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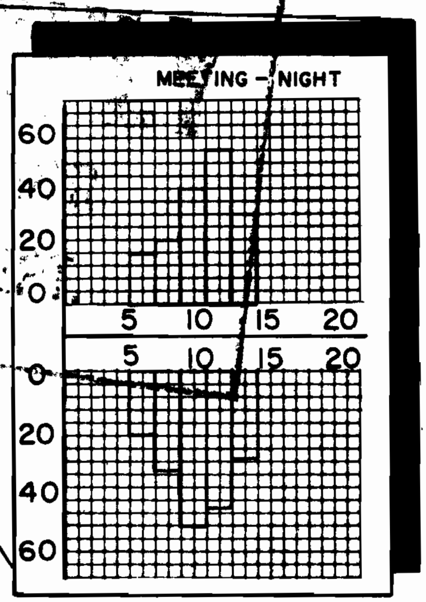
R.P-17

VEHICLE SPEED AND PLACEMENT SURVEY

ON TWO-LANE RURAL HIGHWAYS

RP 17(1)



PREPARED BY
TEXAS HIGHWAY DEPARTMENT
ROAD DESIGN DIVISION
MARCH, 1957

RP-17

VEHICLE SPEED AND PLACEMENT SURVEY
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This research was performed under the general direction of the Road Design Division and was made possible by the co-operation of the U. S. Bureau of Public Roads who furnished the measuring equipment used and also much expert advice and assistance through their representatives from the Headquarters, Regional and District Offices. The project was a co-ordinated effort of the Road Design Division, the Planning Survey Division and Field District Nos. 14 and 15.

The report has been reviewed by the Research and Development Committee of the Texas Highway Department and has been approved for release as an official publication.

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I. GENERAL OBJECTIVES

This study was conducted primarily to obtain facts about vehicle behavior under various conditions on two lane roads as a guide to formulating future design standards. In general the study was limited to traffic volumes that can reasonably be accomodated on two lanes. The results and findings should, therefore, be applicable only to those roads which are not overloaded.

The principal variables which can be studied on a two lane road are somewhat limited, being primarily lane width, shoulder width and shoulder type. Obtaining data in sufficient quantities to hold all but one feature constant while that one was studied was found to be somewhat difficult but a fair sample was possible in each case.

By studying the speed and lateral placement of vehicles, it was hoped to obtain basic data which could be applied in the design of future roads and to the maintenance and redesign of existing roads.

Correlation of some of these data with the results of the Western Association of State Highway Officials, Idaho Road Test makes possible certain structural design criteria while correlation with known accident data allows the development of safety standards. The application of placement in the development of safety standards is in lieu of adequate accident records, but since these are not now available, and since it is possible to associate placement data with the available accident records, it is felt that a reasonable standard can be arrived at.

II. SUMMARY OF FINDINGS

1. Speed was apparently not a factor in the elements studied.
2. Drivers are apparently influenced in their lateral placement more by the edge of the pavement than they are by the centerline of the road.
3. Shoulder width of three feet or more did not appear to affect the lateral placement of vehicles.
4. The type of shoulder had a definite affect on the lateral placement of vehicles. The higher the quality of construction, the closer to the shoulder traffic will drive.
5. Lateral placement appears to be a function of lane width. As lane width increases, traffic moves farther from the centerline but in a ratio of about three to one. For every foot of widening, the average placement moved three inches from the centerline and nine inches from the edge of the lane.
6. Vehicle encroachment across the centerline and on the shoulder is a definite problem. Encroachment on surfaced shoulders can be reduced considerably by providing good contrast between the pavement and the shoulder but even this will not prevent encroachment if the road is overloaded.
7. Trucks behaved about the same as passenger cars. Their overall average placement was a little closer to the edge of the pavement but with their greater width there was slightly less clearance to the centerline.
8. Encroachment on surfaced shoulders by trucks was very evident. This is probably brought about by a desire on the part of truckers to not obstruct traffic. They seem to drive on the shoulder so that faster passenger cars can get by them. This might be combatted by an informational campaign and by designing the shoulder so it does not appear to be a traffic lane.
9. There was not enough data on passing maneuvers to arrive at any definite conclusions in this study.

III. PREVIOUS RESEARCH

Four previous studies of the transverse position of vehicles on two-lane highways are listed below with an abbreviated summary of their conclusions.

1. "Influence of bridge width on transverse positions of vehicles" by W. P. Walker published in Highway Research Board, Volume 21, 1941, Page 361. Mr. Walker found that meeting vehicles require approximately 5 1/2 feet clearance and that free-moving vehicles allow a distance of from 6.2 to 7.4 feet from the right wheel to the curb on the bridge. From this, it was postulated that a bridge width of from 28' to 30' was required for a pavement of 22' with 6' shoulders. For a pavement of 22' the greatest width of bridge was found to be 30.6'. No analysis of the data was made in connection with the needs of truck traffic.

2. "Transverse Placement of Vehicles as related to cross section design" by A. Taragin printed in Highway Research Board, Volume 23, 1943, Page 343. This study was preliminary to a more complete study made by Mr. Taragin and he came to the following conclusions. Trucks stay closer to the edge than do passenger cars and do not shift as much when going from a free-moving to a meeting condition. An edge clearance of approximately 3' is required before added width will be utilized for clearance between meeting vehicles. On the basis of this information, a pavement width of less than 20' was found to be inadequate for even meeting passenger cars.

3. "Effect of Roadway width on traffic operations - Two Lane Concrete Roads" by A. Taragin published in Highway Research Board, Volume 24, 1944, Page 292. This is probably the most inclusive study made on this subject covering 95,000 vehicles at 47 different locations in 10 states.

The following conclusions were drawn:

1. Shoulder width in excess of 4' does not influence effective pavement width when there are no vertical obstructions.
2. Well maintained grass shoulders have the same effect on transverse position of vehicles as do well maintained gravel shoulders.
3. Bituminous treated shoulders 4' or more in width adjacent to 18 and 20 ft. pavements increase the effective surface width approximately 2 feet.
4. Lip curbs reduce the effective surface width approximately 1 foot on 20' pavements.
5. Use of the shoulder increases rapidly on pavements of less than 22'.
6. With even moderate volumes of mixed traffic hazardous conditions exist on pavements less than 22'.
7. Speeds of meeting vehicles are not reduced even though clearance is inadequate.
8. For desired clearances where commercial vehicles meet commercial vehicles, a pavement of 24' is required.

4. "Effect of Lane Width on traffic behavior for two-lane highways" by F. H. Scrivner published by the Texas Highway Department as Research Project # 5, August 1955.

   Conclusions from this survey were as follows:

   1. Distance from both the centerline of highway and outer edge of lane to centerline of vehicle increased as lane width increased.
   2. The probability of edge failure decreased as lane width increased.
   3. The probability of head-on collisions between meeting vehicles decreased as lane width increases.

4. During inadvertant three-lane operations, the probability of head-on collisions appears to decrease as lane width increases.
5. No correlation between speed and lane width was found.

IV. METHOD OF STUDY

The equipment used in obtaining the field data consisted of combination speed-meters and transverse placement detectors, described in detail in the April 1940 issue of PUBLIC ROADS.[1] This equipment was furnished and operated by the U. S. Bureau of Public Roads. (Figure 1)

Fig. 1

View of Lateral Placement and Speed Tapes With Recording Truck in the Background.

The speed-meters operated by use of pneumatic detectors that actuated a timing device which in turn recorded the speed of the vehicle on a moving paper tape. The speed was recorded by groups and for this survey there were twenty five groups with the upper and lower limits being open classifications.

[1] E. H. Holmes & S. E. Reymer "New Techniques in Traffic Behavior Studies" April 1940 Public Roads.

An electro-mechanical tape which actuated a recording device was used to record the transverse placement. This tape was separated so that most vehicles actuated only two pins on the recorder thus giving an accurate location of the vehicle.

The moving paper tapes used for recording were timed so that they moved past the pins at a constant rate. This made possible the classification of maneuvers by time spacing and also the matching of speed and placement for each vehicle. Manual notes were made on the paper tape for vehicles other than passenger cars and for the passing maneuver.

The truck containing the recording equipment was located well away from the road site and was hidden from view to as great an extent as was possible to avoid influencing driver behavior. The data was hand coded and transferred to punched cards for machine tabulation.

V. LOCATION AND DESCRIPTION OF SITES STUDIED

The study was conducted primarily in the Austin area. Some data from a study which dealt primarily with bridges was also included (Sites 50-A & 52-A). The locations of the study sites are shown in Figures 2 and 3. The locations were selected on the basis of providing data which would be uninfluenced by any but the factors under study. The sites were located on long tangents and at spots where no outside influence which might affect traffic behavior would be present. The ideal was not always achieved but in the majority of cases, the external influence was slight. Figure 4 is a tabulation of pertinent data for each site. Traffic volumes, except for Site 2, are within the normal range for two lane roads. The number of examples for each condition was smaller than desirable but the correlation of the data worked out well for the major factors studied. A complete tabulation of the findings for each site condition is included in the Appendixes and individual graphs will be inserted in the text. Photographs of each site are shown in Appendix 4.

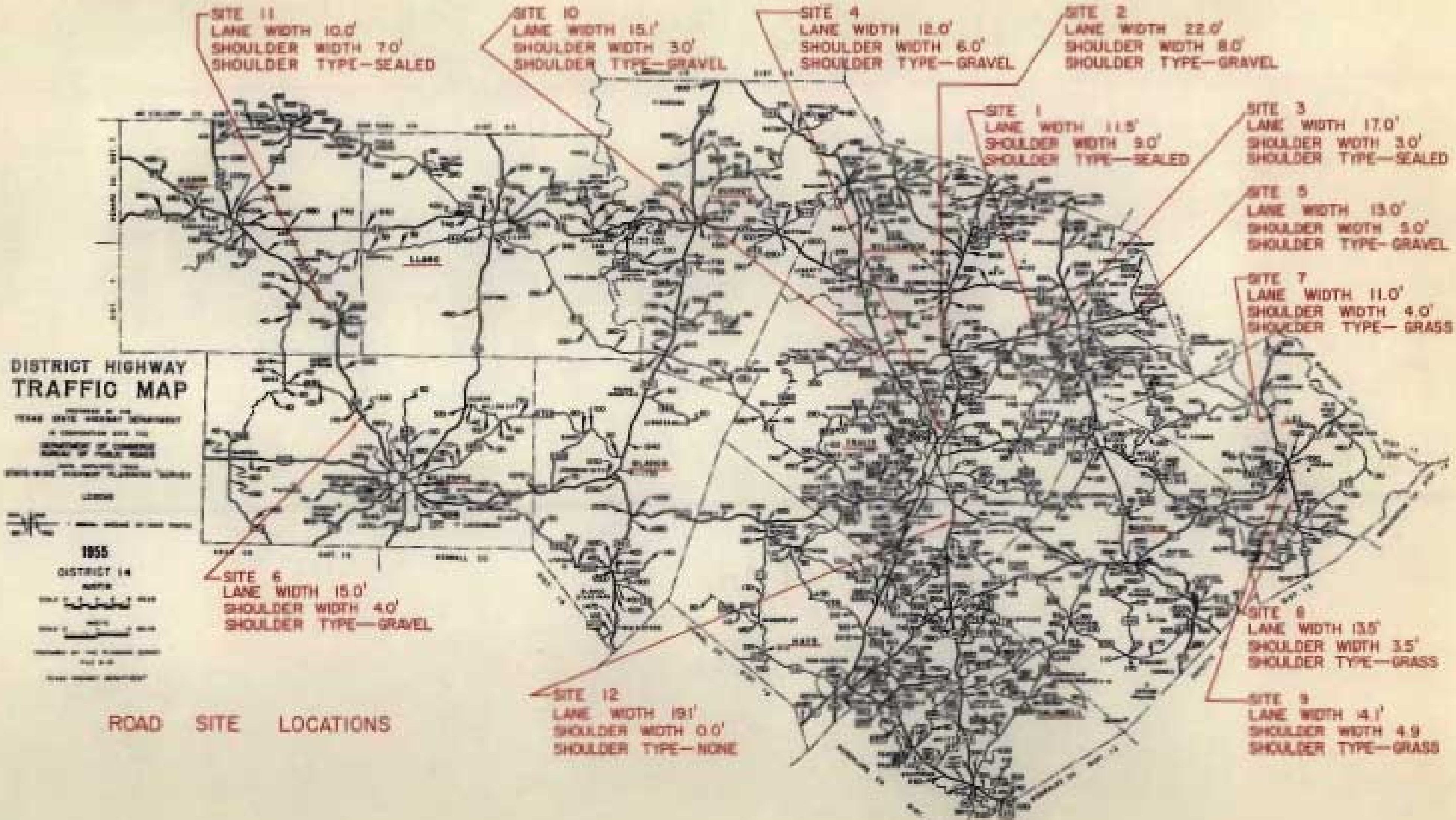

SITE 11
LANE WIDTH 10.0'
SHOULDER WIDTH 7.0'
SHOULDER TYPE—SEALED
SITE 10
LANE WIDTH 15.1'
SHOULDER WIDTH 3.0'
SHOULDER TYPE—GRAVEL
SITE 4
LANE WIDTH 12.0'
SHOULDER WIDTH 6.0'
SHOULDER TYPE—GRAVEL
SITE 2
LANE WIDTH 22.0'
SHOULDER WIDTH 8.0'
SHOULDER TYPE—GRAVEL
SITE 1
LANE WIDTH 11.5'
SHOULDER WIDTH 9.0'
SHOULDER TYPE—SEALED
SITE 3
LANE WIDTH 17.0'
SHOULDER WIDTH 3.0'
SHOULDER TYPE—SEALED
SITE 5
LANE WIDTH 13.0'
SHOULDER WIDTH 5.0'
SHOULDER TYPE—GRAVEL
SITE 7
LANE WIDTH 11.0'
SHOULDER WIDTH 4.0'
SHOULDER TYPE—GRASS
DISTRICT HIGHWAY
TRAFFIC MAP
LLANO
1955
DISTRICT 14
SITE 6
LANE WIDTH 15.0'
SHOULDER WIDTH 4.0'
SHOULDER TYPE—GRAVEL
SITE 8
LANE WIDTH 13.5'
SHOULDER WIDTH 3.5'
SHOULDER TYPE—GRASS
SITE 9
LANE WIDTH 14.1'
SHOULDER WIDTH 4.9
SHOULDER TYPE—GRASS
SITE 12
LANE WIDTH 19.1'
SHOULDER WIDTH 0.0'
SHOULDER TYPE—NONE
ROAD SITE LOCATIONS

Fig. 2

Fig. 3

ROAD SITE LOCATIONS

FIGURE 4

CHARACTERISTICS OF ROADWAY AND TRAFFIC AT OBSERVATION STATIONS 1-12, 50-A & 52-A

Observation Station No.	1	2	3	4	5	6	7	8	9	10	11	12	50-A	52-A
Lane Width (Feet)	11.5	22.0	17.0	12.0	13.0	15.0	11.0	13.5	14.1	15.1	10.0	19.1	12.0	12.0
Shoulder Width (Feet)	9.0	8.0	3.0	6.0	5.0	4.0	4.0	3.5	4.9	3.0	7.0	0.0	8.0	3.0
Type of Shoulder	Sealed	Gravel	Sealed	Gravel	Gravel	Gravel	Grass	Grass	Grass	Gravel	Sealed	-----	Sealed	Sealed
Color-Shoulder & Traffic Lane	Contrasting	Contrasting	Same	Contrasting	Contrasting	Contrasting	Contrasting	Contrasting	Contrasting	Contrasting	Same	-----	Contrasting	Contrasting
Total Vehicles Counted	2270	4298	2630	2593	2006	667	957	1329	1076	2219	621	2421	2031	1148
% Passenger Cars	88.7	77.0	89.1	89.8	83.1	68.1	82.0	80.7	78.3	85.6	76.8	85.1	82.2	78.3
% Trucks	8.4	20.1	8.4	8.8	14.3	24.4	15.8	14.8	18.4	11.2	19.5	12.3	15.7	17.4
% Buses	0.5	0.8	0.7	0.6	0.8	2.4	0.6	1.2	1.2	0.8	1.1	0.6	0.7	2.2
% Others	2.4	2.1	1.8	0.8	1.8	5.1	1.6	3.3	2.1	2.4	2.6	2.0	1.4	2.1
Night Vehicles Counted	455	1141	585	426	340	119	119	178	181	402	117	475	224	195
% Passenger Cars	87.7	64.7	88.5	95.8	85.3	65.5	81.5	80.9	70.2	88.8	64.1	85.9	78.6	76.9
% Trucks	10.5	32.9	9.4	3.5	12.3	29.4	18.5	16.3	26.0	9.2	30.8	13.1	19.6	20.0
% Buses	0.9	1.0	1.4	0.7	1.8	1.7	0.0	0.6	1.1	0.8	1.7	0.4	0.9	1.0
% Others	0.9	1.4	0.7	0.0	0.6	3.4	0.0	2.2	2.7	1.2	3.4	0.6	0.9	2.1
1955 Average Daily Traffic	2320	5670	2720	2680	2140	1330	1140	1450	1290	2000	1295	2930	3290	1800
County	Williamson	Williamson	Williamson	Travis	Williamson	Gillispie	Lee	Lee	Lee	Williamson	Mason	Travis	Bexar	Guadalupe
Highway No.	U. S. 79	U. S. 81	U. S. 79	U. S. 81	U. S. 79	U. S. 87	U. S. 77	U. S. 77	U. S. 77	U. S. 183	U. S. 87	U. S. 183	U. S. 181	S. H. 123
Control and Section	204-2	15-9	204-3	Business 15-11	204-4	71-6	211-3	211-4	211-4	151-5	71-5	152-1	100-2	366-2
Location	5.3 Mi. W. of S.H. 95	1.1 Mi.N. of U.S.79	3.2 Mi.W. of S.H.95	2.2 Mi.N. of U.S.183	1.0 Mi.E. of F.M.1331	1.6 Mi.S. of F.M.648	6.2Mi.N. of S.H.21	3. Mi.N. of U.S.290	1.1 Mi.N. of F.M.1624	0.7 Mi.S.of F.M.1328	8.6 Mi.N. of Gillespie C.L.	1.7 Mi.S. of S.H.71	0.5 Mi.N.W. of Wilson C.L.	1.8 Mi. S. of Hays C.L.

