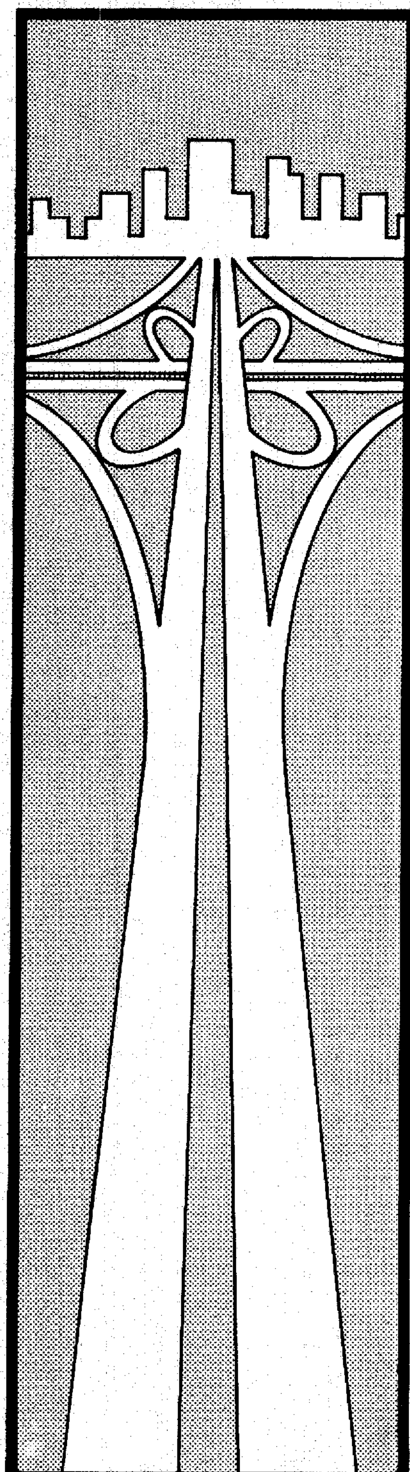
HIGHWAY PLANNING TECHNICAL REPORT



Number 5
October 1966

Evaluation of Rural Coverage Count Duration for Estimating Annual Average Daily Traffic

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

U.S. DEPARTMENT OF COMMERCE

U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

Evaluation of Rural Coverage Count Duration for Estimating Annual Average Daily Traffic

By
R. R. Bodle, Highway Research Engineer
Methods Branch
Current Planning Division
Office of Planning

Estimation of annual average daily traffic (ADT) on sections of a state highway network has long been an important phase of the highway planning process. ADT estimates have been used as a fundamental element in determining vehicle-miles of travel on the various categories of rural and urban highway systems. ADT estimates, together with other important characteristics of traffic, provide the highway engineer, planner, and administrator with information necessary for establishing a systematic classification of highway systems, determining design standards, evaluating safety programs, estimating change in annual traffic volumes, calibrating traffic assignment and distribution models, and developing programs for highway improvement and maintenance. In addition, many commercial activities, such as motels and hotels, restaurants, automobile service and repair industries, and recreational and amusement centers use traffic estimates as a basis for planning.

Three basic types of mechanical traffic counting operations are commonly employed by State highway departments to obtain ADT estimates. Hourly recorders are operated continuously at a limited number of locations. Intermittent counts or seasonal control counts are taken four, six or twelve times a year for durations varying from 48 hours to two weeks. By far, the greatest amount of traffic data results from short coverage counts taken for 24 or 48 hours, but may be as long as five or seven days. In a very few states coverage counts are taken two or four times a year. It is necessary to utilize these coverage counts in arriving at ADT estimates for the many locations on the highway network where continuous recorders and seasonal control stations are not operated.

Over the years, highway departments have used some factoring procedure for adjusting coverage counts to estimates of ADT. Generally this involved associating each short count station with a single permanent recorder believed to have a similar pattern of monthly variation. An adjustment factor from the permanent recorder was then applied to the coverage count to obtain the ADT estimate.

In May 1963, the Bureau of Public Roads published the "Guide for Traffic Volume Counting Manual." This manual was the result of research by several highway departments in cooperation with Public Roads, and presents an efficient procedure for adjusting coverage counts to ADT estimates. The procedure involves grouping together the permanent recorders and seasonal control stations having similar annual traffic patterns. In most States, three to five groups are defined. After assigning all of the state highway network to one of the several groups that may be identified, coverage counts are adjusted to estimates of ADT by applying the appropriate group mean monthly factor.

The monthly factor used in grouping permanent recorders and seasonal control stations is defined as: F = Average Annual Daily Traffic divided by Average Weekday Traffic for the Month. The group mean monthly factor is then the average of the individual monthly factors for the ATR's and control stations in the group. There are three sources of error in this method of estimating ADT at a point:

1. The monthly factor at a coverage count station will generally not be exactly equal to the group mean;

2. The coverage count (24 or 48 hours, 5 days or 7 days) will differ from the average weekday (average day in the case of a 7-day count) of the month; and

3. The road section on which a coverage count is taken may have been assigned to the wrong group. This error is assumed to be negligible.

The percent error or relative error for any estimate of ADT for a link on which a coverage count is taken may be expressed as:

$$E = \left(\frac{XF - ADT}{ADT}\right) 100 \qquad (1)$$

where:

E = estimated percent error

X = 24-hour count or the average day for the period counted

F = the appropriate group mean monthly factor

The coefficient of variation of the relative error of the estimate may be expressed as:

$CV = (CV_x^2 + CV_f^2)^{1/2}$; where CV_x = coefficient of variation of coverage counts
CV_f = coefficient of variation of the monthly adjustment factors (2)

Formula (2) is based on the following assumptions:

1. Both x and f are random variables.

2. The two variables are uncorrelated.

If the continuous traffic recorders were placed on every section of the road network assigned to the group, it may be assumed that the population of resulting monthly factors would be uniformly distributed about the group monthly means. The values for any month would have a range of 0.20 from low factor to high factor. The coefficient of variation of the factors for a month will generally be of the order of magnitude of 4 or 5 percent. Therefore, in order to attain a relative error of 10 percent in the ADT estimate (that is, a coefficient of variation for the estimate of 10 percent), the coefficient of variation of the coverage counts for any month must not exceed 8 or 9 percent.

