Manual of TRANSIT and TRAFFIC STUDIES

AMERICAN TRANSIT ASSOCIATION

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Manual of TRANSIT and TRAFFIC STUDIES

AMERICAN TRANSIT ASSOCIATION

292 MADISON AVENUE

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1947

Foreword

THIS FIRST EDITION of the "Manual of Transit and Traffic Studies" has been designed to assist transit companies and traffic engineers in the conduct and application of studies deemed essential to a solution of present and future problems of urban transportation and traffic movement in our cities.

The Manual was prepared by Harold F. Hammond, who was Manager, Washington Office, American Transit Association, during the period November 1, 1944 to April 15, 1947. It has been reviewed and approved by the Operations Division of the Association.

The twenty studies described herein are considered desirable to proper planning to meet the growing problem of traffic congestion and to enable transit management to develop the basic data needed in the consideration of service improvements, changes in routing, extensions, and other problems with which it is confronted as a result of constantly changing conditions. Although these techniques are known to many transit and traffic engineers, it is hoped that their publication in this form will stimulate their widespread use by all concerned in the urban transportation and traffic field.

Grateful acknowledgment is made of the assistance of the following individuals in reviewing the work during its preparation and in furnishing numerous of the forms and charts used in illustrating the methods described:

Karl A. Bevins, *Traffic Engineer*, Georgia Power Company
H. R. Blomquist, *Supervisor of Engineering and Research*, United Electric Railways Company
John B. Ecker, *Director of Research and Planning*, Capital Transit Company
G. H. Frieling, *Director of Reasearch*, Kansas City Public Service Company
Homer H. Grant, Piedmont, California
W. W. Harris, *Manager*, Delaware Coach Company
W. F. Irvin, *Research Engineer*, Toronto Transportation Commission
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Wm. R. McConochie, DeLeuw, Cather and Company
John B. Moriarty, *Research Engineer*, Indiana Service Corporation
Joe R. Ong, *Director of Research*, The Cincinnati Street Railway Company
Paul A. Rust, *Vice President*, Connecticut Railway and Lighting Company
P. N. Simmons, *Manager, Transportation Department*, Ebasco Services, Inc.

Special appreciation is expressed to the National Conservation Bureau, a division of the Association of Casualty and Surety Executives, for its permission to reproduce portions of the text and some of the forms appearing in its publication, "Manual of Traffic Engineering Studies."

How To Use The Manual

THE MANUAL describes how to make twenty studies. Each has been written as an independent study in concise form. It is not intended that all twenty, studies should be made by any one transit company. Some studies may never be needed. Nor is the order in which the studies have been presented of significance.

To facilitate the use of the manual each of the twenty studies has been divided into four major sections as follows:

DESCRIPTION

WHEN AND WHY STUDY IS MADE

HOW TO MAKE STUDY

EXAMPLES OF APPLICATION

Sample field and summary forms, as well as methods of graphically presenting the data, are included in each study. The examples accompanying each study are presented for illustrative purposes only. The numerical values they contain should not be used for comparative purposes, nor should they be quoted.

Since procedures and field forms cannot be prepared which will fit every special use and every size of property, the forms and procedures as given should be used primarily as guides. Often it will be found desirable to combine two or more studies when conducting a broad survey. In such instances it should be fairly clear that certain adjustments and the elimination of duplication in the field procedures and lay-out of field forms will be necessary. It is important, however, that all factors involved be carefully weighed before making a selection of studies to use.

A detailed index is given in the back of this manual. It should be used liberally. It clearly shows similar or common points covered by the various studies and how the use of certain studies can be interchanged.

MANUAL OF
TRANSIT AND TRAFFIC
STUDIES

TABLE OF CONTENTS

STUDY NUMBER 1

PASSENGER COUNTS AT MAXIMUM LOAD POINTS

DESCRIPTION—A study of transit passenger volume at the maximum load points and other special points on a given transit line.

This study is invaluable to transit. It is basic to the operation of a transit system. It is the most important study for transit given in this manual.

WHEN AND WHY STUDY IS MADE—This study should be made in accordance with seasonal variations in transit riding and as often as conditions warrant. On new routes, re-equipped routes and in times of marked changes in riding habit a constant check on passenger volumes may be necessary, especially at the maximum-load points.

Passenger count studies are well known to most large transit companies. A majority have been making them for years. However, some of the companies still have not made a regular practice of collecting this type of important and basic transit data, and, therefore, fail to derive the full benefit from such factual information.

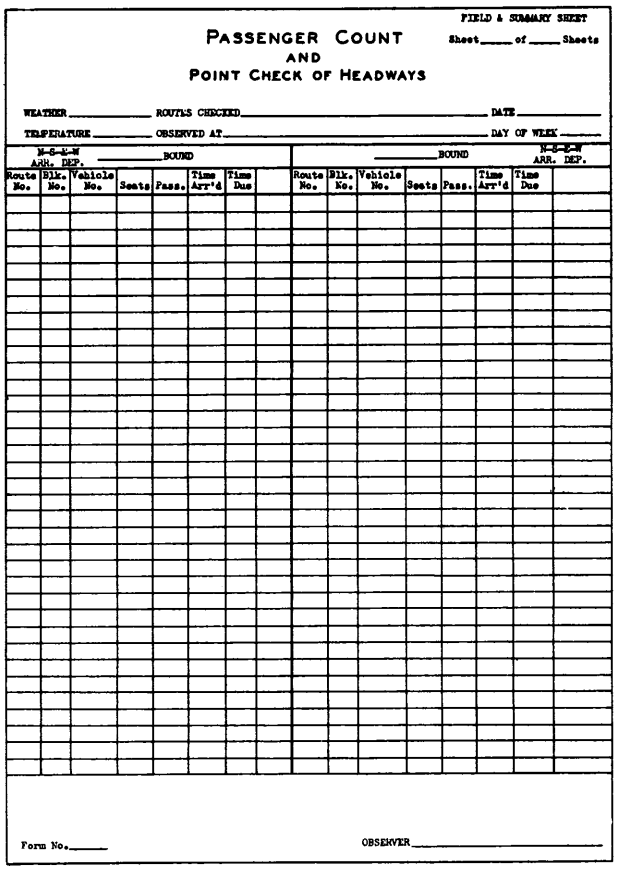
The data obtained by this study are particularly important because of their use in the preparation of schedules. It provides a yard stick to more closely fit the scheduling of transit equipment to rider demands. Specifically, the study should be made:

(1) To determine when and how much service should be added to or deducted from the schedule of an existing line to increase its efficiency.
(2) To check the adequacy of a new schedule.
(3) To check on complaints from the public.
(4) As an aid in determining the size and type of equipment to allocate to various routes.
(5) For use in traffic cordon studies (*see* Study No. 12).
(6) To show need for and value of staggered hours on one or more lines (*see* Study No. 20).
(7) To determine trends in passenger loads and general riding characteristics for each line.

HOW TO MAKE STUDY—This study requires transit passenger loads to be observed and recorded at the heaviest load points and at other specially selected points along the line. If locations are not known, they should be determined by making Study No. 2. It may cover only the inbound maximum or the outbound maximum load point, or it may cover these several maximum load points, plus other key points along the line.

Generally, a whole operating day is checked. Sometimes, however, only the morning and afternoon rush periods and an average midday period are checked. Occasionally, special problems may warrant special periods being checked in addition to these periods. Generally, a single one-day check is adequate providing it can be compared with previous checks, but sometimes a two or three-day check may be necessary to obtain an average count that can be considered typical of normal conditions.

The field form (Exhibit 1) used for each direction of movement includes vertical columns for block (or run)



FIELD & SUMMARY SHEET

PASSENGER COUNT AND POINT CHECK OF HEADWAYS

Sheet ____ of ____ Sheets

WEATHER _____ ROUTES CHECKED _____ DATE _____

TEMPERATURE _____ OBSERVED AT _____ DAY OF WEEK _____

N-S-E-W ARR. DEP. _____ BOUND _____ BOUND N-S-E-W ARR. DEP.

Route No.	Blk. No.	Vehicle No.	Seats	Pass.	Time Arr'd	Time Due		Route No.	Blk. No.	Vehicle No.	Seats	Pass.	Time Arr'd	Time Due	

Form No. ____ OBSERVER _____

EXHIBIT 1
Passenger count and point check of headways field and summary sheet

number, vehicle number, schedule time and actual arrival time, and number of passengers. Alternate field forms also in use are shown on Exhibits 2 and 3.

Transit passengers in each and every transit vehicle are counted as they pass the maximum load point or other key point being checked. The observer is stationed at a point within the area of maximum load or key point load where he can see the approaching transit vehicles from one or both directions being checked, as well as the passengers on the vehicles as they make a stop at the maximum load point or other key point.

Properly instructed and experienced observers are able to check on the number of passengers per transit vehicle with a high degree of accuracy when using this field form.

The observer should be instructed to record the run number, vehicle number, and vehicle destination, as the vehicle is approaching check point in order to save time. The instructions should also include how the passengers in vehicle should be counted. The general practice is to (a) count the individual passengers on the vehicle if there is less than a seated load, and (b) count the standees only if more than a seated load. (In order that an observer may record the total load by counting only standees in a full vehicle, he must either know the seating capacities of the units or be provided with a list of the equipment and its seating capacities.)

The observer should also be instructed as to (a) whether he should check the arrival or departure time of the vehicles; (b) whether he must read the arrival or departure time to the closest ¼ or ½ minute; and (c) whether he should make his count of passengers before

Transportation Department
TRAFFIC REPORT

Date _____ 19___ in A.M. P.M. Line _____

Schedule _____ Place _____

Weather _____ Day of Week _____ Bound _____

Block No.	Short Trip	Car No.	Arrived	De-parted	Head-way	Sched. Time	Stand-ing Pass.	Total Pass.	Remarks

Signed _____

EXHIBIT 2

An alternate passenger count field sheet used by many transit companies. It is convenient to handle in field since it is 4" x 8" in size.

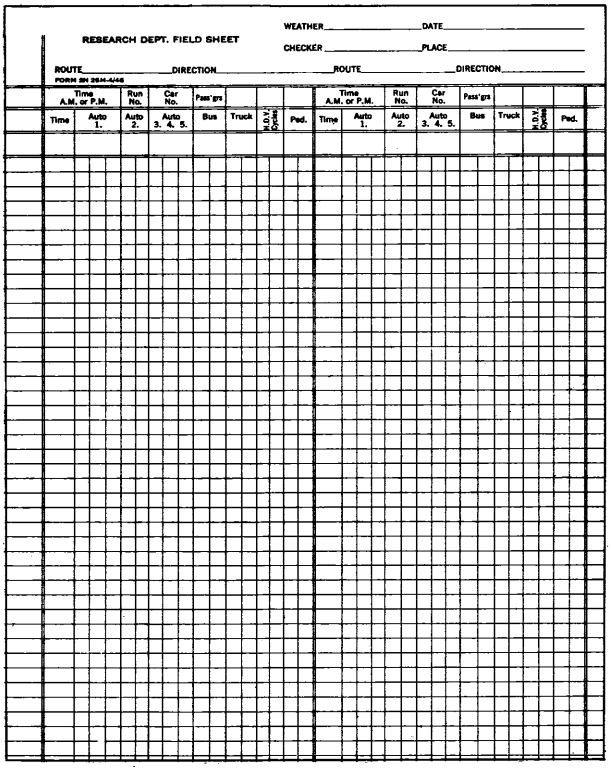


EXHIBIT 3

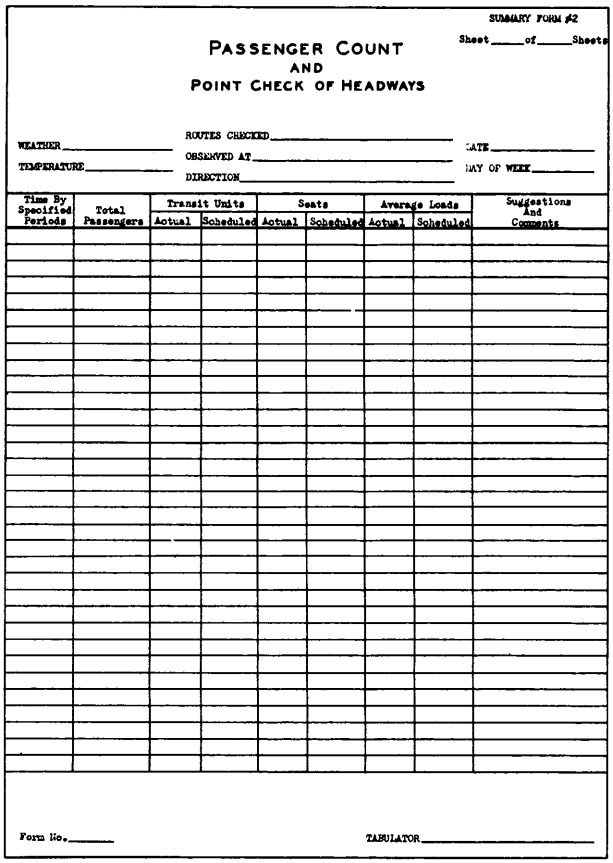
A transit company prepared this general field sheet so it could be used in many ways. The first group of horizontal headings makes the form applicable to a passenger count and point check of headways. The second group of horizontal headings are used for making a general traffic count. The third horizontal column is left blank so that any other headings desired can be inserted.

the vehicle doors are opened or after they have again been closed. These latter instructions will be dependent upon the passenger-count policy established by the company. Generally, however, it is the practice to check the arrival time; to read the arrival time to the closest ½ minute; and to count the passengers before the doors are open.

The personnel for such a study will depend upon the number of routes being checked at one time and the number of points being checked on each route. Usually one observer is capable of checking passengers and arrival times of vehicles from both directions, under normal conditions. If it is an extremely heavy point, however, one man may be required for each direction of movement.

Company employees, especially trained, are used for making the field checks. If possible, the same employees, regardless of whether they are assigned full or part time to field checking, should be used for making all the counts over a period of time. As indicated above, experienced observers can attain a very high degree of accuracy in counting.

The field data are summarized by 15, 20 or 30-minute periods for each location checked. The average load per transit vehicle is then computed. The original field form (Exhibit 1) can be used for summary purposes by tallying with a red pencil the data on a 15, 20 or 30-minute basis, or a special summary form (Exhibit 4) can be



SUMMARY FORM #2

Sheet ____ of ____ Sheets

PASSENGER COUNT
AND
POINT CHECK OF HEADWAYS

WEATHER _____ ROUTES CHECKED _____ DATE _____

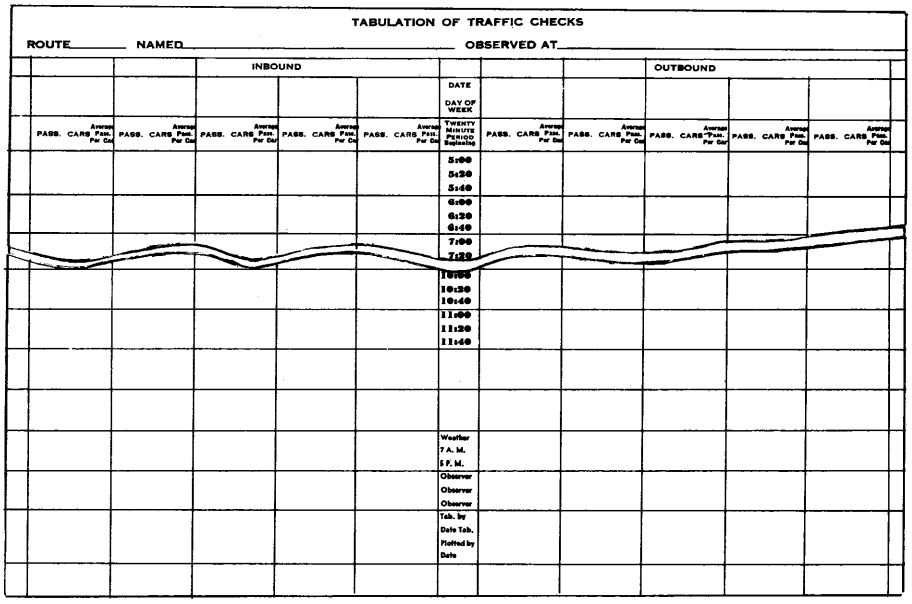
TEMPERATURE _____ OBSERVED AT _____ DAY OF WEEK _____

DIRECTION _____

Time By Specified Periods	Total Passengers	Transit Units		Seats		Average Loads		Suggestions And Comments
		Actual	Scheduled	Actual	Scheduled	Actual	Scheduled	

Form No. _____ TABULATOR _____

EXHIBIT 4



TABULATION OF TRAFFIC CHECKS

ROUTE _____ NAMED _____ OBSERVED AT _____

INBOUND | DATE | OUTBOUND

DAY OF WEEK

PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car	Twenty Minute Period Beginning	PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car	PASS.	CARS	Average Pass. Per Car
												5:00											
												5:20											
												5:40											
												6:00											
												6:20											
												6:40											
												7:00											
												7:20											
												10:00											
												10:20											
												10:40											
												11:00											
												11:20											
												11:40											

Weather 7 A. M. _____ 1 P. M. _____

Observer _____

Observer _____

Observer _____

Tab. by _____

Date Tab. _____

Plotted by _____

Date _____

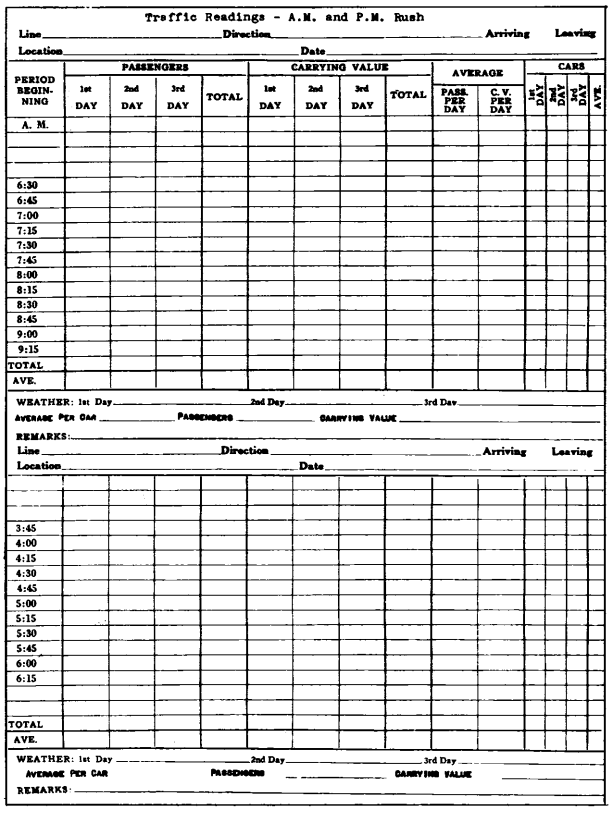
EXHIBIT 5

11" x 14" summary sheet on which only the passengers are recorded (Scheduled times are omitted).

used as illustrated. This special summary form (Exhibit 4) can also be expanded and used to make comparisons of passenger counts taken on different days. Other types of summary forms now in use are shown on Exhibits 5 and 6.

Special tables or charts should then be prepared to show the fluctuation in transit loads (minimum, average and maximum) for each 15, 20 or 30-minute period throughout the entire period checked. (Exhibits 7, 8, 9 and 10) This information is then compared with the capacity and schedule of transit vehicles to determine whether changes are warranted in the operation. For example, the passengers carried over any interval of time (usually 15 to 30 minutes) divided by the capacity of the vehicle equals the number of units, which in turn can be translated into headways.

A study can also be made of the adherence to schedule by taking special note of the relationship of actual arrival time to scheduled arrival time shown on the field sheet, for each transit vehicle passing the points being checked. The scheduled time is filled in by office clerks after the field work is completed.



Traffic Readings - A.M. and P.M. Rush

Line _____ Direction _____ Arriving Leaving

Location _____ Date _____

PERIOD BEGINNING	PASSENGERS 1st DAY	2nd DAY	3rd DAY	TOTAL	CARRYING VALUE 1st DAY	2nd DAY	3rd DAY	TOTAL	AVERAGE PASS. PER DAY	AVERAGE C.V. PER DAY	CARS 1st DAY	2nd DAY	3rd DAY	AVE.
A. M.														
6:30														
6:45														
7:00														
7:15														
7:30														
7:45														
8:00														
8:15														
8:30														
8:45														
9:00														
9:15														
TOTAL														
AVE.														

WEATHER: 1st Day _____ 2nd Day _____ 3rd Day _____

AVERAGE PER CAR _____ PASSENGERS _____ CARRYING VALUE _____

REMARKS: _____

Line _____ Direction _____ Arriving Leaving

Location _____ Date _____

3:45														
4:00														
4:15														
4:30														
4:45														
5:00														
5:15														
5:30														
5:45														
6:00														
6:15														
TOTAL														
AVE.														

WEATHER: 1st Day _____ 2nd Day _____ 3rd Day _____

AVERAGE PER CAR _____ PASSENGERS _____ CARRYING VALUE _____

REMARKS: _____

EXHIBIT 6

Another type of summary, used by a local transit company, which permit a comparison of actual passengers carried to computed carrying capacity for three separate days.

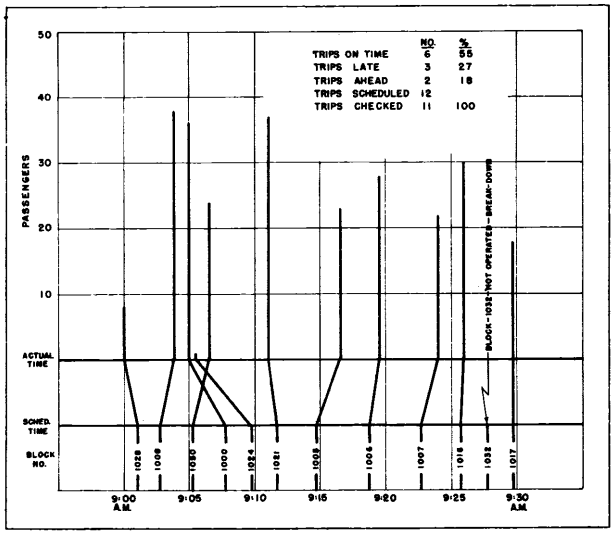


EXHIBIT 7

A graph showing number of passengers carried by each transit vehicle and a comparison of actual to scheduled operations.

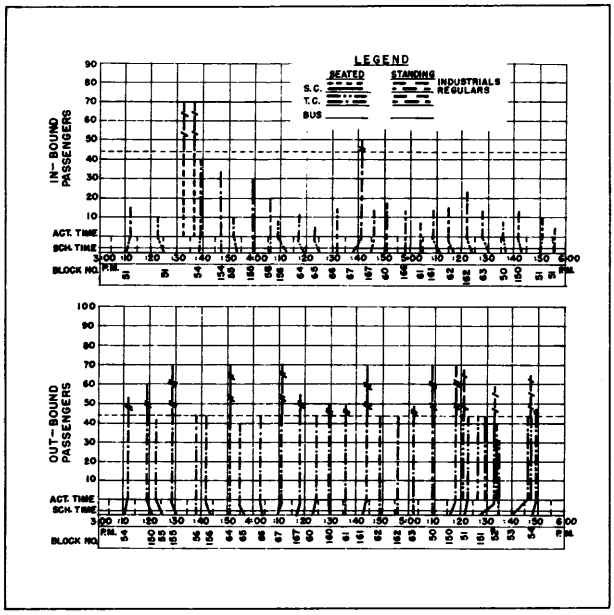


EXHIBIT 8

A typical 3½-hour check at a peak load point showing inbound and outbound passengers per transit vehicle and actual against scheduled arrival time for each unit.

EXAMPLES OF APPLICATION

Example No. 1—Field checks were needed by a schedule department as a basis for preparing an efficient schedule for a local bus route. *First*, personal observations and a study of industries, schools, and residential concentrations along the route were made, and "on-and-

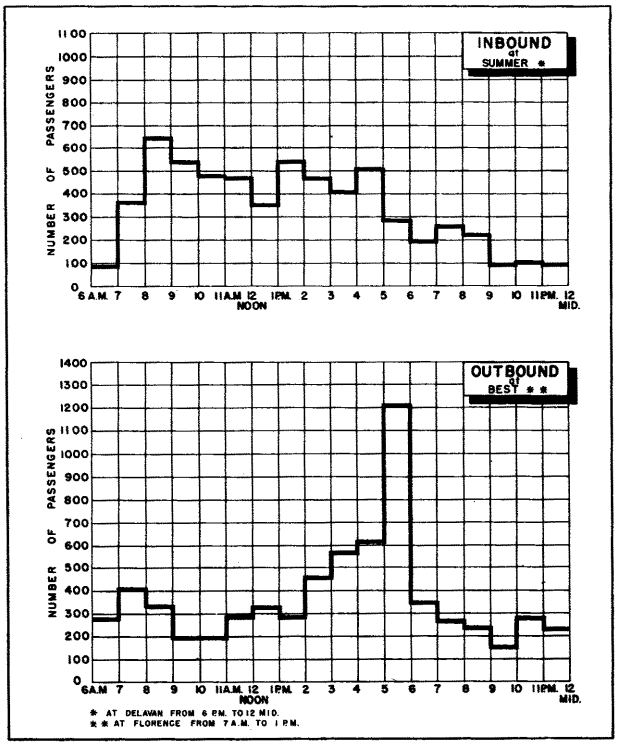


EXHIBIT 9

A graph showing hourly passenger volume at maximum load points (for a street car line) from 6 a.m. to 12 midnight on a typical weekday.

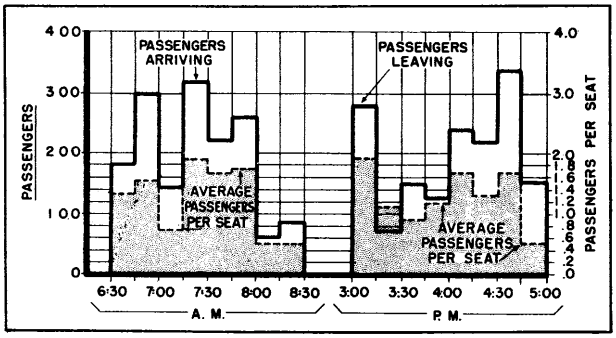


EXHIBIT 10

Application of passenger count to a specific location—in this instance to and from an industrial establishment.

off" checks were taken on a few trips (Study No. 2). These served to locate (a) the maximum load points, and (b) possible turnback locations. *Second*, fixed-point passenger counts, as described herein, were then taken at these locations during morning and evening rush and midday periods.

All checks were summarized by averaging the bus loads in 15-minute periods. From this was determined the number of buses that would be required to provide the correct standard of loading at these various check points. It was found that, even though the loading was below standard at a possible turn-back point, no saving could be effected in bus hours—so no turnbacks were put into effect. Adjustments in headway were required during the rush periods, however. This was effected by a shift in time of several buses from lighter 15-minute periods to the heavier periods, so that it was actually unnecessary to add any units to the line. Several trips were eliminated in the latter portion of the rush periods, which gave a substantial net saving. No saving was possible, however, in the non-rush periods, since it was recognized that the headways being operated were as long as could be possible and still give reasonable service. (Headways for off-peak service are often determined on a basis of policy and not on passenger checks alone.)

Example No. 2—Several complaints were received of overcrowding on a certain line during the morning rush period of 8:00 to 8:15. Three specific passenger counts for this line, two taken before the complaint and one the day after the complaint, showed no over-loads on any of the morning runs at the peak-load point. A further check of the records did reveal, however, that one of the buses had broken down the morning of the complaints in the 8:00 to 8:15 period, which had caused an overload on the next bus and was the reason for the complaints. Supplied with this information, the complainants were satisfied.

Example No. 3—Complaints were received that no trolley coaches for a certain line had arrived between 5:00 and 5:20 during the afternoon rush period, when the schedule called for 12-minute headways. The passenger count study, taken on the day of the complaint, showed in the supplemental data on actual arrival time that a trolley coach had passed the stop of the complainant at 5:13 p.m.

Example No. 4—During September, 1945 all routes of a small transit property were connected as through routes. Prior to this time, they had all looped in the central business district. Since 1945, the decreased Navy Yard activity and a shifting of population from temporary to permanent housing has caused a marked change in riding habits. Lines formerly connected to make through routes, no longer had the same density of travel in both sections of the city. Therefore, excess mileage was being provided to sections of the city which showed the greatest reduction in business. A 12-hour inbound check of passengers was made on each section of line during November 1946. The change of business was measured on each portion of the through routes and it was shown that the lines should be re-connected for greater economy in operation. The comparison of riding

COMPARISON OF RIDING ON THRU ROUTES

TOTAL PASSENGERS THRU MAXIMUM LOAD POINT FOR TWELVE HOUR PERIOD NOVEMBER 1946 COMPARED WITH SEPTEMBER 1945

Present Operation		Proposed Operation	
Thru Route	% Change in No. Pass.	Thru Route	% Change in No. Pass.
Westhaven with Cradock	+ 9 - 5	Westhaven with Loop	+ 9 *
Park View with Prentis Park	- 30 - 17	Park View with 4th Gate	- 30 - 37
Port Norfolk with 4th Gate	- 8 - 37	Port Norfolk with Cradock	- 8 - 5
River Park with Loop	* *	River Park with South Street	* *
6th Avenue with South Street	* *	6th Avenue with Prentis Park	* - 17

* Not operated in September 1945

EXHIBIT 11

COMPARISON OF OFF-PEAK COMBINATIONS ON THRU ROUTES

OLD OPERATION

THRU ROUTE	RUNNING TIME	TERM TIME	TOTAL TIME	REQD. HDWY.	BUSES REQD.
*WESTHAVEN-CRADOCK	68 Min	4 Min	72 Min	10 Min	8
PARK VIEW-PRENTIS PARK	40	3	43	12	4
PORT NORFOLK - 4TH GATE	52	4	56	12	5
VI - SOUTH	42	4	46	20	3
RIVER PARK - LOOP	37	3	40	20	2
TOTAL BUSES REQD.					22

NEW OPERATION

*WESTHAVEN - LOOP	37	3	40	10	4
PORT NORFOLK - CRADOCK	68	4	72	12	6
PARK VIEW - 4TH GATE	31	5	36	12	3
PRENTIS PARK - 6TH AVE.	45	3	48	12	4
RIVER PARK - SOUTH	55	5	60	20	3
TOTAL BUSES REQD.					20

*WESTHAVEN LINE COMPOSED OF TWO BRANCHES EACH REQUIRED A MINIMUM HEADWAY OF 20 MINUTES.

EXHIBIT 12

on certain through routes is shown on Exhibit 11.

A running time survey (similar to Study No. 3) was made by having traffic checkers ride buses and note all deviations from normal operation, the number of stops, and the elapsed time between scheduled time points. Observations were made on a selected number of trips to give a cross section of operation. The running time for each line was computed and various combinations of through routes were compared with the final result as shown on Exhibit 12 entitled, "Comparison of Off-Peak Combinations on Through Routes." By changing the through routing of five lines, it was possible to reduce the number of off-peak buses required in operation by 9 per cent.

STUDY NUMBER 2

ON-OFF PASSENGER COUNTS

DESCRIPTION—The determination of the total passenger load on each transit vehicle at any point on the line as well as the number of on-off passengers at each stop on the line.

WHEN AND WHY STUDY IS MADE—On-off passenger counts provide the basic passenger information necessary to determine the characteristics of a transit line.

This study, like the maximum load point study just described, is well known to most transit companies, but is still not used to its full value. Its applications are more important and broader than most companies realize.

Every transit company should collect and maintain on-off passenger counts for every line in the system.

On-off passenger counts need not be made on a regular schedule. They should be made frequently enough, however, to satisfy the reasons given below and frequently enough to keep track of any shift in the maximum load point locations for each line in the system, which may shift from one location to another on a daily, weekly or seasonal cycle, or move progressively over the years.

A composite of the reasons for making this study are:

(1) To locate maximum load points.
(2) To ascertain whether a transit line can be permanently shortened.

FIELD & SUMMARY SHEET

Sheet ____ of ____ Sheets

ON-OFF PASSENGER COUNT

WEATHER_____
TEMPERATURE_____
TIME ____AM ____PM
ROUTE CHECKED_____ DATE_____
BLOCK NO._____ VEHICLE NO._____ DAY OF WEEK_____
DIRECTION_____ OPERATOR BADGE NO._____

NAMES OF STOPS	ARRIVAL TIME*		PASSENGERS		ON-OFF DIFFERENCE	ACCUMULATED LOAD	COMMENTS
	Actual	Scheduled	On	Off			

*At time points only.

Form No._____ OBSERVER _____

EXHIBIT 13
On-off passenger count field and summary sheet.

ON-OFF RIDING CHECK DAY OF WEEK _____

OBSERVED BY: WEATHER _____

_____ RT. NO. _____ NAMED _____

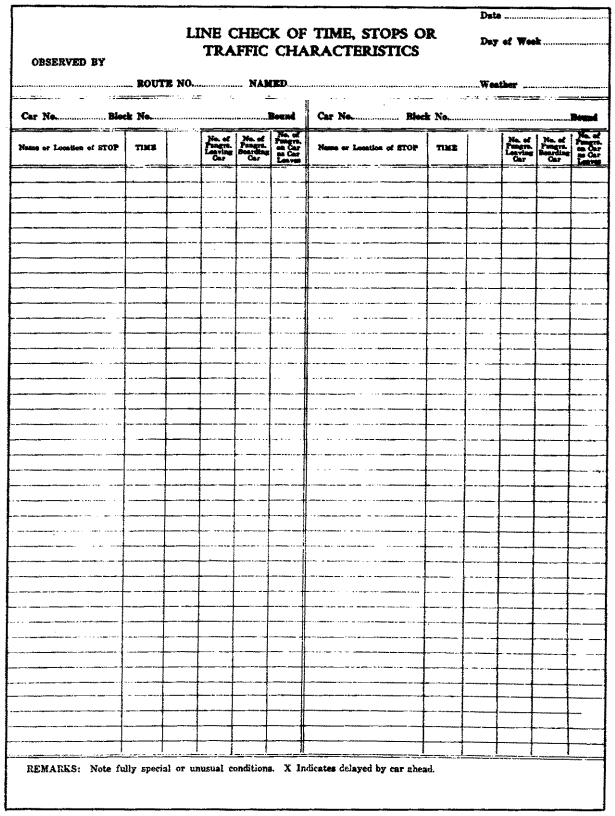
CAR NO. _____ SCH. NO. _____					BOUND	CAR NO. _____ SCH. NO. _____					BOUND
Name or Location of Stop	Time	No. of Pass. Leaving Coach	No. of Pass. Boarding Coach	No. of Pass. As Coach Leaves		Name or Location of Stop	Time	No. of Pass. Leaving Coach	No. of Pass. Boarding Coach	No. of Pass. As Coach Leaves	

EXHIBIT 14
Another type of field form used by some transit companies when checking the number of passengers on-off at each stop.

(3) To indicate opportunities for locating points for turnback service.
(4) To show need and time periods for street loaders at schools, department stores and factories.
(5) To determine which stops can be eliminated or relocated to better serve the public.
(6) To determine average number of stops made and required per mile of route.
(7) To determine average length of ride for a specific transit line.
(8) To aid in determining the proper running time.

HOW TO MAKE STUDY—To make an on-off check the field observer rides selected transit vehicles of a specified line, noting the number of passengers boarding and number alighting at each stop, and the arrival or departure times at the time points on the line.

There is no set rule as to when the checks should be made or how many observations are necessary; however, it is the general practice to check enough specific trips on a given transit line—possibly several heavy trips in each peak period and several in the shopper period—to obtain a true picture of riding characteristics.



LINE CHECK OF TIME, STOPS OR TRAFFIC CHARACTERISTICS

Date ..... Day of Week .....

OBSERVED BY .....

..... ROUTE NO. ..... NAMED ..... Weather .....

Car No. ..... Block No. ..... Bound Car No. ..... Block No. ..... Bound

Name or Location of STOP	TIME		No. of Passgrs. Leaving Car	No. of Passgrs. Boarding Car	No. of Passgrs. on Car as it Leaves	Name or Location of STOP	TIME		No. of Passgrs. Leaving Car	No. of Passgrs. Boarding Car	No. of Passgrs. on Car as it Leaves

REMARKS: Note fully special or unusual conditions. X Indicates delayed by car ahead.

EXHIBIT 15
Another type of on-off field form used for general on-off checks by a transit company.

TRANSPORTATION DEPARTMENT

Date _____ Observation Park Line
Car No. _____ A.M. or P.M. _____
Block No. _____ Time on _____

Southbound	Pass. Arrive	Board	Alight
17-Summit			
17-Belleview N			
17-Ker.CoatesDr.			
18-Holly			
20-Holly			
21-Mercier			
21-Holly N			
21-Jarboe			

Pass. Arrive ___ Time Arrive _____

Car No. _____ Time Depart _____
Block No. _____

Northbound	Pass. Depart	Board	Alight
21-Jarboe			
20-Jarboe			
18-Jarboe			
17-Jarboe			
17-Summit			

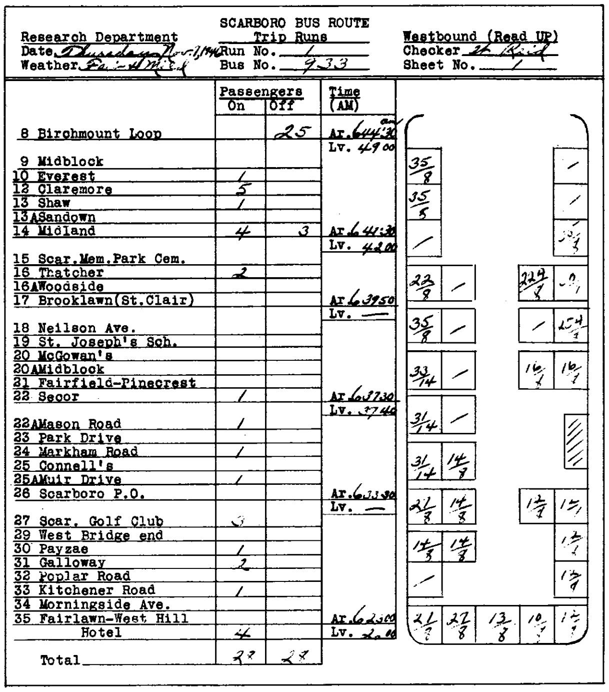
Pass. Depart ___ Time off _____
N=Night stop

Checker _____

EXHIBIT 16
A special on-off field form used by one transit company for checking a short section of a line.

Though it is apparent that such a procedure does not give a 100 per cent check, experience has indicated that the information recorded is satisfactory for most uses. On extremely light lines with a long headway it may prove desirable to check all the trips for the time specified.

