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Shoulder and Rest Area Use Study Procedure Guide

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Highway Shoulder Use Study Procedure Guide

• THIS GUIDE has been prepared by the Highway Research Board Committee on Shoulders and Medians to meet the need for standardized procedures in conducting shoulder use studies.

During its 1958 meeting, the Highway Research Board's Committee on Shoulders and Medians recognized a growing need for more complete factual information on driver stopping practices on highway shoulders. It was evident that such information was needed as a basis for sound policy recommendations regarding the prohibition of parking on highway shoulders and the extent that provision needs to be made for emergency and/or rest stops on freeways. To meet this need, a number of states at the recommendation of the Committee on Shoulders and Medians, initiated shoulder use studies during 1958 and several studies were completed by the end of the year.

In the course of reviewing these studies, the Committee on Shoulders and Medians found that, because of differences in study procedures and analytical methods, the shoulder use data from the several studies were not always on a comparable basis. As a result, a recommendation was made by the committee during its 1959 meeting that a shoulder use study guide be prepared and adopted, and that future studies be conducted in accordance with this guide so that the greatest utility and benefit could be obtained from the studies of the various states.

The purpose of this guide is to describe a method of making a shoulder use study which will provide uniform and reasonably accurate data on the use of highway shoulders for parking or stopping.

BACKGROUND

Parking on highway shoulders with its attendant hazard in entering and leaving the traveled lanes has long been recognized as a cause of accidents. With the ever-increasing mileage of high-speed multi-lane freeways on the highway systems of the nation, it has become evident that control of shoulder parking and provision for emergency and rest stops on such highways are necessary. In the past, shoulder parking restrictions have been applied to limited sections where specific parking hazards existed. However, it was considered neither desirable nor necessary to control parking continuously over the entire length of a highway. With the hundreds of miles of controlled-access highways now under construction or completed on the Interstate and other systems, there is an immediate need for current accurate information on which to base decisions for proper control of shoulder parking and planning of safety rest areas (1, 2).

This guide indicates the basic data to be collected, the methodology and procedures to be followed in collecting, assembling, and analyzing the data, and a suggested outline for a suitable report covering a shoulder use study. The guide is not intended to be all-inclusive or restrictive as far as the scope of shoulder use studies that may be undertaken. All specific problems or conditions that may be the subject of shoulder use studies cannot be covered in a guide of this type. It will be necessary for those conducting studies to supplement and adapt the procedures recommended herein to the specific study conditions at hand, bearing in mind the importance of maintaining uniformity of shoulder stop definitions and basic procedures to assure the comparability and reliability of shoulder use data reported in various studies.

As envisaged in this guide, a shoulder use study should be designed to provide all information necessary for establishing the shoulder parking characteristics of drivers on a selected section or sections of highway and under specified conditions (3). The essential procedural steps in the planning of such a study are as follows:

1. Selection of study site on highway section having the geometric design, traffic, and locational characteristics appropriate to the study objectives.
2. Observation and interviewing of drivers parking on shoulders in the selected study site over such periods of time as will establish, within reasonably accurate limits, the shoulder parking characteristics of drivers in terms of frequency and duration of shoulder stops, reasons for stopping, and related information.
3. Counting and classification of vehicle traffic on the study section during the shoulder use survey to establish accurately the relationship between shoulder stops and vehicle-miles of travel by vehicle types.
4. Tabulation and analysis of the shoulder use observation and traffic volume data, including the arithmetic tabulation and summarization of the data, the statistical analysis and presentation of data in the form of tables, charts, percentage distributions, averages, statistical tests of significance, and analytical interpretation of the data in narrative form.
5. Compilation and presentation of the data in narrative, tabular, and graphic form suitable for publication.

PRELIMINARY PLANNING AND GENERAL PROCEDURE

Before beginning the detailed planning of a shoulder use study, the objectives of the study should be decided on and clearly defined. The following is a list of the more important study objectives:

1. To establish the frequency, purpose, and duration of shoulder parking on certain types and classes of highways or highway systems.
2. To determine the effects of various shoulder parking controls as indicated by signing such as "No Parking," "No Parking on Highway Shoulders," and "Emergency Parking Only."
3. To determine the effect of roadside safety-rest areas on shoulder parking practices, and also information relating to the need for such rest areas and potential uses of them.
4. To determine the relationship between the frequency of shoulder stops and accidents involving a parked vehicle or one engaged in a maneuver leading to a stop or resuming travel after a stop.

In the design of a given study, of course, these objectives may be considered individually or in combination. Once the study objectives have been delineated, it then becomes necessary to choose as a study site a highway section or sections possessing the roadway and traffic characteristics appropriate to the study objectives. Such considerations include the extent of access control, distance between interchanges and population centers, shoulder width, character of abutting land, and others. Additional considerations may also be involved. For instance, if the study is concerned with the effect of shoulder parking control signing, it would be important that advance arrangements be made with the proper authorities for the installation or removal of signs in coordination with the shoulder use field observation schedule. In this connection, where studies are concerned with the effect of parking control signs or rest areas, newly constructed highways will afford a unique opportunity for before- and after-studies under controlled conditions.

The optimum plan for the collection of shoulder use field data would be one in which there were sufficient observers so situated that all drivers stopping on the highway shoulders would be observed and interviewed. From a practical standpoint, experience has shown that the number of observers and interviewers necessary to obtain 100 percent coverage would be excessive in relation to the probable degree of accuracy which would result. As an alternative to total coverage, it is recommended that a part of each study section be set up as a "control" section in which all stops are observed and recorded by fixed observer with mobile observers patrolling the entire section on a regular basis. The ratio of total stops in the "control" section to stops observed by the mobile observers in the "control" section provides a factor for expanding the observed shoulder stops to total stops in the study section.

Considering operational factors, it has been found from experience that study sections of from 4 to 8 mi in length are most suitable. If at all possible, a study section should be so located that an interchange is situated at or near each end, so that the mobile shoulder use observers will have a safe and easy means of changing their direction of travel. Another requirement to be considered is that of providing for a control section of at least 1 mi in length on which continuous observation can be made and on which there is available an advantageous position at which to station the classifier-observer to maintain this continuous surveillance.

As an aid to planning, it is desirable to procure a large-scale map (approximately 1 in. = 1 mi) of the area in which the study section or sections are located, including at least a 5-mi area on either side of the study section. Such a map was used in planning a shoulder use study on a 4-lane divided highway on Interstate 5 in Oregon (see Fig. 1). In this particular instance, the study section was 5.0 mi in length and so located that interchanges were conveniently available at either end to permit the mobile observers to change direction of travel in the course of patrolling the study area. A control section 2.0 mi in length was delineated at the north end of the full study section, and this was subject to continuous surveillance by the observer-classifier stationed at the vantage point offered by the Talbot Road Overcrossing near its midpoint.

There is no substitute for on-the-site observation of proposed study sties. It is important that the roadway in the "control" section be easily observed by the stationary observer. Excessive rise and fall or curvature of the roadway in the section will result in sight restriction, making impractical the complete observation of the control section. It is important to record the exact location of the various roadway features and any signs relating to them. Some of the more important features are parking regulations, safety rest areas, interchanges, crossroads, and special highway and roadside attractions. These signs and also the unmarked roadside features should be located on the map so that they may be considered in analyzing the survey data.

In summary, collecting field data for the shoulder use study involves the following:

1. Interview of drivers parking on shoulders during daylight hours by mobile observers in passenger cars patrolling the study sections in both travel directions.
2. Counting and classifying traffic in the study section during the shoulder use observation study period to obtain an accurate count of vehicle-miles by vehicle type. (Ordinarily one person acting as a combination traffic counter and classifier will suffice to secure accurate traffic data.)
3. Determining the number, type, and duration of shoulder stops occurring in a "control" section of 1 or more mi length under continuous observation during the survey. (This observation may normally be made by the vehicle classifier, mentioned at the same time he is counting traffic.)

COLLECTION OF FIELD DATA

Personnel Requirements

Personnel requirements for the field work of collecting traffic and shoulder use data will vary with the physical characteristics of the study section and the study purposes. Sufficient mobile observers will be required to patrol the highway section and interview drivers parking on highway shoulders to insure that the majority of all drivers stopping in the study section will be interviewed and reliable stop data will be obtained. Although no precise determination has been made, it is suggested that a sufficient number of mobile observers be assigned so that no part of the study section will be unobserved for an interval of more than 10 min (preferably less). In a specific instance, it was found that of the total stops known to have occurred on a 2-mi control section of 4-lane divided highway, approximately 65 percent were observed by two mobile observers traversing the section on a 15-min schedule. The mobile-observer coverage will, of course, be affected by the volume of stops and interview time both of which will vary on different highway study sections.

A stationary observer will be needed to record shoulder stops in the control section. This observer may also tabulate and classify traffic. One person will act as the super-

STATE OF _____
SHOULDER USE STUDY

VICINITY MAP - STUDY SECTIONS

Ankeny Hill - South Jefferson Junction Section
Interstate Route 5, Highway No. 1 - M.P. 57.90-62.90

April, 1959

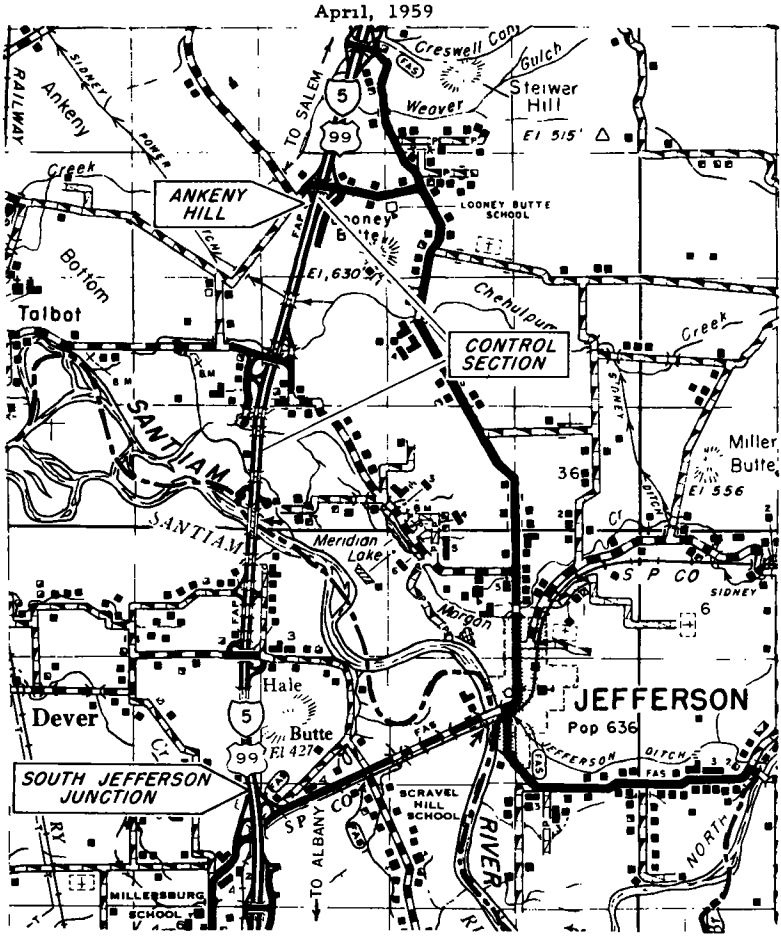


Figure 1.

visor of the field crew. The supervisor, in addition to his duties of coordinating the activities of the survey crew, will act as a relief man for the observers for lunch periods and other purposes. He will also review the data collected and be responsible for the completeness and accuracy of the data. In some instances, depending on the location and features of the survey section, it will be necessary for the supervisor to secure extra gasoline for the patrol cars, and record traffic data from mechanical traffic recorders. If the study section should include a safety rest area, an additional observer will be required to record stops and interview drivers parking in the rest area.

Equipment

The following equipment will ordinarily be required for the collection of the shoulder use field data:

1. Passenger Cars. —A passenger car will be used by each mobile observer in observing stops and interviewing drivers of vehicles parked on shoulders. An additional vehicle will be used in transporting the crew to work, and running errands necessary in the operation of the survey. It is preferable that the cars assigned the mobile observers for cruising the study section have two-way radio communications between them. However, this feature is not essential. In case radio equipment is not available, communication by pre-arranged auto light blinker or card signals may be provided.

2. The 6-bank Veeder Root counter or equivalent is desirable for use in counting traffic by vehicle type.

3. A clip board and pencils should be furnished each member of the survey team.

4. A time piece for each member of the survey team will be needed to coordinate operational schedules.

5. A tape for each mobile observer to measure the distance from the side of parked vehicles to the pavement edge.

Forms and Maps

A regional highway map, including the highway section under study, should be furnished the shoulder use study field supervisor, with the highway section and access routes to be used in reaching the study section identified so that there will be a minimum delay in reaching and no mistake in locating the section under study.

A large-scale map of the study section (preferably at least 1 in. = 1 mi scale) should be provided for laying out the routes of the mobile-observers and the placement of the traffic-observer, and for describing the exact limits of the study site and control section to the field crew (see Fig. 1).

Daily traffic classification count summary forms for entering and summarizing hourly traffic totals by day as counted by the classifier-observer (see Fig. 2).

STATE OF_____
SHOULDER USE STUDY

DAILY TRAFFIC CLASSIFICATION COUNT SUMMARY

Highway No._____

Study Section_____

Date_____

Day_____

Time Period		Northbound				Southbound			
		Pass. Cars (State)	Pass. Cars Out-of-State	Trucks & Buses	All Vehicles	Pass. Cars (State)	Pass. Cars Out-of-State	Trucks & Buses	All Vehicles
0600	0700	93	27	70	190	67	25	56	148
0700	0800	154	39	78	271	172	49	77	298
0800	0900	169	45	77	291	199	42	91	332
0900	1000	161	78	79	318	286	88	94	468
1000	1100	238	77	86	401	197	81	84	362
1100	1200	207	78	84	369	203	86	105	394
Total		1,022	344	474	1,840	1,124	371	507	2,002

Comments_____

(Data shown are for exemplary purposes only).

Figure 2.

STATE OF _____
SHOULDER USE STUDY

SHOULDER STOP INTERVIEW FORM

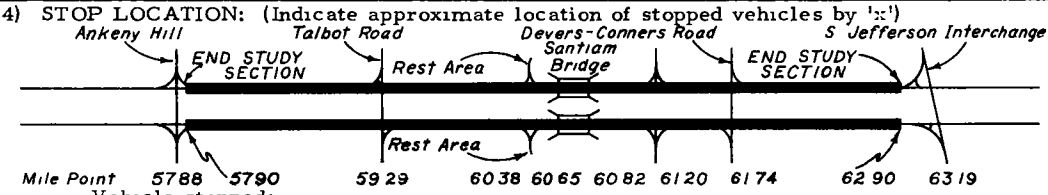
Highway No. _____ Observer _____
Date _____
Study Section _____ Day _____

(1) TIME. a. Observed _____
b. How long have you been here? _____
☐ a. m. c. How much longer will you stay? _____
☐ p. m.
d. Actual departure time, if observed _____

(2) STOP DURATION:
a. Departed _____
b. Stopped _____
c. Length of Stay _____
(Office Use Only)

(3) DIRECTION OF TRAVEL: ☐ Northbound ☐ Southbound

(4) STOP LOCATION: (Indicate approximate location of stopped vehicles by 'x')



Vehicle stopped:
On Median Shoulder ☐
On Outside Shoulder ☐

Distance parked from pavement edge _____ ft. _____ in.

(5) VEHICLE TYPE:
Passenger ☐
Truck and Bus ☐

(6) REGISTRATION:
State ☐
Out of State ☐
Unidentified ☐

(8) TRIP PURPOSE:
☐ Business
☐ Driving to or from work
☐ Vacation
☐ Recreation
☐ Social
☐ Shopping
☐ Other _____ (Explain)

(9) LAST STOP:
a. Time _____
b. Location _____
c. Estimated Elapsed Time _____

(7) IDENTIFICATION _____

(10) NUMBER OF OCCUPANTS _____

(11) TYPE AND PURPOSE OF STOP:

Voluntary

Rest and Leisure
- ☐ Rest or Sleep
- ☐ Checking Map
- ☐ Changing Drivers
- ☐ Eating in Vehicle
- ☐ Car Sickness
- ☐ Recreation (Picnic, Fishing, etc.
- ☐ Visiting
- ☐ Latrine
- ☐ Other _____ (Describe)

Business
- ☐ Discharging or Picking up Pass. (Bus Only)
- ☐ Inspecting Utilities
- ☐ Inspecting Farm and Crops
- ☐ Inspecting Industry
- ☐ Other _____ (Describe)

Other Voluntary
- ☐ Assisting Vehicle
- ☐ Checking Vehicle or Load
- ☐ Minor Mechanical Trouble
- ☐ Police Enforcement Stop
- ☐ Police Assist. Stop
- ☐ Stopped by Police
- ☐ Other _____ (Describe)

Involuntary
- ☐ Flat Tire
- ☐ Out of Gas
- ☐ Involved in an Accident
- ☐ Mechanical Failure
- ☐ Other _____ (Describe)

COMMENTS

(Sketch shown for exemplary purposes only)

Figure 3.

Shoulder use observation forms to record data on each observed shoulder stop and interview by the mobile observers (see Fig. 3). This same form will be used by the stationary classifier-observer to record observed shoulder stop data in the "control" section.

Schedule of Operations

Normally, shoulder use observations will be made during daylight hours. The hazards of nighttime interviewing and difficulties of counting and classifying traffic at night make it difficult to conduct the survey during hours of darkness. However, limited surveys of nighttime shoulder use may be made by a fixed observer covering short "control sections" in a similar manner to that described for the more extensive daytime study.

The observations should be representative of both morning and afternoon conditions and should preferably cover 12 continuous daylight hours; for example, 6:00 AM to 6:00 PM. It should be adequate to limit observations to weekday, daylight hours only. However, in the instance of study sections with unusually high usage by recreational weekend traffic, including recreational rest areas, it may be desirable to make a survey during the weekend.

It is necessary to establish definite mobile-observer trip and traffic counting schedules so that the interviews and traffic data collected will lend themselves to analysis and correlation. A morning trip and traffic-counting schedule for a 5-mi study section based on average mobile-observer speeds of 45 mph, is shown in Figure 4. A similar schedule would be provided for the 12:00 to 6:00 PM observations. This schedule would, of course, require modification to fit other study sections. The schedule assumes an 8-hr workday with 6 hr of observation time and 2 hr allocated for travel time and review of interviews and traffic counts.

Recording Traffic Volume and Classification Counts

Manual traffic classification counts will be made by the classifier-observer stationed at the observation vantage point in the control section. The hourly traffic counts should be entered on the daily traffic classification count summary (Fig. 2) at the times indicated by the shoulder use observation schedule. The traffic classifier-observer should continue his traffic counting during the entire shoulder use observation period, except when relieved of his duties by the supervisor or other relief man. It is important that the counts be as accurate as possible. The traffic classifier should synchronize his watch each day with the watches of the survey supervisor and mobile observers to maintain the coordination of traffic counts with shoulder use observations. The traffic classifier-observer may be seated in a parked automobile where the roadway visibility permits. However, to obtain an unobstructed view of the control section and reliably to count and classify traffic, it will often be necessary for the traffic classifier-observer to be stationed on an overhead crossing or median. In these instances where a car cannot be left parked safely, a folding chair and a beach-type umbrella is recommended for the comfort of the classifier-observer.

For study sections with interchanges or crossroads inside the section which have appreciable traffic off and on the highway under study, it may be necessary to supplement the manual traffic classification counts with mechanical recorder counts. On high-volume highways, any supplementary traffic counts that may be required should be made on the low-volume crossroads or interchange ramps, as experience has shown that automatic count variability on the "high line" will be so much as to add no accuracy to the original manual count.

Motorcycles, horse-drawn vehicles, highway maintenance equipment, tractors, graders and mowers, and other vehicles engaged in actual maintenance activity within the study section should be excluded from the traffic and shoulder stop counts.