VI. STUDIES MADE

Speed

Speed studies were made at each of the sites and the data plotted as a cumulative speed curve, showing the 85 percentile speed for passenger cars and trucks. These curves are shown in Appendix 3. All speeds fell within the normal range for the conditions studied. The 85 percentile speed for passenger cars ranged from 59 to 69 miles per hour and from 45 to 59 for trucks. There does not appear to be a significant correlation between speed and the factors studied.

Lateral Placement

A number of interesting relationships regarding placement were found. Bar charts showing vehicle placements for free-moving and meeting passenger cars and trucks were prepared for both day and night conditions and are shown in Appendix 1. These charts show the average placement for each condition and the percent of vehicles encroaching on the shoulder and across centerline of road.

These Bar Charts provide most of the basic data which was used in developing the average placement relationships and from which the conclusions were drawn.

In plotting the average placement against various width factors such as centerline of road, edge of lane and edge of shoulder, it was found that the best correlation resulted when the distance from the center of the vehicle to the outer edge of the lane was plotted against lane width. This was somewhat contrary to expectations and from it, we must conclude that the driver is influenced more in selecting his lateral position by the edge of the lane than he is by the centerline of the road. These relationships have been plotted and are shown in Appendix 2.

Shoulder Width and Type

Several attempts were made to correlate placement to shoulder width without success. Since this study did not include any shoulders less than three feet in width, we can say that shoulders three feet wide or wider do not affect placement. There is undoubtedly some width of shoulders, less than 3 feet, that would have a definite affect on vehicle placement but it was not within the scope of this study to determine the exact width. The type of shoulder has a very definite affect on the lateral placement of vehicles. This is illustrated in Figure 5 which is a series of curves averaged from the data in Appendix 1. Here is shown the relationship between vehicle placements for free-moving-daylight conditions, which are the most representative, for the various types of shoulder. As the type of shoulder is improved, traffic drives closer to it. Gravel shoulders encourage traffic to travel closer to the edge than do grass, while surfaced shoulders have an even greater effect. It should be noted that all placements for grass shoulders lie closer to the centerline of the road than to the edge. A vehicle is centered in an eleven foot lane with gravel shoulders and is centered in a thirteen foot lane with a surfaced shoulder.

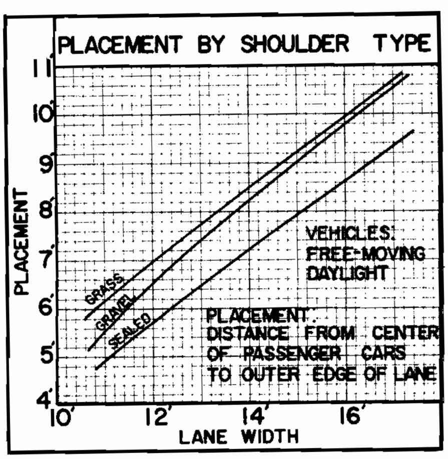


Fig. 5

Lane Width

The relationship between lane width and vehicle placement is shown in Figures 6, 7 and 8. These are average curves taken from the plottings shown in

Appendix 2. The figures show, by the shape of the data lines, that as the pavement is widened the vehicles move out, but for each foot added to the lane, vehicles move an average of three inches from the centerline and nine inches from the edge of the pavement or in a ratio of about 1 to 3. All indications are that no matter how much the pavement is widened, the vehicles

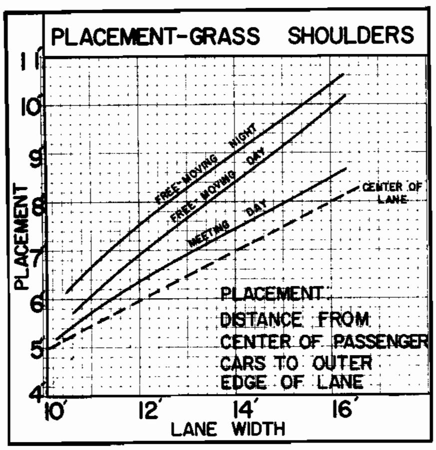


Fig. 6

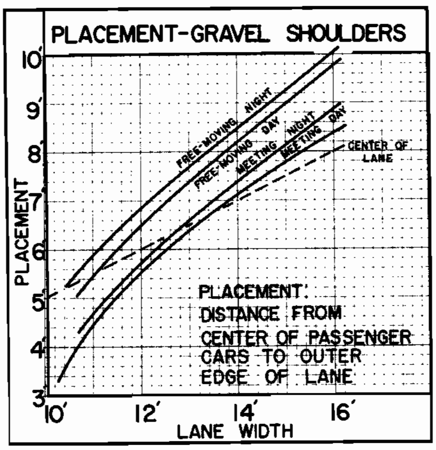


Fig. 7

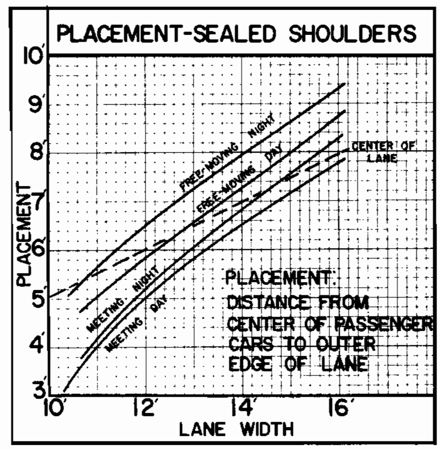


Fig. 8

would continue to move out, staying somewhere near the center of the lane. This can undoubtedly be carried too far both economically and from a safety standpoint. Figure 9[2] shows the accident rates for two lane pavements of various widths. The rates indicate a definite decrease up to a 23 foot pavement. Between 23 and 29 feet, they are somewhat erratic and start back up for pavement wider than 29 feet. This would indicate that the safest lane width is somewhere between 11.5 and 14.5 feet. None of these factors are conclusive within themselves, but taken together they make a rather strong case for a 13 foot lane with eight foot surfaces shoulders. Figure 10 shows the typical placement range for this type pavement. Adequate clearance between meeting vehicles is provided for both passenger cars and trucks; the lane width falls

[2]Rates were compiled by the Traffic Engineering Section of the Division of Maintenance Operations and included all two lane roads in Texas for 1955.

in that range found to have the lowest accident rate and the vehicles tend to center themselves in the lane, thereby making full use of the available facility.

One very important feature in connection with surfaced shoulders, however, must not be overlooked. If they are to function as a shoulder and are not to be considered by the motorist as a part of a very wide lane, a good contrast of color and width should be maintained between the shoulder and the lane. Also, the surfaced shoulder should have sufficient slope to render it uncomfortable to use as a driving lane but still safe for emergency use. It is believed that a slope of three quarters of an inch per foot would accomplish this result.

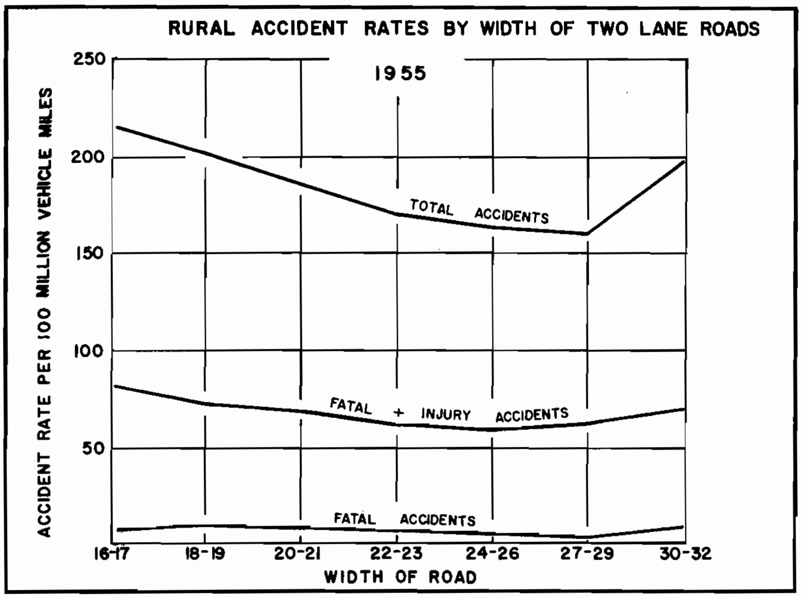


Fig. 9

Encroachment Across Center-Line and on Shoulder

Considerable encroachment on both the shoulder and across the centerline was found. The percentage at the various sites is shown in Figure 11. Several attempts were made to correlate this data, but no consistent relationship was found. Several things are evident from the figures. Encroachment by meeting vehicles on both the shoulder and across the centerline is less than that for free-moving vehicles and is less at night than in the daylight. This could probably be taken to indicate that drivers are more alert when meeting and are consciously placing their vehicle in the lane. Figures 6, 7 and 8 show that meeting vehicles drive on an average of one foot closer to the edge than do non-meeting vehicles.

The percentage of encroachment on the shoulder was considerably higher where shoulders were surfaced. This is to be expected, expecially since some of the surfaced shoulders studied did not contrast greatly with the pavement on the travel lane, and drivers could see little reason for not driving on them when it suited their purpose. An interesting relationship in connection with this is shown in Figure 12. This graph shows the average placement for free-moving passenger cars for each of the sites studied plotted against traffic volume. It indicates a definite trend to a placement nearer the edge of the pavement as volume increases. This was true regardless of lane width, shoulder width and shoulder type.

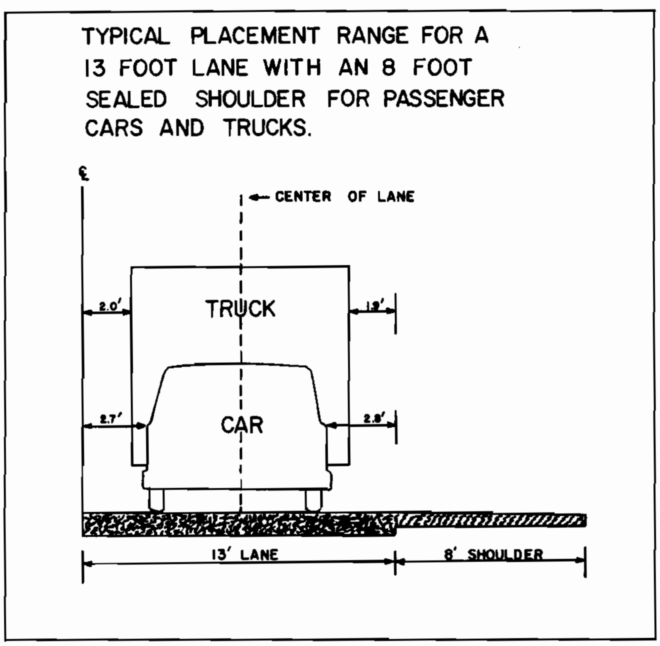


Fig. 10

Encroachment can undoubtedly be reduced by making the shoulder less attractive to drive on by providing distinct contrast in both color and texture; however, from Figure 12, it seems likely that an overloaded condition on the road will result in encroachment regardless of the contrast and that four lane operation will nearly always result where the shoulder is surfaced and traffic volumes are great enough that they cannot be efficiently accommodated on a two lane road.