The field form (Exhibit 13) for this study contains vertical columns for names of stops, scheduled and actual arrival times at time points, passengers on, passengers off, on-off differences, the total accumulated load, and com-



SCARBORO BUS ROUTE
Trip Runs

Research Department — Westbound (Read Up)
Date Thursday Nov. 1, 1946 — Run No. 1 — Checker H. Reid
Weather Fair & Mild — Bus No. 933 — Sheet No. 1

	Passengers On	Passengers Off	Time (AM)
8 Birchmount Loop		25	Ar. 6:44:30 am / Lv. 49:00
9 Midblock			
10 Everest	1		
12 Claremore	5		
13 Shaw	1		
13A Sandown			
14 Midland	4	3	Ar. 6:41:30 / Lv. 42:00
15 Scar. Mem. Park Cem.			
16 Thatcher	2		
16A Woodside			
17 Brooklawn (St. Clair)			Ar. 6:39:50 / Lv. —
18 Neilson Ave.			
19 St. Joseph's Sch.			
20 McGowan's			
20A Midblock			
21 Fairfield-Pinecrest			
22 Secor	1		Ar. 6:37:30 / Lv. 37:40
22A Mason Road	1		
23 Park Drive			
24 Markham Road	1		
25 Connell's			
25A Muir Drive	1		
26 Scarboro P.O.			Ar. 6:33:30 / Lv. —
27 Scar. Golf Club	3		
29 West Bridge end			
30 Payzae	1		
31 Galloway	2		
32 Poplar Road			
33 Kitchener Road	1		
34 Morningside Ave.			
35 Fairlawn-West Hill Hotel	4		Ar. 6:23:00 / Lv. 23:00
Total	28	28	

EXHIBIT 17

A special adaptation of the on-off check which includes a record of the origin and destination of passengers.

ments. This form can be either 8½" x 11" or a smaller size. Several alternate field forms are shown on Exhibits 14, 15 and 16.

Of the several alternate field forms now in use, Exhibit 17 is a special adaptation of the on-off passenger study. On this field form is recorded not only the names of stops, passengers on, passengers off, and arrival and leaving times, but also the origin and destination (on the line) of all seated passengers. The origin destination record is pictorially illustrated on the field form. In each square, representing a seat on the vehicle, are written two numbers. The upper number is the stop number at which that person got on, and the lower number is the stop number at which that same person got off. For example, in the seat behind the driver is a person who boarded at Stop No. 35 and alighted at Stop No. 8. In other words, that person rode the entire length of the line. It will be noted on the sample check that of the 28 shown as getting on and off during the run four passengers rode the entire distance.

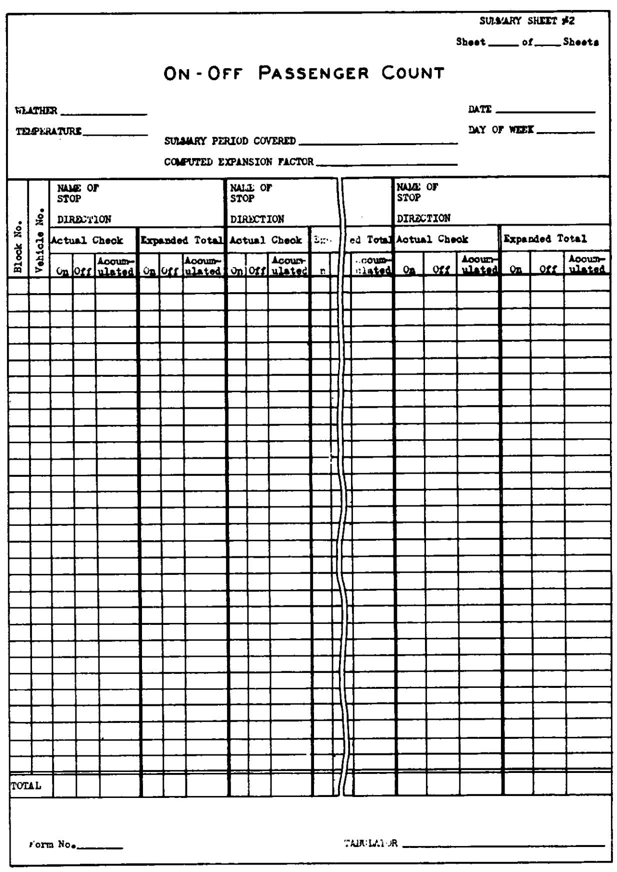
Instructions to field observers should include a list of the selected vehicles on which each is to make on-off checks, a list of the time points and the accuracy to which he is to time the arrival or departure time, and some examples of the types of observations he should record in the comment column.

One observer, occasionally two, is needed on each vehicle being checked. Generally, two are needed only in the rush period on a very heavy line that carries many standees, has two doors, and experiences a continuous and large turnover of passengers.

The total number of observers needed will depend entirely upon the number of vehicles being checked in any given period, as measured against the headways between the vehicles and length of trip.

Much of the information collected can be used directly from the field sheets. It can also be summarized at individual stops to show the total on, total off, and accumulated loads for all vehicles in a given period of time, such as the a.m. rush period, midday period and p.m. rush period. (*See* Exhibit 18, Summary Sheet No. 2, columns noted as "Actual Check.") The Summary Sheet shown contains only enough vertical columns for the names of three stops, however the form can be made wider so that any desired number of stops can be summarized on one sheet.

Since the check may be made on only every second or third vehicle, it may prove desirable under certain conditions to expand the data collected in order to obtain



SUMMARY SHEET #2
Sheet ____ of ____ Sheets

ON - OFF PASSENGER COUNT

WEATHER ____ DATE ____
TEMPERATURE ____ DAY OF WEEK ____
SUMMARY PERIOD COVERED ____
COMPUTED EXPANSION FACTOR ____

Block No.	Vehicle No.	NAME OF STOP / DIRECTION: Actual Check On	Off	Accumulated	Expanded Total On	Off	Accumulated	NAME OF STOP / DIRECTION: Actual Check On	Off	Accumulated	Expanded Total …	… Accumulated	NAME OF STOP / DIRECTION: Actual Check On	Off	Accumulated	Expanded Total On	Off	Accumulated
TOTAL																		

Form No. ____ TABULATOR ____

EXHIBIT 18

On-off passenger count summary sheet No. 2.

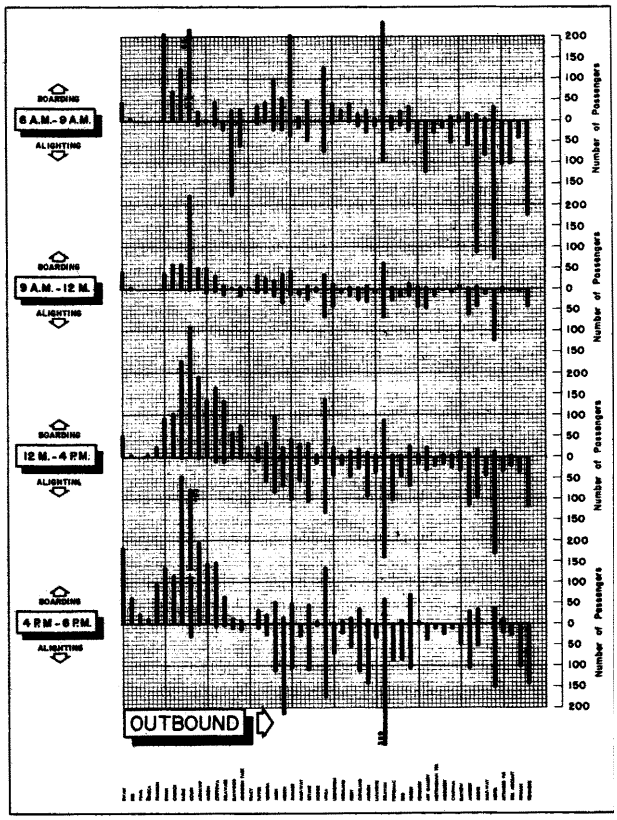


EXHIBIT 19
On-off check for a major line divided into four periods of the day.

a 100 per cent picture for all vehicles. This requires the application of expansion factors to the data on Summary Sheet No. 2. The expansion factors are derived from the ratio of passengers on the selected trips to passengers for all trips as recorded in a regular passenger count at the maximum load point. Columns are included in the Summary Sheet No. 2 in which to record the expanded totals.

Exhibits 19, 20, 21, 22 and 23 show some of the ways in which the on-off data may be graphically prepared to aid in making analyses and to more clearly show the layman the riding characteristics of one or more lines.

Example No. 1—A citizens group petitioned the Utilities Commission to have a major transit line rerouted through a residential section that was already serviced by another major line. Though the transit company pointed out that this rerouting would increase the route mileage and running time considerably, in addition to providing a duplicate service, the citizens still insisted that the change be made. Finally, a complete on-and-off passenger check for the line was made, which showed

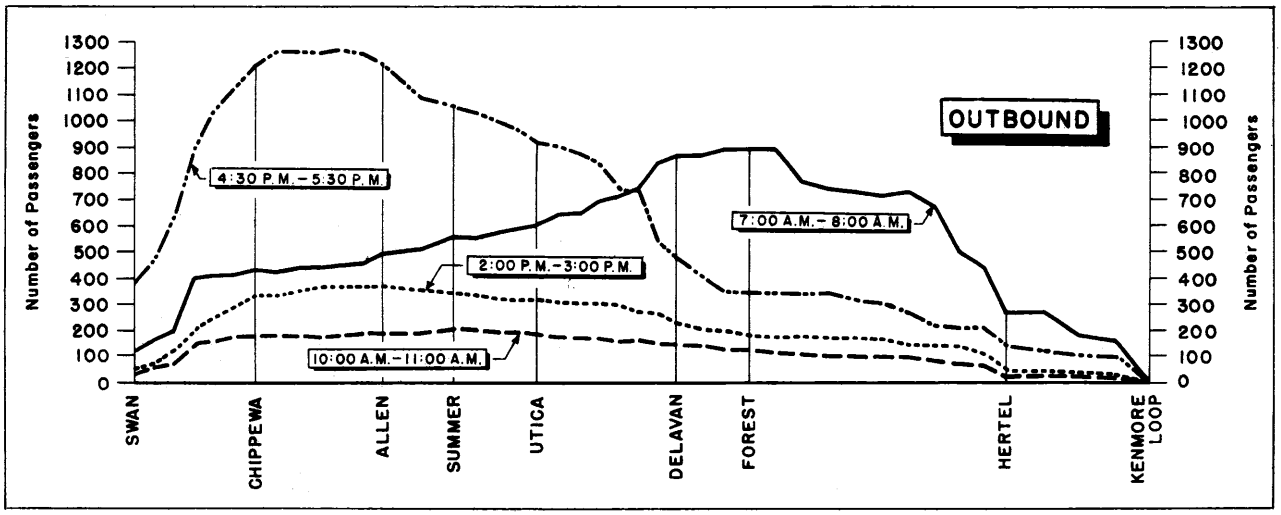


EXHIBIT 20
Passenger volume characteristics for a bus line obtained from on-off check

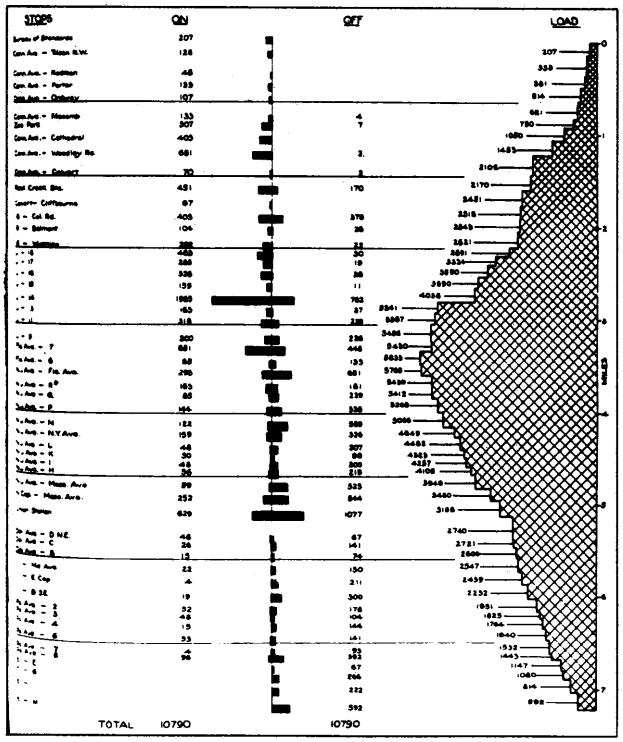


EXHIBIT 21

Graphical presentation of an on-off count and accumulated load for one direction on a single transit line throughout a typical weekday.

that 90 per cent of the present passengers using the line would be inconvenienced by the change. To be most effective the on-and-off data were presented on a time-loss basis for each transit rider and illustrated by large colored charts. After reviewing this information, the group quieted down and the Utilities Commission tabled the request.

Example No. 2—A local transit company was faced with the problem of deciding whether it should construct a bus terminal in the business district for use both by local buses and interstate buses. Once a suitable location had been found for such a terminal in the business district, studies were conducted to determine whether the patronage from the local bus riders would warrant construction of an expensive terminal. An accurate measure of this patronage was also necessary in order to determine the size of the terminal that might be needed and the volume of business that might be received by the various concessions to be located in the proposed terminal. On-and-off checks were made in the business district of each of the five local bus routes that could use such a terminal. The on-and-off checks were further utilized to help determine what curb stops might also be necessary in the business district in addition to the terminal. As a result of these on-off studies, which were made for a period of 8:00 a.m. to 6:00 p.m., it was found that a comparatively small percentage of the 5,550 persons getting on and off the buses in the business district might be expected to use the proposed terminal. This estimated use by local transit riders, combined with the small number of intercity bus passengers, was found to be an inadequate volume of traffic on which to warrant construction of the proposed $400,000 centrally located bus terminal at the present time. Steps were taken, however, to relocate certain of the curb bus stops to be more in keeping with the downtown passenger demands.

Example No. 3—A transit company planned to replace obsolete street cars on two lines with freewheel vehicles. The question of type and size of equipment needed to take the place of the old street cars had to be answered.

To arrive at a scientific answer, it was first necessary to make hypothetical schedules for each type and size of equipment under consideration. But, before such

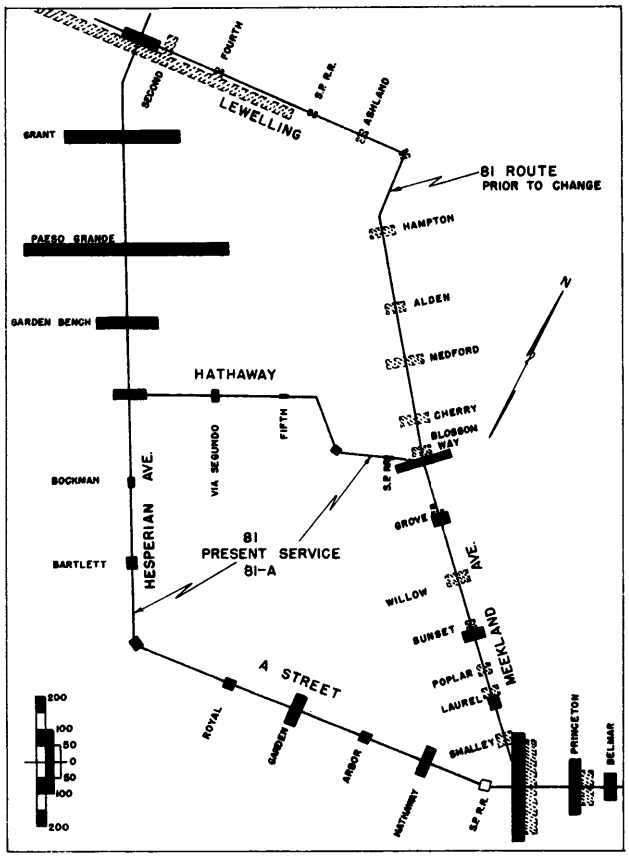


EXHIBIT 22

An on-off check graphically pictured to show the improvements derived from a change in the location of a transit route.

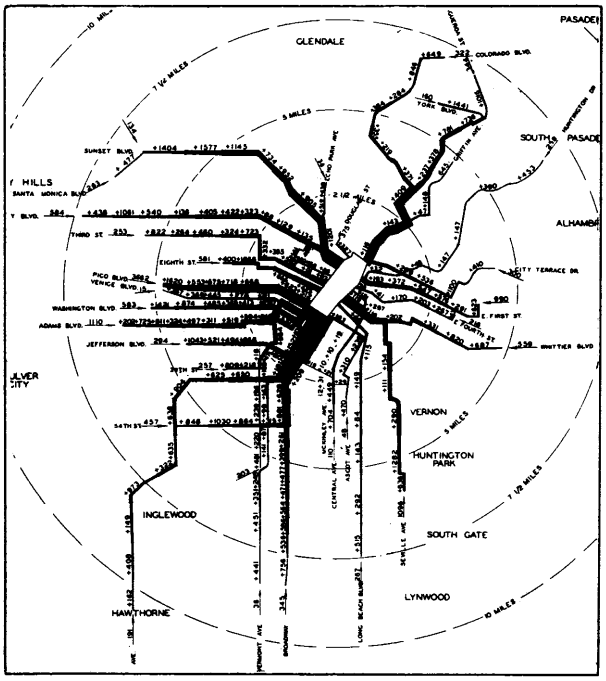


EXHIBIT 23
City-wide transit passenger volume chart developed from an on-off check.

schedules could be prepared, it was necessary to make several field studies, including detailed "on-and-off counts" of the two lines. Specifically, the "on-and-off counts" were used to determine:

(1) Load characteristics on each line.
(2) The average number of stops per mile that would have to be made.
(3) Time spent at each stop or time spent per mile for passenger interchange.

Once the field studies were completed, the question of type and size of replacement equipment was promptly decided.

NOTE—*See* "Route Cost Analysis and Selection of Transit Vehicles—Part II, Selection of Transit Vehicles" by Walter S. Rainville, Jr., Director of Research, American Transit Association, for detailed exposition of one method for selecting vehicle sizes and types.

STUDY NUMBER 3

RUNNING TIME

DESCRIPTION—A study of the running time and the types, causes and amounts of delay to street cars, trolley coaches and motor buses operating on regularly scheduled transit lines.

WHEN AND WHY STUDY IS MADE—Running time studies are a prerequisite to successful transit operation. Their importance will become increasingly evident to transit companies as the need grows for maintaining faster schedule speeds.

Running time for transit vehicles depends on three factors: (a) street traffic conditions, (b) methods and efficiency of operation, and (c) equipment.

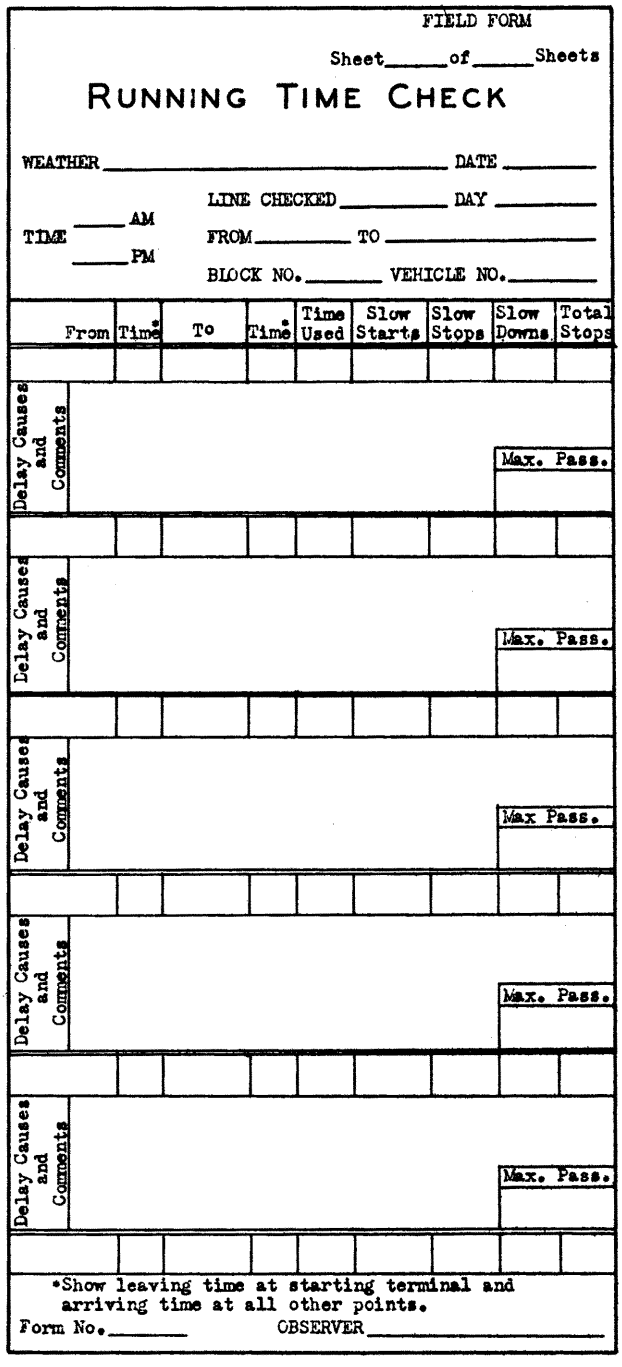
This is considered a special but basically essential study. It is made when warranted under one of the following:

(1) To establish peak-hour running time, off-peak running time, and running times at other periods of the day for purposes of schedule making.
(2) When trip schedule times are not being met on a specific line or lines.
(3) As a part of the control over the "schedule economy" of transit operations.
(4) To indicate those spots where delays are excessive and remedial measures are necessary.
(5) To establish how much the running time can be shortened when the equipment is modernized.
(6) To check the performance of individual operators.
(7) To check complaints from the public about transit speeds.
(8) To demonstrate the extent to which traffic signal timing, curb parking, or other factors are causing delay on a given line.
(9) To estimate how much the running time can be shortened, if congestion at specific spots is reduced.

HOW TO MAKE STUDY—A running time check is generally made over the entire length of a run. Some companies check the running time only at time points on a line. This is not always enough, however, especially when the time points are more than five minutes apart. In general, therefore, the running time check points should not be more than five minutes apart.

There are several ways to make the check:

(1) Field observers ride in the transit vehicle recording


FIELD FORM

Sheet_____of_____Sheets

RUNNING TIME CHECK

WEATHER_____ DATE _____

TIME ____ AM / ____ PM

LINE CHECKED_____ DAY _____

FROM_____ TO _____

BLOCK NO._____ VEHICLE NO._____

From	Time*	To	Time*	Time Used	Slow Starts	Slow Stops	Slow Downs	Total Stops

Delay Causes and Comments — Max. Pass.

Delay Causes and Comments — Max. Pass.

Delay Causes and Comments — Max Pass.

Delay Causes and Comments — Max. Pass.

Delay Causes and Comments — Max. Pass.

*Show leaving time at starting terminal and arriving time at all other points.

Form No._____ OBSERVER_____

EXHIBIT 24
Running time field form.

SAMPLE NOTATIONS OF SLOW OPERATION AND UNUSUAL DELAYS

Comments on Speed, Delays, Etc.

"2–½ k.t." Two average length blocks at one-half speed in attempt to kill time or consume excess running time.

"3-3/4 traf." Three blocks at three-quarter speed due to vehicle interference or slow-moving traffic.

"1–½ lead." Delay to car ahead causing delay to car being checked, or attempt by operator to space his car between leader and follower.

"1½–½ repair. tracks" Reduced speed due to track repairing operations.

"Roosevelt Road to Van Buren St.–½ k.t." Slow speed over a distance exceeding two blocks.

"½–¼ track" One-half block at one-quarter speed due to condition of track.

"½–¼ wagon" Vehicle slow to yield right of way.

"45 sec. at Clark St. by starter" Held by supervisor to space cars or to require adherence to schedule.

"20 sec. at Clark St. by lights" Held by traffic lights — noted only if time exceeds 10 seconds after car is ready to go.

"Raining, snowing, foggy, etc." Notation of weather conditions affecting operation.

"Max. Pass. - 30" Heaviest passenger load on car or bus to be noted for each section of the line between time points.

Slow Starts
Number of instances of slow acceleration in attempt to consume excess running time.

Slow Stops
Number of instances of slow braking in attempt to consume excess running time.

Slow Downs
Number of instances of marked reduction in speed to avoid collisions, etc.

All Stops
Number of full stops for passengers, traffic, etc.

Note Other Conditions or Occurences Resulting in Unusually Fast or Slow Operation.

EXHIBIT 25

Sample notations of slow operation and unusual delays. These notations should be printed on back of field form pad.

RUNNING TIME CHECK CHECKER
LINE ____ DIR ____ BUS CAR ____ BLK ____ DATE ____ 194_

TIME POINT	A.M.–P.M.	RUN TIME		DELAYS		OPERATION		MAX LOAD	NO. OF PASS. STOPS	REMARKS
	H R S	M I N	SEC H	ACT		SEC DELAY		SEC FAST	SEC SLO			

EXHIBIT 26

A 4 x 6 inch card-type running-time field form used by an eastern transit company.

running time data on special running time field sheets.

(2) Field observers ride in the transit vehicle recording running time data in conjunction with an on-off passenger check, described as Study No. 2 in this manual.

(3) Observers are stationed at the curb at important time points along the line and at each end of the line.

(4) Observers ride in a passenger car following the transit vehicle if only a check on the operator for complaints of speeding is wanted.

Methods 1 or 2 are preferred and generally used by transit companies in most instances, because they permit a check on the operation of the vehicle as well as a check on the running time.

The time for, and duration of, running time checks are dependent upon many factors. When selecting a date on which to make a check, be sure to carefully weigh how various days of the week, especially Saturdays, Sundays and holidays, may affect the running time. The duration of checks at any one time will depend upon whether the data is wanted for peak runs, off-peak runs, or both. For use in scheduling purposes, every third or fourth vehicle is generally checked for each period of the day. Exceptions are when headways are extremely short on a heavy line, in which case a smaller percentage of the vehicles are checked, and when headways are very long on a light line, it may be necessary to check every vehicle.

The field form (Exhibit 24) contains columns in which to record time points, actual arrival time, time used, types of delay, and maximum passengers. The only purpose for checking the maximum passengers is to provide a general measure of the passenger loads. Considerable space is also available for each section in which to describe causes of delay and to record comments. This space can also be used in which to record the arrival time at transfer points, if such information is desired.

The total stop time, shown on the field sheet, includes service stops, slowdowns and delays such as slow starts, traffic congestion, and traffic signals. Symbols may be used to indicate slow operation and the type of delay, in order to simplify the taking of field notes. Sample symbols, developed by the 1935 Committee on Street Traffic of the American Transit Operating Association, are shown in Exhibit 25. Alternate field forms are shown on Exhibits 26 and 27.

Instructions to field observers should include a list of the vehicles which each is to ride, a list of the points on the line at which the running time is to be recorded,

Sheet____ of_____

RUNNING TIME CHECK

Line_____ Sch. No._____ Date _____ Day of Week _____

Car or Coach No._____ Operator No._____

Weather_____ Observer_____

From	Time	To	Time	Time Used	Slow Starts	Slow Stops	Total Stops	Traffic Delay Seconds	Max. Pass.	Remarks
1	2	3	4	5	6	7	8	9	10	11
A										
B										
C										
D										
E										

Instructions: Col. 1-4 Use separate lettered space for each part of the line, filling the sheet from top to bottom in one direction and bottom to top in other direction.
Col. 5 Compute in the office.
Col. 6-8 Tally these columns.
Col. 9 List each delay over 30 seconds due to traffic or signals.
Col. 10 List maximum number of passengers on car and under remarks show point of occurrence.
Col. 11 List any other important unusual circumstances.

EXHIBIT 27

Another type of running time field form used by a west coast transit company.

an explanation of the symbols to use for recording slow operation and unusual delays, whether the arrival or departure time at the listed locations is to be recorded.

The amount of personnel needed to make a running time check will depend upon the type of field check used, number of vehicles checked and duration of checks. Generally, one checker riding on a transit vehicle is adequate when applying either Method No. 1 or Method No. 2. This one checker must be well trained and experienced, however, because he must observe and check on the operation of the vehicle as well as observe and record the running time and causes for slow operation and vehicle delays.

If a passenger car is used for checking the speed of a transit vehicle, generally two men will be needed—one to drive and the other to make notations.

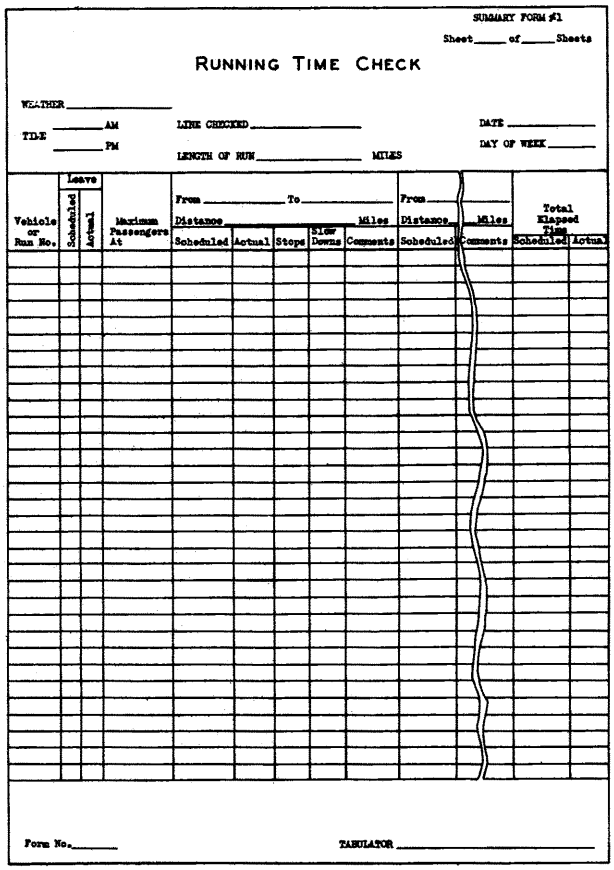
Regular company employees, assigned either full or part time on field studies, are used for making this study.

The field data are summarized on special summary forms. On Summary Form No. 1 (Exhibit 28) can be recorded in the horizontal columns the running time information for each vehicle at each point checked on a given line. Portions of trips that have experienced unusual delays, such as those caused by a fire or serious crash, are eliminated in these summaries. The trips are grouped according to direction and period of the day. The record is then studied for conditions affecting a major portion of the trips. If controllable incidents, such as vehicle interference, are found in certain sections on practically all trips, an attempt is made to eliminate these sources of delay before adjusting running time.

On Summary Form No. 2, Exhibit 29, can be recorded a summary of running time information for all vehicles on a 30 to 60-minute basis.

The 1935 Report of the Committee on Street Traffic of the American Transit Operating Association in reporting on this subject in relation to schedule making stated:

> "When controllable conditions have been improved as far as possible for the time being and enough trips in a given period of the basic day (weekday, Saturday or Sunday) have been found



SUMMARY FORM #1

Sheet ____ of ____ Sheets

RUNNING TIME CHECK

WEATHER _____

TIDE _____ AM _____ PM

LINE CHECKED _____

LENGTH OF RUN _____ MILES

DATE _____

DAY OF WEEK _____

Vehicle or Run No.	Leave Scheduled	Leave Actual	Maximum Passengers At	From _____ To _____ Distance _____ Miles Scheduled	Actual	Stops	Slow Downs	Comments	From _____ Distance _____ Miles Scheduled	Comments	Total Elapsed Time Scheduled	Actual

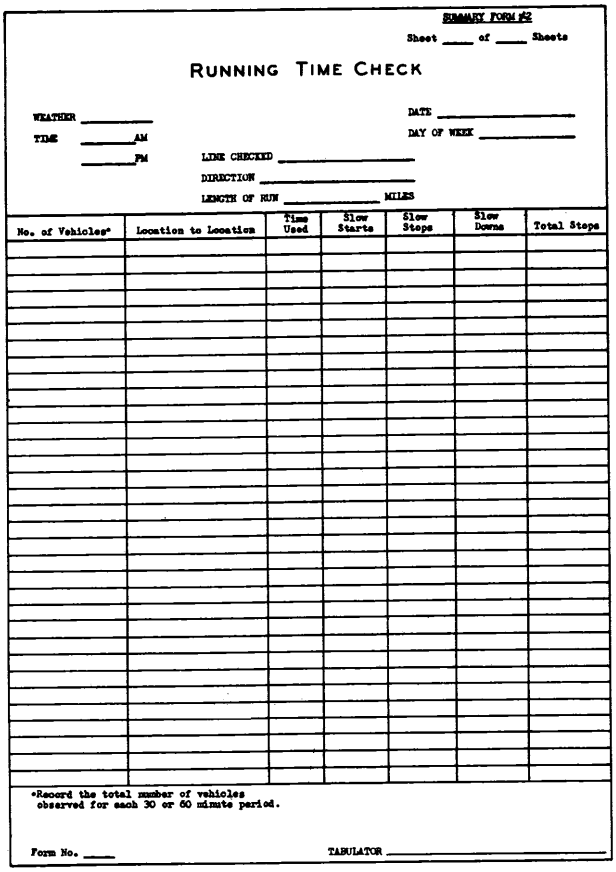
Form No. _____ TABULATOR _____

EXHIBIT 28

Running time check summary form No. 1.

reasonably similar in type to indicate that typical operation has been measured, the schedule maker compares trips for that period to determine what he should consider an average trip. Although no two trips will be exactly alike, it is possible, with enough observations, to develop for each section of the line and for each direction an ideal trip making an average number of stops and slow downs, carrying an average maximum load, and experiencing an average amount of traffic interference. This average trip used a certain noted running time and the conditions of operation were noted by the observers. The time value of the various items is carefully estimated by the schedule maker to determine the possible amount of change, plus or minus, that could be made in the average time as observed if the operation was as competent as an average man could do for a trip with average conditions. This net result then shows whether the scheduled time should be changed and by how much. Terminal checks or sectional checks are often made by observers stationed on the street to show, in addition, the actual elapsed time for every trip or portions of all trips during the day or for certain periods (not here illustrated). The schedule maker, or his superior, also anticipates imminent changes which will materially affect running time. Scheduled running time for each section and each direction is usually designed to fit the needs of an average man on an average trip for the particular period of the day. The principal periods for time records are, for example, morning rush, midday, evening rush, and evening with variations grading from one to the other."

There is also the problem of determining the running time for a new or projected line. This may be determined (a) by estimating the over-all running time of a line of similar character, or (b) by using a bus or private car to simulate trips, providing the top speeds are held down, all anticipated passenger stops are made, and allowances are made for all conditions that may affect the running speed of the transit vehicle that will



SUMMARY FORM #2

Sheet ____ of ____ Sheets

RUNNING TIME CHECK

WEATHER _____

TIME _____ AM _____ PM

LINE CHECKED _____

DIRECTION _____

LENGTH OF RUN _____ MILES

DATE _____

DAY OF WEEK _____

No. of Vehicles*	Location to Location	Time Used	Slow Starts	Slow Stops	Slow Downs	Total Stops

*Record the total number of vehicles observed for each 30 or 60 minute period.

Form No. ____ TABULATOR _____

EXHIBIT 29

Running time check summary form No. 2

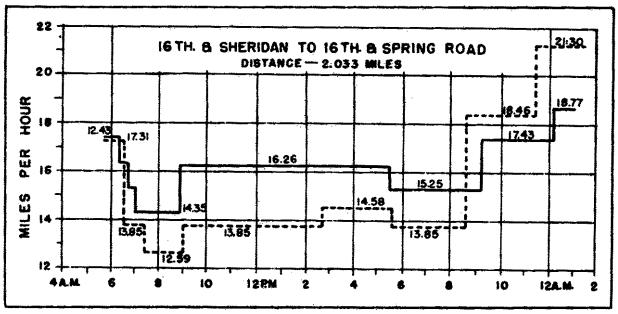


EXHIBIT 30

The type of running-time chart that can be plotted directly from information such as collected on summary form No. 1.

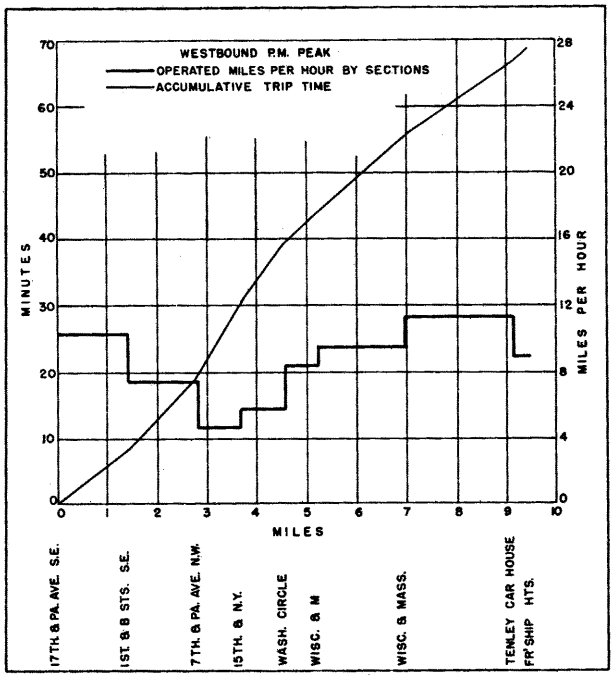


EXHIBIT 31

Another type of graph showing average running time between time points for outbound p.m. rush period over a 9½-mile run.

be used on the new or projected line. Obviously, the running speeds determined from either of these methods must be double-checked as soon as transit equipment is placed in operation on the new or projected line.

Various ways of graphically displaying running time data are shown on Exhibits 30, 31, 32, and 33.

Example No. 1—Street cars were found to be arriving consistently late at the end of Section 3 of a certain line. A running time study was made for the worst period. The study showed that operators were killing time in Section No. 2 so as not to come into Section No. 3 time point ahead of time. To correct this condition the running time was cut in Section No. 2 and increased in Section No. 3.

Example No. 2—Bus operators complained that they could not complete their trips on the scheduled running time because of delays occurring in a particular loading area. Special running time checks, taken during the afternoon rush period, showed an average of 7¾ minutes per bus, with a maximum of 12¾ minutes, through this area. This was considered excessive.

By a rearrangement of loading berths for different routes and special treatment of a bad left-turn movement for some of the buses, the average running time per bus through this area was reduced 39 per cent.

Example No. 3—The time consumed by a major street-car line was found to be excessive because of the interference resulting from downtown congestion. Running time checks for this street car line in the afternoon rush periods showed that 11½ minutes were consumed in

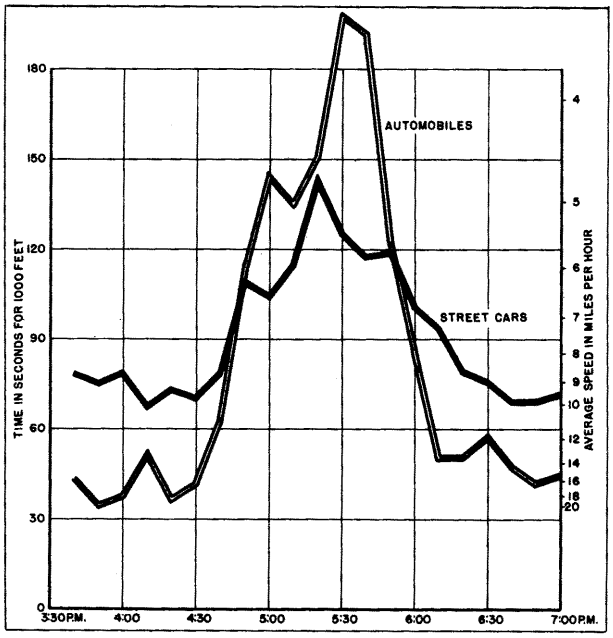


EXHIBIT 32

A running time study showing average time required by auto and street cars to travel 1000 feet at a typical location in a large city.

