FHWA/NJ-81/005
81-005-7792

DETERMINATION OF HOT AND COLD START PERCENTAGES FOR NEW JERSEY

Task No. 4

Sampling Scheme Development

by

Mark Marsella, Principal Engineer

prepared by

Bureau of Instrumentation Services
Division of Research and Development
New Jersey Department of Transportation

HPR Study Number - 7792

Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration

June, 1978

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

Disclaimer Statement

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the New Jersey Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/NJ-81/005		

4. Title and Subtitle
Determination of Hot and Cold Start Percentages for New Jersey - Task #4: Sample Scheme Development

5. Report Date
June, 1978

6. Performing Organization Code

7. Author(s)
Mark Marsella

8. Performing Organization Report No.
81-005-7792

9. Performing Organization Name and Address
New Jersey Department of Transportation
Division of Research and Development
1035 Parkway Avenue, Trenton, NJ

10. Work Unit No.

11. Contract or Grant No.

12. Sponsoring Agency Name and Address
Same as above

13. Type of Report and Period Covered
Final report for this task; Oct. 1977 June, 1978

14. Sponsoring Agency Code

15. Supplementary Notes
Prepared in Cooperation with the U. S. Department of Transportation, Federal Highway Administration

16. Abstract

The hot and cold start project was undertaken in order to obtain data on the percentages of passenger cars and light trucks which are operating in the "Hot Start" and "Cold Start" conditions (by EPA definitions) on the various classifications of New Jersey roads. These percentages will ultimately be utilized as correction factors in the computer program presently being used to predict automotive air pollution for environmental impact statements.

Data will be collected by stopping vehicles at sites which are representative of each of the roadway classifications. With the driver's permission, the engine temperature will be measured at two points. The driver will also be asked to provide estimates of engine running time and soak time for the period just prior to stopping. The data thus obtained will be analyzed to determine whether each vehicle was hot, cold, or stabilized, and what the total percentage is for each of these categories, for each roadway classification.

This task report covers two portions of the project. The first is the selection of the statistical distribution which would be best suited to the data to be collected, and the determination of the sample size appropriate to the desired level of confidence and confidence limits. The second part is the method used to obtain an initial list of 180 potential data collection sites, and the criteria and method applied to reduce this to a final list of 49 sites.

17. Key Words	18. Distribution Statement
Automotive Air Pollution Hot and Cold Starts Site Selection for Data Collection	No Restrictions

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	46	

Form DOT F 1700.7 (8-69)

TABLE OF CONTENTS

TABLE OF CONTENTS

SUMMARY

This task was divided into two main parts, the first being a study of the statistical procedures involved. Although three categories of vehicles were to be considered ("Hot", "Cold", and "Other"), it was determined that the multinomial distribution need not be used. Instead, the binomial distribution was investigated, and being in common use, there was a great deal of textual and tabular information available. This facilitated choosing it for the analysis of data to be collected under a later phase of the project. Once the choice was made, it was rather simple to determine an appropriate sample size for the desired confidence level and interval.

The second part of the task was site selection. After a thorough examination of the variations in the six functional classifications of roads listed in the work proposal, it was decided to subdivide some of them so that these variations would be adequately represented in the final group of sites. Accordingly, twelve categories were obtained, and sites were selected for each. The initial selection was accomplished by randomly entering the New Jersey Department of Transportation road inventory. Fifteen sites were selected for each category. This number was reduced by examining the file for each selection to determine compliance with a set of criteria developed for this task. Sites which were not eliminated by this method were then inspected in situ to ascertain conformity with safety requirements and that adequate traffic volume existed, the goal being to obtain five sites for each category. The final step in site selection consisted of compiling a list of sites with expanded field notes, special travel instructions, and appropriate maps.

INTRODUCTION

Project Introduction

Environmental impact statements require that air pollution levels from the roadway be predicted from traffic data. Such predictions are based, in part, on the percentages of vehicles which will be operating in the "Hot Start" and "Cold Start" conditions. Present estimates of these percentages are based on engineering judgement, and are not accurate enough to meet the standards for environmental impact statements. The objective of the project then is to determine, with known accuracy, the average percentages of vehicles which are operating in the "Hot Start" condition and "Cold Start" condition, the exact definitions of which are contained in Appendix E. The average percentages of "Hot" and "Cold" starts will be determined for the following six functional classifications of roadways:

1) Rural principal arterial system
2) Rural minor arterial and collector road systems
3) Rural local road system
4) Urban principal arterial system
5) Urban minor arterial and collector road systems
6) Urban local street system

This will allow predictions for proposed construction to be based on statistically valid techniques, thereby meeting the requirements for environmental impact statements.

The project will achieve its objective in the following way: First, a method to measure hot/cold start operating characteristics in the field will be developed. Second, a statistically sound field survey plan incorporating the measurement method will be developed to find the percentages

of hot/cold start operation for vehicles operating in New Jersey. Third, the plan will be implemented to collect data which will provide the percentages of hot/cold start vehicles on New Jersey roads. The first two steps make up the first phase of the project, development of the field survey methodology, while the second phase, implementation, consists of the third step. The first phase will be accomplished by performing the following tasks: 1) literature search for general background, definitions, and information on infrared physics and technology; 2) vehicle operation experiment; 3) demonstration and comparison of measurement methods; 4) sampling scheme development; 5) sampling scheme field test.

Task Introduction

The objectives of this task were to provide a list of sites at which hot and cold starts could be measured, and to determine the minimum number of vehicles necessary for a usable sample for each functional classification. The site list was to be properly founded on statistical theory and at the same time was to be compiled in the most practical and efficient manner. For this reason, different methods were considered prior to beginning actual site selection.

The main point to consider in site selection was that although valid statistical methods were to be used, the objective was not to sample sites per se, but merely to insure that the selection was both unbiased and adequate for project needs. On the other hand, vehicles were to be sampled and the larger the sample, the narrower the confidence limits. But while in theory site selection and sample size seemed to be independent, they were in fact related by the practical requirements of the project. This will be discussed below.

STUDY PROCEDURES

Statistical Research

A. Distribution of Data - Since the binomial distribution is simple to work with and has been extensively tabled, it was investigated as the obvious choice in considering sample size requirements. In examining the validity of using the binomial distribution, it was noted that one of the requirements is that the events be independent, or stated another way, that sampling be done with replacement. This d to a brief study of the hypergeometric distribution, which has the same criteria as the binomial, except that sampling is without replacement. But since the project population is very large in comparison to the assumed sample, it will be of little consequence if sampling is done without replacement. In fact, for the conditions expected in the project, there would be no discernable difference between the two distributions. The multinomial distribution was also considered at this time because the categorization of results into "Hot", "Cold", and "Other" seemed to indicate this as a possible choice. Furthermore, the other criteria for the distribution were met [1,5]. However, the binomial distribution proved to be the most suitable of the three.

B. Sample Size Determination - As noted previously, sample size and site selection were interdependent. While it was necessary to comply with statistical theory in determining sample size, it was equally necessary to comply with the very real constraints imposed by limited time and funds available for sampling. Therefore, as a first approximation, sample size was determined on the basis of time available, rather than on theoretical statistical requirements. Using the information available at the time, the following calculations were considered:

1. Of the one year allotted for sampling (260 working days), it was assumed that 240 days would be available for field work.
2. There are 6 functional classifications, so 40 days of sampling could be allotted to each.
3. Assuming six sites per functional classification, and six days per site, there would be 36 days scheduled for sampling and four unscheduled, for contingencies.
4. A sample rate of 20 vehicles per hour was assumed. With six days of sampling per site, and at a minimum of two hours per day, the total vehicles sampled per site would be 240.
5. During the 36 days scheduled for each functional classification, a total sample of 1440 vehicles would be obtained.
6. Since there are four unscheduled days out of each 40, there are 24 such days in all. If all or part were lost due to weather, equipment problems, or personnel problems, sample size is not reduced. If all or part prove usable, sample size could be increased.