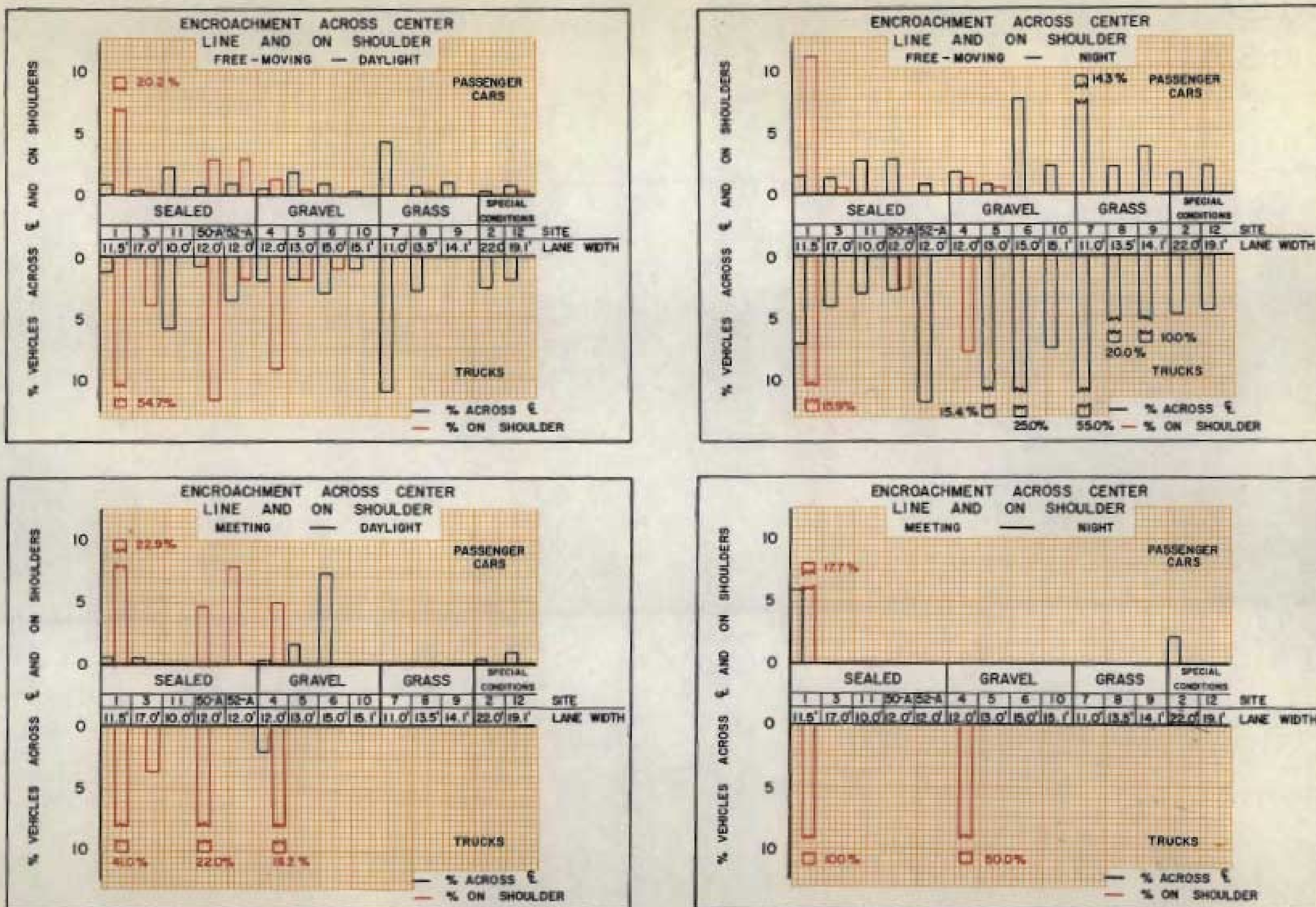
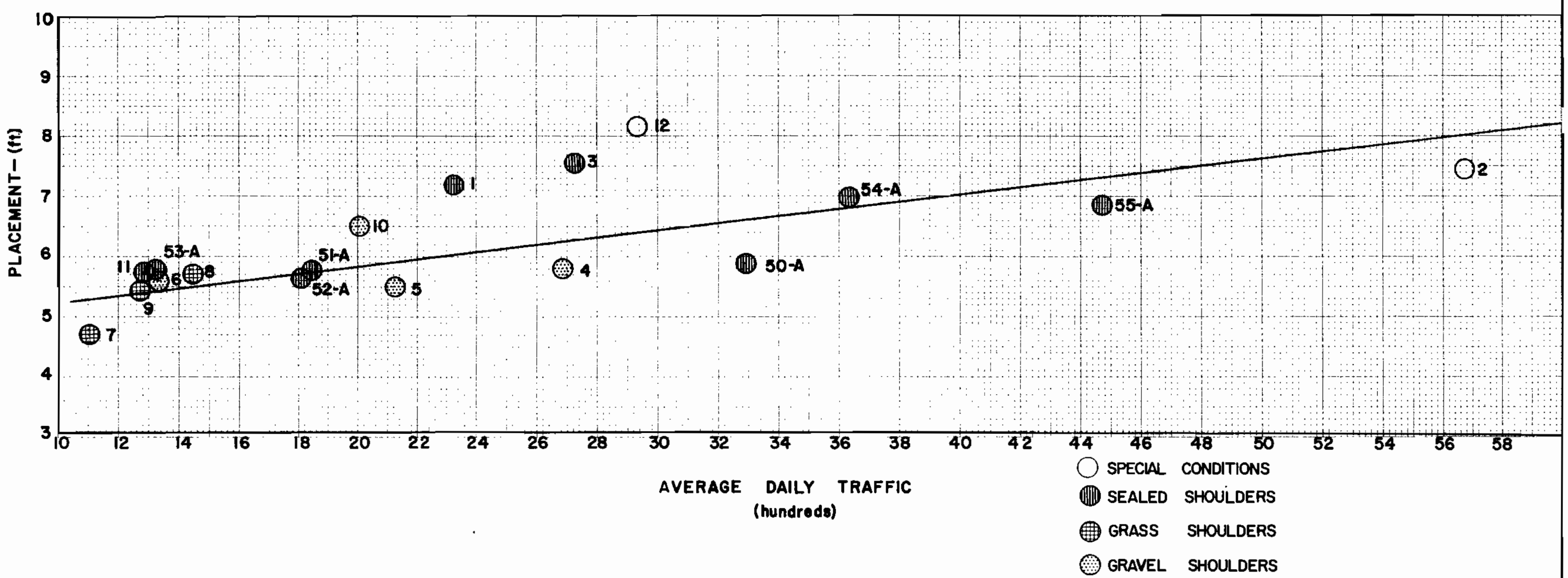

ENCROACHMENT ACROSS CENTER LINE AND ON SHOULDER
FREE-MOVING — DAYLIGHT
FREE-MOVING — NIGHT
MEETING — DAYLIGHT
MEETING — NIGHT
PASSENGER CARS
TRUCKS
% VEHICLES ACROSS ℄ AND ON SHOULDERS
SEALED
GRAVEL
GRASS
SPECIAL CONDITIONS
SITE
LANE WIDTH
1 3 11 50-A 52-A 4 5 6 10 7 8 9 2 12
11.5' 17.0' 10.0' 12.0' 12.0' 12.0' 13.0' 15.0' 15.1' 11.0' 13.5' 14.1' 22.0' 19.1'
— % ACROSS ℄
— % ON SHOULDER
20.2%
54.7%
14.3%
15.9%
15.4%
25.0%
55.0%
20.0%
100%
22.9%
41.0%
22.0%
18.2%
17.7%
100%
50.0%

Figure 11

AVERAGE DAILY TRAFFIC VS. PLACEMENT



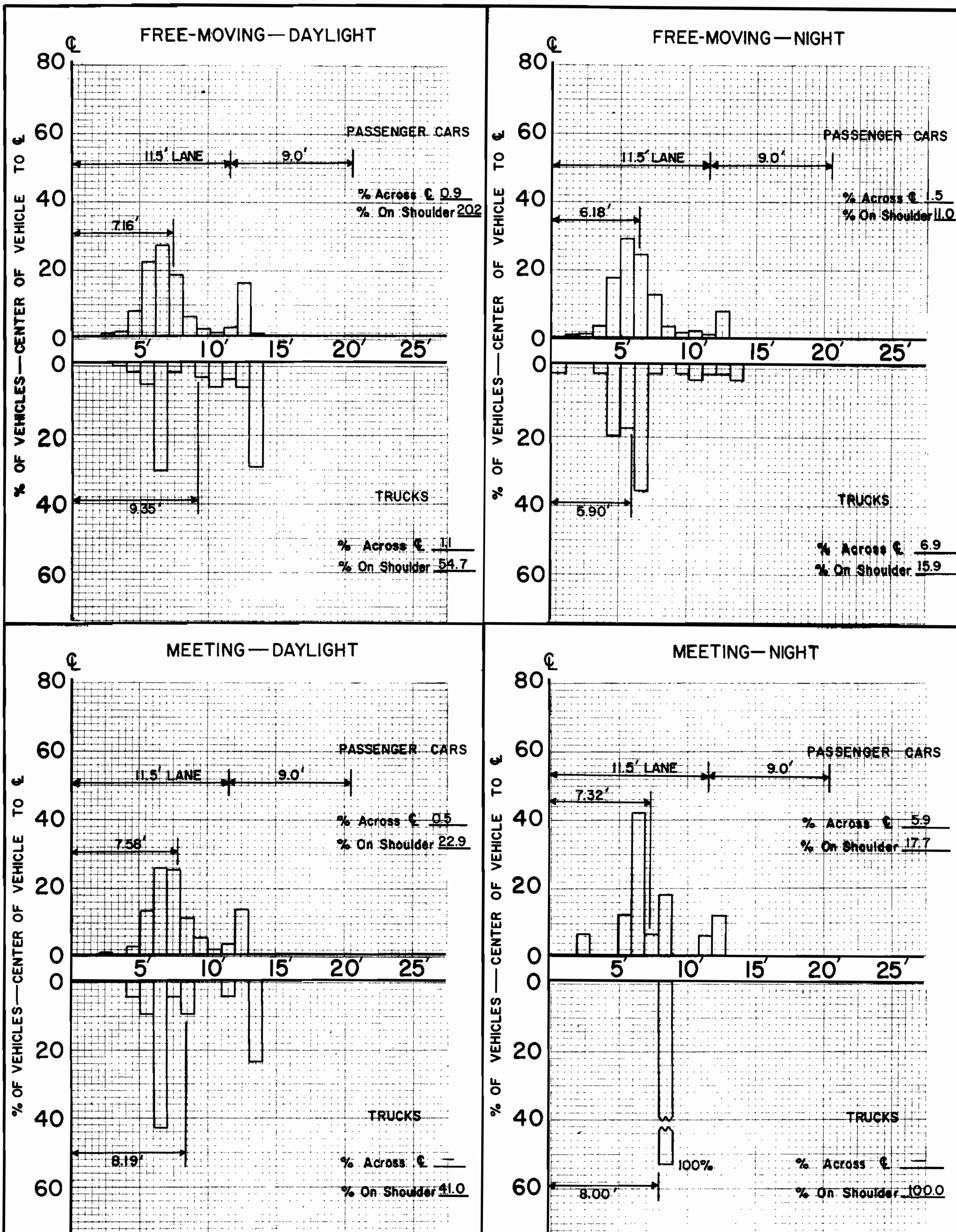
VEHICLES– Free-Moving Passenger Cars in Daylight
PLACEMENT–Center of Vehicle to ℄ of Highway

Figure 12

Trucks

As can be seen from Figure 4, a considerable number of trucks were included in the study. Placement Graphs for trucks are shown in Appendix 2. This data was somewhat more erratic than for passenger cars, but the general trend was very similar to that for passenger cars. Trucks appeared to drive a little closer to the edge of the pavement, especially on extra wide pavements, probably because they try to stay out of the way of faster moving vehicles.

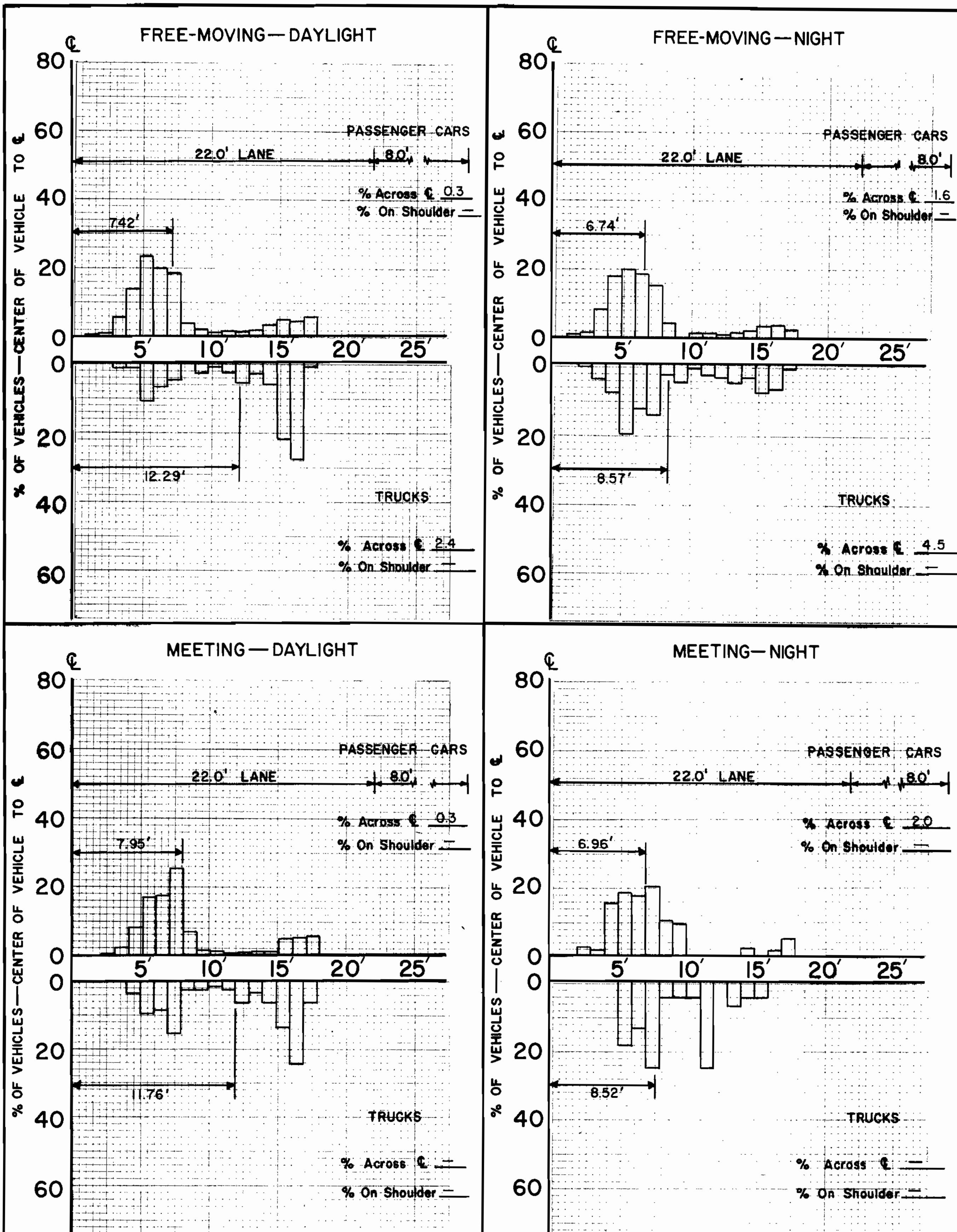
VII APPENDIXES



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

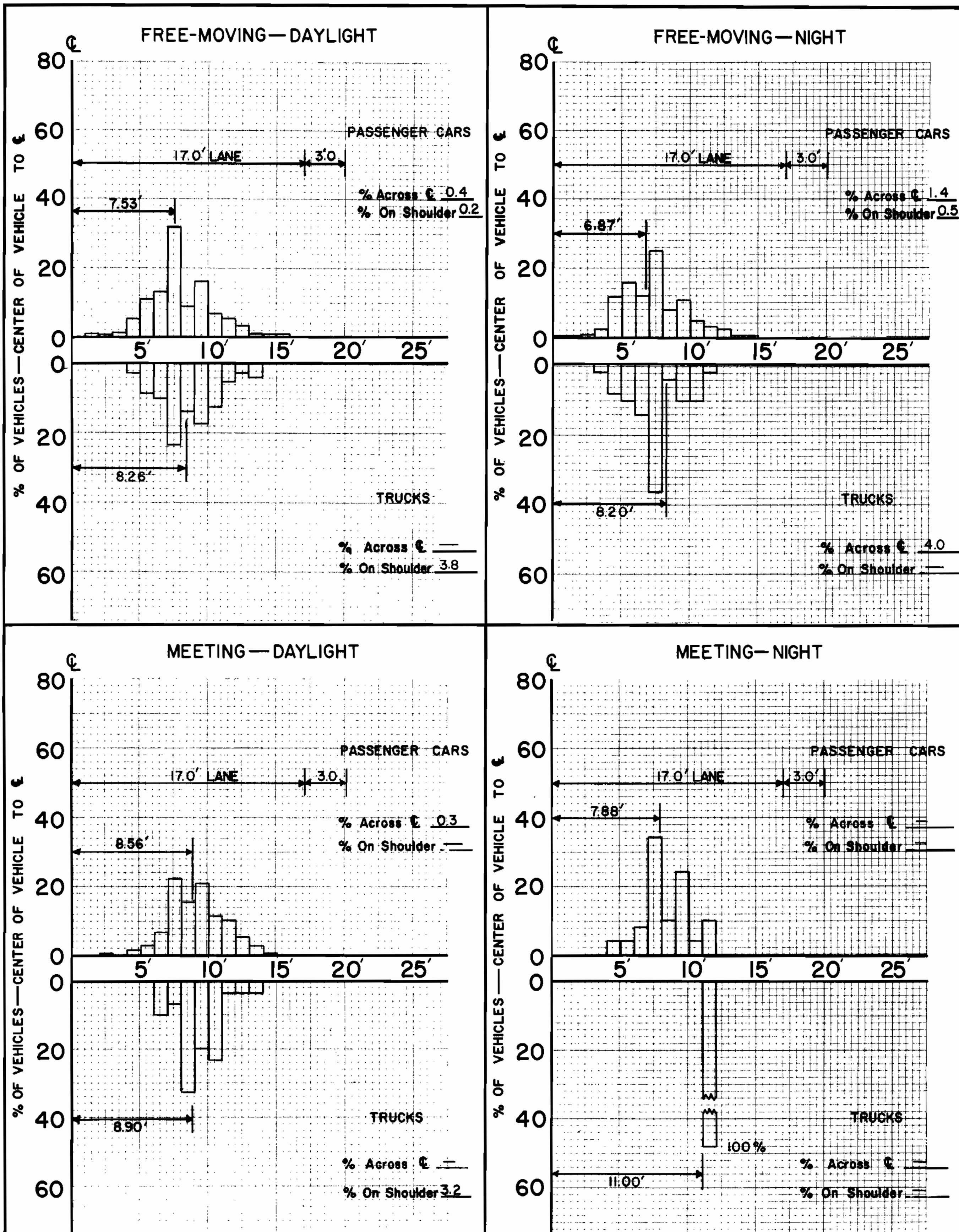
SITE 1
APPENDIX I PAGE I
PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS	SITE 2 APPENDIX I PAGE 2 PLACEMENT BAR CHARTS