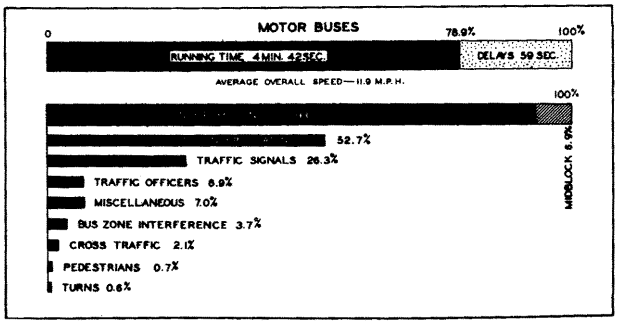


EXHIBIT 33

Another way of graphically showing times, speeds and delays of buses operating over a congested section of a route.

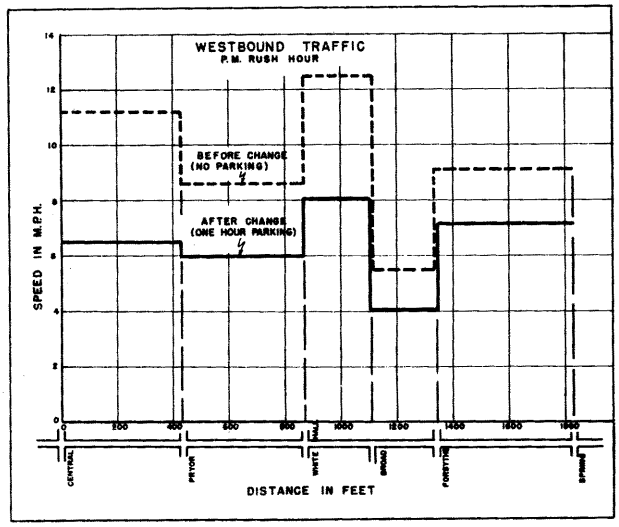


EXHIBIT 34

Application of a running-time check before and after curb-parking prohibition.

moving a short distance in the business district. Applied to the overall run, it was found that 13½ per cent of the total trip time was consumed in traversing only 5½ per cent of the trip distance.

A further check of the on-and-off passengers confirmed that the street car line, which entered the business district on one street and left by a parallel street one block away, could be cut back several blocks, thereby reducing that portion of the trip time consumed in the business district, without inconveniencing more than 5 per cent of the total passengers utilizing the line.

Example No. 4—Operators complained that when street cars were changed from 2-man to 1-man operation they could not maintain the scheduled running time. Studies were made and compared with former 2-man operations. These clearly showed that the scheduled running times could be maintained.

Example No. 5—Exhibit 34 shows a comparison of running time checks taken before and after changes had been made in a curb parking regulation over a 5-block distance in a business district.

Example No. 6—A large transit system had been making regular running time analyses on its routes to determine the correct time allowances between various time points. Changing conditions along a street had made such analyses necessary.

Although a short-cut method is sometimes used to determine the time of passenger interchange, traffic delays and "killing time" between time points, a more complete survey was made in this instance in order to obtain a good understanding of the characteristics of a route. The study consisted of a combination study of running time and boarding and alighting facts. (*See* Study No. 4 for description of latter type of study.)

Teams of two men were assigned to ride every third or fourth trip. Each man carried a good pocket watch and a stop watch. Passenger interchange time, delay time, and stop time were taken with the stop watches. The information recorded by these teams is shown on Exhibit 35. One man recorded passenger data (upper portion of form) and the second recorded delay data (lower portion of form).

From the information recorded it was possible to pick out delay sections of route; terminal to terminal speed; time required between time points; speed between stops; passengers carried per trip; maximum number of passengers on the vehicle; stops per mile; passenger interchange per stop; time of passenger interchange per stop, per trip and per passenger; traffic-delay time both midblock and at intersections, and so on.

Such a study is now being conducted previous to a street-widening project. The data will make it possible to compare the before and after conditions and thus determine the value of the widening project.

RUNNING TIME ANALYSIS

LEAVE TERMINAL_____ M. Hr. Min. Sec. NO. PASS. ON BUS_____ Date_____ Run No.____

ARRIVE TERMINAL_____ M. Hr. Min. Sec. NO. PASS. ON BUS_____

PART I Checker_____

* Bus Stops	Max. Speed	Front Door Boarding. Pass.	Front Door Alight. Pass.	Front Door Time	Total Stop Time	* Bus Stops	Max. Speed	Front Door Boarding. Pass.	Front Door Alight. Pass	Front Door Time	Total Stop Time

PART II Checker_____

* Bus Stops	Midblock Delays** S	T	S	T	S	T	Arrival Time	Center Door No. Alight	Center Door Time	* Bus Stops	Midblock Delays** S	T	S	T	S	T	Arrival Time	Center Door No. Alight	Center Door Time

* List stops in order

** S=Best estimate of speed during delay. T=Time of delay in seconds. Indicate whether traffic delay or killing time by symbol in speed column, T=Traffic, K=Killing Time.

EXHIBIT 35

Running time field form, combined with boarding and alighting check, to show the effect of a street widening project on transit speed.

STUDY NUMBER 4

BOARDING AND ALIGHTING TIME AND CHARACTERISTICS

DESCRIPTION—An analysis of the characteristics of passenger flow into and out of transit vehicles and the time required to board and alight under varying conditions.

WHEN AND WHY STUDY IS MADE—This is a special study and is usually made only as conditions demand. There are several instances where information from this study is extremely important to an operating company. These are:

(1) To determine locations where improved loading or unloading might speed up movement of vehicles. A study may point to the establishment of prepayment areas, or the assignment of street collectors or street loaders.
(2) To arrive at more efficient designs of transit vehicles from the standpoint of passenger handling.
(3) To measure efficiency of door use.
(4) To aid in showing whether more or less stops are needed on a route.

HOW TO MAKE STUDY—Boarding and alighting checks are made only on selected lines or at selected locations on a specific line, depending upon the information required.

Boarding and alighting checks can be made either by (a) observers riding on the transit vehicles, or (b) by observers stationed on the street at chosen locations. The choice of method will depend on the type of information needed.

(a) The riding check is an adaptation of the on-off passenger count. (*See* Study No. 2) It provides information as to the size of boarding and alighting groups at each stop. By expanding the on-off check the time used for passenger interchange and amount of use of each door under various load conditions can also be obtained. Coupled with data relating to the load within a vehicle, the above information will also provide material for a study of load characteristics.

(b) The street check is used particularly for studying door use under general and special conditions, effect of step and door design, and effect of different methods of loading.

There are, of course, many other items not mentioned above that can be obtained by such studies. These studies can be a part of other more complete analyses, such as complete running time analyses and vehicle design studies.

Boarding and alighting checks are generally confined to the morning and afternoon rush periods, since the boarding and alighting characteristics and the time required are most significant in the peak periods. The number of checks needed will depend upon the accuracy of information desired. Generally, a number of vehicles are checked regardless of whether it is a riding check or a street check, in order to obtain good averages.

Two types of field forms are used:

Type One—This field form combines the boarding and alighting information and is one most commonly used by transit companies today. This form, Exhibit 36, is described below.

Type Two—Separate forms are generally used for boarding and alighting where the loads are extremely heavy and where it would be impossible for one man to record both boarding and alighting data.

The combination field form (Type One) contains vertical columns in which to record the vehicle number or the stop location, number of passengers waiting at stop, number of standees in vehicle upon arrival at stop, number alighting from front door and time required, number alighting from rear door and time required, and number boarding and time required. (Exhibit 36)

Note that this field form can be used at a specific location, in which case the vehicle numbers of the vehicles passing the location are recorded in column number one, or it can be used as a running check form when all observations are made from a single vehicle in which case the stop locations are recorded in column one.

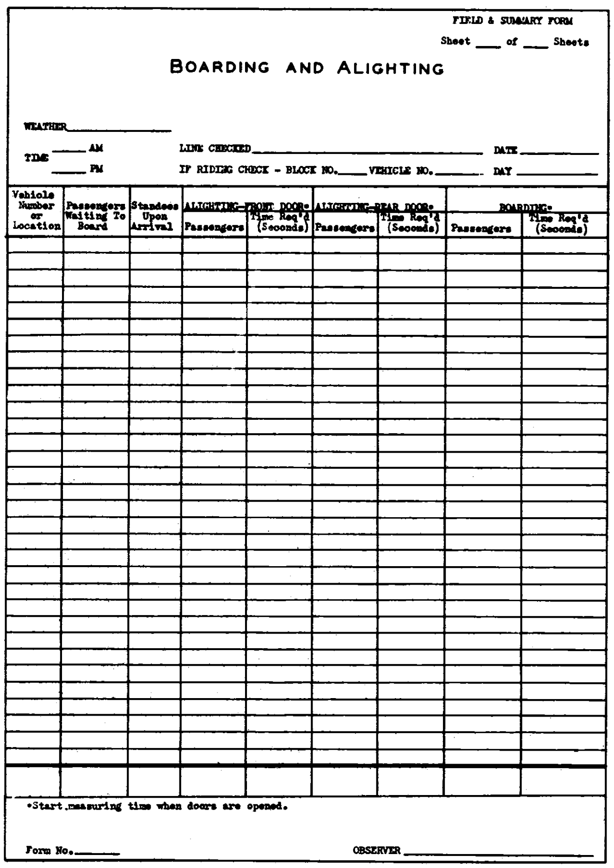
Usually, field checkers are assigned to work in pairs when making this study—one counts waiting passengers on the platform and standees in the vehicle and makes all notations on the field form; the second checker operates the stop watch, or watches, and also observes the number alighting and boarding vehicle within the periods checked.

A separate stop watch is used to clock the time used by each boarding or alighting group. This may require

two or three stop watches. If three are required, they should be mounted on a small board and numbered 1, 2 and 3. All watches should be started simultaneously when the doors are opened. Watch #1 is stopped when alighting has stopped at the front door. Watch #2 is stopped when alighting has stopped at rear door. Watch #3 is stopped when boarding has stopped at front door or when front door is closed. Subtracting the time for Watch #1 from Watch #3' gives the net boarding time for the front door. If vehicle does not have a rear discharge door, Watch #2 can be omitted entirely from the study and the field form can be revised accordingly.

Instructions to the field observers should include a list of the vehicles to ride or locations to be checked, a complete explanation of how to operate the stop watches, and where observers should sit in transit vehicle, or stand at stop, in order to make all the necessary observations.

Regular company employees are used for this study. If possible, they should be experienced field checkers, otherwise the data obtained may not prove sufficiently accurate. The total number of checkers will be depen-


FIELD & SUMMARY FORM
Sheet ___ of ___ Sheets

BOARDING AND ALIGHTING

WEATHER__________

TIME _____ AM / _____ PM

LINE CHECKED__________ DATE __________

IF RIDING CHECK - BLOCK NO._____ VEHICLE NO._____ DAY __________

Vehicle Number or Location	Passengers Waiting To Board	Standees Upon Arrival	ALIGHTING–FRONT DOOR* Passengers	ALIGHTING–FRONT DOOR* Time Req'd (Seconds)	ALIGHTING–REAR DOOR* Passengers	ALIGHTING–REAR DOOR* Time Req'd (Seconds)	BOARDING* Passengers	BOARDING* Time Req'd (Seconds)

*Start measuring time when doors are opened.

Form No._____ OBSERVER __________

EXHIBIT 36
Boarding and alighting field and summary form.

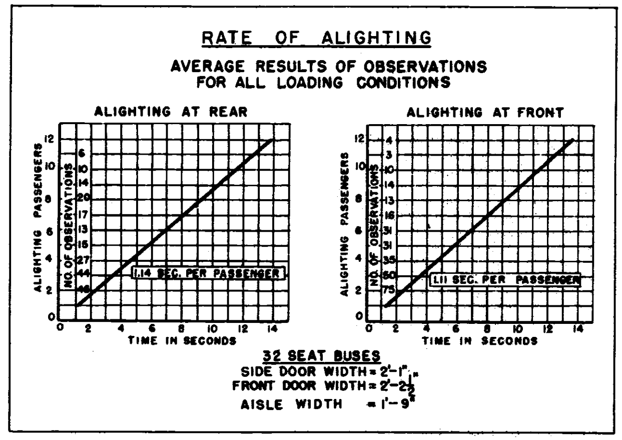


EXHIBIT 37
Typical alighting charts prepared from riding checks and street observations.

dent upon the size of the study and the number of days over which the study is spread. Often three or four pairs of checkers are used when a series of such studies are made, and the project is spread over several days or a week.

The information collected can be summarized to show observations at the heaviest boarding point, at the heaviest alighting point, special key points, and boarding and alighting observations for the entire line.

Bar charts can be prepared to show the number and time required to board at each location checked and the number and time required to alight at the front door and at the rear door. Graphs can also be prepared containing curves that show the time required for various numbers of passengers to board different types of vehicles. Similar charts can be prepared for the alighting passengers. (Exhibits 37 and 38)

EXAMPLES OF APPLICATION

Example No. 1—A considerable number of boarding and alighting checks were made by a transit company for use in improving the design of the entrance and exit of vehicle. The problem was to develop a body design for a street car which would give good load distribution and efficient use of all doors.

One of the first problems was to determine door widths, number of entrance and exit steps, height and depth of steps, location of handrails, and so on. For these studies, street checks were made of boarding and alighting time per passenger with varying types of construction. These checks were supplemented by motion pictures taken with a concealed camera. The pictures were later studied to see just how passengers arranged themselves in going through the doors. The principal question involved was whether a single 44" door was more or less efficient than two 22" doors.

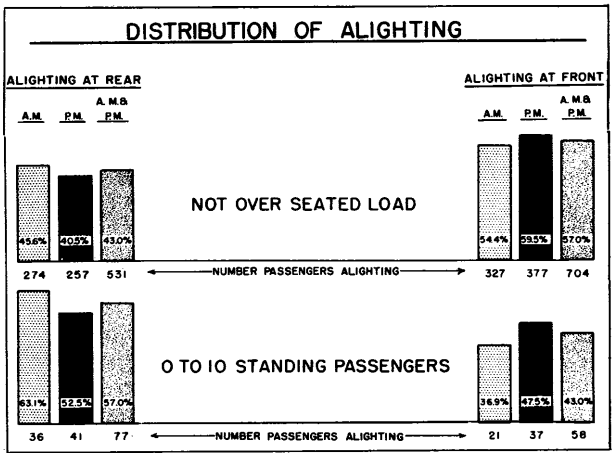


EXHIBIT 38
Another way of showing passenger alighting information.

Example No. 2—Another study was made to determine whether rear or front entrance cars were more efficient. It was found that almost all of the alighting passengers at nearside stops walked on forward to the crosswalk, which result indicated that by using a rear-entrance, front-exit car this natural forward movement would be encouraged and thus give good distribution within the car.

In other studies rear-exit door use on buses and cars has been checked at various times to determine the effect of methods designed to increase its use. In this instance checkers rode the vehicles.

Example No. 3—Boarding and alighting studies are important. Passenger interchange time on a certain bus route represented as much as 15 per cent of the total trip time, while vehicle traffic delay time on this same route was slightly less, indicating that there may be as much to be gained by improvements in loading the transit vehicles as there would be in attempting to reduce traffic congestion along the bus route. Improvements in loading, such as providing street loaders at heavy points, training of operators to better handle their load or eliminating stops, might produce important savings.

Example No. 4—Operators claimed that boarding and alighting time would be increased sharply and costly delays would occur when two-man street cars were changed to one-man buses. Pilot studies of boarding and alighting time factually proved that the increase would be immaterial and would be more than offset by other time-saving factors.

STUDY NUMBER 5

UNIFORMITY OF HEADWAYS AND ADHERENCE TO SCHEDULES

DESCRIPTION—A study of the actual headways and adherence to schedules being maintained in comparison to the scheduled operation at a specific point or points on one or more transit lines.

Study No. 1 is also used to obtain schedule-adherence data.

WHEN AND WHY STUDY IS MADE—Like the running time check, this study is becoming increasingly important in order to give a good, dependable service and to evenly distribute passenger loads.

This is considered a special study. It is warranted:

(1) To double check on passenger complaints that operators are not adhering to schedules.
(2) As a check on the relation of actual prescribed schedules for (a) a new line or (b) a change in an existing line or (c) connections at a transfer point.
(3) As a forerunner to deciding whether a running time check of the entire line is necessary.

HOW TO MAKE STUDY—This study may be made at one point or at a number of predetermined points on a line.

With the advent of the radio car for use by inspectors, some transit properties are making quick spot checks of headways and adherence to schedules at various periods of the day. Upon receiving a signal from the dispatcher all radio cars report to predetermined points on a line specified by the dispatcher and immediately check headways and schedules for 15 minutes. This spot check permits a schedule check-up on every vehicle operating on that line before the word can be passed along.

Headway recorders are also used in certain instances to check on schedule adherence, but will not be described in this manual.

The study can be made at peak or off-peak periods, and for whatever length of time desired, depending upon the purpose of study.

The field form (Exhibit 39) contains columns in which to record the name of route, block number, vehicle number, actual arrival time, and scheduled arrival time. The route name column permits the form to be used for

FIELD & SUMMARY FORM

Sheet_____ of _____ Sheets

HEADWAYS AND SCHEDULES

WEATHER ________________ DATE ________

LOCATION CHECKED ________________ DAY ________

________ BOUND

Route Name	Block No.	Vehicle No.	Arrival Time		Deviation	
			Actual	Scheduled	+	—

*Deviation in + or — minutes.

Form No. _______ OBSERVER ________________

EXHIBIT 39
Headways and schedules field and summary form.

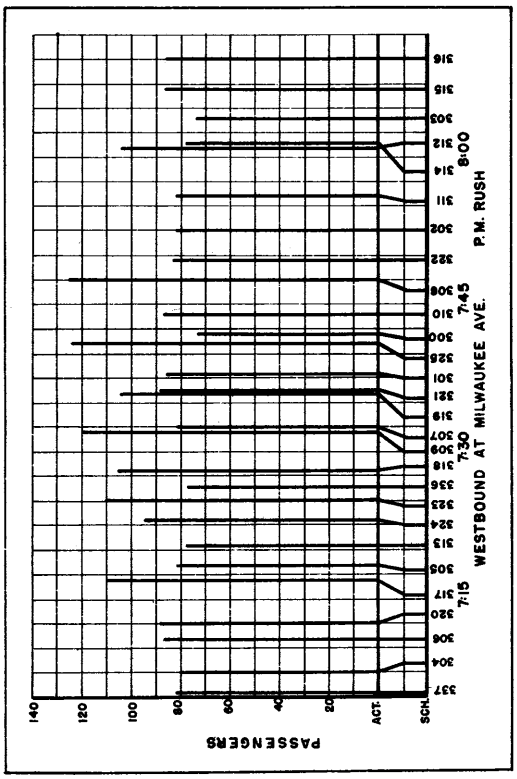


EXHIBIT 40

How field data can be presented in graph form to show the effects of good and poor schedule adherence on passenger loads for individual transit vehicles.

more than one line at a time. There are also additional columns in which to record the deviations in arrival time, whether they are plus minutes ahead or minus minutes behind schedule.

To make checks an observer is stationed at, or near, a specified stop. All transit vehicles that pass the stop (both directions) are recorded within the time period specified.

Instructions to field observers should include the degree of accuracy to which the arrival times should be read (generally, ½ minute) and the period over which they are to make the observations. They should also be instructed to stay out of sight; otherwise, a true picture of operating conditions may not be obtained.

One observer per location is sufficient to conduct the field check. Regular company employees should be used. The field form is also used as a summary form on which to record averages and from which to prepare graphs as shown on Exhibits 40 and 41.

EXAMPLES OF APPLICATION

Example No. 1—Patrons complained that buses were failing to make connections at an important transfer point during the morning rush period. A check of schedule adherence at this transfer point showed that complaints were justified. Operators on one of the lines were found to be leaving ahead of schedule in about 25 per cent of the runs.

Example No. 2—Numerous complaints were received of overcrowding on a particular line, even though the schedules had been set to assure comfortable loading. A field check showed that irregularities in adherence to schedules was the cause of overcrowding on certain buses. Vehicles going through ahead of schedule would be only partially full. Vehicles behind schedule would be overcrowded. Stricter supervision corrected the irregularities and eliminated the uneven loading.

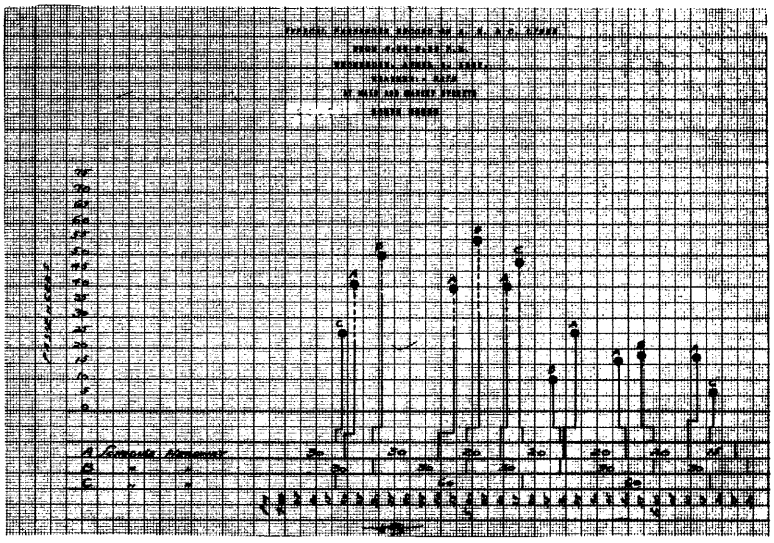


EXHIBIT 41

Chart of schedule adherence on three lines passing the same point. Dotted portions of indicated loads represent standing passengers.

STUDY NUMBER 6

LENGTH OF TRANSIT PASSENGER RIDE OR TRIP

DESCRIPTION—A study of the average length of ride (or trip) of selected groups of all passengers on one or more lines for any or all periods of the day. (Note that a distinction is made throughout this study between average length of ride and average length of trip. Certain field methods will give the average length ride for a ride on single line, omitting the effect of transfers. Other field methods will give the average length of trip including all transfers.)

WHEN AND WHY STUDY IS MADE—Though many companies estimate their average length of ride to be from 2.5 to 3.5 miles per passenger, there is actually very little information of this type available today.

This is considered a special study and is made only at such times as conditions warrant. The study is made for the following reasons:

(1) To help justify and show need for an increase in fare.
(2) To help measure justification for express bus service and premium fares.
(3) To show the amount of through riding from one section of the city to another and the possibility of connecting routes to avoid transferring.
(4) To show variations in traveling characteristics for rush and non-rush periods that may indicate need for changes in types of service being given for these two periods.

HOW TO MAKE STUDY—There are four ways of making this study as indicated in the following:

Method No. 1—On-Off Average—This method is commonly used to determine the average length of a *ride* for a single line or several lines. It is based upon an on-off passenger check of each specific line. How to make such on-off passenger checks is described in Study No. 2.

The average length of ride for passengers on each line, once the on-off data are available, is based upon the following formula:

$$\frac{\text{Total Passenger Miles}}{\text{Total Passengers}} = \text{Average Length of Ride}$$

The total passenger miles for the line consists of the summation of passenger miles between each stop.

Exhibit 42 shows a complete example of how the average length of ride for a specific line was determined from this method.

Method No. 2—Personal Interview—This method can be used to give either the average length of ride for a given line, or the average length of trip for all passengers on a line in a section of the city or for the entire city. This method is particularly adaptable to light passenger lines. Interviews are generally made on the transit vehicles.

Interviews are made over that period of time for which data are desired. Frequently, the interviews are made during both peak and off-peak periods if a general average is wanted. Sometimes special periods that include evening riders or Sunday morning riders are taken.

The questions asked the riders are similar to those used in the questionnaire method explained under Method No. 4 of this study. To record the answers the interviewers are given either cards, similar to the questionnaire card Exhibit 44, or large tabulation sheets containing vertical columns for each question asked and horizontal lines for each person interviewed.

The interviews are made on a sampling basis. (*See*

Stop No.	Passengers On	Passengers Off	Total Passengers On Car Leaving Stop	Distance Between Stops	Total Passenger Miles
1	7	0	7	0.11 mi.	0.77
2	4	0	11	0.16	1.76
3	2	0	13	0.08	1.04
4	0	0	13	0.21	2.73
5	3	0	16	0.19	3.04
6	2	1	17	0.20	3.40
7	0	1	16	0.11	1.76
8	4	2	18	0.13	2.34
9	6	2	22	0.21	4.62
10	3	4	21	0.11	2.31
11	1	3	19	0.17	3.13
12	2	4	17	0.11	1.87
13	4	1	20	0.10	2.00
14	2	3	19	0.15	2.85
15	1	1	19	0.07	1.33
16	0	1	18	0.09	1.62
17	0	2	16	0.11	1.76
18	0	2	14	0.10	1.40
19	0	6	8	0.04	0.32
20	0	8	0		
TOTAL	41	41		2.45 mi.	40.05

Average length of ride = $\frac{40.05}{41}$ = 0.98 mi.

EXHIBIT 42

Determining the average length of a ride for a single line from on-off passenger checks.

Study No. 19.) If possible, a 10 to 20 per cent over-all sample should be obtained. This sample should include 10 per cent or more of the passengers boarding at each stop in order to assure the sample being accurate. To check only those passengers getting on at the beginning of a line would not necessarily give a true picture of average riding or trip distances.

Instructions to interviewers should include a list of transit vehicles on which to conduct interviews, approximate number of interviews to make per stop, how to approach passenger when making an interview, and how to handle passengers that wish to consume interview time by registering verbal complaints about transit operations.

Since this method is generally applied on light transit lines, only one interviewer per vehicle is needed.

The interview data are summarized in a tabular form from which various averages can be readily drawn.

Method No. 3—Numbered Cards—This method is a by-product of the transit Origin-Destination Study (Study No. 9). It requires that serially numbered cards be handed to and collected from the passengers on the vehicle as they board and alight.

This method will produce the average length of *ride* for a specific transit line and also the number of passengers and the peak-load points for that specific line.

This method is applicable to all sizes of transit lines.

Generally, the peak and base periods are both covered when making this study. Sometimes special periods are covered such as the evening theatre crowd or Sunday church group.

A sample of the numbered card is shown on Exhibit 43. A further description of the card is given in the Origin-Destination Study.

A description of the distribution of serially numbered cards to boarding passengers and the collection of cards from alighting passengers at each stop also is given in the Origin-Destination Study.

Instructions to field checkers should include a list of vehicles to check; the care which must be applied in properly recording the blocks of serially numbered cards handed out at each stop; and the group of cards collected at each stop; what to say to passengers when distributing cards; and how to handle complaints.

PLEASE HAND THIS CARD TO
TRAFFIC CHECKER UPON
LEAVING BUS
54629

EXHIBIT 43

Origin-destination form that can be used to show length of ride (method No. 3). This is same form as exhibit No. 51.

Personnel needed for making this study will vary from 6 to 12, depending upon the length of the route and the size of the sample desired. Regular company employees are used for making the field checks. Occasionally the operators are used if the line is a very light one.

Eight checkers, riding in pairs on transit vehicles scheduled for 5-minute headways over routes requiring 60 minutes for round-trip operations, can cover every third transit vehicle, which is equivalent to a 33 per cent sample. Such a large sample is not always necessary, however; 10 to 20 per cent is usually adequate.

The data on the cards are first summarized by routes and then by periods of the day. They can then be displayed in tabular or chart form.

Method No. 4—Passenger Questionnaire—This method involves the use of a special passenger questionnaire form, or it can be a by-product of the Origin-Destination Study (Study No. 9). Either way, this sampling method will give the average length of passenger trip so that even though it is applied to only one line, it may involve many passengers transferring to and riding on other lines to complete their trips.

The study can be applied for whatever period is desired, but generally the two peak periods and the base period are covered in a normal study of this type.

The typical passenger questionnaire form is shown on Exhibit 44 and is the same as shown for and described in the Origin-Destination Study.

PLEASE ANSWER

WHERE DID YOUR TRIP START (nearest corner)_____

WHERE DID YOUR TRIP STOP_____
DID YOU MAKE A TRANSFER_____ WHERE_____
PURPOSE OF TRIP (work, shopping, doctor, etc.)_____
HOUR TRIP BEING MADE (Approximately)_____

EXHIBIT 44

Origin-destination form that can be used to show length of trip (method No. 4). This is same form as exhibit No. 52.

Generally, the questionnaires are distributed, and, if possible, collected on the transit vehicle. Sometimes the loads are so heavy this procedure is not practical. In such instances the questionnaires (prepared in the form of a postal card) can be handed out on the vehicle or at the

stops as passengers board the vehicle with a request that they fill the card out at their leisure and drop it in the mail box. Ten to 25 per cent will generally comply. A more detailed description of this procedure is given in the Origin-Destination Study.

Instructions to field checkers should include a list of transit vehicles to check; what to say to passengers when distributing cards; and how to answer passenger inquiries and complaints.

Regular company employees are used to make this study in most cases. Occasionally, the operators of light lines can distribute the questionnaire cards. Postal card return should always be used in such instances, however.

The data on the questionnaires are first summarized by routes and then by periods of the day. Special note is made of the percentage of questionnaires returned on each line and for each period of the day.

From this summarized data charts can be prepared showing average length of trip for each line and period.

EXAMPLES OF APPLICATION

Example No. 1—One transit company used the length of trip in determining the feasibility of operating express buses in conjunction with the regular street car service on several of its lines. It was found that on some lines the length of total haul was too short to justify express service, while on other lines express service could be operated to good advantage, with reasonable headways, and would eliminate a large amount of transferring.

Example No. 2—Another company determined the average length of ride on a certain transit system for use in a court hearing on rates of fare.

"On-and-off" checks for some routes had been conducted previously, so it was only necessary to fill in the gaps.

Example No. 3—Other companies have found that the length of ride on a route gives an excellent picture of the amount of passenger turnover in the vehicles. It has helped them to determine why the revenue per vehicle mile on one route is more or less than that of another route. Length of ride is a very important factor in understanding the characteristics of a route.

Example No. 4—One company is planning to use a special questionnaire to find out the average length of trip. The questionnaire will be mailed to 20,000 patrons selected on a scientific basis. The returned and completed questionnaires will be broken down according to routes, using the percentage of returns against the entire riding as a basis for arriving at a total for the entire city.

STUDY NUMBER 7

TRAFFIC SIGNAL AND LEFT TURN DELAYS AND STREET AND TRAFFIC CONTROL DEVICE INVENTORY

DESCRIPTION—A study of the individual effectiveness of existing traffic signs, signals and markings, and the physical conditions of a street used as a transit route.

The study is divided into: Part I—Traffic Signal and Left Turn Delays; Part II—General Inventory.

WHEN AND WHY STUDY IS MADE—This study should be made as frequently as conditions warrant. Often it is made as a follow-up to a "Running Time Study." It is not involved and is one which all transit companies can easily make when necessary. It is not intended, however, that this study should be made by the transit company if the city has a qualified traffic engineering department staffed with sufficient personnel to conduct such studies.

Reasons for making the study, whether conducted by the transit company or a city traffic engineering department, are as follows:

PART I

(1) To measure the effectiveness of traffic signal timing at a specific location on a given transit route.

(2) To measure need for prohibiting left turns of all vehicles off a major route in a given area in order to eliminate major tie-ups in traffic movement.

PART II

(3) When necessary to point out the need to the city officials for "spring cleaning" stop signs, parking signs and pavement markings in order to assure greater safety and facilitation in the general flow of all vehicular traffic.

(4) To substantiate verbal complaints about poor condition of pavement surface coming from transit vehicle operators and the general public.

(5) To reveal locations of, and provide a severity yardstick to, blind corners causing traffic accidents.

(6) When necessary, to establish a permanent record of street and intersection traffic and roadway facts about a transit route, block by block.

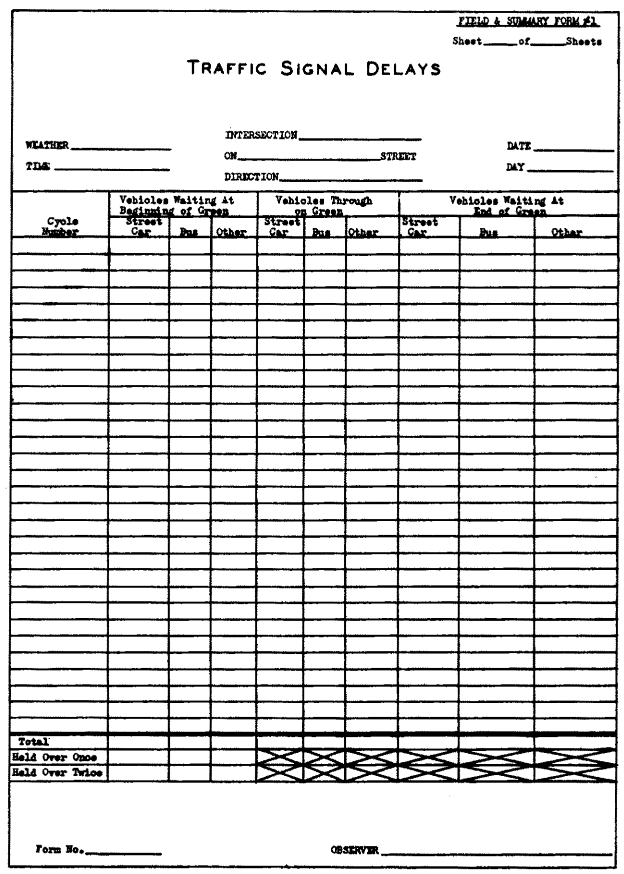
HOW TO MAKE STUDY

Part I—Traffic Signal and Left Turn Delays—Frequently, special studies are warranted at specific intersections as revealed by the "Running Time Study." These special studies generally concern:

(1) Checking transit delay in relation to the operation of traffic signals.

(2) Checking the effectiveness of progressively timed traffic signals as it relates to transit operation.

(3) Measuring the excessive delay to transit vehicles caused by left turns being made from a major street to a secondary street.



FIELD & SUMMARY FORM #1
Sheet____of____Sheets

TRAFFIC SIGNAL DELAYS

WEATHER ____ TIME ____ INTERSECTION ____ ON ____ STREET DIRECTION ____ DATE ____ DAY ____

Cycle Number	Vehicles Waiting At Beginning of Green			Vehicles Through on Green			Vehicles Waiting At End of Green		
	Street Car	Bus	Other	Street Car	Bus	Other	Street Car	Bus	Other
Total									
Held Over Once									
Held Over Twice									

Form No.____ OBSERVER ____

EXHIBIT 45

Traffic signal delays field and summary form No. 1.

Such special studies of traffic signal and left turn delays are made at the worst periods, which generally are the a.m. and p.m. peak periods. Usually, a 30 to 60-minute check of each period is adequate.

Field and Summary Form No. 1 (Exhibit 45) is used to show the number and types of vehicles delayed and those passing through during each cycle period at a signalized intersection. If each complete cycle period is 60 seconds in length, the form, as illustrated, is good for 45 complete cycles, or 45 minutes. A special notation should be made when a vehicle is delayed for more than one complete cycle period. If, for example, out of five street cars in cycle number 2 waiting at beginning of green period, only four got through on the green, the remaining one should be earmarked as a "hold-over" among the cars recorded as waiting at the beginning of the green for cycle number 3. In the same way, vehicles held over through two complete green periods should be identified for summarization at the bottom of the form.

FIELD & SUMMARY SHEET #2

Sheet_____of_____Sheets

LEFT TURN DELAYS

WEATHER_____ INTERSECTION_____ DATE_____

TIME_____ ON_____ STREET DAY_____

DIRECTION_____

5 Second Periods	Left Turn Delays		
	Transit		Autos
	Vehicles	Passengers	Main Street
Total Delay			
Average Delay			
Total Hourly Traffic			
% Delay			

Form No._____ OBSERVER _____

EXHIBIT 46

Left turn delays field and summary form No. 2.

Field and Summary Form No. 2 (Exhibit 46) is used to record the amounts of transit vehicle and passenger car delays resulting from excessive left turns being made off of a major thoroughfare. The form contains columns in which to record the number delayed by 5-second periods, also a column in which to indicate the number of passengers in the transit vehicles being delayed. For example, one vehicle attempting to make a left turn off of a busy main street may delay one bus, carrying 40 persons, and four passenger cars, each 12 seconds. This entry would be made in the 10-15 space on the form. Any other delays within 10 to 15 seconds would also be recorded in this same space.

Observers, working in pairs, are stationed at the curb to make these checks. One man does the counting and handles the stop watch, while the second man makes the recording on the field sheet. Instructions should include whether the men are to check one or both directions and the degree of accuracy wanted in checking the delays.

If it is necessary for the transit company to make these field checks, regular company employees are used. Sometimes the study is conducted jointly with the city, in which case special personnel may be employed to make the checks.

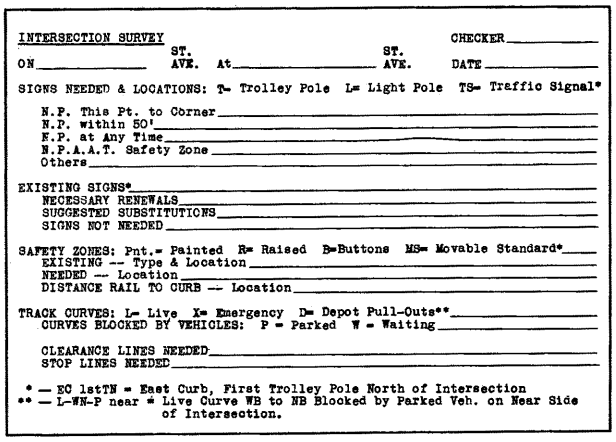
The data are summarized directly on the field forms and then reproduced in simple bar chart form.

Part II—General Inventory—The study requires a notation of all traffic and road conditions affecting transit operation along the route.

This study may be made over a period of time. Once made, it is kept up to date by periodic checks.

No single field form is suggested for use. Often the information is written directly on cards that can be later filed by blocks (See Exhibit 47). At other times, a rough 8½x11" form is prepared containing vertical columns in which to show, block by block, the street conditions, traffic devices, and the operation and condition of traffic control devices.

The inventory can be made by observers riding in a



INTERSECTION SURVEY CHECKER _____

ON _____ ST. AVE. At _____ ST. AVE. DATE _____

SIGNS NEEDED & LOCATIONS: T= Trolley Pole L= Light Pole TS= Traffic Signal*

N.P. This Pt. to Corner _____
N.P. within 50' _____
N.P. at Any Time _____
N.P.A.A.T. Safety Zone _____
Others _____

EXISTING SIGNS* _____
NECESSARY RENEWALS _____
SUGGESTED SUBSTITUTIONS _____
SIGNS NOT NEEDED _____

SAFETY ZONES: Pnt.= Painted R= Raised B=Buttons MS= Movable Standard* _____
EXISTING — Type & Location _____
NEEDED — Location _____
DISTANCE RAIL TO CURB — Location _____

TRACK CURVES: L= Live X= Emergency D= Depot Pull-Outs** _____
CURVES BLOCKED BY VEHICLES: P = Parked W = Waiting _____

CLEARANCE LINES NEEDED _____
STOP LINES NEEDED _____

* — EC 1stTN = East Curb, First Trolley Pole North of Intersection
** — L-WN-P near = Live Curve WB to NB Blocked by Parked Veh. on Near Side of Intersection.

EXHIBIT 47

An intersection survey form (5½" x 8") used by a middle-western transit company. (A sketch of intersection and comments are given on back of form.)

passenger car. Two men to a team are needed, since it may be desirable to make some street measurements. Also, one man can serve as the observer and the other as the recorder.

Regular employees of the company are generally used to conduct this study.

The data collected in the field are summarized and recorded in a card file for company use. Special summary tables and charts may also be prepared to highlight some point.

