the best weapon after all for dealing with this type of driver is the license law. Mr Walter Matthews showed me yesterday a paper by the Secretary of Revenue of Pennsylvania showing what has been done in that State lately through the license law This law permits the suspension of licenses by the State without establishing legal proof of intoxication, which is difficult to prove A defense attorney can usually confuse a jury on the question of whether a man is legally and officially intoxicated If there is a question whether the driver was legally "intoxicated," the Motor Vehicle Commissioner can still suspend the man's license for reckless or unsafe driving

If we are interested in research on traffic accidents, there is no field that is more in need of this than that of alcoholic driving

MR M O ELDREDGE, *Department of Vehicles and Traffic, District of Columbia* We find it extremely difficult to convict a person for drunken driving, or even to take the permit away About three years ago I was called to investigate the death of a little boy and I stopped at the police department to get a policeman to go with me As we came along we saw a man staggering across the street and I suggested to this officer that he stop and see if the man was going to drive a car We drove down the street and before we could get back to the man he had got into a car and started The officer got him, searched him and found a bottle in his pocket He was taken into court and the only witnesses we had were the policeman and myself The attorney asked me what kind of liquor it was the man had been drinking Well, I smelled of the bottle when we found it and I said it was gin The lawyer asked the policeman what he thought it was and he said he thought it was corn liquor So the whole question then was the dispute between the two persons who had made the arrest as to which it was—gin or corn liquor The case was thrown out

TOLL BRIDGE TRAFFIC PATTERNS

BY N W DOUGHERTY

Professor of Civil Engineering, University of Tennessee

SYNOPSIS

The complete daily traffic records for several years beginning in 1930 of 17 toll bridges in Tennessee have been studied The hourly, daily, weekly, monthly, and yearly patterns are analized The traffic on Tuesday, Wednesday or Thursday gave the best indication of the average weekly flow A marked similarity was noted in the seasonal patterns for the different bridges

The Tennessee State Highway Department has been making state wide short time traffic counts on the even years since 1924. To get comparable results, and to get peak flow the counts were made in the last week of August or the first week in September of the year chosen for the count At a number of stations twenty-four hour counts were made to get the hourly patterns and to get the relation between night and day flow

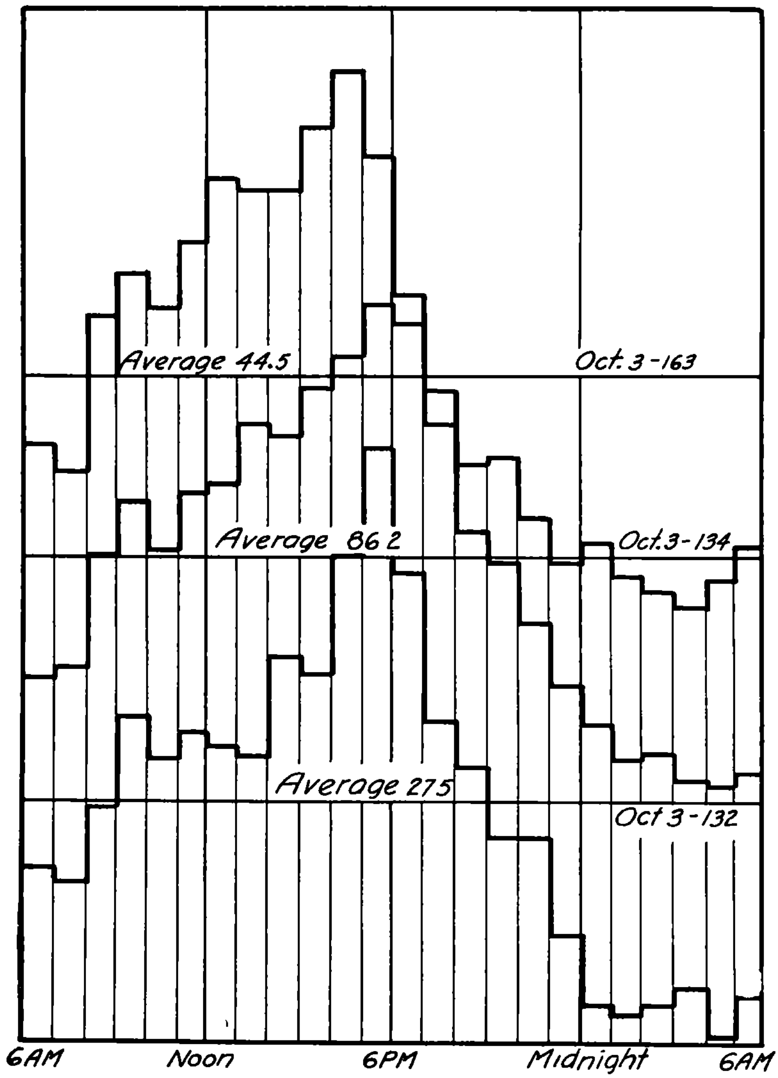

Figure 1 Hourly Variations

In 1927 the Tennessee Legislature authorized the construction of 17 toll bridges across the principal rivers of the State, and by 1930 several of them were open to traffic A toll keeper is kept at each bridge 365 days of the year, thus giving an index to the daily travel from the opening of the bridge to the present time The information is available for traffic studies along with the regular counts

For an eight weeks period during the CWA the Tennessee State Administrator furnished ten employees to make a study of the toll bridge data We accumulated the information, determined averages, and made a study of the patterns at the several bridges It is our hope to print the details of the study along with a summary of traffic on the State Highway system as a University of Tennessee Engineering Experiment Station Bulletin as soon as the 1934 count has been digested and added to the previous records

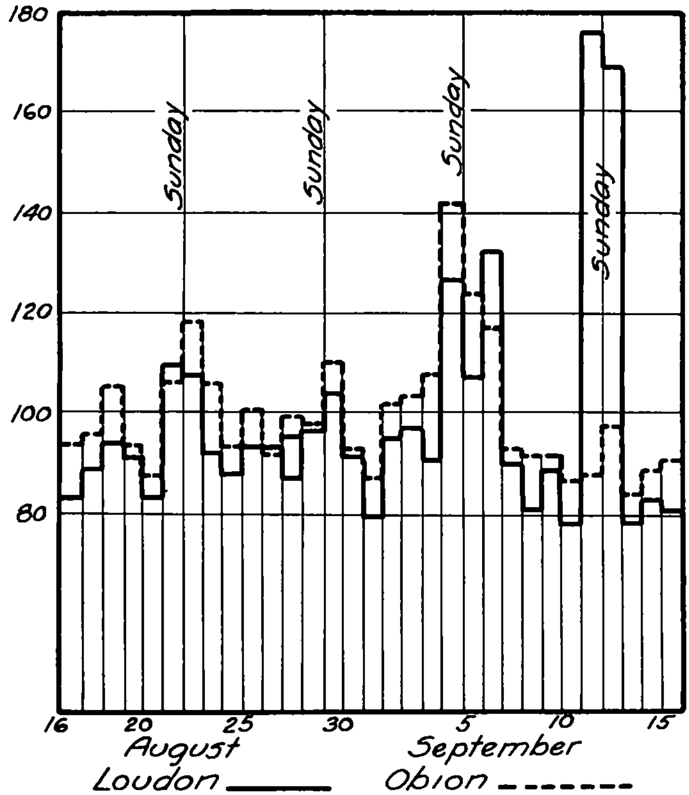

Figure 2. Daily Variations

In this paper we present typical patterns for hourly, daily, weekly, monthly, and yearly flow