Many highway departments take coverage counts of 24- or 48-hour duration with cumulative type traffic counters. A few states take coverage counts of 72 hours, 5 or 7 days. Generally these longer duration counts are taken with portable hourly recorders. In the past, there have been studies to determine the most appropriate duration for coverage counts. These studies generally utilize continuous recorder data and randomly selected samples of varying duration. The samples are then compared with either the average weekday for the month or average day of the month, whichever is appropriate. A great deal of this work has been unreported.

The results of one such study were published in 1954 by Petroff and Blensly.1/ Commenting on Figure 1 which is taken from that report, the authors say:

> "The observation of the data presented in Figure 1 which is of utmost practical significance is that traffic counts of 24-hour duration on weekdays have a coefficient of variation of ±10 percent

------

1/ Petroff, Boris B., and Blensly, Robert C., "Improving Traffic-Count Procedures by Application of Statistical Method." Proceedings, Highway Research Board, 1954.

or less when compared with the mean volume for a weekday in a given month at stations having the mean volume of about 500 vehicles per day or more. This applies usually to all months except the winter months in some states." . . . . . "Counts of 48-hours duration improve the accuracy by 20 to 25 percent, thus raising the confidence limit from 68 percent to about 75 percent for one standard deviation of 10 percent, also extending the range of volumes down to about 300 vpd.

"This translated into everyday language means that two-thirds to three-fourths, depending on the length of the count, of all coverage or blanket counts may be expected to have an error of about 10 percent or less when compared with the true mean weekday volume of the month during which they were taken when volumes are 300 to 500 vehicles per day or more."

These observations are for coverage counts in rural areas. Results of a similar study for urban areas were reported by Petroff and Kancler in 1958. 2/ This paper will be concerned with rural coverage counts only.

The present study examines on a population rather than a sample basis the relative accuracy of coverage counts of 24- and 48-hours on weekdays, 5 weekdays and 7 days. Counts of 72 hours were not tested because of their infrequent use. The study's objective was to determine if the observations of Petroff and Blensly are still applicable and to obtain information on the increase in accuracy of ADT estimates that may be expected by increasing the duration of coverage counts. In some states, Friday volumes are more like those on weekends than on weekdays. For this reason, 24-hour counts taken Monday through Thursday were also tested.

Rather than testing randomly selected sample counts of the desired duration from continuous recorder data, all combinations of data for the five selected count durations were analyzed. This was possible through use of an IBM 7010 computer. In order to draw definite conclusions for all states, it would be necessary to test data from all states. This would be impractical and prohibitively expensive. It was decided to utilize data from a limited number of states geographically distributed around the country. Hourly volume data were obtained for 386 continuous recorders in five states for 1964 as shown below:

2/ Petroff, Boris B., and Kancler, A. P., "Observations Concerning Urban Traffic Volume Patterns in Tennessee." PUBLIC ROADS, December 1958 issue.

State	Number of recorders
Arkansas	76
Florida	80
Georgia	25
Michigan	116
Oregon	89

The states were selected primarily on the basis of ready availability of data and convenient format.

Each state's data were subjected to the same testing procedure. All available volumes at each station for 24 hours and 48 hours on weekdays and five consecutive weekdays were compared with the appropriate average weekday of the month. The standard deviation and coefficient of variation were computed for each month at a station for the five selected count durations. Table 1 is a sample of the computer output.

In computing the standard deviation for the 24-hour counts, the following formula was used:

$$\sigma = \left[\frac{\sum_{1}^{N} X_1^2}{N} - \bar{X}^2 \right]^{1/2}$$

The following formula was used to compute the root mean error about the average weekday of the month for the three additional coverage count durations:

$$RME = \left[\frac{\sum_{1}^{N} X_1^2}{N} - 2\,\bar{X}\,\bar{Y} + \bar{Y}^2 \right]^{1/2}$$

The formula of the root mean square error yields a slight overestimate of the standard deviation. It was adopted in order to compare the 48-hour, 5-day and 7-day counts with the same average weekday of the month as the 24-hour counts. Use of the first formula with the multi-day counts would have resulted in comparing each multi-day count with the average of the multi-day counts. Derivations of the two formulas are found in the Appendix.

All computations, including summarizing hourly volumes into daily volumes, were done on an IBM 7010 computer. FORTRAN IV programs were written for each phase of the study.

RESULTS

Table 2 presents a tabulation of the monthly and overall annual coefficients of variation of the coverage counts for each State and for the five coverage count periods. These are monthly average coefficients of all stations in the state. In these computations, the coverage counts for periods exceeding 24-hour duration were reduced to 24-hour averages. Table 2A presents averages of the monthly coefficients for the five states. These same coefficients are presented in graphical form in Figure 2. Please note that the December results in Oregon are not included in any summaries due to a flood which disrupted traffic in some parts of the State. Also in Oregon, the analysis of 24-hour coverage counts taken Monday through Thursday is omitted, since individual weekdays were not easily identified on the input tape. Table 3 is an overall summary of the coefficients in the last column of Table 2. Annual mean coefficients of variation for the five are also shown in the bar-graph in Figure 3.