Shoulder Stop Interviews

The reliability of the information presented in the shoulder use report will depend on the accuracy and completeness of the shoulder stop interview data. As the sources of

STATE OF_____
SHOULDER USE STUDY

SHOULDER USE OBSERVATION SCHEDULE
July 11, 13, 15 - A.M.

Highway No._____
Study Section_____

Time (A.M.)	Mobile-Observer #1	Mobile-Observer #2	Traffic Classifier-Observer
6:00	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	Start Counts
6:12	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
6:24	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
6:36	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
6:48	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
7:00	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	Post Hourly Totals
7:12	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
7:24	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
7:36	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
7:48	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
8:00	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	Post Hourly Totals
8:12	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
8:24	Lv. Ankeny Hill 1/	Lv. S. Jefferson Jct.	
8:36	Lv. S. Jefferson Jct. 1/	Lv. Ankeny Hill	
8:48	Lv. Ankeny Hill	Lv. S. Jefferson Jct. 1/	
9:00	Lv. S. Jefferson Jct.	Lv. Ankeny Hill 1/	Post Hourly Totals
9:12	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	1/
9:24	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	1/
9:36	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
9:48	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
10:00	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	Post Hourly Totals
10:12	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
10:24	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
10:36	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
10:48	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
11:00	Lv. S. Jefferson Jct.	Lv Ankeny Hill	Post Hourly Totals
11:12	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
11:24	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
11:36	Lv. Ankeny Hill	Lv. S. Jefferson Jct.	
11:48	Lv. S. Jefferson Jct.	Lv. Ankeny Hill	
12:00 (noon)	Arr. Ankeny Hill	Arr. S. Jefferson Jct.	Post Hourly Total

1/ Relief observer replaces regular observer for 24-minute rest periods.

(Data shown are for exemplary purposes only.)

Figure 4.

the data will be the interviewers and the drivers of the stopped vehicles, the success of the survey and the maintenance of favorable public relations will depend much on the manner in which the interviewer meets the public, explains the purpose of the survey, and asks the pertinent questions. The interviewer must present a neat appearance and be courteous and tactful regardless of the driver's attitude toward the survey.

It is important that the interviewers be instructed in advance of the actual work assignments as to the purpose of this survey, the over-all methodology of the survey, and their specific work assignments. Each interviewer should familiarize himself thoroughly with the survey procedures and discuss with the supervisor any points on which he may not be clear in advance of the beginning of the actual survey. It is recommended that the mobile-observers be given a "dry run" cruise of the study section, including trial interviews before the actual survey. A "dry run" should be followed by a review of the trial interview form, and appropriate instruction should be given to correct any deficiencies or answer any questions posed by the interviewer. The observers should be furnished with a supply of shoulder stop interview forms, a shoulder use observation schedule, a tape measure, a clip board, pencils, and scratch paper. It is strongly recommended that completed interview forms be reviewed by the survey supervisor during or at the end of the day on which they are obtained. If there are any corrections or deficiencies they should be discussed with the interviewers before the next day's work. Leaving the first review to a later date or to the office force is a poor practice. It becomes more difficult to recall details that may have been omitted on the form, and in many instances the persons who might be able to supply the correct information are not available for questioning.

The shoulder stop interview form (Fig. 3) should be prepared as completely as possible for each vehicle observed parking on the highway shoulder regardless of whether the driver of the vehicle is interviewed. In addition to the stops recorded by the mobile observers, the classifier-observer stationed in the control section should record all stops observed in the control section with as much detail as possible on shoulder stop interview forms. It is important that the classifer-observer record all stops in the control sections whether observed by the mobile-observers or not, as the ratio of total stops to stops observed by the mobile observers in the control section establishes an expansion factor used in estimating the total number of stops occurring in the study section.

The shoulder stop information should be recorded on the form as accurately as possible at the time of interview or immediately thereafter. Attempts to recall interview data at a later time leads to errors and incompleteness.

Entries

1. Time. —Indicate the time the vehicle stopping on the highway is observed by checking "AM" or "PM," and entering the time of day in the space opposite "observed" to the nearest minute. Enter the driver's answers to the questions "How long have you been here?" (1-b) and "How much longer will you stay?" (1-c) in minutes. If a driver is not interviewed, leave these spaces blank, or if he does not wish to cooperate in answering the questions, so indicate this fact under comments. If the actual time of departure is observed, enter the time in the space opposite "actual departure time" (1-d). If the vehicle is observed parking, it will be unnecessary to ask question 1-b, and a zero (0) should be entered in this space.

2. Stop Duration. —These entries are to be used in computing the estimated length of stop from the data shown in Entry 1, and will be completed in the office or by the survey supervisor. No entry is required here by the field observers.

3. Direction of Travel. —Indicate direction of travel (northbound, southbound, eastbound, westbound, as the case may be).

4. Stop Locations. —Indicate the approximate location of the vehicle stop by entering an X on the sketch. The sketch on the interview form should have a scale of about 1 in. = 1 mi, with major road crossings or other physical feature locations indicated by mile point. Reference by the mobile-observers to odometer mileage in relation to check points will aid in locating stops correctly. Notations as to stop location such as "0.4 mi N of Talbot Road" may be written in the margin.

Indicate the shoulder on which the vehicle parked (median or outside) by checking the appropriate box. Measure the distance from the edge of the pavement to the side of the vehicle nearest the traveled lane. Preferably the measurement should be made from the edge of the pavement as shown by the shoulder delineation stripe. If a shoulder stripe is not present, measure from the pavement edge as shown by the shoulder color or texture delineation. If no measurement is possible, as in the instance of a vehicle which moves away before an interview can be made, write "not measured" in the distance space.

5. Vehicle Type.—Indicate the type of vehicle parked by checking the box opposite the appropriate vehicle type. The passenger car classification should include taxis, passenger cars, and station wagons. Panels, pickups, trucks, specialized equipment (loaders, cranes, tractors, etc.) and buses will be under the truck and bus classification.

6. Registrations.—This entry refers to passenger cars only. Check whether the parked vehicle is currently registered in the state in which the study is being conducted or "out of state" as determined by the current license plate.

7. Identification.—Enter the last 3 digits of the license number of the vehicle so that the vehicle may be identified later in analyzing the data. If the license number is not visible, describe the car, for example, "yellow 1957 Chevrolet pickup." It may be advisable to assure the driver that this information is not being collected for law enforcement purposes in study sections where parking is regulated.

8. Trip Purpose.—Check the purpose of the trip as determined by the driver's answer to the question "for what purpose was this trip made?.....business, vacation, recreation, social, driving to work, shopping, or other."

9. Last Stop.—(a) Enter the location as determined from the question: "Where was your last stop?" The answer to this question should be specific enough so that the mileage from the last stop to the present stop may be readily estimated with the use of highway mileage maps.

(b) Enter the estimated time at which the last stop immediately preceding the observed stop occurred.

(c) The elapsed time between the observed and last stop will be computed in the office. No entry is necessary for the field observers.

10. Number of Occupants.—Enter the total number of occupants of the parked vehicle.

11. Type and Purpose of Stop.—Indicate the type and purpose of the stop by placing an X in the space provided opposite the item providing the best description of the type and purpose of the stop. Enter at the bottom of the questionnaire any supplementary information on the stop purpose or other comments that may clarify a questionable stop classification. A stop should be classified as "involuntary" if it results from immobility of the vehicle (including such things as a flat tire, burned-out bearing, etc.) which may or may not render the vehicle completely immobile, or if the continuation of the trip would cause obvious injury to the vehicle or its occupants, or if the motorist is involved in an accident. All other stops are to be considered "voluntary."

A business stop is defined as a stop in which the purpose is associated with a business activity off the highway. Stops associated with the checking of loads on trucks, which can in a certain sense be called business, are classified as "other voluntary" as are stops associated with police traffic enforcement. In Figure 3 there are 3 types of "other voluntary" stops associated with police action. When a policeman stops a motorist for enforcement purposes, the "police enforcement stop" category should be checked for the vehicle stop represented by the police car, and the "stopped by police" entry should be checked for the vehicle stop made by the motorist. In a similar way, if a policeman stops to assist a stranded motorist, the "police assistance stop" will be checked for the police car and one of the other appropriate stop classifications checked for the private vehicle. As with other multiple stops, a separate Shoulder Stop Interview Form should be used for each vehicle—police or otherwise.

In instances where a vehicle is observed, but resumes its trip before it can be interviewed, the stop is classified "voluntary—unknown," unless there is positive evidence

to indicate otherwise. Such evidence might be in the form of an accident, the presence of a wrecker or service truck, or the observation that fuel was being poured in the gas tank.

SAMPLE CHARACTERISTICS—SIZE AND VARIABILITY

The determination of the sample size required to ensure that the data will have the required degree of accuracy is probably the most difficult problem encountered in any study. This is particularly true in a study such as this one on shoulder use in which the sample size is determined by the number of shoulder use observation periods, inasmuch as scheduling of men and equipment cannot always be done without considerable planning. It is desirable to keep the sampling period as small as possible, but large enough to ensure a reasonable measure of accuracy.

In the shoulder use study, the most important statistic to be considered in determining the sample size is the accuracy of the statistic measuring the relative frequency of shoulder usage—the vehicle-miles per stop average. It is recommended as a minimum requirement that the sample size be chosen to provide an accuracy in which the errors of the vehicle-miles per stop average for all vehicles, all stop types will be 20 percent or less 95 percent of the time. It is, of course, preferable that the errors will be less than 20 percent. However, experience has shown that the additional sampling necessary to improve the statistical accuracy of the data within the desired limits is not always practical.

The process of determining the sample size and statistical variability of the vehicle-miles per stop averages obtained from the sample data may be divided into four major steps:

1. Collection of data for determining an estimate of the variability of the vehicle-miles per stop average by conducting shoulder use observations for a number of days such that a number of fairly reliable vehicle-miles per stop averages (approximately 10) may be obtained for analysis.
2. Determination of the required sample size for the desired accuracy on the basis of the variability of the "sample" vehicle-mile per stop averages.
3. Collection of the shoulder use data for any additional observation periods required, to gain the desired sample accuracy as determined in step 2.
4. Computation of the reliability of the vehicle-miles per stop averages for the total study sample (combined data as obtained in steps 1 and 3). This will be expressed as a range within which the true value is to be found for a given confidence level.

A detailed discussion of statistical procedures, formulas, and methods of analyses to be used in determining the sample size and variability appears in the Appendix.

TABULATION AND ANALYSIS OF DATA

The services of a statistician and an assistant statistician or statistical clerk will usually be sufficient for the tabulation and analysis of the shoulder parking and traffic data collected during the survey. Ordinarily, the number of interviews and the amount of traffic data for the shoulder use study will not be sufficient to warrant machine processing. The following procedures assume the analysis and tabulation of the shoulder use data manually with the aid of adding machines and desk calculators.

It is recommended that the completed shoulder stop interview forms (Fig. 3) and daily traffic classification count summary forms (Fig. 2) for the first day or two of the survey be reviewed by the statistician in charge of the data analysis as soon as practical so that any deficiencies or necessary corrections can be discussed in conference with the field crew chief in order to reduce future errors and allow immediate correction and/or addition of missing data. This practice will correct any misinterpretation of instructions and result in improved data collection procedures for the duration of the survey.

Summary of Traffic Data and Computation of Vehicle-Miles

Figure 5 provides a detailed summary of traffic counts and vehicle-miles by direction

STATE OF_____
SHOULDER USE STUDY

DISTRIBUTION OF TRAFFIC AND VEHICLE MILES BY VEHICLE TYPE AND DIRECTION OF TRAVEL

Highway No _____ Study Section Length 5.0 (miles)
Study Section_____

DATE	Northbound								Southbound								Total							
	Pass.(State)		Pass. (O.S.)		Bus & Truck		Total		Pass.(State)		Pass (O.S.)		Bus & Truck		Total		Pass.(State)		Pass (O.S.)		Bus & Truck		Total	
	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM	Traffic	VM
7-20-59	1,022	5,110	344	1,720	474	2,370	1,840	9,200	1,124	5,620	371	1,855	507	2,535	2,002	10,010	2,146	10,730	715	3,575	981	4,905	3,842	19,210
7-21-59	1,004	5,020	347	1,735	479	2,395	1,830	9,150	1,040	5,200	356	1,780	487	2,435	1,883	9,415	2,044	10,220	703	3,515	966	4,830	3,713	18,565
7-22-59	1,228	6,140	393	1,965	505	2,525	2,126	10,630	1,180	5,900	377	1,885	485	2,425	2042	10,210	2,408	12,040	770	3,850	990	4,950	4,168	20,840
7-23-59	1,095	5,475	343	1,715	450	2,250	1,888	9,440	1,186	5,930	371	1,855	489	2,445	2,046	10,230	2,281	11,405	714	3,570	939	4,695	3,934	19 670
7-24 59	1,195	5,975	386	1,930	429	2,395	2060	10,300	1,244	6,220	401	2,005	499	2,495	2144	10,720	2,439	12,195	787	3,935	978	4,890	4,204	21,020
7-27-59	1,188	5,940	352	1,760	447	2,235	1,987	9,935	1,188	5,940	352	1,760	446	2,230	1,986	9,930	2,376	11,880	704	3,520	893	4,465	3,973	19,865
7-28-59	1,056	5,280	371	1,855	497	2,485	1,924	9,620	1,099	5,495	386	1,930	518	2590	2003	10,015	2,155	10,775	757	3,785	1,015	5075	3927	19635
7-29-59	1,139	5,795	416	2,080	516	2,580	2091	10,455	1,174	5,570	399	1,995	495	2,475	2008	10,040	2,273	11,365	815	4,075	1,011	5,055	4,099	20,495
7-30-59	1,174	5870	356	1,780	478	2,390	2,008	10,040	1,221	6,105	371	1.855	497	2,485	2089	10,445	2,395	11,975	727	3,635	975	4,875	4,097	20485
7-31-59	1,305	6525	437	2,185	514	2,570	2 256	11,280	1,204	6,020	403	2,015	474	2,370	2,081	10,405	2509	12,545	840	4200	988	4940	4,337	21,685
TOTAL	11,426	57130	3,745	18,725	4839	24195	20,010	100,050	11,600	58000	3,787	18935	4,897	24485	20284	101,420	23026	115,130	7,532	37,660	9,736	48,680	40,294	201,470

(Data shown are for exemplary purposes only)

Figure 5.

of travel and vehicle type. The traffic totals are transcribed from the daily traffic classification count form (Fig. 2) and multiplied by the study section length to obtain vehicle-mile totals by day and vehicle type.

Review of Shoulder Stop Interview Data

Although the initial review of shoulder stop interview data will have been accomplished by the field survey supervisor, it is important that a final review of the data be completed by the supervisor in charge of the analysis before the tabulated data are processed. Items that should be checked are as follows:

Item 2. Stop Duration. — The departure time (2-a) is computed by adding the minutes in answer to the question "How much longer will you stay?" (1-c) to the observed time (1-a). The observed departure time (1-d) will be used in place of the computed departure time when it has been recorded. The answers to these questions should be reviewed for reasonableness in relation to other observed stop times and the observer trip schedule.

The time when the vehicle first stopped (2-b) is computed by subtracting the number of minutes entered in answer to the question: "How long have you been here?" (1-b) from the observed time (1-a). If the actual time of stopping has been observed as evidenced by a 0 in item 2-b, no adjustment of the time observed is necessary.

In instances where a stop has been recorded although there is no interview, the initial stop or departure time will be in doubt. However, a reasonable estimate of the stop duration can be made by analysis of the trip schedule of the mobile observers in relation to the time the stopped vehicle is observed. The mobile observers will be traveling the study section at uniform time intervals and an estimate of the time of stopping can be determined by a log of the approximate travel time to various check points in the study section in relation to the time the stop was observed.

Item 3. Direction of Travel. —Verify the direction of travel by comparison with Item 4, Stop Location.

Items 4 through 10. —Check for completeness of entries and consistency with any comments. Item 7 provides a means of checking for possible duplicate stop observations.

Item 11. Type and Purpose of Stop. —Item 11 should be reviewed for consistency with stop definitions. Particular attention should be paid to the classification of borderline stop classifications in order to keep them consistent with the stop definitions.

Listing of Shoulder Stop Interview Data

On completion of review of the shoulder stop interview forms, the forms should be sorted by date and time of stop occurrence as determined by entry 2-b. The data should then be entered on the listing of observed vehicle shoulder stops by time of stop (Fig. 6). This form will serve as the data source for most of the analysis of the shoulder stop data, thus, it is important that the data transcription from the interview forms be thoroughly checked.

Procedure for Computing Number of Total Stops from Observed Stops

It is recognized that the total number of stops observed will be less than the total number of stops occurring in the entire study section by the number of short duration stops unobserved outside the control section.

The total number of stops occurring in the entire study section may be estimated from the observed stops by

$$T = \frac{T_f}{T_c} (T_m - T_c) + T_f \qquad (1)$$

STATE OF _____
SHOULDER USE STUDY

LISTING OF OBSERVED SHOULDER STOPS BY TIME OF STOP

HIGHWAY NUMBER _____

STUDY SECTION _____

Date	Time		Stay (Min.)	Direction of Travel	Vehicle Type	Vehicle Reg	No. of Occupants	Location of Stop			Trip Purpose	Last Stop Location	Time Between Stops	Type & Purpose of Stop
	Stopped	Departed						In Study Section	Shoulder	Dist fm. Pave Edge				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)

Figure 6.

in which

T_m = total stops observed by mobile observers.
T_f = total stops in control section (observed by a fixed observer).
T_c = total stops observed in control section by mobile observers.

In Eq. 1, the ratio of the total control section stops to control section stops recorded by mobile observers, T_f/T_c, is multiplied by the number of observed stops outside the control section, $T_m - T_c$, to compute the total stops outside the control section. The total stops outside the control section are added to total stops in the control section, Tf, to obtain T the estimated total number of stops in the entire study section.

The expansion factor, F, to be applied to the observed stops in estimating the distribution of total stops from observed stops is

$$F = \frac{T}{T_o} \tag{2}$$

in which

T = total expanded number of stops in study section.
T_o = total observed stops ($T_m + T_f - T_c$).

It is possible that the stationary observer may miss one or two stops in the control section that may be observed by the mobile observers. These stops should be added to the total control section stops, as determined by the fixed observer in computing Tf.

An example of the computation of the expanded total of stops, T, and the expansion factor, F, is as follows: If $T_m = 218$, $T_f = 56$; $T_c = 40$; and $T_o = 234$; then by Eq. 1, $T = 305.2$ or rounded, 305; and by Eq. 2, $F = 1.303$.

The total number of observed stops, T_o, multiplied by the expansion factor F will equal the total number of expanded stops. In the hypothetical example (Fig. 7), the observed number of stops are multiplied by the expansion factor F and the product (rounded to the nearest unit) is shown in the next column.

Computation of Vehicle-Miles per Stop Average

The vehicle-miles per stop average is the measure of the frequency of shoulder stops relative to traffic volume. The equation for computing average vehicle-miles per stop is

$$VMS = \frac{VM}{T} \tag{3}$$

in which

VM = total vehicle-miles.
T = total number of stops (expanded).

It is important that the vehicle-miles figure (VM) be comparable to the stop total T in order that the VMS average will be independent of the vehicular composition of the traffic on the study section under study. For example, in computing the VMS average for passenger cars, only vehicle-miles for passenger cars should be used in the numerator, and only stops for passenger cars used in the denominator. Table 1 gives an example of the tabular data required for computing the VMS averages shown in Table 2. The stop totals are transcribed from the expanded stop totals shown in Figure 7 and the vehicle-mile totals are transcribed from the vehicle-miles summary, Figure 5. It is recommended that Tables like 1 and 2 be included in the published report. In the final table prepared for publication, the VMS averages should be rounded to the nearest 100 vehicle-mi.