For use with outside agencies, such as the police and city engineering departments, the data should be displayed in chart form.

EXAMPLES OF APPLICATION

Example No. 1—Bus delay on a major transit route was traced to the traffic signals not being coordinated with the bus loading zones. A study was undertaken to determine the exact effect of these traffic signals on bus movements, with the objective of suggesting changes in the signal timing which would benefit transit and passenger cars alike.

When completed, the study showed that traffic signals actually delayed buses on an average of 3 minutes and 29 seconds inbound during the morning rush and 3 minutes and 16 seconds outbound in afternoon rush.

By adding 5 seconds green on the main street at one intersection, 10 seconds at another and changing the coordination through advancing all intervals 6 seconds, the a.m. inbound delays were reduced to 20.6 per cent and the p.m. outbound delays 21.8 per cent. These savings, when measured on a running time basis through the entire area, equalled 10.4 per cent inbound during morning rush period and 6.8 per cent outbound in p.m. rush period.

Example No. 2—Detailed studies were made of traffic volumes, speeds and traffic signal operation in one section of the downtown shopping district to determine what steps might be taken to improve the general movement of traffic. As a result of these studies, the cycle for all the signals in this area was shortened from 60 to 50 seconds and was connected to work as a simultaneous alternate progressive system, with a 50-50 split at each intersection.

The improvements in traffic flow, which benefited transit as much as autos, is reflected in the improvements of speeds on the various streets as tabulated below for one of the typical streets. Most of the blocks in this area were between 400 and 500 feet in length, and the streets, with one exception, were all 40 feet wide.

	12:00-12:30 p.m.	12:35-1.05 p.m.	5:00-5:30 p.m.
Average speed before change	6.98 mph	7.35 mph	5.54 mph
Average speed after change	10.1 mph	8.6 mph	8.6 mph

Example No. 3—A detailed study of traffic signal operation on a 2315-foot section of a major street proved that the signals could be retimed and coordinated to speed up the movement of both autos and street cars. These changes were made, and produced the following favorable results.

Changing from a 70 to a 50-second cycle, with a new proportioning of the intervals and the elimination of a bus stop, saved autos 85 seconds or 37.6 per cent in operating time and street cars 91 seconds or 29.5 per cent in operating time.

A further change of the signals to operate progressively saved autos an additional 26 seconds and street cars 13 seconds.

The over-all saving to autos was 111 seconds or 49.1 per cent and to street cars, 104 seconds or 33.7 per cent. Measured in miles per hour, this produced an increase in the speed of autos from 6.9 to 13.7, or a 98.5 per cent increase, and for street cars from 5.1 to 7.7, or a 50.9 per cent increase.

STUDY NUMBER 8

TRANSIT VEHICLE PASSENGER STOPS

DESCRIPTION—A study of the size, location, spacing, condition, and use of bus stops and street car loading zones. The study can also be used to show adherence to schedules, vehicle headway, boarding and alighting time, and passenger transfer movements at major transfer points.

This study can be tied in with the curb parking study No. 13, the population density studies Nos. 16 and 17, and the vehicle volume study No. 11.

WHEN AND WHY STUDY IS MADE—This study should be conducted at least once every year. It is warranted as follows:

(1) To obtain basic data on transit vehicle passenger stops for general use by transit company.
(2) To show whether the passenger stops are being adequately maintained to assure maximum safety and efficiency.
(3) To show how the stops are being used.
(4) To indicate whether present passenger stops are large enough to handle maximum number of transit vehicles stopping simultaneously in space set aside for passenger stop.
(5) To show what percentage of total curb space is being devoted to passenger stops.

In 1938 the American Transit Association issued a study entitled "Should Bus Stops Be Located on the Near Side or Far Side of Intersections?" The conclusions set forth in this study, which are quoted below, definitely indicate the need for special studies in certain instances:

> "A review of the contentions put forth by the advocates of the far-side stop, and a full analysis of the relative advantages of the far and near-side locations lead us to the conclusion that, while there can be no invariable rule for all situations, the near-side stop has definite advantages from the standpoint of both traffic movement and traffic safety at the average right angle intersection of streets on which buses alone operate. At certain points, particularly irregular intersections and where buses turn either left or right, the far-side stop may be more advantageous.
>
> "On car line streets, the best location of bus stops can only be determined after a full study of all local conditions, particularly the relative frequency of street car and bus movement and the volume of other vehicle traffic. Not only may near-side and far-side stops be considered but, frequently, especially in central business districts, it has been found advantageous for buses to stop to receive and discharge passengers in the car track area where protected safety zones are installed, instead of at the curb as is generally the practice."

When determining the specific location of a passenger stop, this study should be supplemented with studies of accident records and turning characteristics of all traffic at the location under study.

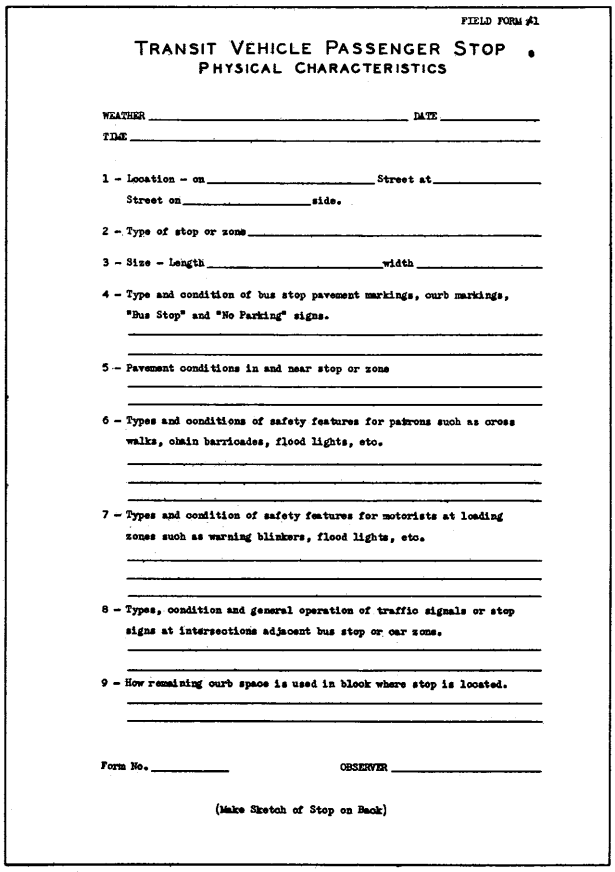
HOW TO MAKE STUDY—This study may cover one route of the city, the downtown business district, or the entire transit system. In any case, a large scale map, approximately 400 feet to the inch, should be obtained on which to record the location and sizes of all stops and zones. There are two parts to the study. The first part relates to the physical characteristics of the stops. The second relates to the use and required sizes of the stops.

Part I—This part, dealing with the physical characteristics of the stops, can be made at any time. Field Form No. 1 (Exhibit No. 48) is used to record the characteristics at and near each stop. To facilitate handling and filing, the field form should be printed on cardboard stock either 4x6" or 5x8" in size. Note that a sketch of the stop should be included on the back of the card as a part of the information for each stop.

No special summary form is necessary. The field forms are filed by transit routes or by streets. Periodically, however, a composite summary of the latest highlights taken from the field sheets should be prepared and carefully studied.

Part II—This part of the study, covering the use of stops and type and amount of interference encountered by each transit vehicle that makes a stop, is generally made during the hours when peak schedules are being operated and when traffic movement is at a maximum on the streets.

The information about stop use and interference can be recorded on a form similar to Field Form No. 2. (*See* Exhibit 49) This form contains vertical columns in



FIELD FORM #1

TRANSIT VEHICLE PASSENGER STOP
PHYSICAL CHARACTERISTICS

WEATHER _____ DATE _____
TIME _____

1 - Location - on _____ Street at _____
Street on _____ side.

2 - Type of stop or zone _____

3 - Size - Length _____ width _____

4 - Type and condition of bus stop pavement markings, curb markings, "Bus Stop" and "No Parking" signs.

5 - Pavement conditions in and near stop or zone

6 - Types and conditions of safety features for patrons such as cross walks, chain barricades, flood lights, etc.

7 - Types and condition of safety features for motorists at loading zones such as warning blinkers, flood lights, etc.

8 - Types, condition and general operation of traffic signals or stop signs at intersections adjacent bus stop or car zone.

9 - How remaining curb space is used in block where stop is located.

Form No. _____ OBSERVER _____

(Make Sketch of Stop on Back)

EXHIBIT 48
Transit vehicle passenger stop—physical characteristics field form No. 1.

which to record the Block Number, Vehicle Number, Arrival and Departure Time, Types and Amounts of Interference, and Passengers On and Off at Stop.

To record the information observers equipped with Stop watches are stationed at or near the stops being studied.

Observers should be instructed to record all transit vehicles entering the stops, to use symbols to denote the types of interferences (see several samples on field form), and to record as "time delayed" any unusual time required to reach or leave stop within 100 feet of stop.

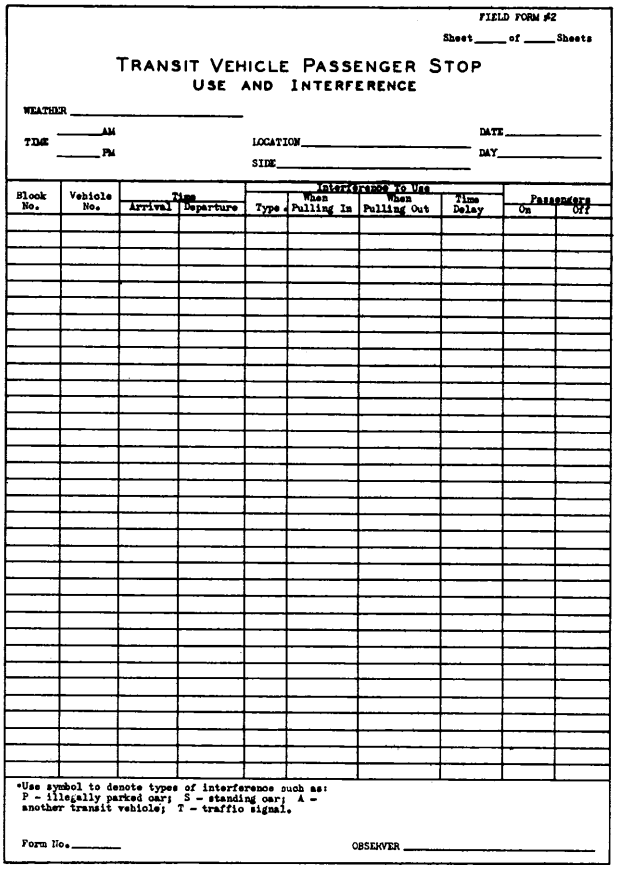
It is preferable to use two men when making this study, although it can be done by a single person if necessary. Regular company personnel is used for both parts of this study.

The Field Form No. 2, with slight modifications, can be used as a summary form from which various types of analyses and tabulations can be prepared. To facilitate the use of the Part II data, it should not only be compared and filed with the Part I physical characteristic field forms, but it should also be keyed by numbers to a large map showing the location of all passenger stops.

Exhibit 50 shows a form being used by some transit companies when making special checks on numbers of passengers and transfers at transit stops.

EXAMPLES OF APPLICATION

Example No. 1—The newspapers in an eastern city recently carried the headline "Survey of Bus Stop to Ease Traffic Congestion Proposed." The article went on to



FIELD FORM #2

Sheet ____ of ____ Sheets

TRANSIT VEHICLE PASSENGER STOP
USE AND INTERFERENCE

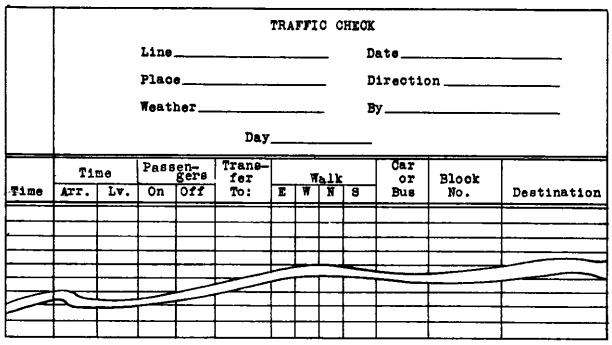
WEATHER _____
TIME _____ AM _____ PM
LOCATION _____ DATE _____
SIDE _____ DAY _____

Block No.	Vehicle No.	Time Arrival	Time Departure	Interference To Use Type*	When Pulling In	When Pulling Out	Time Delay	Passengers On	Passengers Off

*Use symbol to denote types of interference such as: P - illegally parked car; S - standing car; A - another transit vehicle; T - traffic signal.

Form No. _____ OBSERVER _____

EXHIBIT 49
Transit vehicle passenger stop—use and interference field form No. 2.



TRAFFIC CHECK

Line _____ Date _____
Place _____ Direction _____
Weather _____ By _____
Day _____

Time	Time Arr.	Time Lv.	Passengers On	Passengers Off	Transfer To:	Walk E	Walk W	Walk N	Walk S	Car or Bus	Block No.	Destination

EXHIBIT 50
A type of form that is being used to make a special check of passengers and transfers at a bus stop of street car loading zone.

say, "An immediate survey of all bus stops in the congested business area to find out how much space could be cut back for automobile parking was urged yesterday by the Advisory Board of the Blank Club."

As a follow-up to this proposal, the transit company made a combined bus stop and curb parking survey of the downtown area. When completed, it showed each bus stop was approximately 100 feet long, and if reduced to accommodate only one bus, would still have to be 80 feet long. The difference would provide only one curb parking stall per block where curb parking was permitted, or 50 stalls in the entire business district. This would have increased the present curb parking space less than 2 per cent. Moreover, it would have slowed down transit operations, thereby adversely affecting thousands of transit riders, and would also have created passenger car delays because of necessity of buses stopping in street rather than at the curb.

Following a look at the facts, the proposal was forgotten.

Example No. 2—Though transit management knew that a larger bus stop was needed at an important downtown traffic signal controlled intersection, the local authorities had to be sold on the proposition. Convincing evidence was needed, so a special study was made of the use of the existing two-stall bus stop and the amount of delay encountered by the buses waiting to use the stop.

Field information was collected on a form similar to Form No. 2, described above. When completed, the study showed that during the morning rush period 100 buses used the stop, 83 of which experienced excessive delay because of other buses in the stop and the red light. Of these 50 were delayed an average of one red interval, or 27 seconds. The remaining 33 were delayed an average of 2 red intervals, or 107 seconds, for the same reason. Passengers affected by these excessive delays totaled 600 alighting and 80 boarding.

Following a presentation of these facts, the city agreed to increase the length of the bus stop from two to three berths. A later check showed this increase in length had eliminated all the 107-second delays and reduced the one red interval delays from 50 to 41 buses.

STUDY NUMBER 9

ORIGIN AND DESTINATION OF TRANSIT AND AUTO TRAFFIC

DESCRIPTION—A study of the origin and destination of present and/or potential traffic carried by transit and passenger cars and the distance traveled by transit riders.

WHEN AND WHY STUDY IS MADE—This study is becoming increasingly important to transit companies. Important by-products of the transit Origin-Destination Study (Method No. 1) are: transit peak-load points, over-all transit passenger loads, distances from transit lines that patrons now walk, and average length of a transit passenger ride or trip.

This is a special study. It is warranted under the following conditions:

(1) To reveal potential transit patronage not fully developed.
(2) To suggest advantageous route changes.
(3) To determine approximate percentage change in riding habits that might be expected.*
(4) To determine purpose and frequency of trips of present and potential transit patrons.
(5) To determine the value of certain sections of lines for franchise studies.
(6) To determine the average lengths of passenger rides.*
(7) To obtain individual information as to time of movement, working hours, etc., as background for proper staggering of hours.*
(8) To relate origin-destination data and transit passenger facts with population and employment trends in order to plan for future transit needs and express roadways.

HOW TO MAKE STUDY—There are many ways of making origin-destination studies, dependent largely on the type of information desired. They can be divided into three general types:

(1) *Transit only*—Origin and destination of present transit passengers, by-products of which can be the purpose of the trip, the length of ride, peak-load points, and "time of travel" habits.
(2) *General traffic*—Origin and destination of present and potential general traffic, including transit.
(3) *Auto only*—Origin and destination of present motor vehicle traffic.

Ways to make these three types of studies are described in the following:

ORIGIN AND DESTINATION OF TRANSIT PASSENGERS—There are several ways to make this study, depending upon whether the O-D of rides for a single line is wanted, or whether the O-D of trips is wanted for all patrons riding on the one or more lines checked. The first method described provides the O-D of rides for a single line only, and requires the use of serially numbered cards, which are handed the passengers as they board the vehicle. An alternate to this method is also briefly described.

The second method provides the O-D of trips for all patrons riding on the line checked and requires the use of passenger questionnaire cards, which are given to the passengers while they are waiting for a transit vehicle, or while they are riding on the vehicle. A third method, briefly described, is based upon personal interviews and is especially adapted to light lines.

Two other methods which provide limited O-D data for rides on a specific transit line are briefly described. These are based upon (a) a special type of on-off passenger study and (b) a study of the transfers collected at various points on a line.

Method No. 1—Serially Numbered Cards—This method is applied on a transit line basis and the field work is assigned according to runs. The study can be conducted over whatever period of time is deemed necessary to give the desired information.

The study is conducted with serially-numbered cards (Exhibit 51) aided by the use of a key sheet for each direction, showing every stop on the line. These key sheets are columned according to the greatest number of trips scheduled in each direction, and are used by the checker who hands cards to the boarding passengers.

The size of the sample taken will depend upon the purpose of the survey. Also, the smaller the survey the more care must be exercised in the selection of the sample. If a 10 per cent sample is taken, checkers should

**These apply only to the personal interview and questionnaire methods described herein.*

PLEASE HAND THIS CARD TO

TRAFFIC CHECKER UPON

LEAVING BUS

54629

EXHIBIT 51

Origin-destination form that can be used to show length of ride (method No. 3). This is same form as exhibit No. 43.

be assigned to every tenth run. If a 50 per cent sample is taken, the assignments should be for every other run.

The checkers work all of the trips which make up the run. Information derived from this manner of checking produces a very accurate sample of the riding over the entire time the line operates.

Two checkers are placed upon those vehicles which have a separate entrance and exit. The checker at the front door hands each boarding passenger one of the numbered cards, requesting the passenger to hold the card until alighting. If transfer information is desired, cards may be marked with an "X", or some other designating mark when boarding passengers tender or request transfers. Transfer information is often very helpful in studies involving extensions or route changes.

The number of the last card handed out at any stop is entered on the key sheet in the space opposite the name of the street adjacent to that stop, and under the column according to the trip being made.

The second checker stationed at the exit door (if the line being studied is equipped with vehicles having separate entrance and exit doors) collects the cards from persons alighting at the rear door. The checker at the front also collects cards from those alighting at the front door. Each checker then puts a rubber band around the group of cards just collected and writes on the top card the name of the street at which the passengers have just alighted.

If the study is conducted on a line using a single door for entrance and exit, one checker can hand cards to boarding passengers, making notations on the key sheet as well as collecting and bundling tickets received from alighting passengers and noting the street on the top card.

Upon completion of the road work the cards are brought to the office, and on each card in each bundle is written the name of the alighting street that appeared on the top card. The cards are then assorted according to the streets at which the passengers boarded. This is done by referring to the key sheets which were kept by the checker working at the front entrance. The number of passengers boarding at a given street is obtained by taking the difference between the entry at that street and the previous entry.

The next step, after sorting cards as to streets at which passengers boarded, is to assort the cards according to streets at which passengers alighted. Upon completion of this work the number of identical rides between any two streets is then determined. This information is entered upon a large work sheet which is similar to the chart or form in which it is planned to study the data. First, however, the sample is built up to give a 100 per cent picture. Once this is done the work of solving the problem in question may proceed.

Method No. 1—Alternate. Marked cards can also be distributed and collected by placing checkers at key loading and discharge points along the line. Though this procedure provides a check of every transit vehicle, it permits only a partial check of the origin and destination of the passengers. This procedure generally produces less satisfactory data than when the checkers ride the vehicle, and does not even give a complete picture of the origin and destination of all rides for the particular line being checked.

Method No. 2—Passenger Questionnaire Cards— This method, like No. 1, is applied on a transit line basis and the field work is assigned according to runs. The study can be conducted over whatever period of time felt necessary to give the desired information.

The questions on the card should be few in number and to the point. (*See* Exhibit 52 for a sample of card.)

The card should also describe the purpose of the questionnaire and urge public cooperation.

The distribution and collection of passenger questionnaire cards is quite similar to that. just described when using the serially numbered cards.

In a few instances, drivers have been used in small communities to distribute and collect the cards. Generally, this method of distributing and collecting the

PLEASE ANSWER

WHERE DID YOUR TRIP START (nearest corner)_____

WHERE DID YOUR TRIP STOP_____

DID YOU MAKE A TRANSFER_____ WHERE_____

PURPOSE OF TRIP (work, shopping, doctor, etc.)_____

HOUR TRIP BEING MADE (Approximately)_____

EXHIBIT 52

Origin-destination form that can be used to show length of trip (method No. 4). This is same form as exhibit No. 44.

cards is not satisfactory. It is best to have special checkers distribute and pick up the cards.

When transit loads make it impossible to conduct all of this study on moving vehicles, consideration should then be given to the use of return-address postal cards that can be given to the passenger to take with him, fill out, and return at his leisure. This return postal card method seldom produces more than a 25 per cent return, however, and there is always some question as to whether the sample obtained is a true one or not.

As an alternative means, when the loads are not too heavy, the questionnaires may be distributed by checkers located at major pick-up and discharge points on the street to handle the distribution and collection of the questionnaire cards.

Instructions to field men should include a list of runs and vehicles to cover, how cards are to be given to and collected from riders, and how to answer complaints about transit service.

Personnel for Method No. 2 will depend on how much of the study is made in one day and also upon the number of transit vehicles to be checked at one time.

Generally, six to ten checkers make a satisfactory working group. With such a group, it is possible to check passengers on six to ten scheduled units at one time as the units operate from one end of the line to the other.

Method No. 3—Personal Interview—This method is quite similar to the questionnaire card method just described, except that the rider is personally interviewed on the several questions. The field interviewers make the interviews as they ride the transit vehicles. All answers are recorded on tabulation sheets containing space comparable to the questions on the Method No. 2 passenger questionnaire card. Obviously, the interview method cannot be applied to heavy lines. It is best applied to medium and light lines.

Method No. 4—On-Off Passenger Observation—This method provides limited origin and destination data and is an adaptation of the special type of on-off passenger count described in Study No. 2 and Exhibit No. 17. It is based upon the observation and recording of the stops at which each passenger boarded and alighted from the transit vehicle. This method provides only the origin and destination of the rides on each specific line checked and does not give information on the origin and destination of the passenger trip. It can be used most effectively on light and medium-sized lines.

Method No. 5—Transfers—A study of transfers provides still another means of obtaining some transit line origin and destination data of transit passengers. This method at best, however, provides only limited data and is only applicable to those properties where a different color or type of transfer is used for each transit line.

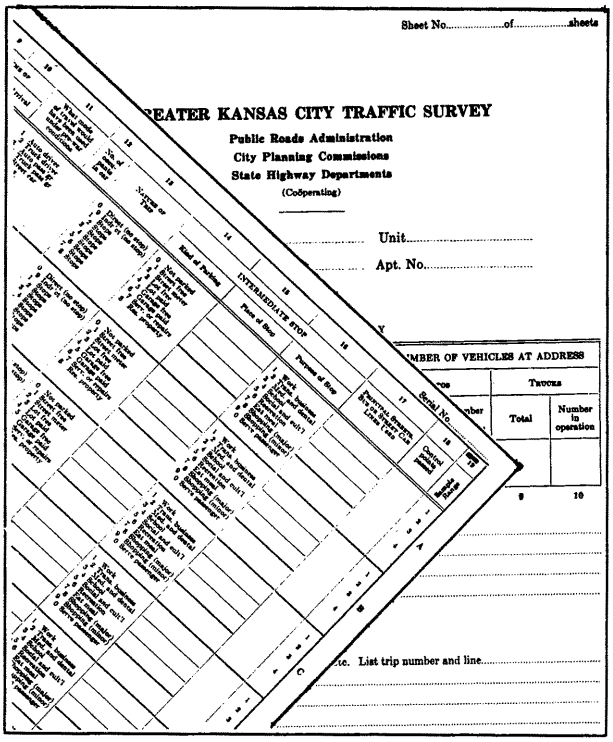


EXHIBIT 53

The home interview double letter-size form used by PRA when conducting a 5 to 10 per cent sample survey of O-D. Some of the forms have contained specific transit questions such as "names of transit lines used".

ORIGIN AND DESTINATION OF GENERAL TRAFFIC, INCLUDING TRANSIT—"The Manual of Traffic Engineering Studies" issued by the National Conservation Bureau described two ways of making general origin-destination studies. These can be used for transit as well as passenger cars. They provide trip origin-destination data on all residents of the community, which includes transit passengers as well as automobile drivers and passengers.

House-to-House Interview—This is a more basic type of origin-destination study than any other described herein. It is based upon a house-to-house interview with a 5 to 10 per cent scientific sample of all the residents of a given area or of the entire community. This method is now being advocated and used by the Public Roads Administration and many of the state highway departments. To date this type of an origin-destination survey has been made in 35 to 40 large cities. (*See* Exhibits 53 and 54)

The amount of personnel needed to make the house-to-house interview study will depend solely upon the size of the project and the time within which the project

STATE OF _____

STUDY OF TRAVEL IN THE _____ METROPOLITAN AREA

1. Dwelling Unit Summary

Tract No. _____ Block No. _____ Schedule No. _____

Address: _____ (Apt. No.) _____ (House No.) _____ (Street)

A. Date of travel _____ , 194__

B. How many passenger cars are owned by persons living at this address? ____

C. How many of these are not in service? ____

D. How many persons live here? ____

E. How many of these are 5 years old or older? ____

(1) How many made no trips on date specified in A? ____

(2) How many made one or more reported trips on that date? ____

(3) For how many was it impossible to obtain trip information? ____

(a) Reason _____

Note: (1) plus (2) plus (3) should equal E.

F. What is the total number of trips reported for persons shown in E(2)? ____

G. If questions B, C, D, or E are not answered what is the reason? _____

H. Date interview completed: _____ , 194__

Signature of interviewer: _____

Note: Fill a separate trip report (reverse side of this sheet) for each trip made by each person, even though two or more of them may have traveled together. The total number of trip reports for the address should equal the number entered in F above. Two trip reports should be completed for each round trip — one for trip away and one for the return trip.

Factor _____

EXHIBIT 54

Dwelling unit summary from O-D home interview type survey.

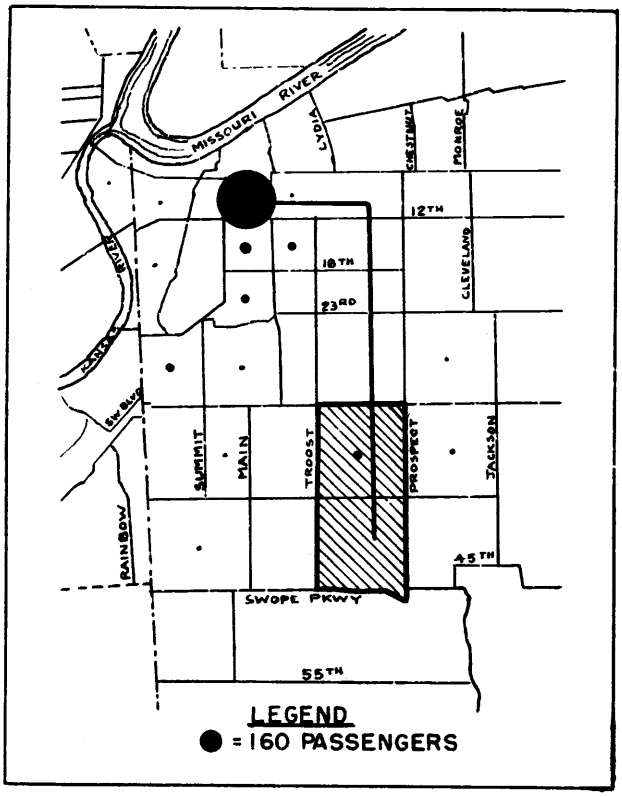


EXHIBIT 55

The origin (shaded area) and destinations (solid circles) of riders on one transit line. This information was derived from a home interview type survey.

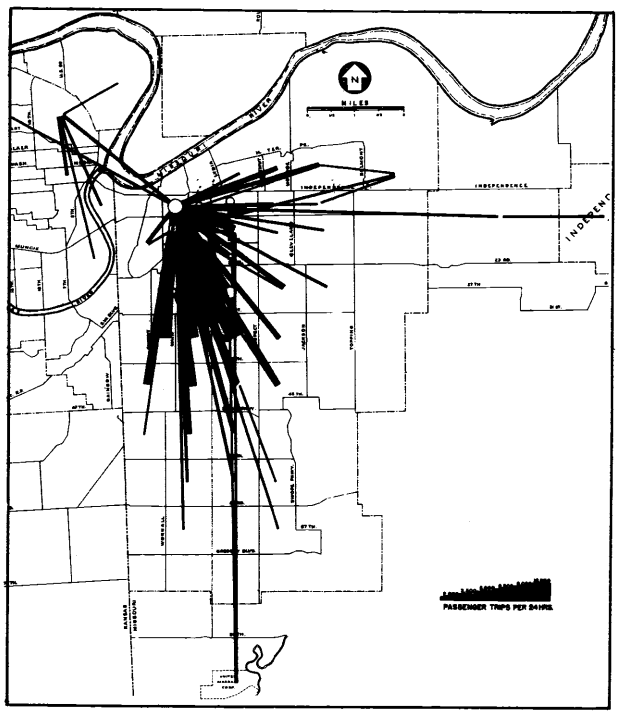


EXHIBIT 56

O-D of transit passenger trips (volumes of 500, and over, transit passenger trips) taken from a house interview type survey.

must be completed. One interviewer can make from six to ten interviews in eight hours and also cover such rechecking that may be necessary to complete unfinished interviews. In all such surveys made to date, the Census Bureau has selected and trained the personnel used for making the interviews. School teachers and housewives have been used in a majority of the surveys.

Transit companies have been asked to cooperate in most of these surveys, and have had access to the final data for use in transit planning whenever desired. (*See* Exhibits 55, 56 and 57)

Questionnaire by Mail—This is an untried method proposed by the National Conservation Bureau in its "Manual of Traffic Engineering Studies." It is believed that a properly worded letter accompanied by a return postal card (postage guaranteed), if sent out to a scientifically selected sample by a well recognized individual, such as the mayor or chief of police, would produce at least a 25 per cent return.

No special personnel is needed for the mail questionnaire method.

It has been suggested that the interview or questionnaire type origin-destination study should cover the following transit considerations:

(1) The distance from point of origin to the transit

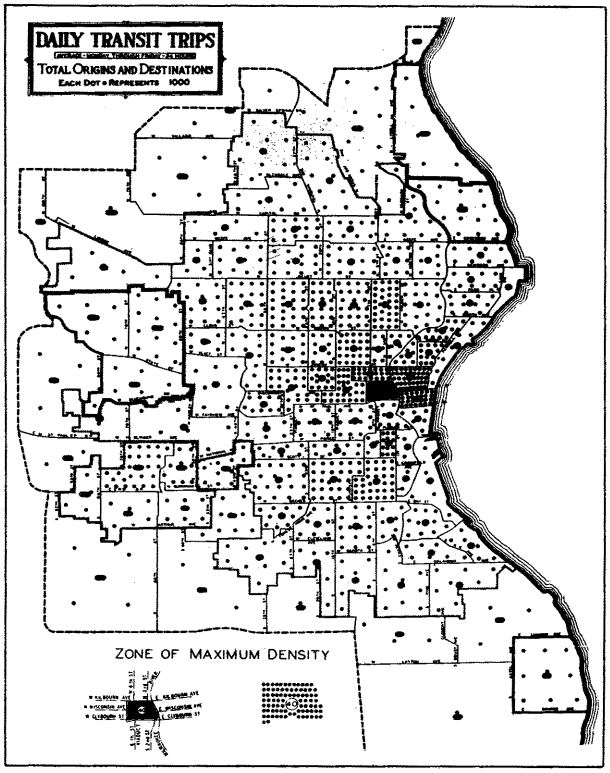


EXHIBIT 57
O-D of daily transit trips in a large city as obtained from a five per cent sample interview study.

line and from the transit line to point of final destination.

(2) The extent to which transfer passengers are subjected to transferring between transit lines.

(3) Whether the origin-destination should be completed by transit lines or by zones or other designated areas.

(4) Whether transit trips should be studied by themselves or combined with automobile trips and how same should be shown.

(5) Whether such study should be made on a full day's basis or whether rush period traffic should govern as far as transit lines are concerned.

ORIGIN AND DESTINATION OF PASSENGER CARS ONLY—"The Manual of Traffic Engineering Studies" also describes four ways of making Type No. 3 Origin-Destination Studies which transit executives should know about. Briefly they are as follows:

Questioning of Auto Drivers—Drivers are stopped and asked their origins and destinations. This study does not, however, produce any data about present transit riders. Exhibit 58 shows a sample field sheet used in this type of curb interview survey.

Postal Cards to Drivers—This is considered an alternate method to the direct questioning of drivers and is used when traffic is heavy and cannot be stopped long enough for an interview.

Recording Vehicle Registrations—Vehicle registration numbers (generally, the last three digits) are noted at each of a number of stations on a major street or streets by 15-minute periods. Registration numbers observed at the various stations are then compared to determine the routes taken by the vehicles. Exhibit 59 shows sample field form.

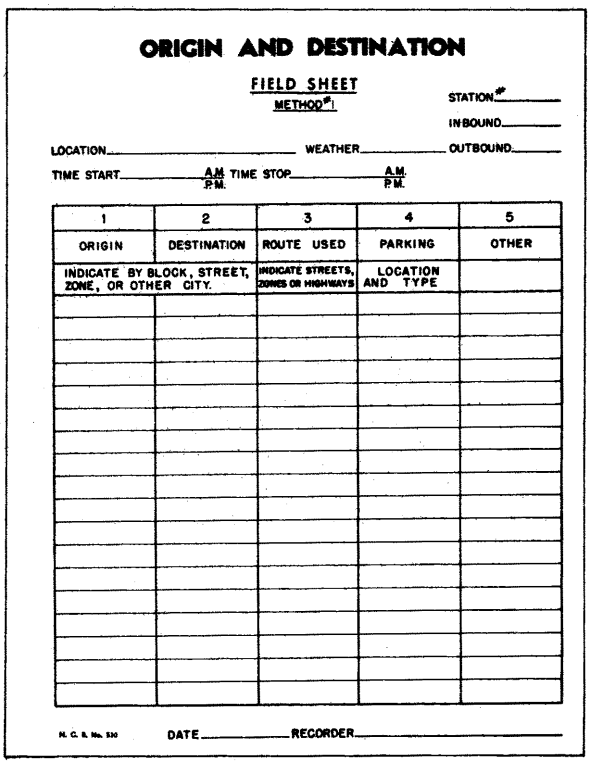
Personnel required for the vehicle registration method depends upon the number and lengths of streets being checked. The number of checkers generally varies from 10 to 25, and the time to make the necessary field checks generally varies from one to ten days.

Registration of Parked Cars—Registration numbers of all cars parked at the curb and in lots and garages are noted (Exhibit 60) and checked against the registration files of the police or motor vehicle department, to obtain the addresses or origin where the cars are permanently garaged.

EXAMPLES OF APPLICATION

Example No. 1—Local officials demanded that a crosstown transit line be established, based upon petitions for such a service from several citizen groups. After much discussion it was agreed that the company should conduct a transit O-D survey to determine the present need for such a crosstown line. The questionnaire card method was used since the trip origin-destination had to be determined for four lines, which involved about 25 per cent transfers. This survey showed that less than one seated bus load per hour would use the crosstown, so the city officials withdrew their demands for such a service.

Example No. 2—Tripper crosstowns were being operated between several residential areas and several large manufacturing plants. From this, the public drew the impression that a regular crosstown scheduled service would be warranted between several large outlying residential areas. To check the validity of such an impression, the company made an O-D survey on two lines serving the two outlying residential areas. The serially numbered cards, similar to that described in Method No. 1, were used. The survey was made on a typical weekday from 7:00 a.m. to 6:00 p.m. in order to obtain a complete picture. Special notations were made on all cards given to passengers who asked for transfers. When the results were tabulated, they showed that 95 per cent of the present transit patrons of the two lines were "local" or "neighborhood" riders whose destinations did not in-



ORIGIN AND DESTINATION

FIELD SHEET

METHOD #1

STATION #

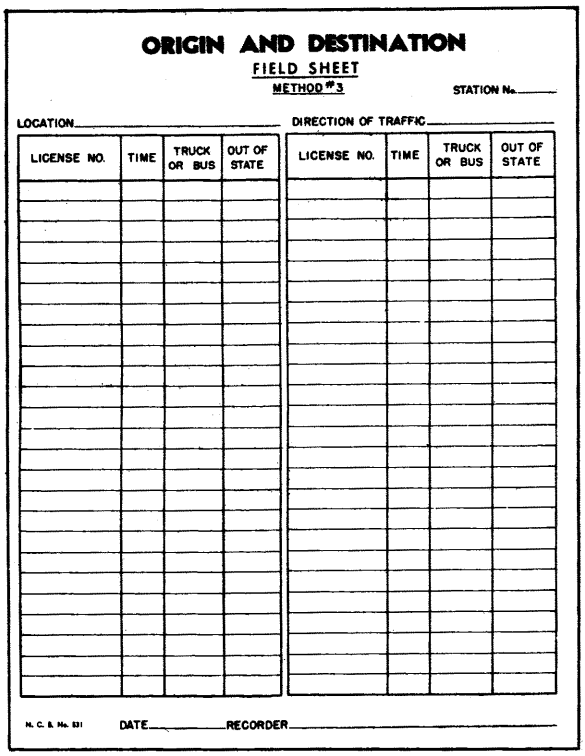
INBOUND

LOCATION WEATHER OUTBOUND

TIME START A.M. P.M. TIME STOP A.M. P.M.

1	2	3	4	5
ORIGIN	DESTINATION	ROUTE USED	PARKING	OTHER
INDICATE BY BLOCK, STREET, ZONE, OR OTHER CITY.		INDICATE STREETS, ZONES OR HIGHWAYS	LOCATION AND TYPE	

N. C. B. No. 530 DATE RECORDER



ORIGIN AND DESTINATION

FIELD SHEET

METHOD #3

STATION No.

