It was noted that occasionally the FHWA questions how traffic data were collected and projected. In other cases the data used in environmental impact statements and design have been scrutinized by court judges. In litigation cases, which appear to be increasing at a great rate, the traffic forecasts are frequently attacked by the people in opposition to a project. As a result, it appears that in many cases an excessive amount of traffic data are requested to guard against unforeseen controversies or legal problems. Any errors made by failing to request enough data could result in disapproval of a project or plan. At the very least it could bring criticism upon the planners from Department officials, the courts, the FHWA, local governments, and private citizens.

Most of the data requirements for the Transportation Planning Division are related to a functional classification system whereas the count programs are based upon administrative highway systems. The representatives of the Division reported that the use of the data could be improved if the count program were based upon the functional system.

As reported earlier the Traffic and Safety Division computes statewide VMT values for reporting to the FHWA; however, the values for the urban areas are estimated from gasoline sales revenues. It is impossible to compute VMT from the existing urban count program. Currently the Transportation Planning Division does not compute nor use urban VMT statistics.

It was noted that enforcement of the Clean Air Act of 1977 by the Environmental Protection Agency (EPA) will necessiate the reporting of annual VMT statistics in urban areas and will create additional problems relative to traffic count data. Many officials question the use of VMT values as a measure of vehicle emissions. Their concerns appear to have merit when considering that most "hot spots" of air emissions occur at signalized intersections that carry much stop and go traffic. An idling vehicle in heavy congested traffic contributes to the emission levels, although it is not creating any vehicle miles of travel. If VMT data are required in the future, the existing count program must be modified and a sampling procedure for estimating VMT should be considered and developed.

Location and Design Division

The Location and Design Division requires traffic data for developing highway plans. Basically the needs include ADT, design hourly volumes, percentage of trucks, and directional distributions of vehicles. These data are required for both the current year and a forecasted design year (10 years hence for secondary projects and 20 years for projects in other highway systems). Occasionally, detailed design requires additional information on directional maneuvers and the level of service, the latter of which involves peak period counts.

All traffic data are obtained from either the Transportation Planning or the Traffic and Safety Division. Location and Design personnel in the Central Office and district offices do not use the data published in the "Average Daily Traffic Volumes on Interstate, Arterial and Primary Routes", "Secondary Traffic Tabulation", and "Urban Traffic Counts". Most of the basic traffic data requests are filled within two to three weeks. Where the requests have necessitated special field studies such as a compilation of directional turning movements it takes four to six weeks normally, but on occasions it has taken two to three months for the data to reach the Location and Design Division.

Because of the time involved in the development of plans for a highway project the Division may initiate several traffic data requests for each project. In order to have up-to-date information, requests may be made during the (1) preliminary design, (2) public hearings, (3) environmental impact assessment, and (4) final design stages of a project. When responding to a request, the Transportation Planning and Traffic and Safety Divisions usually send copies of the data to the other divisions which are or will be involved in the project.

It appears that the needs of the Division are being met as the representatives noted no problems with the present traffic data information system nor recommended improvements.

Environmental Quality Division

The Environmental Quality Division, like the Location and Design Division, requests all traffic data from the Transportation Planning and the Traffic and Safety Divisions. The Transportation Planning Division provides data for the facilities within the metropolitan study areas and Traffic and Safety provides information on the systems in the rural areas. The Division personnel do not utilize the traffic data in the Department's publications.

The Division's work is mostly project related and traffic data are required during two phases of project development. The traffic count data first required are basically the same (ADT, design hourly volume, percent trucks, directional distribution) as required by the Location and Design Division during preliminary design. The traffic data are used to conduct a systems level environmental review of the impact of each alternative of the proposed improvement. This review identifies the location where noise and air quality problems are likely to occur and indicates the type of data that may be required for the preparation of the environmental impact statement.

The next, and most important, phase relates to the environmental impact statement. During this phase the Environmental Quality Division usually requires detailed traffic data. In reviewing the environmental impact of a proposed facility computerized simulation models are employed to describe the noise and air quality conditions. The input for the models include traffic volume data (present and design year) such as ADT, hourly volumes, directional distributions, peak-hour volumes, classification of vehicles, and directional turning movements. In addition to the present and design year data the same information is required for an interim year, usually a 10-year interval. Traffic data are frequently required on all "crossing roadways" in addition to the roadway scheduled for improvement. The scope for alternative highway design configurations include emission units and noise levels along the project route and all adjacent highways where traffic volumes are expected to be changed plus or minus 5% by construction of the project. Also required is information on major intersections and all ramps and loops at interchanges within the project limits. One reason for this requirement is to determine if the distribution of vehicles among adjacent traffic lanes will allow satisfactory dispersion of vehicle emissions.

The hourly volume requirements for environmental studies cover the period between 6 a.m. and 9 p.m.rather than the more common 12-hour data (7 a.m. to 7 p.m.) usually required for other traffic and travel studies. It is necessary to identify both the peak-hour period and the period having the highest consecutive 8 hours of traffic flow in analyzing the environmental impacts.

Specific data are required if schools, parks, and churches are to be impacted by the proposed project. Frequently data relative to hourly volumes, percentage of truck traffic, and level of service must be collected on Sundays.

The environmental models also require more detailed information about vehicle classifications than is obtained for the average traffic study. For example, the percentage of through trucks is required. The four categories used in the classification of vehicles are (1) light duty passenger cars, (2) light duty trucks, (3) heavy duty gasoline trucks, and (4) heavy duty diesel trucks. These categories are obtained and/or estimated within the standard data collection practices of the Department; however, the Environmental Quality Division reported that the FHWA has asked for other classifications. These classifications include light duty diesels (Mercedes and similar cars) and motorcycles. Other categories which have been mentioned are air conditioned cars and heavily loaded passenger cars with three or more occupants. Such classification appears to be impractical because it would be almost impossible to obtain the required data.

Although the Division calculates VMT on a project basis there has not been a requirement for VMT on a regional level. The Division's representatives, like those in the Transportation Planning Division, speculate that the Clean Air Act of 1977 may require annual studies of gross air quality based upon VMT in some of the urban regions.

With the exception of a few cases, the Environmental Quality personnel expressed satisfaction with the traffic data obtained from the Transportation Planning and Traffic and Safety Divisions. When special data are required frequently 1 to 2 months pass before the requests are filled, but this delay appears to be acceptable.

One of the Division's main concerns relates to the accuracy of vehicle operating speed data. Although speed data are outside the scope of this study they are used in the computerized simulation models with the traffic count data and will be briefly

addressed. The environmental quality models are very sensitive to changes in operating speeds. A small speed change will cause substantial changes in the simulated air and noise levels. The Division's staff would prefer that present year operating speed data be based upon field travel time and delay studies; however, it appears the operating speeds are estimated from level of service calculations.

The methods of determining operating speeds were discussed with representatives of the Transportation Planning Division. When determining either present or forecasted vehicle operating speeds, planners and engineers are aware that speeds as low as 15-20 mph (24-32 k/hr) will invite the disapproval of a planned highway design. Some people question if the precision of the environmental models is such that the special speed studies are warranted.

Secondary Roads Division

An interview with representatives of the Secondary Roads Division revealed that the volume counts secured on the secondary system are used extensively by the Division. The published 24-hour counts obtained every other year, commonly and incorrectly referred to as ADT, are used in determining needs, planning, and establishing priorities of improvements on the secondary roadways. The traffic counts are also used to compute VMT at a county level. The Code of Virginia requires that secondary construction and maintenance funds for each county be allocated by a formula using four parameters — population, land area, road mileage, and VMT. The VMT statistics are prepared by the Traffic and Safety Division by multiplying the traffic counts by the respective lengths of the links of roadways. In accordance with the Code, additional weights are given to highways which are not hard-surfaced and have more than 50 vehicles per day using them.

The representatives expressed concern about the relationship of the 24-hour counts to the true ADT; however, local governments have raised very few questions on this matter. Frequently, citizens have questioned when and where counts were made. The Division's staff noted that the acquisition of a 7-day count would improve the accuracy of the traffic counts and increase the credibility of the Department.

At the project level, the traffic forecasts are made by the Transportation Planning and Traffic and Safety Divisions, and frequently outside agencies provide travel projections on proposed industrial and recreational access highways.

Other Divisions

Because of the importance of traffic volume counts in the transportation field, every division in the Department makes use of them. Many of the divisions were interviewed during the study and, basically,it was found that they either used data prepared for the above mentioned divisions at the project level or the statistics published in the Department's documents. Usually the needs include only ADT but on occasions when dealing with specific problems special detailed data are required from the Transportation Planning and Traffic and Safety Divisions.

Other Agencies

During the interviews it was noted that the Department receives many requests for traffic volume data from other state agencies. While most of them relate to ADT data, travel services, realtors, businessmen, etc. frequently desire information on the percentage of out-of-state passenger cars and vehicle classifications. Representatives of several divisions and field offices reported that they received these types of requests; however, no records were available that indicated the numbers of requests. Generally these requests are filled using data gathered through the routine count programs.