It can be seen then that the sample size depended upon the number of sites selected, and vice versa. An even number of days per site were chosen so that

opposite sides of the road could be sampled on alternate days. Four days would perhaps have yielded too small a sample on a low volume road, while allowing 67% more sites to be visited. Eight days would have reduced the number of sites by 16%, while virtually insuring that a large enough sample would be obtained. In either case there would have been no unscheduled days for contingencies. Six proved to be the most practical number however. It allowed for 10% of the working days to be unscheduled, giving great flexiability to the field program. It also allowed for a 50% reduction in the assumed sampling rate of 20 vehicles per hour, while still yielding a large total sample, even at a minimum of two hours per day.

Having considered the practical aspects, it was then necessary to determine that the projected sample size was statistically sound. As a first estimate of the validity of this approach, the appropriate charts in Reference [3] were consulted (Figure 1, page 7). These supported the method, so a more detailed study was made.

Assuming no a priori knowledge of the percentage of hot (or cold) starts, the worst case ($p = .50$) was taken to determine sample size [7]. In the following formulas $U_{\alpha/2}$ is the abscissa for the normal curve for which $\pm\ U_{\alpha/2}$ times s (standard deviation) equals the confidence limit. For example $\pm$ 1.96 s equals 95% confidence limit. From

$$n_{max} = \left(\frac{U_{\alpha/2}}{\text{arc sin } 2\delta^*}\right)^2 \quad (1),$$

it was found than $n_{max} = 1066$, for a confidence interval $\delta^* = .03$ at the 95% level. Using the same formula to find δ^* for $n_{max} = 1440$,

$$\text{arc sin } 2\delta^* \doteq \frac{U_{\alpha/2}}{1440} \quad (2),$$

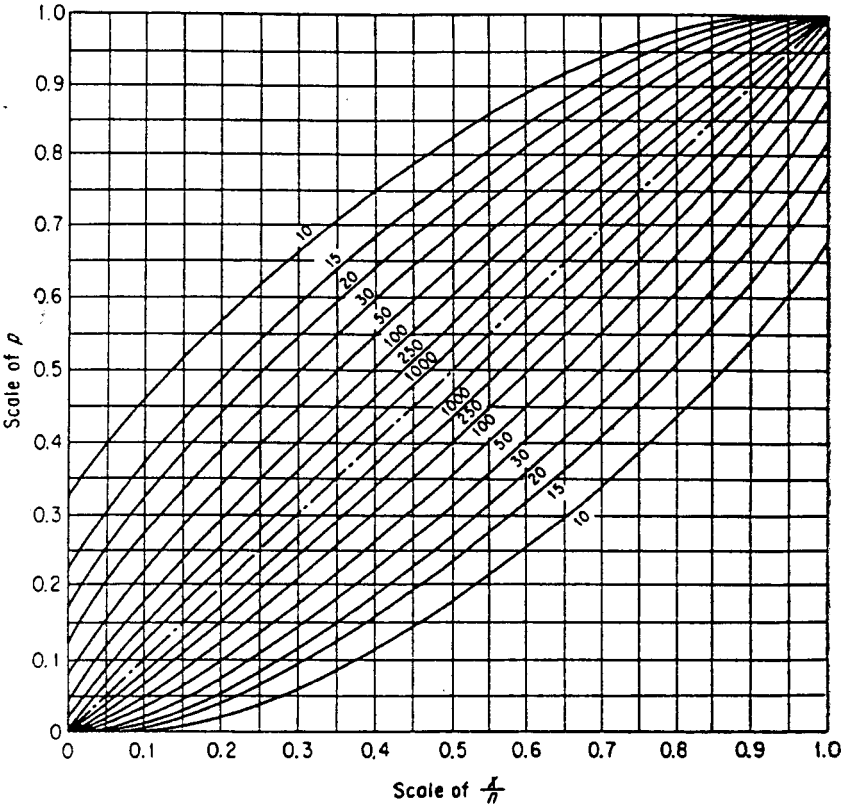
$$\delta^* \doteq .026$$

FIGURE 1

Confidence Limits for Proportions

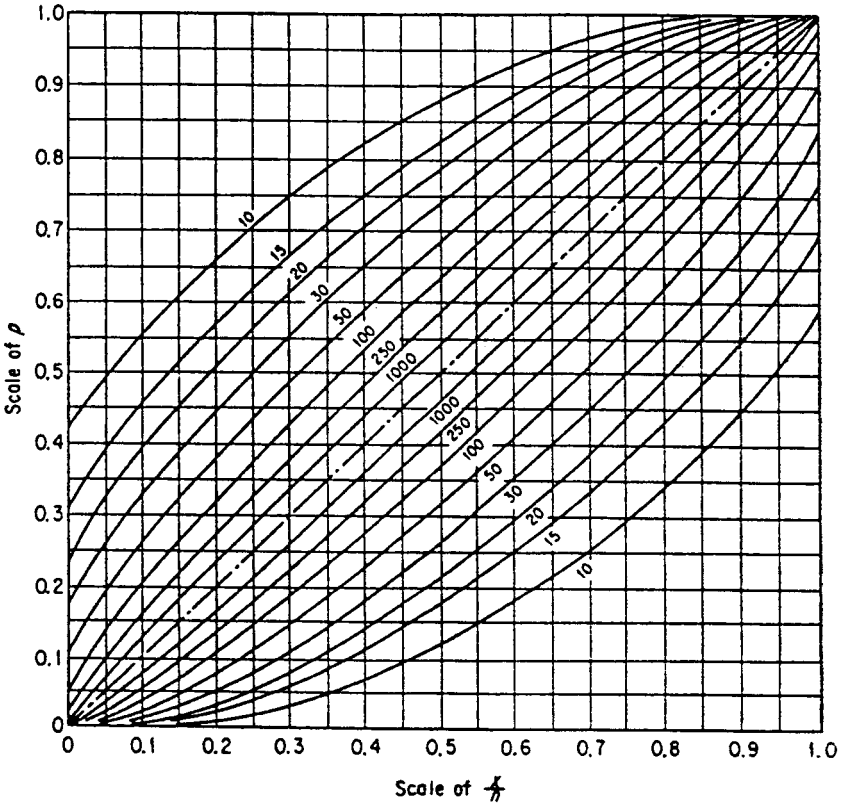
Confidence Belts for Proportions*

(Confidence coefficient .95)



Confidence Belts for Proportions* (*cont.*)

(Confidence coefficient .99)



It can now be seen that 1440 is certainly an adequate sample size for even a worst case situation. Furthermore, the confidence limits for the individual sites themselves (n = 240) are $\pm$ .063, which is not excessive.

The preceding was based on p = .50. If a less unrealistic case is taken, say p = .25, the sample size for δ^* = .063 is (again from [7]),

$$n = \left[\frac{U_{\alpha/2}}{\arcsin \left(\frac{\delta^*}{\sqrt{p} \cos (\arcsin \sqrt{p})} \right)} \right]^2$$

$$= \left[\frac{1.96}{\arcsin \left(\frac{.063}{.5 \cos (\arcsin .5)} \right)} \right]^2$$

$$n \doteq 180$$

For n = 240, $\delta^* \doteq .055$, a reduction of about 13%. If 99% confidence is desired for n = 240, the limits spread to $\pm$ .071, an increase of 13%.