HOURLY PATTERNS

Each station has a general traffic pattern with slight variations from day to day and with the condition of the weather For hourly flow there is usually a peak sometime in the morning and a second peak in the late afternoon Generally the morning peak comes between 9 and 10 o'clock and the afternoon peak between 4 and 7 o'clock.

Individual patterns vary with the volume of traffic Where there is a small flow a few vehicles in any one hour may change the form of the pattern very greatly while at the large flow stations a few vehicles do not materially change the hourly index A platoon of vehicles in any

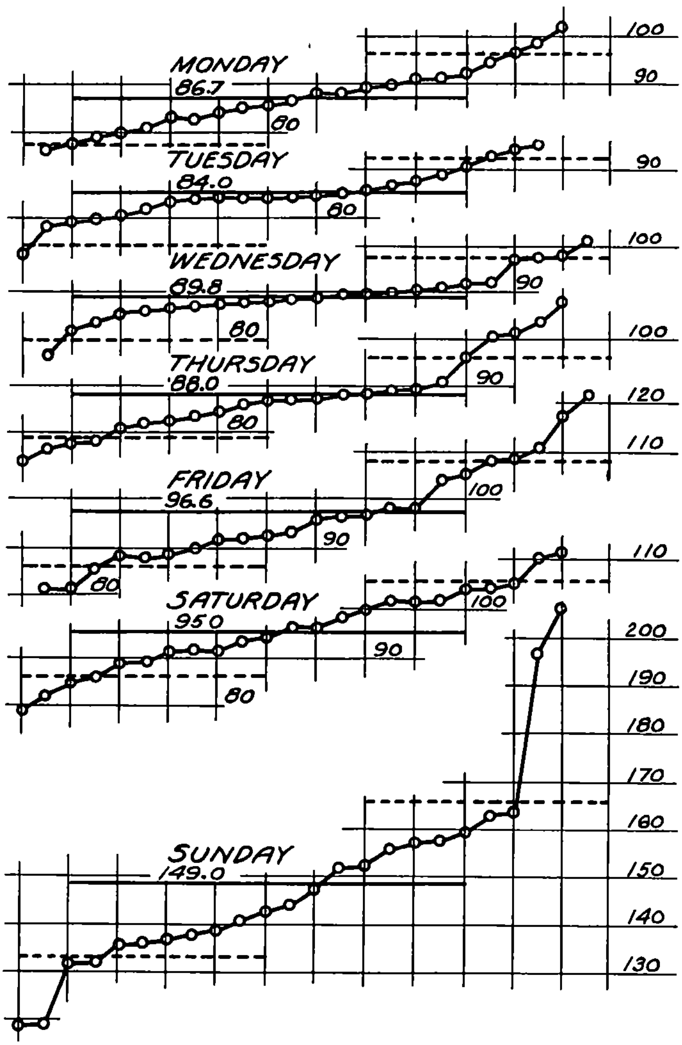

Figure 3 Variation in Daily Travel, Percentage of Weekly Average in Order of Magnitude. Obion Bridge

one case may make the pattern take abnormal form while the same platoon at the other station will have little effect

When the flow reaches from 50 to 100 vehicles per hour the pattern assumes a type and remains approximately the same from day to day Each day of the week has its own pattern, though for the days in the middle of the week they are very similar

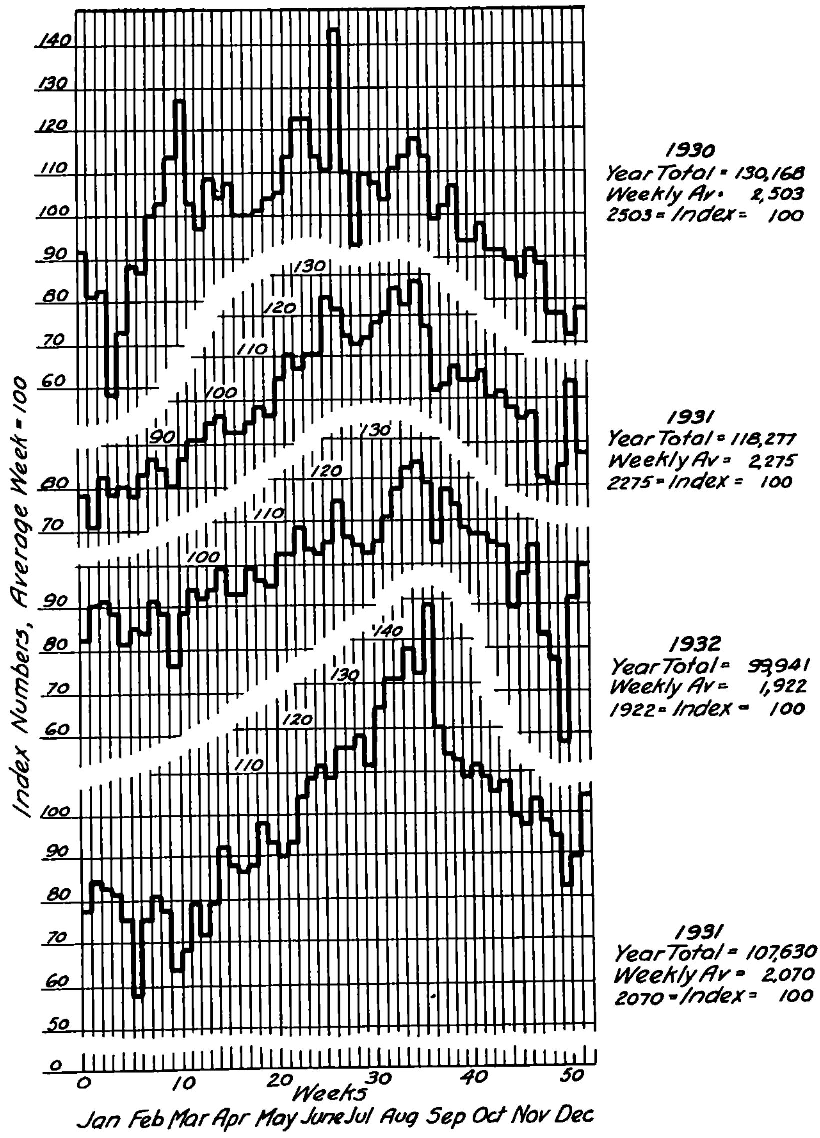

Figure 4. Weekly Traffic Variations 1930–1933, Obion Bridge

The three patterns given in Fig 1 are for different stations separated by several hundred miles, yet there is a marked similarity in general form The flow for different periods of the day is given as follows