EVALUATION OF EXISTING COUNT PROGRAMS

The Traffic and Safety Division is responsible for the collection of traffic count data and administers four formal count programs. They are:

1. The Interstate, Arterial and Primary Route Count Program,
2. The Automatic Traffic Recorder Program,
3. The Secondary Route Count Program, and
4. The Urban Traffic Count Program.

In addition to these routine programs the Division receives and responds to special requests for detailed traffic data from many other divisions. The requests are usually project related. With the exception of the Automatic Traffic Recorder Program the count programs are adequately described in Department publications entitled "Operation Manual - Traffic and Safety Division" and "Traffic Counting on Interstate, Arterial, and Primary Routes".[3,4]

Brief descriptions of the programs are given in the following sections of this report; however, the reader should refer to the above publications for detailed information about the methods, procedures, equipment, etc. employed in the various programs.

Interstate, Arterial and Primary Route Count Program

The largest count program in terms of both data generated and expenditures is the Interstate, Arterial and Primary Route Count Program. Table 3 summarizes the number of counts and the annual expenditures. The objective of the program is to obtain an average number of vehicles by type that daily use each section of the roadway.

The program covers all of the interstate, arterial, and primary routes maintained by the Department. It does not include counts on the arterial and primary routes within cities and towns which are controlled and maintained by the local governments.

Methods and Procedures

The program consists of manual traffic counts conducted by observers using a set of hand counters to record hourly vehicle classification and directional traffic data during 12-hour periods. Table 3 shows that 5,276 traffic counts are made annually at 1,345 stations throughout the state.

Table 3

Number of Counts and Annual Expenditures
of Interstate, Arterial, and Primary Route Count Program

Type of Count	Interstate		Primary	
	No. of Stations	No. of Counts	No. of Stations	No. of Counts
Key (9-count)	11	99	69	621
Seasonal (4-count)	200	800	823	3292
Coverage (2-count)	0	0	242	464
Total	211	899	1134	4377
Cost of Data Collection		$110,162		$316,896
Cost of Analysis		15,000		73,375
Subtotal Cost		$125,162		$390,271
Total Cost				$515,433

The following three types of stations are utilized in the program.

1. Key stations — The locations for key stations were selected to reflect the volume trends and seasonal fluctuations within the area. Accordingly, key stations are located at points through which intercity, intercounty, and interstate traffic flows but sufficiently distant from cities and towns to avoid the effect of local traffic. There are 80 key stations in the state and they are usually located at the intersections of principal routes outside of cities and towns. Seven counts annually are made at key stations. Five of the 7 counts are taken on weekdays, Monday through Friday, 1 on Saturday and 1 on Sunday. Five counts are made for a 12-hour period from 7:00 a.m. to 7:00 p.m. and 2 counts are made for a 24-hour period.

2. Four-count stations (seasonal) — Interspersed among the key stations are the four-count stations. These are generally located on routes near the peripheral influence of cities and towns and in rural areas. The data obtained supplement those acquired at key stations. The seasonal fluctuations in traffic volumes are measured at 1,023 count stations located throughout the state. All counts are made for 12-hour periods from 7:00 a.m. to 7:00 p.m. on the days of the week including a Saturday or a Sunday, but rarely both. One count is made during each of the four seasons of the year.

3. Two-count stations (coverage) — The two-count stations are distributed throughout the state to supply basic traffic volume data to supplement the data obtained at key and four-count stations. Two 12-hour counts are made from 7:00 a.m. to 7:00 p.m. annually on the weekdays including a Saturday but rarely a Sunday. The counts are generally spaced 6 months apart. There are 242 two-count stations located on the primary system.

Generally, count stations on the primary system are located at intersections. On limited access facilities such as interstate roads, the stations are located between interchanges.

In an attempt to have each station counted on the same day every year the Traffic and Safety Division prepares an annual counting schedule which is distributed to the district and resident engineers. A sample schedule page, shown in Figure 1, lists stations, locations, dates, and times that the counts are to be made. Securing the counts is the responsibility of the resident engineer, who uses either hourly or permanent employees to conduct the field studies.

The traffic data are categorized and recorded in accordance with the T & S -1 form shown in Figure 2. The completed forms are checked by the resident engineer and are forwarded to the district traffic engineer for review. Once the data are determined to be correct, the form is sent to the Traffic and Safety Division, where it is again reviewed and coded for keypunching. Each count is compared with the count taken the year before at the same location and time. Usually the count is considered accurate if it is within plus or minus 10% of the previous value. Larger differences in the data are checked out by comparing them with data from adjacent traffic count stations and contacting the field engineers. Any incorrect data results in the count being rescheduled or the data being deleted from the analysis.

The Traffic and Safety Division maintains a computerized control sheet (Figure 3) that shows all counts gathered at a station during the year. Each year after the data are gathered for the four-count and two-count stations, mathematical formulas are used to convert the 12-hour (7:00 a.m. to 7:00 p.m.) data into 24-hour traffic counts.

The direction counts acquired at stations on limited access highways (interstate and many arterial highways) are factored and the 24-hour volumes are usually the values published. However, on other highways, where the counts are made at intersections, an additional computation is required to obtain the annual average daily volumes on each segment of roadway. In most cases, the data gathered at the ends of the segment (at the intersections) are averaged. In other cases when traffic volumes are high on one end of the segment and low on the other a weighted average is utilized.

The ADTs on the interstate, primary, and arterial roadway segments are published each year in the "Average Daily Traffic Volumes on Interstate, Arterial and Primary Routes". A page of the annual tabulation is shown in Figure 4. In addition to the ADT

1972 SCHEDULE OF TRAFFIC COUNTS RICHMOND DISTRICT

SANDSTON RESIDENCY SHEET 43

STATION NO.	DESCRIPTION	DAY	DATE	HOURS
4007 KEY	NEW KENT COUNTY AT BOTTOMS BRIDGE INT OF RTS 60E 60W 33N			
		MON	JAN 31	7A 7P
		THUR	MAR 30	7P 7A NITE
		TUES	APR 18	7A 7P
		FRI	JUNE 16	7A 7P
		WED	JULY 19	7A 7P
		SAT	AUG 26	7A 7P
		THUR	SEPT 21	7A 7P
		TUES	OCT 17	7P 7A NITE
		SUN	NOV 12	7A 7P
4052	NEW KENT COUNTY AT CARYS CORNER INT OF RTS 33E 33W 608S 608N			
		TUES	JAN 25	7A 7P
		FRI	APR 14	7A 7P
		SAT	AUG 19	7A 7P
		MON	OCT 09	7A 7P
4108	NEW KENT COUNTY AT ANGEL VIEW CHURCH INT OF RTS 33E 33W 168S			
		MON	JAN 24	7A 7P
		WED	MAY 03	7A 7P
		TUES	JULY 11	7A 7P
		THURS	OCT 19	7A 7P
4109	NEW KENT COUNTY NORTH OF BARHAMSVILLE INT OF RTS 168NW 168SE 30NE			
		FRI	FEB 18	7A 7P
		FRI	AUG 25	7A 7P

Figure 1. Schedule of traffic counts.

COMMONWEALTH OF VIRGINIA

T&S 1 (Rev. 9/1/73)

DEPARTMENT OF HIGHWAYS

TRAFFIC COUNT STATIONS

Station Location _____ District _____ County _____

Station No. _____ Weather _____ Date _____ 19____ Day _____ Hours From _____ To _____

All Traffic using the _____ North · East · South · West Leg of Route _____ Between This Station and _____ Nearest Town or Route

HOURS	LOCAL VEHICLES					BUSES		OUT OF STATE VEHICLES					Total All Vehicles	BICYCLES
		Single Unit Trucks			Trailers				Single Unit Trucks			Trailers		
	Passenger Cars	Panel and Pickup	Other Two Axle	Three Axle	Trailer-Trucks 3,4 and 5 Axle	School	Other	Passenger Cars	Panel and Pickup	Other Two Axle	Three Axle	Trailer-Trucks 3, 4 and 5 Axle		
Total														

All Traffic using the _____ North · East · South · West Leg of Route _____ Between This Station and _____ Nearest Town or Route

Total														

Figure 2. Traffic counting form (T&S-1).