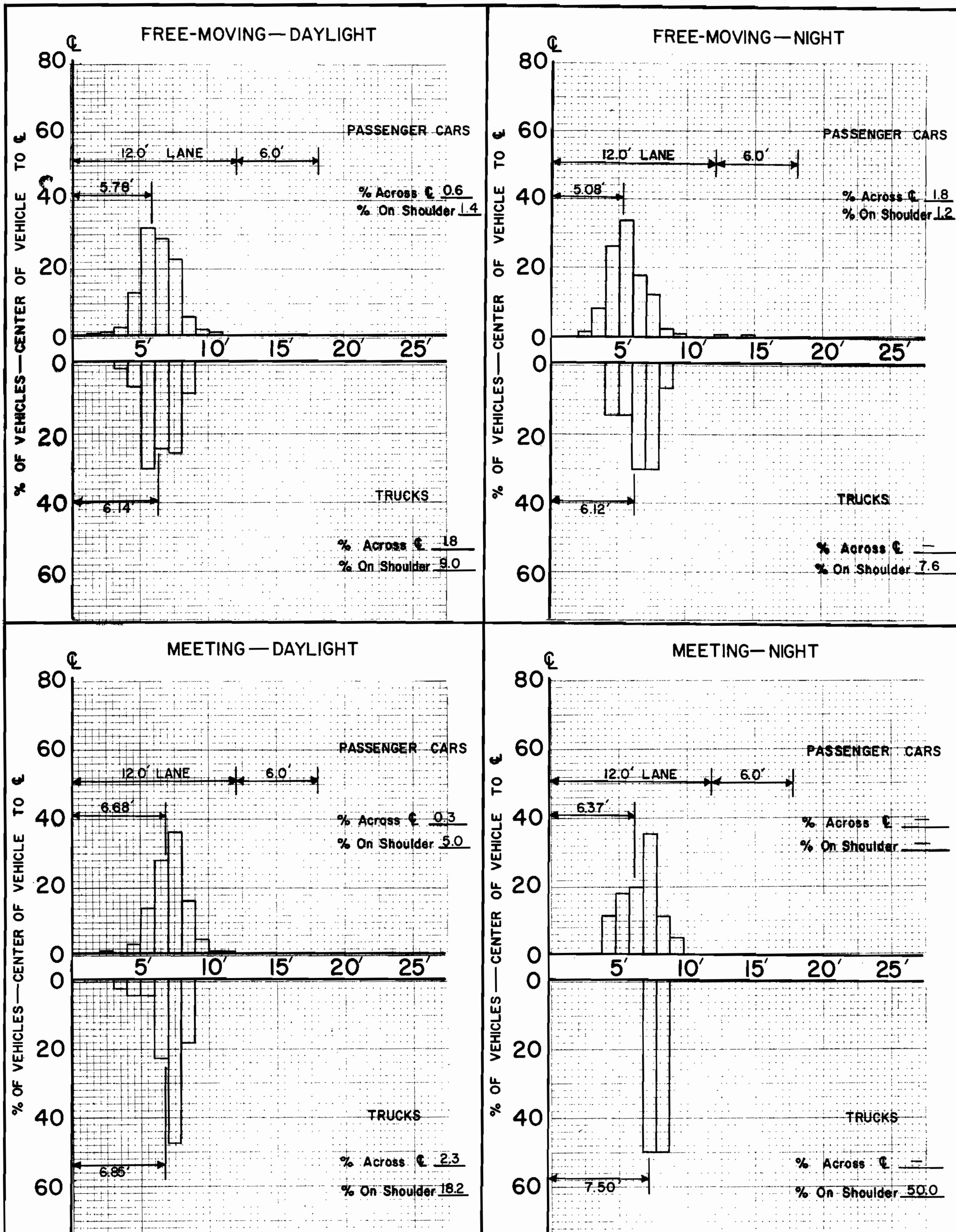
Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 3
APPENDIX I PAGE 3
PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

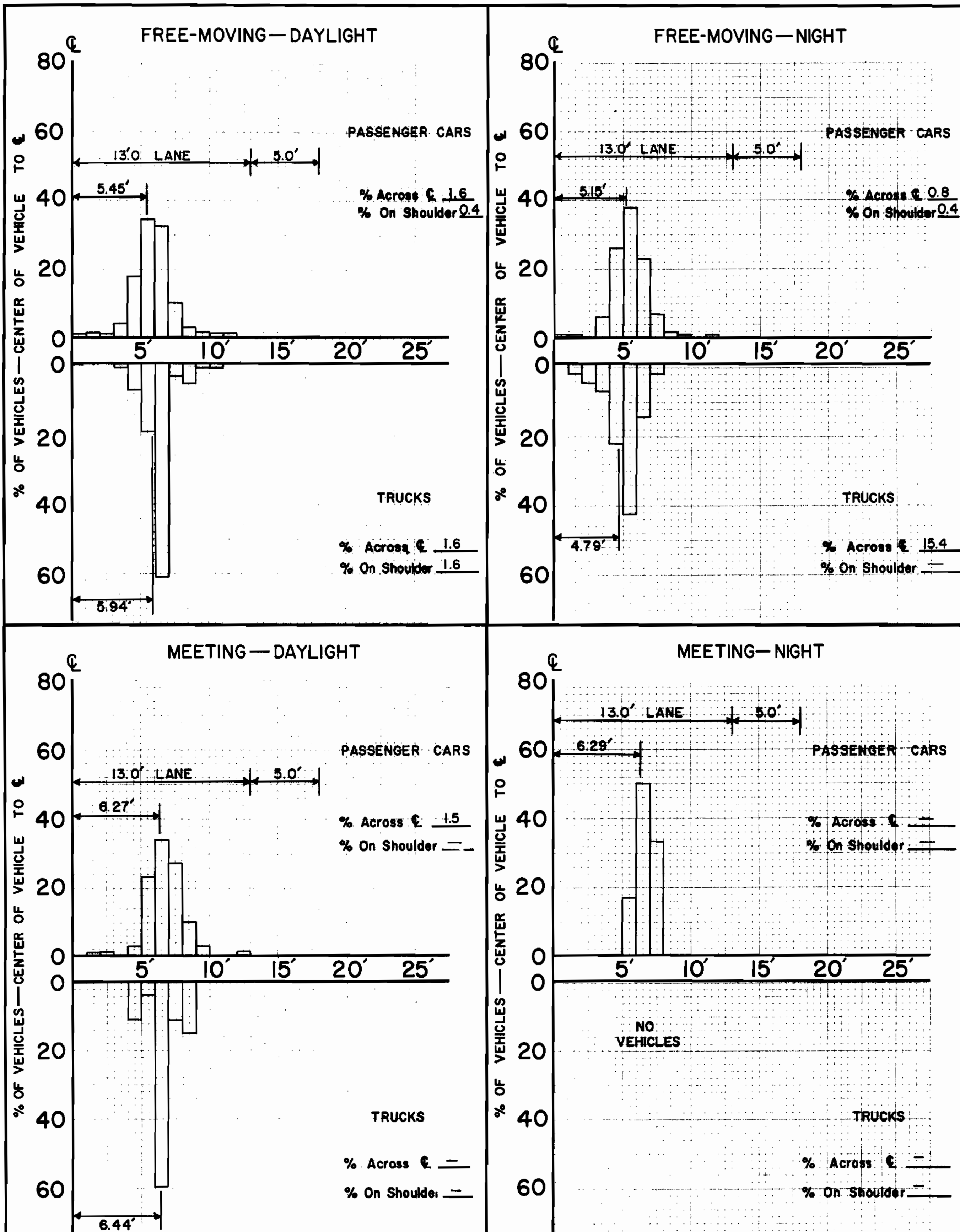
SITE 4

APPENDIX I PAGE 4

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department

March 1957



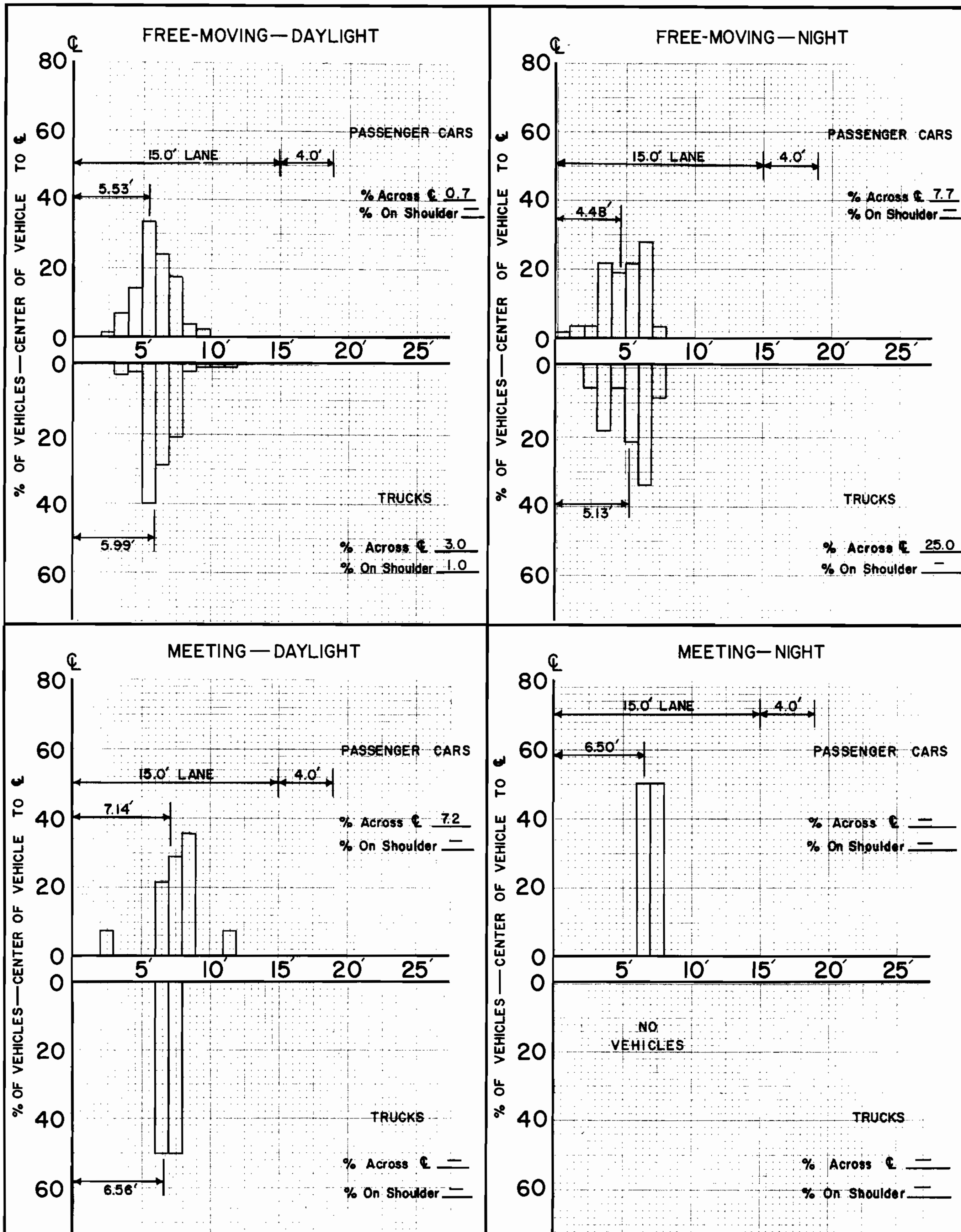
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 5

APPENDIX I PAGE 5

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



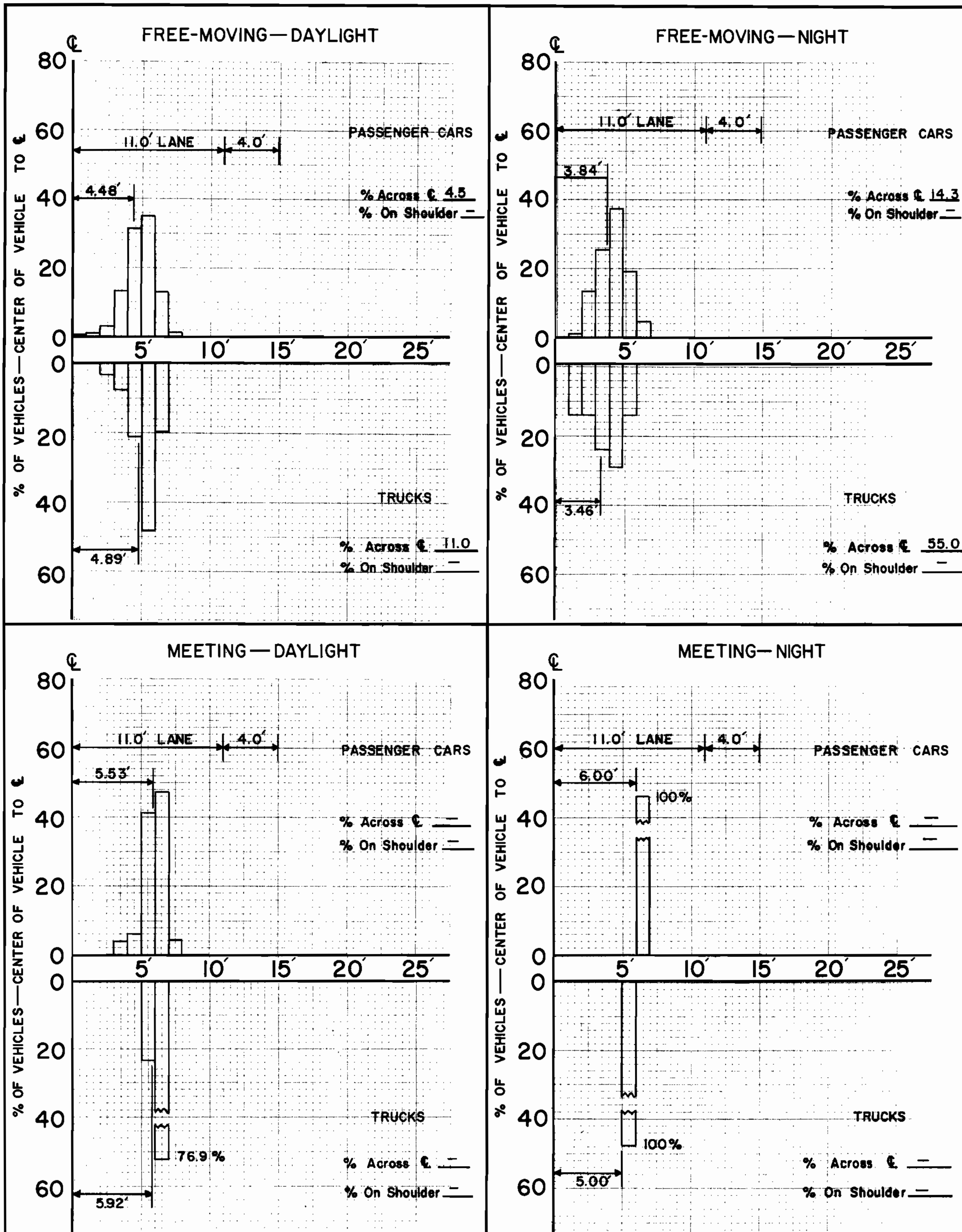
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 6