	Station		
	27 5 per hr	44 5 per hr	86 2 per hr
5 P M to 6 P M	244	190	204
10 A M to 3 P M	132	163	134
6 A M to 6 P M	136	131	153

DAILY PATTERNS

Sunday is usually though not always the peak day of the week On the toll bridges the index for Sunday travel is not very good because the local pleasure and recreation travel avoids the bridge Tuesday or

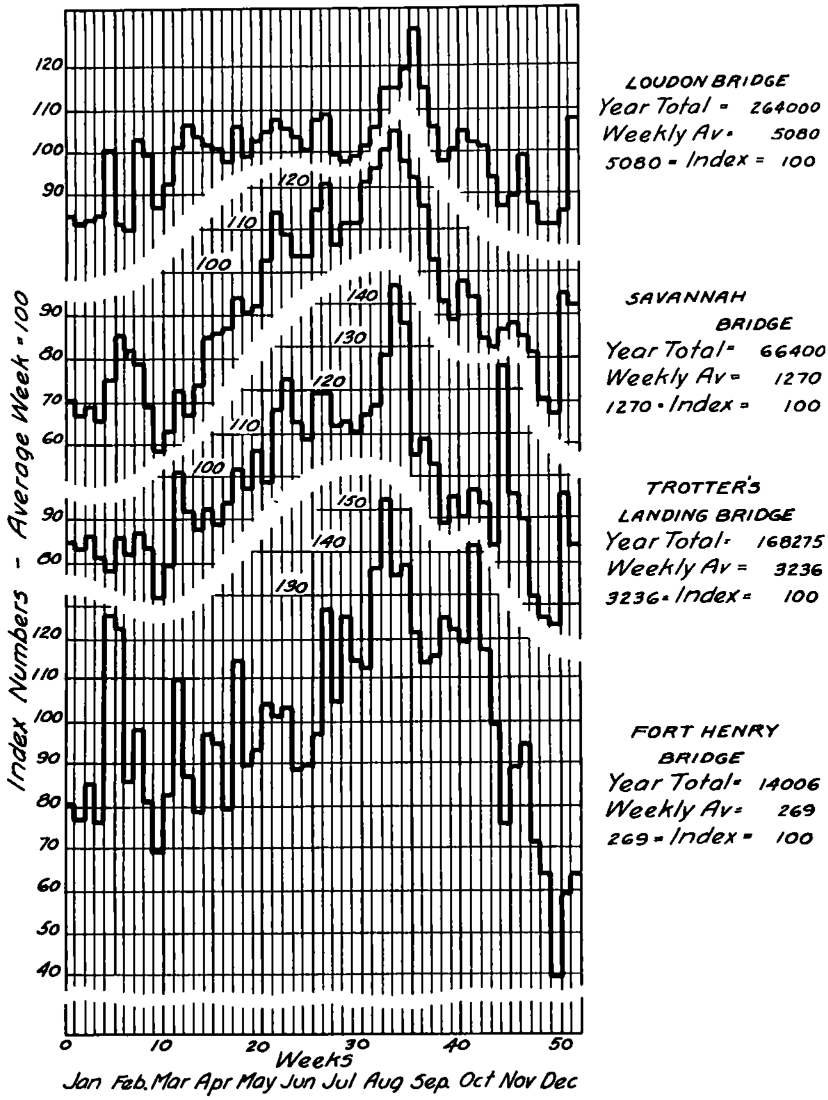

Figure 5. Weakly Variations in Traffic—1932

Thursday is usually the minimum day The minimum, however, will vary with the weather, and local movements

Data are available for an extended study of daily flow throughout the year Typical patterns (Fig 2) for the last half of August and the first half of September are presented During the last ten years the counts have been made during this part of the year It will be noted that Labor Day has a marked effect on the travel at the two stations presented