TABLE 1

DISTRIBUTION OF VEHICLE-MILES BY VEHICLE TYPE AND EXPANDED NUMBER OF SHOULDER STOPS BY PURPOSE OF STOP AND VEHICLE TYPE

Vehicle Type	Vehicle-Miles	Voluntary Stops				Involuntary Stops	All Stops
		Rest and Leisure	Business	Other	Total		
Passenger:							
State	131,065	104	16	43	163	26	189
Out-of-state	39,555	26	1	3	30	5	35
Total	170,620	130	17	46	193	31	224
Truck or bus	30,840	29	8	34	71	10	81
All	201,470	159	25	80	264	41	305

Analysis Purpose of Trip Data. —It is recommended that the data obtained on trip purpose (Fig. 6, Col. 12) be tabulated and presented in a form similar to that shown in Table 3.

Purpose of Stop Data. —In addition to the analysis of shoulder stop frequency in terms of vehicle-miles per stop, it is recommended that a detailed analysis be made of the observed stops by type and purpose. Table 4 gives a suggested format for presentation of detailed data on the distribution of stops by type and purpose of stop. Table 5 gives hypothetical data on the percentage distribution of involuntary stops by vehicle type and reasons for stop. Figure 8 shows a graphic comparison of the percentages of shoulder stops by vehicle type and purpose. The data for these tables may be tabulated from the listing of observed vehicle shoulder stops by time of stop (see Fig. 6).

Time of Stopping. —An analysis of the time of day vehicles stopped on shoulders (Fig. 6, Col. 2) will supply an indication of the peak demand for safety-rest area parking spaces by time of day. A simple table giving the distribution of the number and percentage of stops by hour of occurrence and type of stop should provide the necessary analysis data.

Duration of Stop. —For purposes of analysis, the data on duration of stops (Fig. 6, Col. 4) may be arranged in a cumulative frequency distribution presented in the form of an ogive showing the cumulative percent of observed shoulder stops lasting less than a specified number of minutes (see Fig. 9).

TABLE 2

AVERAGE VEHICLE-MILES PER STOP BY VEHICLE TYPE AND PURPOSE OF STOP[a]

Vehicle Type	Voluntary Stops				Involuntary Stops	All Stops
	Rest and Leisure	Business	Other	Total Vol.		
Passenger:						
State	1,260	8,191	3,048	804	5,041	693
Out-of-state	1,521	39,555	13,185	1,318	7,911	1,130
Total	1,312	10,036	3,709	884	5,504	762
Truck or bus	1,063	3,855	907	434	3,084	381
All	1,269	8,059	2,518	763	4,914	661

[a] Data shown are for exemplary purposes only.

TABLE 3

PURPOSE OF TRIP AS GIVEN BY DRIVERS INTERVIEWED WHILE PARKING ON HIGHWAY SHOULDER

Trip Purpose	Passenger Vehicle				Trucks and Buses		All Vehicles	
	State		Out-of-State					
	No.	%	No.	%	No.	%	No.	%
Business								
Driving to or from work								
Vacation								
Recreation								
Social								
Shopping								
Other								
Total								

STATE OF_____
SHOULDER USE STUDY

WORKSHEET FOR COMPUTING DISTRIBUTION OF TOTAL SHOULDER STOPS FROM OBSERVED SHOULDER STOPS BY VEHICLE TYPE AND PURPOSE OF STOP

Highway No._____ Study Period_____

Study Section_____ Expansion Factor 1.303

Purpose of Stop	Passenger Vehicles				Trucks & Buses		All Veh.	
	State (obs.)	State (exp.)	Out of State (obs.)	Out of State (exp.)	Trucks & Buses (obs.)	Trucks & Buses (exp.)	All Veh. (obs.)	All Veh. (exp.)
Voluntary	(125)	(163)	(23)	(30)	(54)	(71)	(202)	(264)
Rest or Leisure	80	104	20	26	22	29	122	159
Business	12	16	1	1	6	8	19	25
Other Voluntary	33	43	2	3	26	34	61	80
Involuntary	20	26	4	5	8	10	32	41
Total Observed	145		27		62		234	
Expanded Total		189		35		81		305

(Data shown are for exemplary purposes only.)

Figure 7.

TABLE 4

NUMBER OF OBSERVED SHOULDER STOPS CLASSIFIED BY TYPE AND PURPOSE OF STOP

Type	Purpose of Stop	Number	Percent of Total	Percent of Class
Involuntary	Flat tire			
	Out of gas			
	Mechanical failure			
	Involved in an accident			
	Other			
	Subtotal			
Voluntary	Rest and Leisure:			
	Rest or sleep			
	Checking map			
	Changing drivers			
	Eating in vehicle			
	Car sickness			
	Recreation			
	Visiting			
	Latrine			
	Other rest or leisure			
	Subtotal			
	Business:			
	Discharging or picking up passengers (buses only)			
	Inspecting utilities			
	Inspecting farm or crops			
	Inspecting industry			
	Other business			
	Subtotal			
	Other Voluntary:			
	Assisting another vehicle			
	Checking vehicle or load			
	Minor mechanical trouble			
	Police enforcement stop			
	Police assisting stop			
	Stopped by police			
	Unclassified			
	Subtotal			
	Total			

Last Stop Data. —Analysis of the data showing the last stop location provides an indication of the needed spacing of safety rest areas in terms of distance between stops in miles and travel time. The location of the last stop as recorded on the listing of observed shoulder stops by time of stop (Fig. 6, Col. 13) should be converted to the distance traveled in miles since last stop, using mileages on current highway maps.

For purposes of analysis, the data on elapsed time between stops (as tabulated in Fig. 6, Col. 14) may also be arranged in a cumulative frequency distribution and presented graphically in the form of an ogive chart.

Place of Stop. —The locations of shoulder stops within the study section will be of value in determining the effect of physical features of the highway, roadside attractions, and culture on stop frequency and location. Item 4 (stop location) of the shoulder use

TABLE 5

REASONS FOR INVOLUNTARY STOPS OF VEHICLES OBSERVED PARKING ON HIGHWAY SHOULDERS[a]

Reason	Passenger Vehicles		Trucks and Buses		All Vehicles	
	No	%	No.	%	No	%
Flat tire	11	46	3	38	14	44
Out of gas	4	17	2	25	6	19
Involved in accident	1	4		-	1	3
Mechanical failure	5	21	2	25	7	22
Other	3	12	1	12	4	12
Total	24	100	8	100	32	100

[a]Data shown are for exemplary purposes only

interview form furnished the data with which to plot a scatter diagram of the stop locations on a "blowup" map of the study section. Analysis of the scatter diagram will indicate whether there are significant tendencies for vehicle stops to occur at certain places.

On divided multi-lane highways it is not always possible or desirable for vehicles to cross traffic lanes in order to park on the outside shoulder during peak traffic hours or in emergencies. Analysis of the stop location data (Fig. 6, Col. 10) showing the location of stops by shoulder type (median or outside) in combination with the purpose of stop data (Fig. 6, Col. 15) will provide the information to determine the amount and type of median shoulder use as compared to the outside shoulder.

Vehicles parked on shoulders present a continuous hazard to traffic by the lateral displacement of vehicles on the traveled way and by the occupation of shoulder space that is needed by traffic for emergency escape movements in preventing accidents. Study has shown that vehicles parked at the pavement edge have the greatest effect on traffic on the adjacent lane and that lateral displacement of traffic decreases sharply as the distance between the parked vehicle and the pavement edge increases (5). Analysis of the Figure 6, Column 11 data will indicate the pattern of parked vehicle place-

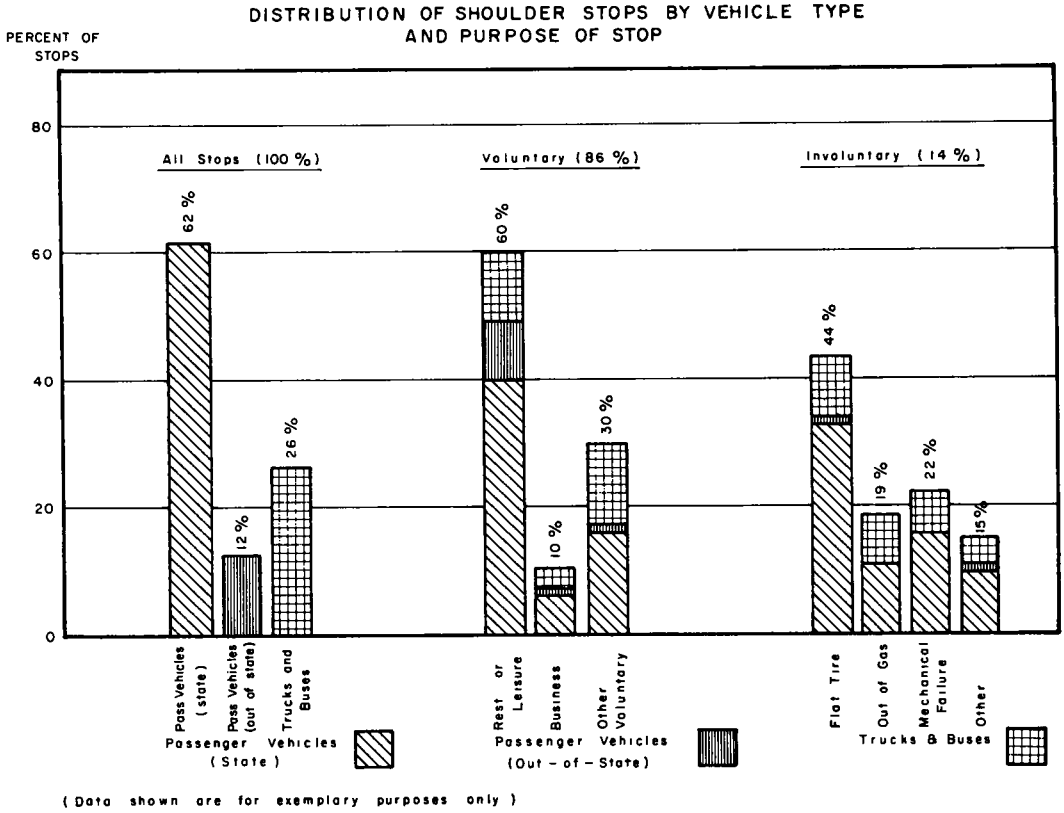


Figure 8.

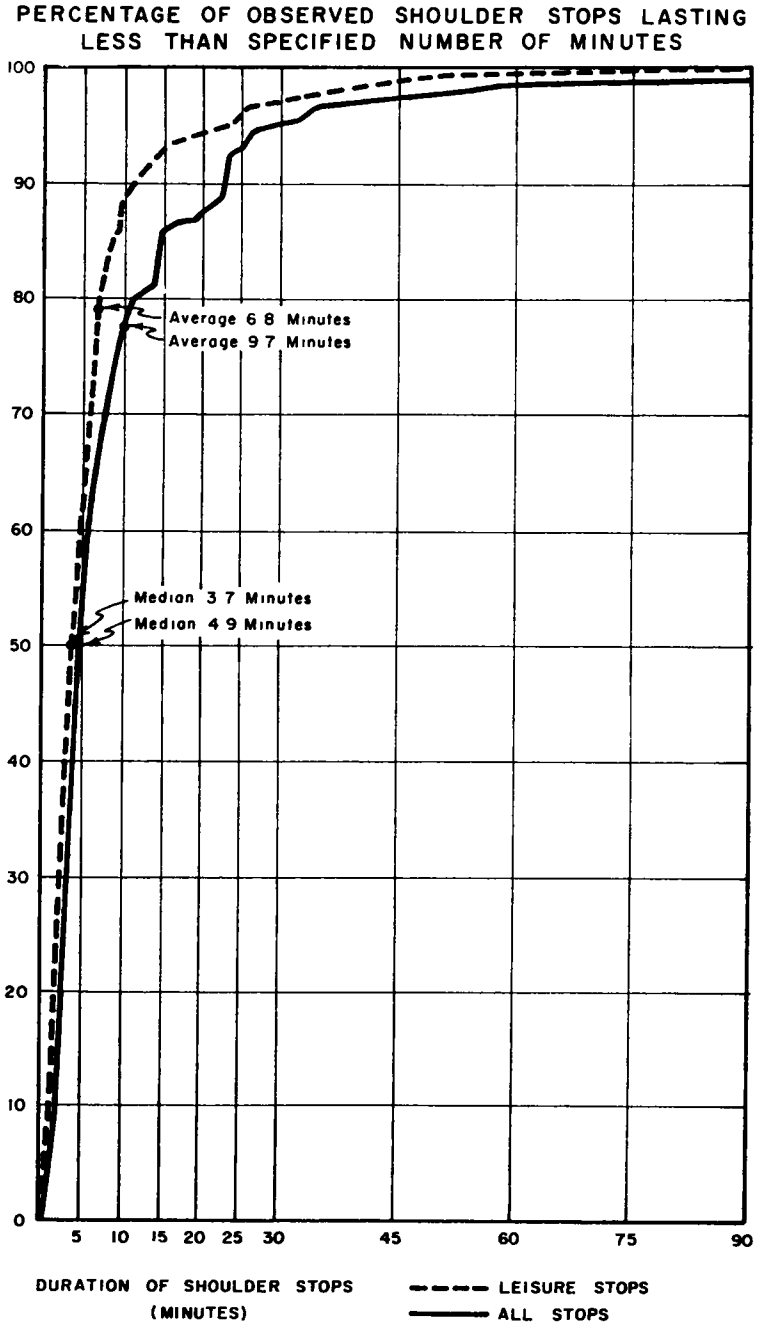
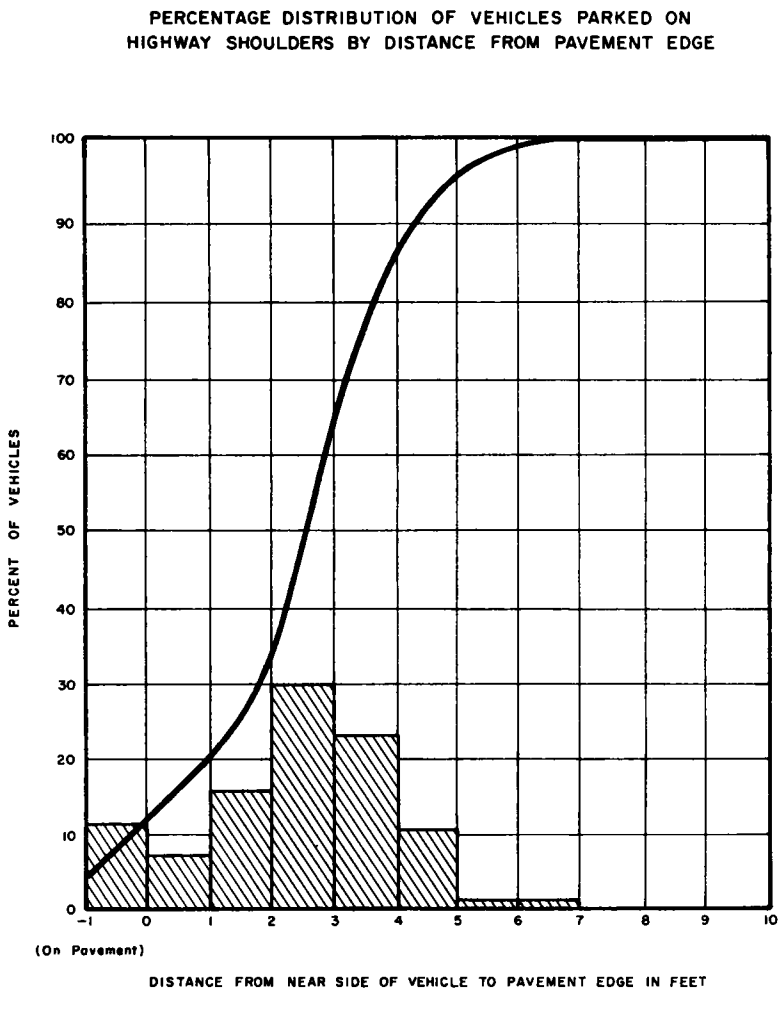

PERCENTAGE OF OBSERVED SHOULDER STOPS LASTING LESS THAN SPECIFIED NUMBER OF MINUTES
100
90
80
70
60
50
40
30
20
10
0
Average 6 8 Minutes
Average 9 7 Minutes
Median 3 7 Minutes
Median 4 9 Minutes
5
10
15
20
25
30
45
60
75
90
DURATION OF SHOULDER STOPS (MINUTES)
LEISURE STOPS
ALL STOPS
(Data shown are for exemplary purposes only.)

Figure 9.

ment on the shoulder for the section under study. It is suggested that the analysis include a cumulative frequency distribution table or chart showing the number and percent of stops by vehicle distance from the edge of the pavement in 1-ft intervals (see Fig. 10).

Accidents. — There are several different approaches to the problem of accident analysis in relation to shoulder usage. The type and extent of accident analysis is necessarily determined by the detail, accuracy, and reliability of the accident data available for analysis. The forms of analysis suggested assume that accurate, detailed, and complete accident history records are available for the shoulder use study sections. Otherwise, it is doubtful that an attempt at accident analysis is worthwhile. For purposes of this study, a shoulder use accident will be defined as one involving a parked vehicle, or one engaged in a maneuver leading to a stop or of resuming travel after a stop.

The first step in an accident analysis is the determination of the accident hazard resulting from shoulder use in relation to total accident hazard. Measures of the shoulder



Adapted from Figure 7, New York Shoulder Occupancy Study (4)

Figure 10.

usage accident hazard can be determined by computing the percentage of shoulder use accidents and by comparing the shoulder accident rates per million vehicle-miles with the total accident rate per million vehicle-miles.

One of the assumed benefits of providing safety-rest areas along highways and of controlling parking on the shoulder is the reduction of traffic hazards associated with shoulder use accidents. To ascertain more exactly these benefits in relation to accident experience, it would be in order to proceed in one of the following ways:

1. Calculate the percent of total accidents related to shoulder use for a study section having a rest area with an otherwise comparable highway section or sections without rest areas.
2. Calculate the percentage of shoulder use accidents on a before-after basis for a given study section that has controlled shoulder parking or safety rest areas.
3. Relate the percentage of shoulder use accidents for each of 10 or more highway sections with vehicle-miles per stop averages for each given section. If sections having low vehicle-miles per stop averages tend to have high "shoulder use" accident percentages, it would point to possible benefits from installing shoulder parking controls or safety-rest areas.

It is essential to have reliable accident data for all the above analyses. This implies that there should be at least 3 (preferably more) years of accident data available for the analyses. In the before-after proposal (2) this would mean 6 years of accident data. It would be necessary to examine the roadway conditions, traffic characteristics, etc., to insure that the rest area or the shoulder parking control was the only apparent difference between the before-after study periods. A need for reliable accident data and a long sample accident history period is particularly necessary because only a small part of the total accident experience on any given section is related to shoulder use. Figures from the New York shoulder occupancy study (4) reveal that accidents involving shoulder use involve roughly 1 to 7 percent of the total number of accidents on given study sections.

With regard to the proposal involving comparisons of accidents and stop frequency, it is also essential that long enough sampling periods of shoulder use be employed to provide reliable vehicle-miles per stop data. In this regard, the remarks concerned with the determination of sample size of the shoulder use study are relevant. If the sampling periods are inadequate, a ratio of vehicle-miles per shoulder stop will be excessively unstable and conclusions may not be reliable. If reliable ratios of vehicle-miles per stop are available for each of the 10 or more study sections, and the percents of shoulder use accidents are similarly consistent, a rank order correlation procedure may be applied. Results of this procedure would provide information as to the direction in magnitude of the relationship between actual parking usage and recorded shoulder parking accident experience.

An analysis of the correlation type would be applicable to highway sections which do not have rest areas or controlled shoulder parking. Thus, any roadway could be studied to ascertain the extent to which shoulder use could be used for establishing a priority system for construction of rest areas or control of shoulder parking.

An example of the application of the correlation analysis to the shoulder use vehicle-miles per stop and accident data of 8 hypothetical highway sections is shown in Table 6.