One striking observation that can be made is that the coefficient of variation for 24-hour counts taken Monday through Friday is nearly always greater than ±10 percent. This is true for both the overall monthly averages and annual average (Table 2A). Arkansas and Florida were the only two states where the monthly coefficients were under ±10 percent in more than one or two months. Consideration of only the months March through November, when some states do all coverage counting, does not alter the picture described above. These are rather significant observations, since quite a number of states now use 24-hour coverage counts for ADT estimating purposes. Perhaps an evaluation of the 24-hour counts in these states would be in order to determine if this study's results also apply to the particular states concerned.

By taking 48-hour weekday counts, it appears that the coefficient of variation of the count can be reduced below the ±10 percent level to a point where ADT estimates will more closely approach the desired accuracy. Exclusive of Michigan where the volumes are more variable than in the other four states, the overall annual coefficient of variation for 48-hour weekday counts is ±9.0 percent. This is approximately the same relative improvement observed by Petroff and Blensly. Scheduling of 48-hour counts does not generally present any greater problems than those for 24-hour counts. There is the possibility that field men may have all their recorders picked up by Friday noon. Many states utilize Friday afternoons for equipment maintenance, special purpose counts, or travel.

In recent years, many states have observed that Friday traffic, especially Friday afternoon, more closely resembles weekend rather than weekday traffic. Insofar as the total daily volumes are concerned, these observations are substantiated in this study by the reduction in the coefficient of variation resulting from considering only Monday through Thursday for 24-hour counts. Table 2 and Figure 2 show a very close similarity between 48-hour counts and 24-hour counts which exclude Fridays.

The decrease in annual mean coefficients of variation between the 48-hour counts and the 5-day count was 3.9 percent as compared to 2.9 percent between 24-hour and 48-hour counts (Table 3). The results for the 7-day counts are almost the same as for 5-day counts. Either count duration cuts the 24-hour relative variation in half. The ADT estimates resulting from the expansion of 5- or 7-day counts should have a total relative error of about ±6-8 percent. This figure for total relative error in the ADT estimate is obtained using Formula 2 on page 3 which combines the effect of variation of daily volumes with the effect of using a group mean factor. These longer coverage count durations are popular in northern climates and where there is extensive mileage of low-volume highways. From a scheduling standpoint, the 7-day counts may be more practical.

Many highway departments exclude the winter months from their coverage counting schedules. In order to determine the effect of winter months, the overall mean coefficients of variation were calculated for the months March through November. These figures are shown in the last column of Tables 2 and 2A. Although there is little change in the overall mean coefficients, Figure 2 shows the definite advantage of eliminating winter months since they generally have higher coefficients than the remaining months.

The unusually high coefficients of variation for September are due largely to steadily decreasing volumes throughout the month at most stations. Failure to eliminate from consideration certain holiday periods during the month further contributed to the variation of the weekday volumes. In an effort to determine the degree to which the September coefficients of variation were affected by the Labor Day traffic, two weekdays (September 4 and 7, 1964) were eliminated and coefficients recomputed for 24-hour weekday counts. The average decrease in the coefficients of variation was - 4.7 percent. Similar decreases in variation for the other four count durations would be expected. Table 2B shows the results of the comparison in detail. Figure 2A shows a comparison of monthly fluctuation of 24-hour weekday counts taken Monday through Friday. It is seen that the September variation is still high. This must be attributed to a significant decrease in volumes during the month. Table 2C shows overall mean coefficients of variation for the period March through November, excluding September for all count durations other than 24-hour Monday through Friday. This shows that all coverage counts taken during this period, except 24 hours Monday through Friday, have coefficients of variation sufficiently low to produce satisfactory estimates of ADT.

The "Guide for Traffic Volume Counting Manual" suggests treating all roads with ADT less than 500 in a separate category. Of the 386 permanent recorders studied, fewer than 40 had ADT's less than 500. These were concentrated in Arkansas (21) and Oregon (15). Table 4 shows that very slight effect on the annual mean coefficients of eliminating these lower volume stations. The remaining three states had no more than three low-volume stations each. Therefore, the observations discussed above can be considered representative of higher-volume locations.

In a 1946 paper 3/, Petroff reported on the fluctuation of weekday volumes at locations where the ADT is less than 500 vehicles per day. The study utilized data from 10 permanent recorders in northern states and 10 recorders in southern states. The mean annual coefficients of variation in the northern states for 24- and 48-hour counts were 24.96 percent and 19.50 percent, respectively. In the southern states, the coefficients were 19.32 percent and 14.85 percent.

Table 5 presents the mean monthly coefficients of variation for Arkansas and Oregon plus coefficients for three additional stations. Although the coefficients are not as high as those reported by Petroff, the difference of about three percent between the two count periods is comparable to Petroff's results. The coefficients in Table 5 produce the additional observation that ADT estimates with a standard deviation of ±10 percent or less are unlikely for low-volume stations, at least in these states, unless coverage counts are of 5 or 7 days duration.

Conclusions

The most important result of this study relates to the use of 24- or 48-hour coverage counts for ADT estimating purposes on rural roads with ADT's greater than 500 vpd. Coverage counts taken for 48 hours on weekdays will have a mean annual coefficient of variation of ±9.0 to ±9.5 percent when compared to the average weekday of the month. The study results strongly indicate that a coefficient of ±10 percent or less is not to be expected for coverage counts of 24 hours taken Monday through Friday. If these results are fairly representative of

---

3/ Petroff, Boris B., "Some Criteria for Scheduling Mechnaical Traffic Counts," Proceedings, Highway Research Board, 1946.

conditions in other states, 24-hour counts taken Monday through Friday should generally not be used to obtain ADT estimates with a relative error of ±10 percent. Although this study included only five states, the results appear definite enough to warn against use of 24-hour weekday coverage counts without sufficient proof that results will be satisfactory in the particular state.