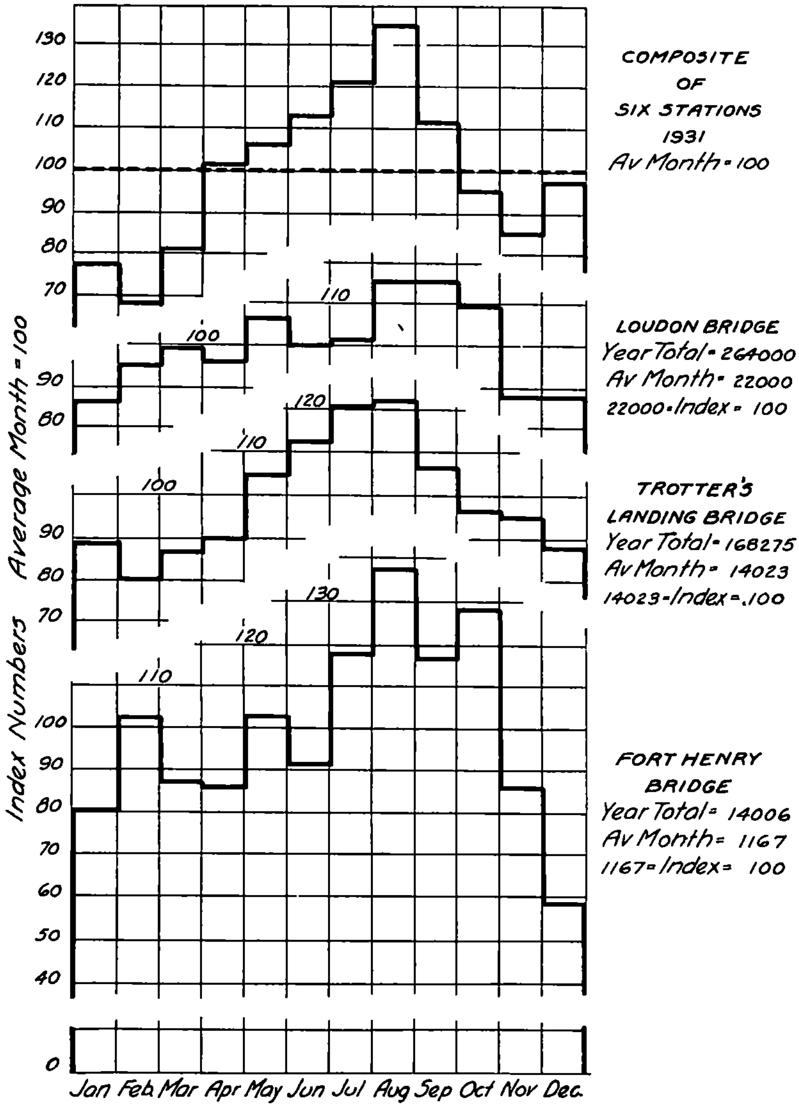

Figure 6 Monthly Variations in Traffic 1931 Composite Compared with Three Stations during 1932

A study of the variations of each day from the average for the week shows that Tuesday, Wednesday, and Thursday have a more constant ratio to the average for the week than the other four days Figure 3 shows the departure from the weekly average in the order of magnitude Note that Sunday has the greatest range of any day of the week

Should a traffic survey be designed to get the average weekly flow a count on Tuesday, Wednesday, or Thursday will give the best approximation Sunday has the widest range of travel because of the large percentage of pleasure and recreation travel

WEEKLY PATTERNS

Much time was used in developing seasonal patterns using the weekly flow as a unit Typical stations are presented The variations in flow for the same station for different years may be as great as the variations at different stations for the same year. This is shown by the accompanying comparisons (Figs 4 and 5)

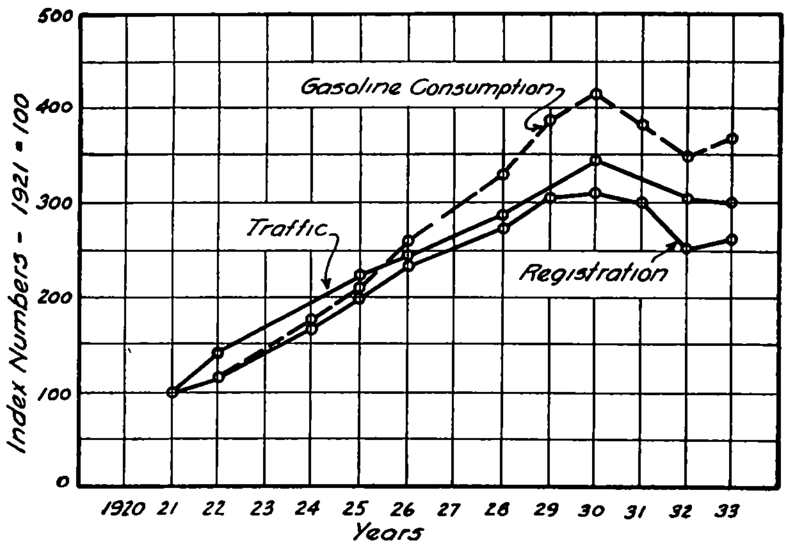

Figure 7 Relations Between Traffic, Motor Vehicle Registration and Gasoline Consumption.

When this study was first begun we were surprised at the similarity of the patterns from year to year The similarity is quite marked for stations having 500 to 1000 vehicles per day

When the flow is small the pattern may vary greatly from year to year, and certainly there will be great variations from station to station

MONTHLY PATTERNS

When the seasonal pattern is studied taking the monthly flow as the unit there is still greater similarity in the flow Daily volumes have smaller influence and the result is a station pattern that resembles a composite pattern for many stations (Fig. 6)

Not only is the pattern similar for many stations during the same year but they are quite similar from year to year, even for the whole period of the data available

PATTERN FOR A SERIES OF YEARS

Figure 7 shows that there is a close relation between traffic on the highways, automobile registration, and gasoline consumption During the period to 1930 there was a more marked increase in gasoline consumption than there was in either registration or traffic This was, no doubt, in part due to increased weight of vehicles and increase in speed During 1932 and 1933 there was a greater decrease in gasoline consumption than in the traffic or registration This was probably due to the fact that gasoline consumption is taken from the excise tax division reports and shows gasoline consumed that pays tax and does not show gasoline consumed that was tax exempt Many of the city and county officials have adopted a policy of purchasing gasoline in bulk to get tax exemption

The traffic increased more rapidly than the motor vehicle registration This is explained by the increase in miles traveled by Tennessee automobiles and the increase in tourist travel

DISCUSSION—TOLL BRIDGE TRAFFIC PATTERNS

Mr E W James, *U S Bureau of Public Roads* You will remember perhaps that last year I presented a paper calling attention to three things related to our traffic census work that required investigation First was the accuracy of our present method of making the traffic census We had not been able to make a comparison with the true annual mean of traffic and so the means which we were getting—the average daily traffic reports which resulted from our traffic census—had an unknown relation to the true mean How close that would make our computations—those were matters of doubt and still are I next pointed out that the cost of taking our traffic census as we usually plan it was expensive and some means should be discovered of providing first the man time required, making our traffic census less costly, and then, in order to get the results of our studies more promptly and therefore increase their use, some means should be devised for abbreviating the over-all periods of the traffic census As we now check the traffic, we have no way of determining the seasonal fluctuations except by carrying the census through all four seasons, which means practically a complete year's work The work done by Mr Dougherty, which he has reported here today, and that done by a good many other investigators, have developed the increasing knowledge of uniformity of traffic habits of our drivers, and more of that information should be collected because it is through a development of known traffic patterns for definite periods that we will be able to abbreviate the over-all period of our traffic census work For instance, if we knew the annual traffic pattern, we could pick out a spot in the year—one or two days—and take a traffic census and extend it to a year's census, but we don't know the annual traffic pattern