APPENDIX I PAGE 6

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



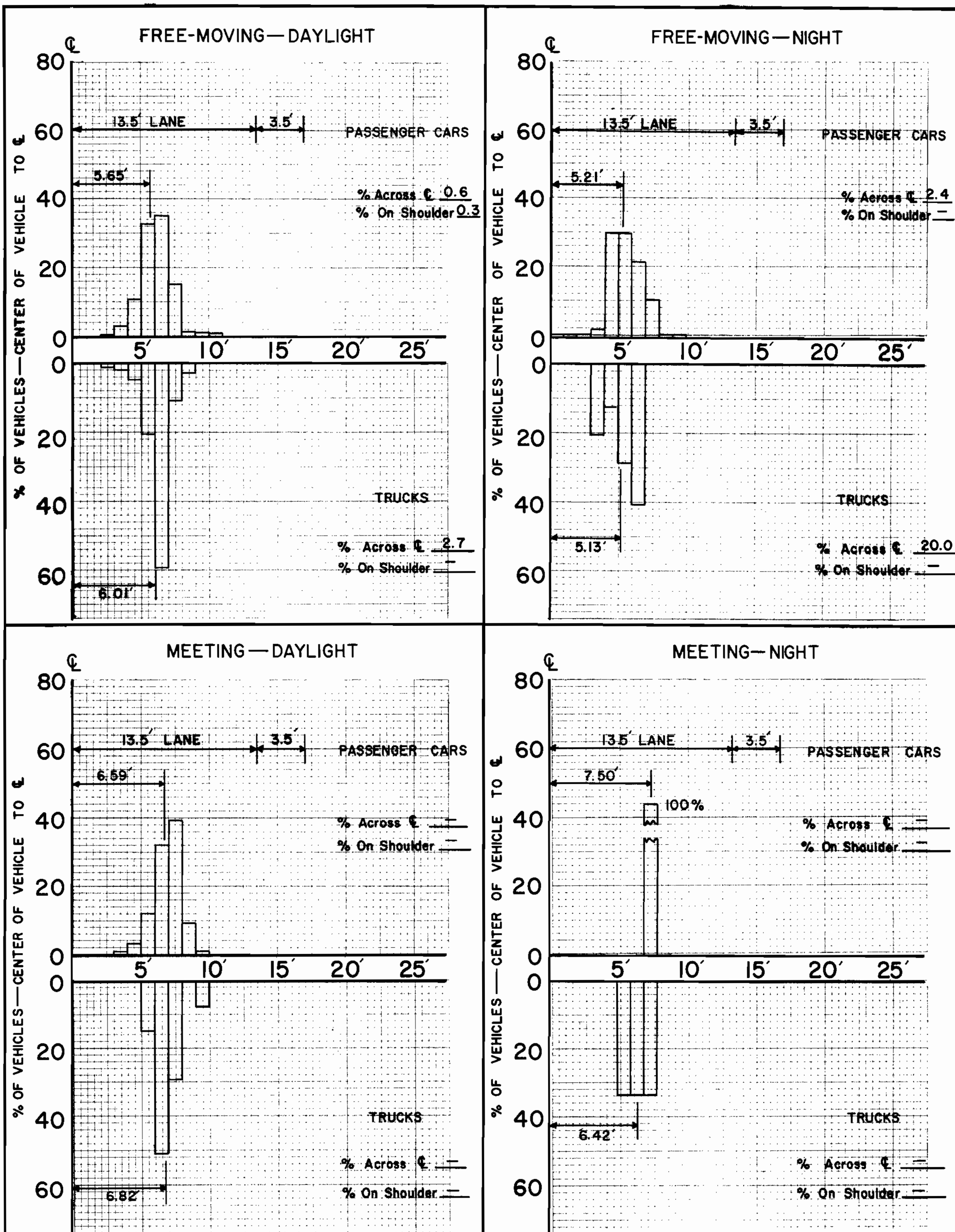
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 7

APPENDIX I PAGE 7

PLACEMENT BAR CHARTS

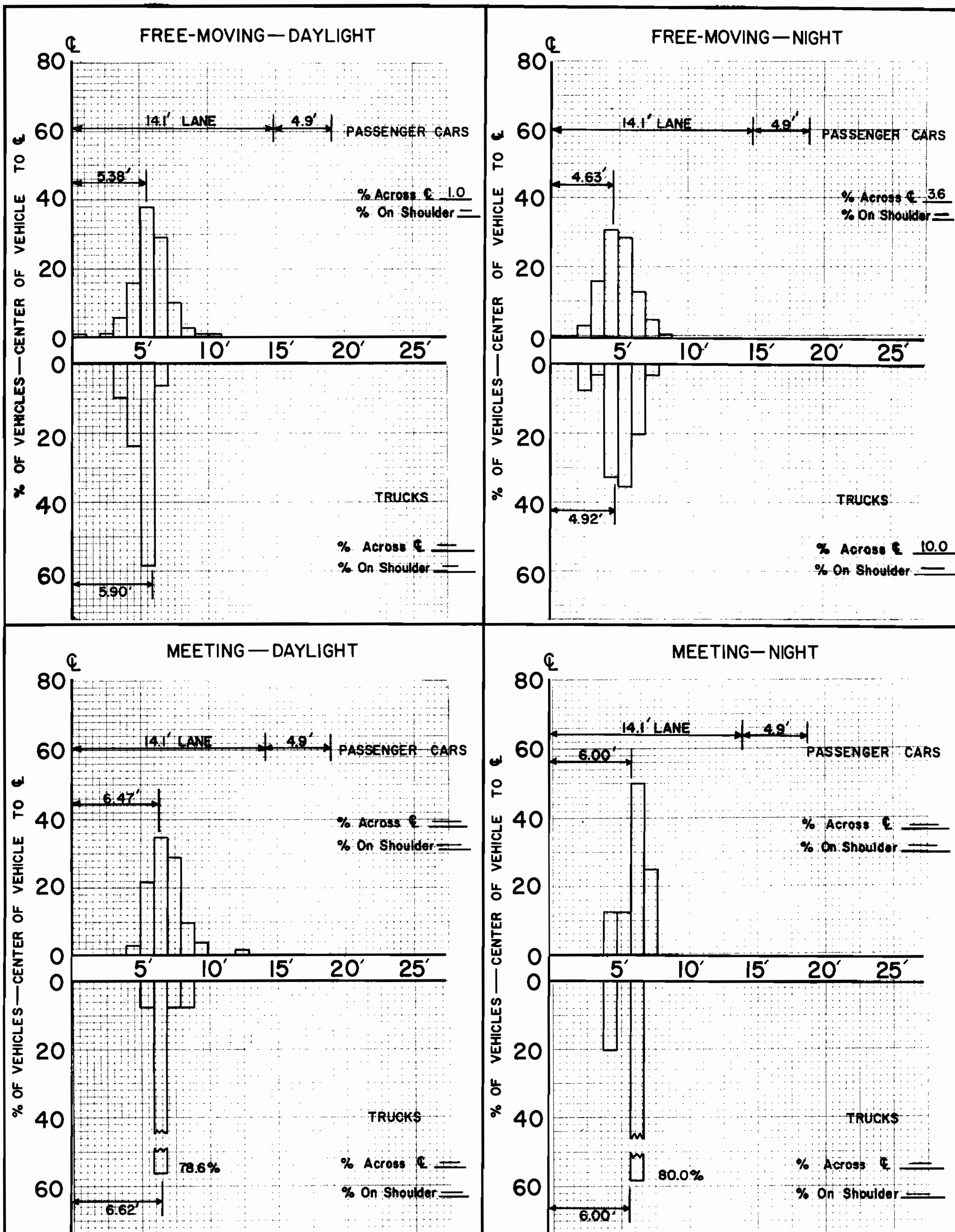
Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE
RURAL HIGHWAYS IN TEXAS

SITE 8
APPENDIX I PAGE 8
PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



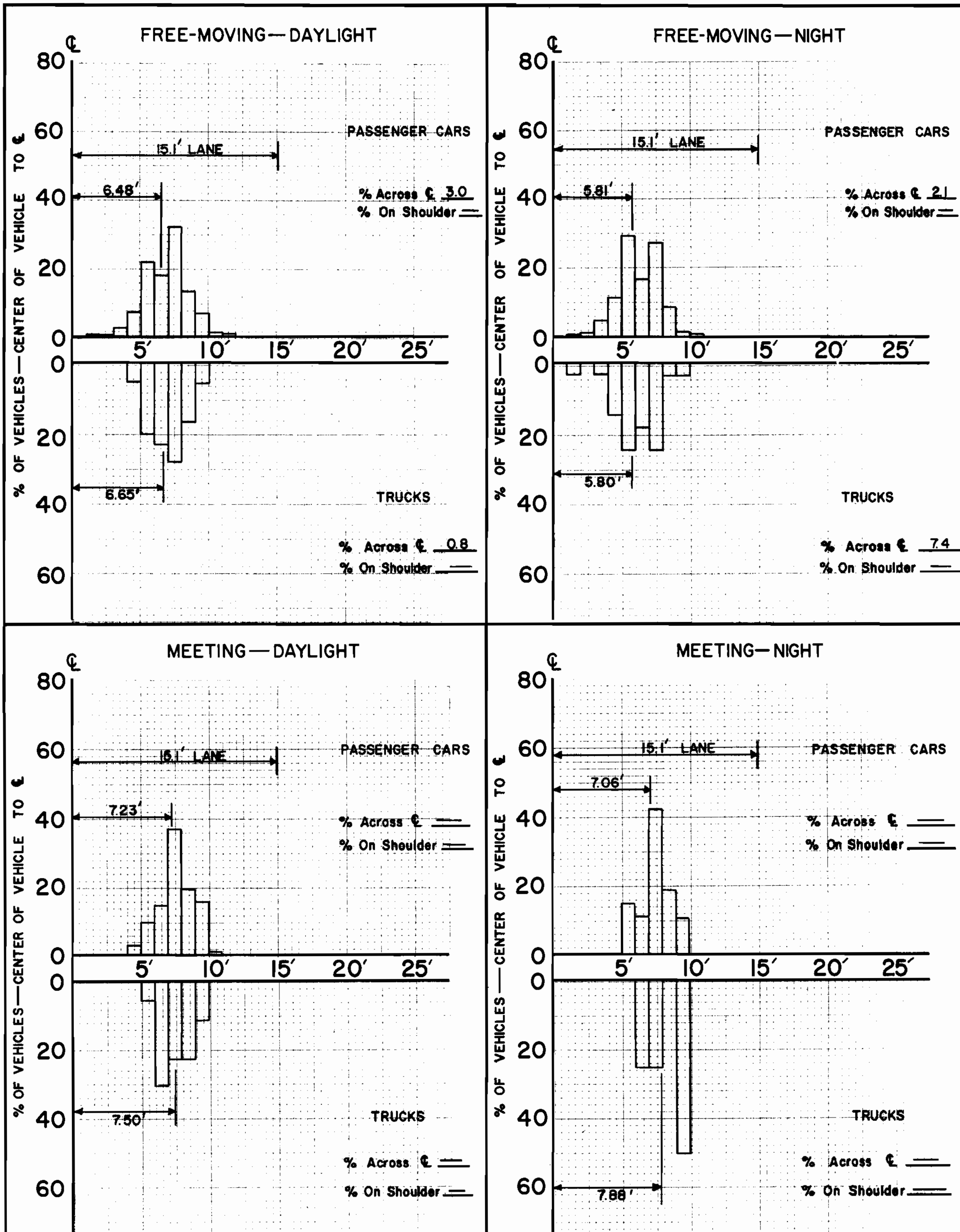
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 9

APPENDIX I PAGE 9

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

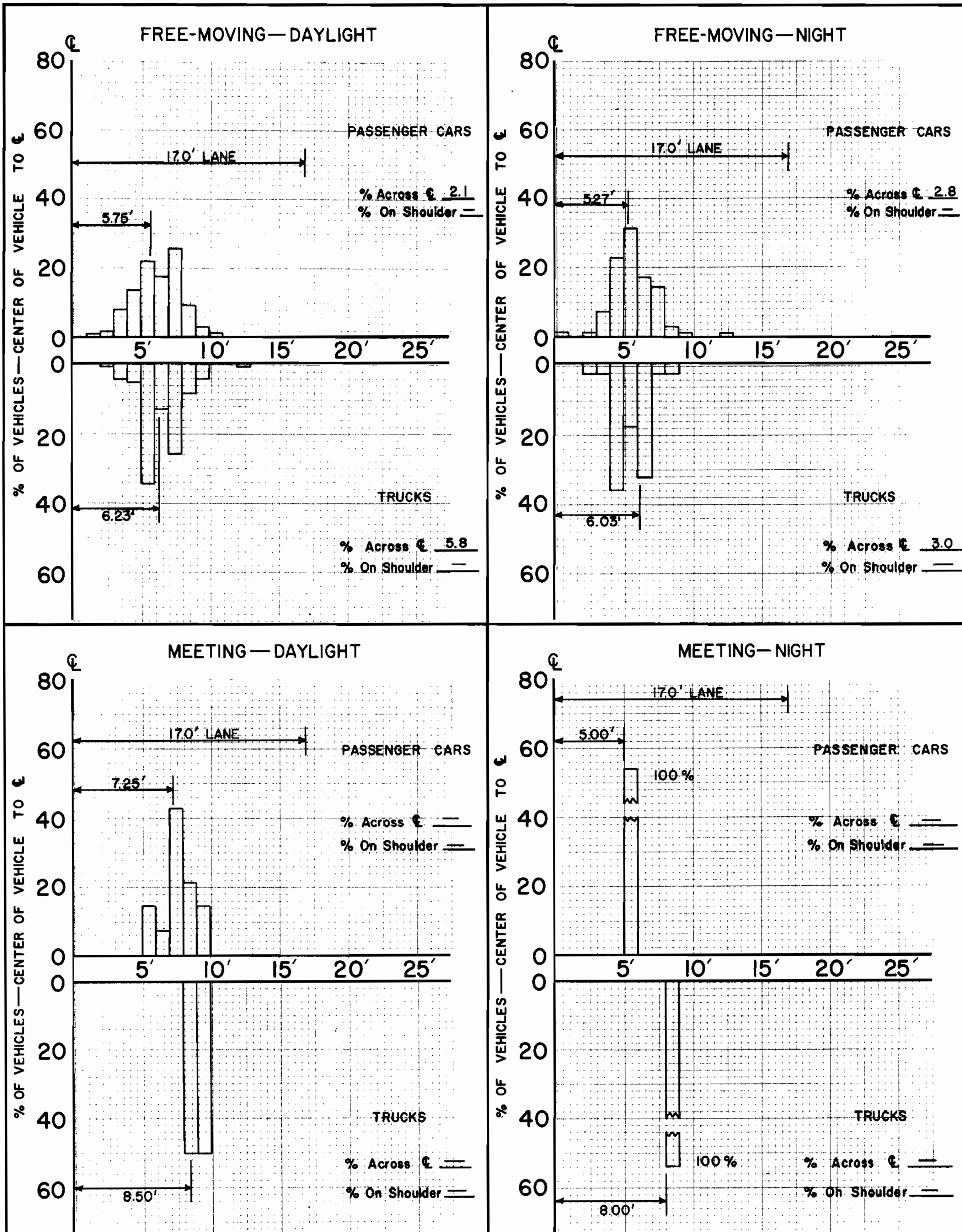
Road Design Division Texas Highway Department