Before proceeding with the analysis, it should be remembered that a high percent of "shoulder-use" type accidents would be expected to occur when there are few vehicle-miles per stop (that is, relatively frequent shoulder stops).

$$\rho = 1 - \frac{6 \Sigma D^2}{N (N^2-1)} \tag{4}$$

in which

$$N = 8 \text{ and } \rho = 1 - \frac{6 \cdot (28)}{8 \cdot (63)} = + 0.67.$$

The interpretation of this large positive value is simply that sections with high shoulder-use accident frequencies have low vehicle-miles per stop averages.

TABLE 6

SHOULDER USE VEHICLE-MILES PER STOP AND ACCIDENT DATA FOR 8 HYPOTHETICAL HIGHWAYS

Study Site Identification	Vehicle-Miles Per Stop		Shoulder Use Accs.		Difference In Ranks	
	Average	Rank	Percent Tot. Acc.	Rank	(D)	$(D)^2$
A	2,800	6	3.0	4	2	4
B	1,700	3	1.5	7	4	16
C	1,400	2	6.0	1	1	1
D	1,900	4	3 5	3	1	1
E	4,700	8	2.0	6	2	4
F	3,500	7	0.5	8	1	1
G	900	1	5.5	2	1	1
H	2,400	5	2.5	5	0	0
$\sum D^2$						28

PREPARATION OF REPORT

The following suggestions and outline for content of the shoulder use report should not be considered as all-inclusive or restrictive in regard to the preparation of individual reports. The suggestions are intended to indicate the logical order of presentation and a minimum report content. The varied study conditions and objectives preclude other than the setting forth of basic report content, such that valid comparisons between data and findings of the various shoulder use studies may be made. The individual study objectives and data analyses will require additional report content, which must be determined by those analyzing the data and preparing each shoulder use report.

Suggested Report Outline

A. Introductory Pages
   1. Title page
   2. Preface
      a. Reason for report
      b. Purpose of study
      c. Acknowledgments
   3. Table of Contents
   4. List of tables and figures
   5. Introduction

B. Summary of Findings
   1. Statement of Effect of Control Conditions on Frequency of Shoulder Use (Comparison of vehicle-miles per stop averages under the controlled study conditions—for example, parking vs no parking, with or without rest areas, 2-lane vs 4-lane highways serving different types of traffic such as suburban vs intercity rural, or recreational rural).
   2. Statement of Average Relative Frequency of Shoulder Stops in Terms of Vehicle-Miles Per Stop for Major Types and Purpose of Stop Classifications, as disclosed in Table 2.
   3. Comparison of the Frequency of Stops by Vehicle Types, as disclosed in Tables 1 and 2.
   4. Statement of Distribution of Stops by Purpose, as disclosed in Tables 1 and 4.
   5. Comparison and Statement of Travel Time and Distance Between Stops by Vehicle Types and Stop Purpose, as disclosed in analysis of data from Cols. 13, 14 and 15, Figure 6.

6. Statement of Time Distribution of Shoulder Stops, as disclosed by analysis of data from Col. 2, Figure 6.
7. Statement of Average Duration of Shoulder Stops by Stop Type, as disclosed by Figure 9.
8. Statement of Distribution of Shoulder Stops by Type of Shoulder, as disclosed by analysis of data from Col. 10, Figure 6.
9. Statement of Shoulder Parking Hazard, as determined by analysis of data from Col. 11, Figure 6.
10. Statement of Contribution of Shoulder Accidents to Total Accident Hazard, based on accident reports and effect of "control" conditions on shoulder accidents, if such information can be obtained.

Scope of Study

A. Background and Purpose of Study.

B. Description of Highway Study Sections. Describe geometric design, physical features, ADT, vehicular composition of traffic, economic use of highway, surrounding areas, roadside attractions, and other features that may have a bearing on the types and amount of shoulder use. The descriptive material should include a picture of the study sections, a regional map on which the location of the study sections are indicated in relationship to major geographic places, and a large-scale sketch map (see Fig. 1) of the immediate study area.

C. Description of the Study Methodology.

Analysis

A. Types and Purpose of Stops. Discuss distribution and compare differences in the distribution of stops under the "control" (parking, no parking, with or without rest area) conditions of the study. Include tabular data on the number and distribution of stops as shown in Tables 1, 3 and 5. A percentage comparison of the distribution of shoulder stops by vehicle type may indicate significant relationships.

B. Frequency of Stops. Discuss and compare significant relationships of vehicle-miles per stop averages. Include tabular (rounded) data as shown in Table 2. Tables and graphs should be constructed to present comparisons of vehicle-miles per stop averages under the "control" conditions when such are study objectives. Significant differences in the frequency of stops by direction of travel will be of value.

C. Variability of Data. Analysis of the variability of the vehicle-miles per stop data as previously determined (see Appendix) should be discussed and the expected range of vehicle-miles per stop averages shown for the major stop categories.

D. Distance Since Last Stop. Discuss and present data on the average distance from the last stop in terms of mileages and travel times for state and out-of-state vehicles.

E. Length of Stop. Discuss the most significant relationships derived from the cumulative frequency distribution of stops by length and types. A suggested form of presentation is shown in Figure 9.

F. Time of Stop Occurrence. Discuss the distribution of the stops by time of day (volunatry and involuntary). A simple table or bar graph showing the distribution of stops by hour of day should be included.

G. Trip Purpose. The suggested table showing data on trip purpose is shown in Table 3. Accompanying narrative should point out the more interesting and important relationships. A comparison of the distribution of stops by trip purpose on different study sections may be helpful in explaining differences in observed shoulder stop frequencies.

H. Analysis of Accident Rates. Discuss the significant relationships between accidents (total and shoulder). If possible these data should be related to vehicle-miles per stop averages to determine if any significant relationship exists.

I. Place of Stop. Discuss any significant relationships between the placement of stops in the study section and the physical features of the highway and/or roadside attractions as developed from the scatter diagram of shoulder stops in the study section.

For divided highway study sections, discuss the findings of the analysis of stops classified by shoulder type (median or outside). The narrative should indicate significant differences in the types, duration and frequency of median shoulder stops in comparison to outside shoulder stops. Discuss the analysis of Col. 11, Figure 6, data showing the distance vehicles parked from the pavement edge in relation to probable accident hazard. A suggested basis for classifying shoulder stops by severity of hazard due to displacement of adjacent lane traffic is as follows:

Distance from Pavement Edge	Hazard
Less than 3 ft	Extreme hazard
3 to 6 ft	Moderate hazard
Over 6 ft	Minimum hazard

J. Occupancy. Compare the average occupancy of vehicles (All Stops, Voluntary and Involuntary Stops, and Rest and Leisure Stops).

Appendix

A. Table A-1, Table showing basic shoulder use data for each study section (see Table 7). The Service Type will describe the study section in terms of the normal type of service (usage) of the highway in which the study section(s) is located (for example, Interstate Intercity Primary, Intercity Secondary, Recreational Secondary, Local Market Road, etc.).

B. Figure A-1, Shoulder Stop Interview Form (see Fig. 3).

C. Table A-2, Accident History Summary of Study Sections (see Table 8).

D. Table A-3, Listing of Observed Shoulder Stops by Time of Stops (This table is optional, depending on the volume of stops observed and the length of the study period (see Fig. 6).)

COST OF CONDUCTING STUDIES

The cost of conducting shoulder use studies will vary considerably due to differences in the scope and purpose of the various studies that are made. Data collection costs will probably be the major cost item. The amount of data collection cost incurred will depend largely on the location and number of study sections and the number of hours it is necessary to make shoulder use observations in order to obtain statistically reliable stop data. Data tabulation costs, which include the coding and summarization of the survey data and the compilation of basic tables set forth in this guide, will depend not only on the amount of data collected but on the purposes and detail of analysis planned for the study. Planning, analysis, and reporting costs will be mainly independent of the volume of data collected.

Estimates based on New York (4) and Oregon experience in conducting shoulder use studies indicate that gross personnel costs for data collection will range from $1.00 to $2.00 per observation hour per study section mile. Travel expense for data collection is estimated at $0.70 to $1.35 per observation hour per study section mile. The lower travel cost figure is based on anticipated costs using public owned vehicles operating at $0.55 per mile on study sections where no per diem expense is involved. The upper cost estimate includes per diem allowance of $12.00 per day and a car mileage charge of $0.080 per mile.

Data tabulation costs for an adequate study are estimated at $500 to $1,000 depending on the volume of data collected and the scope of the study. Analytical and reporting costs for an acceptable study similar to that described by this guide are estimated at $1,000 to $1,200.

STATISTICAL ANALYSIS

Sample Size Determination

The usual method for determining sample size is based on the desired width of the confidence interval of the statistic in question. This width is usually expressed as a

TABLE 7

SHOULDER USE STUDY

BASIC DATA SUMMARY

Key Name or Route No	Location	No Lanes	Avg Daily Traffic Volume	Length in Miles	Study Period and Date	Service Type	VEHICLE MILES OF TRAVEL DURING STUDY PERIOD					NUMBER OF OBSERVED STOPS																					ALL STOPS	
												VOLUNTARY																					INVOLUNTARY				
												Rest & Leisure					Business					Other									Passenger				
							Passenger Car			Truck & Bus	All Vehicles	Passenger			Truck & Bus	All Veh	Passenger			Truck & Bus	All Veh	Passenger			Truck & Bus	All Veh	Passenger			Truck & Bus	All Veh			Observed	Total (Exp)
							(State)	(Out of State)	Total			State	O.S.	Total			State	O.S.	Total			State	O.S.	Total			State	O.S.	Total						

TABLE 8

ACCIDENT HISTORY SUMMARY OF STUDY SECTIONS

STUDY SECTION DESCRIPTION					TOTAL ACCIDENT DATA										SHOULDER ACCIDENT DATA				
							All Acc		Fatal Acc		Pers Inj [1]		Prop Damage		All Acc		Fatal Acc		
Location	Lanes	Length (Miles)	ADT (1958)	Service Type	Study Period	Traffic M V M	No	Rate/ M V M	No	Rate/ 100 M V M	No	Rate/ M V M	No	Rate/ M V M	No	Rate/ M V M	No	Rate/ 100 M V M	Percent All Acc

1/ Includes only those accidents wherein one or more persons were injured Does not include property damage accidents

percentage of the statistic. For example, if it is desired to have the sample mean within a given percent of the population mean, it follows that

$$| C\overline{X} | = | \mu - \overline{X} | = t\,{}^{\sigma}m = \pm t\,\sigma/\sqrt{N-1} \qquad (5)$$

in which

N = sample size (number of observation periods) required
μ = population mean
$\overline{X}$ = sample mean (size n)
${}^{\sigma}m$ = standard deviation of the sample means
C = permitted error in the sampling as a decimal part of the mean (the 100 C is a percent of the mean)
σ = standard deviation of the sample (size)
t = value of t-distribution at specific level of confidence

This equation is solved for the sample size yielding,

$$N = 1 + \frac{t^2\sigma^2}{C^2\overline{X}^2} \qquad (6)$$

If the standard deviation of the population is known, t is the normal deviate as based on a near-normal distribution. If the standard deviation has to be estimated from the sample, the value for t is obtained from the t-distribution of the specified level of confidence.

The formula for the sample size as previously stated can be expressed in raw score form for easier computation:

$$N = 1 + \frac{t^2\,[n\Sigma X^2 - (\Sigma X)^2]}{C^2\,(\Sigma X)^2} \qquad (7)$$

A vehicle-miles-per-stop average X in Eq. 7 would be established from part or all of each day's shoulder use observations. Although it is desirable to increase n, precaution must be taken to prevent the introduction of bias into the study. One procedure for increasing the number of observations with a minimum of bias is to take each 12-hr day's data and divide them into two sets of representative observations. Because there is reason to believe that a significant difference does exist between AM and PM observations, it is proposed that the even numbered hours of observation be taken as one 6-hr sample period and the data of alternate hours be taken as another 6-hr sample period, providing two sets of observations from one day's study. This procedure does not unduly bias either set with data from any part of the day, but does yield two sets of data for assisting in the determination of a standard deviation.

From the standpoint of practical statistics, a sample of at least 10 representative observations should be made. It is doubtful if less than a 6-hr observation can be considered representative. If the foregoing procedure is employed for determining an observation, five 12-hr days of shoulder use observation would be employed in obtaining the field work. It is at this stage that further analysis could be made to determine whether further field work would be warranted.

Analysis of Sample Variability

This analysis of the data is carried out in two general parts: (a) an analysis on the frequency of stops, and (b) an anlysis on the vehicle-miles per stop.

The frequency of stops are analyzed to discover any gross inconsistencies in the data. Such inconsistencies could arise from the selection of the observation times, particularly if some abnormal use of the roadway is encountered or, as previously mentioned, if some sets of observations are for one part of the day and others from

another. Such unwarranted observations could tend to produce large standard deviations in the subsequent analysis, making it difficult to interpret the data.

In analyzing the frequency of stops, an adjustment must be made to compensate for the difference in traffic volumes. The number or frequency of stops are analyzed by a simple chi-square (χ^2) test. The observed frequencies of stops, denoted by o are added together and proportionally distributed according to the traffic volumes of the study intervals to obtain the expected frequency of stops. The testing statistic is then given by

$$\chi^2 = \frac{(|\ o-e\ |\ -0.5)^2}{e} \tag{8}$$

in which

o = observed frequency of stops.
e = expected frequency of stops.

If the calculated value of χ^2 is above the critical value as determined by the level of confidence desired, it follows that the frequency of stops is not proportionally distributed with respect to the volumes. If this occurs, the data should be scrutinized to determine the cause of the anomalies. The vehicle-miles per stop cannot be expected to yield consistent results unless the frequency of stops are themselves consistent. (If anomalies do arise in the frequency of stops, the sample data must be carefully investigated to ascertain the probable cause of such irregularities. Potential causes of irregularities could be among the following:

1. Climatic or weather variation;
2. Time variation in the hours of study (effective hours);
3. Seasonal variation;
4. Variation in roadway culture; and
5. Variation in the proportion of business, social, recreation, or commuting use.)

(No attempt is made to discuss all possibilities as each study may have its own unanticipated peculiarities. If a controllable cause for the irregularities in the frequencies can be found, the sampling should be continued with all attempts to control these factors.)

The stops and vehicle-miles for each time period in the study is then converted to a vehicle-miles per stop. Each of these vehicle-miles per stop is then considered as an element in the new population. The population arithmetic mean $\overline{X}$ and its standard deviation S is then calculated as follows:

$$\overline{X} = \frac{1}{N} \Sigma Z \tag{9}$$

$$S = \frac{1}{N} \sqrt{N\Sigma X^2 - (\Sigma X)^2} \tag{10}$$

These statistics are now used for determining the confidence interval on the mean of the universe μ. The universe mean must satisfy the following inequality:

$$\overline{X} - \frac{tS}{\sqrt{N-1}} \leq \mu \leq \overline{X} + \frac{tS}{\sqrt{N-1}} \tag{11}$$

where the level of confidence is specified in the value of the t-statistic. The values with equality yield the upper and lower bounds to the confidence interval.

The error as a percent of the mean at a given confidence level is given by $100\ t\ S/\overline{X}\ \sqrt{N-1}$. If this percentage is too large, it in general can be reduced by increasing the number of sample observations. Increasing the sample size by a factor of four can be expected to cut the confidence interval in half unless the estimate on the standard deviation is changed appreciably in the sampling.

If the data are to be tested against a theoretical population mean, $\mu.$, the following statistic is used:

$$Z = \frac{|\overline{X} - \mu.|}{S\sqrt{N-1}} \tag{12}$$

where $\overline{X}$, S, and N are defined as before. The statistic Z has a t-distribution with N-1 degrees of freedom. If the calculated value of Z is not less than or equal to the t-value as specified in the tables at the desired level of significance, the hypothetical value must be rejected.

Before comparing the data to a theoretical distribution, the decision must be made as to whether more sampling would be desired with the hope of refining the data.

Example of Computation of Sample Size and Variability

Table 9 gives basic data used in the sample size and variability computations.

If a χ^2 test is applied to the first 10 observations in the previous study, a calculated value of 14.453 is obtained which is less than the critical value of 16.919 at a confidence level of 95 percent (5 percent level of significance). From this information, there would be no reason to suspect any irregularities in the data, and hence one would proceed with the analysis or determination of sample size.

If it is assumed that the first 10 observations were made for the purpose of determining the sample size and if one wishes to establish with 95 percent confidence that the population mean is within 20 percent of the sample mean, the sample size estimate is given by

$$N = 1 + \frac{t^2S^2}{C^2\overline{X}^2} = 1 + \frac{t^2n^2S^2}{C^2(n\overline{X})^2} \tag{13}$$

where t = 2.262 at the 95 percent confidence level. Because $n\overline{X}$ = 18,600 and n^2S^2 = 55,640,000, Eq. 13 gives N = 1 + 20.59; hence, N = 22 would be the desired sample size.

After collecting the data to make a sample of 22 observations (24 observations were available from the New York Study), the data are again analyzed for consistency by the χ^2 test. Using the 24 tabulated frequencies of stops a χ^2 value of 23.092 is calculated which is considerably less than the critical value of 35.172 for 95 percent confidence. It follows that there is no reason to suspect any irregularities in the frequencies of stops.

Because no apparent anomalies exist in the frequencies of stops, the data are converted to vehicle-miles per stop and further analyzed. The arithmetic mean and standard deviation of the vehicle-miles per stop is calculated giving $\overline{X}$ = 2,050 by Eq. 9 and S = 1062.6 by Eq. 10. For the 23 degrees of freedom (N-1) had in the sample, t = 2.069. The mean of the universe then satisfies the inequality:

$$\overline{X} - \frac{tS}{\sqrt{N-1}} \leq \mu \leq \overline{X} + \frac{tS}{\sqrt{N-1}} \tag{14}$$

in which

$$\frac{tS}{\sqrt{N-1}} = \frac{(2.069)(1,062.6)}{\sqrt{23}} = 458.4$$

Rounding these values to the nearest 10 miles, the mean of the universe can be expected with 95 percent confidence to satisfy $1,590 < \mu < 2,510$. Any hypothetical mean within the interval of 1,590 to 2,510 could not be rejected on the basis of this sampling, even though the error as a percent of the mean is 22.36 percent.

It has probably been observed that the error obtained from the sample of 24 observations is greater than the error decided on with a sample size of 22. Sampling theory

cannot guarantee the accuracy of the sampling and such discrepancies frequently arise. However, because no irregularities were apparent from the χ^2 testing on the frequency of stops, the analyst is not justified in deleting any observation from the analysis. For example, the analyst is not justified in removing the 18th observation which has an abnormally high number of vehicle-miles per stop and the omissions of which would reduce the standard deviation of the sample considerably.

REFERENCES

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4. Billion, C.E., "Shoulder Occupancy on Rural Highways." HRB Proc., Vol. 38 (1959).
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TABLE 9

STOPS ON SHOULDERS AND VEHICLE-MILES TRAVELED ON 2-LANE HIGHWAYS, NEW YORK STATE[a]

Stops			Vehicle-Miles	Veh-Mi./Stop
e_{10}	o	e_{24}		
7.10	8	6.47	11,075	1,800
6.07	11	5.53	9,467	900
15.97	15	14.56	24,905	1,700
9.03	4	8.23	14,076	3,500
13.40	13	12.21	20,886	1,600
7.35	6	6.70	11,464	1,900
9.03	5	8.23	14,076	2,800
9.32	17	8.49	14,525	900
12.84	9	11.71	20,023	2,200
8.88	11	8.09	13,845	1,300
	5	3.98	6,801	1,400
	3	3.23	5,532	1,800
	8	8.59	14,690	1,800
	7	4.90	8,346	1,200
	5	6.41	10,962	2,200
	3	6.00	10,266	3,400
	8	6.97	11,925	1,500
	3	10.47	17,909	6,000
	4	3.63	6,213	1,600
	7	7.01	11,985	1,700
	4	4.42	7,555	1,900
	4	2.49	4,257	1,100
	2	3.38	5,783	3,000
	2	2.31	3,959	2,000

[a]These observed stop and vehicle-miles totals were taken from New York State Highway Shoulder Occupancy Study (1958) Table 1A, (4), using data for all stops on 2-lane highways. Expected (e) stop totals are calculated values.