Now, with respect to the second point, that of reducing the amount of man time necessary for the traffic survey, the Bureau has been interested during the past year in making a very elaborate study which has been carried on by Mr W A Shelton of my division, and I wish to report regarding that I called attention last year to the fact that the determination of the true mean and the comparison of our computed means with that true mean would develop the relative accuracy of our present method and the accuracy of other possible methods of an abbreviated nature We secured a complete traffic population or universe for the Holland Tunnel 365 days throughout the year, 24 hours a day by hours We then set up a traffic census schedule just as if we were going to make observations on the road and we picked out of that record just the data we would have gotten had we been on the ground and counted the traffic We made 52 such census records just as if each of the 52 was an independent traffic census, computing each one by itself, depending on no other information than that which was picked out of the traffic universe for the schedule in question The first schedules run were the 16 observations of 8 hours each Fifty-two of those were taken and computed We then took an entirely different traffic schedule consisting of 70 observations of one hour each We set up a schedule running through the year and computed the mean out of those hypothetical observations and compared those means with the true mean Then we dropped to 35 one-hour observations, 28 one-hour observations, and finally 24 one-hour observations and then 19, and we found that down to 24 one-hour observations we were getting practically the same accuracy that we get with the 16 8-hour observations, 128 observation hours The last one required 24 observation hours At 35 observations of one hour each, we get an accuracy that is about 33 percent greater than that of 16 record 8-hour observations The accuracy of these computations have been displayed by the ordinary statistical methods and of course the conclusions are true only so far as the significance of those statistical methods is accurate

MR W ARTHUR SHELTON, *U S Bureau of Public Roads* Since the delivery of the paper on the traffic census before the Highway Research Board a year ago,[1] the Bureau of Public Roads has made some tests of the best methods of estimating the volume of highway traffic The data used are the records of the Holland Tunnel for the calendar year 1933 The traffic volume through this tunnel is large and consists of a wide variety It includes vehicles with origin and destination in almost all parts of the country The total constitutes a highly complex variable and is the result of custom and habit of the widest variation Such a record of traffic by hours for a year is a mine of material on the traffic variable

[1] "Making and Using the Traffic Survey," Proceedings, Highway Research Board, Vol 13, pp 57-64

A test of the best method of estimating the mean daily number of all vehicles has been made by drawing 52 samples according to each of the methods used and computing 52 estimates for each method, of the average daily total for the year The number of observations in a sample range from 16 for the eight-hour watches and 19 for the smallest sample of one-hour watches up to 70 for the largest sample The purpose of the study is to determine the accuracy of the mean computed from continuous watches of eight hours as compared with the true mean, and further to determine whether a larger number of separate watches of one hour gives greater precision at a lower cost than the schedule requiring eight hour observations The 52 estimates made for the Holland Tunnel by each of seven types of sample are similar to 52 surveys by each of these seven types though confined to a single channel of large volume of complex traffic The variation of the 52 estimates of the daily mean flow of traffic obtained from each of the seven types of sample should be fairly conclusive as to the reliability of the results

The hourly records of the volume of traffic for the calendar year 1933 constitute a complete natural population, or universe, from which the samples were drawn with a regular variation of one day forward for each sample from the preceding one The data for the complete variable form the basis for the computation of the true, mean, annual daily volume of traffic, with which all estimates of means and other statistical measures are compared This obviates the correction of measures computed from the differences between the true mean and the means of the samples, which is an unusual experience in the analysis of original natural data in the field of small sampling

In order that the myriad variations might be molded into satisfactory averages from small samples, records have been drawn from the annual cycle at regular time intervals by (1) the hours of the day, (2) the days of the week, and (3) the months of the year The other functional factors of variation are neither sufficiently regular in time nor sufficiently evident to make it possible to draw the observations according to the functions The variation arising out of these irregular factors (e g , holidays) must be consigned to the mercies of the average of records taken at random, and this is one reason for erratic estimates computed from very small samples In the case of the variations that recur in a cycle of time, a small sample of items may suffice to give a satisfactory average, while a larger one would be required for variations that occur rarely and irregularly In the latter case the number of items in the sample should be great enough to yield a rough average of all the variations It is necessary to include sufficient items within the sample to reduce wide error in the estimate, and it is more important that the sample contain a large number of observations than that the observations themselves be of great magnitude This is in accord with the general theory of sampling, and it has been verified by the results of the present study in the field of the small sample.

The current method of the Bureau of Public Roads of samples of 16 watches of eight hours each has been compared with watches, or records, of one hour each ranging from 70 watches per sample to 19 and including for the several types of sample 70, 62, 35, 28, 24, and 19 hours, respectively The results from these samples have been compared with those for the longer watches of eight hours

The method of long watches of eight hours each has been standardized at 16 watches consisting of 14 of the day period (from 6 in the morning to ten at night) and two at night, a total of 128 hours of record. Of

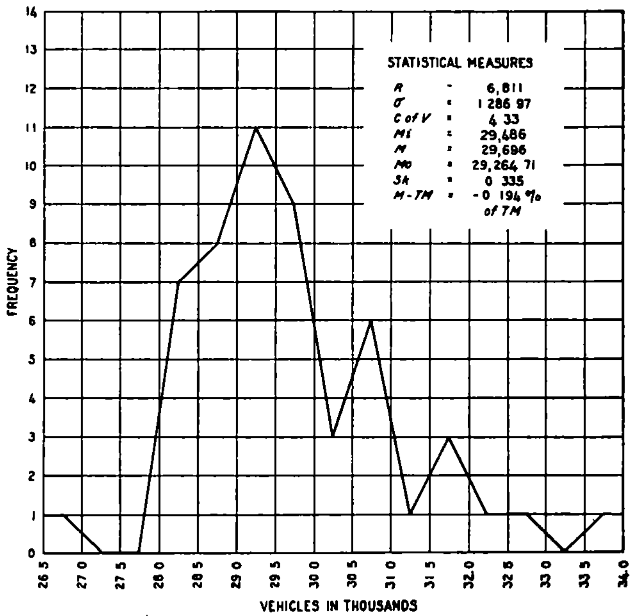

Figure 1. Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 16 Observations of Eight Hours Each.

Glossary of symbols in figures. R = range of variation; σ = standard deviation, C of V = coefficient of variation; Mi = median; M = mean (arithmetic); Mo = mode, Sk = skewness; M-TM = mean of means; minus true mean.

these long watches of eight hours each sixteen are included in each of the 52 samples The sample, which is quite small, is therefore confined to 16 observations but includes a total of 128 hours of record.