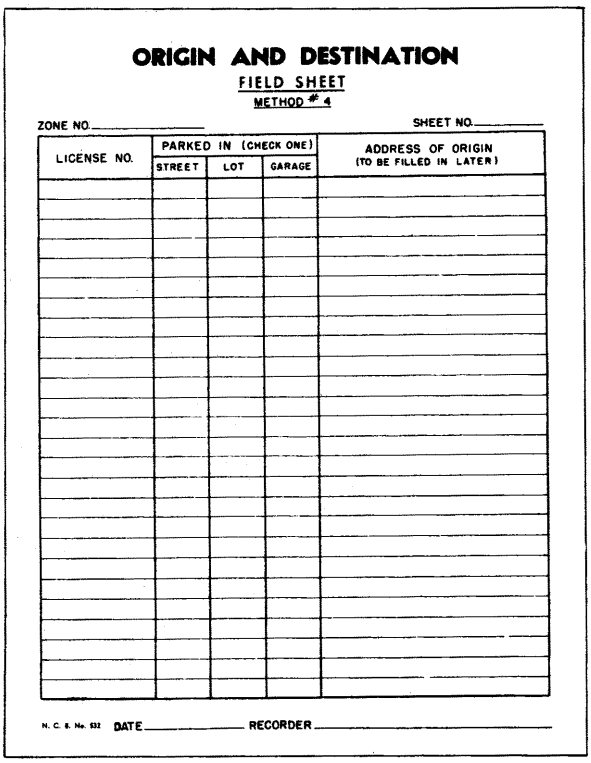
LOCATION DIRECTION OF TRAFFIC

LICENSE NO.	TIME	TRUCK OR BUS	OUT OF STATE	LICENSE NO.	TIME	TRUCK OR BUS	OUT OF STATE

N. C. B. No. 531 DATE RECORDER

EXHIBITS 58, 59 and 60

Origin and destination field sheets for 3 methods—issued by National Conservation Bureau.



ORIGIN AND DESTINATION

FIELD SHEET

METHOD # 4

ZONE NO. SHEET NO.

LICENSE NO.	PARKED IN (CHECK ONE)			ADDRESS OF ORIGIN (TO BE FILLED IN LATER)
	STREET	LOT	GARAGE	

N. C. B. No. 532 DATE RECORDER

volve a transfer or a ride on another transit route to complete their trips. Of the remaining 5 per cent only 2 per cent could be earmarked as potential crosstown riders. This was recognized as insufficient patronage on which to establish such a special service.

Example No. 3—A large transit property found it necessary to know what percentage of the riders made the downtown district their destination. With the help of the transit vehicle operators 124,000 colored tickets were distributed to, and collected from, passengers during a 1-day check. A final tabulation showed that 20 per cent of the riders in this city of over 3 million population made the downtown district their ultimate destination.

Example No. 4—A state highway department in cooperation with a transit company in a large midwest city made a study of travel habits of downtown employees. The distance traveled by employees to reach work by various modes of transportation was a part of the study. The information collected was placed on IBM cards. When analyzed according to riding from an inner zone with a 4-mile radius to an outer zone beyond this 4-mile radius, the following facts were revealed: of the downtown workers who live in the inner zone, 29 per cent drive to work, and 71 per cent use public transportation. Of those living in the outer zone, 54 per cent drive to work and 46 per cent use public transportation. Of the total workers in the downtown area, 63 per cent live in

the outer zone, and 37 per cent live in the inner zone.

From these facts the following major conclusions were, reached by the transit company:

(1) The transit service was unattractive to those people living in the outer zone.
(2) Potential increase in transit patrons is greatest from the outer zone.

Example No. 5—The 1946 modernization plan adopted by the company included a change in the Pulaski Heights route from street car to trolley coach operation. Special summaries were made of the questionnaire cards completed by Pulaski Heights passengers. It was found that 1,066 persons were interviewed who start their trips west of Victory Street and who are destined for points within the area shown in Exhibit 61.

Of these, 746 gave destinations south of Third Street, that is, points closer to Capitol Avenue than to Markham Street.

These cards were collected from the passengers on 8 of the 15 rush hour Pulaski Heights cars, alternate cars being chosen to get a true sample, and from the passengers on all Pulaski Heights cars after the rush hour and up to 3:30 p.m. The figures, when corrected for this partial coverage, showed 2,050 Pulaski Heights passengers daily with their destinations and origins closer to Capitol Avenue than to Markham Street, while a maximum of 880 passengers were interested in points closer to Markham Street.

Traffic conditions were much more congested along Markham Street between Victory and Main Streets than along the corresponding section of Capitol Avenue.

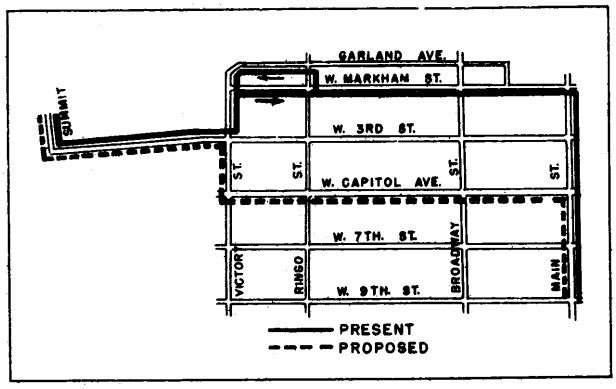


EXHIBIT 61

Proposed rerouting in a capitol city following a study of origin and destination of transit patrons.

Trolley coaches would be delayed more often and more seriously if operated along this portion of Markham than if they were using Capitol Avenue. The delays would affect very adversely the proposed Pulaski Heights-South Main Street trolley coach operation.

Operation over Capitol Avenue would reduce by five minutes the one-way travel time between Victory and West Third Streets, and Main Street and Capitol Avenue. This would be a fine improvement for the great majority of Pulaski Heights patrons.

It was recommended, therefore, that the Pulaski Heights-South Main Street trolley coach line be operated east and south along the present Pulaski Heights route to Victory and West Third Streets, south to Capitol Avenue, east to Main Street and south over the present South Main Street route, returning over same route.

STUDY NUMBER 10

FUNCTIONAL USE OF STREETS

DESCRIPTION—A study of the type and extent of use being made of a particular street or section of a street by various classes of traffic.

WHEN AND WHY STUDY IS MADE—This is a study new to the transit industry. Only a few have been made to date. It will, however, become increasingly important to the larger properties.

This is a special study. It is warranted by the transit company:

(1) When conflicts exist between various types of traffic in the use of a street or section of a street.
(2) When transit vehicles are delayed by many cars that need not be traveling on that same street.
(3) When transit company must prove that it deserves more consideration in traffic signal timing, turning movements, and physical roadway design on a given section of a street.
(4) When transit company wishes to show that the use of a street should be based more upon the number of people being moved rather than upon the number of vehicles being moved.

HOW TO MAKE STUDY—This study, when applied to any section of street or to one or more streets, is divided into four parts:

(1) Character of traffic
(2) Traffic signal operation
(3) Curb parking
(4) Cross traffic and turning movements

Application of these four parts is briefly described in the following paragraphs.

(1) ***Character of Traffic*** (on the major thoroughfare)—This involves a determination of the relative amounts of local and through traffic carried by transit and by passenger cars—measured in terms of the number of passengers or occupants, as well as number of vehicles traveling to or passing through the zone under study. This comparison of the amount of local to through traffic, measured in the zone at various periods of the day, indicates whether the present traffic being handled by each mode of transportation consists largely of local shoppers (those shopping in the immediate zone under study), or through workers (those going beyond zone under study), or local or through pleasure seekers. It also indicates whether present traffic operations and street use are in line with the general business characteristics of the area under study.

To determine the amount of local and through transit and passenger car traffic for a given zone requires: (1) a combination transit passenger count and on-off passenger check of all transit vehicles passing through the zone, and (2) a field check of passenger cars similar to that required in a simple origin-destination study. Both of these studies should cover a 10 to 12-hour period on a typical weekday so that the peak periods will be covered as, well as the base periods.

To make the transit check see Study No. 1 and No. 2 for methods.

To make the passenger car check the registration numbers of all motor vehicles are noted as they enter and leave the zone being checked. The time each vehicle enters and leaves the zone is also noted.

The field form on which the passenger car information is recorded (Exhibit 62) contains vertical columns in which to record the actual registration numbers and occupants of cars entering and leaving the zone, for each time period specified. The time periods should be quite short—between 2 and 4 minutes. A separate field form should be used for "entering traffic" and "leaving traffic" at each end of the zone.

Not more than four persons are needed to make the average traffic character study. Two are stationed at each end of the zone or section of street being checked. Of each pair, one serves as an observer and the other as a recorder. Both directions can be checked simultaneously, but on separate field forms, if traffic is not too heavy. Otherwise, the directions can be treated independently and on different days, or simultaneously by the doubling of checking crews.

Regular or special company employees may be used as field checkers.

Before summarizing the data, it is necessary to establish a travel time factor for the zone. This time factor should about equal the actual running time through the zone. Vehicles that check out of the zone in a time

FIELD SHEET

Sheet____ of____ Sheets

PASSENGER CAR CHECK

WEATHER____ LOCATION____ DATE____

TIME____ DIRECTION____ DAY____

Time Periods	Registration Numbers	Occupants

Form No.____ OBSERVER____

EXHIBIT 62
Passenger car check field form.

that is greater than the "time factor" are considered local or non-through traffic; conversely, vehicles taking less time are considered through traffic.

Once the comparison of registration numbers has been completed and checked against the time factor, the vehicles and occupants can be divided into local and through traffic and appropriate tables and charts prepared, showing the general character of the traffic to and through the zone.

Traffic Signal Operation—This part of the functional study requires a check of the signal timing and progressive movement permitted by those traffic signals located in the zone under study. It also involves a study of the relative amount of delay which the signal timing and progression imposes upon transit vehicles and transit passengers in comparison to delay imposed upon passenger cars and their occupants. Procedure to follow for determining relative signal delays is given in Study No. 7.

Curb Parking—This part of the functional study necessitates a measurement and weighing of curb parking importance and characteristics in comparison to the need for providing more street space to keep through traffic moving smoothly.

The effect of curb parking on transit operations within the zone under study can be determined by a "Running Time Study." (Study No. 3.)

Curb parking importance and characteristics can be determined by making Study No. 13 and Study No. 15.

Cross Traffic and Turning Movement—This fourth part of the functional study involves a determination of the effects of cross traffic and/or turning movements in relation to resulting traffic conflicts and delays to through traffic for the purpose of ascertaining whether such movements should be restricted or completely prohibited.

A partial answer to the cross traffic question may be found in (a) general observations, (b) the traffic signal delay study described above, and (c) by making traffic volume counts at the worst corners (see Study No. 11).

The answer to the turning movement question can be found by (a) general observations and (b) making left turn delay studies at the worst points as described in Study No. 7.

EXAMPLE OF APPLICATION

Example No. 1—The city's constant classification of passenger cars as "through traffic" and the favoring of their movement over the movement of transit vehicles, prompted the company to make this special study. It was found that in a 14-block section of one street in question only 10 per cent of the automobiles could be classed as through traffic, and these vehicles carried only 1/30 of the people moving through this section. These facts helped to revise the notions of the city authorities as to the relative importance of transit and private vehicles in this area.

STUDY NUMBER 11

VEHICLE VOLUME

DESCRIPTION—A study of the number and types of vehicles (passenger cars, trucks, motor buses, street cars, trolley coaches and taxicabs) moving through key intersections on specific transit routes, especially at peak hours when intersection capacity figures are important.

WHEN AND WHY STUDY IS MADE—This is considered a basic study by traffic engineers. In large cities the traffic engineer generally has such information currently on hand, so that it is not necessary for transit to sponsor a general volume study. Volume data for special locations and up-to-date data are not always available, however.

This study is made by the transit company only when special conditions warrant, such as:

(1) When it is necessary for transit to substantiate its position regarding traffic control devices and their operation.

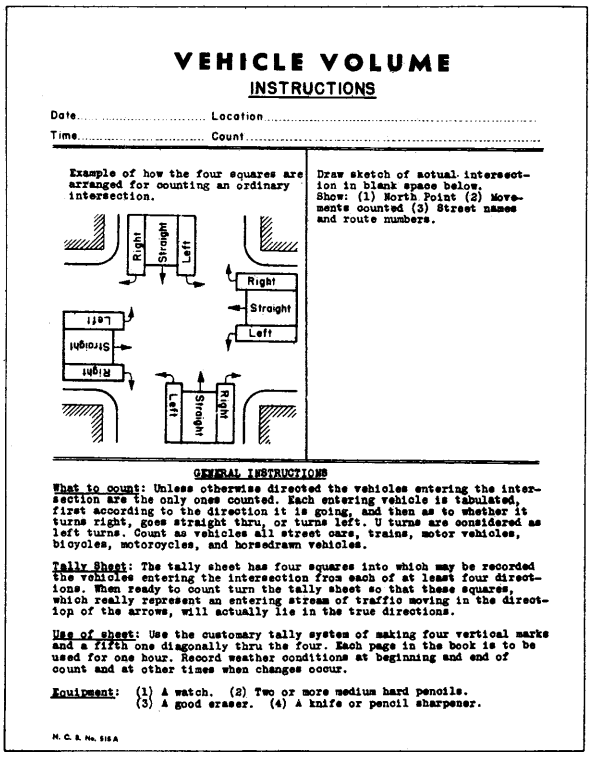
(2) When local officials fail to provide up-to-date vehicle volume data for use by the transit company to meet its normal needs for basic traffic data.

(3) When transit needs certain definite volume data to help show the relationship of transit operations to other forms of transportation on any given street or group of streets.

HOW TO MAKE STUDY—This manual will not attempt to describe how to conduct a city-wide traffic volume study which requires the use of key traffic volume stations and adjustment factors. A detailed description of such a study can be found in the "Manual of Traffic Engineering Studies," produced by the National Conservation Bureau.

The study described herewith will be confined to how to make a general vehicle volume study at a single intersection or at a mid-block location.

A vehicle volume study at either of the foregoing loca-



VEHICLE VOLUME

INSTRUCTIONS

Date..... Location.....

Time..... Count.....

Example of how the four squares are arranged for counting an ordinary intersection.

Draw sketch of actual intersection in blank space below. Show: (1) North Point (2) Movements counted (3) Street names and route numbers.

GENERAL INSTRUCTIONS

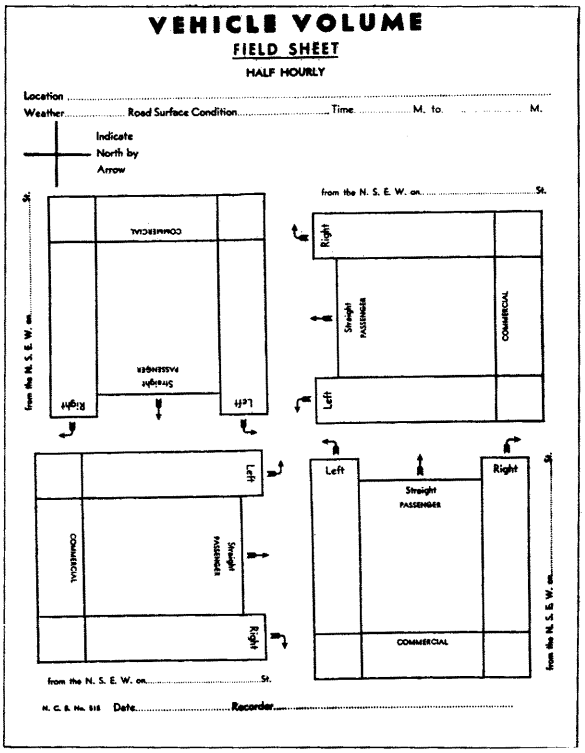
What to count: Unless otherwise directed the vehicles entering the intersection are the only ones counted. Each entering vehicle is tabulated, first according to the direction it is going, and then as to whether it turns right, goes straight thru, or turns left. U turns are considered as left turns. Count as vehicles all street cars, trains, motor vehicles, bicycles, motorcycles, and horsedrawn vehicles.

Tally Sheet: The tally sheet has four squares into which may be recorded the vehicles entering the intersection from each of at least four directions. When ready to count turn the tally sheet so that these squares, which really represent an entering stream of traffic moving in the direction of the arrows, will actually lie in the true directions.

Use of sheet: Use the customary tally system of making four vertical marks and a fifth one diagonally thru the four. Each page in the book is to be used for one hour. Record weather conditions at beginning and end of count and at other times when changes occur.

Equipment: (1) A watch. (2) Two or more medium hard pencils. (3) A good eraser. (4) A knife or pencil sharpener.

N. C. B. No. 516 A



VEHICLE VOLUME

FIELD SHEET

HALF HOURLY

Location .....

Weather..... Road Surface Condition..... Time..... M. to. ..... M.

Indicate North by Arrow

from the N. S. E. W. on..... St.

from the N. S. E. W. on..... St.

COMMERCIAL

PASSENGER

Straight

Right

Left

Straight PASSENGER

COMMERCIAL

from the N. S. E. W. on..... St.

from the N. S. E. W. on.....

N. C. B. No. 516 Date..... Recorder.....

EXHIBITS 63 and 64

Vehicle volume instructions and field sheet—issued by National Conservation Bureau.

tions can be made for whatever period of time is desired. A normal volume study, generally required for traffic signal timing, covers a 12-hour period. This period, which includes the two peak hours of the day, generally is taken from 7:00 a.m. to 7:00 p.m. Short counts for special uses are frequently made for from one to six hours. Transit companies generally find that their greatest need is for morning and afternoon peak-hour counts.

The field form (Exhibit 64) is typical of that used for years by traffic engineers. With slight changes, it can be adapted to fit practically any irregular and multiple approach intersection the transit engineer may plan to check. Also illustrated is a Vehicle Volume Instruction Sheet—Exhibit 63. Alternate field forms used by some transit companies are shown on Exhibits 65 and 66.

Personnel needed for volume counts will depend upon the volume of traffic to be checked and the number of turning movements. For the average four-direction intersection, two checkers are needed. Between intersection checks generally require only one checker, unless the traffic is running four deep. If the study is small, company employees can be used for making the check. If the study is large, outside personnel should be used. Boy Scouts are satisfactory.

VOLUME COUNT - FIELD SHEET

_____ Bound on_____ at _____ Weather_____

Day_____ Date _____ Checker_____

	15 Minute Period Ending ____ M	
Left Turns	Straight PRIVATE PASS. VEHICLES Throughs	Right Turns
	Commercial Vehicles	
	Transit	
	15 Minute Period Ending ____ M	
Left Turns	Straight PRIVATE PASS. VEHICLES Throughs	Right Turns
	Commercial Vehicles	
	Transit	

EXHIBIT 65

Another type of vehicle volume field form that is used by many transit companies.

VEHICLE VOLUME PER CYCLE PERIOD

N S E W Bound on _____ St. at _____ St.

Day_____ Date _____ Weather _____ Checker_____

Cycle No.		Street Car Lane				2nd Lane			Curb Lane		
		Left Turn	Straight Through	Right Turn	Ped.	Left Turn	Straight Through	Right Turn	Left Turn	Straight Through	Right Turn
	PassVeh										
	Truck										
	PassVeh										
	Truck										
	PassVeh										
	Truck										
	PassVeh										
	Truck										
	PassVeh										
	Truck										
	PassVeh										
	Truck										

EXHIBIT 66

A special vehicle volume form (8½ x 11) used to record vehicles per lane through a signalized intersection per cycle period.

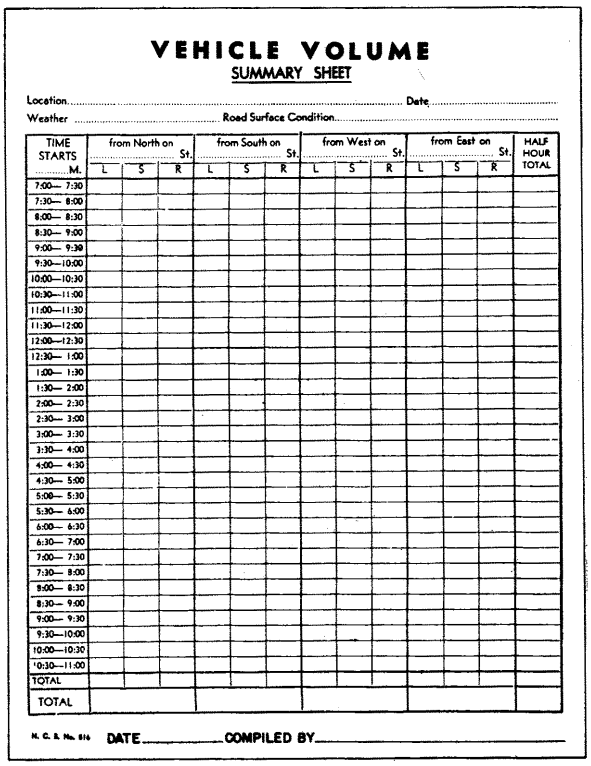
The volume facts for each intersection are first summarized for each 30-minute period, then put into tabular form for the entire period checked. General summary forms issued by National Conservation Bureau are shown on Exhibits 67, 68 and 69. Exhibit 70 shows a special type summary form used by some transit companies.

In final form, the volume facts for each intersection are usually presented graphically. If a number of contiguous intersections are checked under similar conditions, the information is presented in the form of a flow chart. An illustration is given on Exhibit 71.

Whether the facts are solely for company use or for outside purposes makes very little difference in presenting the data. Either way, the data must be prepared so that whoever interprets it may obtain a quick and clear picture of the facts.

EXAMPLES OF APPLICATION

Example No. 1—A transit company believed that the traffic signal timing was out of line with the movement of traffic during the off-peak period between 10:00 a.m. and 4:00 p.m. In conjunction with a signal delay study (Study No. 7) the company also made a general vehicle volume study at five such intersections to prove or disprove its contention. The vehicle volume study was made in 30-minute periods for the 6-hour period for three separate days in order to obtain a fair average. Traffic was recorded according to types, turning movements and directions for the main and side streets. Results of the study showed that the main street carried 70 per cent of the traffic and that turning movements constituted less than 5 per cent of the total vehicles throughout the 6-hour period.



VEHICLE VOLUME
SUMMARY SHEET

Location..... Date.....
Weather..... Road Surface Condition.....

TIME STARTS ..M.	from North on ..St. L	S	R	from South on ..St. L	S	R	from West on ..St. L	S	R	from East on ..St. L	S	R	HALF HOUR TOTAL
7:00— 7:30													
7:30— 8:00													
8:00— 8:30													
8:30— 9:00													
9:00— 9:30													
9:30—10:00													
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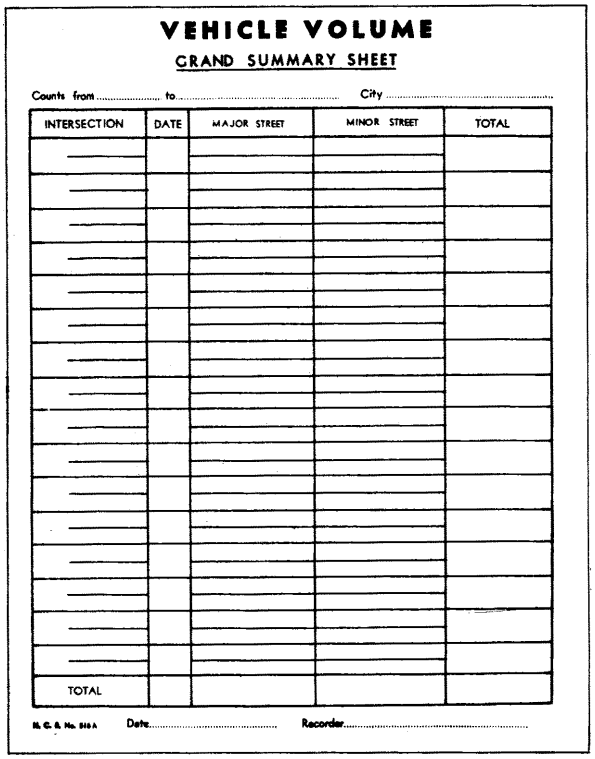
9:00— 9:30													
9:30—10:00													
10:00—10:30													
10:30—11:00													
TOTAL													
TOTAL													

N. C. B. No. 816 DATE..... COMPILED BY.....

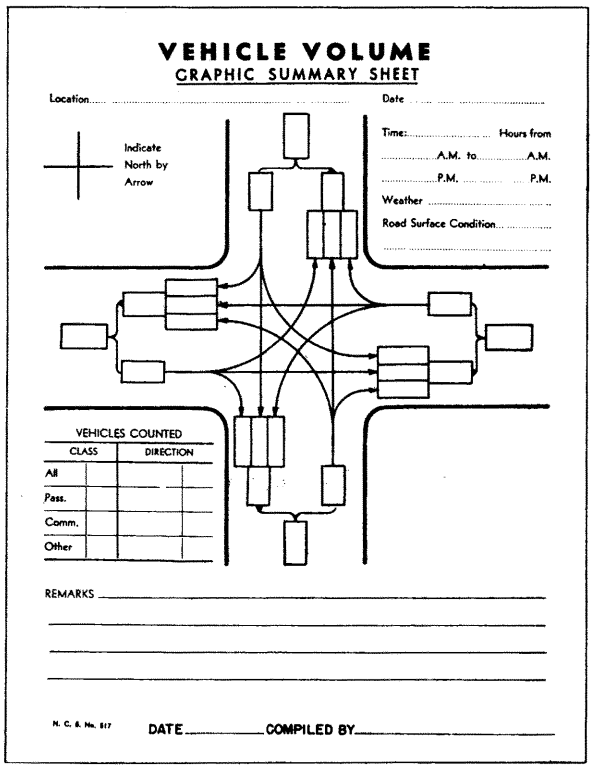


VEHICLE VOLUME
GRAND SUMMARY SHEET

Counts from..... to..... City.....

INTERSECTION	DATE	MAJOR STREET	MINOR STREET	TOTAL
TOTAL				

N. C. B. No. 816 A Date..... Recorder.....



VEHICLE VOLUME
GRAPHIC SUMMARY SHEET

Location..... Date.....

Indicate North by Arrow

Time:..... Hours from
.....A.M. to.....A.M.
.....P.M. .....P.M.
Weather.....
Road Surface Condition.....

VEHICLES COUNTED

CLASS	DIRECTION		
All			
Pass.			
Comm.			
Other			

REMARKS.....

N. C. B. No. 817 DATE..... COMPILED BY.....

EXHIBITS 67, 68 and 69

Vehicle volume summary sheet, grand summary sheet and graphic summary sheet—issued by National Conservation Bureau.

VOLUME COUNT DATA

Intersection _____ _____ _____

Day_____ Date _____ TRAFFIC VOLUME Weather_____
Length of Count_____ From_____ M to_____ M

	Passenger Vehicles	Service Vehicles	Total Vehicles	Pedestrians
Northbound				
Southbound				
Total				
Eastbound				
Westbound				
Total				
Total				
Grand Total				

Day_____ Date _____ TRAFFIC MOVEMENTS Weather _____
Length of Count_____ From_____ M to_____ M

	Left Turns	Straight Throughs	Right Turns	Total
Northbound				
Southbound				
Total				
Eastbound				
Westbound				
Total				
Total				
Grand Total				

Day_____ Date _____ PEDESTRIAN VOLUME Weather _____
Length of Count_____ From_____ M to_____ M

	East Side	West Side	Total
Northbound			
Southbound			
Total			
	North Side	South Side	Total
Eastbound			
Westbound			
Total			
Grand Total			

EXHIBIT 70

A special type summary form for recording traffic volume, traffic movement and pedestrian volume.

The signals which had been programmed by a time clock for a 50-50 split in traffic during this period were retimed for a 70-30 split. All traffic movement, including transit, benefited.

Example No. 2—Buses operating on a light residential line on the outskirts of a city had experienced several minor accidents at an intersection controlled by stop signs. The transit operators said the accidents were caused by motorists not obeying the stop signs. After a preliminary check of the location, which revealed that the stop signs were in good physical shape and well placed to be clearly seen by the approaching traffic, a brief vehicular volume count was made of the intersection. This volume count revealed that 60 per cent of the traffic was on the stop street. In other words, 60 per cent of the traffic was being stopped for 40 per cent of the traffic. Once the community had switched the stop signs around to stop the 40 per cent, the violations dropped materially and no more accidents were reported at this intersection for at least two years.

Example No. 3—A transit company was interested in obtaining a measure of the general movement of automobile traffic into and out of the community over a period of years for use in determining long range trends and riding relationships between transit and autos. Since the city did not have such information, the transit company set up volume count stations on three bridges adjacent to the business district that were known to carry about half of all the traffic entering and leaving the district. The checks were made by the transit company for one day every six months for a 12-hour period from 7:00 a.m. to 7:00 p.m., on a 30-minute basis, by types of vehicles, and by directions of movement. Charts were then made on an index basis to show the semiannual traffic movement over the three bridges, compared to daily average number of transit passengers being carried, population, bank debits and other factors affecting or reflecting trend characteristics.

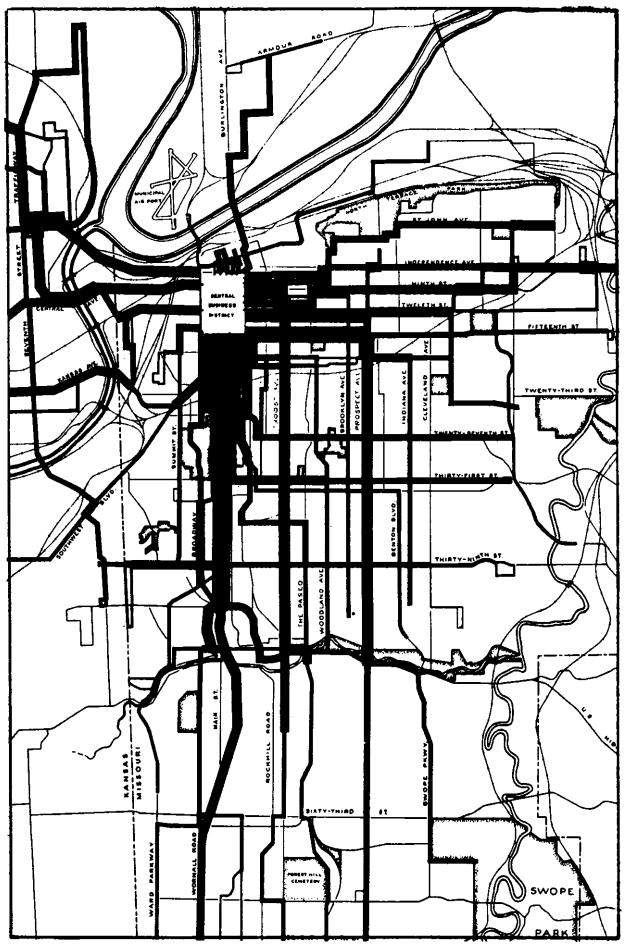


EXHIBIT 71

A typical flow diagram showing transit vehicular volume for a 24-hour period on a normal weekday.

STUDY NUMBER 12

BUSINESS DISTRICT GENERAL TRAFFIC CORDON COUNT

DESCRIPTION—A study of the number of vehicles and *persons* entering and leaving a given area for a specific period of time. Generally, a traffic cordon count is applied to the major business district, although there are occasions when a cordon study may be made of a neighborhood shopping area.

WHEN AND WHY STUDY IS MADE—This study is frequently made by city traffic engineers, but seldom are the studies broad enough to be used advantageously by transit companies. Too often the cordon omits a count of the total persons carried by each mode of transportation.

In the larger cities, this study should be made at least biannually. In all instances the city should be encouraged to make the study, permitting the transit company to cooperate. Reasons for the transit company interest in such a study are indicated in the following warrants:

(1) To compare the number of passenger cars and transit vehicles in relation to the number of persons each are bringing into the district.
(2) When the transit company wishes to show the local officials and business leaders the percentage of persons entering and leaving the business district by transit vehicles.
(3) When facts are needed to substantiate the need for creating off-street parking facilities.
(4) To show the need for and as a basis for determining use of further traffic engineering measures, such as one-way streets, unbalanced traffic flow, and traffic signal improvements.

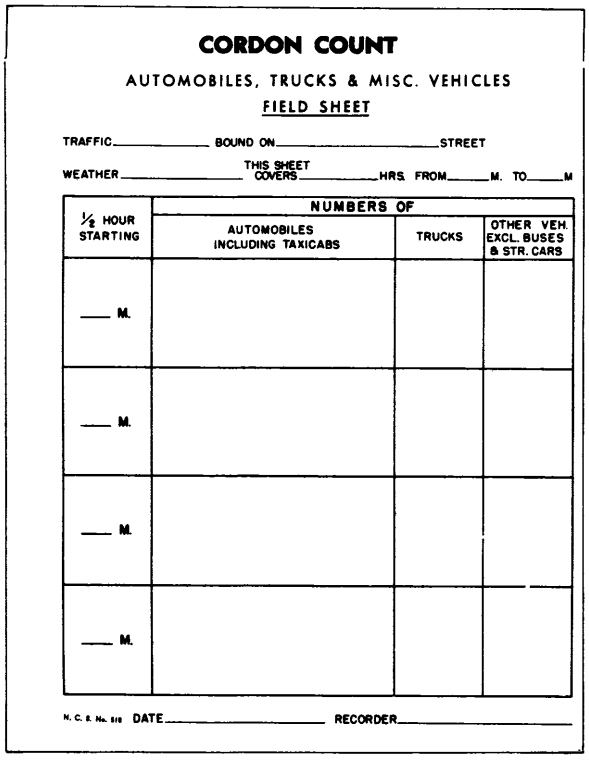
HOW TO MAKE STUDY—The cordon ring, at which all general traffic counts are made by the city, is generally established on the edge of the central business district. Sometimes special conditions may make a larger cordon area desirable. Cordon stations are established mid-block on the cordon on every street leading into and out of the district, except those that are known to carry an extremely small number of vehicles, occupants or pedestrians.

A comprehensive all-purpose cordon is made in the middle of the week and covers the period from 7 a.m. to 7 p.m. The period 8 a.m. to 6 p.m. is also quite common.

A cordon study, to be complete, must include a count of persons within the passenger vehicles as well as the number of vehicles. Too many cordon counts have omitted the check of persons. From a transit standpoint, this check of persons is particularly important. Major items checked in a cordon count are: pedestrians, automobiles and their occupants; transit vehicles and their passengers; trucks and their occupants, and taxicabs and their occupants. In cities under 100,000 population, a cordon count of the principal business district generally includes a check of all these vehicles crossing the cordon line.

Transit Cordon—The cordon of transit vehicles and their occupants is made as a separate section of the general traffic cordon count and is conducted by the transit company. A special transit cordon check is not always necessary, however. Often it will be found that the cordon points will correspond very closely to the transit peak load points so that the most recent transit passenger load checks taken at the peak load points can be used in the general traffic cordon study. If such peak load figures are too old, or not available, or do not cover the desired period of time, then the transit company should make a special passenger study at the cordon points according to the procedure described in Study No. 1 of this manual.

Auto, Truck and Pedestrian Cordon—The cordon count of passenger cars, trucks, other types of vehicles (excluding transit), and pedestrians, should constitute



CORDON COUNT

AUTOMOBILES, TRUCKS & MISC. VEHICLES

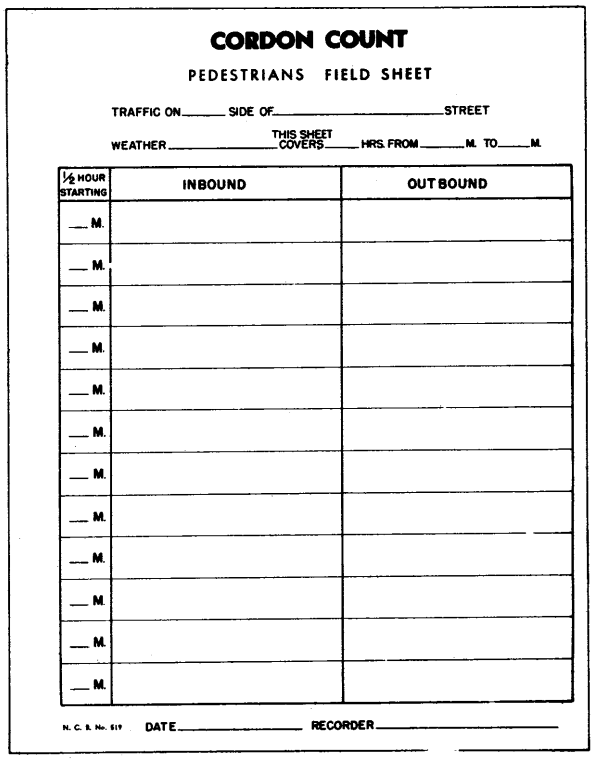
FIELD SHEET

TRAFFIC_____ BOUND ON_____ STREET

WEATHER_____ THIS SHEET COVERS_____ HRS. FROM____ M. TO____ M

½ HOUR STARTING	NUMBERS OF		
	AUTOMOBILES INCLUDING TAXICABS	TRUCKS	OTHER VEH. EXCL. BUSES & STR. CARS
__ M.			
__ M.			
__ M.			
__ M.			

N. C. S. No. 818 DATE_____ RECORDER_____



CORDON COUNT

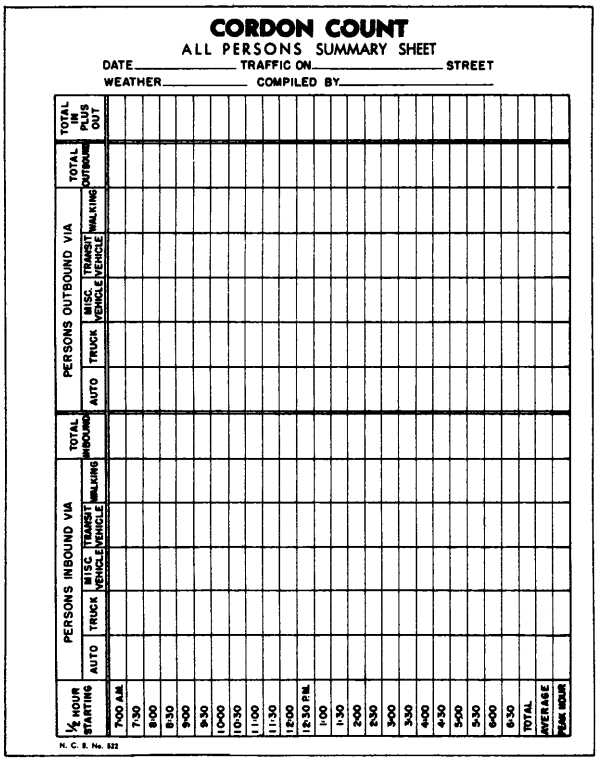
PEDESTRIANS FIELD SHEET

TRAFFIC ON____ SIDE OF____ STREET

WEATHER____ THIS SHEET COVERS____ HRS. FROM____ M. TO____ M.

½ HOUR STARTING	INBOUND	OUTBOUND
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		
__ M.		