The study results also indicate that, if Fridays can be excluded from coverage counting, the coefficients of variation for 24-hour weekday counts will be comparable to 48-hour counts taken Monday through Friday. It should be noted that the full 24-hour Friday volumes were excluded in this part of the analysis. Although many states exclude Friday p.m. volumes, this practice was not tested. It would seem prudent, however, for individual states using Friday morning volumes to verify that they are not significantly different from those of other weekdays.

For estimating ADT on rural roads with ADT's under 500 vehicles per day, it appears that neither 24- nor 48-hour counts should be used if the desired relative error of estimate of ADT is ±10 percent. In this case, either 5-day or 7-day coverage counts are recommended. Many highway departments do not feel it is necessary to maintain the same accuracy of ADT estimates for roads with ADT under 500 vehicles per day as for the higher volume roads. Coverage counts of 48-hour duration on low-volume roads, having coefficients of variation of about ±12 percent when compared with the average weekday of the month, will probably produce ADT estimates with a standard deviation of about ±12-14 percent. Similarly 24-hour coverage counts with coefficients of variation of approximately ±16 percent should produce ADT estimates with a standard relative error of about ±16-17 percent.

In scheduling coverage counts, most states, except those in the southern part of the country, exclude the winter months. Tables 2 and 2B do not indicate a marked decrease in annual coefficients of variation for the five states studied when winter months are excluded. Experience has shown that permanent recorders in most states are difficult to group following the Bureau of Public Roads' "Guide for Traffic Volume Counting Manual" when winter months are included. The practice of excluding winter months from coverage counting schedules, therefore, appears desirable in all but a few southern states.

Table 1 - GEORGIA

EVALUATION OF 48 HOUR COVERAGE COUNTS

STATE	STATION	MONTH	OBSERVATIONS	AVG WKDY	STD DEVIATION	COEF OF VARIATION
36	1001	1	19.0	9444.0	635.4	6.7
36	1001	2	19.0	9664.5	907.7	9.3
36	1001	3	21.0	9615.4	1394.1	14.4
36	1001	4	21.0	10535.1	658.6	6.2
36	1001	5	20.0	10860.5	658.5	6.0
36	1001	6	21.0	11499.8	1099.0	9.5
36	1001	7	22.0	11871.3	657.0	5.5
36	1001	8	20.0	11893.9	573.3	4.8
36	1001	9	21.0	11035.5	1073.7	9.7
36	1001	10	21.0	9544.3	672.1	7.0
36	1001	11	20.0	9615.9	737.9	7.6
36	1001	12	22.0	10032.3	1455.6	14.5
36	1002	1	19.0	8703.3	636.6	7.3
36	1002	2	19.0	9137.9	434.2	4.7
36	1002	3	21.0	9380.9	440.6	4.6
36	1002	4	21.0	9873.9	543.8	5.5
36	1002	5	20.0	10469.3	590.1	5.6
36	1002	6	21.0	10864.7	462.5	4.2
36	1002	7	21.0	10934.7	514.5	4.7
36	1002	8	20.0	11360.6	637.8	5.6
36	1002	9	21.0	11295.3	674.3	5.9
36	1002	10	21.0	9552.0	1006.8	10.5
36	1002	11	20.0	9405.7	869.4	9.2
36	1002	12	22.0	9535.0	1110.6	11.6
36	1004	1	19.0	3147.2	182.4	5.7
36	1004	2	19.0	3224.6	296.1	9.1
36	1004	3	21.0	3411.6	389.1	11.4
36	1004	4	21.0	3674.0	343.9	9.3
36	1004	5	20.0	3923.7	348.1	8.8
36	1004	6	21.0	4396.9	272.0	6.1
36	1004	7	22.0	4436.3	511.0	11.5
36	1004	8	20.0	4202.3	396.4	9.4
36	1004	9	21.0	3921.0	497.0	12.6
36	1004	10	21.0	3493.3	416.0	11.9
36	1004	11	20.0	3262.5	444.5	13.6
36	1004	12	22.0	3564.0	383.8	10.7
36	1007	1	19.0	5228.4	433.3	8.2
36	1007	2	19.0	5689.0	574.2	10.0
36	1007	3	21.0	6465.5	1180.5	18.2
36	1007	4	21.0	6417.0	613.5	9.5
36	1007	5	20.0	5944.6	1410.3	23.7
36	1007	6	21.0	1533.0	171.1	11.1
36	1007	7	22.0	1344.9	108.9	8.1
36	1007	8	20.0	1223.4	62.2	5.0
36	1007	9	21.0	1061.6	45.7	4.3
36	1007	10	21.0	1075.5	68.4	6.3
36	1007	11	20.0	1050.2	48.6	4.6
36	1007	12	22.0	1048.9	90.5	8.6
36	1008	1	19.0	2969.4	134.0	4.5
36	1008	2	19.0	3099.5	214.8	6.9
36	1008	3	21.0	3125.9	109.2	3.4
36	1008	4	21.0	3300.0	183.6	5.5
36	1008	5	20.0	3323.5	203.1	6.1
36	1008	6	21.0	3525.6	215.7	6.1
36	1008	7	22.0	3790.4	303.1	7.9
36	1008	8	20.0	3761.4	175.0	4.6

Table 2

Summary of monthly coefficients of variation of rural traffic volumes.

		JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG.	Average (Mar.-Nov.)
MICHIGAN	24 hr.	13.2	11.8	15.5	13.3	17.9	14.0	14.1	11.5	22.8	15.6	21.6	16.1	15.6	16.2
	24 hr.*	10.6	7.0	13.2	7.7	9.1	10.6	9.9	8.7	21.2	9.5	19.8	14.8	11.8	12.2
	48 hr.	8.8	7.7	12.5	10.0	12.3	11.1	10.8	8.8	19.4	12.0	17.8	12.7	11.9	12.7
	5 day	4.4	2.9	7.0	5.7	5.4	5.9	5.2	4.8	14.0	6.1	12.1	9.2	6.9	7.4
	7 day	5.5	3.2	6.1	6.6	6.1	6.2	4.4	5.5	12.3	6.2	12.7	9.2	7.0	7.3
GEORGIA	24 hr.	10.0	10.1	12.2	11.8	11.6	9.9	11.5	8.9	13.3	10.8	11.6	13.8	11.3	11.3
	24 hr.*	8.4	6.9	8.6	8.1	6.7	7.4	7.1	6.1	11.2	6.5	10.4	14.1	8.4	8.0
	48 hr.	7.1	7.6	9.7	8.8	8.1	7.8	8.9	6.7	10.5	7.4	8.0	11.8	8.5	8.4
	5 day	4.6	3.6	5.1	4.3	4.0	4.3	4.9	3.8	6.3	3.4	3.7	9.1	4.8	4.4
	7 day	4.7	3.6	5.8	4.7	4.2	4.5	4.5	4.2	6.3	4.0	3.8	9.2	5.0	4.7
OREGON	24 hr.	13.2	10.7	13.7	10.6	14.8	11.4	11.3	8.9	16.5	15.8	15.3	--	12.9	13.1
	24 hr.*	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	48 hr.	10.6	7.7	11.6	7.6	10.1	9.2	8.6	6.7	13.8	11.6	11.4	--	10.2	10.1
	5 day	7.1	4.5	8.4	3.9	5.4	5.8	4.6	3.6	9.5	5.7	6.8	--	5.9	6.0
	7 day	8.2	6.0	8.3	4.7	6.7	6.1	4.6	4.2	8.7	5.3	6.6	--	6.3	6.1
ARKANSAS	24 hr.	12.2	10.4	12.7	9.5	9.9	8.3	10.2	9.3	12.3	10.7	13.1	14.9	11.1	10.7
	24 hr.*	11.8	8.8	10.9	8.0	8.2	7.2	7.9	7.6	11.2	8.6	13.0	14.2	9.7	9.2
	48 hr.	8.8	7.7	9.8	7.1	7.2	6.4	7.8	6.3	9.2	8.2	10.2	12.0	8.3	8.0
	5 day	6.0	4.6	5.9	3.8	4.1	3.8	4.6	3.6	5.5	4.8	9.9	7.5	5.2	5.1
	7 day	6.9	3.9	5.7	3.9	4.0	3.6	4.2	3.6	6.1	4.9	6.3	8.2	5.0	4.7
FLORIDA	24 hr.	11.5	10.3	10.3	10.9	9.9	8.3	10.5	7.8	15.4	10.3	11.5	15.6	11.1	10.5
	24 hr.*	10.3	9.1	7.8	8.5	6.0	6.4	7.5	5.7	14.4	7.2	10.7	14.6	9.0	8.2
	48 hr.	8.9	8.5	8.6	8.7	7.1	6.5	8.6	5.7	12.6	7.7	8.7	13.9	8.8	8.2
	5 day	5.6	5.1	5.0	4.6	3.7	3.4	5.5	2.8	8.6	4.1	7.1	10.0	5.4	5.0
	7 day	5.7	5.2	5.3	4.0	3.9	3.3	5.0	3.0	8.3	4.5	3.8	10.6	5.2	4.6

Table 2A - Mean monthly coefficients of variation.

		JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	AVG.	Average (Mar.-Nov.)
AVERAGE	24 hr.	12.0	10.7	12.9	11.2	12.8	10.4	11.5	9.3	16.1	12.6	14.6	15.1	12.4	12.4
	24 hr.*	10.3	8.0	10.1	8.1	7.5	7.9	8.1	7.0	14.5	8.0	13.5	14.4	9.8	9.4
	48 hr.	8.8	7.8	10.4	8.4	9.0	8.2	8.9	6.8	13.1	9.4	11.2	12.6	9.5	9.5
	5 day	5.5	4.1	6.3	4.5	4.5	4.6	5.0	3.7	8.8	4.8	7.9	9.0	5.7	5.6
	7 day	6.2	4.4	6.2	4.8	5.0	4.7	4.5	4.1	8.3	5.0	6.6	9.3	5.9	5.5

*24-hour weekday counts taken Monday through Thursday.

Table 2B

Effect on variation of 24-hour weekday volumes of eliminating Labor Day holiday period.

State	Mean September coefficients		Difference
	Original	After eliminting Sept. 4 & 7, 1964	
Michigan	22.8	13.7	9.1
Georgia	13.3	10.7	2.6
Oregon	16.5	11.4	5.1
Arkansas	12.3	9.8	2.5
Florida	15.4	11.2	4.2
Average	16.1	11.4	4.7

Table 2C

Mean monthly coefficients of variation for rural traffic volumes.

Duration	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Avg.
24 hr.	12.9	11.2	12.8	10.4	11.5	9.3	11.4	12.6	14.6	11.9
24 hr.*	10.1	8.1	7.5	7.9	8.1	7.0	---	8.0	13.5	8.8
48 hr.	10.4	8.4	9.0	8.2	8.9	6.8	---	9.4	11.2	9.0
5 day	6.3	4.5	4.5	4.6	5.0	3.7	---	4.8	7.9	5.2
7 day	6.2	4.8	5.0	4.7	4.5	4.1	---	5.0	6.6	5.1

* Twenty-four hour weekday counts taken Monday through Thursday.

Note: September coefficients excluding Labor Day period calculated only for 24-hour counts Monday through Friday.

Table 3

Analysis of rural coverage count duration

Coefficients of variation summary table

State	24 hour	24 hour*	48 hour	5 day	7 day	No. of stations
Georgia	11.3	8.4	8.5	4.8	5.0	25
Florida	11.1	9.0	8.8	5.4	5.2	80
Oregon**	12.9	---	10.2	5.9	6.3	89
Michigan	15.6	11.8	11.9	6.9	7.0	116
Arkansas	11.1	9.7	8.3	5.2	5.0	76
Average	12.4	9.7	9.5	5.6	5.7	Total = 386

* Weekday counts taken Monday through Thursday.