SITE 10

APPENDIX I PAGE 10

PLACEMENT BAR CHARTS

March 1957



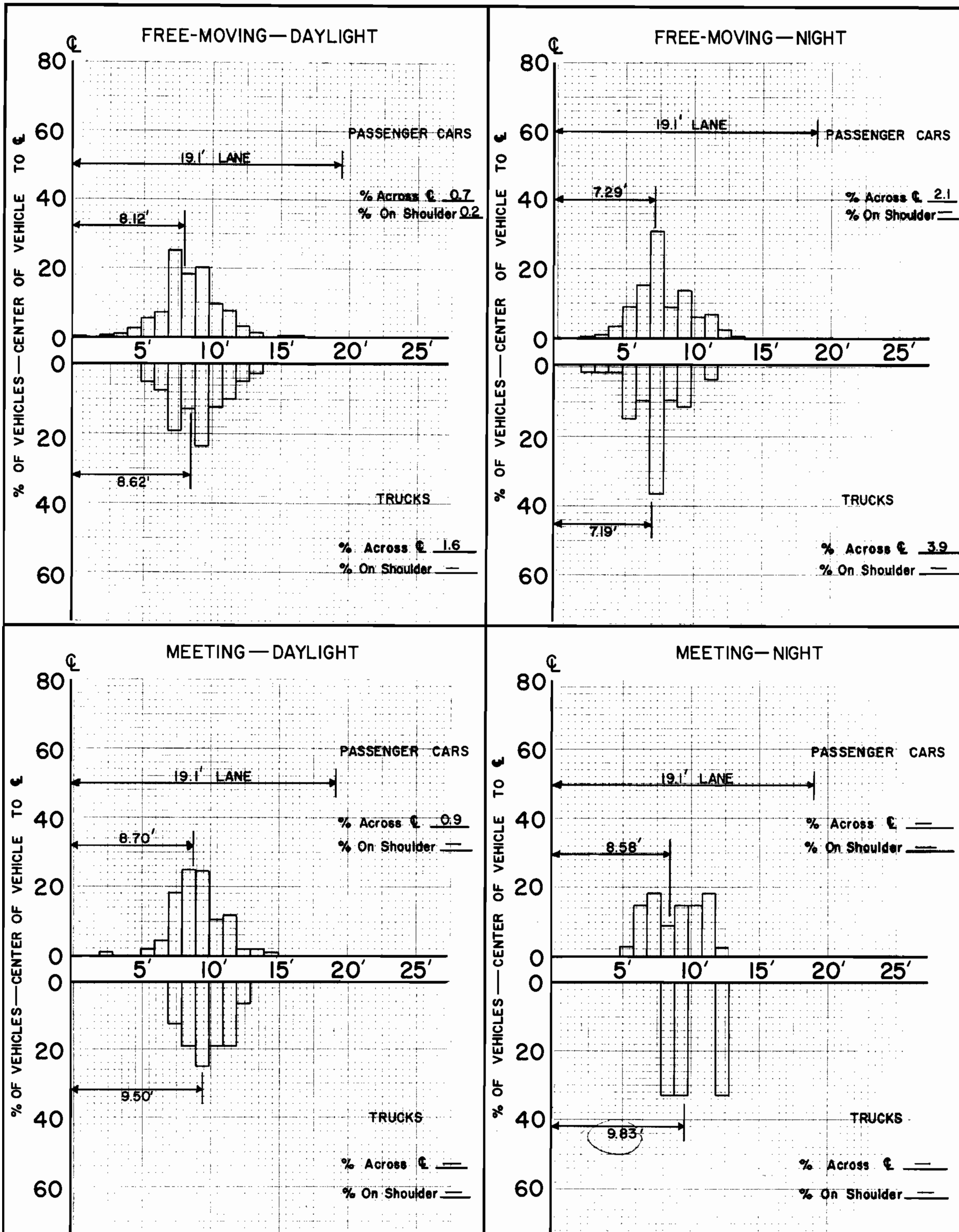
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 11

APPENDIX I PAGE 11

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



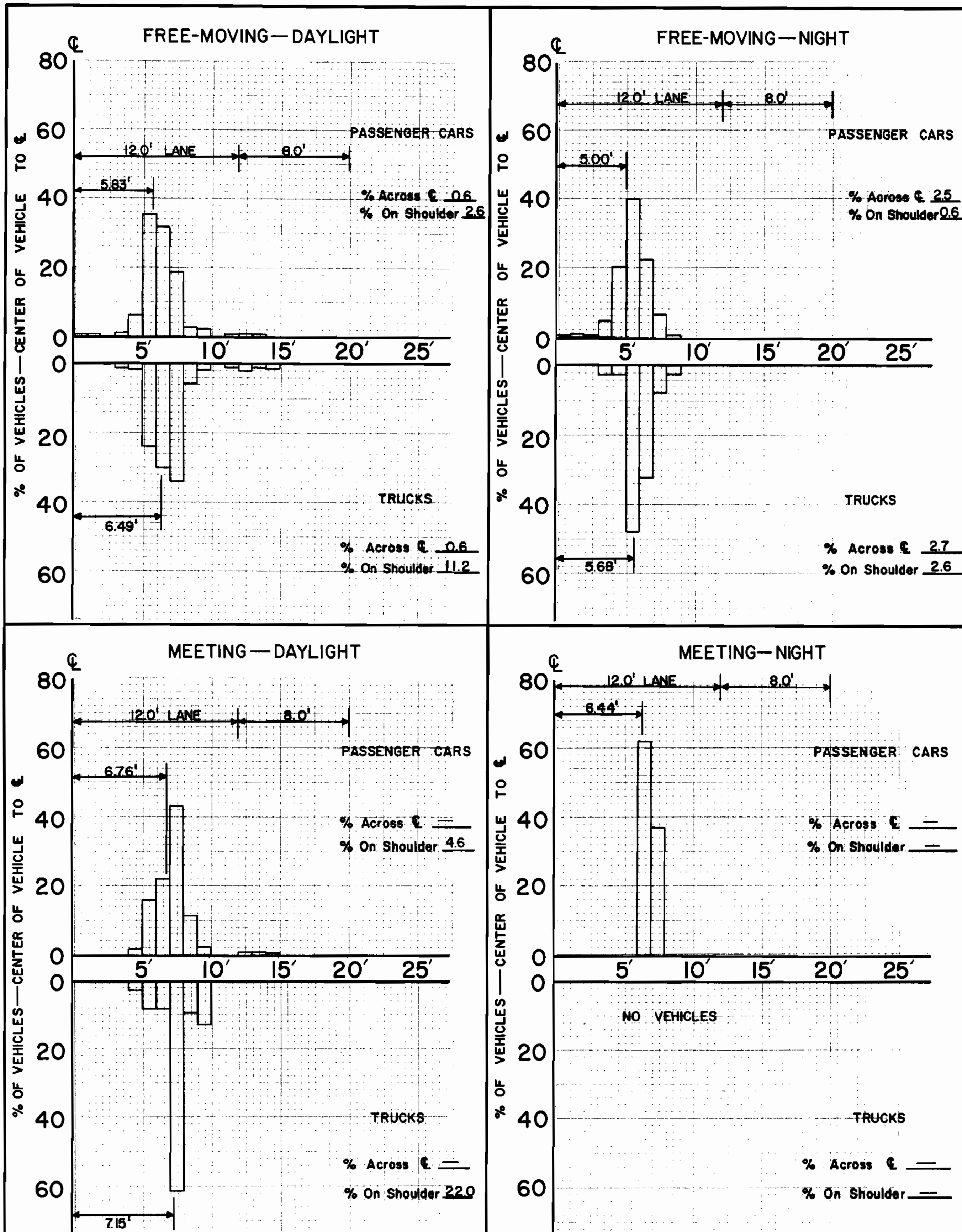
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 12

APPENDIX I PAGE 12

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



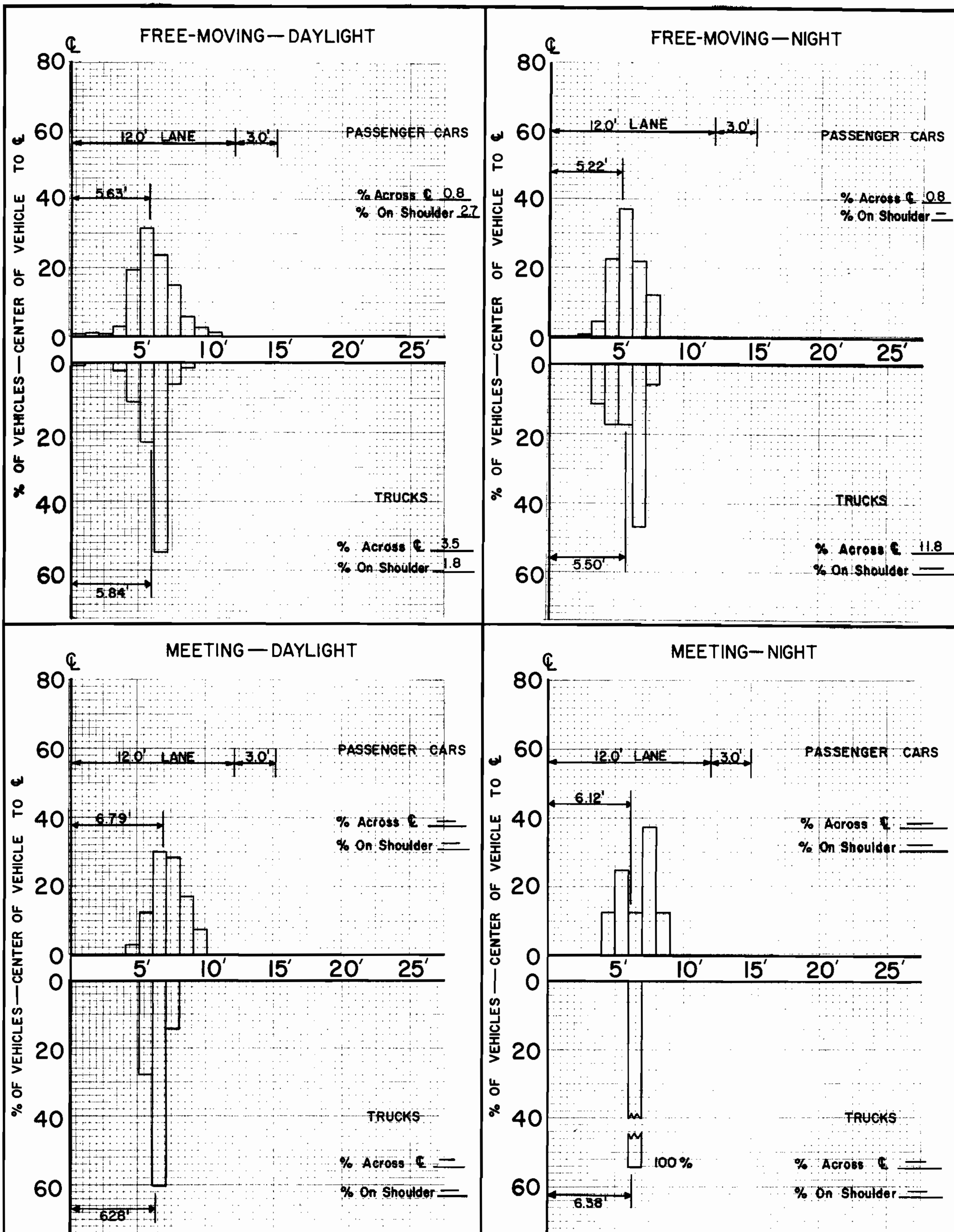
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 50-A

APPENDIX I PAGE 13

PLACEMENT BAR CHARTS

Road Design Division Texas Highway Department March 1957



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

SITE 52-A

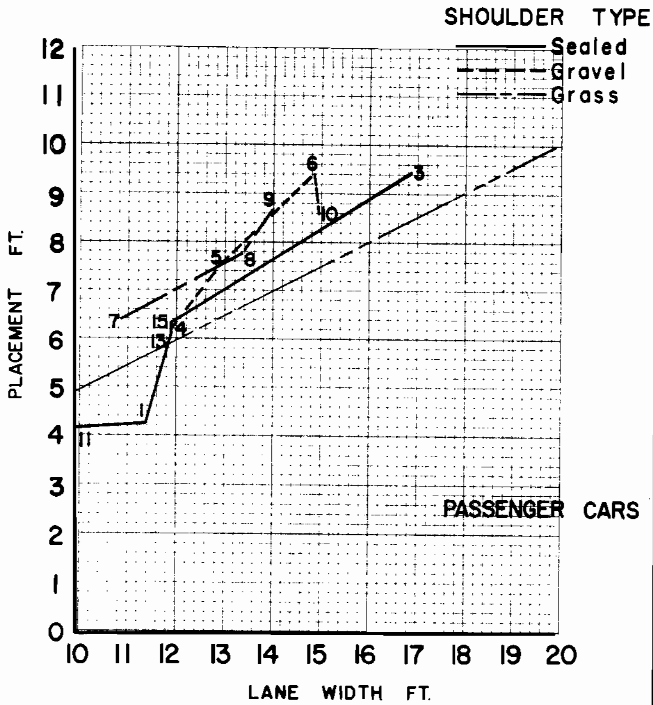
APPENDIX I PAGE 14

PLACEMENT BAR CHARTS

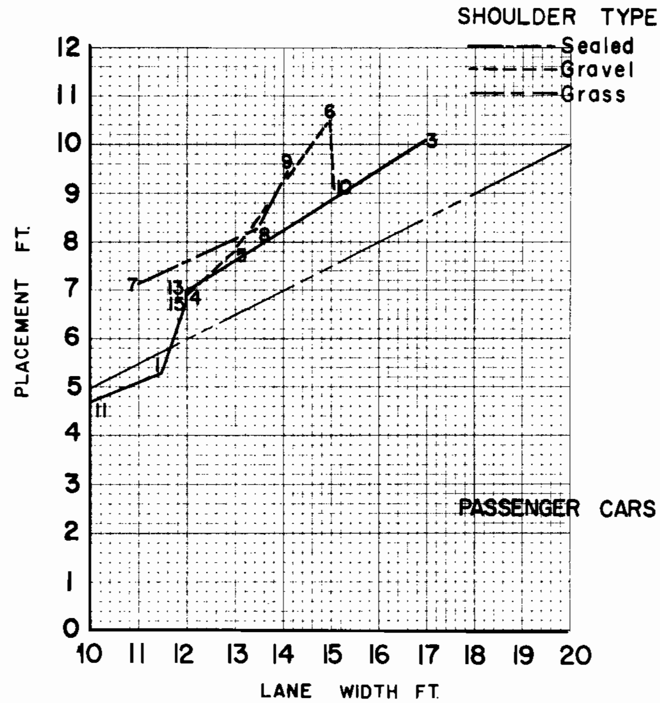
Road Design Division Texas Highway Department March 1957

PLACEMENT BY LANE WIDTH AND SHOULDER TYPE

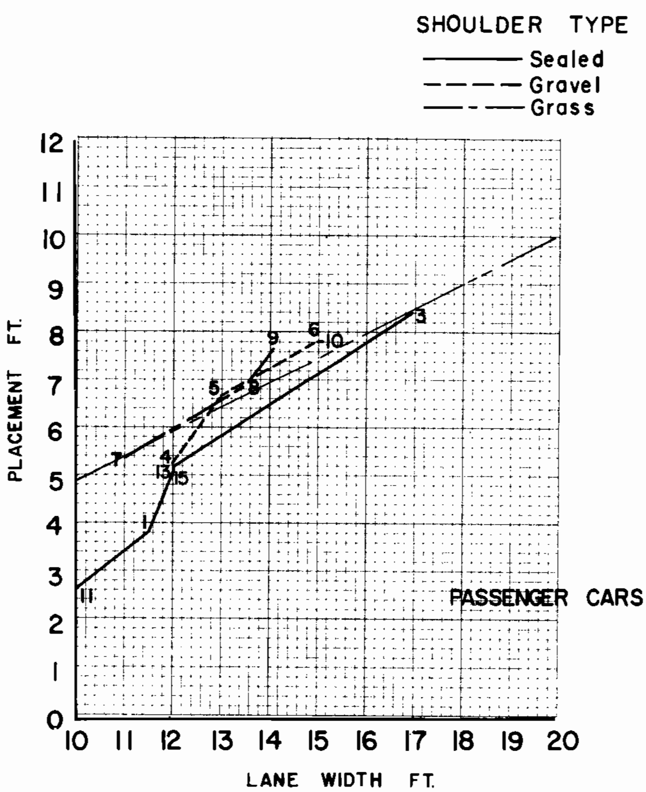
FREE-MOVING—DAYLIGHT



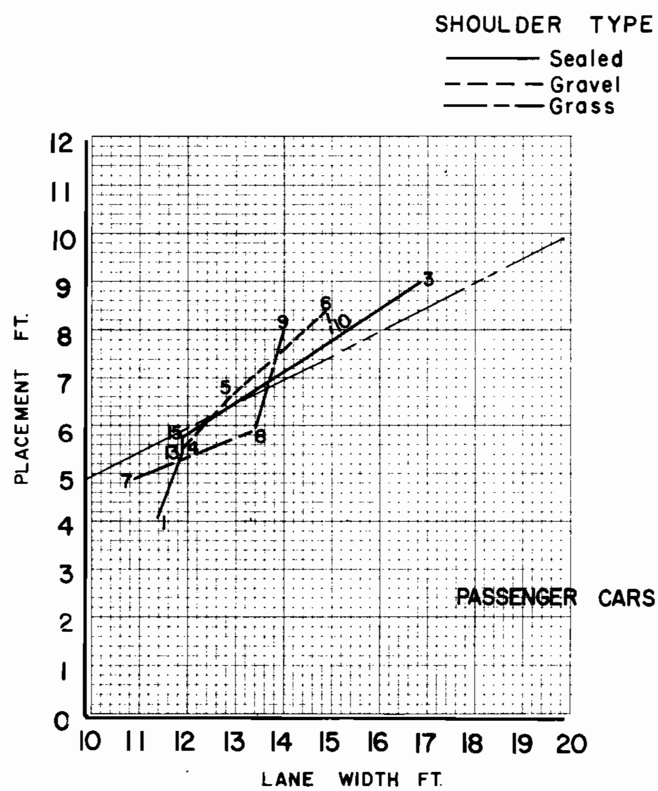
FREE-MOVING—NIGHT



MEETING—DAYLIGHT



MEETING—NIGHT



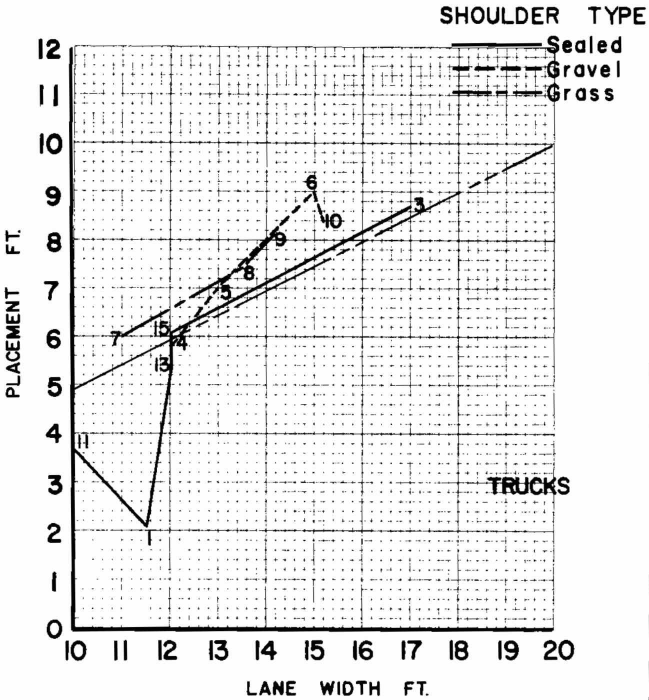
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