As a last calculation, consider the case where the total sample size for the functional classification is reduced by 50%, and choose a 99% confidence level, for a worst case (p = .50) calculation of δ^*. Using (2),

$$\arcsin 2\delta^* = \frac{2.576}{\sqrt{720}}$$

$$2\delta^* = .0958$$

$$\delta^* \doteq .048$$

These calculations show clearly that the sample size per site and per classification is adequate for even the worst case. It will be seen in the sequel that it was necessary to limit the sites to five per category resulting in a maximum expected sample size of 1200. However, this is more than adequate, as seen from the foregoing.

Development of Site Selection Criteria

Four general groups of criteria were developed for the selection of sampling locations. In choosing these criteria it was assumed that a great deal of field inspection of tentative sites could be eliminated and that the actual field work would be greatly facilitated by applying the criteria on the basis of written information, prior to making field inspections. Accordingly, a determination of the information available on road characteristics from within the NJDOT was undertaken prior to developing criteria. Files, maps, engineering opinions, and general assistance were obtained from the Bureaus of Data Resources, Statewide Transportation Planning, Highway Planning, Environmental Analysis, and the Division of Data Processing.

In certain instances, engineering judgement was the major factor in deciding whether or not a site met a particular criterion. In others, the physical characteristics of the site immediately yielded a "yes-or-no" answer. The following discussion will clarify the status of each criterion in this respect.

A. Variation Within Functional Classifications - From the outset it was apparent that there would be variations within the functional classifications, and that these should be considered if the data for the classification was to be valid. The concept of actual usage rather than functional classification was considered at length, and it was finally determined that certain classifications should be subdivided into those predominately affected by hot start generators, cold start generators, and neither (designated H, C, and O). This satisfied the requirement for including usage while encompassing the variations within the functional classifications. The final subdivision is listed below.

URBAN

Principal Arterial

1. Hot Start Generator
2. Cold Start Generator
3. All Others

Minor Arterial and Collector

1. Hot Start Generator
2. Cold Start Generator
3. All Others

Local - no subclassification

RURAL

Principal Arterial - no subclassification

Minor Arterial and Collector

1. Hot Start Generator
2. Cold Start Generator
3. All Others

Local - no subclassification

It should not be inferred from this that sites were selected because generators were (or were not) within site limits. On the contrary, under the definitions for Hot and Cold Starts (See Appendix E) such generators could be several miles away.

The ultimate goal was to obtain five sites plus one alternate for each of the functional classifications or subdivisions thereof. Accordingly an initial list of fifteen sites for each category was compiled randomly, for a total of 180. It was assumed that starting with such a large number would virtually insure that the final group of 72 would be available. This approach was taken so that subdivisions of the functional classifications would be represented by samples which were as large as possible. Recalling the earlier assumptions of 20 vehicles per hour and a minimum of 2 hours per day for six

days, each site would yield a sample of 240 cars, or 1200 for the five sites in the category. Therefore, even if only one site out of the original fifteen proved usable, a useful sample could be obtained.

B. Safety - The foremost consideration in developing selection criteria was safety. It had already been decided to conduct the field study by stopping vehicles at the roadside and interviewing the drivers, in addition to obtaining engine temperatures. The interviewers would necessarily be on the traffic side of the stopped vehicle, so adequate clearance between the stopped vehicles and the roadway was the first consideration. Next, line of sight was taken in account. As a rule of thumb, line of sight was considered adequate if it appeared that a vehicle could be stopped in three-quarters of the distance the driver could see ahead, assuming that the posted speed limit was not exceeded. Further safety factors were non-interference with traffic flow, including that on intersecting roads or utilizing adjacent businesses, ease of return to traffic stream after stopping, and avoidance of fallen rock zones, deer crossings, cattle crossings, truck and equipment crossings, bicycle routes, parks and playgrounds.

C. Sample Size - The second major consideration was that there should be enough traffic to obtain a sample of 240 vehicles for six days at the site. Because of the considerable distance to many of the sites, it was determined that generally no more than four hours of sampling could be undertaken each day. While it was clear that for the Urban Principal Arterial and Urban Minor Arterial and Collector classifications the sample size would be limited only by the capability of the personnel and equipment, it was not clear that the criterion of 240 vehicles could be met for the remaining classifications. Furthermore, traffic counts were not available for local and county roads,

and only for certain locales on state, U.S., and interstate highways. Accordingly, it was decided to rely on engineering judgement based on field observation of traffic volumes rather than to attempt to develop a criterion which might later prove to be unrealistic.

D. Miscellaneous Criteria - In addition to the preceding criteria certain types of roads were assumed to be unsuitable for sampling. These were dead ends, alleys, dirt roads, one-lane roads, and multi-lane roadways divided in one or both directions.

Site Selection

A. Office - The New Jersey Department of Transportation maintains an inventory of all roads in the state. Each road is divided into segments with computer printouts available describing each segment. Such information as number of lanes, width and type of median, county, parking, and lane width is included in the description. A new segment is designated when certain characteristics of the road change (e.g., shoulder width, pavement type, crossing a municipal boundary, etc.). In addition, a new segment is automatically designated if the preceding one exceeds ten miles in length.

The road segments are grouped into two major collections. One comprises interstate, U.S., state and toll roads, starting with the lowest number road (U.S. 1) and proceeding to the highest (N.J. 904). This was called the "state list". Record numbers were assigned to each segment, starting with one. The second list is by county, the county roads being listed first in numerical sequence, followed by municipal roads and streets. As before record numbers are assigned to each segment, starting with number one in each county.

These two collections of road segments were used to make the initial selection of sites. Selection was accomplished by utilizing a computer program

which randomly chose between the county lists and the state list, and then entered the list and randomly chose a record number from the list selected. In this manner a list of 400 segments was randomly selected. From this, 180 segments were obtained to provide 15 initial sites for each of the functional classifications and their sub-divisions. The program and an example of the printout are in Appendices B and C. There is also an annotated example of the printout in Appendix D. This indicates the sequential manner in which the 180 sites were selected.

The determination of the functional classification of each segment was made using maps which have all roads in the state color-coded by functional classification. The characteristics of each segment were examined as it was selected in sequence, and nearly half of the segments were rejected immediately for failure to meet the selection criteria. In the case of local roads, the most common deficiency was that the segment was a dead-end street; for highways it was the lack of adequate shoulder width. As a complement to the printouts, the NJDOT straight line diagrams were used to assess highway characteristics; for county and local roads, the road inventory files of the NJDOT Bureau of Data Resources were used.

B. Field - All tentative sites not eliminated during the previous office phase were inspected for compliance with all selection criteria. The inspection was undertaken in the following manner:

1. An itinerary was made on Monday or Friday for the work week. Two methods were used. In the first, sites which were in the same general area were grouped together. In this way as many as eight could be inspected in one day. The second method consisted of inspecting sites at locales near an arterial road, so that the

more remote sites could be reached easily, while the driving time to and from such locations was not wasted but instead interspered with short side trips to inspect other sites.

2. Each site was examined thoroughly for compliance with all criteria.
3. Notes on acceptance or rejection were made at the time of inspection. Included were pertinent information on parking, terrain, line-of-sight, hazardous conditions, adequacy of traffic volume, landmarks, and nearby generators of hot and/cold starts.

Usually sites other than those classified as Urban Principal Arterial in heavily travelled and congested areas had to be rejected as being unsafe because of inadequate space in which to set up the test equipment.