** Due to a bad flood in December 1964 counts for this month are not included in the averages.

Table 4

Summary table
(Affect of eliminating station with ADT less than 500)

Mean annual coefficients of variation

	24 hr.	24 hr.*	48 hr.	5 day	7 day	No. of stations
Arkansas						
All stations	11.1	9.7	8.3	5.2	5.0	76
High-volume stations	9.2	7.5	6.8	4.1	4.1	55
Difference	1.9	2.2	1.5	1.1	0.9	11
Oregon						
All stations	12.9	---	10.2	5.9	6.3	89
High-volume stations	12.5	---	9.8	5.6	6.0	74
Difference	0.4	---	0.4	0.3	0.3	15

* Weekday counts taken Monday through Thursday.

Table 5

Average coefficients of variation

Low-volume rural stations

Station	Coverage count	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	September** Adjusted	Oct.	Nov.	Dec.	Avg.
Arkansas	24 hr.	17.5	17.0	19.4	14.4	13.0	12.1	14.2	12.1	16.7	16.4	16.0	18.0	20.5	15.9
	24 hr.	17.8	16.9	19.6	14.2	12.6	11.9	12.6	12.5	16.5	-	15.2	17.6	21.0	15.7
(20 stations)	48 hr.	13.3	13.2	14.7	10.7	9.7	9.9	10.7	8.8	13.1	-	12.7	15.0	17.1	12.4
	5 day	9.2	8.3	9.3	6.4	5.4	6.3	6.4	5.4	8.1	-	8.6	*	10.8	7.6
	7 day	9.3	7.4	8.1	6.5	5.1	6.0	5.5	5.0	7.8	-	8.3	10.0	10.9	7.5
Oregon	24 hr.	18.3	11.6	16.3	13.7	15.4	15.2	14.4	11.3	18.0	12.2	19.4	17.0	*	15.3
	24 hr.	--	--	--	--	--	--	--	--	--	-	--	--	--	
(15 stations)	48 hr.	11.5	10.0	13.9	10.3	11.2	12.2	11.6	8.6	14.7	-	15.1	12.8	*	12.1
	5 day	8.0	7.0	10.2	6.7	6.8	8.2	7.0	5.6	10.2	-	9.2	8.3	*	7.8
	7 day	10.8	7.7	10.0	6.5	7.6	8.3	6.2	6.0	10.6	-	9.2	8.5	*	8.1
#4,039 Michigan	24 hr.	18.1	10.2	15.5	17.4	19.9	14.3	12.2	10.2	36.1	19.8	8.5	23.5	17.7	17.0
	24 hr.	15.9	9.5	17.0	16.2	17.8	14.9	12.9	10.7	39.1	-	7.6	25.6	17.0	17.0
	48 hr.	16.1	6.3	10.7	15.8	16.4	13.2	10.6	8.8	32.2	-	6.8	20.5	13.6	14.2
	5 day	14.1	4.1	5.0	13.6	13.3	10.0	8.0	7.5	27.2	-	3.6	16.3	8.1	10.9
	7 day	16.3	4.1	5.9	22.0	15.4	8.9	6.3	9.7	28.9	-	5.7	18.4	10.7	12.7
#4,099 Michigan	24 hr.	33.7	13.0	26.8	22.9	34.6	14.3	18.8	17.8	78.5	15.5	25.9	53.9	24.5	30.4
	24 hr.	31.0	9.7	29.6	19.3	10.1	10.2	10.9	14.8	86.7	-	17.8	59.0	23.1	26.8
	48 hr.	28.9	8.9	20.6	18.3	20.9	11.2	13.6	15.3	63.6	-	21.9	50.3	19.3	24.4
	5 day	18.9	6.0	15.1	12.2	10.7	6.9	5.3	12.8	44.9	-	13.2	38.5	14.1	16.6
	7 day	38.4	9.1	11.9	12.5	16.2	6.4	11.2	14.0	41.5	-	18.1	42.4	15.9	19.8
#1,033 Georgia ADT = 442	24 hr.	9.8	8.8	11.9	11.8	9.1	25.8	12.0	12.1	11.2	10.9	10.6	11.2	14.6	12.4
	24 hr.	10.7	8.5	8.1	12.6	9.0	23.3	8.4	12.6	9.2	-	8.4	10.1	15.4	11.4
	48 hr.	6.0	6.6	8.7	9.3	7.3	24.0	8.2	5.8	7.6	-	6.1	8.4	12.3	9.2
	5 day	4.3	4.1	4.8	5.6	4.2	21.8	4.7	2.8	3.2	-	4.2	4.0	8.0	6.0
	7 day	5.5	3.1	4.6	4.5	3.5	18.9	4.5	4.3	4.6		5.2	4.3	6.1	5.7