PLACEMENT GRAPHS

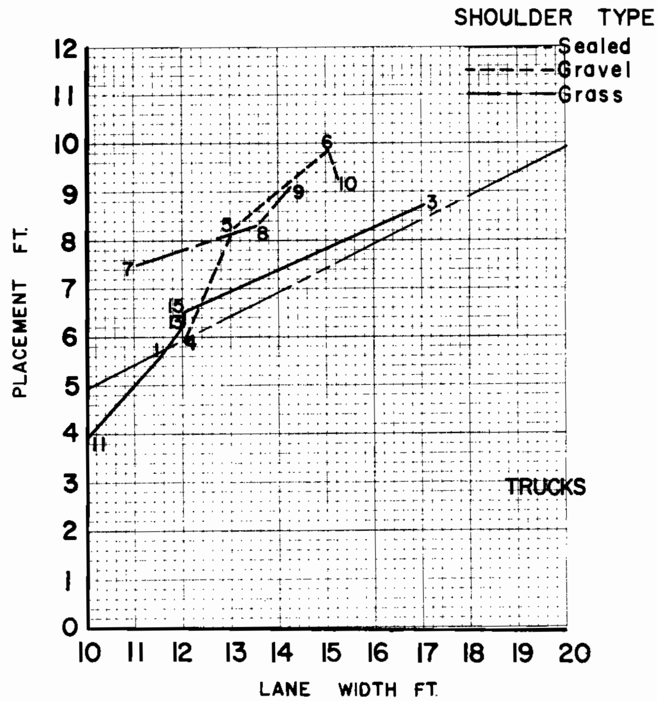
Road Design Division Texas Highway Department March 1957

PLACEMENT BY LANE WIDTH AND SHOULDER TYPE

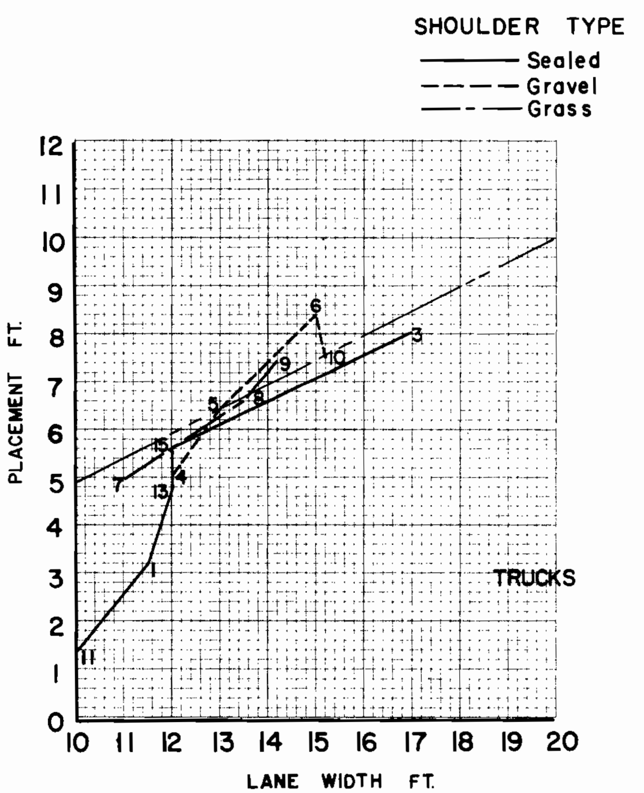
FREE-MOVING — DAYLIGHT



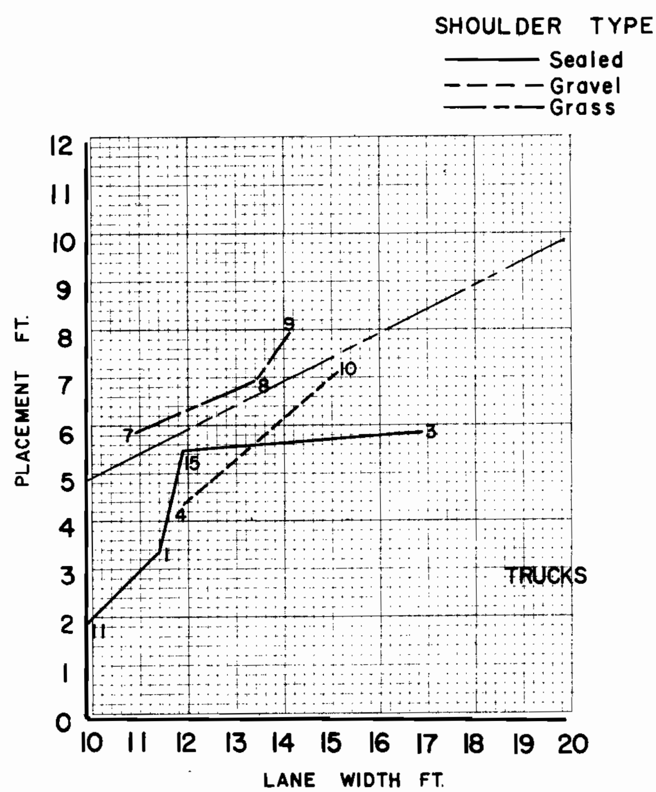
FREE-MOVING — NIGHT



MEETING — DAYLIGHT



MEETING — NIGHT



TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

PLACEMENT GRAPHS

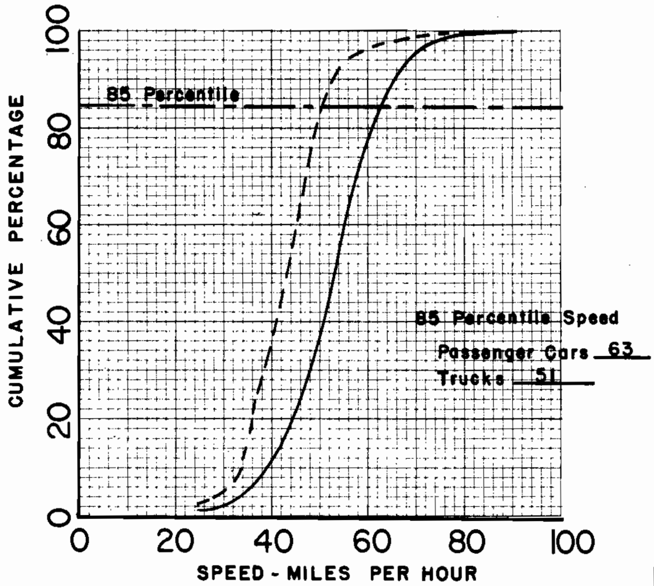
Road Design Division Texas Highway Department March 1957

SITE 1

DAYLIGHT

LEGEND

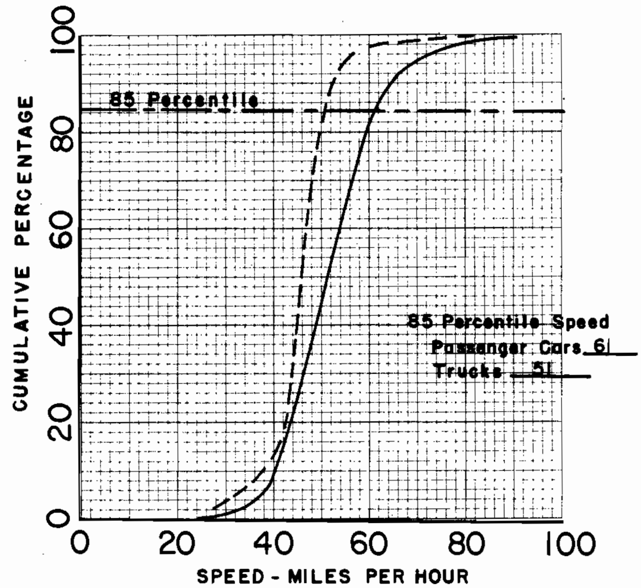
——— Passenger Cars
– – – – Trucks



NIGHT

LEGEND

——— Passenger Cars
– – – – Trucks

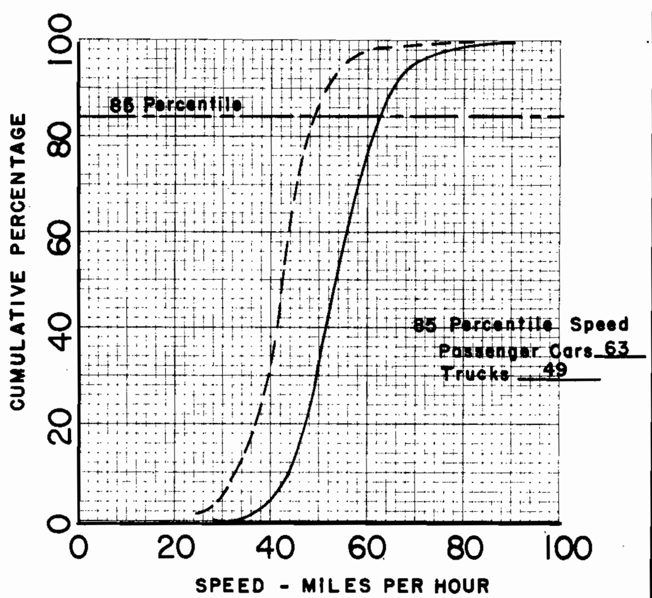


SITE 2

DAYLIGHT

LEGEND

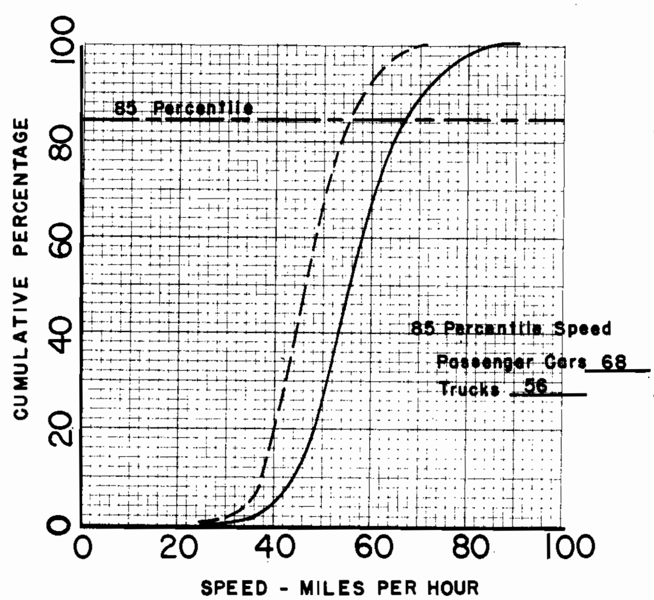
——— Passenger Cars
– – – – Trucks



NIGHT

LEGEND

——— Passenger Cars
– – – – Trucks



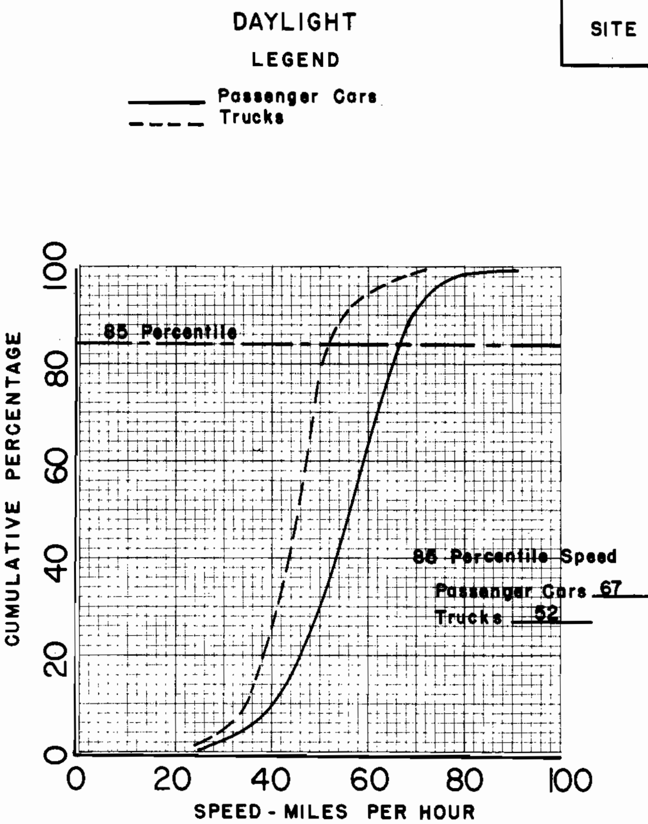
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

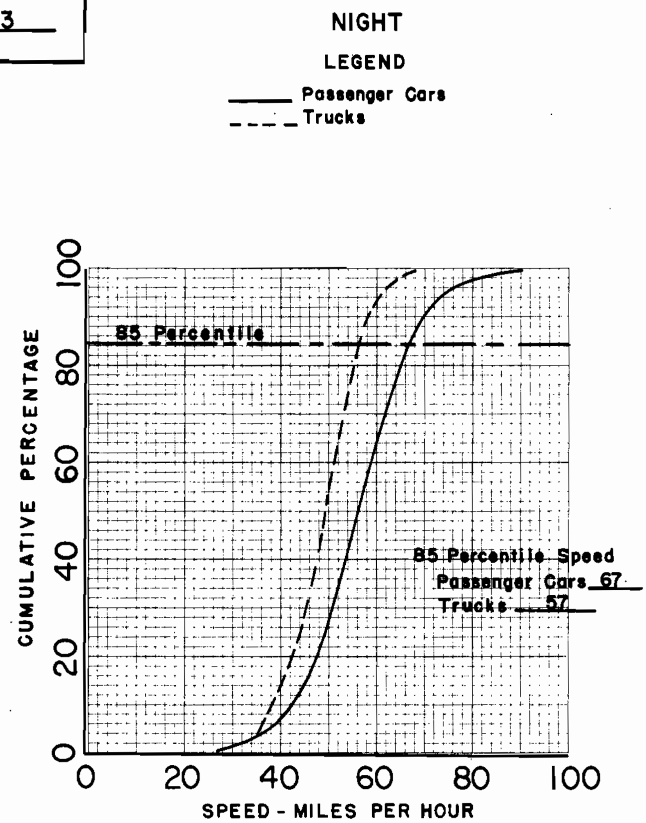
CUMULATIVE SPEED CURVES

APPENDIX 3 PAGE 1

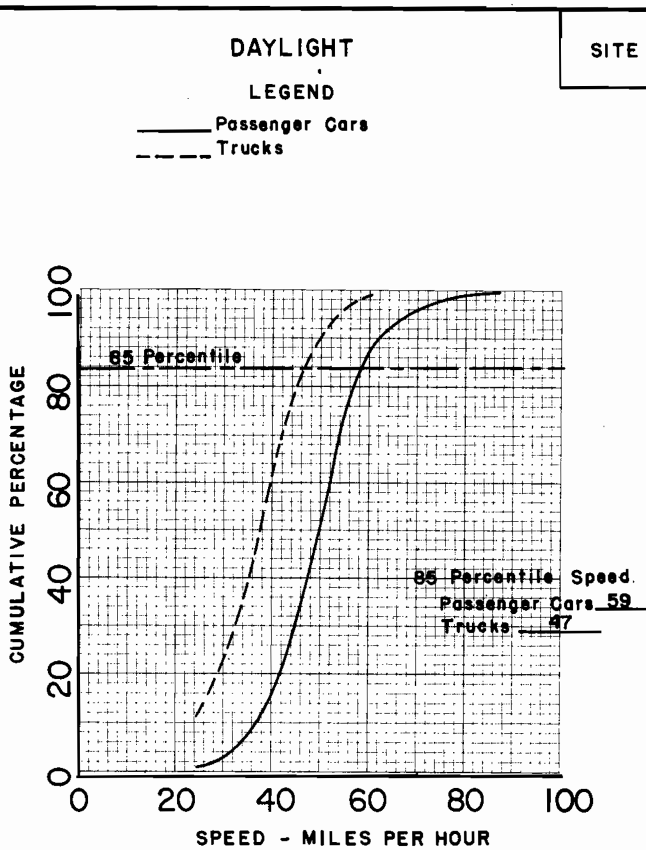
Road Design Division Texas Highway Department March 1957