Compilation of Site Lists

Of the original 180 sites, 72 survived the selection process. A complete recheck of the functional classification of each was made. The sites were then listed by classification and by the category H, C, or O, where pertinent. Within each subdivision (or classification) the sites were listed in the sequence in which they were chosen from the original randomly numbered list. In this way the first five in each list could be selected without loss of randomness. In addition to this listing, expanded field notes were entered on individual forms, one for each site. Appendix A contains the lists of the 72 sites from which its final selection was made, and the forms for the final 49 sites on which the expanded field notes were recorded.

RESULTS AND DISCUSSIONS

Statistical Results

The first result of the statistical research was to eliminate the multinomial distribution as the one with which to describe and analyze the

data. In addition to the references previously indicated, [2] specifically indicates that for more than two classes, the sample may be considered as only having two classes, specifically a_i, the class of interest, and all others. Furthermore, even though sampling is without replacement, the hypergeometric distribution is again eliminated by the fact that the population is large in relation to the sample. This reference also discusses the finite population correction, which may be ignored in this case since the sample certainly does not exceed 5% of the population.

A second result of the statistical research was the determination of a sample size which would be feasible to obtain, theoretically sound, and would lend itself to comparisons between sites within a functional classification. It was indeed serendipitous that the projected sample size of 240 vehicles per site met these requirements. This relatively small sample size eliminated the anticipated problems in choosing sites. It allowed for a large number of sites to be selected so that variations within classifications could be considered; it allowed for adequate alternate side of the road sampling; it allowed for considerable flexibility in that "high" and "low" volume sites could be selected; and assuming adequate volume, it indicated that meaningful data could be obtained even if five sites per category were not available.

The validity of earlier calculations of sample size is borne out by [2]. By utilizing the information in Sections 4.1 through 4.4, it can be seen that a first approximation of n at p = .50, at a 95% confidence level, and limits of $\pm$ .05 is equal to 400. This is in close agreement with the result using the method of [7]. (See (1), page 6). Also, for n = 240, the confidence limits are $\pm$ .063 using the method of [7]. It is therefore reasonable to assume even for a worst case, with a sampling rate only 1/3 of the previous estimate, that the completely acceptable confidence limits of $\pm$ .05 would be

obtained for each functional classification or subdivision thereof.

Lists of Sites

A. Subdivision of Functional Classifications - As previously stated, the selection of sites was made so that locations affected by generators would be included in the final list of sites. However, the original plan to select 60 sites plus 12 alternates could not be carried out, primarily because of a lack of time. In the course of compiling the initial list of 180 sites, it was apparent that there was an overabundance of Urban Principal Arterial and Urban Local sites, while sites in the other four classifications were in relatively short supply. At the completion of the office phase of site selection, the list was reduced by about 25%, both by the application of the selection criteria and by the rejection of the surplus sites in the Urban Principal Arterial and Urban Local classifications. By the completion of the field phase this list was reduced to 72. The final number of sites in each classification and subdivision is given in Table 1, below.

TABLE 1

Results of Site Selection Process

	Principal Arterial	Minor Arterial and Collector	Local
		URBAN	
H	8	3	--
C	4	5	--
O	8	2	8
		RURAL	
H	--	2	--
C	--	10	--
O	8	11	3

Of these 72 sites, the first five in each category were chosen as sampling locations. Where five were not available, all those in the category were used This yielded a total of 49 sites for the twelve categories.

In several instances the goal of five sites plus one alternate for each classification or subdivision was not met. A careful assessment of the factors involved in completing the partial lists indicated that as mush as another 15 working days might be needed to obtain enough sites. Because of the considerable delay already caused by bad weather and unforseen internal problems, and because of the fact that even a sample from two sites would yield data of value, it was decided not to attempt to make up any deficie- in the lists. This decision was supported by the fact that the projected sample size of 240 vehicles per site would result in a large sample even for those classifications for which only two sites were chosen.

Implicit in the subdivision of the functional classifications is the necessity of planning for more time to complete the data collection under Phase II of the project. Originally 6 working days were required for each site, for a total of 216 assigned days, plus another 24 unassigned, for contingencies. However, under the subdivision of functional classifications, the first five sites (or available portion thereof) were chosen in each category, for a total of 49. Therefore, the actual number of working days now anticipated is 294, plus another 48 for contingencies which brings the total to 342. Also, the original total of 240 had reduced by 8% the total working days in the year. Applying the same percentage to the new total, 372 working days (about 17 months) would be required.

It might now be well to consider a means of reducing the sampling time required to something closer to the original twelve months. Of course, any

of the categories may be arbitrarily dropped to achieve a reduction, but the urban local and rural local roads could be deleted with the least loss, for two reasons. First, light to very light traffic is anticipated for both, with the possible exception of some urban local streets during morning rush hour. It is therefore possible that individual site samples might be too small to have meaningful confidence intervals, and that even the total for each classification might produce an unacceptably wide interval. Second, very little air pollution prediction is done for local streets and roads, so any effort to obtain data on hot and cold starts may be almost entirely wasted. It is therefore worthwhile considering the deletion of the two local categories from the project. This would reduce the actual working days to 246. With contingencies and the 8% increase used previously, the total is 311 days, or about 14.5 months.

B. Conditions Affecting Site Selection - Certain conditions were necessarily accepted because of the inordinate consumption of time and/or extreme difficulty in overcoming them. For instance, in choosing sites having two or more lanes in each direction, it was obvious that it might be difficult or impossible to sample vehicles travelling in the fast lanes. This could bias the sample, but when safety and the difficulty in finding sites more completely suitable are considered, the possible bias must be ignored.

Another condition which was not taken into account was the actual ratios of H, C, and O sites within a functional classification. First of all, any subclassification under a functional classification, no matter how carefully contrived, is a matter of judgement. Therefore, assigning ratios is one step further removed from a factual analysis. Second, there is no indication that the H, C, and O sites are in any way dependent, so preserving the ratios,

even if known, would be of doubtful value. Third, any "natural" ratio would probably be destroyed by the application of the selection criteria. Therefore no attempt was made to develop or maintain any ratios during site selection.

A third condition affecting site selection resulted from the combined attempt to preserve randomness while applying the selection criteria. The basic rule was that any segment must be chosen as a result of its appearing in sequence on the random number printout. The site itself could be anywhere in the segment, but could not be in either of the adjacent segments. While this assured randomness, it also prolonged the site selection process. Unfortunately, it was not apparent that this was the case until well into the field selection process. At that time a reconsideration showed that the following steps would have shortened the process in the office and in the field, with no loss of randomness.

1. Enter the appropriate listing using the record number listed randomly, as before.
2. If the segment meets the criteria in the office, retain it for field inspection.
3. If it does not, choose randomly from the two adjacent segments, if they exist (or one, if there are not two).
4. Proceed as in Step 2.
5. If there are no adjacent segments, proceed to the next record number and continue as in Step 2.
6. Make a field inspection of all segments selected above and retain those containing satisfactory sites.
7. For segments not containing usable sites, proceed as in Step 3 and Step 5, and retain any satisfactory sites.

It is assumed that any adjacent segments selected would be in the same category as the original.

This simple procedure would certainly make for a more efficient site selection process. However, it was not introduced even when it was found to be needed, in order to maintain uniformity in carrying out the field inspection and selection.