*Coefficients not calculated

**These coefficients show effect of eliminating Labor Day Period and are not included in last column

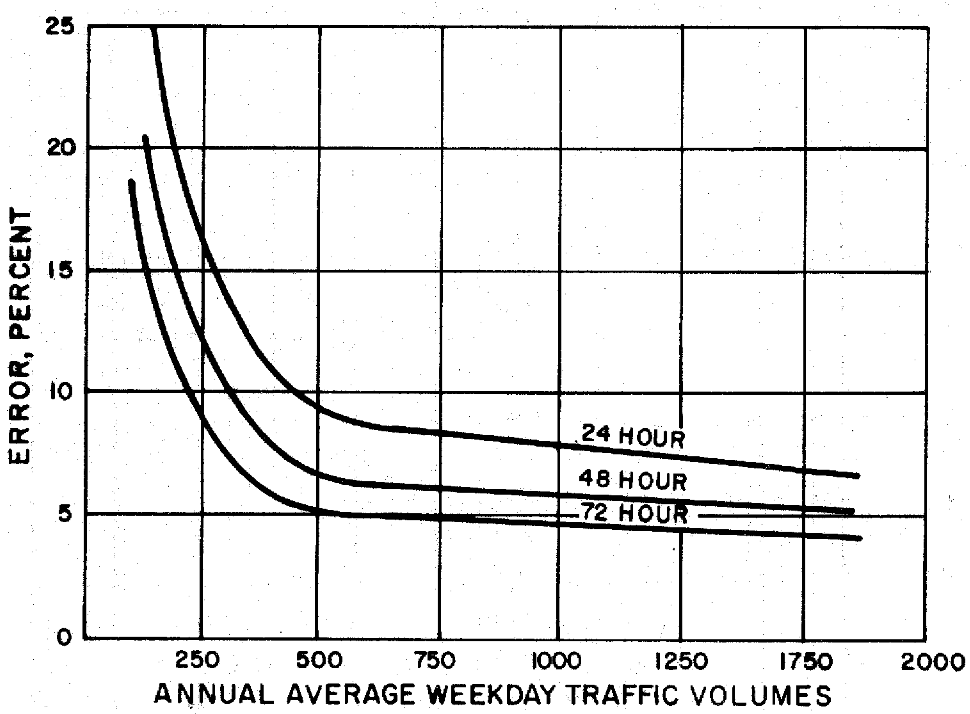


FIGURE 1-VARIATION OF WEEKDAY TRAFFIC VOLUMES

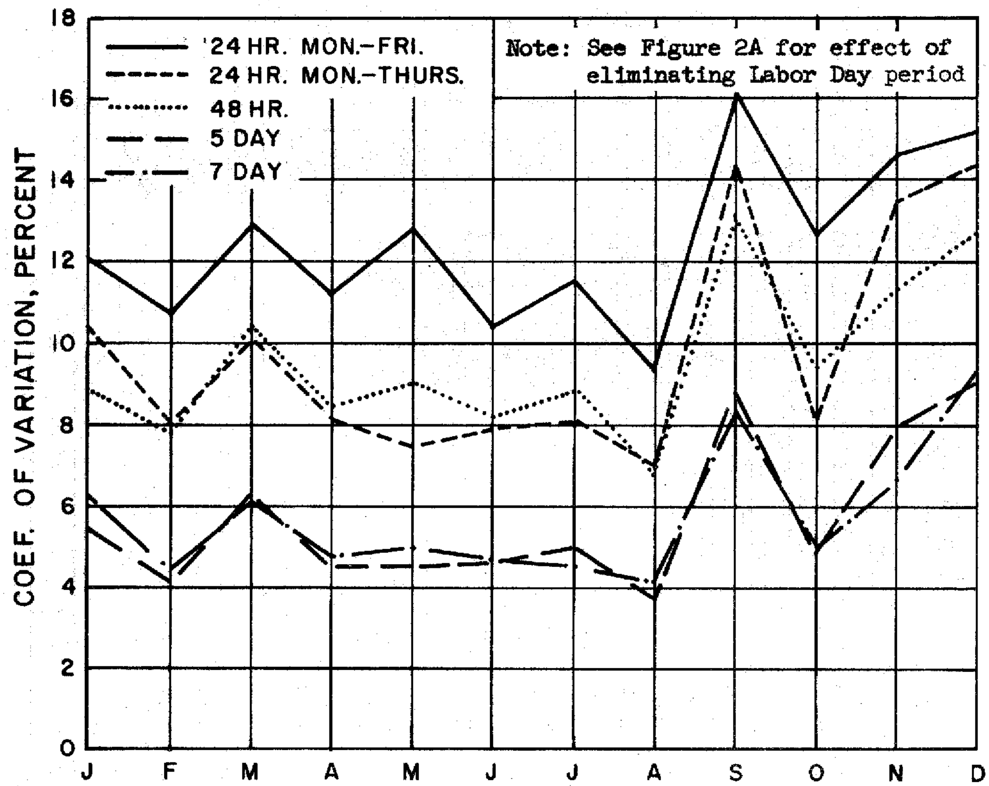


FIGURE 2-MONTHLY FLUCTUATION OF COEFFICIENTS OF VARIATION FOR RURAL TRAFFIC VOLUMES

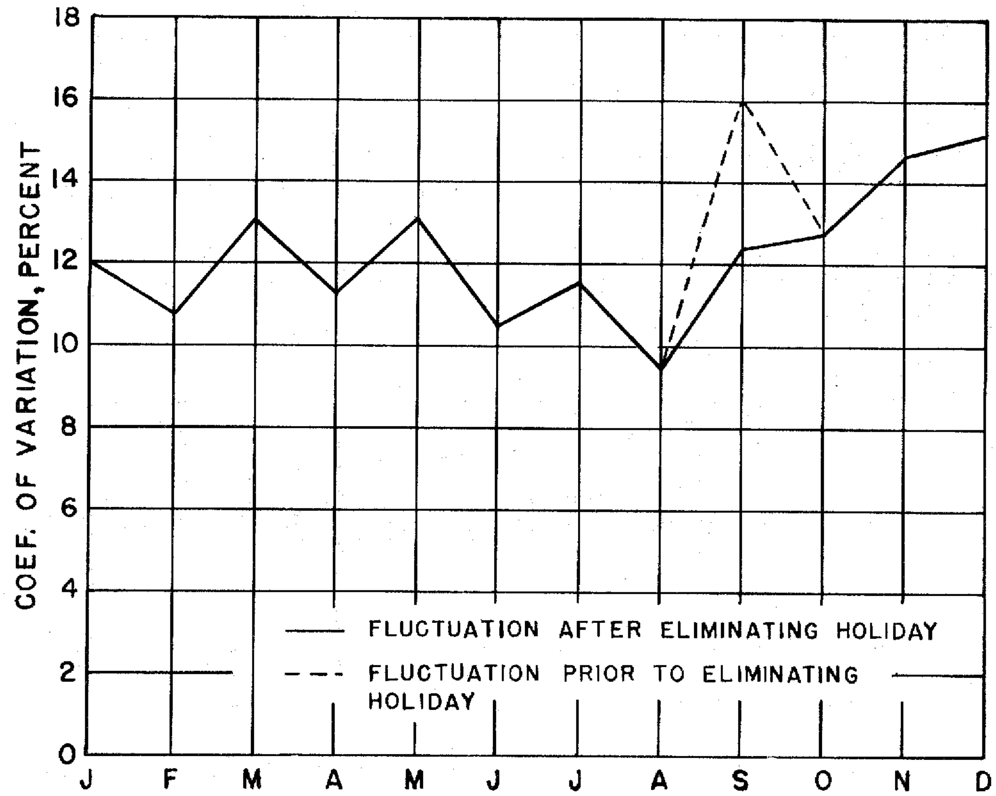


FIGURE 2A-EFFECT ON 24-HR WEEKDAY COUNTS OF ELIMINATING LABOR DAY PERIOD

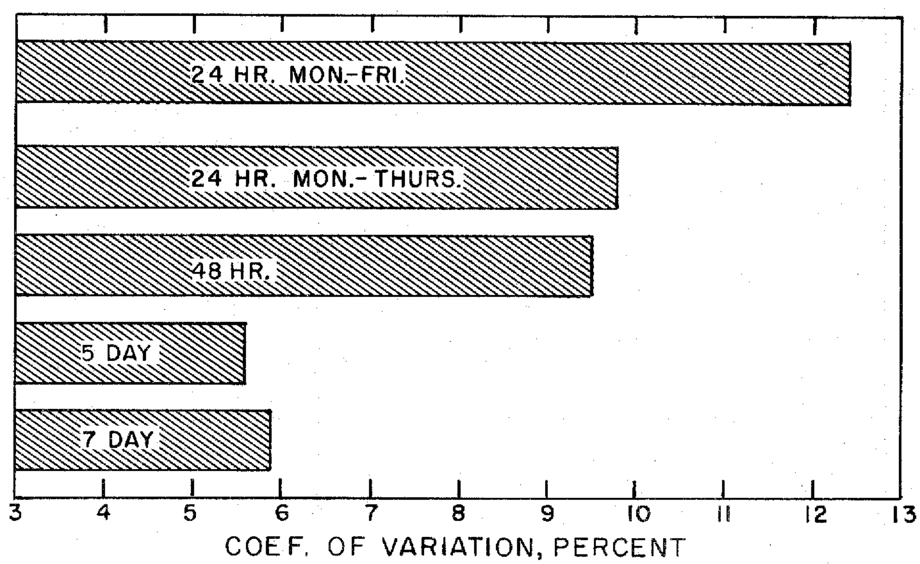


FIGURE 3-ANNUAL MEAN COEFFICIENTS OF VARIATION FOR RURAL TRAFFIC VOLUMES

APPENDIX

Derivation of formula for use with 24-hour counts.

N = Number of 24-hour samples in a month.

X_i = The "i"th 24-hour sample in a month.

$\bar{X}$ = Average weekday of the month.

= Standard deviation.

$$\sigma\, 2 = \frac{\sum_{i=1}^{N} (X_i - \bar{X})^2}{N} = \frac{1}{N} \sum_{i=1}^{N} (X_i^2 - 2\,\bar{X}\,X_i - \bar{X}^2)$$

$$\sigma\, 2 = \frac{\sum_{i=1}^{N} X_i^2}{N} - 2\,\bar{X} \quad \frac{\sum_{i=1}^{N} X_i}{N} \quad + \frac{\sum_{i=1}^{N} \bar{X}^2}{\quad}$$