TYPE OF COUNT	MONTH	DAY OF MONTH	DAY OF WEEK	COUNT NO	NUMBER OF COUNTS	COUNTY	STATION NUMBER	ROUTE NUMBER	DIRECTION	PASSENGER CARS		SINGLE UNIT TRUCKS			TRAILER TRUCKS	BUSES	TOTAL ALL VEHICLES	FOREIGN		SCHOOL BUSES
										VIRGINIA	FOREIGN	TWO AXLE 4 TIRES	TWO AXLE 6 TIRES	THREE AXLE 6 10 TIRES				LIGHT AND MEDIUM TRUCKS	TRAILER TRUCKS	
1	1	2	5	7	1	1	4	84	1008	0023	3	1411	410	528	83	14	51	5	2502	155	21	0
1	1	5	6	6	1	2	4	84	1008	0023	3	2344	959	1076	311	49	136	29	4904	573	85	22
1	1	8	4	5	1	3	4	84	1008	0023	3	2113	1225	1007	366	109	222	15	5057	653	115	10
1	1	11	8	3	1	4	4	84	1008	0023	3	2359	841	887	246	60	183	4	4580	480	107	0
2									1008	0023	3	2758	1050	994	286	66	200	15	5369	529	111	
1	1	2	5	7	1	1	4	84	1008	0058	7	685	181	304	60	6	9	2	1247	51	1	0
1	1	5	6	6	1	2	4	84	1008	0058	7	1229	397	585	140	16	52	29	2456	201	24	26
1	1	8	4	5	1	3	4	84	1008	0058	7	1150	444	575	197	73	84	3	2526	270	34	2
1	1	11	8	3	1	4	4	84	1008	0058	7	1448	313	519	110	20	59	0	2469	184	37	0
2									1008	0058	7	1570	453	557	145	32	97	9	2863	198	46	
1	1	3	7	2	1	1	2	84	1009	0071	3	397	81	308	68	14	14	8	890	58	13	8
1	1	8	20	7	1	2	2	84	1009	0071	3	510	112	283	24	3	4	0	936	44	1	0
2									1009	0071	3	614	117	410	67	12	13	4	1237	71	9	
1	1	3	7	2	1	1	2	84	1009	0071	7	512	97	377	78	11	16	15	1106	65	13	15
1	1	8	20	7	1	2	2	84	1009	0071	7	587	141	347	32	2	4	0	1113	54	1	0
2									1009	0071	7	758	161	388	62	7	17	7	1400	64	11	
1	1	1	11	3	1	1	9	84	1010	0023	5	4834	1404	2620	410	51	111	5	9435	704	81	0
1	1	3	16	4	1	2	9	84	1010	0023	5	6975	2315	2951	533	128	158	49	13119	1101	76	45
1	1	4	25	2	2	3	9	84	1010	0023	5	2276	612	949	107	10	75	2	4031	265	51	2
1	2	5	7	7	1	4	9	84	1010	0023	5	8558	3397	3514	276	30	57	11	15843	1077	29	6
1	1	7	24	1	1	5	9	84	1010	0023	5	6354	4142	2259	55	4	19	16	12849	819	12	3
1	1	8	19	6	1	6	9	84	1010	0023	5	7399	2939	3242	537	62	217	20	14416	1156	133	3
1	1	10	10	2	1	7	9	84	1010	0023	5	6817	2410	3108	486	79	180	45	13205	1194	91	38
1	1	10	20	5	2	8	9	84	1010	0023	5	2365	522	899	96	25	107	4	4018	206	75	3
1	1	12	8	5	1	9	9	84	1010	0023	5	7430	2115	3514	498	67	149	54	13835	975	80	49
2									1010	0023	5	9231	3242	3967	501	78	218	32	17269	1239	135	
1	1	1	11	3	1	1	9	84	1010	0023	7	4742	1330	2555	414	52	117	7	9217	668	83	0
1	1	3	16	4	1	2	9	84	1010	0023	7	6080	2298	2958	543	140	165	69	13061	1071	78	66
1	1	4	25	2	2	3	9	84	1010	0023	7	2172	554	920	105	10	78	2	3841	247	53	2
1	2	5	7	7	1	4	9	84	1010	0023	7	8511	3347	3660	268	30	58	10	15092	1095	30	3
1	1	7	24	1	1	5	9	84	1010	0023	7	6406	4256	2375	57	7	22	12	13135	843	13	3
1	1	8	19	6	1	6	9	84	1010	0023	7	7613	2981	3391	601	71	216	21	14894	1199	132	4
1	1	10	10	2	1	7	9	84	1010	0023	7	6943	2423	3275	469	78	185	64	13437	1203	91	57
1	1	10	20	5	2	8	9	84	1010	0023	7	2304	480	903	94	25	106	6	3928	204	75	5
1	1	12	8	5	1	9	9	84	1010	0023	7	7539	2091	3623	523	66	160	65	14067	973	82	59
2									1010	0023	7	9186	3197	4032	510	82	224	39	17270	1233	137	
1	1	1	11	3	1	1	9	84	1010	0058	3	940	178	571	108	3	8	2	1810	82	4	0
1	1	3	16	4	1	2	9	84	1010	0058	3	1755	359	725	114	34	25	32	3044	148	10	31

Figure 3. Traffic count stations summary.

INTERSTATE, ARTERIAL AND PRIMARY TRAFFIC TABULATIONS

ROUTE NUMBER	FROM	TO	AVERAGE DAILY TRAFFIC							
			VIRGINIA PASSENGER CARS	OUT-OF STATE PASSENGER CARS	SINGLE UNIT TRUCKS			TRAILER TRUCKS	BUSES	TOTAL VEHICLES
					2 AXLE 4 TIRES	2 AXLE 6 TIRES	3 AXLE & 10 TIRES			
I & 95	FOURTEENTH STREET BRIDGE	RT 95	46,900	42,800	4,500	2,700	410	1,600	2,700	101,610
I	RT 95	NCL ALEXANDRIA	16,000	9,800	1,750	1,100	100	300	480	29,530
I	SCL ALEXANDRIA	RT 241 SOUTH OF ALEXANDRIA	18,000	8,000	1,900	730	110	220	140	29,100
I	RT 241 SOUTH OF ALEXANDRIA	RT 235 GUM SPRINGS	23,700	8,300	2,350	910	110	190	230	35,790
I	RT 235 GUM SPRINGS	RT 235 NEAR ACCOTINK	15,700	8,300	1,400	640	110	120	190	26,460
I	RT 235 NEAR ACCOTINK	FORT BELVOIR	13,700	8,300	1,150	540	110	110	100	24,010
I	FORT BELVOIR	RT 242 GUNSTON HALL	9,300	3,450	1,100	320	130	60	85	14,445
I	RT 242 GUNSTON HALL	RT 95 NORTH OF WOODBRIDGE	8,900	3,350	1,050	290	140	60	45	13,835
I	RT 95 NORTH OF WOODBRIDGE	RT 253 WOODBRIDGE	14,900	3,450	2,050	540	110	190	45	21,285
I	RT 253 WOODBRIDGE	DUMFRIES	12,300	3,250	1,800	490	75	160	110	18,185
I	DUMFRIES	RT 610 AQUIA	4,850	1,650	900	250	50	150	90	7,940
I	RT 610 AQUIA	BUS 17 FALMOUTH	6,600	850	1,150	250	40	160	100	9,150
I & 17 BUS	BUS 17 FALMOUTH	NCL FREDERICKSBURG	15,700	1,800	2,400	550	120	470	190	21,230
I BY-PASS	SCL FREDERICKSBURG	RT 208 FOUR MILE FORK	5,000	700	800	180	35	170	40	6,925
I	RT 208 FOUR MILE FORK	RT 95	5,100	870	830	210	40	200	55	7,305
I& 17 BY-PASS	RT 95	RT 17 BY-PASS	2,800	350	590	180	30	220	30	4,200
I	RT 17 BY-PASS	RT 606 THORNBURG	2,150	250	480	160	20	190	20	3,270
I	RT 606 THORNBURG	RT 605 NANCY WRIGHTS CORNER	1,450	200	290	110	15	90	20	2,175
I	RT 605 NANCY WRIGHTS CORNER	RT 639 LADYSMITH	1,350	190	270	80	10	90	25	2,015
I	RT 639 LADYSMITH	RT 207 CARMEL CHURCH	1,350	170	270	85	10	90	30	2,005
I	RT 207 CARMEL CHURCH	RT 30 DOSWELL	1,650	140	350	170	100	140	20	2,570
I	RT 30 DOSWELL	RT 738 GUM TREE	1,950	180	360	150	30	140	25	2,815
I	RT 738 GUM TREE	RT 54 ASHLAND	3,800	170	560	220	50	170	30	5,000
I	RT 54 ASHLAND	SOLOMONS STORE	5,200	190	970	260	50	160	25	6,855
I	SOLOMONS STORE	RT 73 PARHAM ROAD	11,000	240	1,600	510	50	170	65	13,635
I	RT 73 PARHAM ROAD	NCL RICHMOND	18,800	500	1,550	440	45	200	65	21,600

FORM LD-107

Figure 4. Annual traffic volume tabulation.

on each section of each route, the publication also contains the following.

1. A base map of the state showing the counties and districts.
2. The distribution of VMT by type of vehicle in each district.
3. The ADT by vehicle type at each drawbridge.
4. A comparison of VMT with miles of road in each county.
5. An array by rank of VMT in each county.
6. An array by rank of traffic density per mile of road for each route.
7. VMT by type of vehicle for each route.

Twelve hundred copies of the document are printed at a cost in excess of $7 per document and approximately 650 are sent outside of the Department. Copies are supplied to federal, state, and local governments at no cost; private companies and individuals are charged $1.50 for each book.

The data are also used to prepare traffic flow maps which graphically portray the relative daily volumes by section of each route. Also, a monthly report is developed from the counts which shows the percentage change in travel on interstate, arterial, and primary routes when compared with the same month of previous year.