From the 52 samples of 128 hours each was computed the 52 estimates of daily volume of traffic shown in Figure 1 The day watches were drawn 24 days apart through the year, alternating between the morning and afternoon watches and including seven of each, and in addition two night watches, one in the spring and the other in the fall The first sample was dated beginning January 13 and extending through the year, and each succeeding one beginning a day later, so that the spread of all observation dates has a range of 52 days

The range of variation of the 52 means (of estimate) is greater for the 16 observations of eight hours each than for any set of means computed for samples of separate hours for any of the other six types of sample from 70 hours to 19 (See Table I and Figures 1–6) This shows that the estimates from a sample of 16 observations of eight hours each have a wider range of error and are less trustworthy than those from any other type of sample here compared, and that the fear sometimes expressed that the estimates from short watches are not reliable is not well founded The standard deviation of the 52 means computed from the samples of 16 watches of eight hours each is also larger than for any other type of sample containing from 70 to 28 hours, inclusive The extreme variation is greater, and the standard deviation is also greater

The central tendency is likewise greater for the other types of sample than for those of the 16 watches of eight hours each Only nine of the 52 means are included within the group of the true mean for the samples of 16 watches For the other five types of sample of from 70 to 24 hours each the central group includes the following numbers of means. 12, 9, 12, 10, and 11 (Table I and Figures 2–6) For the three central groups (centering on the true mean) the samples of 16 watches furnish only 23 means, while those of 70 hours furnish 34, those of 62 hours furnish 26, those of 35 hours, 31, those of 28 hours, 28, and those of 24 furnish 27 For the five central groups the results are as follows for the 16 watches of a total of 128 hours, 37, for 70 hours, 44, for 62 hours, 42, for 35 hours, 45, for 28 hours, 40, and for 24 hours, 38 Every type of sample showed greater concentration than the one with the fewest watches but containing the largest number of total hours

These comparisons show that samples of separate hours beginning at 70 hours and descending to 24 are all better as bases for estimates than the extremely small sample of 16 items of a watch eight times as large as the single hour used in the other types of sample The central tendency, the standard deviation, and the extreme range of variation all show that the larger sample of hourly watches gives a better estimate than the small sample of larger watches They show that: (1) the close estimates are more numerous, (2) the standard deviation from the true mean is smaller, and (3) the extreme range of variation is not so wide for the larger samples of short counts as for the samples of long counts The balance to the right and the left of the true mean is also more nearly equal, the coefficient of variation smaller, the variation of the median from the true mean is smaller, and the standard error of the means of estimate is smaller for the measures computed from the hourly counts (Table I and Figures 1–6) For samples of fewer than 28 hours, some of the statements do not apply

Why are all these measures arrayed on the side of the short count? Why is an estimate made from 128 hours taken in blocks of eight hours not as good as one made from 70 hours or 35 hours of separate hourly records? The answer is that the latter samples are divided by a larger factor in obtaining the average, the variation is divided into more parts

TABLE I

COMPARISON OF SOME STATISTICAL MEASURES OF THE VARIATION OF 52 MEANS OF ESTIMATE COMPUTED FROM SAMPLES DRAWN FROM HOLLAND TUNNEL TRAFFIC

(Calendar Year 1933)

No of Items in each sample	Range of variation (Vehicles)	Standard deviation* (Vehicles)	Central tendency — No of means in central groups		
			One	Three	Five
(1)	(2)	(3)	(4)	(5)	(6)
16‡	6,811	1,286 97	9	23	37
70§	3,660	813 44	12	34	44
62§	3,589	906 99	9	26	42
35§	3,934	824 25	12	31	45
28§	5,258	1,165 22	10	28	40
24§	5,553	1,297 93	11	27	38
19§	5,840	1,489 75	7	17	30

No of items in each sample	Balance of means (Number)†	Coefficint of variation (Percent)	Median (Vehicles)	Mode (Vehicles)
(7)	(8)	(9)	(10)	(11)
16‡	21 r, 31 l	4 325	29,486	29,265
70§	25 r, 27 l	2 734	29,730	30,100
62§	25 r, 27 l	3 048	29,707	29,250
35§	29 r, 23 l	2 770	29,905	29,789
28§	23 r, 29 l	3 916	29,605	29,750
24§	20 r, 32 l	4 362	29,479	29,289
19§	22 r, 30 l	5 007	29,407	28,769

No of items in each sample	Mean (Vehicles)	Average deviation from true mean (Percent)	Skewness	Standard error of mean (Vehicles)
(12)	(13)	(14)	(15)	(16)
16‡	29,696	−0 194	+0 335	±178
70§	29,601	−0 515	−0 614	±113
62§	29,707	−0 157	+0 504	±126
35§	29,799	+0 153	+0 012	±114
28§	29,707	−0 159	−0 037	±162
24§	29,674	−0 268	+0 297	±180
19§	29,652	−0 344	+0 592	±207

* Of the means from the true mean daily volume for the year
† Number of means to right and to left of the true mean
‡ Sixteen watches of eight hours each
§ Number of watches of one hour each

The eight hour blocks on the contrary are taken at wide intervals of time and are divided by a small number, so that the resulting estimates vary widely. The observations are also more representative when scattered than when clustered

The frequency distribution of the 52 means shown in Figure 1 displays some concentration, with the mode to the left of the central group, and some scatter to the right, which is to be expected from a small sample The tests of the precision of estimate of the true mean by the eight-hour method are shown in Table I The range of variation (column 2) shows that at least a few of the 52 estimates are erratic, the standard deviation (column 3), the coefficient of variation (column 9), and the standard error (column 16) display the wide average error of

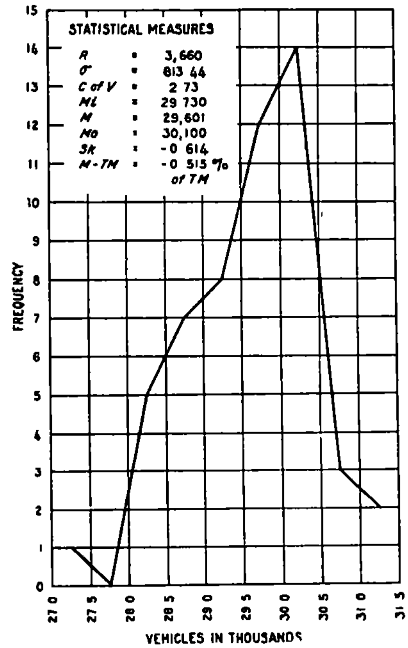

Figure 2. Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 70 Observations of One Hour Each

estimate, and the central tendency (the number of close estimates) is not large as shown in columns 4–6 These are the three best tests that the precision of estimate by the long-watch method is not satisfactory when compared with the results obtained from larger samples of shorter watches (Table I, columns 2, 3, 4–6, 9 and 16)

The sharp peak and narrow base of Figure 2 stand in marked contrast with Figure 1 and show that a very large number of the means computed from 70 separate hours fall within the three central groups In brief 12 bull's eyes and 22 first-ring shots (a total of 34) were made in 52 estimates, while the remaining 18 fell within a very narrow range outside the three central groups The standard deviation for the 70 separate hours is only two-thirds of that for the 128 hours in watches of eight hours, and the range of variation is but little more than half as great