N. C. B. No. 519 DATE____ RECORDER____



CORDON COUNT

ALL PERSONS SUMMARY SHEET

DATE____ TRAFFIC ON____ STREET

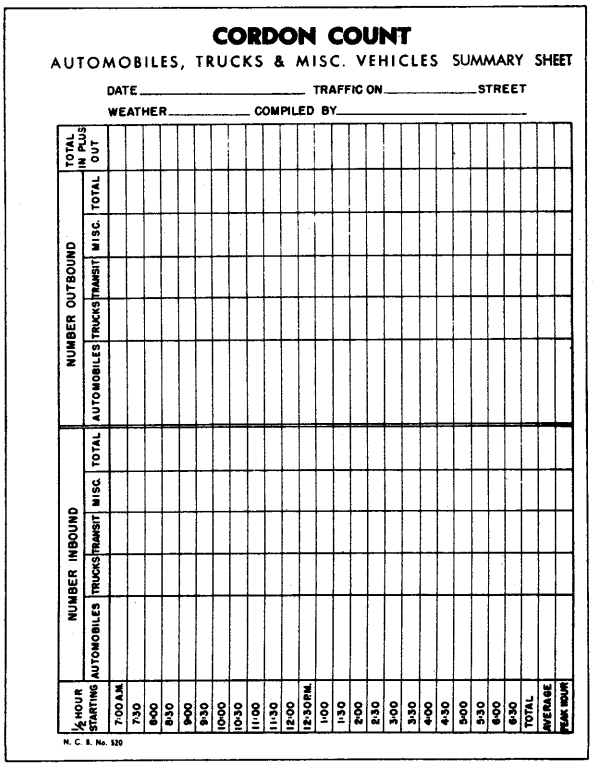
WEATHER____ COMPILED BY____

½ HOUR STARTING	PERSONS INBOUND VIA: AUTO	TRUCK	MISC. VEHICLE	TRANSIT VEHICLE	WALKING	TOTAL INBOUND	PERSONS OUTBOUND VIA: AUTO	TRUCK	MISC. VEHICLE	TRANSIT VEHICLE	WALKING	TOTAL OUTBOUND	TOTAL IN PLUS OUT
7:00 A.M.													
7:30													
8:00													
8:30													
9:00													
9:30													
10:00													
10:30													
11:00													
11:30													
12:00													
12:30 P.M.													
1:00													
1:30													
2:00													
2:30													
3:00													
3:30													
4:00													
4:30													
5:00													
5:30													
6:00													
6:30													
TOTAL													
AVERAGE													
PEAK HOUR													

N. C. B. No. 522

EXHIBITS 72, 73, 74 and 75

Cordon count field and summary sheets—issued by the National Conservation Bureau



CORDON COUNT

AUTOMOBILES, TRUCKS & MISC. VEHICLES SUMMARY SHEET

DATE____ TRAFFIC ON____ STREET

WEATHER____ COMPILED BY____

½ HOUR STARTING	NUMBER INBOUND: AUTOMOBILES	TRUCKS	TRANSIT	MISC.	TOTAL	NUMBER OUTBOUND: AUTOMOBILES	TRUCKS	TRANSIT	MISC.	TOTAL	TOTAL IN PLUS OUT
7:00 A.M.											
7:30											
8:00											
8:30											
9:00											
9:30											
10:00											
10:30											
11:00											
11:30											
12:00											
12:30 P.M.											
1:00											
1:30											
2:00											
2:30											
3:00											
3:30											
4:00											
4:30											
5:00											
5:30											
6:00											
6:30											
TOTAL											
AVERAGE											
PEAK HOUR											

N. C. B. No. 520

another section of the cordon study. This section of the cordon is generally conducted by the city traffic engineer.

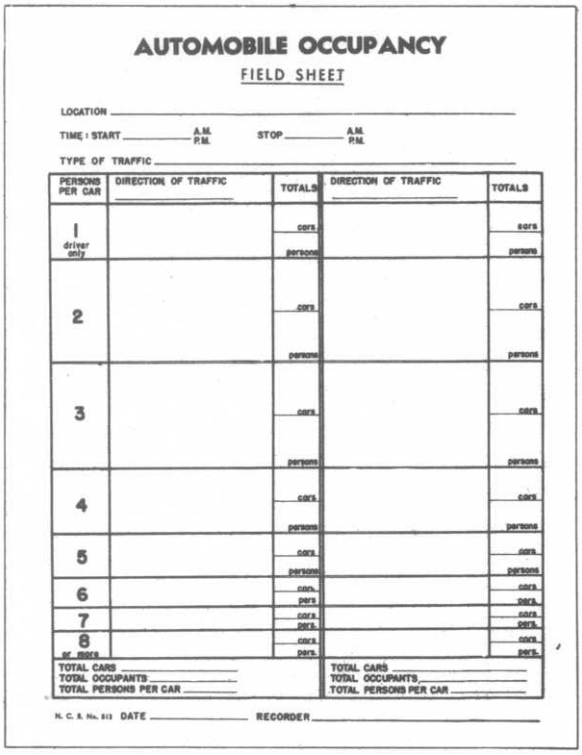
Usually, the traffic is too heavy for all types of vehicles to be recorded on one field form, therefore two forms are used. Generally, all types of vehicles (transit excluded) are noted on one form (Exhibit 72) and pedes trians are recorded on a second form (Exhibit 73).

These field forms, plus the several summary forms shown (Exhibits 74 and 75) were prepared and published by the National Conservation Bureau and are similar to those used by traffic engineers throughout the country.

Generally, the cordon field data are collected on a basis of 30-minute periods. Separate field forms are used for inbound and outbound traffic, so that the difference in flow, plus the accumulation of traffic, can be measured later.

Occupancy for passenger cars and trucks is determined by making sample checks of the number of occupants per vehicle (Exhibit 76). The inbound and outbound samples are kept separate and are taken at approximately the same time of the day as the original cordon (Exhibit 77). Several hundred vehicles observed at one-half dozen locations is enough of a sample. These are averaged and the resultant figures applied to the original cordon of passenger cars.

Personnel needed for a passenger car and pedestrian cordon study will depend upon the number of locations



AUTOMOBILE OCCUPANCY

FIELD SHEET

LOCATION _____

TIME: START _____ A.M. P.M. STOP _____ A.M. P.M.

TYPE OF TRAFFIC _____

PERSONS PER CAR	DIRECTION OF TRAFFIC	TOTALS	DIRECTION OF TRAFFIC	TOTALS
1 driver only		cars / persons		cars / persons
2		cars / persons		cars / persons
3		cars / persons		cars / persons
4		cars / persons		cars / persons
5		cars / persons		cars / persons
6		cars / pers.		cars / pers.
7		cars / pers.		cars / pers.
8 or more		cars / pers.		cars / pers.
TOTAL CARS _____ TOTAL OCCUPANTS _____ TOTAL PERSONS PER CAR _____			TOTAL CARS _____ TOTAL OCCUPANTS _____ TOTAL PERSONS PER CAR _____	

N. C. B. No. 813 DATE _____ RECORDER _____

EXHIBIT 76

Automobile occupancy field sheet—issued by National Conservation Bureau.

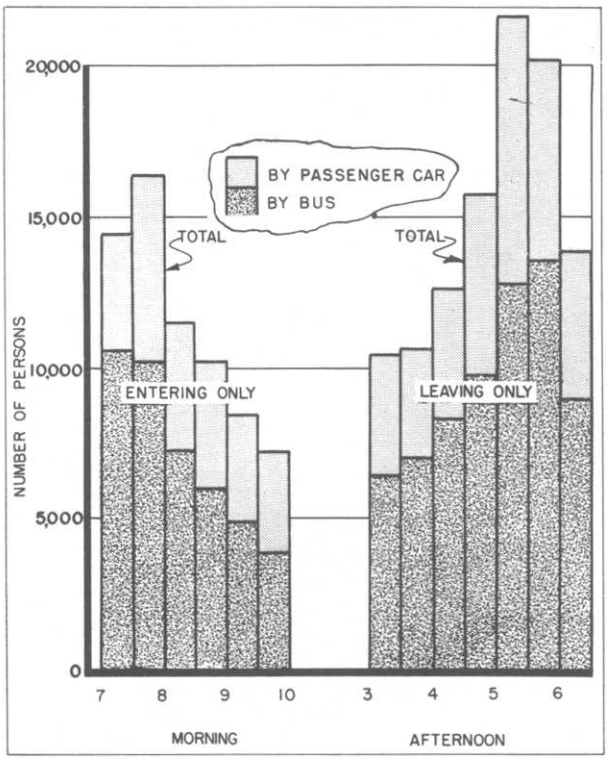


EXHIBIT 78

Cordon summary showing persons entering and leaving by bus and by passenger car.

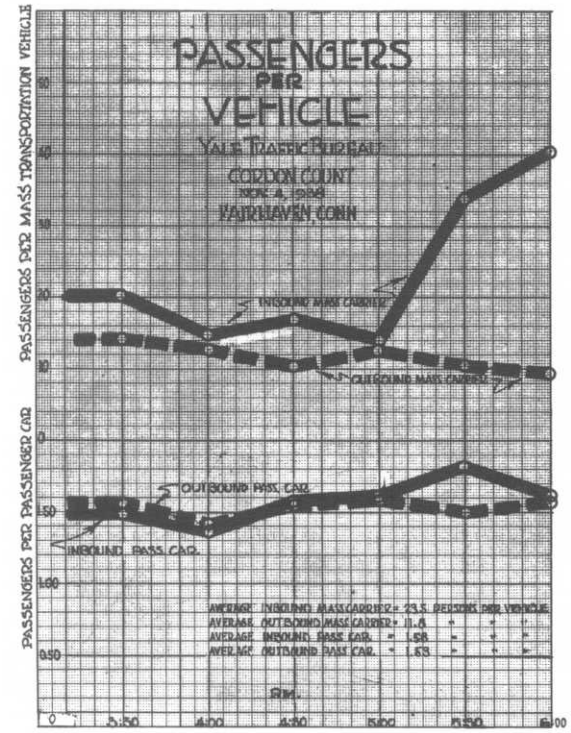


EXHIBIT 77

Graphical summary of passengers per vehicle

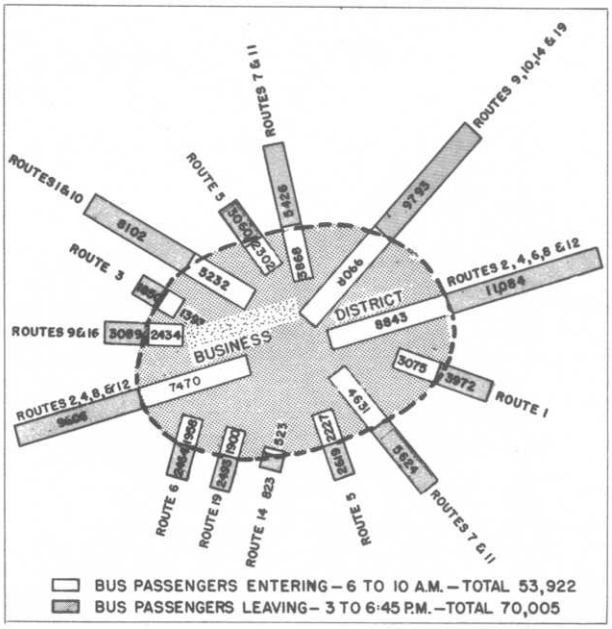


EXHIBIT 79

A typical transit cordon by routes for 7¾ hour period.

being checked at one time, and the duration of the check. If possible, all the locations should be checked simultaneously on a single weekday. This can generally be done in the smaller cities.

Boy Scouts, ladies' clubs, and many other groups have been called upon to assist in making cordon studies. If properly instructed in advance, such volunteer helpers are efficient and accurate.

The data are first summarized by time periods for each location. They are then summarized by time periods for the various classes of vehicles and the occupants in each. Finally, the data are prepared in graphic form as shown on Exhibits 78, 79, 80 and 81.

Further information about making cordon studies and summarizing the data can be found in the "Manual of Traffic Engineering Studies" produced by the National Conservation Bureau.

EXAMPLES OF APPLICATION

Example No. 1—Retail merchants gave little attention to the importance of transit to the business district until a cordon study revealed that transit vehicles were carrying 40 per cent of all the people that entered the business district and 60 per cent of those that entered between 10 a.m. and 4 p.m. Following this revelation, their attitude toward, and interest in transit changed considerably.

Example No. 2—The need for and value of staggered hours were measured dozens of times during the war by cordon studies. Such studies are still applied periodically in those cities where staggered hours still remain to prove and reassure the officials and general public of the importance of continuing the present staggered hours. (*See* "Examples" in Study No. 20)

Example No. 3—A 14-hour cordon count around the central business district in a southern city of one-third million population revealed that the city's motor buses, trolley coaches and street cars used only 9 of the 24 streets entering the central business district; yet these transit vehicles transported 54 per cent of the total per-

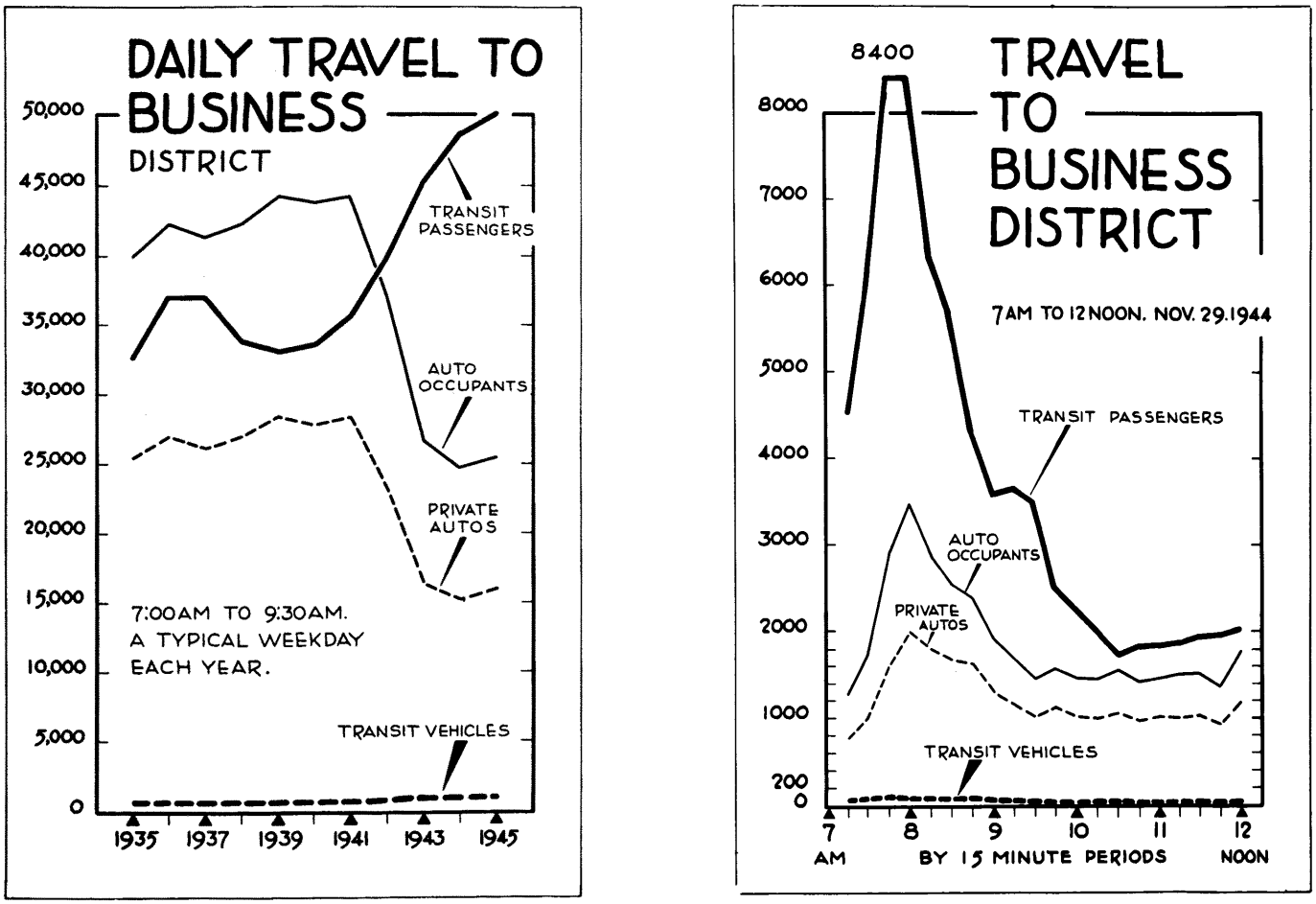


EXHIBIT 80

Several illustrations taken from cordon studies in a midwestern city showing the relative importance of passenger car and transit vehicle—(a) annually and (b) morning rush period.

sons entering and leaving this central area.

During the maximum half hour (5:00 p.m. to 5:30 p.m.) 9,874 persons were transported in 5,291 private automobiles into and out of the central business district, while 10,910 persons entered and left this same area during the same half hour in 222 transit vehicles.

Example No. 4—One transit company was constantly being bombarded with complaints and unfavorable publicity from several local groups. These local groups claimed that buses were congesting downtown streets and thereby encouraging decentralization of business. They even went so far as to suggest that the buses be prohibited from the business district. Neither side had any traffic facts, so for a while it was a battle of words. Finally, the transit company, working in cooperation with the city officials, sponsored a complete traffic cordon count of the business district. One hundred Boy Scouts, trained and supervised by the city, were used to make a 12-hour check at the 25 important street entrances and exits to the downtown district. The boys checked all the pedestrians, passenger cars, trucks, and taxicabs entering and leaving the area by 30-minute periods. The transit company provided information on the number of buses and the passengers in the buses entering and leaving the area at the same points as checked by the boys.

When completed, the study showed that, although buses constituted only 5 per cent of the total vehicles entering and leaving the district, they were carrying 50 per cent of the people. At the same time the study showed that whereas the bus only occupied an average of 16 square feet per passenger, motor vehicles occupied 64 feet per occupant. Supported by other facts of a similar nature, the transit company was able to convince the local people that transit was the most efficient user of street space, and its operation in the business district should be encouraged rather than prohibited.

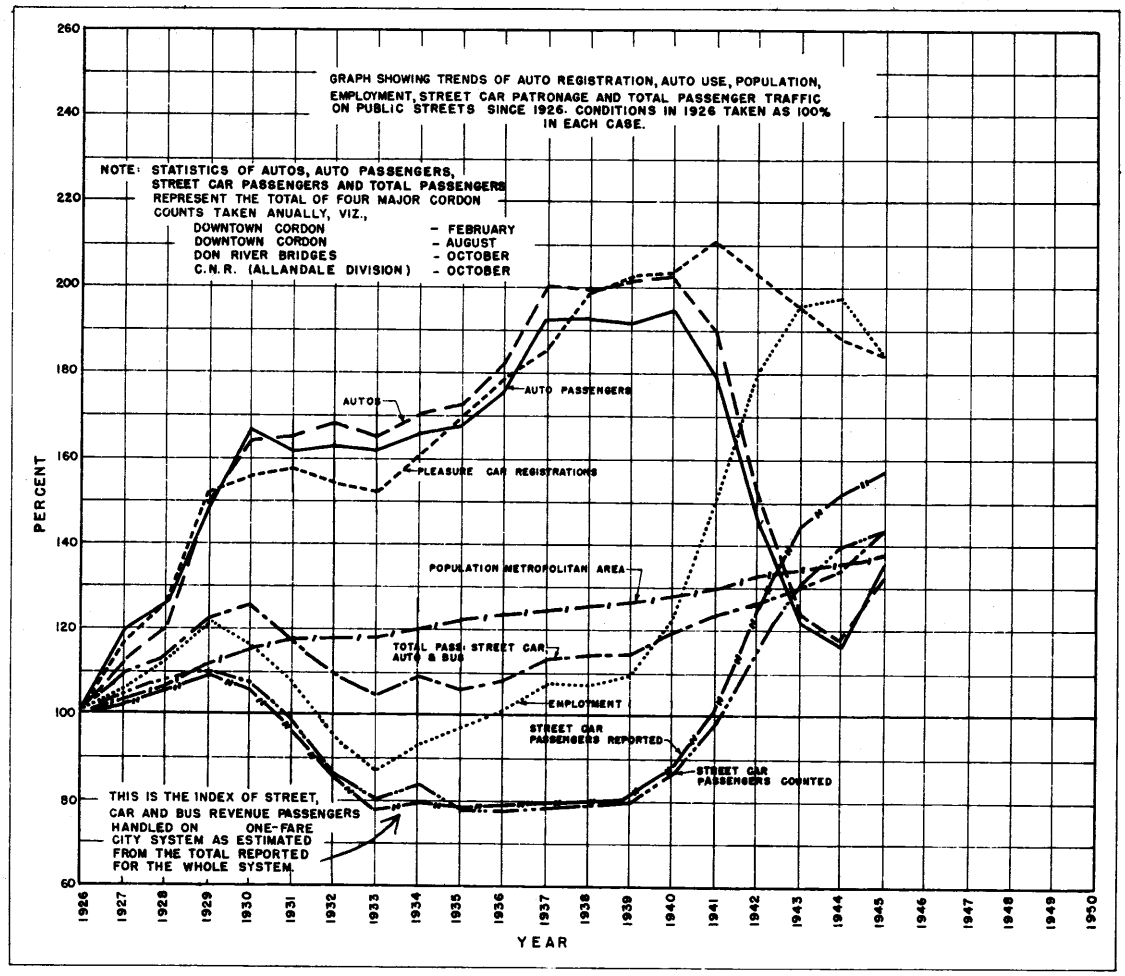


EXHIBIT 81

An excellent example of how transit cordon data can be compared with other factors affecting transit trends over a period of years.

STUDY NUMBER 13

CURB PARKING

DESCRIPTION—A study of curb space available for various types of curb parking and how the space is being used.

The bus loading zone study (Study No. 8) may be tied in with this study. The off-street parking study (Study No. 14) may also be tied in with this study.

WHEN AND WHY STUDY IS MADE—This is a special study. If possible, it should be made by the city traffic engineer. From a transit standpoint it is warranted as follows:

(1) To show whether employees, shoppers or store owners are abusing curb parking privileges.
(2) To show need for developing off-street parking facilities.
(3) When used in conjunction with safety zone study, to show small amount of space required for safety zones and the little additional space that would result for curb parking if safety zones were shortened or eliminated.

HOW TO MAKE STUDY—A comprehensive curb parking study is divided into the three following sections:

(1) Curb parking inventory
(2) Duration of parking at curb
(3) Types of curb parkers

Since the curb parking study should be made by the city, and not the transit company, only a very brief description of these three sections are given herein.

Curb Parking Inventory—On a large scale map of the area being studied is shown to scale, by colored lines, the actual space available for curb parking in each block. Also, shown on the map are the restricted and prohibited areas and spaces designated for commercial vehicle loading and transit vehicle stops.

From the large colored map is prepared a summary table, by streets, of the spaces available for various types of time-limited parking, loading zones, etc.

Duration of Parking—This portion of the curb parking study, confined to determining the length of time parked, is generally made from 7:00 a.m. to 7:00 p.m., but can be shortened if necessary to 8:00 a.m. to 6:00 p.m.

Sampling methods are also employed when there is a shortage of manpower. Instead of covering every block in the area under investigation, every second or third block is often checked.

The National Conservation Bureau Street Parking Field Sheet No. 533 (Exhibit No. 82) is recommended for use in making this study. Note that the form is good for ten trips, so that if repeat trips are made every 30 minutes, this form is good for a 5-hour check.

When making a curb parking study, the checker starts at one end of the street or block assigned to him, observing and recording the last three numbers, or letters of the registration plates of each vehicle. Providing the checker with a car and driver will permit him to cover two or three times the area as compared to walking.

If the merchants, police, or any other agency wish to know who is using the curb parking space in any particular block or adjacent to any given store, this field study can be readily adapted to provide such field information. It only requires that the full registration be recorded in the first column rather than the last three digits as mentioned above. Checking these registration numbers against the registration books maintained by the state motor vehicle department or local police department will reveal the name and address of the person to whom the car is registered.

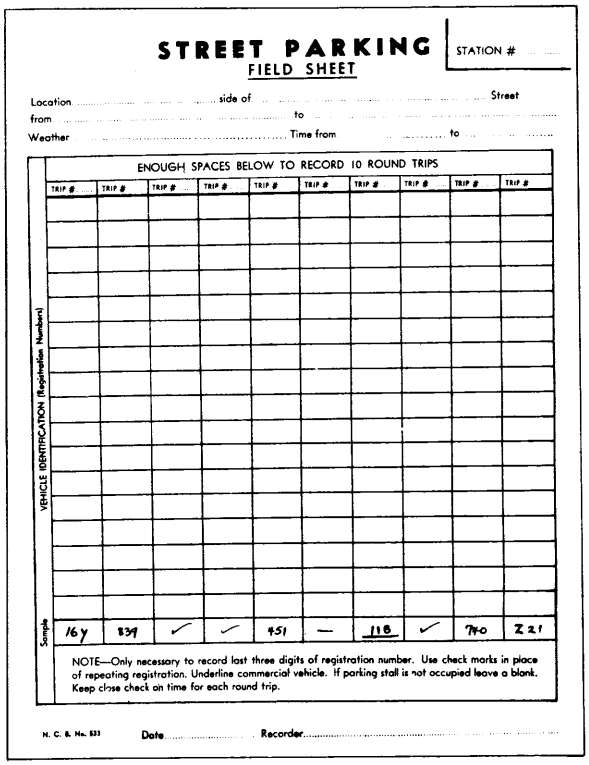
This field form, plus the full registration numbers from which the names and addresses of owners can be traced, also provides the base data for the parked car origin and destination study described in Study No. 9.

Field personnel with which to make this curb parking duration study maybe either volunteers or paid assistants. Since it involves considerable walking and recording, paid help is generally the best.

Several summary sheets, giving the number and length of time passenger and commercial vehicles are parked, are shown on Exhibits 83, 84 and 85.

Types of Curb Parkers—This study is based upon the use of a postal card questionnaire. Only four questions are asked, namely:

1— Major reason for parking at this curb location? To work. To make a business call. To shop.



STREET PARKING
FIELD SHEET

STATION #

Location ..... side of ..... Street
from ..... to .....
Weather ..... Time from ..... to .....

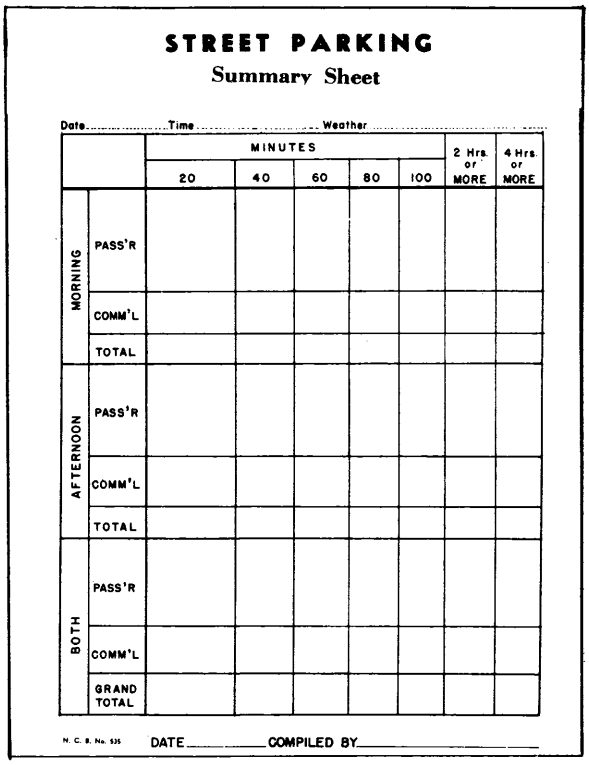
ENOUGH SPACES BELOW TO RECORD 10 ROUND TRIPS

VEHICLE IDENTIFICATION (Registration Numbers)

TRIP #	TRIP #	TRIP #	TRIP #	TRIP #	TRIP #	TRIP #	TRIP #	TRIP #	TRIP #
Sample									
16y	839	✓	✓	951	—	118	✓	740	221

NOTE—Only necessary to record last three digits of registration number. Use check marks in place of repeating registration. Underline commercial vehicle. If parking stall is not occupied leave a blank. Keep close check on time for each round trip.

N. C. B. No. 533 Date ..... Recorder .....

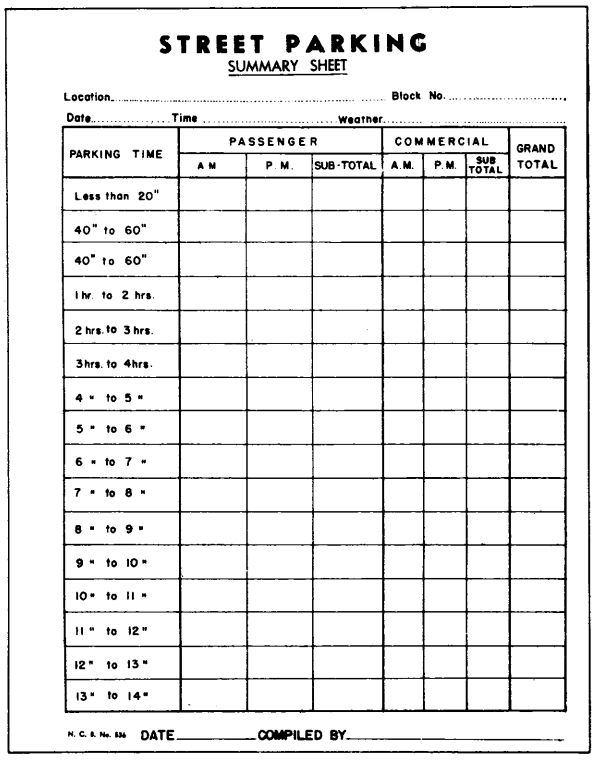


STREET PARKING
Summary Sheet

Date ..... Time ..... Weather .....

		MINUTES					2 Hrs. or MORE	4 Hrs. or MORE
		20	40	60	80	100		
MORNING	PASS'R							
	COMM'L							
	TOTAL							
AFTERNOON	PASS'R							
	COMM'L							
	TOTAL							
BOTH	PASS'R							
	COMM'L							
	GRAND TOTAL							

N. C. B. No. 535 DATE ..... COMPILED BY .....

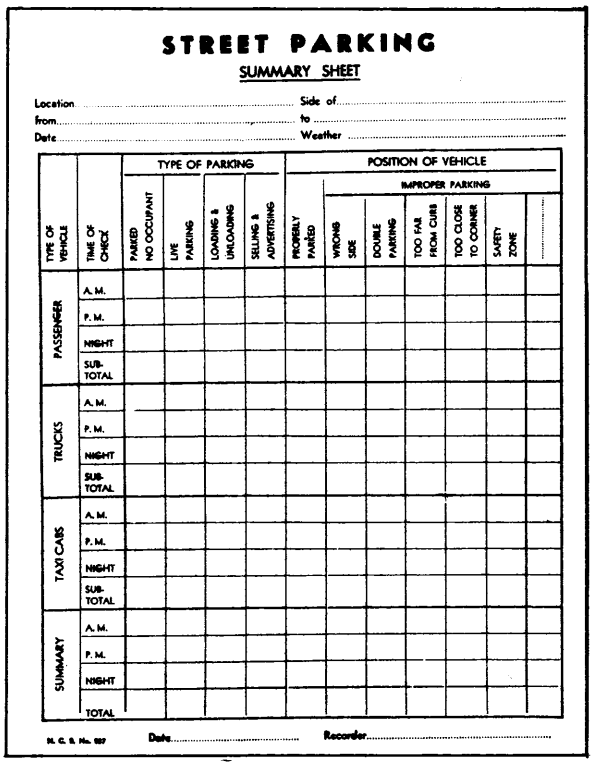


STREET PARKING
SUMMARY SHEET

Location ..... Block No. .....
Date ..... Time ..... Weather .....

PARKING TIME	PASSENGER			COMMERCIAL			GRAND TOTAL
	A.M.	P.M.	SUB-TOTAL	A.M.	P.M.	SUB TOTAL	
Less than 20"							
40" to 60"							
40" to 60"							
1 hr. to 2 hrs.							
2 hrs. to 3 hrs.							
3 hrs. to 4 hrs.							
4 " to 5 "							
5 " to 6 "							
6 " to 7 "							
7 " to 8 "							
8 " to 9 "							
9 " to 10 "							
10 " to 11 "							
11 " to 12"							
12" to 13"							
13" to 14"							

N. C. B. No. 536 DATE ..... COMPILED BY .....



STREET PARKING
SUMMARY SHEET

Location ..... Side of .....
from ..... to .....
Date ..... Weather .....

TYPE OF VEHICLE	TIME OF CHECK	TYPE OF PARKING				POSITION OF VEHICLE							
		PARKED NO OCCUPANT	LIVE PARKING	LOADING & UNLOADING	SELLING & ADVERTISING	PROPERLY PARKED	IMPROPER PARKING: WRONG SIDE	DOUBLE PARKING	TOO FAR FROM CURB	TOO CLOSE TO CORNER	SAFETY ZONE		
PASSENGER	A.M.												
	P.M.												
	NIGHT												
	SUB-TOTAL												
TRUCKS	A.M.												
	P.M.												
	NIGHT												
	SUB-TOTAL												
TAXI CABS	A.M.												
	P.M.												
	NIGHT												
	SUB-TOTAL												
SUMMARY	A.M.												
	P.M.												
	NIGHT												
	TOTAL												

N. C. B. No. 537 Date ..... Recorder .....

EXHIBITS 82, 83, 84 and 85
Street parking field and summary sheets—issued by National Conservation Bureau.

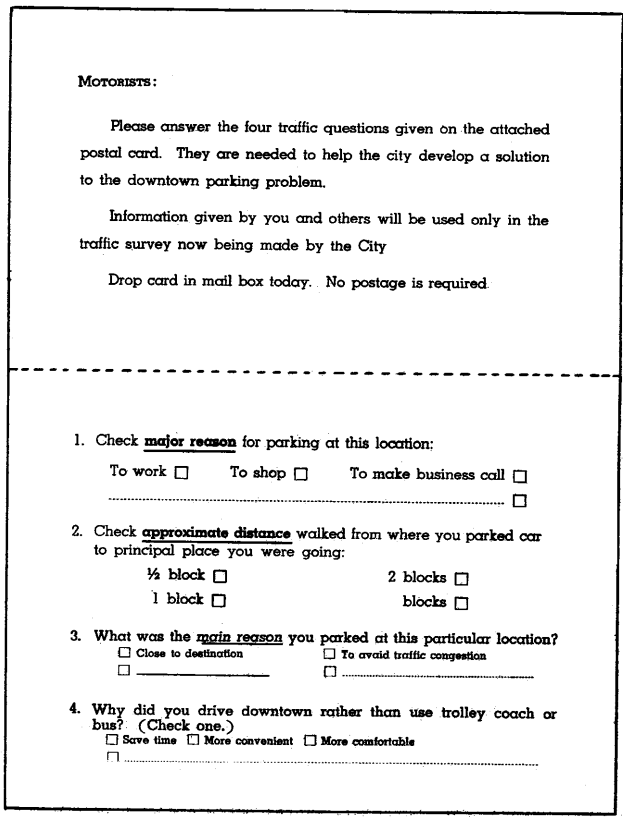
2— Approximate distance walked from where car parked to principal place of business?
3— Why did not park in lot or garage? Too expensive. Too far away. All full.
4— Why did not use transit? Not comfortable. Too slow. No line near home.

A sample postal card of this type is shown as Exhibit 86. Also shown are the letter and questionnaire card used in the 1946 Philadelphia Parking Survey (Exhibit 87) and another used in Chicago (Exhibit 88).

The questionnaires are placed under the windshield wipers or on the driver seats of cars parked at the curb in the business district. The field men can place about 100 cards per hour on vehicles without being overtaxed. So that the returns can be classified geographically, each card is given a predetermined block number by the field man as he places it on the vehicle. Two complete rounds of all curb parked cars in the morning and two more rounds in the afternoon are considered an adequate sample. If the study is properly publicized beforehand and the cards contain an official designation, the returns should total 25 to 35 per cent of those distributed.

Volunteer or paid personnel can be used to distribute the postal card questionnaires.

The returned cards can be summarized in several ways—by general location or section of business district, by type of parker. Several typical charts prepared from such studies are shown on Exhibits 89 and 90.



MOTORISTS:

Please answer the four traffic questions given on the attached postal card. They are needed to help the city develop a solution to the downtown parking problem.

Information given by you and others will be used only in the traffic survey now being made by the City

Drop card in mail box today. No postage is required.

1. Check **major reason** for parking at this location:
   To work ☐ To shop ☐ To make business call ☐
   ..... ☐
2. Check **approximate distance** walked from where you parked car to principal place you were going:
   ½ block ☐ 2 blocks ☐
   1 block ☐ blocks ☐
3. What was the *main reason* you parked at this particular location?
   ☐ Close to destination ☐ To avoid traffic congestion
   ☐ _____ ☐ .....
4. Why did you drive downtown rather than use trolley coach or bus? (Check one.)
   ☐ Save time ☐ More convenient ☐ More comfortable
   ☐ .....

EXHIBIT 86

A type of curb parking questionnaire postal card placed in the driver seat of parked cars or underneath windshield wiper.

Curb Parkers Questioned by Mail

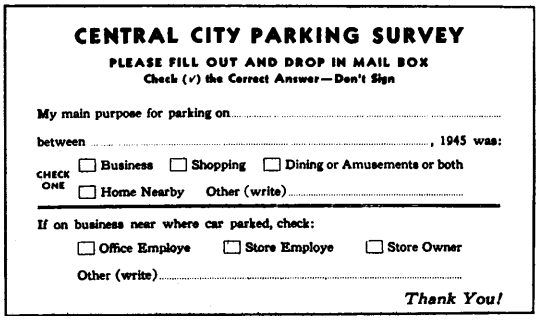
The license numbers of passenger cars were then traced by the Bureau of Traffic Engineering and the following letter mailed out immediately on the Bureau's official stationery.

Dear Mr . . . . . :

The City of Philadelphia is making a study of automobile parking in the Central City Business District. You can help us in this work. In return, with the aid of this and other traffic surveys we hope eventually to Make your trips to and from Central Philadelphia faster and more convenient in every possible way. The immediate job is fact finding.

On the day noted on the accompanying post card your car was parked in the City's Central Business District. Will you be kind enough to check the reason for your visit and, if for business reasons, whether you are an office employee, store employee, store owner in this mid-city area. Please do not sign the card. We do not wish to check on you personally. But PLEASE fill it out and drop it in the mail. You will make a real contribution to our understanding of the habits of Philadelphia motorists.

Sincerely yours,



CENTRAL CITY PARKING SURVEY

PLEASE FILL OUT AND DROP IN MAIL BOX
Check (✓) the Correct Answer—Don't Sign

My main purpose for parking on ..... between ..... , 1945 was:

CHECK ONE ☐ Business ☐ Shopping ☐ Dining or Amusements or both ☐ Home Nearby Other (write) .....

If on business near where car parked, check:
☐ Office Employe ☐ Store Employe ☐ Store Owner
Other (write) .....

Thank You!

EXHIBIT 87

A typical parking questionnaire (post card) and the accompanying letter, signed by the city traffic engineer, which explains how the survey was made.

EXAMPLES OF APPLICATION

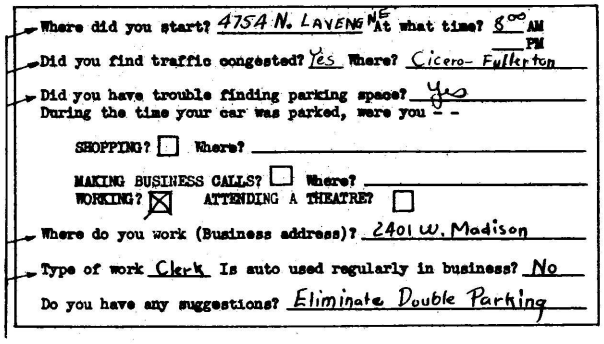
Example No. 1—Curb parking was the bottle neck of transit movement through an outlying business section during the afternoon rush period. Eighty-six outbound transit vehicles, carrying 5,100 passengers, plus several thousand passenger cars were being delayed daily because

of curb parking in a 5-block section on the major thoroughfare. A curb inventory check showed that only 10 cars per block (each side) or 100 total could be legally parked in the 5-block section at any one time. A questionnaire study showed 75 per cent of those parked between 4 and 6 p.m. in the 1-hour zones were employers and employees in the adjacent or near-by stores.