Costs of Program

As shown in Table 3 the collection, analysis, and publication of the data cost the Department an estimated $515,433 in 1976. State funds were used to collect the manual counts and HPR funds were utilized to analyze and publish the data.

Problem Areas

During the interviews with the users of the data many issues arose relative to the accuracy of traffic volume information. Because the questions ranged from the collection of data to the factors used to convert 12-hour manual counts to 24-hour volumes, a substudy was initiated. The purposes of the substudy were

as follows:

1. To examine the working practices followed in obtaining the manual traffic counts on interstate and primary highways, and

2. To evaluate the accuracy of the counts.

Although the findings are presented in detail in the final report entitled "An Evaluation of Manual Traffic Counts on Primary Highways" (2), many are summarized in this section of this report.

Interviews with personnel counting traffic revealed that some people did not understand their work nor take it seriously. Many are not conscientious about the time they start and terminate work even though instructions state the specific time that a count must be made and the data must be recorded hourly. Others were observed taking breaks and then apparently guessing at the traffic volumes that had occurred while they were away from the station. In one particular case the two persons manning a station left for 25 minutes and were found to have recorded low traffic volumes on the T & S -1 form when it was checked in the field. However, when the completed form was furnished to the authors, the volumes for that particular hour had been increased to values approximately equivalent to adjacent hourly volumes.

Several people were observed terminating the count prior to 7:00 p.m., but the worksheets reflected complete 12-hour volume counts. Many stated that they received minimal supervision and that only a few of the questions addressed to their supervisors relative to the use of data and collection procedures were satisfactorily answered. The resident engineer determines how many people are required to make each count and the number of people counting traffic varied among the stations. On some low volume roads only one person made the counts while on others two persons were employed. The Traffic and Safety Division does not provide guidelines for determining the number of people on a team; however, representatives who are experienced with collection operations recommend that more than one person be assigned to stations having 5,000 vehicles per day. The field observations revealed that usually when a two-person team was utilized only one person conducted the count while the other took a break.

The count teams asked many questions about the various classifications of vehicles and most of them readily stated that they could not see all of the license plates and thus could not distinguish out-of-state traffic. It was noted that this problem was compounded when counting large trucks and when taking counts in darkness during the winter months. In this connection, a comparison of Figures 2 and 4 revealed that the traffic count personnel are required to count and record 13 categories of traffic but only

7 classification categories are published. Furthermore, several representatives of the Department stated that they furnish only the data requested, even though the requestor may not be aware that the data are categorized by vehicle type. In other words, if the caller requests total volumes then volumes are provided. It was also noted that only published data are provided to people who telephone for volume information. In many cases more accurate data could be provided by supplying data from an individual count station rather than the combined published data. If the public is interested only in total volumes, it appears that traffic flow maps could replace the approximately 650 publications furnished to the private sector annually.

The factors used to convert 12-hour counts to 24-hour volumes were of much concern to the users. Many questioned the accuracy of published ADT figures. The factors were developed in the late 1930's and are periodically checked by reviewing the data from the 80 key count stations which are counted 9 times annually. The last in-depth study of the factors was made in 1969 when the number of counts per station was reduced from 14 to 9. It should be pointed out that the review used manual data and when considering the previously mentioned field practices the accuracy is still questionable. Representatives of the Traffic and Safety Division felt that the reduction in the frequency of counts at the key stations has lowered the accuracy of the traffic counts.

In the substudy, several manual counts were compared with both machine counts and data acquired through time-lapse photography. In most cases the 12-hour counts made by the manual count teams were fairly accurate, within plus or minus 5%; however, it was reported that one team undercounted the traffic by 10% while another overcounted by 7%. Once the 12-hour counts were factored to 24-hour volumes, the differences between them and the machine counts varied from minus 15.4% to plus 20.3%.

Although there are obvious errors in the factors the credibility of the entire manual program could be improved if the data user had a better understanding of the methods, procedures, analysis,etc. employed in the program. Likewise, it would be beneficial for the provider to have a better understanding of how the data were being applied by the users.

Automatic Traffic Recorder Program

The Department's smallest traffic count program is the Automatic Traffic Recorder Program. The program is not highly

publicized and, in fact, there is no formal document that describes the objectives, procedures, equipment, analysis and uses of the data acquired through the program. The main purpose of the program is to provide continuous data to monitor travel trends in the state. The data are furnished the FHWA for their use in developing monthly travel trends. These are published and distributed nationwide.

Methods and Procedures

Generally, the program consists of 16 stations located on interstate and primary roadways where continuous traffic volumes are recorded with mechanical equipment. The nonaccumulative traffic recorder prints on a paper tape the traffic volumes in 15-minute intervals. The printed tapes are retrieved and the machine serviced once a week by a technician from the Central Office.

A computer program tabulates the following data.

1. Average daily traffic by month.
2. Average weekday traffic by month.
3. Average Saturday and Sunday traffic by month.
4. Monthly percent of annual traffic by class of road.
5. Variation of traffic by day of week and class of road.
6. Percent of traffic by selected hour periods and class of road.
7. Volume and percent of ADT by highest and 30th highest hours.

The above data are published annually by the Traffic and Safety Division in a document entitled "Automatic Traffic Recorder Data".

The data relative to peak hour and the 30th highest hour are useful in the design of highway facilities.

Cost of the Program

In 1976 the estimated cost of gathering, analyzing and publishing the data was $8,000. The program was financed entirely with HPR funds.

Problem Areas

The interviews conducted with the Department's divisions did not reveal any problems relative to the administration of the program. The program provides the only continuous traffic data, with the exception of those for the toll facilities, in the state and it appears that the greatest problem is the lack of utilization of the data. At these 16 locations it is possible to determine the annual average daily traffic and to define the relationships of hourly volumes to daily volumes, daily volumes to monthly volumes, monthly to yearly, etc. With these types of data the number of the sampled (9-, 4-, and 2-count stations) data can be reduced. Several studies have shown that by obtaining good continuous count data the accuracy of volume estimates can be improved while the sample sizes can be reduced. [5, 6, 7] It should be pointed out that the number of continuous count stations in Virginia is not sufficient nor are the stations properly located to allow statistical estimates of volumes. Unfortunately, the number of stations has been reduced during the past few years to a level where the effectiveness of the program for uses other than design purposes is questionable.

Secondary Route Count Program

Secondary traffic counts have been secured for approximately 40 years and the program has been changed several times since its formation. The last change was in 1953, when the schedule of obtaining one 24-hour count on each secondary route segment every other year was developed. The most common use of the counts is the computation of VMT values in each county, which is one of four factors used in the allocation of secondary construction and maintenance funds.

Methods and Procedures

The regularly scheduled traffic counts made on the secondary routes vary considerably in character, timing, and analysis from those of the two previously described programs on the interstate and primary highways. The secondary counts are made with automatic recorders, accumulative type, nondirectional, for one 24-hour period every other year. This procedure does not include classification of vehicles nor adjustments for seasonal and daily variations. The counting season begins near the first of April and ends as soon after the middle of December as possible.

A station is located on each section of each secondary route in each county. For counting purposes a road section lies between —

1. two intersections;

2. an intersection and the end of maintenance or cul-de-sac; or

3. an intersection and the corporate line of a city or town.

When any section of a road is 3.5 miles (5.6 km) or more in length, two counts are made and averaged to determine its average traffic. However, if a relatively large traffic generator is located on a section, additional counts are taken. Using the above criteria for the placement of recorders, the distance between stations averages 0.57 mile (0.9 km).

The Traffic and Safety Division prepares a schedule for counting each construction district. The schedules are developed on the basis that the technicians will begin counting the first week in April. During the first week the technicians will work 6 days. Recorders are installed on Monday, Wednesday, and Friday and removed on Tuesday, Thursday, and Saturday. The second week involves a 4-day work week with recorders being installed on Monday and Wednesday and removed on Tuesday and Thursday. This cycle is repeated until all counts are completed.

One technician can install approximately 50 automatic recorders per day. The automatic recorder reading is registered when the recorder is placed on the roadway and again when it is removed the following day. The difference in the readings is the traffic count for the hours the recorder was in place. The technician is usually under the supervision of the district traffic engineer.

Once the field data are recorded the counts are sent to the resident engineer for review. If erroneous counts are discovered reschedules are made prior to sending the data to the Traffic and Safety Division in the Central Office. The Division verifies the counts and prepares them for computer processing. The traffic is tabulated as in the typical summary shown in Figure 5.

Cost of Program

In 1976 a total of 37,437 secondary traffic counts were taken at a total cost of $202,377. State funds ($170,518) were used to collect the data and HPR funds ($31,859) were used to analyze and tabulate the data.