Likewise the frequency curve for 62 separate hours contains 26 means within the three central groups and 42 within five groups leaving only 10 without, while 15 fall outside the five groups in the curve for 16 watches of eight hours each (Fig 3) The frequency curve for the samples of 35 hours (Fig 4) presents a case of remarkable concentration of 52 means, showing 12 means in the central group, 31 in the three central ones, and 45 in the five central groups The narrow base of

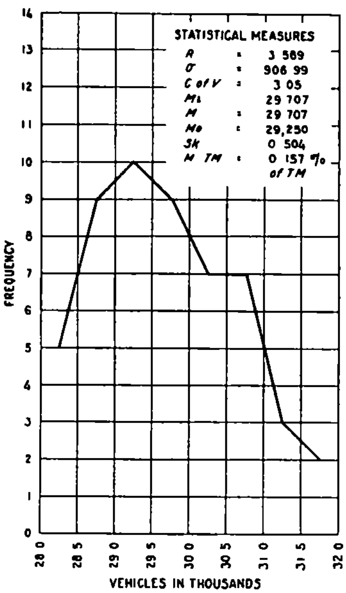

Fig. 3

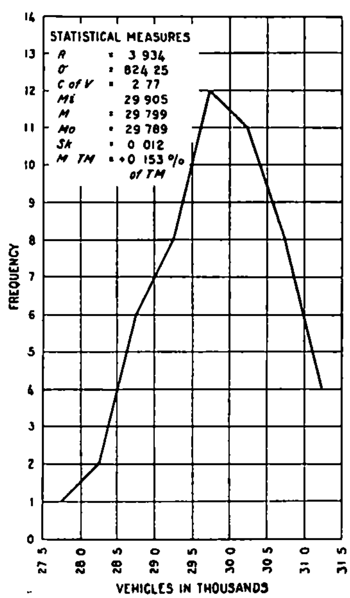

Fig. 4

Figure 3. Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 62 Observations of One Hour Each

Figure 4. Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 35 Observations of One Hour Each.

Figure 4 is indeed striking, and it indicates that the estimates that fall near the true mean are numerous, while only seven lie beyond the limits of the five central groups

The samples of 35 hours gave a surprising set of 52 means (of estimate) They contain only 28 hours from the day period, which forced the elimination of four hours of the second day period of 16 hours Those omitted were 12–2 in the afternoon and 6–7 and 9–10 in the evening. The hours 6–7 and 9–10 are extremes Getting rid of these and including the intervening hours, which are of greater than average constancy, improved the samples The elimination of the hours 12–2 in the afternoon also resulted in discarding hours of some irregularity The means tell the story The estimates have been improved by the inclusion of hours of more than average constancy and by the exclusion of those that are irregular

The frequency curve for the means computed from samples of 28 hours is strikingly well balanced (Fig 5), but the concentration begins to decrease with the reduction in the number of items in the sample, and a slight scatter to the right is manifest in the curve—both indications of the results of a small sample In the selection of the 21 hours of the day period, hours of more than average constancy were added after the first complete day cycle of 16 hours were included The additional hours are 10–12 in the morning and 12–1 and 7–9 in the afternoon and

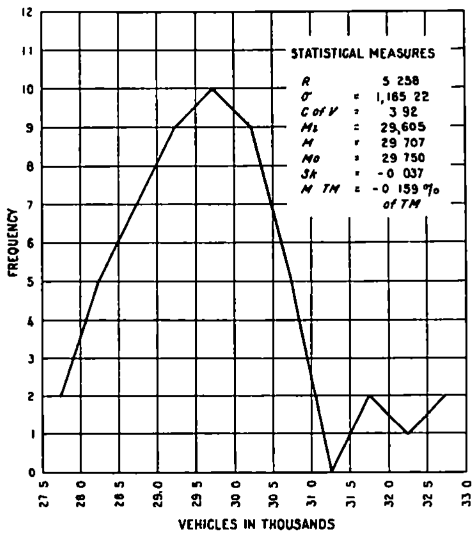

Figure 5 Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 28 Observations of One Hour Each

evening Of these 10–1 are rather constant, and 7–9 are representative of those before and after that period, which are omitted because they are irregular

It seems uncanny that 28 separate hours constitute a better sample than 128 taken in 16 blocks of eight hours each Yet the concentration, the standard deviation, and the range of variation are all much better for the samples of 28 hours, there being ten means in the central group against 9, 28 in the three central groups against 23, and 40 in the five central groups instead of 37 The coefficient of variation and the standard error are also smaller, and the skewness is negligible If these results were based on a very few means, they might be passed over as chance occurrences, but since 52 estimates were computed from 52 samples containing a total of 1,456 hours, the evidence is convincing that the samples are representative of the population

The frequency curve of the means computed from 24 hours shows distinctly more concentration than the one for 16 watches of 8 hours each (Figs 1 and 6) For the central group the comparison is 11 means against 9, for the three central groups, 27 against 23, and for five groups 38 compared with 37 The standard deviation, the coefficient of variation, and the standard error are almost identical (Table I), and the range of variation and the skewness are both less than in the case of the samples of 16 items

The results charted and discussed above make it clear that the number of independent items is the chief factor that reduces error and increases

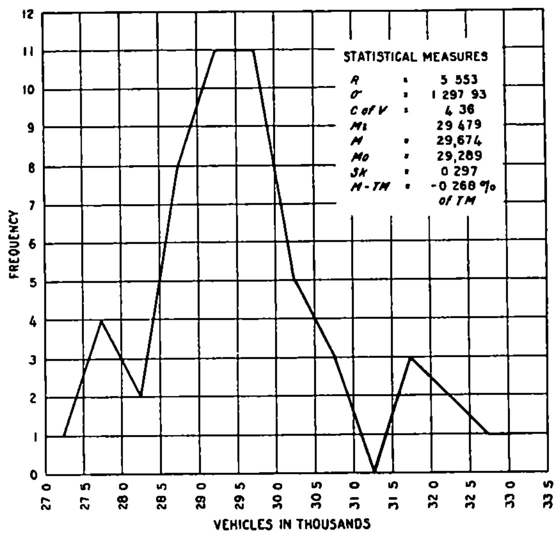

Figure 6 Frequency Distribution of Means of Daily Volume of Traffic Through Holland Tunnel Estimated from Samples of 24 Observations of One Hour Each

precision, but they also show that the magnitude of observations is a factor The measures of 24 separate hours are more stable than those of 16 watches of eight hours, but it is manifest that 16 separate hours would not be as efficient as 16 watches of a total of 128 hours The addition of eight separate hours, however, is sufficient to offset the disparity in efficiency This statement is based on the results of the study, and does not merely rest on the theory of sampling The 52 means and other measures computed from the 1,248 separate hours of the 52 samples of 24 hours each are the proof of the statement The measures computed from the 11,388 separate hours for the five different sizes of sample of separate hours are likewise the basis for the general conclusions of the paper