Rest Area Use Study Procedure Guide

• DURING THE 1960 meeting of the Highway Research Board's Committee on Shoulders and Medians, the Committee adopted and recommended publication of a Highway Shoulder Use Study Procedure Guide in recognition of the growing need for comparable and reliable data on driver-stopping practices on highway shoulders. It was published as Highway Research Board Correlation Circular 426, August 1960. During the discussion at the 1960 meeting, it was pointed out that in addition to shoulder use data, factual data on roadside rest area use and occupancy were needed for the intelligent planning and justification of roadside emergency and rest stop facilities. As a result, it was recommended that a Rest Area Use Study Procedure Guide be developed as an adjunct to the Shoulder Use Study Procedure Guide. The Bureau of Public Roads 1959 policy statement (1) indicating that "convenience and comfort facilities provided at the safety rest areas are to be non-participating items for Federal-aid funds except where, because of specially significant, historical or national values, especially high continuing use may be expected" was of special concern. It underscored the need for factual information on the amount and character of rest area use which can only be obtained through extensive "on the site" studies.

The Rest Area Use Study Procedure Guide has been prepared to develop and standardize procedures for conducting studies of rest area use. It is hoped that this guide will be used by all States interested in obtaining data of this type. The purpose of the guide is to describe study procedures that will be adaptable to various study conditions, and that will provide reasonably uniform, comparable, and accurate data of greatest utility and benefit to the States preparing and using future rest area study data.

The Oregon State Highway Department, in cooperation with the U.S. Bureau of Public Roads, prepared the basic guide for committee adoption. They also predicated all of the items contained herein on actual field experience at some eight locations during 1960 and 1961.

GLOSSARY

Arterial Highway.—A general term denoting a highway primarily for thru traffic, usually on a continuous route.

Automatic Traffic Recorder.—A mechanical device for counting vehicular traffic on a highway.

Average Daily Traffic.—The average 24-hr volume, being the total volume during a stated period, divided by the number of days in that period. Unless otherwise stated, the period is a year and the term is commonly abbreviated as ADT.

Freeway.—A divided arterial highway for thru traffic with full control of access and with grade separations at intersections.

Light Vehicle.—A motor vehicle with size and operating characteristics similar to those of a passenger car; including specifically passenger cars, station wagons, and light panels, pickups, or delivery trucks of 6,000-lb gross weight or less.

Highway (or Street or Road).—A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Interviewer-Observer.—A study crew member whose primary duties are the interviewing and observing of vehicle occupants.

Peak Moment.—The interval of the day during which the number of vehicles accumulated in (occupying) the rest area is a maximum.

Safety Rest Area.—A roadside area separated from the roadway with provisions for stopping and resting by motorists for short periods.

Rest Area Facilities.—The accouterments or improvements installed in a safety rest area for use by occupants of vehicles parking in the rest area (tables, restrooms, drinking water, fireplaces, telephones, etc.).

Vehicle-Classifier.—A study crew member whose primary duty is counting traffic by vehicle type.

Vehicle Party.—All of the occupants of a single motor vehicle. Used to provide an animate measure when the occupants of a vehicle are considered as a unit and not individually.

INTRODUCTION

During the last decade, there has been an increasing emphasis on, and a recognition of, the need for providing adequate facilities for rest and emergency stops on arterial highways. The combined effects of increased vehicle ownership, higher traffic volumes, high vehicle speeds, and major developments in automotive and highway design have created a need for the control of and planning for emergency and rest stops on rural arterial highways. Parking on highway shoulders and the attendant hazard while leaving or re-entering the traveled way constitutes a recognized accident hazard, particularly to high-speed freeway traffic. As a result, it has become necessary to control and restrict highway shoulder parking (see Fig. 1), chiefly on high-speed multi-lane freeways.

There is now general acceptance of the premise that highways must be designed not only for the moving but also for parked vehicles (2). The AASHO Policy on Safety Rest Areas for the National System of Interstate and Defense Highways (3) states "... use of shoulders is to be limited to emergency and vehicle breakdown stops. Shoulders should not be considered as space for safety rest areas. In the interest of safety and convenience to the motoring public, safety rest areas are necessary." The importance of providing safe stopping places to break long trips is pointed out by highway safety experts who advise continuous driving should not exceed 1½ to 2 hr (4) (see Fig. 2). Thus, with the tremendous expansion of freeway travel expected and the large investment being made on the hundreds of miles of the Interstate Highway System completed or under construction, there is a basic need for data on which to base planning of adequate safety rest areas.

This study guide indicates the basic considerations in planning a rest area use study, the data to be collected, and the methodology and procedures to be followed in collecting, compiling, and analyzing the data, and a suggested outline for a report. As in the Shoulder Use Study Procedure Guide (5), the suggested procedures should not be considered as all-inclusive or limitational in respect to future studies that may be conducted. It may be necessary for the various States conducting studies to adapt the procedures to the immediate study conditions and goals, keeping in mind the need for uniformity in definitions and basic procedures, so that the reliability and comparability for the data are assured and maximum utility derived from the various studies.

Figure 1. Shoulder parking signing on Interstate 5 in Oregon.

Figure 2. Rest area signing on Interstate highway in Idaho.

PRELIMINARY PLANNING AND GENERAL PROCEDURE

Study Objectives

The first step in the planning of any study should be the careful definition of the study objectives. The following are among the more important objectives of a rest area study:

1. The measurement of rest area use on certain classes or types of highways and systems.
2. The determination of rest area use relative to its location to other rest areas, parks, and private roadside service facilities.
3. The determination of rest area facility use with respect to the various facilities available (parking, table-bench units, rest rooms, shelters, fireplaces, drinking water).
4. The determination of the effect of various types of signing, illumination, signboards, telephones, and other facilities on rest area use.
5. The determination of the adequacy of existing rest area facilities in meeting present user needs.
6. The measurement of data which provides the base for predictions of future rest area use necessary for design purposes.

Selection of Study Sites

Selection of study sites will depend primarily on the major objectives of the study and secondarily on the rest area sites available for study. The following are factors to be considered in site selection:

1. Rest area type and design.
2. Location.
3. Suitability of the site for collection of traffic volume data and interview and observation data.
4. The manpower and equipment available for the study.

Obviously, the rest area study sites should be of the type and design required to meet study objectives. For example, use of roadside rest areas located on major highways may not be representative of safety rest areas on freeways. The sites selected must be situated so that their locations are representative of the highway system, type of highway, or other conditions required by the study purpose. Sites selected for study of rest area use on a selected highway system should be representative of the various geographic, population, and terrain characteristics encountered on that highway system. The types and number of rest area access points and access roads are important in planning for the collection of accurate traffic data, either by manual or traffic recorder equipment. Rest areas with highway shoulder access will not be suitable for obtaining traffic volumes with automatic traffic recorders.

The number of automatic traffic recorders available for a study may be an important factor in site selection. A site requiring the installation of several traffic recorders to obtain accurate counts of entering vehicles will be less desirable, discounting other factors, than one requiring a single traffic recorder. A site located on the same section of highway as a permanent automatic traffic recorder would be most desirable, because it will obviate the installation of traffic recorders on the highway adjacent to the rest area in order to relate rest area use to highway traffic.

Sites with rest area facilities located on both sides of the highway will require additional interviewer-observers. Rest areas selected for the study should be situated so that the interviewer-observers may obtain vehicle entrance and exit times for all cars leaving and entering the rest area. Finally, the number and type of facilities, signing, recreational aspects, and regulation of overnight stops may be important considerations depending on the purposes of the study.

As an aid to planning, it is recommended that field inspection be made of the proposed study sites before final site selection. Planning of the stationing of interviewer-observers and location of traffic counting equipment will be materially aided by personal knowledge of the rest area study sites and will afford information useful later in re-

viewing and analyzing data collected. Also, problems that would arise without first-hand knowledge of the sites may often be anticipated.

The form "Description of Rest Area and Related Information" (see Appendix) should be completed at the time of observations of proposed study sites. The information required for this form will be valuable as reference material in site selection, and provide basic information required in analysis of the rest area data and preparation of a final report.

Summary of Study Procedure

The essential study procedural steps listed are those suggested for conducting a comprehensive study of rest area use:

1. Establish study objectives.
2. Select study sites.
3. Count traffic to obtain reliable average daily traffic volumes on the rest area access road and highway.
4. Interview vehicle-parties entering rest areas and observe use of rest area.
5. Count and classify highway traffic adjacent to rest area during interview periods.
6. Review and tabulate data collected.
7. Compile, analyze, and present data.

Limited surveys of rest area use may be made by the collection of traffic volume data on the rest area access road and adjacent highway. It is suggested, however, that such surveys be supplemented with manual counts by vehicle type of vehicles entering the rest area, and counts of vehicles accumulated in the rest area at regular intervals (5 or 10 min). A 1960 Oregon rest area survey indicated that substantial rest area access road traffic did not stop in the rest areas, but drove on through without stopping. Thus, traffic volume data alone may considerably overstate actual rest area use.

COLLECTION OF FIELD DATA

Personnel

Normally a team of three or more qualified men will be needed to collect the rest area study data at each site. The minimum crew will be comprised of one vehicle classifier, and two interviewer-observers. Additional crew members will be needed under the following conditions:

1. The highway traffic is so high as to require another vehicle classifier (daily traffic volumes of approximately 6,000 vehicles or more).
2. The number of vehicles stopping in the rest area requires additional interviewer-observers. (As a rule of thumb for estimating personnel requirements, an average of 10 interviewers per hour per interviewer may be assumed. A team of two interviewer-observers may be expected to handle approximately 15 interviews per hour when one of the interviewer-observers is also taking counts of the number of persons using a certain facility; for example, rest rooms or drinking water).
3. The number and location of rest area facilities for which usage counts are to be obtained requires additional observers.

One member of the team should be selected as a crew leader. He will coordinate the activities of the team, review the field data collected to insure completeness and compliance with established study procedures, act as a relief man for lunch periods, and perform other survey duties as required.

One or more interviewer-observers will make observations of vehicles entering and leaving the rest area and interview the driver or other responsible occupants of the vehicles stopping in the rest area. A Rest Area Interview Form (Fig. 3) should be completed insofar as possible by the interviewer-observers for each vehicle entering the rest area even though it does not stop. The duties of one of the interviewers-observers may also include the recording of the number of persons using specific rest area facil-facilities, such as drinking water and rest rooms.

In other instances, depending on the location of facilities and the amount of highway traffic, it may be desirable for the vehicle-classifier to take the counts of facility use, thereby relieving the interviewer-observers of this duty. The physical layout of the

STATE OF_____
REST AREA USE STUDY

REST AREA INTERVIEW FORM

I. INTERVIEW IDENTIFICATION:
- a. Serial Number (office entry) ☐☐☐☐
- b. Highway Number ☐☐☐
- c. Rest Area ☐☐☐
- d. Day ☐
- e. Date ☐☐☐☐

II. VEHICLE IDENTIFICATION:
- a. Description_____
- b. Number of Axles ☐
- c. Registration: ☐
  1. Study State
  2. States Bordering
  3. "
  4. "
  5. "
  6. Other States
  7. Foreign Country
  8. Unknown
- d. Vehicle Type ☐
  1. Light Vehicle
  2. Light Vehicle & Trailer Coach
  3. Light Vehicle & Other Trailer
  4. Truck or Bus
  5. Truck and Trailer Combinations

III. TIME (Military)
- a. Entered rest area ☐☐☐☐
- b. Departed rest area ☐☐☐☐
- c. Stay (minutes) ☐☐☐

IV. DIRECTIONS OF TRAVEL: ☐
1. Northbound 3. Southbound
2. Westbound 4. Eastbound

Occupant Comments:

V. NUMBER OF OCCUPANTS: ☐

VI. LAST STOP: (Office Entry)
- a. Location ☐☐☐
- b. Time ☐☐☐

VII. PURPOSE OF STOP: ☐
1. Rest or Nap
2. Eating
3. Restroom
4. Drinking Water
5. Recreation (Picnic, Fishing, etc.)
6. Other_____ (Describe)
7. Drive through (no stop)

VIII. FACILITY USE:
- Drinking Water ☐
- Restrooms ☐
- Tables and Benches ☐
- Fireplace or Cooking Facility ☐
- Shelters ☐
- Other_____ (Describe) ☐

IX. HOW DID YOU LEARN OF OR LOCATE THIS REST AREA? ☐
1. Located from Road Map
2. Located from Road Signs
3. Known from Previous Visits
4. Other_____ (Describe)

X. OTHER DATA (Optional) ☐

Interviewer Comments: ☐
1. Interview
2. No Interview

Interviewer_____

Figure 3. Rest area interview form.

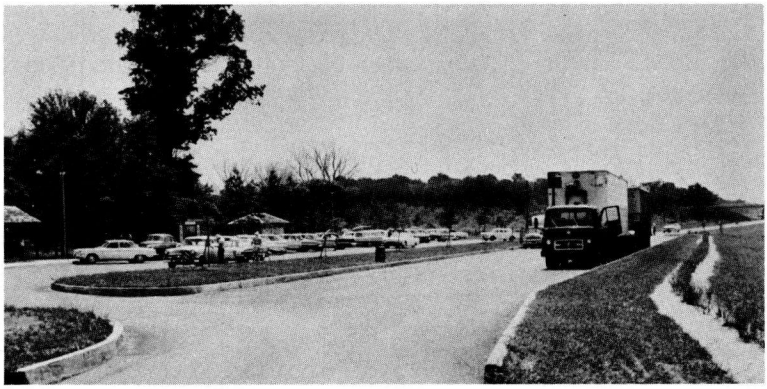


Figure 4. Interviewing at safety rest area on Interstate 71 in Ohio.

rest area, location and type of facilities, and volume of rest area traffic are all important factors in determining the amount of manpower required for the survey. It will be necessary for the crew leader to evaluate the conditions at each study site and assign personnel and duties accordingly.

Figure 4 shows a view of an Ohio safety rest area on Interstate 71 at the time interviews were being conducted for an eight-day rest area use survey in July 1961. The survey indicated 9.8 percent of the adjacent northbound traffic entered the rest area (6). The interviewer-observers in sun helmets can be seen in the figure near the exit of the light vehicle parking area.

When traffic volume data on the highway and rest area access road are to be collected by manual counts, rather than by mechanical recorders, for time periods outside the interview period, vehicle classifiers will be required.

Equipment and Supplies

The following equipment and supplies will normally be required for the collection of the rest area use data:

1. Passenger cars for the transportation of rest area study crew.
2. A multi-bank tally counter for use in counting traffic by vehicle type.
3. Clipboards, pencils, and note paper for each member of the survey crew.
4. A timepiece for each member of the survey team to record the vehicle entrance and departure times accurately.
5. State Highway maps and rest area or park guides for furnishing information to rest area occupants.
6. A supply of Rest Area Interview Forms (Fig. 3).
7. Daily report forms (tally sheet) for counting persons using specified rest area facilities (Fig. 5).
8. Daily traffic count summary forms for entering and summarizing hourly traffic totals by day and hour (Fig. 6).
9. Daily report of rest area operations (Fig. 7).
10. Automatic traffic counters for collecting traffic volume data.

The collection of traffic volume data on the rest area access road and highway by mechanical means will normally require the temporary installation of one automatic traffic recorder on the rest area access road and an additional automatic traffic recorder on the highway. In the instance of a four-lane divided highway having rest area units on opposite sides of the highway, a total of four traffic recorders would be normally required. If a permanent automatic traffic recorder were on the same section of highway as the rest area units, only rest area access road traffic counters would be required.

When manual counts of highway and rest area traffic volumes are to be obtained rather than mechanical counts, an additional car will be required for the transportation of the vehicle classifier, and a clipboard, pencils, and traffic summary forms supplied for his use.

STATE OF_____

REST AREA USE STUDY WORKSHEET

REPORT OF NUMBER OF PERSONS USING REST AREA FACILITIES

Highway No I-50 Date 7/7/61

Rest Area Shady Spot Day Friday

Facility Restrooms Observer RA

Time Period (Hour)		Number of Persons (tally) Using Facility	Total
1000	1100	𝍸 𝍸 𝍸 𝍸 𝍸 //	27
1100	1200	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	40
1200	1300	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 //	52
1300	1400	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 ///	38
1400	1500	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	35
1500	1600	𝍸 𝍸 𝍸 𝍸 /	26
1600	1700	𝍸 𝍸 𝍸 𝍸 ////	29
Daily Total			247

Comments Additional rest room facilities needed between 1200 and 1300.

(Data are for exemplary purposes only)

Figure 5. Report of number of persons using rest area facilities.

STATE OF_____

REST AREA USE STUDY WORKSHEET

SUMMARY OF HIGHWAY TRAFFIC BY VEHICLE TYPE

Highway No _____ Observation Period

Rest Area_____ Hours _____to_____

Date_____

Time Period		Direction						Direction					
		Light Vehicle	Lt. Veh & Trailer Coach	Lt Veh & Other Trailer	Single Truck or Bus	Truck & Trailer	Total	Light Vehicle	Lt Veh & Trailer Coach	Lt Veh & Other Trailer	Single Truck or Bus	Truck & Trailer	Total
Total													

Recorded by_____

Figure 6. Summary of highway traffic by vehicle type.

STATE OF_____

REST AREA USE STUDY

DAILY REPORT OF REST AREA OPERATIONS

Highway No._____ Day and Date_____
Rest Area_____ Observation Period ____to____
Observer_____

1 Weather Conditions
(Describe weather and noticeable effects on amount and character of rest area use).

2. Parking
(Comment on adequacy of parking space and any parking or rest area traffic problems).

3. Facility Use
(Comment on adequacy of facilities to accommodate occupants, unusual facility use, demands for facilities not available).

4. Rest Area Maintenance
(Comment on quality of maintenance, indicate maintenance needs such as repair of faucets or tables, rest room supplies).

5. Other Comments
(Indicate any other special events or incidents affecting operation of the rest area, or problems encountered in conducting the survey).

Figure 7. Daily report of rest area operations.

Schedule of Operations

Studies of rest area use should normally be conducted during the summer months so that the data will be respresentative of periods of maximum use. This is important so that data on rest area use during peak periods will be available for design purposes and evaluation of the rest area operations. It will also make possible valid comparison of the data with other rest area use studies.

It is recommended that the interview-observation days be scheduled so as to include at least one Saturday and Sunday, and a representative group of weekdays (preferably a minimum of five). By grouping the study periods in sets of not more than three days, preferably one or two days, the study periods may be dispersed to be representative of typical summer conditions.

Normally, interviews will be conducted during daylight hours. Where rest areas are illuminated and substantial nighttime use is expected, it is desirable to consider a supplementary schedule of nighttime observation. Interview and observation periods should include the hours of highest rest area use. Experience indicates that the hours from 11 AM to 3 PM will normally include the periods of peak use. A continuous six- to seven-hour study period starting at 10 AM is suggested. The continuous observation schedule may be maintained by the rotation of duties among the survey team to allow the relief of each member of the crew for eating and rest at appropriate "off peak" interview periods.

When the daily traffic volumes are to be obtained from automatic traffic recorders, it is suggested that a one-month data collection period be scheduled initially. Additional counts may be required, depending on the variability of the data (see section on Sample Size and Variability). The traffic recorder counts should cover as much of the interview-

observation study period as possible. When daily traffic volume counts are obtained from personal observation, practical considerations will probably limit the schedule of counts to a much shorter period. The rest area and highway traffic counts should be taken simultaneously, so that the percent of traffic entering the rest area may be accurately determined.

Traffic Volumes

Traffic volume data are required in the rest area use study for the determination of the average percent of highway traffic entering the rest area. To determine average percent of highway traffic entering the rest area, it is necessary that daily counts of traffic on the rest area access roads and adjacent highways be made concurrently over sufficient periods of time to establish their relationship with reasonable accuracy (see section on Sample Size and Variability).