NEW KENT COUNTY

ROUTE NUMBER	ROAD CLASS	FROM	TO	24-HOUR TRAFFIC	LENGTH IN MILES
600	1	RT 30	RT 673	161	0.45
600	1	RT 673	RT 635	144	2.75
600	1	RT 635	RT 601	74	0.60
600	1	RT 601	JAMES CITY CL	72	1.40
				TOTAL	5.20
601	1	JAMES CITY CL	RT 634	204	0.98
601	1	RT 634	RT 635	164	1.00
601	1	RT 635	RT 600	112	0.60
				TOTAL	2.58
602	1	RT 155	0.25 MI E OF RT 155	88	0.25
602	2	0.25 MI E OF RT 155	RT 629 W INT	39	0.25
602	1	RT 629 E INT	RT 60	191	0.06
				TOTAL	0.56
603	1	JAMES CITY CL	RT 620	127	1.24
603	1	RT 620	RT 627	147	3.00
				TOTAL	4.24
604	3	RT 33	RT 617	54	1.70
604	3	RT 617	RT 608	27	0.50
				TOTAL	2.20
605	3	RT 33	DEAD END	20	1.25
				TOTAL	1.25
606	1	HANOVER CL	RT 607	163	2.50
606	1	RT 607	RT 608	172	1.60
606	1	RT 608	RT 619	120	0.30
606	1	RT 619	RT 612	192	0.49
606	1	RT 612	RT 609	65	2.67
				TOTAL	7.56
607	1	RT 619	RT 606	130	1.10
607	2	RT 606	DEAD END	22	0.75
				TOTAL	1.85
608	1	RT 60	RT 666	621	2.10
608	1	RT 666	RT 604	502	2.25
608	1	RT 604	RT 617	502	0.80
608	1	RT 617	RT 33	510	0.90
608	1	RT 33	RT 614	181	3.78
608	1	RT 614	RT 609	177	1.10
608	1	RT 609	1.00 MI W OF RT 609	91	1.00
608	2	1.00 MI W OF RT 609	RT 606	72	1.40
				TOTAL	13.33
609	1	RT 608	RT 606	111	2.80

1

Figure 5. Secondary traffic volume tabulation.

Problem Areas

Interviews with the personnel collecting the data and observations of the field operations revealed several minor problems. Vandalism and tampering with the machines frequently resulted in erroneous data which required recounts on many sections of roadway or the use of estimates of the 24-hour volumes. Several technicians were observed to not adhere to the 24-hour schedule for placing and picking up the recorders. In other words, the recorders were picked up at a time different than when they were placed the day before. A review of the worksheets also revealed mathematical errors. As previously mentioned, the traffic count is obtained by calculating the difference in the recorder reading at the time the recorder is placed and the reading at the time the recorder is removed. A final problem relates to urban areas. Many of the new subdivisions incorporate underground utilities and thereby do not have fixed objects to which the traffic recorders are usually secured. In these cases the technician was observed estimating the 24-hour volumes.

Urban Count Program

The Urban Count Program was developed in the 1960's as a part of the formal planning process mandated by the U. S. Department of Transportation. The principal uses of the traffic counts are to —

1. determine existing traffic volumes;
2. aid in evaluation of the thoroughfare network and to identify the influence of any recent major development;
3. monitor changes in traffic flow;
4. provide traffic volume counts for utilization by the staffs of local governments; and
5. provide traffic volume counts for design purposes.

In this program, approximately 2,500 mechanical counts are made annually in 63 cities and towns in Virginia.

Methods and Procedures

The Transportation Planning Division selects the locations for 24-hour counts inside cities and towns having a population of more than 3,500. The counts are made with automatic, nonaccumulative

type printing recorders. The counting season begins near the middle of January and ends around the first of December. In order to determine travel trends, the urban count schedule is prepared so that each city or town is counted at approximately the same time each year.

Two technicians from the Traffic and Safety Division in the Central Office are required to obtain the counts. Each technician is provided a truck and 30 Streeter Amet MR 101A recorders, and he is expected to average 50 traffic counts each week.

The data tapes are reviewed and the data are prepared for computer processing. A typical summary of the data is shown in Figure 6. The volumes are tabulated in 15-minute intervals along with other information relative to peak volumes.

The 24-hour volume data are not converted into annual average daily traffic estimates.

The 24-hour volumes for each station are published in "Urban Traffic Counts", a sample sheet of which is shown in Figure 7.

Cost of Program

In 1976, a total of 2,325 counts were made at an estimated cost of $36,350. An additional $25,600 was needed to edit, tabulate, and publish the data. The entire cost ($61,950) was financed with HPR funds.

Problem Areas

Generally, no major problems were noted in the collection and tabulation stages of the Urban Count Program. The users of the data appear satisfied with the accuracy and they are not troubled by the use of 24-hour volumes rather than annual average daily traffic volumes. In some areas additional counts would be desirable, and in most areas concern was expressed that some stations were inappropriately located for user purposes. The station locations should be reviewed to ensure that an adequate number are located on screen lines and cordon lines. These counts are necessary in the monitoring of travel trends by the Transportation Planning Division.

VIRGINIA DEPARTMENT OF HIGHWAYS AND TRANSPORTATION - URBAN TRAFFIC COUNT

STUDY AREA	STATION	JURISDICTION	MONTH	YEAR	DIRECTION
100	820	9	07	1975	EAST BOUND

15 MINUTE INTERVAL ACCUMULATIONS (AVE)

HOUR	1ST	2ND	3RD	4TH	VOLUME
12 PM TO 1 AM	112	71	63	57	303
1 AM TO 2 AM	39	42	19	21	121
2 AM TO 3 AM	27	20	14	17	78
3 AM TO 4 AM	11	13	16	23	63
4 AM TO 5 AM	16	18	18	29	81
5 AM TO 6 AM	34	54	99	159	346
6 AM TO 7 AM	285	532	671	876	2364
7 AM TO 8 AM	906	926	906	894	3632
8 AM TO 9 AM	783	763	741	682	2969
9 AM TO 10 AM	672	681	649	543	2545
10 AM TO 11 AM	490	500	452	406	1848
11 AM TO 12 AM	410	438	416	424	1688
12 AM TO 1 PM	346	385	362	376	1469
1 PM TO 2 PM	344	389	397	332	1462
2 PM TO 3 PM	350	390	394	376	1510
3 PM TO 4 PM	354	387	361	376	1478
4 PM TO 5 PM	416	445	404	404	1669
5 PM TO 6 PM	384	488	410	411	1693
6 PM TO 7 PM	440	434	365	342	1581
7 PM TO 8 PM	298	315	323	276	1212
8 PM TO 9 PM	252	290	243	229	1014
9 PM TO 10 PM	250	282	251	226	1009
10 PM TO 11 PM	256	225	190	175	846
11 PM TO 12 PM	178	163	189	135	665

A. M. TOTALS	16038
P. M. TOTALS	15608
7 A. M. TO 7 P. M. TOTAL	23544
PCT. OF 24 HOUR TOTAL	74.40 %
24 HOUR TOTALS	31646
A. M. PEAK HOUR	7:00 AM TO 8:00 AM
VOLUME	3632
PCT. OF 24 HOUR TOTAL	11.48 %
P. M. PEAK HOUR	5:15 PM TO 6:15 PM
VOLUME	1749
PCT. OF 24 HOUR TOTAL	5.53 %

Figure 6. Summary of urban traffic counts.

DANVILLE AREA TRANSPORTATION STUDY

1976 - 24 HOUR TRAFFIC VOLUMES

ROUTE	STREET NAME	STA. NO.	BETWEEN	VOLUME	DATE
29 Bus.	N. Main Street	1	Piney Forest Rd. & NCL Danville	16,240	6-14,15 M.,Tu.
29 Bus.	N. Main Street	2	Piney Forest Rd. & Cheryl Dr.	5,150	6-14,15 M.,Tu.
29 Bus.	N. Main Street	3	Parkland Dr. & Fegan St.	14,280	6-14,15 M.,Tu.
29 Bus.	N. Main Street	4	New & Girard Sts.	12,610	6-14,15 M.,Tu.
29 Bus.	N. Main Street	5	Moffett & Campbell Sts.	15,670	6-14,15 M.,Tu.
29 Bus.	N. Main Street	6	Front St. & Riverside Dr.	11,410	6-16,17 W.,Th.
29 Bus.	Main Street Bridge	7	Riverside Bridge & Bridge St.	15,240	6-17,18 Th.,F.
29 Bus.	Main Street	8	Market & Craighead Sts.	5,060	6-29,30 Tu.,W.
29 Bus.	W. Main Street	9	Chestnut St. & Jefferson Ave.	11,230	6-23,24 W.,Th.
29 Bus.	W. Main Street	10	Holbrook Ave. & Broad St.	15,240	6-29,30 Tu.,W.
29 Bus.	W. Main Street	11	West End Ave. & S. Main St.	9,230	6-29,30 Tu.,W.
29 Bus.	W. Main Street	12	Tunstall Rd. & Wooding Ave.	12,000	6-29,30 Tu.,W.
29 Bus.	W. Main Street	13	Bishop & Wood Aves.	9,560	6-29,30 Tu.,W.
29 Bus.	W. Main Street	14	Stokesland Ave. & Memorial Dr.	9,070	6-22,23 Tu.,W.
29	W. Main Street	15	Country Club Pkwy. & River Oak Dr.	22,030	6-22,23 Tu.,W.
29	W. Main Street	16	Holcomb & Garden Grove Sts.	16,970	6-22,23 Tu.,W.
29	W. Main Street	17	SCL Danville & Grove Ave.	12,780	6-22,23 Tu.,W.