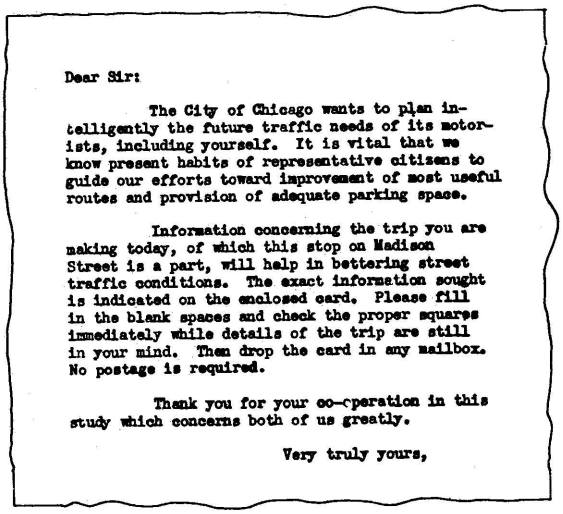
Supported by these facts the police agreed to prohibit curb parking on the outbound. side during the rush period. This resulted in general speed up in traffic and a 20 per cent improvement in transit running speed through the 5-block section.

Example. No. 2—At the request of a community of 1,000,000 population, the transit company made a de-study of parking in the downtown section to de-termine whether the angle parking should be changed to parallel parking. These studies revealed there were 1,586 angle parking spaces in the area, which, if changed to parallel parking space, would reduce the number to 1,124 or a reduction of 29 per cent. Further studies show that 25 per cent of the space was used by all-day parkers. It is obvious, therefore, that if the all-day parkers were eliminated that the 25 per cent saving of space would about equal the loss in space resulting in the change over from angle to parallel parking.

Following the change to parallel parking, bus travel



Superfluous questions to allay suspicion



Dear Sir:

The City of Chicago wants to plan intelligently the future traffic needs of its motorists, including yourself. It is vital that we know present habits of representative citizens to guide our efforts toward improvement of most useful routes and provision of adequate parking space.

Information concerning the trip you are making today, of which this stop on Madison Street is a part, will help in bettering street traffic conditions. The exact information sought is indicated on the enclosed card. Please fill in the blank spaces and check the proper squares immediately while details of the trip are still in your mind. Then drop the card in any mailbox. No postage is required.

Thank you for your co-operation in this study which concerns both of us greatly.

Very truly yours,

EXHIBIT 88

Another curb parking questionnaire, designed for checking on long-time parkers. The accompanying letter was signed by the Board of Trade. Letter and questionnaire card were placed under windshield wipers at hourly intervals. There was a small identifying mark on the face of each card which was keyed to each vehicle's license number for later analysis.

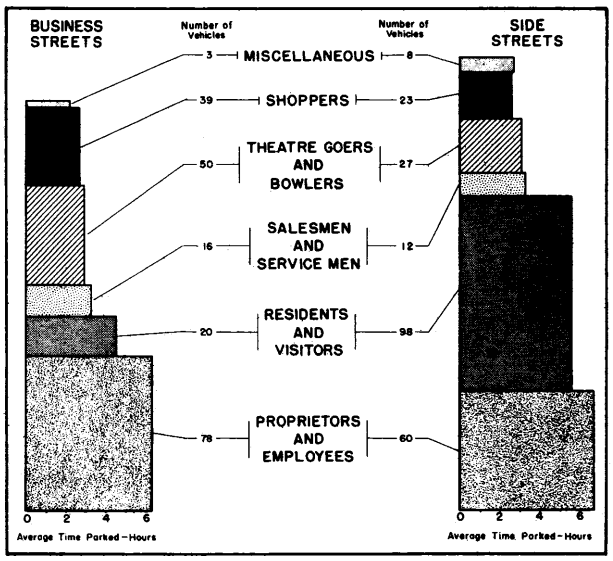


EXHIBIT 89

Taken from a survey of parkers that stayed longer than 90 minutes at the curb.

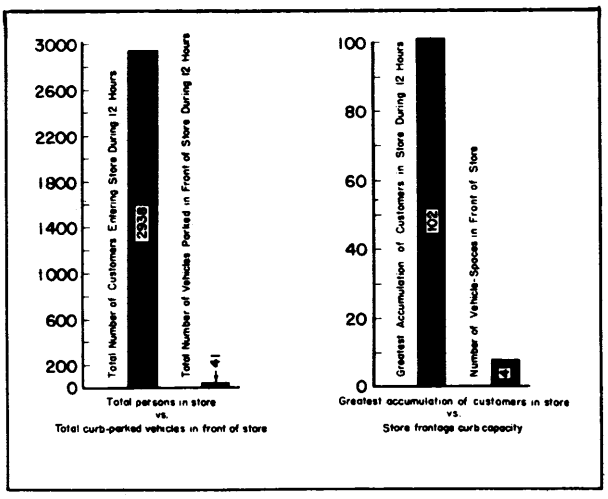


EXHIBIT 90

Results of a special curb parking survey that shows contrast between number of customers entering a small department store and number of vehicles parked in front of store over a 12-hour period.

time in the downtown district was reduced from 15 minutes to 6 minutes and the speed of traffic in general was improved from a low of 28 per cent on one street to a high of 102 on another. In all six streets, where the change over was made, general improvements occurred. Exhibit 91 shows the improvements on three of these streets.

There are still several locations in the downtown section of this community where angle parking exists. To obtain further facts as to why parallel parking should be installed, a special study was made of the traffic accidents that could be contributed to angle parking in this area. It was found that 43 out of 57 accidents occurring in the 1,200-foot section, where angle parking still existed, were caused either directly or indirectly by the angle parking. Exhibit No. 92 is a collision diagram showing these accidents. The city is now giving serious consideration to making parking changes in this area to conform to the remainder of the downtown section.

Example No. 3—The traffic department of a large transportation company made checks on operating conditions in the mid-city area late in December and then again, following establishment of a new curb parking prohibition in the central business district, on January 2, 1946.

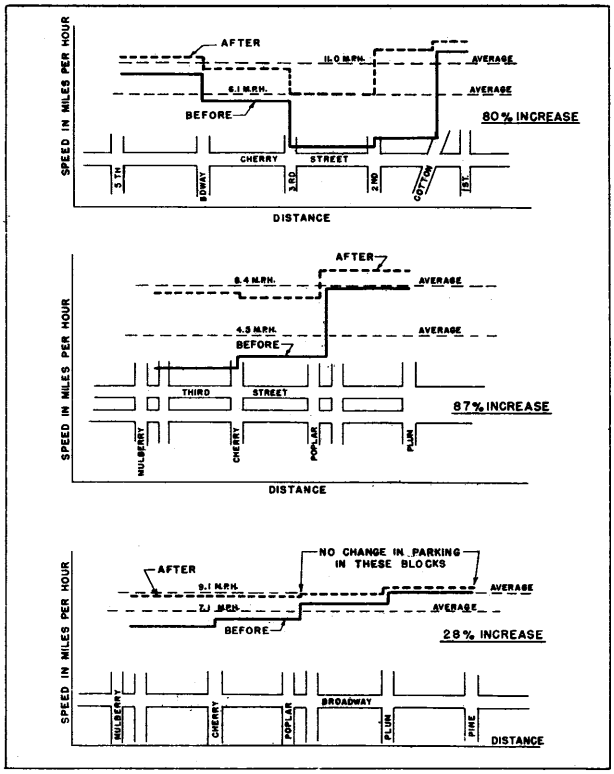


EXHIBIT 91

Vehicular traffic speeds, including transit, before and after curb parking was changed from angle to parallel on three downtown business streets.

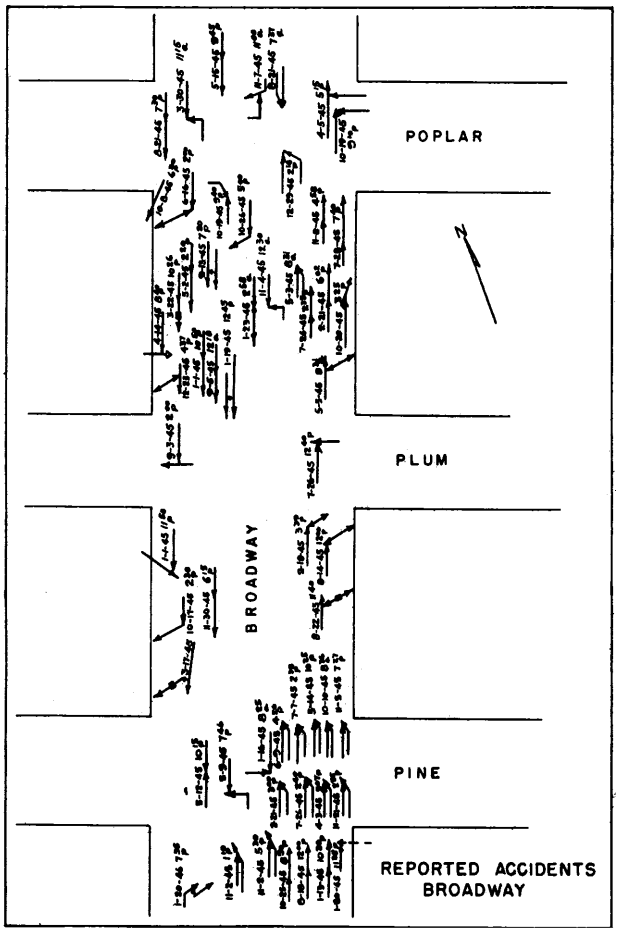


EXHIBIT 92

Types and locations of automobile accidents occurring on a section of street for which it had been recommended that curb parking be changed from angle to parallel.

This before and after survey revealed that the time necessary to cross the central business district on a street car, bus, or trackless trolley has been reduced approximately 20 per cent.

More important, however, was the marked improvement in smoothness of service. Now one seldom sees those traffic tie-ups which formerly were so common and which, during the peak hours, would cause five or six street cars to "bunch up" in a row. As a result, passengers are distributed evenly on the transit vehicles instead of being concentrated in the first one or two cars.

Also, there was a great reduction in the number of turnbacks formerly caused by irregular loading and poor spacing. Thus, on one main route, the transit company has practically stopped using 10th Street as a turnback point and has greatly reduced turnbacks at 6th Street. During the morning and evening traffic peaks, several streets get service every two minutes, whereas such service was formerly reduced at times to 10-minute intervals.

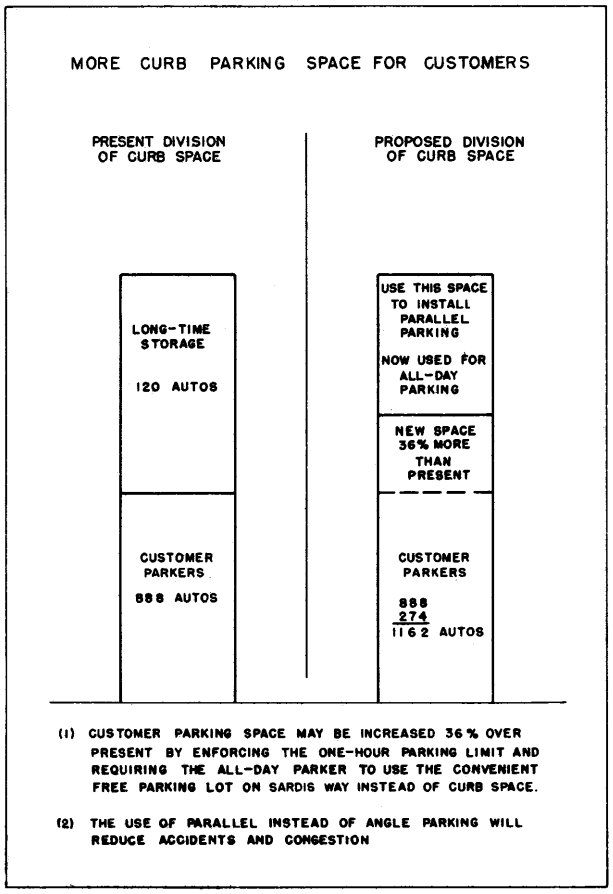


EXHIBIT 93

How it was proven that more curb parking spaces would be made available for customers even though angle parking was changed to parallel parking.

In addition, customers are now seldom left standing at corners in the central city area, as had happened all too frequently in the past.

There has been a 15 per cent average speed-up of operations on two of the major east-west streets. But major improvement along these east-west arteries has been recorded at over 20 per cent during the mid-afternoon period of 2:00 to 4:30 p.m., when general street traffic is at its heaviest. A faster movement on north-south streets has been particularly noticeable.

A preliminary report indicates that there has been a decrease of 15 per cent in frequency of accidents since inauguration of the new rules. In the past, a high proportion of accidents and delays on the transit lines was due to inexperienced and inattentive motorists pulling into and out of parked spaces at the curb. This type of interference with the operation of public transit at the surface level is now greatly reduced in the business district.

Signals formerly synchronized for speeds of 12 to 16 miles per hour have been set to a range of 15 to 18 miles.

Example No. 4—Angle parking at the curb in a suburban shopping center, which served one of the finest residential sections in the city, created excessive congestion. Business was being driven away from this area. At the request of the merchants and the chief of police the transit company made a detailed study of the parking conditions in this area. The transit company found, that although the all-day parkers constituted only 12 per cent, they occupied 51 per cent of the curb space. In other words they deprived the business men of this section of 51 per cent of the valuable curb space which should be reserved for customers. (*See* Exhibit 93) It also was clearly shown that angle parking could not be justified on the narrow business street. Upon completion of the field studies, the transit company recommended the following:

1— Reduce congestion and accidents by installing parallel curb parking instead of the existing angle parking.

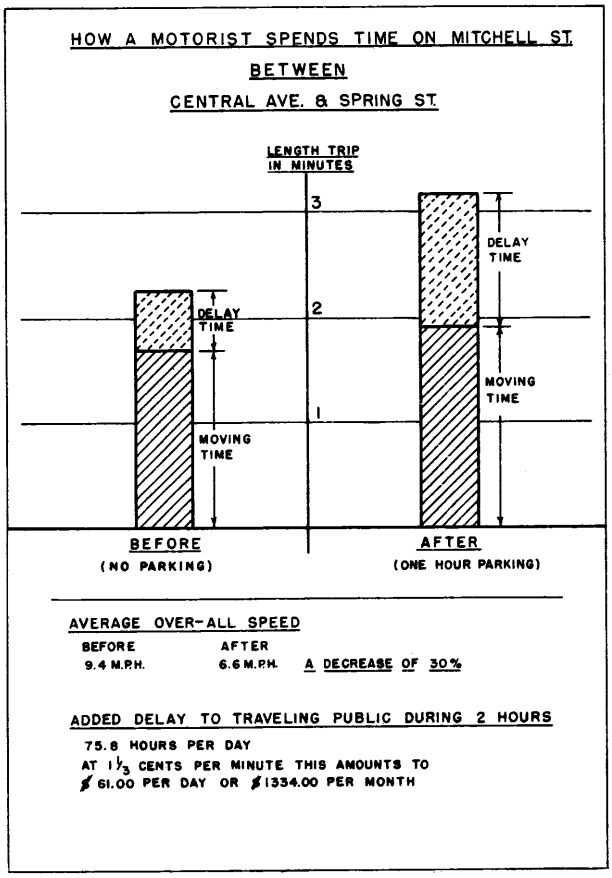


EXHIBIT 94

Traffic speeds decreased thirty per cent on this business street when curb parking was again permitted.

2— Enforce the one-hour parking regulations to eliminate the all-day parker from the curb, which in turn would encourage the all-day parker to use the ample free parking space available, one or two blocks from the business section.

The abolition of angle parking and the installation of parallel parking was recently approved by the official governing body of the community and the one-hour parking regulation is now being strictly enforced. Though the angle parking actually reduced the number of curb spaces, approximately 25 per cent of this loss is more than made up to the shoppers by the availability of those spaces which had previously been used by all-day parkers.

Example No. 5—Political pressure forced a change in the curb parking ordinance to again permit parallel 1-hour parking on both sides of a heavily traveled 40-foot street, after it had been prohibited for some time.

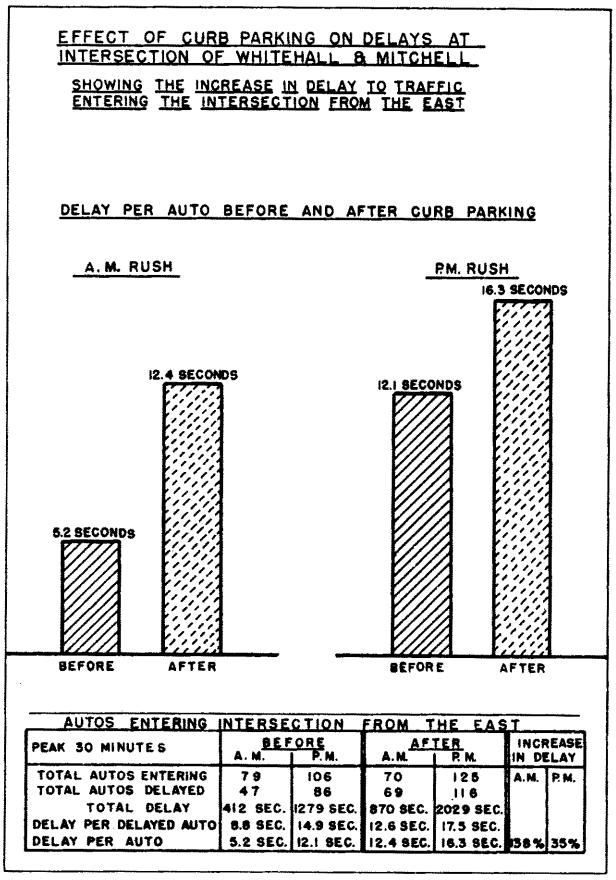
A combination of volume, delay, and parking studies made during the no parking era and 30 days after curb parking had again been instituted showed the following results:

Average over-all speed when parking was prohibited, equalled 9.4 miles per hour as compared to 6.6 miles per hour after parking had again been permitted.

Of the 115 parking spaces on this 40-foot street the maximum number filled at any one time during the rush period was 58 per cent. Forty per cent of the space in use was taken by store employees.

The several charts graphically illustrate how seriously curb parking affects all vehicular movement on a narrow street. (*See* Exhibits 94 and 95)

The transit company in this community is still trying to convince the city that the parking prohibition should be reestablished—at least during the afternoon rush period.



AUTOS ENTERING INTERSECTION FROM THE EAST

PEAK 30 MINUTES	BEFORE A.M.	BEFORE P.M.	AFTER A.M.	AFTER P.M.	INCREASE IN DELAY A.M.	INCREASE IN DELAY P.M.
TOTAL AUTOS ENTERING	79	106	70	125		
TOTAL AUTOS DELAYED	47	86	69	116		
TOTAL DELAY	412 SEC.	1279 SEC.	870 SEC.	2029 SEC.		
DELAY PER DELAYED AUTO	8.8 SEC.	14.9 SEC.	12.6 SEC.	17.5 SEC.		
DELAY PER AUTO	5.2 SEC.	12.1 SEC.	12.4 SEC.	16.3 SEC.	138%	35%

EXHIBIT 95

How curb parking adversely affected traffic movement at a specific intersection.

STUDY NUMBER 14

OFF-STREET PARKING

DESCRIPTION—A study of the present and potential off-street parking facilities in the business district, the types and amounts of off-street space needed, and the relationship of off-street parking to transit operations.

WHEN AND WHY STUDY IS MADE—The merchants or city officials should be encouraged to sponsor this study.

Adequate off-street parking facilities, properly regulated and operated on a self-supporting basis, will help the community, and whatever helps the community will help transit in the long run.

This is a special study. It is warranted:

(1) In working toward the eventual prohibition of curb parking in the congested portion of the business district.
(2) To help develop a sound, self-supporting off-street parking system.
(3) To indicate where transit might provide special motor bus services to and from parking facilities.

HOW TO MAKE STUDY—There are two parts to this study. The first part relates to the location and use of existing off-street parking facilities. The second part relates to finding out where people would like to park and the possibilities of locating parking facilities in those areas.

Part I—Location and Use—A large scale map is prepared on which to show the locations, sizes, and types of existing off-street parking facilities. Information for this map is obtained from a field check covering all existing facilities in the area under study.

The field form (Exhibit 96) used in making this check provides for recording the following: location, whether lot or garage, capacity, and number of cars using facility at the time of check. This form also provides for the recording of the capacity of locations that appear to the observer as potentially available for off-street parking use.

These field forms are keyed to the map for ready reference.

Part II—Parking Desires of Motorists—Information as to where motorists want to park and how far they will walk can best be obtained from a questionnaire. An eastern city recently completed such a questionnaire study (Exhibit 97), and obtained a 25 per cent return of the questionnaires.

Major questions asked were:

How long did you park here today?

Purpose of trip today?

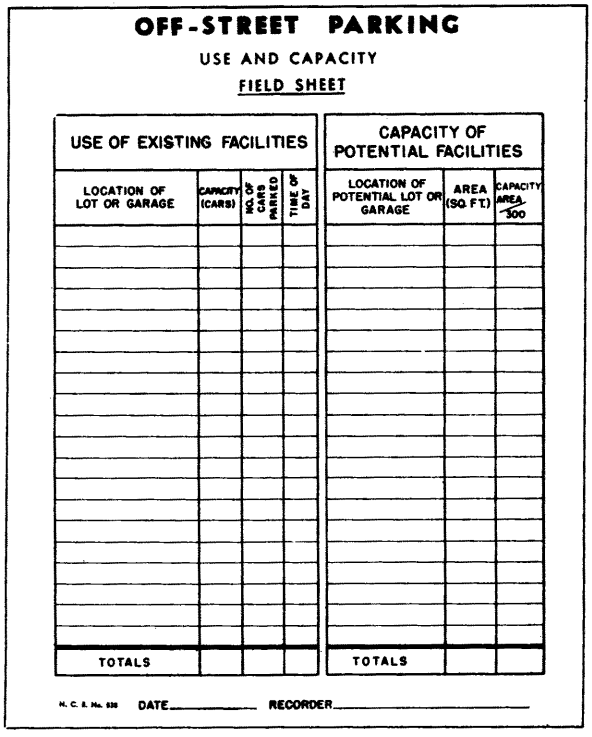
Main reason parked at this particular location?

Places of business contacted while car was parked?

Parking fee paid and the additional amount willing to pay for better parking?

Why drove downtown rather than use transit?

The questionnaires and attached letter of explanation are placed on cars parked in existing parking lots and garages. By the use of colored cards or special key numbers, the approximate time that the card is placed on car is noted, together with the name of the lot or garage in which it is parked. The questionnaires are printed on



OFF-STREET PARKING

USE AND CAPACITY

FIELD SHEET

USE OF EXISTING FACILITIES				CAPACITY OF POTENTIAL FACILITIES		
LOCATION OF LOT OR GARAGE	CAPACITY (CARS)	NO. OF CARS PARKED	TIME OF DAY	LOCATION OF POTENTIAL LOT OR GARAGE	AREA (SQ. FT.)	CAPACITY AREA ÷ 300
TOTALS				TOTALS		

N. C. S. No. 000 DATE_____ RECORDER_____

EXHIBIT 96

Off-street parking field sheet for recording use and capacity of parking garages and lots—issued by National Conservation Bureau.

postage-guaranteed postal cards, addressed for return to the individual or agency conducting the study.

Distribution of cards to 50 per cent of the parked cars is considered adequate. With a 25 per cent return, this will produce an over-all sample of 12.5 per cent. Since the cards need not all be distributed in one day, only a few field men are necessary.

When the bulk of the questionnaires has been returned, the cards are sorted and summarized by the general locations where cars have been parked. Maps are then prepared for each general location showing the destination of the occupant of the parked car. From these maps and the destination data, a composite picture can be prepared showing points where additional parking facilities are needed. These centers of desired parking concentrations are then checked against the present use of the property to determine availability of property for parking purposes.

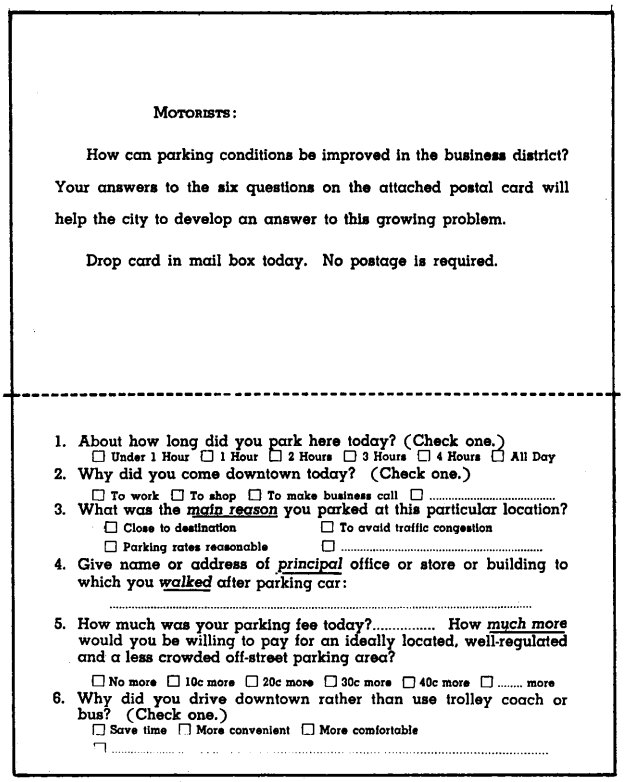
The present use of business district property can be readily obtained from a set of Sanborn (insurance) maps. Sanborn maps are made to scale. They show the location and type of every building in the business district. A record of the assessed property values should be obtained from the local real estate board, planning commission, or directly from the tax department at city hall.

As the selection of proposed off-street parking facilities begins to shape up, the question of present and potential transit service should be introduced. Improved transit service may eliminate the need of certain parking facilities, or the transit company may wish to establish special parking lot bus services to the proposed facilities, providing the parking facilities are accessible to good transit service.

The data are prepared and presented in summary tables and on large scale street maps.

EXAMPLES OF APPLICATION

Example No. 1—Transit companies in many instances are supporting community programs aimed toward the development of good, well regulated and self-supporting off-street parking facilities in the business district. These companies recognize that street congestion caused by curb parking cannot be cleared up until the curb parked cars have some place else to go. These companies also realize that self-supporting nonsubsidized off-street parking areas produce the fairest form of automobile competition.



MOTORISTS:

How can parking conditions be improved in the business district? Your answers to the six questions on the attached postal card will help the city to develop an answer to this growing problem.

Drop card in mail box today. No postage is required.

1. About how long did you park here today? (Check one.)
   ☐ Under 1 Hour ☐ 1 Hour ☐ 2 Hours ☐ 3 Hours ☐ 4 Hours ☐ All Day
2. Why did you come downtown today? (Check one.)
   ☐ To work ☐ To shop ☐ To make business call ☐ .....
3. What was the *main reason* you parked at this particular location?
   ☐ Close to destination ☐ To avoid traffic congestion
   ☐ Parking rates reasonable ☐ .....
4. Give name or address of *principal* office or store or building to which you *walked* after parking car:
   .....
5. How much was your parking fee today?..... How *much more* would you be willing to pay for an ideally located, well-regulated and a less crowded off-street parking area?
   ☐ No more ☐ 10c more ☐ 20c more ☐ 30c more ☐ 40c more ☐ ..... more
6. Why did you drive downtown rather than use trolley coach or bus? (Check one.)
   ☐ Save time ☐ More convenient ☐ More comfortable
   ☐ .....

EXHIBIT 97

A postal card type questionnaire used in checking on-off street parkers. These were placed under the windshield wipers every hour. All cards were keyed to the lots or garages in which they were distributed.

Example No. 2—Transit companies in about six large cities are now providing some shuttle bus service to and from fringe parking lots. This service is offered as an aid to meeting the downtown traffic problem. The fringe lots are either being operated by local business interests or are provided by the municipality. In certain instances the merchants are underwriting the shuttle bus operating costs so that 2½ to 5-minute headways can be maintained in order to make the service attractive.

Example No. 3—A transit property in a large eastern city is operating a fringe parking lot in conjunction with a loop bus service as a contribution toward helping to alleviate downtown traffic congestion. At present the combined operations are breaking even financially.

STUDY NUMBER 15

SHOPPER TRANSPORTATION

DESCRIPTION—A study of the modes of transportation used by shoppers and the parking practices of those shoppers who drive downtown.

The procedures outlined in this study can also be applied to the modes of transportation and parking practices of downtown store and office employees.

WHEN AND WHY STUDY IS MADE—Merchants can usually be interested in sponsoring, or at least cooperating in, such studies for their own information as well as for the information of public officials and the transit company. The local chamber of commerce or retail merchants association will usually take the lead in such a study. It is best, however, that the study be made by the city.

Shopper transportation is considered as a special study. It is made only under certain conditions. Its purpose is:

(1) To show what percentage of shoppers come by public transit.
(2) To show what percentage of shoppers walk to business center.
(3) To show officials and merchants how much or how little shopping business is produced by (a) curb parking and (b) off-street parking.
(4) To help determine why shoppers use one form of transportation rather than another.
(5) To produce proof as to why transit may need more local consideration and favorable attention from the merchants and traffic officials.

The need and demand for this type of study is constantly growing. See Public Opinion Poll, Study No. 19, for additional ideas.

Business men and local officials usually have no conception of the relative numbers of shoppers and customers who arrive in automobiles, on public carriers, or on foot. Moreover, they have no idea of what per cent of those shoppers and customers traveling by auto, are able to park cars at the curb near their stores, or in lots and garages at some distance away, and why shoppers generally use one form of transportation rather than another.

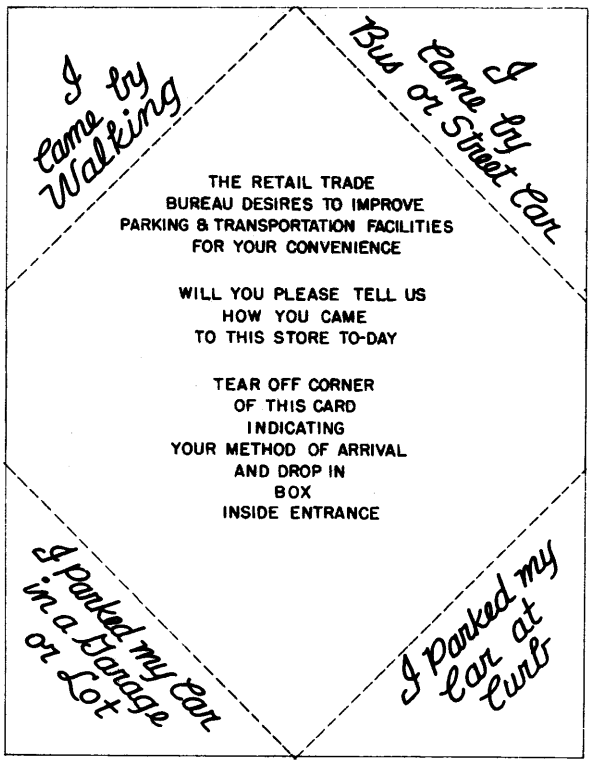


EXHIBIT 98
A shopper tear card type questionnaire.

HOW TO MAKE STUDY—There are several ways in which the modes of transportation and the parking practices of shoppers can be determined:

(1) Use of a tear card.
(2) Use of a questionnaire card.
(3) Personal interview.

In all instances, the results are based upon a sample of 25 to 50 per cent of the total shoppers and customers in the various types of downtown stores. The size of the sample will depend upon the number of clerks or interviewers used in making the study. If clerks are used, a 25 per cent sample is fairly certain.

To assure maximum cooperation and understanding from shoppers, large signs should be posted in stores to explain the purpose of the study and to urge cooperation of the shopping public.

Method No. 1—Tear Card—The simplest form of shopper transportation study involves the use of a tear card. The card is handed to the shopper or customer by

TRAFFIC AND TRANSPORTATION SURVEY

Instructions to Proprietors and Clerks for Studies of Area of Influence and Means of Transportation

1. Several stores are co-operating in this study. Your store has been selected as representative of its type.
2. Facts are needed on which to base plans for improved traffic and transportation facilities for this shopping district. Care should be taken that instructions are carried out fully and accurately.
3. Ask each customer to fill out a survey card, a facsimile of which is shown below. This can be done while purchase is being wrapped or change is being made. Have a supply of pencils on hand.
4. Proprietors or clerks should fill out cards for customers who have difficulty in understanding questions or in reading the card.
5. During busy periods, it may be impossible to have every customer fill out a card. This is to be expected.
6. Customers who do not fill out cards willingly should not be urged to do so.
7. Customers who say they have filled out a similar card in another store should be asked to fill out another one for your store. The results of each store will be tabulated separately.
8. The study will be made _____
9. Hold cards until they are called for.

THE BUSINESSMEN OF THIS NEIGHBORHOOD
WANT TO SERVE YOU BETTER

WILL YOU PLEASE TELL US HOW YOU CAME TO THIS STORE TODAY?

BY AUTOMOBILE ☐
BY STREET CAR ☐
WALKED ☐

YOUR HOME ADDRESS _____

EXHIBIT 99

A shopper questionnaire and instruction sheet used by a neighborhood business group to determine modes of transportation.

THE EAST 63RD STREET COUNCIL
WANTS TO SERVE YOU BETTER
WITH IMPROVED PARKING AND TRANSPORTATION FACILITIES

WILL YOU PLEASE TELL US HOW YOU CAME TO THIS STORE TODAY?

BY AUTO-MO-BILE	PARKED AT CURB ☐	STREET CAR ☐	WALKED ☐
	CAR DRIVEN AWAY ☐	BUS ☐	OTHER ☐
	NO SPACE - DRIVER GOING AROUND BLOCK ☐		
	PARKED IN GARAGE OR LOT ☐	NAME _____	
		ADDRESS _____	

EXHIBIT 100

A more detailed type of shopper questionnaire card.

a clerk or special checker. The customer is asked to tear off and drop in a box that corner of the card which describes the form of transportation he used to reach the store that day.

A sample card, Exhibit 98 is shown. The corners read as follows:

I came by walking
I came by bus or street car
I parked my car at the curb
I parked my car in garage or lot

To gain simplicity in tear cards, the address of the customer is not requested. Hence, the origin of the customer is unknown. If it is felt that origin must be known, then Method No. 2, described below, should be used.

Method No. 2—Questionnaire Card—Cards are printed with space for the address of one customer on each card, to provide origin of customer (Exhibits 99 and 100). Below this are shown the available forms of transportation to the district being studied, with space for a check mark in front of each.

One of several methods may be used to get cards properly filled out:

(1) Clerk may ask customer to fill out card, while former wraps packages or makes change.
(2) Special checkers, properly identified, may hand cards to shoppers and ask them to fill in blanks.

In large stores, the department heads should be given written instructions by personnel manager the day before transportation study is made, explaining how questionnaires are to be handled. Supervisors should make frequent inspections on day of study to see that the proper procedure is being used.

See Curb Parking Study No. 13 for description of a general curb parking questionnaire survey that also provides shopper data.

SHOPPER INTERVIEW

QUESTION	ANSWER	COMMENTS
1-Mode of transportation? (Check One)	Drove car ☐ Auto passenger ☐ Trolley coach or bus ☐ Walked ☐	
2-Purpose of trip? (Indicate main purpose with "1" and secondary purpose with "2".	To shop ☐ Visit doctor ☐ Theatre ☐ Employed downtown ☐ Dine ☐ Transact business ☐	
IF TROLLEY COACH OR BUS RIDER ALSO ASK NO. 3		
3-Why trolley coach or bus used in preference to auto? (Check one)	Don't own car ☐ Transit cheaper ☐ Transit more convenient ☐ Parking conditions bad ☐ Will quit using transit soon as car can be purchased ☐	
IF DRIVER OF CAR ALSO ASK THESE		
4-Where car is parked? (Check one)	At curb ☐ Private lot ☐ Public lot ☐ Public garage ☐	
5-About how long will car be parked at this location today? (Check one)	15 minutes ☐ 2 hours ☐ 30 " ☐ 3 hours ☐ 45 " ☐ All day ☐ 60 " ☐	
6-If parked at curb, why did not use parking lot or garage? (Check one)	Lots & garages all full ☐ Lots & garages too far away ☐ Lots & garages too expensive ☐	
7-How many blocks parked from this store or building? (Check one)	One-half ☐ Three ☐ One ☐ Four ☐ Two ☐ Over four ☐	
8-Approximate fee for parking in lot or garage today? (Write amount)	_____ cents	
9-How much more willing to pay for closer, well-regulated and a less crowded off-street parking area? (Check one)	No more ☐ 30¢ more ☐ 10¢ more ☐ 40¢ more ☐ 20¢ more ☐ ____ more ☐	
10-Why car was used rather than trolley coach or bus? (Check one)	Save time ☐ Save walking to transit line ☐ More comfortable ☐ Carry packages ☐	

Name of Shop or Store _____ Name of Interviewer _____

EXHIBIT 101

A typical shopper interview form.

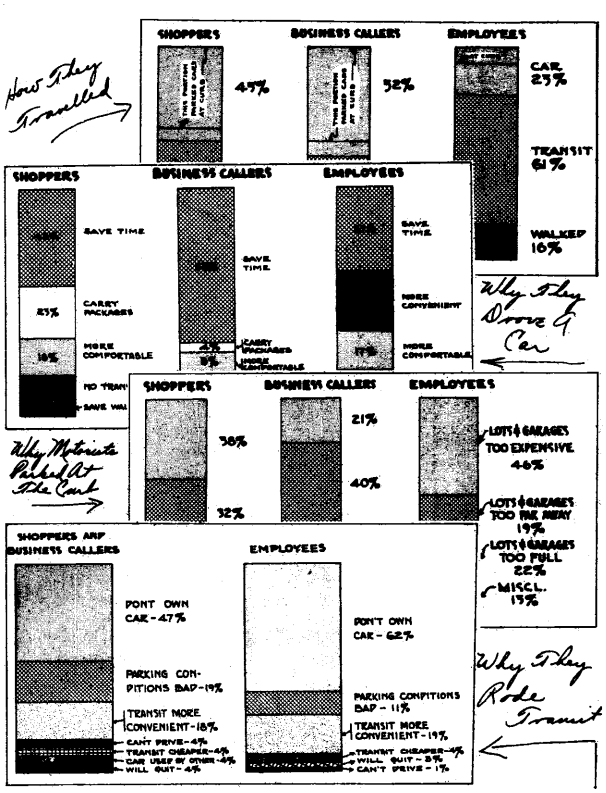


EXHIBIT 102
Four illustrations taken from a special shopper and employee study.

Method No. 3—Personal Interview—The questionnaire card method just described can be improved upon if the questions are answered through a personal interview. Store clerks or special personnel can be used to conduct the interview. Instead of cards, interview forms (one for each person interviewed) are used. A shopper interview form used in an eastern city recently is shown on Exhibit 101. Some 2,000 shoppers, in 25 key stores of various types, were interviewed over a 4-hour period by 35 women who volunteered their services.

Advance instructions, printed, and verbal, should be given the interviewers to make sure that the interviewers all function alike. Advance publicity in the press is also important toward assuring full public support.

The results of the questionnaire, or interview, are generally put on punch cards so that they can be quickly summarized in various ways. Then they are checked against the number of retail sales for each of the stores in which the study was made, to provide a rough indication of the size of the sample.

Exhibit 102 shows several charts prepared from a combined shopper interview and employee questionnaire study.

EXAMPLES OF APPLICATION

Example No. 1—A local chamber of commerce wished to find out just how important curb parking was to shoppers in the downtown section. A shopper study revealed that 50 per cent of the shoppers drove downtown, but only 10 per cent of the 50 per cent parked at the curb. The remainder parked off-street. From that time on less significance was placed on curb parking by the chamber.