It is desirable that the traffic counts be taken to establish the average daily traffic volumes with accuracy. If traffic recorder equipment is available, it will provide the most economical means of obtaining the required traffic counts, although manual counts may also be used.

In addition to the 24-hour traffic volume counts, manual vehicle classification counts of highway traffic should be taken during the interview-observation study period. These counts will usually be made by a member of the survey crew stationed in a parked car in the rest area, on the shoulder of the access road, or at some other nonhazardous location. Accurate counting will be materially aided by the use of a talley counter. The vehicle classification counts accumulated in the talley counter should be entered hourly on the forms, Summary of Highway Traffic by Vehicle Type (Fig. 6) and summarized daily. The vehicle classifier may also record axle counts of multiple axle vehicles and combinations, if such counts are required for adjustment of road tube traffic recorder data.

The collection of rest area traffic volumes by mechanical means will require the temporary installation of an automatic traffic recorder on the rest area access road. If a permanent automatic traffic recorder installation is located on the adjacent highway at a reasonable distance from the rest area without significant differences in traffic volume between it and the rest area, it should be used to supply the highway traffic counts. Otherwise, it will be necessary to install an additional traffic recorder to count the adjacent highway traffic. The rest area access road traffic recorder should preferably be placed to count entering traffic and at a distance as far as possible from the parking area and rest area facilities to prevent tampering by occupants and actuation of the counter by vehicles turning around, parking, backing, etc.

If traffic volume data are obtained from road tube type traffic recorders, classification of traffic by number of axles should be made, if not otherwise available, to provide the data for adjusting the traffic counts. Number of axles recorded under Item B of the Rest Area Interview Form (Fig. 3) will provide the data for adjustment of rest area access road traffic counts. Magnetic-type traffic recorders do not require this adjustment. Hourly recording traffic recorders are recommended for installation on the rest area access roads. Operational and mechanical troubles will show up in the hourly traffic counts, as well as unusual variations from tampering by rest area occupants, which will remain undetected in non-recording traffic recorder counts. Installation of traffic recorder equipment and collection of data will probably be most efficiently performed by crews normally doing this work. Figure 8 is an example of a traffic recorder installation at a safety-rest area on Ohio Interstate 71.

Interview and Observation Data

The reliability of the final rest area report and success of the study will depend on the accuracy and completeness of the rest area interview and observation data.

Much of the success of the interviews depends on the manner in which the interviewer-observer meets the public, explains the purpose of the survey, and asks pertinent questions. The interviewer-observers should present a neat appearance and be courteous and tactful, regardless of the rest area occupant's attitude toward the survey.

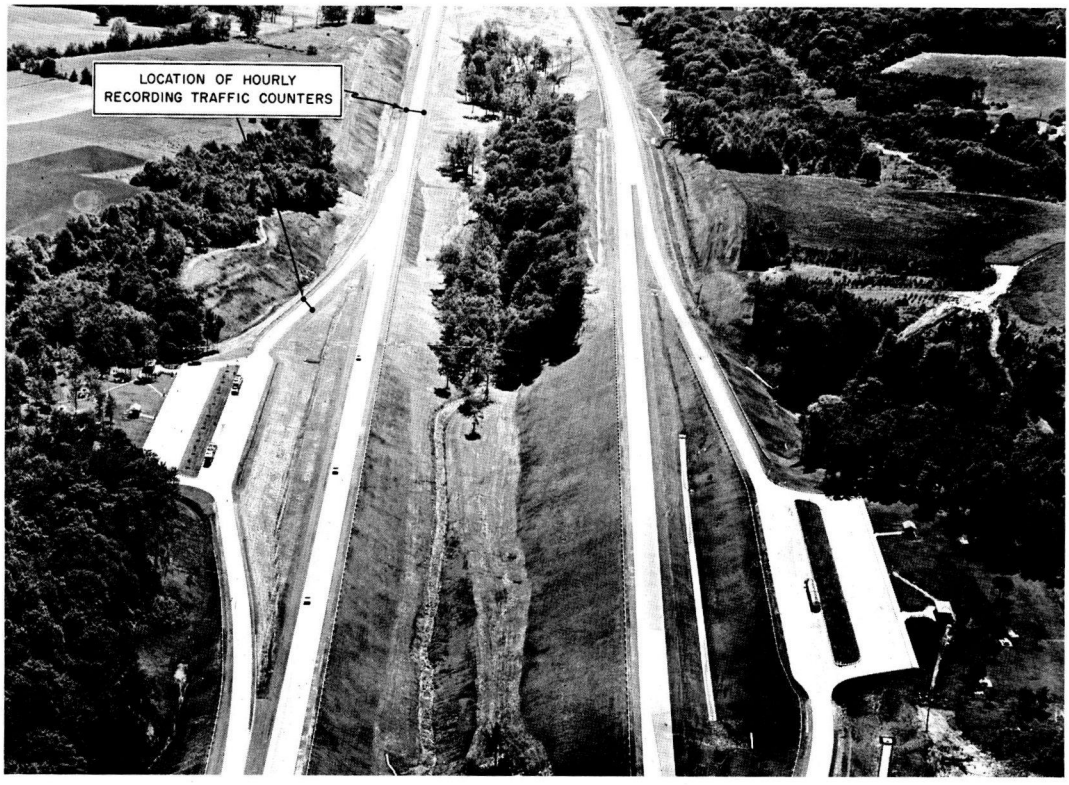


Figure 8. View of safety rest areas on Ohio's Interstate 71 showing location of automatic traffic recorders.

Experience has shown that most rest area occupants will be cooperative and interested in the survey, as they are the immediate beneficiaries of the rest area.

It is important that the survey crew be instructed in advance of their work assignments on the over-all purposes of the study, the general procedure that will be followed in processing the data collected, and their specific duties. Each member of the survey crew should be familiar with all work assignments as he will be required to rotate duties at various times during the study. Advance training of all crew members by making trial interviews prior to the actual beginning of the survey is recommended. A review of the trial interviews by the study supervisor or crew leader will bring out questions that need to be answered and provide opportunity for correction of errors and discussion of points of misunderstanding. One of the better training aids for interviewers is to have them review, code, or tabulate the rest area data that other members of the crew have collected. This practice will emphasize the need for obtaining accurate and complete data in the field.

The field crew supervisor should review the completed interview forms during and at the end of each day for completeness and accuracy. Corrections and deficiencies can then be discussed before the next day's work. Leaving the initial review to the office force at a later date is not advisable as missing information cannot be recalled accurately, and errors initially made cannot be corrected and will be continued.

The Rest Area Interview Form (Fig. 3) should be prepared for all vehicles entering the rest area, regardless of whether the vehicle stopped or the occupants were interviewed. Normally, items I-VII, with the exception of "Last Stop" (item VI), will be apparent by observation of those vehicles making short stops or just driving through the rest area access road. Items for which information is not obtained should be coded as "X" in the appropriate code box. Interview information should be entered on the

form as completely as possible at the time of interview, as attempts to recall information later will lead to errors and incompleteness. If there is doubt as to the proper classification of data, supplementary explanatory remarks should be made on the form.

Entry I—Interview Identification

a. No serial number entry is required in the field as this is an office entry.
b. Enter the highway number designating the highway on which the rest area is located in the code boxes.
c. Enter the code for the day of week (1-7) in the code box, starting with Sunday as one and ending with Saturday as seven.

Entry II—Vehicle Identification

a. Indicate a useful quick description of the vehicle entering the rest area; e.g., red and white 1960 Ford Sedan. The only use of this item is by the interviewer-observers in maintaining control of the interviews and recording entrance and departure times.
b. Enter the total number of axles of the vehicle or vehicle-combination in the code box; e.g., station wagon-2, car and trailer coach-3. These axle count data are used to derive correction factors for rest area traffic volume counts made by road tube-type traffic recorders. The item may be omitted when using magnetic detectors for the vehicle recorders or manual counts for rest area traffic volumes.
c. Enter the code number designating the place of vehicle registration in the code box as determined by vehicle license plate. If the license plate is not visible, determine the place of registration by interview.
d. Enter the code number identifying the vehicle type in the code box. Light vehicles are defined as passenger cars, station wagons, and light panel or pickup trucks. Trucks towing resident-type trailer coaches are classified as truck-trailer combinations.

Entry III—Time

a. Enter the time the vehicle enters the rest area to the nearest minute in military time (0000-2400).
b. Enter the departure time of the vehicle.
c. The length of stay will normally be computed in the office or by the crew leader. No entry is required by the interviewer-observer.
Estimates of entry and departure times for vehicles which enter or leave the rest area before or after the interview study period may be obtained from occupants of the vehicle. Experience has shown that a supplementary listing of vehicle exits and entries by time of day made by the traffic classifier or one of the interviewer-observers will be helpful in establishing accurately the vehicle entrance and departure times. This supplementary listing is especially useful when all of the parking space cannot readily be observed from where the interviewers are stationed.

Entry IV—Direction of Travel

Indicate the direction of travel by entering the appropriate directional code in the code box.

Entry V—Number of Occupants

Enter the total number of occupants of the vehicle in the code box.

Entry VI—Last Stop

a. Enter the location of last stop on the line opposite "Location" as determined by the question, "Where was your last stop?" The answer to this question

should be specific enough so that the distance from last stop to the rest area may be readily estimated with use of highway mileage maps.
The code boxes for this item and item "b" will be left blank in the field as the elapsed time and distance since last stop will be computed in the office and then entered in the code boxes.
It is important to recognize probable differences in standard and daylight time and time zones during the interview and correct for this to maintain comparability of the rest area entrance and last stop times. A good practice is for the interviewer to indicate the current time as a point of reference. It is important for the interviewer to emphasize that the last stop will be any stop (emergency, rest, service, or recreational) and should not be considered in respect to trip origin only.

b. Enter the estimated time at which the vehicle left the place of last stop in military time on the line opposite "Time."

Entry VII—Purpose of Stop

Enter the number of the primary purpose of the rest area stop as listed in the code box. The primary purpose of the stop will, in most instances, be obtained during the interview by asking the question, "What was the primary purpose of your stop?" In certain instances, particularly where the stop is quite short, and there is no time for interview, the purpose of stop may be obtained by observation.
For example, the purpose of a five-minute stop for rest rooms or drinking water use, when these were the only facilities used, would be obviously classified as rest room or drinking water. Eating stops include stops for the purpose of eating meals, light lunches, snacks, or "coffee breaks." Recreational stops are defined as rest area use for the primary purpose of recreation such as picnicking, fishing, or sun-bathing, in which the rest area is regarded as the destination rather than a stopping place incidental to travel to another destination. Thus, recreational stops should not include a lunch or refreshment stop made by vacationers enroute to other destinations. Among the types of stops which are classified as "other" are checking vehicle, changing drivers, making short stops for reading historical markers, exercising pets, checking maps, obtaining information, changing tires, and overnight stops. If substantial rest area use other than described by the major purpose of stop is known to exist, it should be added to the form as a separate category.

Entry VIII—Facility Use

Indicate the use of each of the specified rest area facilities by any member of the vehicle-party interviewer by entering the code one (1) in the appropriate box. No facility use is indicated by the code zero (0). The facilities to be listed in this item will necessarily reflect those available at the selected study sites.

Entry IX—How Did You Learn of or Locate This Rest Area?

Enter in the code box the number designating the answer to the question of how the interviewer learned of or located the rest area. This is an optional question which may be used to indicate the effectiveness of advance signing, rest area informational boards, and other means in directing travelers to rest area, as well as the amount of repeated use of rest areas.

Entry X—Additional Optional Questions

Additional items of significance to the study objectives should be added to the questionnaire as required. Other items that might be included are trip pur-

pose, number of rest area stops during trip, residence of vehicle-party, or occupant's alternate choice of stopping place.

Occupant and Interview Comments

The interviewer should encourage the occupants to make comments or constructive criticism regarding the operation of the immediate rest area or rest areas in general. Abstracts of these comments should be written in the space provided at the bottom of the form. The space under "Interviewer Comments" should be used by the interviewer to explain any pertinent information about the rest area use associated with the particular interview. For example, if the table-bench units are all occupied and the party is eating in the car, a comment should made "tables all in use—party eating in car." Such comments are very useful in review of data and evaluating the adequacy of rest area facilities. The number 1 should be entered in the code box under Interview Comments to indicate an interview, or the number 2 to indicate no interview. These codes are also useful in reviewing the data.

The Daily Report of Rest Area Operations (Fig. 7), which is completed by the crew leader, provides a useful source of qualitative information for evaluating the operation of the rest area. This information should be of special interest to those responsible for maintaining and planning of rest area facilities, and will be of value in analyzing the other rest area study data. The daily reports should accompany the other data collected at the various study sites and be turned in to the study supervisor at frequent intervals.

SAMPLE SIZE AND VARIABILITY

The determination of the required sample size and periods of data collection to insure that the data will have the required degree of accuracy and be typical of the characteristics of the population under study is one of the most important and sometimes difficult elements in conducting a study. The sample size and timing of data collection to achieve accuracy and reliability are of particular significance when the scheduling of men and equipment is involved in the collection of the sample data—as in the rest area studies. The decisions as to the maximum errors to be tolerated in the most important statistics of the study and the degree of reliability desired must be evaluated in relation to the data variability. The determination of practical sample sizes must consider manpower, time, and equipment available for the study. It is, of course, desirable to make the results as accurate as possible within the limitations of the variability of the data being studied and practical considerations.

In the instance of Rest Area Studies, the following statistics are recommended for sample size determination:

1. The percent of highway traffic entering the rest area in a 24-hour period.
2. The number of vehicles occupying the rest area during the peak moment of a 24-hour period.

In reference to the percent fo highway traffic entering the rest area, it is recommended as a minimum requirement that the sample size be chosen to provide accuracy of at least ± 10 percent, 95 percent of the time. This recommendation is based on the fact that these data can be obtained using automatic traffic recorders which result in data that are less expensive and easier to collect over extended time periods than data obtained by manual methods. Experience in the analysis of traffic recorder data from rest area surveys in 1960 indicates the practicability of obtaining data with this accuracy. Analysis of traffic counter data collected during the summer of 1960 at two Oregon rest areas over a period of approximately two months showed that traffic recorder counts for sample periods of 22 and 24 days would have achieved the desired accuracy of ± 10 percent 95 percent of the time. Analysis of one week's traffic recorder data at an Ohio safety rest area (6) on Interstate 71 (Fig. 8) indicated variability such that the percent of highway traffic entering the rest area would have been within 10 percent of the true

average 95 percent of the time. Of course, a single week's data cannot be regarded as representative of the entire summer season, and additional sampling periods should be scheduled. However, the analysis indicates the relative consistency of the rest area traffic data.

On the basis of the foregoing analysis, a minimum sample data collection period of approximately four weeks is recommended which includes an allowance for the loss of a few day's data due to adverse weather conditions, or mechanical and other traffic recorder difficulties. Practical considerations of moving traffic recorder equipment and developing a traffic recorder counting schedule consistent with the interview schedule may make it preferable to install traffic recorders during the entire summer interview schedule (probably two months) in preference to scheduling several short periods for collection of traffic recorder data.

In reference to the required sample size for the number of vehicles accumulated at the peak moment, it is recommended that the sample be of sufficient size to provide accuracy of ± 20 percent, 95 percent of the time. The accuracy recommendation for rest area use data is the same as for the shoulder use study data (5).

An analysis of the variability of peak moment vehicle accumulations from data collected for Oregon rest areas in 1960 indicated errors in the average peak moment vehicle accumulation at individual rest areas ranging from 12 to 23 percent with a confidence level of 95 percent. The Oregon data were based on observations scattered throughout the summer of 1960 and included a 7-hour observation period for each of five weekdays, plus a Saturday and Sunday at each study site.

On this basis, it is recommended that the mimimum interview and observation data consist of a sample of data for seven days, preferably including one Saturday, one Sunday, and five weekdays. The days should be dispersed throughout the summer to prevent bias of the sample.

In regard to the adequacy of this sampling period (sample size), it is worth mentioning that other pertinent rest area use data will have a higher degree of statistical reliability than that of the peak-moment vehicle accumulation data previously discussed. Other data would include, for instance, the proportion of vehicle-parties using table-bench units for which the observed percentage of 45 percent at a 1960 Oregon study site was reliable within ± 4 percent at the 95 percent level of confidence. The reason, of course, is that such data as these are based on the total number of vehicle-parties observed, whereas the reliability of the peak moment accumulation, because it can occur only once a day, is based on the number of days of observation.

A discussion of a method of statistical analysis and formulas for analysis of sample variability and sample size appear in the Appendix.

TABULATION OF DATA

The services of a statistician and statistical clerk, supported by data-processing equipment, will usually meet the requirements for tabulation and analysis of rest area study data. As the volume of rest area interview data may be substantial, machine punch card processing of interview data is generally desirable. The suggested rest area interview form was designed for mechanical data processing. Detailed instructions for machine processing or tabulation are not included in the Guide as machine processing or tabulating procedures are dependent on the type of processing equipment available and data volume, and can best be determined by the data processing supervisor in consultation with the rest area study supervisor.

The following suggested procedures assume that the rest area interview form data (Fig. 3) are machine tabulated, with the exception of occupant and observer comments, and that the automatic traffic recorder data, manual traffic classification counts, and counts of persons using rest area facilities are manually processed with the aid of adding machines and calculators. The illustrations and explanations of suggested tables, charts, and figures in the Guide will indicate tabular data requirements. Basic data will be tabulated by rest area study site to provide the data required for a case history of each study site.

Traffic Volume Counts

The collection and analysis of highway traffic volume data are normally an important phase of the work of the State Highway Department. Forms used in collection and processing traffic volume data should be already available for use in processing the traffic volume data by day of week. If traffic counts are collected by mechanical equip-

OREGON STATE HIGHWAY DEPARTMENT
Traffic Engineering Division
Planning Survey

AUTOMATIC RECORDER TRAFFIC COUNTS

Portable Recorder ☐ Permanent Recorder ☐

Route or Highway No. _____ Station No. _____

Location _____

Week Beginning _____

Day of Week		Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Total
Day									
Hour of Day									
A. M.	12-1								
	1-2								
	2-3								
	3-4								
	4-5								
	5-6								
	6-7								
	7-8								
	8-9								
	9-10								
	10-11								
	11-12								
P. M.	12-1								
	1-2								
	2-3								
	3-4								
	4-5								
	5-6								
	6-7								
	7-8								
	8-9								
	9-10								
	10-11								
	11-12								
Automatic Recorder Total 24 Hours									
Axle Correction Factor									
Adjusted All Vehicle Total 24 Hr.									

REMARKS _____

Figure 9. Automatic traffic recorder counts worksheet.

ment, probably the most efficient procedure is to arrange for the collection and processing of the rest area traffic counter data by the personnel normally doing this type of work. Figure 9 shows a form suitable for tabulating and review of the traffic recorder data. It is important that the data be reviewed thoroughly after transcription from the counter tapes to check for inconsistencies in the counts resulting from mechanical failure, tampering by rest area occupants, and transcription errors. Obviously, erroneous data should be deleted.

The form "Summary of Highway Traffic by Vehicle Type" (Fig. 6) may also be used to summarize the daily classification counts of highway traffic adjacent to the rest area by vehicle type and day of week. The form is initially used to summarize the traffic classification counts by hour obtained from the tally counter. The daily traffic totals by vehicle type from the initial hourly summary are transcribed as line entries to the daily summary and totaled.

Rest Area Use Data

Rest Area Interview Data.—The rest area interview form is self-coding with the exception of Item VI, Last Stop, and Item X, Other Data and Comments. The data for Item VI, Last Stop, will usually be coded in the office, although if time permits the data may be coded by the field crew leader. The distance since last stop in miles, as determined by the location of last stop and mileages shown on current highway maps, is entered in the code boxes opposite "Location." The elapsed time between last stop and rest area stop is coded in the boxes opposite "Time."