Figure 7. Urban traffic volume tabulation.

When considering the number of stations in the small cities and towns it appears that the technician may not have sufficient work to keep him busy 8 hours a day. Each technician is provided with 30 recorders and is expected to place 25 operative recorders each day. However, many cities and towns do not have 25 stations. For example, the city of Galax has 15 stations and because of the distance to adjacent cities it is impractical for the technician to gather data in them on the same day. Additional recorder counts could be obtained at minimal cost, or the technician could gather samples of other types of data such as classification of vehicles, directional distribution, and occupancy rates which would be beneficial to the Transportation Planning Division. Furthermore, in the large cities the number of stations should be in multiples of 25. This procedure would provide additional data and ensure an efficient field operation.

Special Count Program

As noted in the section of this report relating the traffic data needs there are many data requirements that are not met with routine count programs.

A review of the Traffic and Safety Division's weekly activity records showed that during the 180-day period ending March 28, 1978, there were 58 requests for special traffic data. The requests necessiated 77 traffic studies of which 83% related to volume counts. The majority of the studies involved directional turning movements while others required the collection of data such as ADT, vehicle classification, pedestrian volumes, and vehicle occupancy. Many of the requests necessiated a tremendous effort to acquire and process the data. It was noted that one request required 140 pieces of data.

The Traffic and Safety Division maintains a field party that collects the special data. Occasionally office personnel are required to assist the field party when large studies are conducted or there is a backlog of work. The Traffic and Safety Division also processes and disseminates the data related to rural areas. Urban data are forwarded to the Transportation Planning Division for processing and dissemination.

Much of the work is charged to specific projects under preliminary engineering codes; however, in 1976 approximately $81,000 were charged to the HPR traffic counting codes.

In addition to the above mentioned special studies, every 5 years the Division conducts the Virginia Visitor Travel Survey. The survey consists of the collection and analysis of information such as travel patterns, trends, volumes, origin, destination, trip purpose, length of stay, accommodations, and expenditures of out-of-state visitors using the highways of Virginia. The findings are published in a report which is made available to interested parties in the travel trade industry for their use in evaluating and promoting tourism in the state. The study is federally funded and costs approximately $85,000.

Problem Areas

When considering the number and magnitude of special data requests received by the Traffic and Safety Division along with the manpower available, it is understandable that the field work is not initiated immediately upon receipt of a request. It was reported that the time period between the initiation and filling of a request has been 2-3 months on some occasions.

In conducting vehicle occupancy studies there are questions as to which vehicles should be included. Guidelines for collecting occupancy data are needed and, hopefully, the current efforts by the FHWA will develop procedures for obtaining such data.

The Division experiences unusual problems with the Virginia Travel Survey conducted every fifth year. There have been suggestions that the study be conducted by temporary employees of other state agencies. This practice would afford several advantages. The Traffic and Safety Division would be relieved of the manpower problems associated with the study. Correspondingly, the Department would be removed from the great numbers of public relation conflicts which invariably occur during the roadside interviews with motorists. The motorists recognize the interviewer as an employee of the Department and become irritable when questions are asked which are clearly beyond the scope of the Department's role in transportation activities. Such questions are imposed by other state agencies and include inquiries about personal background and spending habits.

COMPARISON OF AVAILABLE DATA AND REQUIREMENTS

In the previous sections of the report it has been shown that the data requirements of the various divisions in the Department are being met, even though many special studies are required. In this section the data requirements are compared with the data available through the routine count programs in an attempt to delineate deficiencies, duplications, improvements, etc. For simplicity, the various programs are reported separately, although they were analyzed as a unit to avoid duplication of traffic data.

Interstate, Arterial, and Primary Route Count Program

The Interstate, Arterial, and Primary Route Count Program provides much data relative to ADT and classification of vehicles on the interstate and primary highways. Major emphasis has been

placed on the classification of vehicles through the manual counting procedures. Very few states have a program that determines the traffic mix to the degree the Department does.[8] In the Department's program, the manual classification data are supplemented with those from machine counts, whereas most other states obtain machine counts and supplement them with manual counts. When reviewing the needs of volume data on highways covered by the program, it was found that the majority relate to ADT volumes rather than to traffic mix. The accuracy of the ADT volumes obtained in the current program is questioned by many officials, mainly because of the factors used in expanding the 12-hour manual counts to ADT and the field collection practices. On the other hand, the same officials readily accept and use 24-hour machine counts. It was noted that many requests to the Traffic and Safety Division for data included 24-hour machine counts on routes that were covered by the subject count program.

In regard to the classification of vehicles, few data requirements were found to necessitate the published categories of traffic mix. The percentage of trucks was the most frequently requested classification information. One division requested several categories of truck data; however, the data were combined into a single category — percent of heavy trucks — before being utilized.

Only a few people in the Department stated that they needed out-of-state passenger car data. In fact, many felt it was superfluous and misleading, especially in areas adjacent to the state boundary. Others noted the large number of military people who reside in Virginia but have their vehicles registered elsewhere.

When designing highway facilities the directional distribution of vehicles is required. The current program does not provide for the publication of directional information. This information can be obtained from the worksheets at count stations located on limited access highways; however, for the majority of primary facilities, the distribution must be obtained through special counts or estimates.

In summary, it appears that the program provides more data than are used or needed. Most requests from people outside of the Department, like many of those from within the Department, are concerned only with total volumes. Frequently the requestors are not aware that the traffic mix data are available. The authors are of the opinion that the major problem with the subject program is not the type or amount of data provided but rather the accuracy and dependability of the data. The data may be accurate, but this assumption cannot be verified within the existing program.

During past years the numbers of continuous - and key-station counts have been reduced to a level where the relationships between short period (12-and 24-hour) counts and annual average daily traffic volumes cannot be determined. The administrative and operational problems associated with the field personnel collecting the manual data have contributed to the lack of confidence placed in the data by the people who use them.

Automatic Traffic Recorder Program

The Automatic Traffic Recorder Program consists of continuous counts which determine the relationships between short period counts and the ADT. The data relative to peak hour and 30th highest hour are useful in designing highway facilities. Also the program serves as a basis for establishing travel trends. As mentioned earlier, the program has been reduced drastically. Consequently, much of the effectiveness of the program has been lost and only limited use is made of the data acquired. If a sufficient number of the continuous count stations were properly located in the state, many of the questions about the interstate and primary count program could be addressed. Furthermore, many of the special data collection studies could be eliminated because more peak period information would be available.

Secondary Count Program

The basis requirements for traffic volume data on the secondary highways are the determination of needs, establishment of priorities for improvements and computation of VMT in each county for fund allocations. The count program provides 24-hour counts, incorrectly referred to as ADT, which apparently meet most of the needs of the Department. During past years the program has received much political attention, mainly because of the allocation of funds and the public's desire to "get out of the mud" by paving the dirt roads.

The program has been restructed several times since it was initiated and the latest modification resulted in the present schedule of obtaining counts once every 2 years rather than once every 4 years. It was noted that during the past 20 years the shift in the population from the central business districts to the suburban areas has increased the size of the program. Each year many hundreds of counts are gathered in subdivisions and they are not used except for the calculation of VMT.

The district and residency offices need and use the data in scheduling manintenance activities and establishing priorities for improvements. However, before making improvements many resident engineers require updated data gathered with more sophisticated equipment than presently used in the Secondary Count Program.

Urban Count Program

The interviews with the representatives of various divisions in the Department revealed that the majority of the data requirements are related to streets and highways in urban areas. The emphasis on transportation planning and environmental impacts of transportation facilities has necessitated types and magnitudes of volume data that were not conceived of 10 to 12 years ago. The urban count program provides limited data; therefore, many special studies are required to provide the data for planning and environmental studies. Many of the studies are project related and it would be impractical to have a count program that would provide all of the data required. However, the acquisition of more data in the routine count program could eliminate many of the special data studies. Furthermore, additional data would enable planners and engineers to make more accurate estimates than they are presently able to make.

The existing data provide a limited amount of monitoring of travel in the urban areas, but as noted previously sufficient ADT data are not being gathered at each cordon line and screen line crossing. These data are required to verify the validity of the original survey data and it is reasonable to maintain an annual surveillance of survey control lines. A minimum of 1 count per year is required at each screen line and cordon line crossing, and in areas that experience seasonal travel variations more than 1 count may be required.

Table 1 shows that estimates of peak hour traffic are needed in many studies conducted in urban areas. The existing count program has been structured to provide data in 15-minute intervals; however, the planners frequently need directional peak period traffic values which usually necessitate a special collection study.

Classifications of vehicles are required in most urban studies, especially the environmental quality studies. The current program provides no classification data and the Department does not have valid estimating procedures. In the interviews with the representatives of the Transportation Planning Division one case was cited where subjective estimates of the percent of trucks were made. Using the conservative estimate of 5%, the simulation models predicted highway project noise levels that required a $700,000 noise barrier. Special classification counts were conducted which revealed that trucks comprised only 1% of the total traffic. Using the revised data the simulation model predicted

acceptable noise levels and thereby eliminated the need for the noise barrier.