If the standard deviation of the means computed from the 16 watches of eight hours each be taken as a base of 100 in the precision of estimate, the efficiency of the standard deviation of the means computed from 35-hour samples is 136 percent The same comparison for 70-hour samples is 137 percent, and for 28-hour samples it is 109 percent The 35-hour method therefore seems the most desirable if consideration be given to both precision and cost

Since a reduction in time from 128 hours to 35 hours has been made with an increase in precision of 36 percent by taking separate and independent hours instead of watches of eight continuous hours, it would seem that a further reduction to a half hour or lower might be made with but little loss in precision of estimate The observation by hours would seem to include most of the daily variation, and a further reduction in size of observation to a half hour would likely reduce the precision but little If a reduction of 5 percent be allowed for samples of 35 hours, the precision of estimate for 35 half hours would be 134 percent of that for 128 hours taken in clusters of eight hours

If 35 half hours were taken and an equal number of half hours used in transferring from station to station, the time required would be 35 hours, which is 27 34 percent of 128 hours The observation cost would therefore be reduced to 27 34 percent of that of the eight-hour method, and the total cost would probably be reduced to roughly one-half that of the longer method The use of the shorter method would result in a saving of $150,000 in an annual expenditure of $300,000 by the States and the Federal Government

The cost could be reduced still further by adopting smaller samples than 35 hours If samples of 28 hours were adopted, the cost would be reduced 20 percent below that of 35 hour samples, but the efficiency of estimate would be increased by only 9 percent in contrast with an increase of 34 percent by the use of samples of 35 hours instead of 128 If samples of 24 hours were adopted, the cost would be reduced 31 percent from that for samples of 35 hours, but the efficiency of estimate would be reduced by almost one percent from that obtained from samples of 128 hours

Samples of 28 hours might well be adopted especially when it is desired to make a survey within a month or some other short period Half hour counts could be made for every day for 28 days, and the daily estimate computed from these counts could be converted to the daily average for the year by the use of the relative for the month in which the survey is made Samples of 35 observations may also be taken for each day for a period of 28 days for the observations of the day period, and for every fourth day for the observations of the night period By this schedule the scope of time included would be confined to a single month, and the estimate computed thus could be converted to an estimate for the daily average for a year by the use of the monthly relative for the month in which the survey is made These methods could also be extended over two months or any other number of months by the use of the ratios of the months covered to the annual monthly average

The restriction of the traffic survey to a month or a few months should not be confused with the various short-count methods that have been used The reduction in the length of the watch and in the total period of the survey here proposed does not restrict the counts to one or a few watches at a given point An average of 28 or 35 watches taken throughout the daily and weekly cycles, whether for a month or for a year, is an average based on that number of independent items in the sample, and the conversion of a monthly average to an annual one by the use of a monthly norm (or relative) confines the final average (of estimate) only to the product of an average and a relative But the final estimate is not based on a single item or a very few items as in the case of the short-count methods that have been used in a number of State and local surveys The error of estimate is much larger from the use of those methods than from the use of the method here explained

MR O W MERRILL, *Ohio Department of Public Works* I listened with very much interest to Mr James' and Mr Dickinson's talks on obtaining traffic figures because in Ohio we are facing a similar problem at the present time Last July we attempted to inaugurate a program whereby we would obtain this traffic factor for both daily and seasonal variations to supplant the present traffic factors which we are now using and which were secured in 1925 We have located 72 stations on the State highway system in Ohio, and have classified them into six groups, each being in an entirely different location One group has industrial primary stations, a second group industrial secondary, and a third industrial tertiary stations Another group has agricultural primary, agricultural secondary and agricultural tertiary So when we get done next June we perhaps will have the basic fundamentals to derive real daily and seasonal variations

MR ARTHUR RICHARDS, *Trenton, N J* In Mercer County we made a number of surveys between the hours of 4 and 8 o'clock in the afternoon After the survey was all completed I tried to combine it with the McClintock short method of survey I did that for a number of stations and problems just to see what could be done The McClintock method did not give any answer whatsoever to the Mercer County problem It seems to me that the factors for the particular locality must be determined before short method survey can be used reasonably well I went further in the study in Mercer County—I could take a survey made on Tuesday in 1924 in the afternoon from 12 to 6 o'clock and from those data determine within 5 or 10 per cent what the traffic would be on a Sunday afternoon in 1933 The reason I could do that was because I had accurate data for the particular county traffic for all those periods in between, but the minute one would try to apply Mercer County data to the District of Columbia or any other place, it would not amount to anything at all

MR JAMES· That is the very reason why we are attempting to formulate these skeleton surveys We recognize that a pattern for one community cannot be transferred to another community

REPORT OF SUBCOMMITTEE ON TRAFFIC REGULATION IN MUNICIPALITIES

BY W S CANNING

Engineering Director, Keystone Automobile Club

SYNOPSIS

A study of traffic problems and their solution without large expenditure of funds for municipalities under 100,000 population Among the subjects discussed are Best methods of adapting obsolete or inadequate signal equipment to modern conditions, principles of sign and signal installation, outline of parking regulations, their need and method of analysing References are given which can be used for a study in detail of the subjects discussed

The large cities of the country have many advantages over the smaller communities in handling traffic flow by reason of their extensive technical bureaus, which embrace traffic engineers, police officials giving full time to traffic problems, or nationally known traffic consultants resident in the community The smaller municipalities are in no such fortunate position Frequently the superintendent of police, the city engineer or chairman of the street committee is confronted with the solution of a difficult traffic problem and is without the means to study the situation adequately or to obtain competent consulting service

Ofttimes local officials charged with the problem find it difficult to obtain information or literature applying to the particular phase of the situation as it confronts them No general review of traffic literature or publications may come before them They may not be in regular attendance at the meetings of national organizations where such problems are discussed They must provide some means of protection for school children, pedestrians, vehicle operators and residents on busy streets Some means must be offered them to a solution of the problem with the minimum of effort and expense and the maximum of efficiency consistent with the local conditions

Almost every day those who are in contact with the motoring public hear a lament regarding the lack of uniformity of signs or of traffic signals throughout the country Meanings differ and an interpretation is often a matter of guess work