REFERENCES

[1] Bradley, James V.: Distribution Free Statistical Tests, Prentice-Hall, 1968

[2] Cochran, William: Sampling Techniques, John Wiley and Sons, New York 1963

[3] Crow, Edwin F., Davis, Frances A., and Maxfield, Margaret W.: Statistics Manual, Dover Publishing, Inc., New York 1960

[4] Dwass, Meyer: Probability Theory and Applications, W. A. Benjamin, Inc., New York 1970

[5] Guenther, William C.: Concepts of Probability, McGraw-Hill 1968

[6] Huntsberger, David V. and Billingsley, Patrick: Elements of Statistical Infererce, Allyn and Bacon, Inc., Boston Third Edition 1973

[7] Mace, Arthur E.: Sample Size Determination, Rheinhold Publishing Corp., New York 1964

[8] U. S. Environmental Protection Agency: Mobile Source Emission Factors EPA-400/9-78-006 March 1978

APPENDIX A

SITE LISTS

This appendix consists of two parts. The first is a listing by functional classification, of the 72 sites which remained as possible data collection locations after all of the selection criteria were applied. The second portion of the appendix consists of the individual forms for each site finally selected, which contain the expanded field notes.

The column headings for the first portion of the appendix are as follows:

No. - This is the number signifying the sequence in which the site was originally selected for examination. Numbers which are missing indicate that the site was eliminated through application of the selection criteria. The numbers are in sequence within the subclassifications O, C, and H, in order to maintain the original randomness of their appearance in the list.

Record No. - This is the punchcard number on which all of the inventory data for the particular segment of road is recorded.

Road - The route number or street name.

Muncipality - The actual municipality is listed, rather than the local name of the particular area in which the site is located.

County - Self-explanatory

Subclassification - H: hot starts predominately C: Cold Starts predominately; O: neither

The coding used at the top of each of the individual forms in the second portion of the appendix is as follows:

Site No. - This is a bookkeeping number which indicates the sequence in which the final 49 sites were selected.

B.I.S. Site No. - B. I. S. is an abbreviation for the Bureau of Instrumentation Services, which carried out the site selection. The numbers immediately following the colon are the same as the items No. and Record No. explained above. The letter designations indicate the functional classification of the particular site, as explained below.

RL - Rural local

RMA & C - Rural minor arterial and collector

RPA - Rural principal arterial

UL - Urban Local

UMA & C - Urban minor arterial and collector

UPA - Urban principal arterial

SITE LIST BY FUNCTIONAL CLASSIFICATION OF ROADWAY

RURAL LOCAL

No.	Record No.	Road	Municipality	County	Sub-Classificati
30.	2705	Stuart Rd.	Princeton Twp.	Mercer	-
48.	367	Ervey Road	Allamuchy	Warren	-
87.	1700	Wood Drive	Union Twp.	Hunterdon	-

RURAL MINOR ARTERIAL AND COLLECTOR

1.	3175	Rt. 47	Middle Twp.	Cape May	0
6.	4665	U.S. 130	South Brunswick	Middlesex	0
12.	2296	Rt. 34	Colts Neck	Monmouth	0
24A-1.	5348	U.S. 206	Branchville	Sussex	0
24C.	1118	Rt. 18	Colts Neck	Monmouth	0
65A.	3608	Rt. 70	Southhampton Twp.	Burlington	0
77A.	4251	Rt. 94	Fredon Twp.	Sussex	0
78.	5098	U.S. 206	Hammonton	Atlantic	0
85A.	3867	Rt. 77	Harrison Twp.	Gloucester	0
110.	408	Rt. 535	South Brunswick	Middlesex	0
120.	5110	U.S. 206	Shamong Twp.	Burlington	0
14.	5704	U.S. 322	Logan Twp.	Gloucester	C
21A.	4445	U.S. 130	Logan Twp.	Gloucester	C
23A	2045	Federal City Rd.	Hopewell Twp.	Mercer	C
24A.	2574	Rt. 37	Lakehurst	Ocean	C
24B.	171	Rt. 526	Upper Freehold Twp.	Monmouth	C
24D.	3223	Rt. 47	Franklin Twp.	Gloucester	C
88A.	3199	Rt. 47	Maurice River Twp.	Cumberland	C

RURAL MINOR ARTERIAL AND COLLECTOR (cont.)

No.	Record No.	Road	Municipality	County	Sub-Classificati
120A-1.	5754	U.S. 322	Monroe Twp.	Gloucester	C
120B.	3179	Rt. 47	Middle Twp.	Cape May	C
120C.	2683	U.S. 40	Pilesgrove Twp.	Salem	C
78A.	2677	U.S. 40	Pilesgrove Twp.	Salem	H
98A.	2085	Rt. 31	Raritan Twp.	Hunterdon	H
		RURAL PRINCIPAL ARTERIAL			
1.	2207	Rt. 33	Millstone	Monmouth	-
7.	5666	I-295	Springfield Twp.	Burlington	-
8.	1565	Rt. 23	West Milford	Passaic	-
9.	597	U.S. 9	Manalapan	Monmouth	-
10.	4983	U.S. 202	West Amwell	Hunterdon	-
12.	2107	Rt. 31	Clinton Twp.	Hunterdon	-
13.	1324	U.S. 22	Clinton Twp.	Hunterdon	-
14.	2934	U.S. 46	White Twp.	Warren	-
		URBAN LOCAL			
2.	2170	Rolling Lane	Cherry Hill	Camden	-
3.	11736	Frederick St.	Waldwick	Bergen	-
7.	6088	So. Essex Ave.	Orange	Essex	-
11.	980	Arch St.	Butler	Morris	-
17.	5501	Monticello Ave.	Newark	Essex	-
19.	2343	33rd St.	Union City	Hudson	-
21.	2051	52nd St.	Sea Isle City	Cape May	-
22.	6260	Borig Ave.	Lodi	Bergen	-

URBAN MINOR ARTERIAL AND COLLECTOR

No.	Record No.	Road	Municipality	County	Sub Classificatio
64.	917	Railroad Ave.	Jersey City	Hudson	0
64A.	3419	Rt. 53	Parsippany-Troy Hills	Morris	0
18.	952	California Ave.	Atlantic City	Atlantic	0,C
18A.	3213	Rt. 47	Millville	Cumberland	C
100.	293	Reservoir Dr.	Montclair	Essex	0,C
116.	4195	Rt. 91	New Brunswick	Middlesex	0,C
117	2172	Conant St.	Hillside	Union	0,C
17A.	3283	Rt. 48	Carney's Pt.	Salem	H
18B.	3669	Rt. 71	Sea Girt	Monmouth	H
117A	3273	Rt. 47	Deptford	Gloucester	H

URBAN PRINCIPAL ARTERIAL

1.	1665	Rt. 24	Summit	Union	0
8.	5543	I-287	Hanover Twp.	Morris	0
11A.	151	Co. 603	Passaic	Passaic	0
11B.	4061	I-80	Denville	Morris	0
12A.	3770	Rt. 73	Waterford Twp.	Camden	0
28.	5142	U.S. 130	Pennsauken	Camden	0
30.	5599	I-295	Paulsboro	Gloucester	0
34A.	5297	Rt. 206	Stanhope Twp.	Sussex	0
3.	3073	U.S. 46	Totowa	Passaic	H
10.	2623	Rt. 38	Cherry Hill	Camden	H
13.	2443	Rt. 35	Middletown	Monmouth	H
15.	1297	U.S. 22	Lopatcong Twp.	Warren	H

URBAN PRINCIPAL ARTERIAL (cont.)