The existing Urban Count Program does not provide vehicle occupancy data. The needs for occupancy data are increasing as emphasis is placed on the movement of people rather than vehicles. The existing needs are being met through special data collection.

Although the Department does not use VMT values on a regional level it appears that future federal requirements may require them. VMT statistics cannot be computed utilizing the information in the existing count program.

The data for many traffic and travel studies conducted in urban areas require special volume counts. Data such as directional turning movements will always require special counting procedures that cannot be incorporated into a routine program.

ALTERNATIVES FOR IMPROVEMENT

The comparison of the data requirments with the data available from the routine count programs revealed many areas for improvements. In the following sections the alternatives for improvements of the programs are discussed.

Interstate, Arterial, and Primary Route Count Program

The current program provides much data that are not being utilized. The lack of utilization can be attributed to both an excessive amount of data and the suspicions of the users relative to the accuracy of the data. The following two alternatives for improving the program are offered for consideration. The first alternative relates to upgrading the existing manual program, while the other deals with a new mechanical program supplemented with a few manual classification counts.

Existing Manual Program

As previously reported the users of data from the existing program place diminished credibility in the information they are supplied because the program has been reduced to a level where the validity of the data cannot be verified. During the interviews the lack of supervision of the count teams, the manner in which the counts were made, and the accuracy of the expansion factors were questioned frequently.

The effectiveness of the program starts with the field personnel. The final data output is only as good as the collected field data. The count teams should consist of enough people to properly gather the information. They must be conscientious about their work and must be properly supervised. They need instructions relative to the different categories of vehicle classification. The deletion of categories not published in the Department's documents would improve the efficiency of the count team. Likewise, the unused categories should be deleted and combined with other categories.

A review of the accuracy of the existing expansion factors must be initiated. Intuitively, this review would require the establishment of continuous mechanical count stations. These stations combined with the existing stations in the Automatic Traffic Recorder Program could produce data with which the relationships between short period counts and annual average daily traffic volumes can be determined. The data would provide statistics such as daily, weekly, monthly, and seasonal variations, as well as peak periods, design volumes, and directional distributions.

The locations of existing stations should be reviewed. Generally manual counts are taken on each leg of a primary intersection and in some areas of the state it appears that counting every other intersection would be sufficient. The volume on each leg of the uncounted intersection could be estimated from adjacent intersections. Even counting traffic at every other intersection may not be necessary. For example, on long routes carrying large volumes of traffic, considerable savings can be achieved by locating stations only at points where there is a significant break in traffic volumes. This procedure would also be applicable on the interstate system. For example, it does not appear to be necessary to gather volume data between every interchange on Route I-64 between Richmond and Charlottesville.

Mechanical Recorders

The findings in this research have shown that highly accurate traffic volume counts can be obtained with mechanical recorders.[1] The main disadvantage with mechanical counts is that the traffic mix is not identified. If road tubes are used, an added disadvantage is that the number of axles is recorded rather than the number of vehicles. When other detection devices such as loops, radar, and magnetics are employed the actual vehicle is detected and recorded.

In a mechanical count program the manual count teams would be replaced with mechanical equipment. In order to meet the needs of the Department three categories of station locations should be utilized. They are continuous, control or seasonal, and coverage count stations.

At a continuous count station the number of vehicles are mechanically recorded 24 hours a day, 365 days a year. The equipment,consisting of electrical detection devices and storage cabinets for the recording equipment, should be permanent.

As the name implies, traffic counts are secured during each season at the seasonal stations. The counts are taken for 7 consecutive days. The recorder and even the detectors may be portable and easily transported for efficient use. On high volume, multilane roadways permanent detectors such as loops should be provided.

At the coverage station traffic volumes may be secured during consecutive 24- or 48-hour periods. These counting periods should be repeated on a predetermined schedule that ranges from one count every year to one count every 5 years. Portable equipment should be used at coverage count stations.

The analysis of the count data can be improved by using an automatic translator/tape reader. The translator/tape reader links the field data with the computer and significantly reduces the cost of analysis and clerical work. The Rhode Island Department of Transportation estimated that the cost of the equipment could be recovered in six months when considering the clerical savings.(7)

To supplement the mechanical volumes a small sample of manual classification counts would be required to determine the traffic mix on the interstate and primary routes.

Cost of Alternatives

In January 1976 the Traffic and Safety Division made an analysis of the cost differential and the initial cost of additional equipment needed to obtain mechanical traffic volumes as compared to the Department's existing method of collecting traffic data by manual classification counts. The final report (Appendix A) concluded that converting to a mechanical program would result in an annual savings of $110,000; however, an initial investment of $1,300,000 would be required.

The program proposed in the Traffic and Safety Division report was more extensive than the above outlined program. One of the main advantages of continuous counts is that the duration of other counts can be shortened. The Traffic and Safety proposal appeared to call for an excessive number of seasonal counts. Also coverage counts usually are gathered only once a year, rather than the proposed twice a year schedule in the Traffic and Safety report. After the continuous stations have been in operation for several years and trends have been established, the number of seasonal counts may be reduced along with a reduction in the frequency of obtaining coverage counts. Furthermore, improved techniques of installing loop detectors have resulted in lower costs since the Traffic and Safety report was prepared. The Utah Department of Transportation has developed procedures for fabricating and installing preformed loop detectors which cost approximately one-fourth as much as conventionally installed loop detectors.(9)

It is difficult to estimate the annual cost savings and the initial cost of the mechanical count program for the interstate and primary system without making a comprehensive study. The number of continuous, seasonal, and coverage counts along with the sample size of classification counts must be established. Several studies have recommended that statistical analysis be used in the selection of the various types of stations and have warned against arbitrarily selecting the locations.(5, 6)

When considering the cost savings estimated in the Traffic and Safety report, the new techniques of fabricating and installing loop detectors, and the considerable expenditure that will be required to verify the existing expansion factors, it is reasonable to assume that a tremendous cost savings will result by adopting the mechanical program.

Automatic Traffic Recorder Program

The Automatic Traffic Recorder Program consists of 16 stations located on the interstate and primary systemsand provides continuous volume counts. Unfortunately, the program is not sufficient to meet the requirements of the Department; therefore, in the previous sections, both of the described alternatives included the acquisition of continuous data. In the manual program alternative, continuous data are required to verify and/or correct the existing expansion factors. In the mechanical program they are needed to establish the relationships between short period counts and the annual average daily traffic volumes. These types of data allow a reduction in the number of stations in a program as well as a reduction in the frequency of counting.

It appears that the Automatic Traffic Recorder Program should be eliminated and the existing stations incorporated into the program selected for the interstate and primary systems.

Secondary Route Count Program

As reported eariler the Secondary Route Count Program has been restructured several times. It appears that many of the changes were made because of political concerns. The major use of the data is the calculation of the VMT statistics for fund allocations. Other requirements for secondary data relate to needs and priorities; however, it is questionable if all of the information gathered in the program is used for these purposes. For example, the 24-hour counts obtained on streets in subdivisions are rarely used.

From a planning and scheduling standpoint it seems that the program could be reduced; however, another method of calculating VMT would have to be developed. Statistical sampling procedures can be utilized with a high degree of accuracy to estimate VMT. Another alternative is to substitute the VMT statistics in the allocation formula with a parameter such as vehicle registration. The cost of approximately $400,000 every two years required to count the entire secondary system appears to be excessive for the information provided by the program. Because of the political overtones and the fact that this matter is beyond the scope of this project, a comprehensive study of the necessity for and the computation of VMT values on the secondary roadways would be appropriate.

In the interim, the minor problems noted during the data collection phases such as technicians not adhering to the 24-hour schedule can be corrected by proper supervision.

Urban Traffic Count Program

Throughout this report the data requirements for accommodating planning and environmental studies have been frequently mentioned. The majority of the Department's data needs are generated in the urban areas, but the urban count program is small when compared to those serving the rural areas. In 1976 the Urban Traffic Count Program cost approximately $63,450 while the programs for the interstate, primary, and secondary routes cost in excess of $724,000. Perhaps this is one reason for the large number of special studies conducted in the urban areas. The findings in this study revealed that the needs in the urban areas warrant an expanded program. Furthermore, the needs in the urban areas are such that the count program should be based upon a functional classification system rather than an administrative classification system.

The review of the urban program revealed that the locations of the current count stations should be reviewed to ensure that all screen line and cordon line crossings are covered. These stations should be counted at least annually and more frequently if seasonal traffic variations occur. In many cities and towns the technicians' schedule can accommodate additional count stations at a minimal expenditure. When additional 24-hour volumes are not desired the technician's schedule may allow the collection of other data such as directional distribution, traffic mix, and occupancy volumes.

Many of the special studies relative to vehicle classifications could be eliminated if the traffic mix was routinely sampled. In most cases classification counts of 4-hour duration, including one peak period, would yield the needed information.

The construction of facilities and the implementation of transportation systems management strategies for high occupancy vehicles have necessitated the need for occupancy data in many urban transportation corridors. People movements should be monitored and standardized procedures for doing so should be established.