$$\sigma\, 2 = \frac{\sum_{i=1}^{N} X_i^2}{N} - 2\,\bar{X} \quad \frac{\sum_{i=1}^{N} X_i}{N} \quad + \frac{N\,\bar{X}^2}{N}$$

$$\sigma\, 2 = \frac{\sum_{i=1}^{N} X_i^2}{N} - 2\,\bar{X}^2 + \bar{X}^2$$

$$\sigma = \frac{\sum_{i=1}^{N} X_i^2}{N} - \bar{X}^2 \qquad ^{1/2}$$

Derivation of formula for 48 hour, 5 day and 7 day.

$$X_i = \frac{\text{Vol } 1 + \text{Vol } 2 + \text{Vol } 3 + \text{---- Vol } n}{n} \text{ ; where "n" = 2, 5 or 7}$$

N = Total number of possible samples in the month.

$$X = \text{Average of samples} = \frac{\sum_{1}^{N} X_i}{N}$$

Y = Average weekday or average day of the month (X is not necessarily equal to Y, but will be a close approximation to Y).

$$(\text{RM error})^2 = \frac{\sum_{1}^{N} (X_i - Y)^2}{N} = \frac{1}{N}\sum_{1}^{N} (X_i{}^2 - 2X_i\, Y + Y^2)$$

$$(\text{RM error})^2 = \frac{\sum_{1}^{N} X_i{}^2}{N} - 2\,Y\,\frac{\sum_{1}^{N} X_i}{N} + \frac{\sum_{1}^{N} Y^2}{N}$$

$$(\text{RM error})^2 = \frac{\sum_{1}^{N} X_i{}^2}{N} - 2\,Y\,X + Y^2$$

$$\text{Root mean square error} = \left[\frac{\sum_{1}^{N} X_i{}^2}{N} - 2\,X\,Y + Y^2\right]^{1/2}$$