No.	Record No.	Road	Municipality	County	Sub-Classificatic
19.	1838	Rt. 28	Scotch Plains	Union	0
24.	620	U.S. 9	Sayreville	Middlesex	0
27.	4149	Rt. 82	Union Twp.	Union	0
34.	5855	Rt. 440	Jersey City	Hudson	0
12B.	4028	Grove St.	Haddonfield	Camden	C
16.	1216	Rt. 20F	Paterson	Passaic	C
20.	5644	I-295	Cherry Hill	Camden	
25	2357	Rt. 35	Mantoloking	Ocean	C

SITE DESCRIPTIONS

SITE NO. 5

B.I.S. Site No.: 30. 2705 RL

Location Description - Stuart Road, between The Great Road and Cherry Hill Road. Narrow, and hilly, but line of sight adequate in spots. Can use berm for parking at certain locations. No shoulders. Light to very light traffic.

SITE NO. 11

B.I.S. Site No.: 48. 367 RL

Location Description - Ervey Road, between Quakerchurch Road and county line (1.26 miles). Hills and curves, with no berm or shoulder. Probably light traffic, so blocking one lane for parking should not cause a problem.

SITE NO. 17

B.I.S. Site No.: 87. 1700 RL

Location Description - Wood Drive, between Rt. 579 and Cooks Cross Road. Farmland, with a few new houses. Probably light traffic at any time. Narrow, but usable as a site. Road is only a few hundred yards long.

SITE NO. 1

B.I.S. Site No.: 1 3175 RMA & C

Location Description - Rt. 47, between 1.55 and 1.76. On causeway, just west of bridge into Wildwood. Many businesses adjacent to causeway. Area one or two miles west is about 80% developed commercially.

SITE NO. 7

B.I.S. Site No.: 6. 4665 RMA & C

Location Description - U.S. 130, between 76.22 and 78.60. A few small businesses in area. About 5% developed.

SITE NO. 13

B.I.S. Site No.: 12. 2296 RMA & C

Location Description - Rt. 34, between 10.56 and 11.76. Top of hill is best spot. Excellent line of sight and parking. Almost no development in area.

SITE NO. 19

B.I.S. Site No.: 24A-1 5348 RMA & C

Location Description - U.S. 206, between 117.07 and 117.34. Parking is limited, but line of sight is good.

SITE NO. 24

B.I.S. Site No.: 24C. 1118 RMA & C

Location Description - Rt. 18F, between 19.28 and 21.92. Near Rt. 34 interchange. No commercial development in area, except about 10% on Rt. 34. Parking adequate throughout.

SITE NO. 29

B.I.S. Site No.: 14. 5704 RMA & C

Location Description - U.S. 322, between 2.19 and 2.21. Just before approach to Commadore Barry Bridge. Can use berm on both sides of road. Site is just outside of Bridgeport, but definitely rural.

SITE NO. 32

B.I.S. Site No.: 21A. 4445 RMA & C

Location Description - U.S. 130, between 11.71 and 12.16. Starts just south of bridge and includes part of intersection with U.S. 322. Parking and line of sight good. Small businesses and residential. On outskirts of Bridgeport.

SITE NO. 35

B.I.S. Site No.: 23A. 2045 RMA & C

Location Description - Federal City Road, between Rt. 546 and Ewingville Rd. Usable at locations between Rt. 546 and I-295 only. Much too narrow to use over remainder of segment. Urban changing to suburban and rural, proceeding toward Rt. 546.

SITE NO. 38

B.I.S. Site No.: 24A 2574 RMA & C

Location Description - Rt. 37, between 31.74 and 31.79. Almost at Rt. 70 circle. Two small berm areas plus shoulders give adequate parking.

SITE NO. 41

B.I.S. Site No.: 24B 171 RMA & C

Location Description - Rt. 526, between Lakeview Drive and railroad tracks. Adequate parking on berms or commercial driveways and lots. May have to get permission from owners. Line of sight very good.

SITE NO. 44

B.I.S. Site No.: 78A. 2677 RMA & C

Location Description - U.S. 40, between 7.60 and 10.05. Parking good just west of state police barracks, but no good elsewhere. Line of sight good. Rural; residential, farms, small businesses. About 3 miles from CBD of Woodstown.

SITE NO. 46

B.I.S. Site No.: 98A. 2085 RMA & C

Location Description - Rt. 31, between 19.85 and 20.65. South half of segment is rural, north half about 90% developed commercially. Many small businesses, and two shopping centers. Shoulders usable throughout, and berm in some spots.

SITE NO. 6

B.I.S. Site No.: 1. 2207 RPA

Location Description - Route 33, between 19.46 and 20.08. Approximately opposite Millstone Flea Market. Excellent line of sight, and excellent parking on shoulder and berm. About 30% developed residentially and commercially, but definitely rural.

SITE NO. 12

B.I.S. Site No.: 7. 5666 RPA

Location Description - I-295, 49.24 to 49.96. Typical interstate with wide shoulders, generally usable berm, and excellent line of sight. About halfway between interchanges for Mt. Holly and Columbus, about five miles apart. Completely rural.

SITE NO. 18

B.I.S. Site No.: 8. 1565 RPA

Location Description - Rt. 23, between 23.29 and 23.96. Hills and curves, but

parking and line of sight good. Rural, with some small businesses, and heavily developed commercial areas a few miles east.

SITE NO. 23

B.I.S. Site No.: 9. 597 RPA

Location Description - U.S. 9, between 117.67 and 119.22. Line of sight very good and parking on shoulders throughout segment. Listed as rural, but at least 80% developed commercially, with many small businesses, and a shopping mall one mile south of site.

SITE NO. 28

B.I.S. Site No.: 10. 4983 RPA

Location Description - U.S. 202, between 0.79 and 0.88. Less than one mile from Rt. 29 interchange. Rural, but about 1-2 miles from Lambertville.

SITE NO. 4

B.I.S. Site No.: 2. 2170 UL

Location Description - Rolling Lane, between Country Club Drive and Gatewood Road. Wide, straight road in a large housing development. Moderate traffic estimated for rush hour, and light to very light during rest of day.

SITE NO. 10

B.I.S. Site No.: 3. 11736 UL

Location Description - Frederick St., between Franklin Tpk. and Harrison Avenue. Side road from Franklin Tpk. and CBD to RR station.

SITE NO. 16

B.I.S. Site No.: 7. 6088 UL

Location Description - South Essex Ave., between Central and Jackson and I-280. Adjacent to CBD. Hospital at north end of segment. Most parking places will be filled during the day. Area congested.

SITE NO. 22

B.I.S. Site No.: 11. 980 UL

Location Description - Arch Street and East Arch Street, between Manning and Main. Wide residential street, adjacent to CBD. Appears to have light to moderate traffic. Parking is good.

SITE NO. 27

B.I.S. Site No.: 17. 5501 UL

Location Description - Monticello Ave., between Marian and South Orange. One way South Orange, with stop sign at exit. Residential area adjacent to CBD. Light traffic during off-peak hours. Site may be of doubtful value because of lack of traffic.

SITE NO. 3

B.I.S. Site No.: 64. 917 UMA & C

Location Description - Railroad Ave., between Henderson and Hudson. Adjacent to Exchange Place PATH Station. Very wide with parking both sides, filled during business hours: offices, warehouses, high-rise apartments.

SITE NO. 9

B.I.S. Site No.: 64A. 3419 UMA & C

Location Description - Rt. 53, between 1.55 and 1.65. At Route 10 interchange. Primarily residential with a few small businesses. Parking restricted but adequate and line of sight good. About two miles from Denville CBD and near commercial development on Rt. 10.

SITE NO. 15

B.I.S. Site No.: 18. 952 UMA & C

Location Description - California Ave., between Artic and Fairmount Ave. One way side street with small businesses. One block from CBD. Parking places are completely filled during the business day. Completely urbanized.