It is important that a thorough review of the rest area interview data and coding be completed before the data are processed. All items should have entries entered in the appropriate code boxes. Items for which no data were obtained should be coded "X" and not left blank to differentiate between oversights in coding and items for which data were not obtained. The coded mileage and elapsed time (minutes) since last stop should be consistent with the location and time entries for last stop. Purposes of stop and facility use should be consistent. It is recommended that the forms for each rest area be sorted by date and time of vehicle entrance and number in sequence for identification purposes before key punching. A final review of the data before summarization of the data should be made by reviewing card listings by rest area, primary purpose of stop, day, and time of vehicle entry. The review of these listings should disclose any key-punching or coding errors and other inconsistencies in the data which will require correction before beginning summarization of the data.

Number of Persons Using Facilities.—Data on the average daily number of persons using specified facilities should be summarized from the form "Report of the Number of Persons Using Rest Area Facilities" (Fig. 5). Summarizing the daily totals for each rest area by day of week (weekday, Saturday, and Sunday) and computing the daily averages will provide the summary data required for analysis.

ANALYSIS OF DATA

The purpose of the analysis suggested here is to summarize and analyze the rest area study data in a simple and direct manner, oriented towards the practical use of the data for planning purposes. The suggested methods and types of analyses are indicated by narrative exemplary illustrations of tabular and graphic data presentation. The types of data analysis and report content suggested provide for the summary and analysis of data in two stages. The first stage is the summary and analysis of data for each individual study site which is used in the compilation of a case history for each rest area studied. The second stage is the summary and comparative analysis of data for more than one study site to provide a composite picture of rest area use on the highway system.

Case History Analysis

In studies of rest area use covering several study sites, it is recommended that a

case history be prepared for each rest area study site. The case history will summarize the detailed information collected at each study site in a logical sequence and serve as the source data for the summary analysis section of the report. Although it is not suggested that an extensive analytical narrative be included in each case history, the data presented should be supported by essential explanatory narrative and statements of the most significant aspects of the data. The case history should also contain a detailed description of the rest area, the adjacent highway, and related information pertaining to location of nearby cities, rest areas, parks, and service facilities. It is also desirable to mention any circumstances unique to a particular study site which affected the collection of data or required changes in the study procedures to fit the circumstances. The following section, "Compilation and Presentation of Analysis," is indicative of other case history content and format.

Summary Analysis

The summary analysis section is intended to provide a summary and comparative analysis of the principal data presented in the case histories of the various study sites. The order of presentation should be consistent with the case history data.

Compilation and Presentation of Analysis

The computations and tabulations required for the case history and summary analysis sections of the report are simple and require little explanation. The following comments supplemented by the exemplary tables and figures should provide adequate instructions for compiling and presenting the analysis.

Description.—Use the form, "Description of Rest Area and Related Information," prepared in the site selection process as a guide for preparation of the case history rest area descriptions. For the main body of the report, it is suggested that the more important descriptive information on each of the study sites be summarized (see Fig. 10), and supplemented by narrative description. A regional map showing the location

STATE OF_____

REST AREA USE STUDY

DESCRIPTION OF REST AREA STUDY SITES

Rest Area & Highway	ADT	Location	Facilities
Shady Spot, Interstate 50 M.P. 225.5	7,100	35 miles east of Metropolis, 25 miles west of Plainview in flat open country, adjacent to the Powder River.	Parking space for 30 vehicles, 12 table-bench units, 2 modern rest rooms, drinking water, artificial lighting, no fireplaces or camp sites.
Pleasant View Interstate 50 M.P. 342.2	6,500	40 miles east of Capitol City, 50 miles northwest of Westport, in the foothills of the Pine Mountains.	Parking space for 25 vehicles, 10 table-bench units, 2 modern rest rooms, spring water, no artificial lighting or fireplaces.
(etc.)	(etc.)	(etc.)	(etc.)

Figure 10. Description of rest area study sites.

of the study sites in respect to the highway system, major cities, and other important geographic places should be included.

Traffic Volumes.—For the case histories compute for each study site the weekday, Saturday, and Sunday average daily traffic volumes for the vehicles entering the rest area and those on the adjacent highway from the manual and/or traffic recorder count summaries (Fig. 9). The axle overcount adjustment factors required for counts from road tube recorders may be computed from a tabulation of the punch card data from Item II-b, Number of Axles, of the rest area interview form. The average daily traffic on the adjacent highway and entering the rest area are entered in Table 1, and the percent of highway traffic entering the rest area by day of week computed.

For the summary analysis Table 2 gives a comparison of the average daily summer rest area and adjacent highway traffic volumes, and the percentage of highway traffic entering the rest area at individual sites with the average for all study sites. The data for each study site are copied directly from the case histories.

TABLE 1

COMPARISON[a] OF HIGHWAY AND REST AREA TRAFFIC VOLUMES, SHADY STOP REST AREA

Day	Avg. Daily Summer Traffic		Percent Entering Rest Area
	Highway	Entering Rest Area	
Weekday	7,650	367	4.8
Saturday	8,665	450	5.2
Sunday	9,855	473	4.8
Avg.	8,110	394	4.9

[a]Data shown for exemplary purposes only.

Rest Area Use.—The following suggested analyses of data on rest area use are based on information obtained during the interview-observation study periods. These study periods will usually be of limited duration as compared to the traffic volume data collection periods; therefore, it is desirable that the report sections of the case history and summary analysis be prefaced with a description of the study periods to provide an indication of the reliability and comparability of the data.

Vehicles Entering.—The number of entering vehicles that are accumulated in (occupy) a rest area is an important measure of rest area use. Peak vehicle accumulations are of particular value for design considerations.

TABLE 2

COMPARISON[a] OF HIGHWAY AND REST AREA TRAFFIC VOLUMES

Rest Area	Hwy Route	Average Daily Summer Traffic		Percent Entering Rest Area
		Highway	Entering Rest Area	
Shady Spot	I-50	8,110	394	4 9
Oak Dell	I-50	8,640	482	5 6
Trout Creek	I-50	5,000	420	8 4
Pleasant View	I-50	7,210	425	5 9
Sleepy Hollow	I-50	5,100	310	6 1
Avg		6,812	406	6 2

[a]Data shown for exemplary purposes only

In this guide, two basic methods of obtaining the number of vehicle accumulations in the rest area during study periods are suggested. The first method suggested for obtaining rest area vehicle accumulation counts, and probably the most efficient assuming electronic data processing equipment is available, is to compute the number of vehicles accumulated in the rest area at regular short intervals from the entrance and departure times of the vehicles as recorded in Item III of the rest area interview form (Fig. 3), and the rest area interview punch cards. The number of vehicles accumulated in the rest area may then be machine computed at regular time intervals (preferably five minutes) throughout each interview day and listed in time order. Electronic data-processing equipment such as the IBM 650 or equivalent is suitable for this calculation. If the vehicle accumulation data are to be computed by an electronic calculator, the tabulation of other rest area data during the same "pass" of data cards through the calculator should be considered).

For a study involving only one rest area, a hand tabulation of the vehicle accumulation data may be more satisfactory than electronic data processing, although it requires

very careful checking. The hand tabulation may be accomplished by preparation of a tally sheet showing the hours of the study period divided into 5 minute intervals. The entry and exit time of each vehicle is observed by the person tabulating the data and a tally entered in the appropriate time intervals covering the duration of the vehicle's stay in the rest area. All vehicles traveling through the rest area without stopping (coded 7 for purpose of stop) would be excluded from this tabulation as they would not occupy any parking space.

The second method is for one of the interviewer-observers to make physical counts of the numbers and types of vehicles accumulated in the rest area at regular time intervals (5 to 10 minutes) during the study period. This method has the disadvantage of interference with the normal interviewing duties of the rest area study personnel and requires a high degree of concentration on the part of interviewers regularly to obtain accurate counts at the specified time intervals when absorbed with other duties. For example, experience has shown that rest area occupants may expect the interviewers to provide assistance in checking vehicles and assisting in routing trips. These activities may break into the schedule of the interviewers as situations requiring assistance to the public cannot be ignored. One solution to this problem is to assign one crew member to the full-time activity of making vehicle accumulation and facility use counts. In other instances, it may be possible to have the traffic-classifier to make the vehicle accumulation counts where visibility permits.

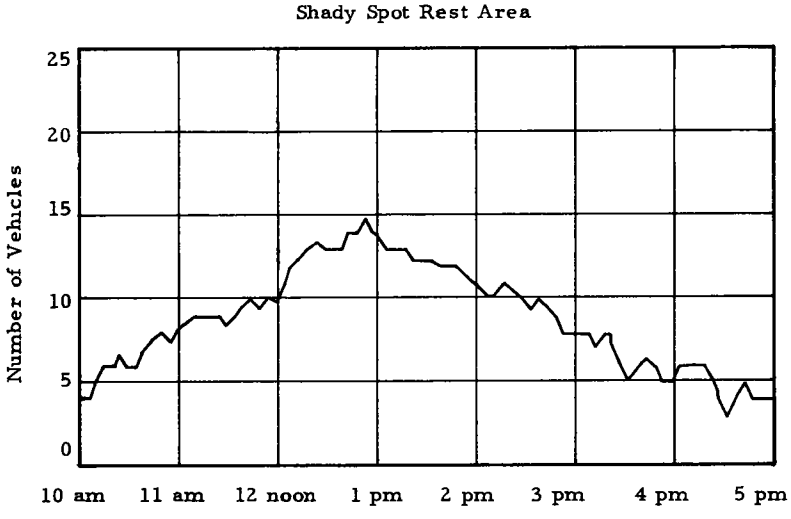
TABLE 3

RELATIONSHIP[a] OF VEHICLES ACCUMULATED DURING PEAK MOMENT TO VEHICLES ENTERING, SHADY SPOT REST AREA

Day	Number of Vehicles		Percent
	Entering[b]	Accumulated During Peak Moment	Accumulated During Peak Moment
Monday	380	20	5 3
Tuesday	365	19	5 2
Wednesday	340	17	5 0
Thursday	372	20	5 4
Friday	408	27	6 6
Weekday Avg	373	21	5 6
Saturday	460	32	7 0
Sunday	472	34	7 2
Avg	400	24	6 0

[a]Data shown for exemplary purposes only
[b]In 24 hours

Figure 11 shows the suggested form of presentation for the average number of vehicles accumulated in the rest area by time of day during the sample observation periods. The averages plotted are computed by totaling the vehicle accumulations during the specified time intervals for each observation day and dividing by the number of observation days.



(Data shown for exemplary purposes only)

Figure 11. Average number of vehicles accumulated in rest area by time of day.

For the summary analysis it is suggested that the average vehicle accumulation data be summarized as in Table 3. Here the minimum and peak-hour vehicle accumulations are expressed as a percentage of the average daily number of vehicles (24 hours) entering the rest area. The peak-hour time period and average peak-hour vehicle accumulations are determined by computing successive hourly totals of the average vehicle accumulations (the sum of 12 consecutive 5-minute average accumulations) starting near the beginning of peak period of use as shown in Figure 11. The highest hourly accumulation total obtained (the peak hour) is divided by the number of accumulation counts during the hour to determine the average peak hour accumulation. The minimum accumulation for the average day is determined by visual inspection of the average vehicle accumulations.

The number of vehicles accumulated during the peak moment is of special importance for determination of parking space requirements. The peak moment is defined as the interval during the day in which the number of vehicles accumulated in the rest area is

TABLE 4

RELATIONSHIP[a] OF VEHICLES ACCUMULATED TO VEHICLES ENTERING FOR AN AVERAGE SUMMER DAY

Rest Area	Route	Accumulation			
		Minimum (%)	During Peak Moment (%)	Average During Peak Hour	
				%	Hour Beginning
Shady Spot	I-50	0.8	6.0	3.4	12:15
Sleepy Hollow	I-50	1.0	7.1	4.1	11:55
etc.	etc.	etc.	etc.	etc.	etc.
Avg.		1.0	6.4	4.0	--

[a]Data shown for exemplary purposes only.

TABLE 5

CLASSIFICATION OF TRAFFIC, SHADY SPOT REST AREA

Vehicle Type	Vehicles Entering Rest Area		Highway Traffic	
	Number	Percent	Number	Percent Each Type Entering Rest Area
Light vehicle	1,189	85.0	17,130	6.9
Light vehicle & trailer coach	93	6.6	1,012	9.2
Light vehicle & other trailer	26	1.9	425	6.1
Bus or single unit truck	30	2.1	903	3.3
Truck-trailer combination	62	4.4	2,044	3.0
Total	1,400	100.0	21,514	6.5

[a]Data shown for exemplary purposes only.

a maximum. The determination of the peak moment vehicle accumulation may be made by a part of the electronic data processing program or may be easily made by visual inspection of all the vehicle accumulation totals listed for each day. The daily "peak moment" totals are then listed by the day of week for the case history as given in Table 4. The 24-hour counts of the number of vehicles entering the rest area given in Table 4 are traffic volume counts for the days that the peak moment accumulations were obtained. If 24-hour counts are not available for these days, estimates can be made by expanding the interview period rest area traffic count to a 24-hour count. The relationship between the peak moment accumulations and daily rest area traffic is shown. The summary analysis Table 3 includes a summary of the case history peak-moment accumulation data expressed as a percentage of daily number of vehicles entering.

Table 5 is a suggested form of presentation of case history data on rest area use by vehicle type. Data on the type of vehicles using rest areas are useful in parking area design. The data for this portion of the table are obtained from a tabulation of the interview data for Item II-d, Vehicle Type. The highway traffic data are obtained from the worksheet (Fig. 6). A similar table would be prepared for the summary analysis in which the case history traffic classification data for all sites would be combined to show the composite distribution and relation of rest area and highway traffic by vehicle type.

It is suggested that rest area vehicle occupancy data be presented in terms of persons per vehicle as given in Tables 6 and 7. The data for the case history are obtained from a tabulation of the interview form data for Entry V, Number of Occupants. If there are substantial amounts of use of the rest area by trucks, it may be desirable to show separate occupancy data for light vehicles and trucks. The summary analysis data are transcribed from the case histories and an all site occupancy average computed as in Table 7.

Vehicles Stopping.—Experience has shown that a significant number of vehicles entering the rest area access roads do not stop to use the rest area facilities, but drive on through the rest area without stopping. The following data and analyses pertain to vehicles stopping in the rest area.

The relationship between the number of vehicles stopping in the rest area and the number entering the rest area access road for the case history is given in Table 8. The data for Table 8 are obtained from the work sheet for classifying entering vehicles by purpose of stop (Fig 12). A table showing the case history data for the average daily percent of entering vehicles stopping in the rest area will be adequate for the summary analysis. The case history and summary analysis narratives should indicate reasons for vehicles driving through the rest area without stopping as obtained from a review of interviewer comments and the daily report of rest area operations (Fig 7).

The state of registration of vehicles stopping is indicative of the proportion of resident and out-of-state use of the rest area. Data for the case history, Table 9, are prepared from a tabulation of the interview data by place of registration (Entry II-c). Data for a similar table for the summary analysis section may be compiled by summarizing the case history data and computing the percentage distribution of vehicles stopping by place of registration. Comparisons of the percentages of out-of-state and resident light vehicle traffic entering the rest areas and traveling the adjacent highways will indicate whether the proportion of resident and out-of-state traffic using rest areas was significantly different.

The time and distance intervals since last

TABLE 6

VEHICLE OCCUPANCY,[a] SHADY SPOT REST AREA

Day	Vehicles Entering	Persons	
		No.	Per Vehicle
Weekday	185	594	3 2
Saturday	230	748	3. 3
Sunday	245	760	3 1
Avg	200	640	3. 2

[a] Data shown for exemplary purposes only.

TABLE 7

VEHICLE OCCUPANCY[a]

Rest Area	Route	Average Daily Number		Persons Per Vehicle
		Vehicles Entering	Persons	
Shady Spot	I-50	200	640	3.2
Sleepy Hollow	I-50	165	495	3.0
etc.	etc	etc.	etc.	etc.
Avg.		190	589	3.1

[a]Data shown for exemplary purposes only.

stop by rest area users are indicative of the needed spacing of rest areas. For the case histories the time and distance intervals traveled since last stop are obtained from tabulations of the interview data for Entry VI, Last Stop. The distribution of stops by mileage since last stop may be obtained from a tabulation of the mileage data in selected class intervals and presented as a bar chart of cumulative percentage distribution (Fig. 13). A similar tabulation of the rest area stops by time in minutes since last stop will furnish data for a similar case history figure. The average time and distance since last stop are computed by totaling the mileages (or times) since last stop and dividing the sum by "N" (the total stops with mileage or time entries). For the summary analysis, it is suggested the case history distributions of stops by time and distance since last stop be combined for all study sites and presented in two charts similar to those shown in the case history.

For the case history analysis of the length of stop, it is suggested that Table 10 be prepared. The length of stop is shown as the difference between the entrance and departure times in Entry III-c of the interview form. The data for the table may be obtained from a tabulation of the stop times in minutes grouped in appropriate intervals by stop purpose. The average length of stop is computed by summing the length of all stops (Entry III-c) and dividing by "N" (the number of stops). For the summary analysis a chart or table would be prepared from the combined length of stop data for all study sites.

Purpose of stop data for the case history (Table 11) and the summary analysis (Table 12) are derived from the rest area study worksheet (Fig. 12). The worksheet data are compiled from a tabulation of the interview data (Entry VII) by purpose and day of week. If a large proportion of the stops are classified as "other," an analysis of the composition of this group by stop purpose should be made.

Facility Use.--Data on rest area facility use in terms of the number of vehicle-parties or number of persons using specific rest area facilities are important considerations in the design of rest areas as to types and number of facilities required.

Facility use in terms of the percentage of vehicle-parties' use of specific facilities for the case history are given in the suggested Table 13. The data are derived from a tabulation of the interview data, Entry VIII. The percentage of vehicle-parties using the various facilities are computed by dividing the number of

TABLE 8

RELATIONSHIP[a] OF VEHICLES STOPPING TO VEHICLES ENTERING REST AREA, SHADY SPOT REST AREA

Day	Number of Vehicles		Percent Stopping in Rest Area
	Entering	Stopping	
Weekday	185	168	91
Saturday	230	205	89
Sunday	245	215	88
Avg.	200	180	90

[a]Data shown for exemplary purposes only.

STATE OF_____

REST AREA STUDY WORKSHEET

NUMBER OF VEHICLES ENTERING REST AREA CLASSIFIED BY PRIMARY PURPOSE OF STOP AND DAY OF WEEK

Highway No. I-50 Study Period 10 AM - 5 PM

Rest Area Shady Spot July 7, 8, 30, 31, Aug. 15, 16, 31

Date & Day	Primary Purpose of Stop: Rest or Nap	Eating	Rest-room	Drinking Water	Recreation	Other	Unknown	All Stops	Drive Thru	Total Vehicles Entering
Weekday	40	49	36	25	4	4	2	160	15	175
Weekday	41	48	41	30	2	5	1	168	12	180
Weekday	48	55	39	28	1	2	2	175	17	192
Weekday	31	57	34	31	2	8	3	166	19	185
Weekday	43	51	39	24	3	7	4	171	22	193
Weekday Total	203	260	189	138	12	26	12	840	85	925
Saturday	44	69	55	26	4	5	2	205	25	230
Sunday	40	82	52	30	5	3	3	215	30	245
Weekly Total	287	411	296	194	21	34	17	1,260	140	1,400

(Data shown for exemplary purposes only)

Figure 12. Number of vehicles entering rest area classified by primary purpose of stop and day of week.

vehicle-parties using each facility by the total number stopping on the respective day. For the summary analysis, the vehicle-party facility use data may be presented as in Table 14. Facility use data in terms of vehicle-parties are most significant in regard to tables, fireplaces, or shelters as a single party will usually occupy the unit regardless of the number of persons in the party.

The case history data for relationship of vehicle-parties stopping during noon hour to vehicle-parties stopping to eat (Table 15) are obtained from a tabulation of the interview form Entry VII data (purpose of stop) by hour of day. These noon-hour data provide an estimate of the potential peak use of table-bench units. It should be recognized that in certain instances the number stopping to eat may be limited by the type and number of eating facilities available in the rest area and weather conditions. The data for the summary analysis are transcribed from the case histories and an all-site average computed as in Table 16.