The requirements for VMT should be determined. If VMT values are needed, methods of computing them should be developed. Statistical procedures appear to be the most practical approach; however, they need to be developed and evaluated. The required data samples for the statistical analysis could be obtained in the routine urban count program.

Special Count Program

Even though the number of special data requests can be reduced by improving the other count programs a need for special data will always occur.

Many requests received by the Traffic and Safety Division appeared to be for superfluous data. Few exact sciences exist in the highway field, particularly those dealing with traffic, planning, and environmental quality, and the users should review their models and techniques to determine if the amount and specified accuracy of data are necessary.

The time required to fill the data requests appears to be excessive. The schedules and manpower requirements of the Traffic and Safety Division's special count teams should be studied in an attempt to improve the service to other divisions requesting volume data. Finally the problems associated with conducting the Virginia Visitor Travel Survey should be addressed.

RECOMMENDATIONS

The review of the data requirements revealed that every division within the Department utilizes traffic volume data to make many decisions in their daily activities. Furthermore, many other governmental agencies, businesses, and individuals base their plans and operations upon the numbers and types of vehicles utilizing the streets and highways in the Commonwealth. The Department annually spends approximately $780,000 in an attempt to fill the needs for data, and a review of the count programs revealed that many special collection studies are required. The findings of this study showed than excessive amount of volume data is being collected in the rural area while many of the urban data requirements are not being met. In an attempt to provide the users with adequate and accurate data the following recommendations are offered for consideration.

1. It is recommended that the existing manual classification count program on the interstate and primary routes be replaced with a mechanical recorder program consisting of continuous, seasonal, and coverage traffic counts. To supplement the mechanical volumes, a small sample of classification counts will be required to determine the traffic mix. The use of loop detectors at all continuous count stations and at the seasonal and coverage stations located on high volume, multilane highways is recommended. It is also recommended that a translator/tape reader be utilized in analyzing the traffic count data.

2. The existing Automatic Traffic Recorder Program on the interstate and primary systems should be combined with the mechanical recorder count program previously recommended.

3. The Code of Virginia requires that VMT be considered in the allocation of construction and maintenance funds for the secondary highways. The present method of computing VMT requires an extensive secondary count program and frequently it was reported that this was the only use made of the data. It is recommended that a study be initiated to determine if other parameters can replace the VMT statistics in the allocation formula. If a substitution is not feasible, the study should determine other methods of computing VMT on the secondary system which would be practicable and politically acceptable.

4. Additional data are required in the urban areas and it is recommended that the existing urban count program be expanded. The existing count station in each urban area should be examined to ensure proper coverage. Some stations may have to be relocated and additional ones may be required in order to properly monitor urban travel. It is recommended that the program include the acquisition of traffic mix data and be based upon a functional classification roadway system.

5. In many urban transportation corridors occupancy data are required. The development of standardized procedures for gathering occupancy data is recommended. Also, in many areas the monitoring of vehicle occupancy rates should be included in the urban count program.

6. The requirement for VMT data in the urban areas should be determined. If VMT values are to be required in the immediate future, statistical procedures for computing them should be developed and evaluated.

7. The data needs of the Department will always require special data collection; therefore, the special count program should be continued. It is recommended that the schedules and manpower requirements of the program be studied to determine areas in which the efficiency of the program can be improved and consequently the service to other divisions.

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The authors express gratitude to L. H. Dawson, Jr., Assistant Traffic and Safety Engineer, and R. C. Lockwood, Assistant Transportation Planning Engineer, of the Virginia Department of Highways and Transportation for their advice and assistance in this research.

Appreciation is extended to all of the individuals who were interviewed for their contributions of time, effort, and data. Without their cooperation, completion of the study would have been impossible.

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APPENDIX

TRAFFIC AND SAFETY DIVISION REPORT ON TRAFFIC COUNTING PROCEDURES

IN REPLY PLEASE REFER TO

J. P. MILLS, JR.
TRAFFIC AND SAFETY ENGINEER

January 5, 1976

Traffic Counting Procedures

Memorandum

To - Mr. L. H. Dawson, Jr.

Reference is made to your memorandum of November 28, 1975, requesting a comparative analysis of the cost differential and the initial cost of the additional traffic recorders needed to obtain traffic counts, as outlined in the brochures from FHWA, compared to our present method of collecting traffic data by manual classification counts.

Manual classification counts are not scheduled annually in urban areas; therefore, this comparison will be made on the Interstate, Rural Primary and Arterial routes.

Thorough knowledge of the traffic mix is imperative in the development of benefit-cost ratios, design 18^k axle loads and the many other studies where capacity and design are factors of concern. A reduction in the number or the elimination of classification counts could require estimates of the traffic mix or special counts obtained on a study-by-study basis.

A review of "Acquisition and Analysis of Traffic Data in Georgia", the "Manual of Procedure for Conducting Traffic Surveys" in Tennessee, the "Volume Counting Program" in West Virginia, the "Traffic Volume Estimation Study" by Amerad Corporation and "Traffic Counting Interstate, Arterial and Primary System" prepared by the Traffic and Safety Division, reveals that manual vehicle classification counts are obtained or recommended on a scheduled basis in addition to machine counts secured.

The Salem District, with 12.27 percent of Interstate, Rural Arterial and Primary road mileage accounting for 11.31 percent of the state total vehicle miles of travel on these routes in 1974, has been selected to be used as a basis for this comparative analysis.

The following assumptions are made if the procedure, as outlined in the "Traffic Volume Counting Manual" furnished by FHWA, were to be followed.

(a) Key stations would be assigned as continuous count stations.

(b) Four count stations would be assigned as seasonal control stations at which seven day machine counts would be secured four times each year.

(c) Two count stations would be assigned as coverage count stations and counts secured for a 24-hour period twice a year.

(d) Counts secured by the use of automatic traffic recorders at all locations with hourly volumes recorded.

(e) Loop detectors would be installed for obtaining all recorder counts at the continuous count stations.

(f) Road tubes would be used at the seasonal and coverage count stations.

There are 178 counting locations in the Salem District scheduled to be counted for a 12-hour period. Since most counting stations are located at intersections, one manual classification count at each of the 178 stations would produce 399 counts, excluding Secondary routes, and for the year, 1578 classification counts as indicated in the following table.

Number of Stations	Times Counted	Counts Per Year	Legs Counted Each Station	Legs Counted Per Year
42	2	84	84	168
124	4	496	285	1140
12	9	108	30	270
178		688	399	1578

To secure traffic counts at each of the stations by the use of automatic traffic recorders would require placing 505 recorders. At primary intersections, a recorder would be required for each leg and if the facility were divided, additional recorders would be required. The following table gives a breakdown of the number of recorders required for each of our two, four and nine count stations.

Number		Recorders Placed For	
Stations	Counts	One Count	Annual Counts
42	2	96	192
124	4	372	1488
12	9	37	37
178		505	1717

Following the assumption that nine count stations would be assigned as continuous count stations, then 37 recorders would be placed and serviced each week. Recorders would then be placed at 372 locations for a seven day period, four times a year and at 96 locations, 24-hour counts would be obtained twice a year to provide seasonal control and coverage counts.

Two employees obtaining 50 recorder counts each, per two week period would complete the annual schedule of recorder counts in 33 to 34 weeks. An additional 1152 hours would be required to obtain 24-hour classification counts each season at the continuous count stations to be used in the development of adjustment factors to apply to recorder counts secured at the seasonal and coverage as well as continuous count stations.

At continuous count stations, loop detectors are recommended with rubber road tube detectors used at the seasonal control and coverage count stations.

The initial cost for additional traffic recorders and items to implement the Federal procedure of traffic counting is estimated to be as follows:

40 recorders for loop detectors	$ 63,000
37 loop detectors installed	18,500
110 recorders for road tube detectors	69,000
1/8 cost of translator (tape reader)	2,500
Battery chargers	1,800
Batteries, ribbon cartridges, printed paper tape, road tube, etc.	8,000
TOTAL	$162,800

To operate for one year -

**5216 man hours	24,098
Annual rent 2 vehicles	2,400
Accessories	8,000
TOTAL	34,498 *

*Assuming that supervision, space for service shop, computer programs, etc. would be equal to or near the same as for our present counting program.

**One man required full time for service shop and related work on count program.

The charges for obtaining 688 manual classification counts, each for a 12-hour period at all counting locations in the Salem District for the year ending June 30, 1975 were $48,259. For each counting location the average cost of a 12-hour count was $70.14 or for each of the 1578 legs counted the cost was $30.58.

It is estimated that the adoption of the FHWA recommended procedure as outlined above would result in an annual saving of $13,761 for one district or $110,088 state-wide.

To initiate this program would require an estimated initial outlay of $1,302,400.

There are numerous variations in the recommendations of FHWA, such as a grouping procedure, obtaining counts over a period of two or more years and estimating traffic for the year at locations which are not scheduled and counted each year. The adoption of a procedure other than as outlined could affect the cost of obtaining traffic recorder counts.

C. E. Powell
Traffic Engineer

CEP:gyj