SITE NO. 21

B.I.S. Site No.: 18A. 3213 UMA & C

Location Description - Rt. 47, between 41.23 and 41.70. Wide, but no shoulders delineated. Small businesses and bottled gas facility, with residences nearby. CBD within one mile.

SITE NO. 26

B.I.S. Site No.: 100. 293 UMA & C

Location Description - Reservoir Drive (Co. 618), between Valley Road and Corporate line (near Highland Ave.). No shoulders but wide enough for parking. Hilly, but line of sight acceptable. This site is somewhat doubtful because of possible safety problems. Residential; about one mile from CBD.

SITE NO. 31

B.I.S. Site No.: 116. 4195 UMA & C

Location Description - Rt. 91, between 1.31 and 2.31. Small factories and warehouses on both sides. Fully developed industrially. Parking on berm or edge of parking lots. May have to get permission from property owners. Moderate to heavy traffic expected.

SITE NO. 34

B.I.S. Site No.: 117. 2172 UMA & C

Location Description - Conant St., between Valley View and Fairview. Residential area some distance from CBD's. Moderate to heavy traffic during day. No shoulders, but wide enough for parking. Line of sight good.

SITE NO. 37

B.I.S. Site No.: 17A 3283 UMA & C

Location Description - Rt. 48, between .32 and .35. Wide street in residential and small business area. Local high school nearby on Rt. 48. Line of sight excellent, parking very good.

SITE NO. 40

B.I.S. Site No.: 18B 3669 UMA & C

Location Description - Rt. 71, between 2.34 and 2.53. Line of sight is very good and shoulders are adequate for parking. About 95% developed commercially, with homes and some businesses on cross-streets.

SITE NO. 43

B.I.S. Site No.: 117A. 3273 UMA & C

Location Description - Rt. 47, between 71.98 and 72.23. Small businesses and a Gaudio's Garden Center along segment. About 75% developed commercially. Parking on shoulders is barely adequate. Urban, changing to rural within a mile or two.

SITE NO. 2

B.I.S. Site No.: 1 1665 UPA

Location Description - Rt. 24, between 52.81 and 52.94. Fully developed residentially and commercially. Short Hills Mall is adjacent to site, with interchanges to mall and major roads. Nearby parking on shoulders.

SITE NO. 8

B.I.S. Site No.: 8. 5543 UPA

Location Description - I-287, between 39.40 and 39.47. At Rt. 10 interchange. Near shopping and businesses on Rt. 10.

SITE NO. 14

B.I.S. Site No.: 11A. 151 UPA

Location Description - Co. 603. (Passaic Ave.), between Terhune and Brook. No shoulders, but wide enough for parking. Fully developed residentially, but near businesses in various municipalities. About a quarter-mile from Rt. 3.

SITE NO. 20

B.I.S. Site No.: 11B. 4061 UPA

Location Description - I-80, between 40.28 and 40.30. Hilly but line of sight good. Listed as urban, but definitely rural along highway.

SITE NO. 25

B.I.S. Site No.: 12A. 3770 UPA

Location Description - Rt. 73, between 15.30 and 15.78. At U.S. 30 interchange. Only certain areas are suitable for parking. Listed as UPA but mostly rural.

SITE NO. 30

B.I.S. Site No.: 3. 3073 UPA

Location Description - U.S. 46, between 57.81 and 57.95. Parking area is short both EB and WB, and requires careful positioning. Meets minimum safety standards. Line of sight good. Heavy traffic day and night.

SITE NO. 33

B.I.S Site No.: 11. 2623 UPA

Location Description - Rt. 38, between 396 and 398, at circle. Parking restricted to one area, just east of circle. Area is completely urbanized, with businesses, shopping centers and residential areas for at least a two-mile radius.

SITE NO. 36

B.I.S. Site No.: 13. 2443 UPA

Location Description - Rt. 35, between 34.65 and 36.71. Fully developed commercially with small businesses, shopping centers and homes in a 5-mile radius.

SITE NO. 39

B.I.S. Site No.: 15 1297 UPA

Location Description - U.S. 22, between 2.25 and 3.21. Curves and hills, but line of sight very good. Wide shoulders for parking. Listed as urban, but rural in area of site. About 25% developed commercially with small businesses.

SITE NO. 42

B.I.S. Site No.: 19. 1838 UPA

Location Description - Rt. 28, between 18.50 and 18.84. Completely urbanized, with homes and small businesses. Scotch Plains CBD about 1 mile away with other CBD's ten to fifteen minutes away. Line of sight good, but parking somewhat limited.

SITE NO. 45

B.I.S. Site No. 12B. 4028 UPA

Location Description - Grove St., between the stream and Redwood Ave. Residential with small businesses and school (s). About one mile from CBD. This is a wide city street with no shoulders, but adequate space for parking. Hilly, but line of sight is good. Moderate to heavy traffic with delays can be expected.

SITE NO. 46

B.I.S. Site No.: 98A. 2085 RMA&C

Location Description - Rt. 31, between 19.85 and 20.65. South half of segment is rural, north half about 90% developed commercially. Many small businesses, and two shopping centers. Shoulders usable throughout, and berm in some spots.

SITE NO. 47

B.I.S. Site No.: 16. 1216 UPA

Location Description - Rt. 20 F., between 1.69 and 1.78. At underpass. LLine of sight and parking very good.

SITE NO. 48

B.I.S. Site No.: 20. 5644 UPA

Location Description - I-295, between 32.12 and 32.40. At the Rt. 561 interchange. Parking restricted, but adequate.

SITE NO. 49

B.I.S. Site No.: 25. 2357 UPA

Location Description - Rt. 35, between 9.09 and 9.12. At the end of two lane section. Excellent line of sight. Fully developed; 95% homes, 5% small businesses. Off-peak traffic often heavy during summer.

APPENDIX B

Random Number Program

```
TOF:
      DIMENSION NCYSEG(21), CUMPRB(21), DATA(2)
      COMPLEX*16 COUNTY(21)/'ATLANTIC','BERGEN','BURLINGTON','CAMDEN',
     *'CAPE MAY','CUMBERLAND','ESSEX','GLOUCESTER','HUDSON','HUNTERDON',
     *'MERCER','MIDDLESEX','MONMOUTH','MORRIS','OCEAN','PASSAIC',
     *'SALEM','SOMERSET','SUSSEX','UNION','WARREN'/
      DATA NSTSEG/6086/, NCYSEG/5029,13155,5913,6814,2852,2399,7245,
     *3450,2606,1898,3842,7750,8498,7482,8009,4830,1484,2727,2309,6522,
     *2198/
      DATA CUMPRB/.047,.170,.225,.289,.316,.338,.406,.438,.462,.480,
     *.516,.588,.667,.737,.812,.857,.871,.896,.918,.979,1./
      WRITE(6,100)
100   FORMAT('0','ENTER DESIRED QUANTITY OF RANDOM SELECTIONS ',
     *'(MAXIMUM 1000) AND',/,1X,'7-DIGIT ODD NUMBER TO START RANDOM ',
     *'GENERATOR')
      CALL FREERD(2,DATA)
      N=DATA(1)
      IF((N.LT.1).OR.(N.GT.1000)) STOP
      ISEED=DATA(2)
      WRITE(6,110)
110   FORMAT('0','THE PROBABILITY OF SELECTION FOR EACH COUNTY IS ',
     *'PROPORTIONAL TO',/,1X,'THE TOTAL NUMBER OF SEGMENTS IN EACH ',
     *'COUNTY.  IF IT IS DESIRED',/,1X,'TO WEIGHT THE RELATIVE ',
     *'PROPORTION OF STATE AND COUNTY SELECTIONS',/,1X,'IN A SIMILAR ',
     *'MANNER, THE APPROPRIATE PROPORTION IS 0.054.',//,1X,'ENTER ',
     *'DESIRED PROPORTION OF STATE SELECTIONS')
      CALL FREERD(1,PROP)
      IF((PROP.LT.0.).OR.(PROP.GT.1.)) STOP
      WRITE(6,200)
200   FORMAT(1X)
      DO 4 I=1,N
      CALL RAND(ISEED,RUX)
      IF(RUX.GT.PROP) GO TO 1
      CALL RAND(ISEED,RUX)
      IX=1+IFIX(NSTSEG*RUX)
      WRITE(6,300) IX
300   FORMAT(1X,'STATE',8X,I4)
      GO TO 4
1     CALL RAND(ISEED,RUX)
      DO 2 J=1,21
      IF(RUX.LE.CUMPRB(J)) GO TO 3
2     CONTINUE
3     CALL RAND(ISEED,RUX)
      IX=1+IFIX(NCYSEG(J)*RUX)
      WRITE(6,310) COUNTY(J), IX
310   FORMAT(1X,'COUNTY',6X,A8,A2,4X,I5)
4     CONTINUE
      STOP
      END

EOF:
```