Restroom use data in terms of the number of persons counted using restrooms for the case history are given in Table 17. The data for Table 17 are obtained from the daily report of the number of persons using the rest area facilities (Fig. 5). The number of persons using the restrooms are related to the number of vehicle-parties entering the rest area and shown as a persons per vehicle-party average. A similar

case history table should be prepared for all other types of facility use which were counted during the study in terms of numbers of persons, such as drinking water or telephone use. For the summary analysis, the personal facility use data may be summarized as in Table 18.

Means of Locating Rest Area.—The data from the interview question "How did you learn of or locate this rest area?" are indicative of the effectiveness of signing, and other means in directing the motorist to the rest area. The data from this question are summarized in the case history as in Table 19 from a tabulation of the interview data by the codes (1-4) for Entry IX. If different types of rest area signing are installed on the highway for each direction of travel, analysis of the data by travel direction (Entry IV) should be considered.

These data may be presented in the summary analysis in the form of comparative percentage distributions of rest area stops, similar to the purpose of stop (Table 12).

Other Data.—Additional questionnaire items that were collected during the survey should be analyzed and appropriately presented in the case history section of the report. The question content will, of course, determine its proper relation in the report outline.

TABLE 9

VEHICLE REGISTRATION[a] OF REST AREA USERS, SHADY SPOT REST AREA

Place of Registration	Vehicles Stopping	
	No.	% of Total
State of study	683	54.2
Bordering State:		
No. 1	198	15.7
No. 2	155	12.3
No. 3	63	5.0
No. 4	39	3.1
Other State	76	6.0
Foreign country	36	2.9
Unidentified	10	0.8
Total	1,260	100.0

[a]Data shown for exemplary purposes only.

TABLE 10

PERCENTAGE DISTRIBUTION[a] OF REST AREA STOPS BY LENGTH OF STAY AND STOP PURPOSE, SHADY SPOT REST AREA

Length of Stay	Purpose				All Stops
	Rest or Nap	Eating	Restroom	Other	
Less than 10 min	9	5	55	16	25
10 - 19 min	17	18	25	18	22
20 - 29 min	23	22	9	15	14
30 - 39 min	36	35	8	12	12
40 - 49 min	10	18	3	10	8
50 - 59 min	2	1	-	9	6
1 - 1 1/2 hr	1	1	-	12	5
1 1/2 - 2 hr	1	-	-	4	3
2 - 3 hr	1	-	-	-	1
3 - 4 hr	-	-	-	-	1
4 hr or more	-	-	-	4	3
Total	100	100	100	100	100
Avg. (min)	30	38	14	46	32

[a]Data shown for exemplary purposes only.

TABLE 11

PERCENTAGE DISTRIBUTION[a] BY PRIMARY PURPOSE OF STOP, SHADY SPOT REST AREA

Day	Primary Purpose of Stop (%)							
	Rest or Nap	Eating	Rest-room	Drinking Water	Recrea-tion	Other	Unknown	All Stops
Weekday	24.2	31.0	22.5	16.4	1.4	3.1	1.4	100.0
Saturday	21.5	33.7	26.8	12.7	1.9	2.4	1 0	100.0
Sunday	18.6	38.1	24.2	14.0	2.3	1.4	1.4	100.0
Avg.	22.8	32.6	23.5	15.4	1 7	2.7	1.3	100.0

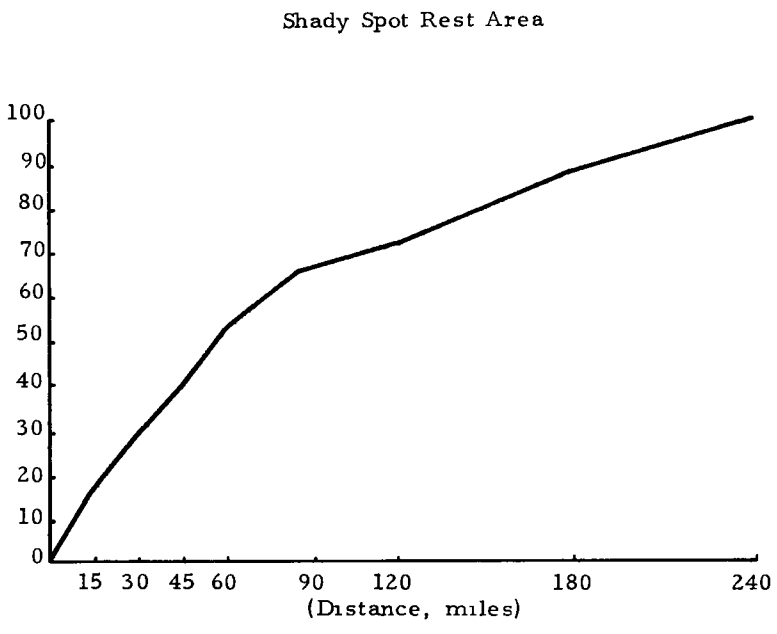
[a]Data shown for exemplary purposes only.

TABLE 12

PERCENTAGE DISTRIBUTION[a] BY PRIMARY PURPOSE OF STOP

Rest Area	Route	Primary Purpose of Stop (%)							
		Rest or Nap	Eating	Rest-room	Drink-ing Water	Recrea-tion	Other	Unknown	All Stops
Shady Spot	I-50	22.8	22.6	23.5	15.4	1.7	2.7	1.3	100.0
Sleepy Hollow	I-50	27.5	31.2	17.6	13.9	3.1	5.7	1 0	100.0
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.
Avg.		24.5	33.0	21.0	14.2	2.9	3.3	1 1	100.0

[a]Data shown for exemplary purposes only.



(Data shown for exemplary purposes only)

Figure 13. Cumulative percentage of vehicle-parties by distance traveled since last stop.

TABLE 13

PERCENTAGE DISTRIBUTION[a]

Day	Type of Use[b] (%)						
	Drinking Water	Restrooms	Tables & Benches	Shelters	None	Unknown	Total
Weekday	75.1	52.3	31.0	15.9	11.4	1.0	100.0
Saturday	69.2	55.7	36.8	14.5	10.9	1.3	100.0
Sunday	71.7	60.2	29.9	13.1	14.1	1 4	100.0
Avg.	73.8	53.9	31.7	15.3	11.7	1.1	100.0

[a]Data shown for exemplary purposes only.
[b]Percentage of vehicle-parties stopping in rest area which used designated facility. Percentages will not add to total as one vehicle-party may use more than one facility.

TABLE 14

PERCENTAGE DISTRIBUTION[a] BY TYPE OF FACILITY USED

Rest Area	Route	Type of Use[b] (%)						
		Drinking Water	Rest-Room	Table-Bench Units	Shelters	None	Unknown	Total
Shady Spot	I-50	73.8	53.9	31.7	15.3	11.7	1.1	100.0
Sleepy Hollow	I-50	68.0	44.7	30.5	14.6	13.2	0.9	100.0
etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.	etc.
Avg		72.1	47.7	30.8	15.1	12.4	1.1	100.0

[a]Data shown for exemplary purposes only.
[b]Percentage of vehicle-parties stopping in rest area which used designated facility.

TABLE 15

RELATIONSHIP[a] OF VEHICLE-PARTIES STOPPING DURING NOON HOUR TO VEHICLE-PARTIES STOPPING TO EAT, SHADY SPOT REST AREA

Day	Vehicle-Parties (no.)		Percent of Vehicle-Parties Stopping During Noon Hour to Eat[b]
	Total Stopping	Stopping to Eat	
Weekday	19.2	10.6	55.2
Saturday	26	18	69.2
Sunday	31	23	74.2
Avg.	21.9	13.4	61.2

[a]Data shown for exemplary purposes only.
[b]Potential users of tables and benches.

General Comments.—Summaries of the rest area occupant and interview comments should be prepared from the remarks entered at the bottom of the rest area interview forms. The daily report of rest area operations made by the study crew chief will also aid in the analysis of the observer comments. As a means of organizing the many diverse comments received and shown on the interview forms, it is suggested that extracts of typical comments be compiled from the rest area interview forms into four categories:

1. Favorable occupants comments.
2. Unfavorable occupants comments.
3. Favorable observers comments.
4. Unfavorable observers comments.

TABLE 16

RELATIONSHIP[a] OF VEHICLE-PARTIES STOPPING DURING NOON HOUR TO VEHICLE-PARTIES STOPPING TO EAT

Rest Area	Route	Vehicle-Parties (no.)		Percent Stopping to Eat During Noon-Hour[b]
		Stopping	Stopping to Eat	
Shady Spot	I-50	21.9	13.4	61.2
Sleepy Hollow	I-50	19.0	12.2	64.2
etc.	etc.	etc.	etc.	etc.
Avg.		21.4	12.9	60.3

[a]Data shown for exemplary purposes only.
[b]Potential peak table use.

TABLE 17

RELATIONSHIP[a] OF PERSONS USING RESTROOMS TO VEHICLE-PARTIES ENTERING REST AREA, SHADY SPOT REST AREA

Day	Number of Vehicle-Parties Entering Rest Area	Number of Persons Using Restrooms	Restroom Use (persons/vehicle-party)
Weekday	185	293	1.6
Saturday	230	345	1.5
Sunday	245	373	1.5
Avg.	200	312	1.6

[a]Data shown for exemplary purposes only.

TABLE 18

RELATIONSHIP[a] OF PERSONS USING RESTROOMS TO VEHICLE-PARTIES ENTERING REST AREA

Rest Area	Route	Number of Vehicle-Parties Entering Rest Area	Number of Persons Using Restrooms	Restroom Use (persons/vehicle-party)
Shady Spot	I-50	200	312	1.6
Sleepy Hollow	I-50	165	250	1.5
etc.	etc.	etc.	etc.	etc.
Avg.		190	280	1.6

[a]Data shown for exemplary purposes only.

A review of this compilation will ordinarily disclose a pattern of typical comments, and an evaluation of the data then can be made.

PREPARATION OF REPORT

The following suggestions for report content are intended as a guide only and should not be considered as restricting the report content. A broad report outline is shown to indicate a logical order of data presentation and report content based on the data collection and analysis procedures previously described. The narrative accompanying the analysis tables and charts should summarize the most important and significant data, and indicate meaningful relationships shown by comparison of data at the various study sites.

TABLE 19

MEANS[a] OF LOCATING REST AREA, SHADY SPOT REST AREA

Means	Number of Vehicles Stopping	Percent of Total
Road map	58	4.6
Road signs	642	51.0
Previous visits	420	33.3
Other	116	9.2
Undetermined	24	1.9
Total	1,260	100.0

[a]Data shown for exemplary purposes only.

Suggested Report Outline

A. Introductory Pages

1. Title page
2. Preface
   a. Reason for report
   b. Purpose of study
   c. Acknowledgments
3. Table of Contents
4. List of Tables and Figures
5. Introduction

B. Conclusions

State significant conclusions that have been drawn from and are supported by findings of the study. Such conclusions might include statements regarding potential amounts of use of certain types of rest areas or facilities; the effect of rest area location, types of facilities, signing, and design on the amount or character of rest area use; the adequacy of existing rest area facilities; deductions pertaining to required rest area spacing; and the adequacy of rest area maintenance.

C. Summary of Findings

The summary of findings should include, but not be limited to, the following:

1. Statements of the average daily number of vehicles and percent of highway traffic entering the rest areas.
2. Statements of the average and peak moment accumulations of vehicles in the rest areas (number and percents).
3. Statements regarding the findings of any control conditions on the amount and types of rest area use (advance signing vs no advance signing, shoulder parking vs no parking, freeway vs expressways, etc.).
4. Statements of peak periods of rest area use (hour, day of week) and relative use during these periods.

5. Statements of the average time and distance since last stop and the percentage of rest area stops that occur within specified times and distances since last stop which are indicative of current policy on rest area spacing.
6. Statements of the amount of rest area use by vehicle type.
7. Statements of the amount of use of rest area facilities (parking, table-bench units, restrooms, drinking water, etc.).
8. Statements regarding primary purposes of rest area stops (percent of vehicle-parties stopping for various purposes).
9. Statements of the average number of persons per vehicle entering the rest area and significant differences, if any.
10. Statements of the proportions of in- and out-of-state vehicle use of rest areas (vehicle registration data).
11. Statements of the proportion of entering rest area vehicle traffic that

Shady Spot Rest Area

Week Beginning	Day of Week						
	Sun.	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.
July 2	-	385	396	362	375	389	410
July 9	468	362	341	321	384	371	460
July 16	492	372	392	341	362	355	442
July 23	462	369	382	391	400	425	489
July 30	441	341	381	361	345	367	449
August 6	497	321	352	339	360	368	-

Sleepy Hollow Rest Area

Week Beginning	Sun.	Mon.	Tue.	Wed.	Thur.	Fri.	Sat.
July 2	-	275	281	306	291	317	392
July 9	367	270	291	269	268	284	381
July 16	352	286	300	277	287	289	402
July 23	371	296	269	276	274	246	410
July 30	361	293	301	300	299	266	380
August 6	349	291	268	294	285	278	-

(Data shown for exemplary purposes only)

Figure 14. Rest area traffic volume count summary.

stops in the rest area and the primary reasons for not stopping.
12. Statements regarding occupant attitudes toward rest areas and major points of satisfaction and dissatisfaction.
13. Statements regarding evaluations of operation of the rest areas as determined by observers and occupants comments.

D. Study Methodology

1. Selection and description of study sites.
2. Description of data collection.

E. Analysis

1. Traffic volumes.
2. Rest area use.

F. Case Histories

G. Appendix

1. Rest Area Interview Form.
2. Rest Area Traffic Volume Count Summary (Fig. 14).

REFERENCES

1. "Safety Rest Areas on Interstate Highways." U.S. Department of Commerce, Bureau of Public Roads, Circular Memo. (August 6, 1959).
2. "Parking Turnouts and Rest Areas." HRB Special Report 7 (1951).
3. "A Policy on Safety Rest Areas for the National System of Interstate and Defense Highways." AASHO (April, 1958).
4. "Freeway Operations." Institute of Traffic Engineers (1961).
5. "Shoulder Use Study Procedure Guide." HRB Correlation Circular 426 (Aug. 1960).
6. Ohio Department of Highways, unpublished data on rest area use (Aug. 1961).

Appendix A

STATISTICAL ANALYSIS

Sample Size Determination

The purpose in this appendix is to describe a statistical method of estimating the sample size required to provide data with sampling errors at or below a given value. In other words, what is the sample size necessary so that the proportional sampling error of certain statistics will be within a specified range?

In the instance of rest area studies, it is desirable to ascertain the sample size needed to determine the average percent of highway traffic entering the rest area in a 24-hour period and the average number of vehicles accumulated during the daily peak moment within reasonable accuracy (± 10 and ± 20 percent, respectively).

A standard sample size determination method may be applied as follows:

If C = allowable proportional error in sample mean;

P = daily sample percent of highway traffic entering rest area;

$\overline{P}$ = average of daily sample percents;

σ_P = standard deviation of sample percents;

$t_{0.05}$ = critical value of t exceeded only 5 times in 100 as obtained from t distribution for appropriate number of degrees of freedom; and

N = number of sample days;

then,

$$|C\overline{P}| = t_{0.05}\sigma_P/\sqrt{N-1} \quad (1)$$

Solving Eq. 1 for N,

$$N = \frac{1 + t^2_{0.05}\sigma_P^2}{C^2\overline{P}^2} \quad (2)$$

Eq. 2 may be expressed in raw score form for easy machine calculation as follows:

$$N = 1 + \frac{t^2_{0.05}[(N\Sigma P^2) - (\Sigma P)^2]}{C^2(\Sigma P)^2} \quad (3)$$

A percentage of traffic P in Eq. 3 would be established from each day's highway and rest area traffic recorder counts, and the derived sample percentages P would be used in calculating the required sample size. If a larger sample were indicated by the required number of days N to achieve the desired accuracy, additional counts should be taken.

The sample evaluation procedure as just described applies to the required sample size for determining the average peak-moment vehicle accumulation in the rest area. In this instance, the number of vehicles accumulated each day at the peak moment X would be substituted for P in Eq. 3,

$$N = 1 + \frac{t^2[(N\Sigma X^2) - (\Sigma X)^2]}{C^2(\Sigma X)^2} \quad (4)$$

The following is an example of the sample size computation applied to peak moment vehicle accumulation data for a 7-day sample at an Oregon rest area: Number of Vehicles accumulated at peak moment X for each day = 9, 9, 8, 7, 9, 11, and 13; $\Sigma X = 66$; $C = 0.2$; $\Sigma X^2 = 646$; $\overline{X} = \frac{\Sigma X}{N} = 9.429$; $\sigma_X = \frac{1}{N}\sqrt{N\Sigma X^2 - (\Sigma X)^2} = 1.841$; $t_{0.05} = 2.247$ (6 degrees of freedom); and $N = 7$. Substituting in Equation 4,

$$N = 1 + \frac{(2.447)^2[7(646) - (66)^2]}{(0.2)^2(66)^2} = 1 + \frac{993.977}{174.240} = 6.705$$

Thus, 7 days would be sufficient sample size to achieve the desired accuracy of ±20 percent, 95 times in 100.

Method of Evaluating Variability of Given Sample

If a sample of a given size has been obtained, it is desirable to analyze the variability of the data in terms of the relative accuracy of the major statistic derived. To determine the variability in terms of expected percent of error, Eq. 1 may be rearranged for the solution of C, the proportional error of the sample mean, as

$$C = \frac{t_{0.05}\sigma X}{\sqrt{N-1}\,(\overline{X})} \quad (5)$$

Here, all components have the same meaning as in Eq. 1 except that X is substituted for P. Applying this equation to the peak moment vehicle accumulation data used in the previous example,

$$C = \frac{2.447(1.841)}{\sqrt{6}\,(9.429)} = \frac{4.505}{23.101} = 0.195$$

This result is interpreted to mean that the sample average peak-moment vehicle accumulation is expected to be within ± 19.5 percent of the true mean, 95 times in 100.

Stating the variability of the sample in terms of the confidence interval of the mean by use of the t-distribution, where μ is the population mean;

$$\overline{X} - \frac{t\sigma}{\sqrt{N-1}} \leq \mu \leq \overline{X} + \frac{t\sigma}{\sqrt{N-1}} \qquad (6)$$

Substituting the components of the example, $\frac{t\sigma}{\sqrt{N-1}} = \frac{2.447\ (1.841)}{\sqrt{6}} = 1.839.$

Substituting in Eq. 6 and rounding to the nearest tenth, the mean of the population can be expected to lie between 7.6 and 11.3, 95 percent of the time.

Appendix B

DESCRIPTION OF REST AREA AND RELATED INFORMATION

Rest Area _____ Date _____

1. Highway No. _____, _____, _____, _____, _____.
   Milepoint, No. Lanes, Lane Width, Shoulder Width

2. General Description of Rest Area (Physical size, geographic location, physical features, topography, recreational aspects, visibility from highway).

3. Inventory of Facilities:

   (a) Restrooms (Number and type).

   (b) Table and bench units (Number and location).

   (c) Cooking facilities (Type, number, and location).

   (d) Parking facilities (Type, number of spaces, size).

   (e) Other facilities (Shelters, drinking fountains, telephones, informational signboards, electrical outlets, camp sites, et cetera—number and type).

4. Log of signs related to rest area use (rest area signs, sign for nearby State Parks or nearby public or private rest area facilities, and regulatory shoulder parking signs).

Sign	Milepoint	Comments (Direction of travel served, miles from rest area, size, condition).

5. Log of Service Stations, Parks, Cities, and other private or Public Rest Areas within 15 miles of the study Rest Area.

Name	Location	Description

6. Sketch of Rest Area (Show general plan of rest area in relation to highway, access roads, parking, facilities locations).

7. Sketch map of rest area (Scale 1" = 1 mile) and surrounding area about five miles each side of area. (Obtain from Highway Department maps).

8. Photographs of rest area. (An aerial photo is desiralbe.)

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