Example No. 2—A transit company wanted to prove to the merchants that curb parking in the business district could be prohibited and not affect shopper trade coming downtown by private car. A special shopper study revealed that 95 per cent of the shoppers were unable to find curb parking space on Main Street and therefore would not be adversely affected by a curb parking prohibition on Main Street.

Example No. 3—A transit company urged that a shopper study be made to find out what might be done to make transit more attractive to shoppers. As a result of the study, midday schedules were changed on several lines, three downtown stops were relocated and space was provided in the midday buses for parking bundles belonging to homebound shoppers.

STUDY NUMBER 16

DENSITY OF BUSINESS AND INDUSTRIAL EMPLOYMENT

DESCRIPTION—A study of the types, locations, number of employees, and working periods of business and industrial establishments in a metropolitan area.

WHEN AND WHY STUDY IS MADE—Every transit company in medium and large size cities should make such a study every three to five years as a part of its background for immediate and long range planning. It is warranted:

(1) As a part of a general appraisal of the commercial life of the community.
(2) To check transit coverage being given to white collar and factory workers.
(3) As the first step in making a staggered hour study.

HOW TO MAKE STUDY—The types, locations and employment figures for commercial And industrial establishments can generally be obtained from the local chamber of commerce or local industrial council. It is also possible that the local planning or zoning commission will have at least a part of the desired information.

Up-to-date, scaled maps showing the locations and sizes of all buildings in the community, both business and residential, are generally available from large insurance companies or agents. These maps are known as the Sanborn maps. Agents for these maps are also located in most large cities.

Working period figures for commercial and industrial employees are seldom available, however. Even if they are available, they are seldom up to date. Hence, a special letter must be sent to, or telephone inquiries made of, employers to obtain these data.

It is desirable to have the employee information collected by a disinterested party, such as the chamber of commerce. Generally, a third party has a better chance

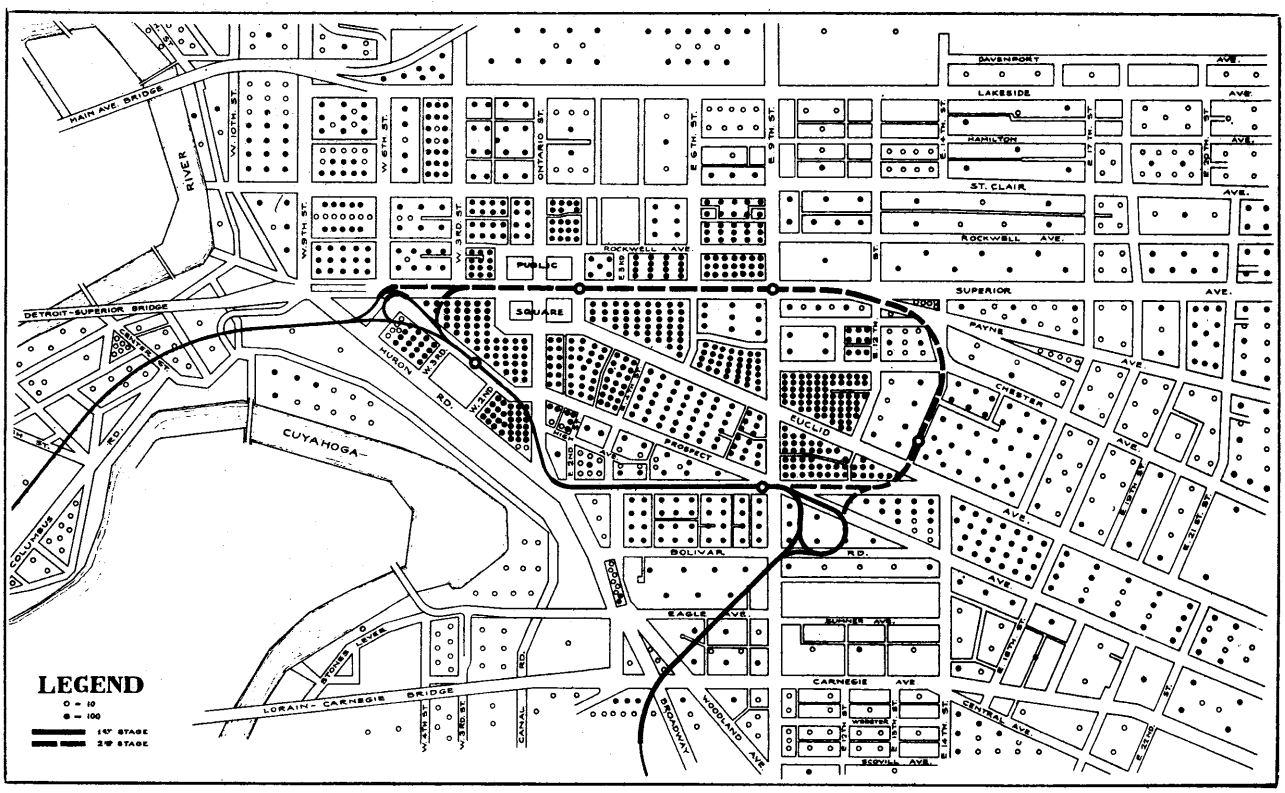


EXHIBIT 103
A chart showing distribution of downtown daytime population

of getting complete information than the transit company, and there is greater acceptance of the survey when completed.

The information is summarized in tabular form and then shown pictorially on a map (Exhibits 103 and 104).

EXAMPLES OF APPLICATION

Example No. 1—A study was made of the amount of transit patronage obtained from each industrial plant in a given area. *First*, a map was prepared showing the location of 12 plants in the district. *Second*, the employees of each plant, for each shift, were plotted on the map in relation to the possible transit stops that each group would use. A detailed on-off study was then made in the district during shift changes on the several lines serving the 12 plants. From a comparison of the on-off counts to the industrial population of each plant for each shift, riding characteristics were developed that were then applied to several other industrial areas where transit service was being considered.

Example No. 2—To help measure a gradual shift in transit maximum load points that was occurring on several long established downtown lines, a transit company made a study of the business district population. This study was based upon figures furnished by the chamber of commerce and showed that the center of density of the business district population was moving north about one block, every three years.

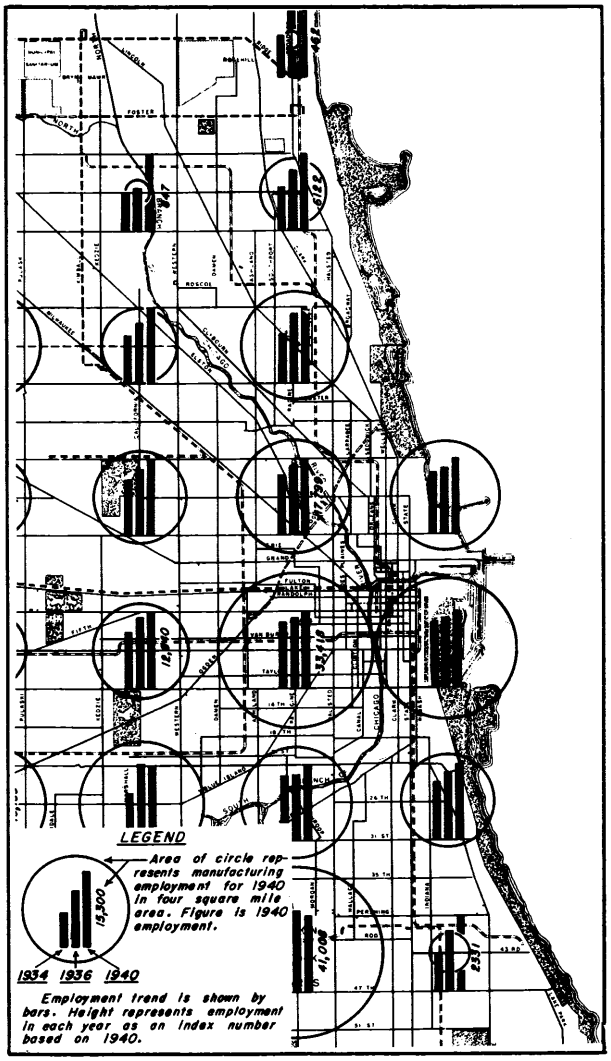


EXHIBIT 104

Results of a special industrial employment study which shows plant employment and trends from 1934 for specific areas in the city.

STUDY NUMBER 17

DENSITY OF RESIDENT POPULATION

DESCRIPTION—A study of resident population by census tracts or other political subdivisions.

This study should generally be made in conjunction with Study No. 18, "Density of Passenger Car Registration."

WHEN AND WHY STUDY IS MADE—This study should be made following each population census to:

(1) Measure transit coverage of residential areas.
(2) Measure passenger car registration density per 100 persons or per family for various sections of the city.
(3) Reveal trends and shifts in the metropolitan population as a means of forecasting future transit needs—city wide and for specific areas. (*See* Exhibit No. 105).

HOW TO MAKE STUDY—For every city of any size there exists a set of population maps prepared by the census bureau. These can generally be obtained through the local planning commission and sometimes from the chamber of commerce. If none can be found locally, a set for your community can be obtained from the census bureau.

The Sanborn maps, mentioned in Studies 14 and 16, are also helpful in making this study. By combining the census maps and Sanborn maps, it is possible to determine the average number of persons per home or per mile for a given stretch along a given transit route. By combining with Study No. 18 it is possible to determine the number of passenger cars per acre, per 100 persons or per family for each section of the city.

Special outside personnel are not required to make this study. Generally, it is made with the regular personnel of the company.

The information obtained generally is summarized in tabular form by areas of the city or along existing transit routes. It is also shown in spot map form (one pin to five or ten people) on which the transit routes have been superimposed.

EXAMPLES OF APPLICATION

Example No. 1—Questions were raised by municipal officials about the lack of transit coverage for the community. Claims were made that upward of 25 per cent of the residents within the city limits did not have access to a transit line. Demands were then made that the transit company increase its coverage accordingly.

The transit company prepared a detailed density map of the population by census tracts. On this was superimposed the transit lines. All areas within one-quarter mile either side of the transit lines were then shaded to show the present coverage. Population outside of the shaded areas was then checked. The study, when completed, showed the existing transit lines actually were providing physical coverage of 92 per cent of the population. Demands for extensions, etc. were dropped.

Example No. 2—In order to weigh the demands for a second crosstown line a transit company compared the resident population density along the proposed route to that of the existing crosstown line. It was found that the houses within one-quarter of a mile of the present crosstown line totaled 7,483, compared to 5,890 on the

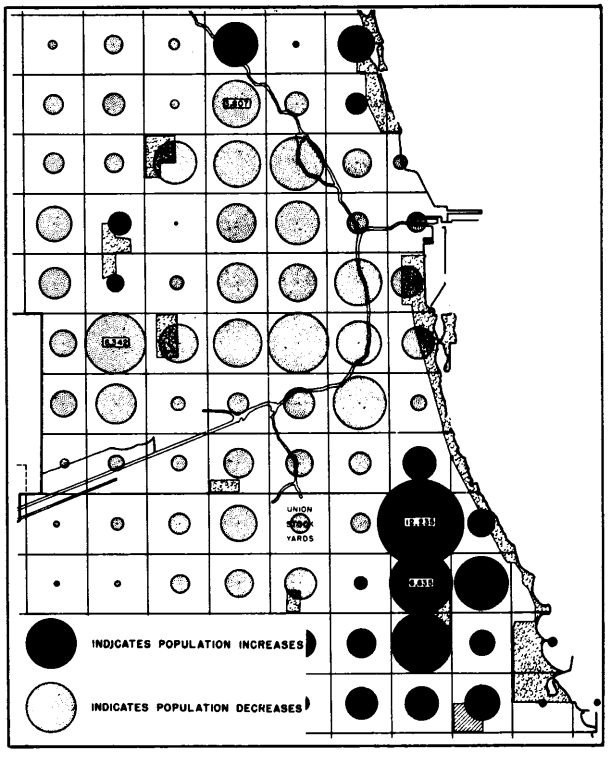


EXHIBIT 105
Showing population trend by census tracts.

proposed crosstown line. The homes served per mile of route were 1,313 on the present and 1,370 on the proposed crosstown. An on-off riding check of the present line showed 63 passengers per bus trip during the peak period. However, the mileage of the proposed crosstown was 25 per cent less than the present crosstown, and since approximately the same density of population was served per mile on the present and proposed, the patronage on the proposed crosstown would be 25 per cent less, or would total 47 passengers per trip in the peak period. These facts, when weighted against transit operating costs, clearly indicated that the proposed crosstown line could not be justified.

Example No. 3—Real estate promoters urged a transit company to extend a transit line into a new development. They claimed the district would soon develop three rides per home per day. The transit company checked other residential areas of a similar character that were already fully developed and found transit rides were only 1.9 per home per day. Based upon the number of homes being built in this new development the company declined to make any promises to the real estate promoters about future transit service.

STUDY NUMBER 18

DENSITY OF PASSENGER CAR REGISTRATION

DESCRIPTION—A study of the number of passenger cars registered in each census tract or other political subdivisions.

This study should generally be made in conjunction with Study No. 17, Density of Resident Population.

WHEN AND WHY STUDY IS MADE—This study should be made to:

(1) Show amount of passenger car transportation available in a given area.
(2) Measure passenger car registration density per family or per acre or per 100 persons for a given area.
(3) Indicate general income levels of various areas.
(4) Prove or disprove need for extension of transit service.

HOW TO MAKE STUDY—Before embarking on this study a check should be made with the local officials (traffic engineer and city planning bureau) to ascertain whether such data are not already available in summary form on an area and population basis. Most large cities have made such studies in the past ten years. If they don't have it, check with the local chamber of commerce. Possibly, some large retail agency has made such a study.

Should it prove necessary to undertake the complete study, access to the addresses of passenger cars registered in the community can generally be obtained from either the local police department, state police or the state motor vehicle department. Such registration data are maintained in large loose-leaf ledgers and are listed (1) by registration numbers and (2) by name of owner. Either list can be used since the address is given in both instances.

The addresses need not be transcribed if the recorder is able to properly spot the approximate locations on a map or on a form which is divided into census tracts.

EXAMPLES OF APPLICATION

Example No. 1—Transit service was requested for an exclusive residential area in which a car registration density study showed an average of 1.4 passenger cars per family. A population density study showed less than three persons per acre and a special check on domestic help indicated most of it lived in, or had private transportation. The company declined to provide the transit service after fully weighing all these facts.

Example No. 2—Transit riding declined 20 per cent in a residential area over a 5-year period. A check of car registration density trend for the five years showed a sharp increase and was earmarked as the cause of the drop in transit riding.

STUDY NUMBER 19

PUBLIC OPINION POLL

DESCRIPTION—This is a poll of public opinion on transit equipment likes and dislikes, quality and type of service desired, and riding habits of present and potential transit patrons.

WHEN AND WHY STUDY IS MADE—To date only a limited number of public opinion polls have been taken. For an industry that depends 100 per cent on the general public for its business, more appear warranted. Polls provide a measure of public reaction and an expression of transportation desires which cannot be obtained in any other way.

Though a public opinion poll for transit might properly be made annually to show trends, it is generally felt today that transit polls of a specialized nature should be made only on special occasions, such as:

(1) When contemplating a change in type of transit equipment.
(2) When considering a change in the amount and type of service.
(3) When needed to help prove a controversial point with public officials.
(4) To measure public reaction to some change that has been made.
(5) To compare transit and passenger car riding.
(6) As a background for advertising and sales promotion or public relations activities.

HOW TO MAKE STUDY—Though many types of polls can be made, there are four that have special significance today:

(1) Measure of service being given, which would include whether schedules were frequent or infrequent, too fast or too slow, interest in express service, and whether certain lines could be consolidated or changes made in the routes.
(2) Types of people (purposes of rides) riding public transit and the frequency of rides.
(3) What the public is willing to pay for special types of services and how much they will pay to save various amounts of time.
(4) Interest of the public in combining the use of transit and passenger cars through use of fringe parking lots.

One of the most important steps in making a public opinion poll is preparation of questions to be asked. They must be clear, fair and to the point.

A second important step is the selection of the sample. National polls taken by professional groups are usually based upon a sample of less than 5,000 interviews. Many local polls are based upon samples of only 300 interviews. It is possible to base public opinion on these small samples because of the care taken in selecting those to be interviewed. The selection is based upon geographical spread, occupations, income groups, ages, and sex.

A third important step is the method of reaching the sample selected. Personal interviews are the best. A lot depends upon the interviewer, however, as to the type and completeness of answers obtained. The interviewers must be properly instructed as to how to approach the prospect and how to ask the questions.

School teachers, college students and carefully chosen housewives make the best interviewers. It is better to use a small, well-instructed group of interviewers and to do the job over a period of several weeks than to use a large number of interviewers and attempt to do the job in one day.

A second method of obtaining the answers is through the distribution and collection of questionnaires (Exhibit 106) If such a procedure is used, the questionnaire should be keyed in some way so it can be determined whether the replies represent a balanced cross-section of the original sample. Mail questionnaires are less satisfactory than personal interviews. However, they can be used satisfactorily in cases where only one or two rather direct questions are asked. In such instances, however, the questionnaire should be accompanied by an explanatory letter. To assure a good return, the letter and questionnaire should be handled by the chamber of commerce or some city official. (Study No. 9)

The "Manual of Traffic Engineering Studies" issued by the National Conservation Bureau has the following to say about drawing up questionnaires:

> "The preparation of a questionnaire which will report the desired information is a highly technical task. For one thing, the questions have to be so worded that no person could misconstrue the meaning. This is not an easy thing to do, and takes

a great deal of thought. Where questionnaires are to be sent through the mails and there will be no interviewer to interpret the questions for those interviewed, special care must be exerted to make certain the questions are utterly simple and easy to answer. If not, the answers may be omitted, or inconsistent, or the questionnaires may not be returned at all.

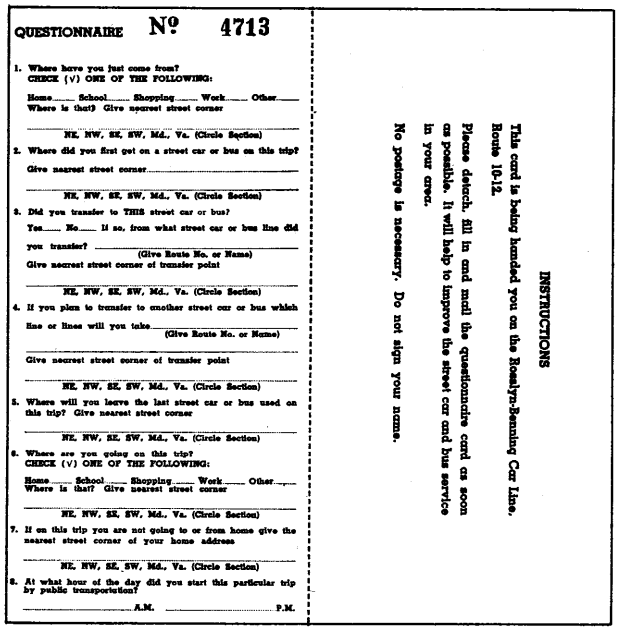
"At best, only about 30 per cent of questionnaires mailed out will be returned, and the figure may be less than 20 per cent where the questionnaire is too detailed or ambiguous.

"The results given by a mail questionnaire may be biased by the following:

(a) The persons to whom the questionnaires are mailed in the first place may not represent a cross-section of the group desired.

(b) Those answering may not answer correctly because of pride, emotion, laziness, lack of knowledge, confusion, or because the person has been led astray by a leading question.

(c) Perhaps the persons who return the questionnaires do not represent a true cross-section of the group desired. Those to whom the questionnaire appeals, and who take the time to answer it, may represent only those especially interested and one biased segment of the population.



QUESTIONNAIRE No. 4713

1. Where have you just come from?
CHECK (√) ONE OF THE FOLLOWING:
Home..... School..... Shopping..... Work..... Other.....
Where is that? Give nearest street corner
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

2. Where did you first get on a street car or bus on this trip?
Give nearest street corner.....
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

3. Did you transfer to THIS street car or bus?
Yes..... No..... If so, from what street car or bus line did you transfer? .....
(Give Route No. or Name)
Give nearest street corner of transfer point
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

4. If you plan to transfer to another street car or bus which line or lines will you take.....
(Give Route No. or Name)
.....
Give nearest street corner of transfer point
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

5. Where will you leave the last street car or bus used on this trip? Give nearest street corner
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

6. Where are you going on this trip?
CHECK (√) ONE OF THE FOLLOWING:
Home..... School..... Shopping..... Work..... Other.....
Where is that? Give nearest street corner
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

7. If on this trip you are not going to or from home give the nearest street corner of your home address
.....
NE, NW, SE, SW, Md., Va. (Circle Section)

8. At what hour of the day did you start this particular trip by public transportation?
..... A.M. ..... P.M.

INSTRUCTIONS

This card is being handed you on the Rosslyn-Benning Car Line, Route 10-12.

Please detach, fill in and mail the questionnaire card as soon as possible. It will help to improve the street car and bus service in your area.

No postage is necessary. Do not sign your name.

EXHIBIT 106

A questionnaire used to check 5 per cent of the riders on a specific line.

"In order to make certain that the questions will be answered fairly and by enough people to constitute a worthwhile sample, the following rules should be followed in preparing the questionnaire:

(1) Ask for 'Yes' or 'No' answers if possible.

(2) Never instruct the writer to cross out the answer not applicable (where two are given), as many persons will put a cross through the answer they wish to indicate. If 'Yes' or 'No' cannot convey the meaning, list a number of items, one of which is to be checked as the answer.

(3) If this is not feasible, then insert blanks with subscripts suggesting the general classifications of the facts asked for.

(4) Avoid issues of pride or prestige of the individual.

(5) Emotionally charged questions should be avoided. These may make the return selective.

(6) Leading questions should be avoided.

(7) The number of questions should be kept to a minimum; only two or three if possible.

(8) The questions should be short and clear.

(9) The questions should yield answers which can be tabulated easily.

(10) The questionnaire should be attractive. The questions should be printed in large size type.

(11) The signature of the person answering should not be called for unless absolutely necessary. Many people hesitate to place their signature on questionnaires and hence may fail to return the questionnaire on this account.

"In order to obtain the best results from a questionnaire survey, it is advisable to test it on a small scale and tabulate the answers before forms are mailed out in large quantities. Thus, some poorly worded questions may be discovered, or problems of tabulation revealed, and the questionnaire may be altered accordingly. Also, the approximate percentage return will be apparent, which will help to ascertain how many forms should be sent out to get back a sizable sample."

EXAMPLES OF APPLICATION

Example No. 1—A transit company made an extensive poll of public opinion to help determine its policy and program for the years ahead. An outside agency was

employed to help select a scientific sample and to assist in properly wording the questions which were to be asked by the interviewers. Some 2,000 interviews were made. Highlight findings of this study included the following:

(1) 11 per cent of the persons now riding transit would change to automobiles just as soon as new cars were plentiful.
(2) 20 per cent said they would use automobiles more than street cars or buses primarily to save time. (Faster schedules, or at the very least more rigid maintenance of present schedules, will be vitally important to the company's future program.)
(3) 36 per cent of the transit riders living more than 20 minutes from the central business district said they would pay an extra fare to get express service downtown.
(4) Young people and employed women are the most frequent transit riders at present.

Example No. 2—Another transit company conducted a special poll to find out the purposes of transit trips as a measure of the type of improvements that should be made to hold riders and attract new patrons. This public opinion poll showed 47 per cent of the total population or 73 per cent of the employed people said they used transit to go to work last week; 69 per cent said they used transit for other purposes, such as:

41 per cent said they went shopping via transit one or more times the previous week.
20 per cent said they went visiting.
11 per cent said they went to church.
20 per cent said they went to the movies.
21 per cent said they used transit for other miscellaneous trips.

Example No. 3—A big difference of opinion developed in the community when the transit company proposed that the remaining street car line be replaced with either trolley coaches or buses. The franchise called for the maintenance of street cars on this last line, but the city council was willing to permit the change if the public approved. Finally, it was agreed to call in a consulting firm to conduct a public opinion poll to determine the preference of equipment for this major transit line.

The poll, called a "preference poll," covered the existing street car line, two trolley coach lines and three bus lines and was made on a week day between 7 a.m. and 1 p.m. No advance publicity was given the poll. Seventy-eight university students, all nonresidents, were employed to conduct the poll. They were divided into pairs and assigned to ride certain vehicles the entire length of the line. These assignments constituted 20 per cent of the vehicles in the rush period and 40 per cent in the base period for each of the six lines.

The poll was made with the aid of 3 x 5 cards, on which was printed the following:

> We are making a survey of the transit facilities.
> Please indicate by a check mark below your
> preference as to type of vehicle:
>
> Street car
> Trolley coach or bus

Half the cards were printed with "street car" on top line and the other half with "trolley coach or bus" on top line. These were thoroughly shuffled before being distributed.

The students were given a supply of cards and pencils. One was stationed at the front door to distribute and collect cards, and the other at the rear door to collect cards. Cards were given to all those boarding the line from terminal to terminal.

Cards to the number of 14,400 were turned in from the six lines. Only 204 had to be discarded because of double checking, no check marked, etc.

When tabulated, the over-all results showed 86.6 per cent were in favor of rubber-tire vehicles. The street car riders on the line about which the controversy existed voted 2 to 1 in favor of rubber-tire vehicles.

A further check of the ballots returned by each line against the total riders for each line showed the poll coverage totalled 18 per cent. This was considered an excellent sample.

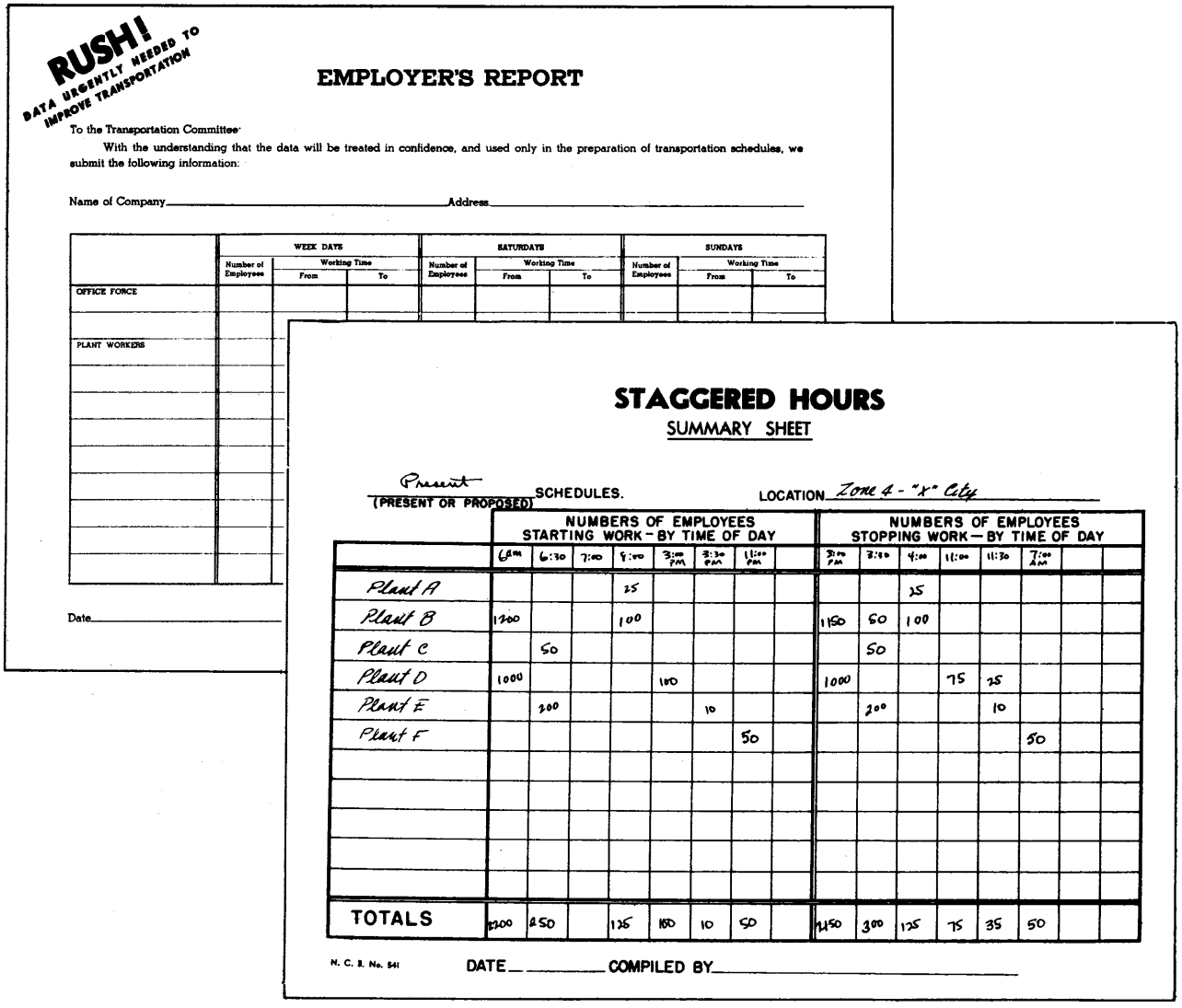
No question remained about the public's preference for transit equipment. The city council agreed that the change should be made at once.

STUDY NUMBER 20

STAGGERED HOURS

DESCRIPTION—A study of the working hours of employees in one or more industrial plants, or the opening and closing hours of stores, or the opening and closing periods of schools—pointing toward the staggering of working, shopping and school hours to reduce the peak transit load and general traffic congestion.

WHEN AND WHY STUDY IS MADE—Staggered hour use in industrial plants, stores and schools reached a peak during the war. They were accepted as a *must,* but were not too popular. Unfortunately, most of those changes adopted at that time have been discontinued. Future use of staggered hours will be greatly limited because of popular reaction. Traffic conditions may become so bad, however, in some communities that a return to staggered hours for a major plant, a group of stores, the schools, or entertainment centers will become necessary.



RUSH! DATA URGENTLY NEEDED TO IMPROVE TRANSPORTATION

EMPLOYER'S REPORT

To the Transportation Committee:

With the understanding that the data will be treated in confidence, and used only in the preparation of transportation schedules, we submit the following information:

Name of Company_____ Address_____

	WEEK DAYS			SATURDAYS			SUNDAYS		
	Number of Employees	Working Time From	Working Time To	Number of Employees	Working Time From	Working Time To	Number of Employees	Working Time From	Working Time To
OFFICE FORCE									
PLANT WORKERS									

Date_____

STAGGERED HOURS

SUMMARY SHEET

Present (PRESENT OR PROPOSED) SCHEDULES. LOCATION Zone 4 - "X" City

	NUMBERS OF EMPLOYEES STARTING WORK – BY TIME OF DAY								NUMBERS OF EMPLOYEES STOPPING WORK – BY TIME OF DAY							
	6am	6:30	7:00	9:00	3:00 PM	3:30 PM	11:00 PM		3:00 PM	3:30	4:00	11:00	11:30	7:00 AM		
Plant A				25							25					
Plant B	1200			100					1150	50	100					
Plant C		50								50						
Plant D	1000				100				1000			75	25			
Plant E		200				10				200			10			
Plant F							50							50		
TOTALS	2200	250		125	100	10	50		1150	300	125	75	35	50		

N. C. B. No. 541 DATE_____ COMPILED BY_____

EXHIBIT 107

Field form and summary sheet on which are recorded the number of employees and their work schedules.

MORNING RUSH HOURS

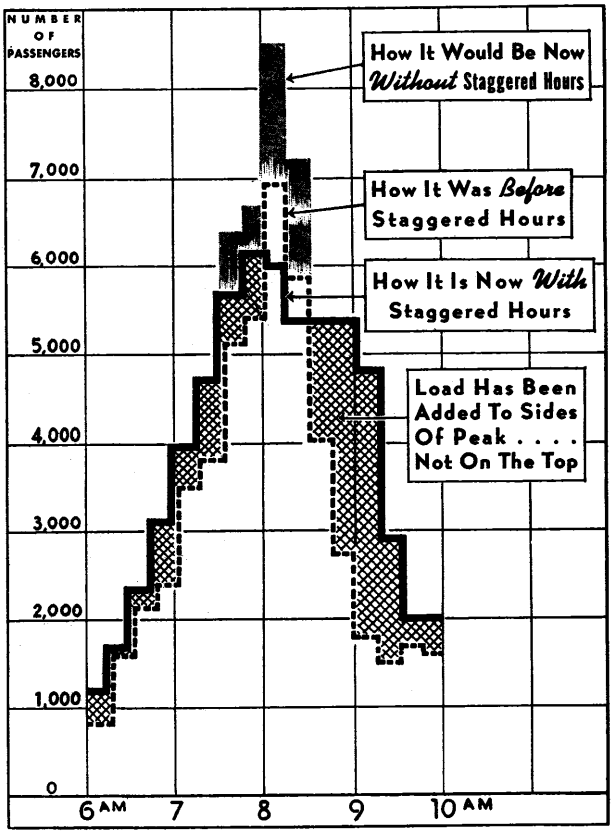


EXHIBIT 108

The effectiveness of staggered hours on local transit riding.

If possible, the transit company should urge some other agency or group to sponsor the study, possibly the city traffic engineer, police department or chamber of commerce.

This is considered a special study and is made only when the occasion demands. Warrants for making the study include:

(1) Inability to handle peak load on a given line because of excessive demands of patrons from a single manufacturing or business establishment.
(2) Excessive "five o'clock" transit load from the business district.
(3) Acute traffic congestion at some specific time because of a condition that can be isolated and corrected by staggered hours.

HOW TO MAKE STUDY—The Manual of Traffic Engineering Studies describes how to make a staggered hour study which is applicable to special conditions as well as general conditions.

The study described in this manual is built around a simple questionnaire. (*See* Exhibit No. 107) This questionnaire is sent to the employer or employers in the area under study, along with a letter describing why the information is needed and how it will be used.

The manual states that where automobile traffic congestion at parking lots and on the adjacent streets is the major reason for making this study a vehicle volume count should also be made of vehicles bound toward and away from the establishment, before and after shift changes; further, that it will be necessary to have a record of the number of transit units and employee-

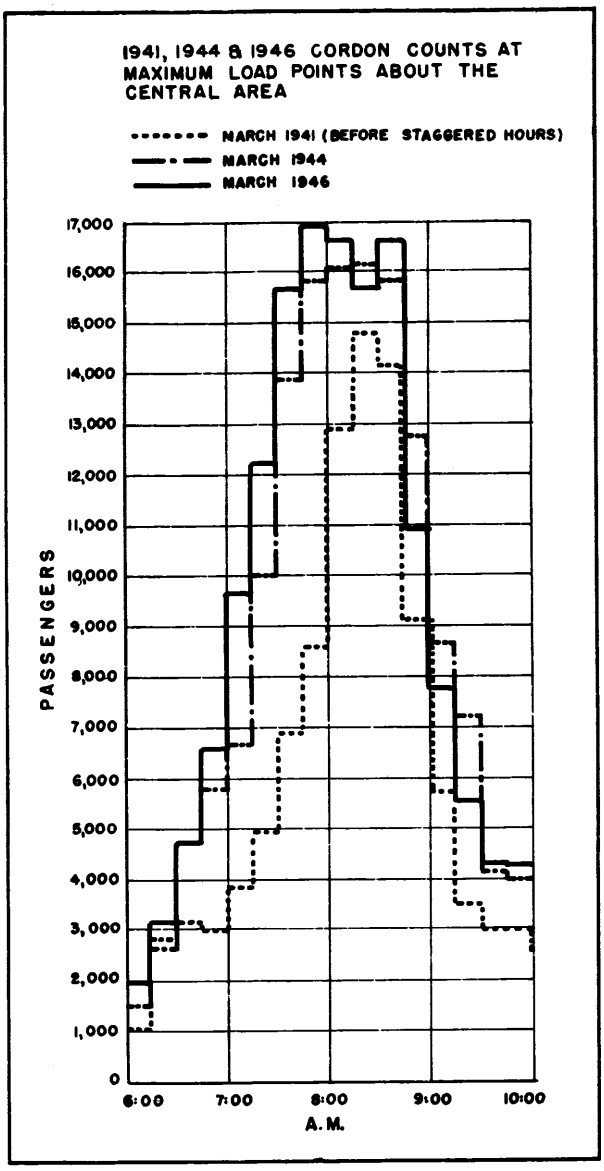


EXHIBIT 109

Transit cordon counts at maximum load points about the central business area showing the value of staggered hours in a large city.

passengers arriving at and departing from the establishment or group of establishments during each 15-minute period for at least an hour at each time of major shift changes.

One establishment or a group of adjacent establishments may be treated in the same manner. The working schedules and transit passenger data or vehicle volume data may be shown on the same chart.

Exhibits 108 and 109 show the value of and results achieved from staggered hours.

EXAMPLES OF APPLICATION

Example No. 1—Transit service was provided to two large industrial plants on the outskirts of a city. Even though the transit company was doing everything possible to meet the service demands from these two plants it was unable to provide sufficient equipment at the peak periods to avoid excessive overloading. The peak loads were the result of simultaneous work periods for the two plants. Studies revealed that a 15-minute difference in the closing period of the two plants would be equivalent to adding four new buses to handle the peak homebound workers. After several conferences with the plant personnel and proper publicity in the employee paper, the working periods of one of the plants was moved forward 15 minutes. Excessive overloading disappeared and so did service complaints.

Example No. 2—A staggered hour program was instituted in an eastern city during the war. It proved highly effective. When the war terminated, demands were immediately made from various groups in the community to drop the staggered hour program. The transit company foresaw what would happen and initiated a program to offset the demands. An important part of this program was publicity showing how the public was benefiting from staggered hours. Exhibit 110 shows one of the charts used in this public education program. To date the transit company has been able to keep staggered hours in effect in this community.

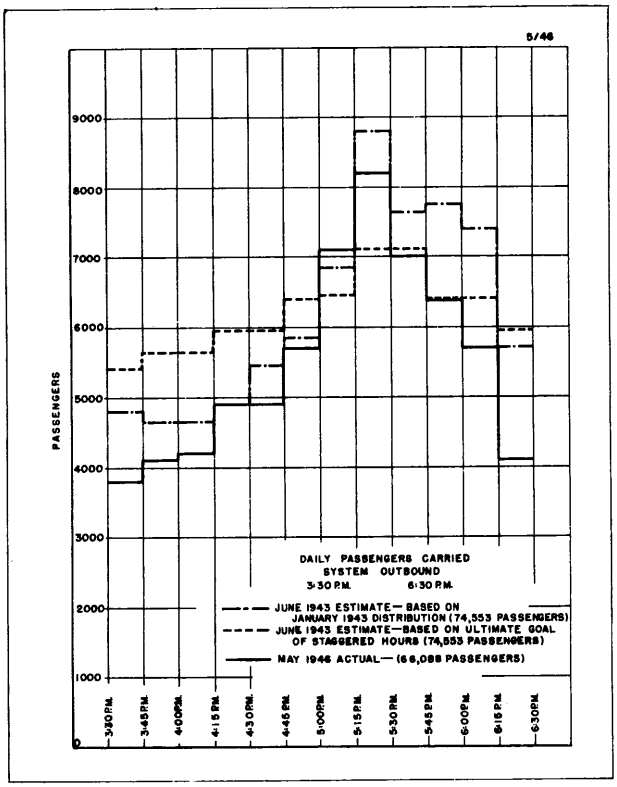


EXHIBIT 110

Daily outbound passengers carried on a large transit system before and with staggered hours. Fortunately, staggered hours are still in effect in this particular instance.

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