APPENDIX C

Random Number Printout (Partial)

```
EXECUTION BEGINS...

ENTER DESIRED QUANTITY OF RANDOM SELECTIONS (MAXIMUM 3000) AND
7-DIGIT ODD NUMBER TO START RANDOM GENERATOR
?
30 1234567

THE PROBABILITY OF SELECTION FOR EACH COUNTY IS PROPORTIONAL TO
THE TOTAL NUMBER OF SEGMENTS IN EACH COUNTY.  IF IT IS DESIRED
TO WEIGHT THE RELATIVE PROPORTION OF STATE AND COUNTY SELECTIONS
IN A SIMILAR MANNER, THE APPROPRIATE PROPORTION IS 0.354.

ENTER DESIRED PROPORTION OF STATE SELECTIONS
?
.5

STATE          3175
COUNTY       CAMDEN          2170
COUNTY       BERGEN         11736
COUNTY       BERGEN          8812
COUNTY       SUSSEX           662
STATE          4665
STATE          1665
COUNTY       ESSEX           6088
STATE          2888
STATE          3283
COUNTY       ESSEX           4337
STATE           109
COUNTY       MORRIS          5089
STATE          3033
COUNTY       MORRIS           980
STATE          3073
STATE          1288
STATE          5480
STATE          2296
COUNTY       MONMOUTH        2907
STATE          5704
COUNTY       ESSEX           3934
COUNTY       GLOUCESTER      2101
COUNTY       BERGEN          6840
STATE          2472
COUNTY       ESSEX           5501
COUNTY       ATLANTIC         952
COUNTY       HUDSON          2343
COUNTY       MIDDLESEX       2544
STATE           736
```

APPENDIX D

Annotated Random Number Printout (Partial)

```
EXECUTION BEGINS...

ENTER DESIRED QUANTITY OF RANDOM SELECTIONS (MAXIMUM 1000) AND
7-DIGIT ODD NUMBER TO START RANDOM GENERATOR
?
30 1234567

THE PROBABILITY OF SELECTION FOR EACH COUNTY IS PROPORTIONAL TO
THE TOTAL NUMBER OF SEGMENTS IN EACH COUNTY.  IF IT IS DESIRED
TO WEIGHT THE RELATIVE PROPORTION OF STATE AND COUNTY SELECTIONS
IN A SIMILAR MANNER, THE APPROPRIATE PROPORTION IS 0.054.

ENTER DESIRED PROPORTION OF STATE SELECTIONS
?
.5

RC   STATE        3175
UL   COUNTY       CAMDEN          2170
UL   COUNTY       BERGEN         11736
  X  COUNTY       BERGEN          9812 - DEAD END
  X  COUNTY       SUSSEX           662 - DEAD END
RMA  STATE        4665
UPA  STATE        1665
UL   COUNTY       ESSEX           6088
  X  STATE        2888 - NO SHOULDER
UMA  STATE        3283
  X  COUNTY       ESSEX           4337 - RUN DOWN RESIDENTIAL, ONE BLOCK, TERMINATED BY
  X  STATE         109 - NO SHOULDER - BRIDGE          RT. 78; ALMOST NO TRAFFIC
  X  COUNTY       MORRIS          5080 - VERY LIGHT TRAFFIC; SMALL DEVELOPMENT
  X  STATE        3033 - NO SHOULDER
UL   COUNTY       MORRIS           980
UPA  STATE        3073
  X  STATE        1288 - NO SHOULDER
  X  STATE        5480 - NO SHOULDER
RMA  STATE        2296
  X  COUNTY       MONMOUTH        2907 - DEAD END
RMA  STATE        5704
  X  COUNTY       ESSEX           3834 - DEAD END
  X  COUNTY       GLOUCESTER      2101 - DEAD END
  X  COUNTY       BERGEN          6849 - NARROW SIDE ROAD; VERY LIGHT TRAFFIC
  X  STATE        2472 - NO SHOULDER
UL   COUNTY       ESSEX           5501
UC   COUNTY       ATLANTIC         952
UL   COUNTY       HUDSON          2343
  X  COUNTY       MIDDLESEX       2544 - SHORT SIDE ROAD IN DEVELOPMENT; VERY LIGHT
  X  STATE         736 - PULASKI SKYWAY                                        TRAFFIC
```

On the previous page the following abbreviations were used:

UPA - Urban Principal Arterial

UMA - Urban Minor Arterial

UC - Urban Collector

UL - Urban Local

RMA - Rural Minor Arterial

RC - Rural Collector

X - Failed to meet selection criteria

UMA and UC are actually one functional classification (UMA AND C). They were separated here merely to facilitate the work: similarly with RMA and RC.

EXAMPLE: Under the county listing Camden 2170, Bergen 11736, Bergen 9812, Sussex 662, Essex 6088, etc. were examined for compliance with selection criteria using the N.J.D.O.T. road inventory files. Those failing to meet the criteria were marked "X", and the reason noted. The remaining segments were inspected in the field, and the same procedure followed. The segments which contained usable sites were marked according to the appropriate functional classification, and notes were made separately concerning items of interest.

In the case of classification UL, Camden 2170, Bergen 11736, Essex 5088, Morris 980, and Essex 5501 were chosen in that sequence as the five UL sites. For the classification UMA and C (listed here as two separate classifications), the sub-divisions H, C, and O apply. Hence, State 3283 is the first selection under H, while Atlantic 952 is the first under C.

APPENDIX E

Hot and Cold Start Definitions

The following definitions are from Reference [8].

Hot Starts

1. For a catalyst - equipped vehicle which has had an engine-off period of less than one hour, the hot start condition exists for the first 505 seconds of operation after engine restarting.
2. For a non-catalyst - equipped vehicle which has had an engine-off period of less than four hours, the hot start condition exists for the first 505 seconds of operation after engine restarting.

Cold Starts

1. For a catalyst - equipped vehicle which has had an engine-off period of at least one hour, the cold start condition exists for the first 505 seconds of operation after engine restart.
2. For a non-catalyst - equipped vehicle which has had an engine-off time of at least four hours, the cold start condition exists for the first 505 seconds of operation after engine restart.