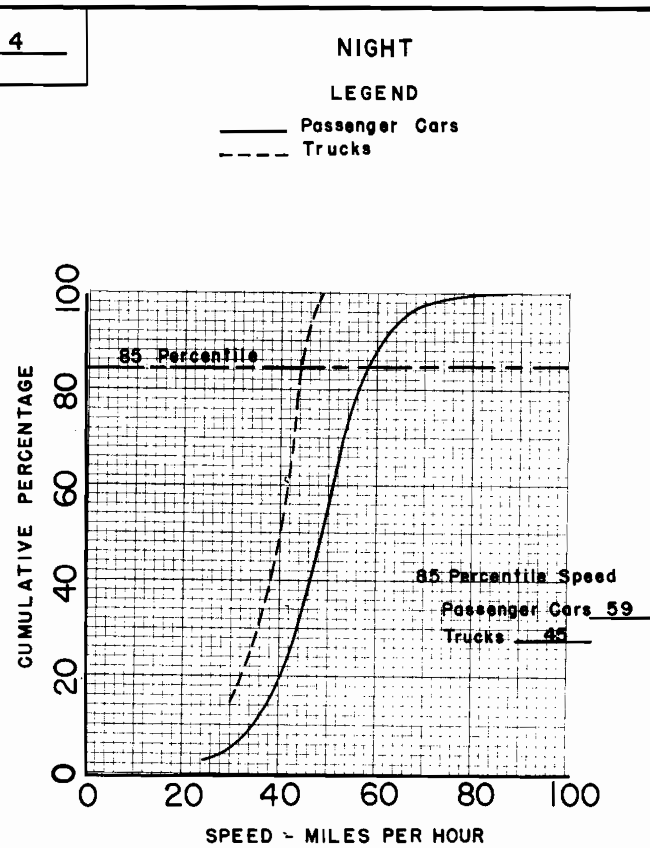
SITE 3





SITE 4





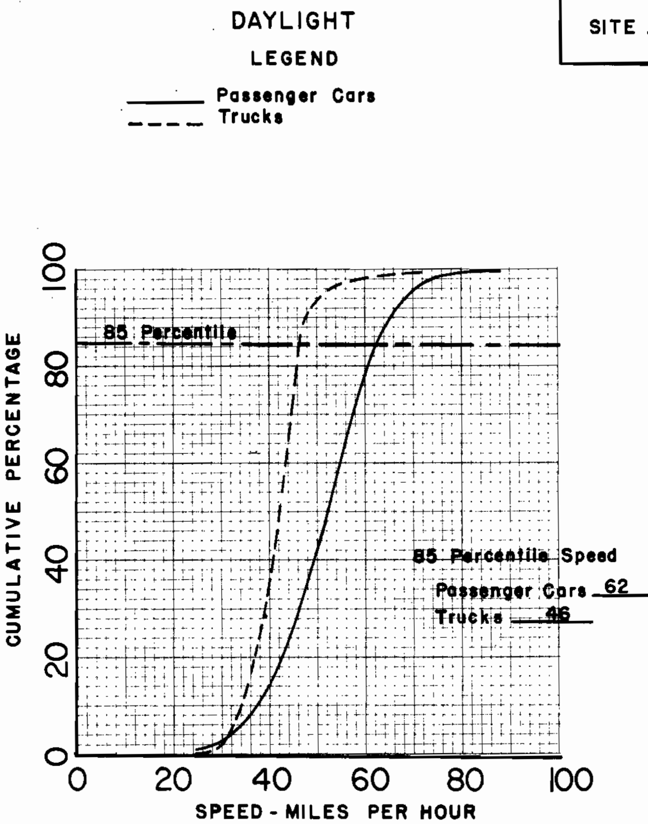
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

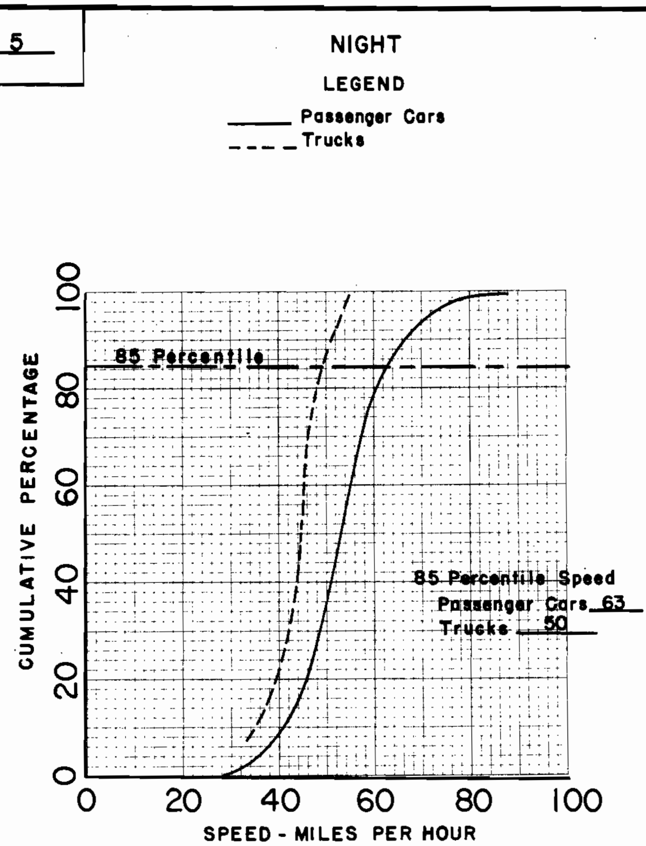
CUMULATIVE SPEED CURVES

APPENDIX 3 PAGE 2

Road Design Division Texas Highway Department March 1957

SITE 5





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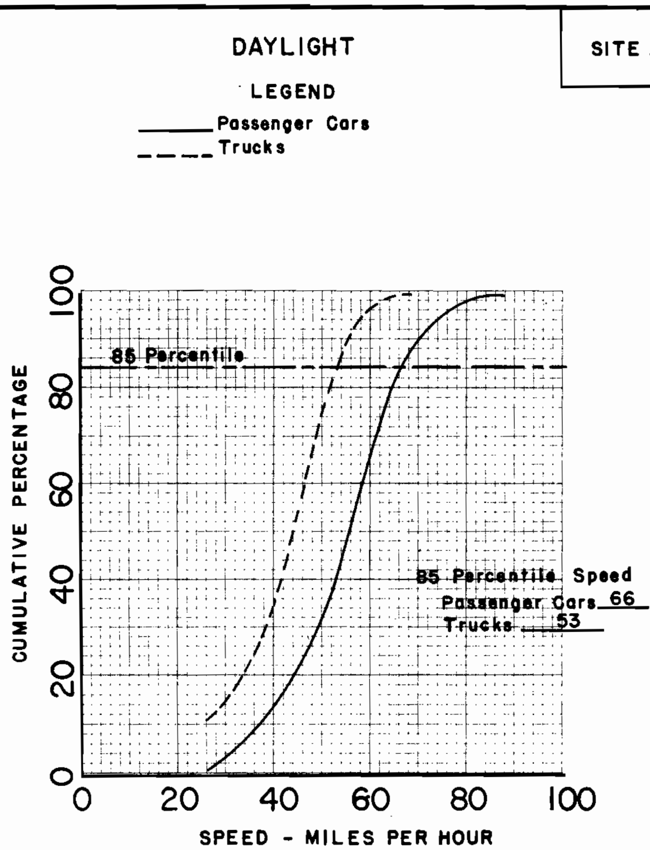
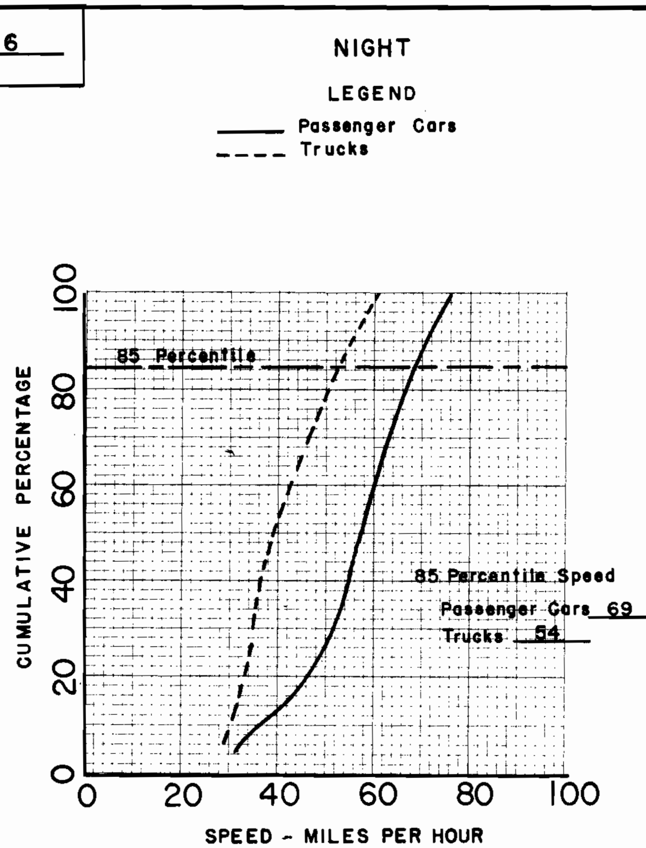




TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

CUMULATIVE SPEED CURVES

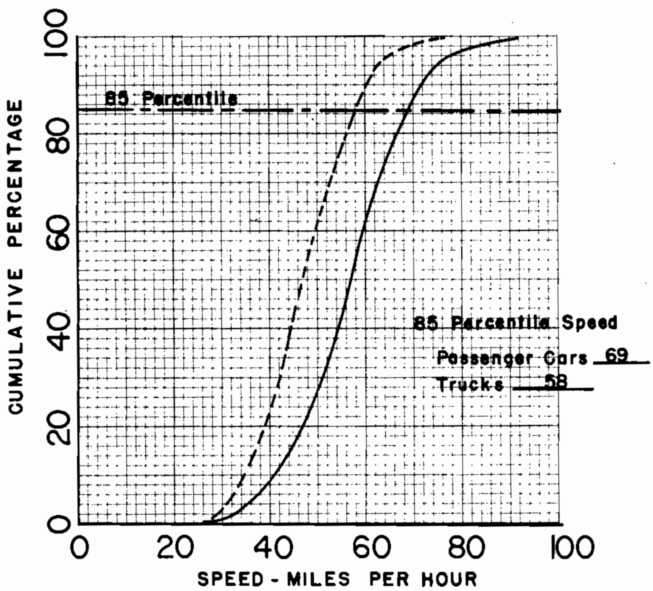
Road Design Division Texas Highway Department March 1957

SITE 7

DAYLIGHT

LEGEND

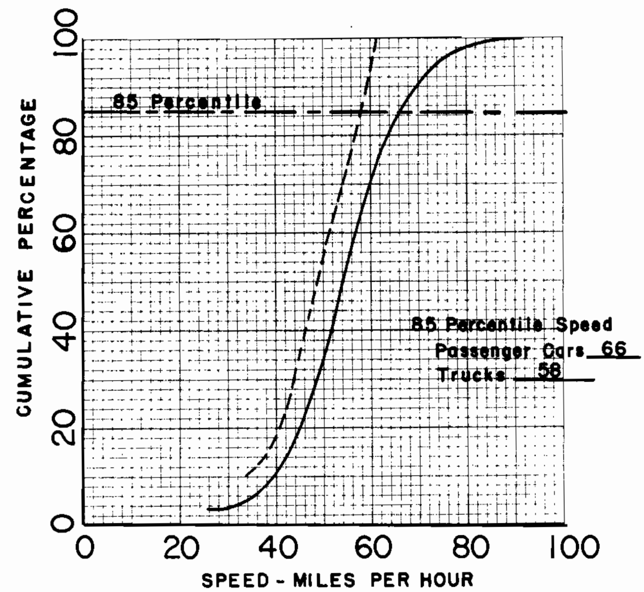
——— Passenger Cars
– – – – Trucks



NIGHT

LEGEND

——— Passenger Cars
– – – – Trucks

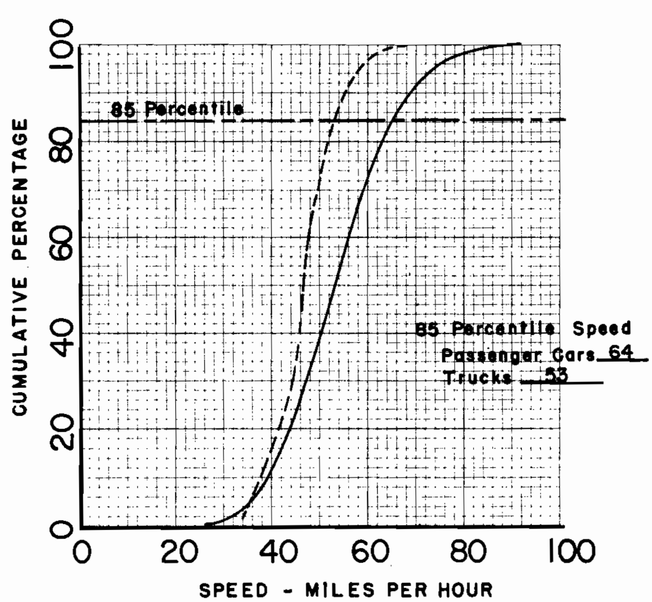


SITE 8

DAYLIGHT

LEGEND

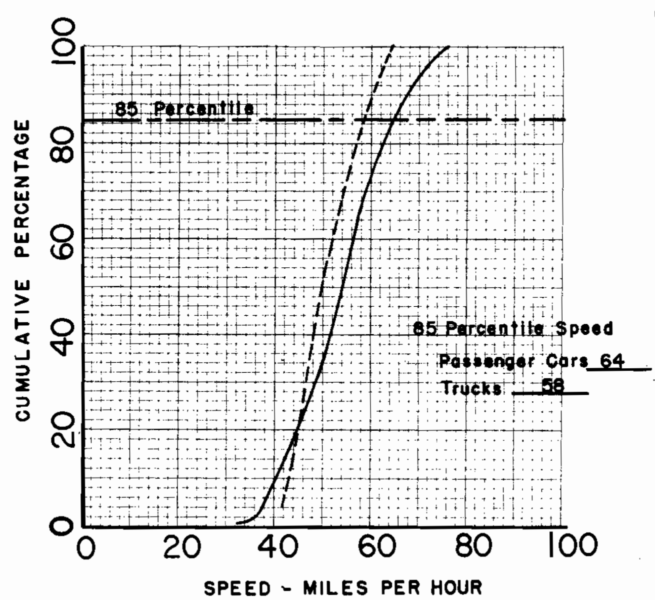
——— Passenger Cars
– – – – Trucks



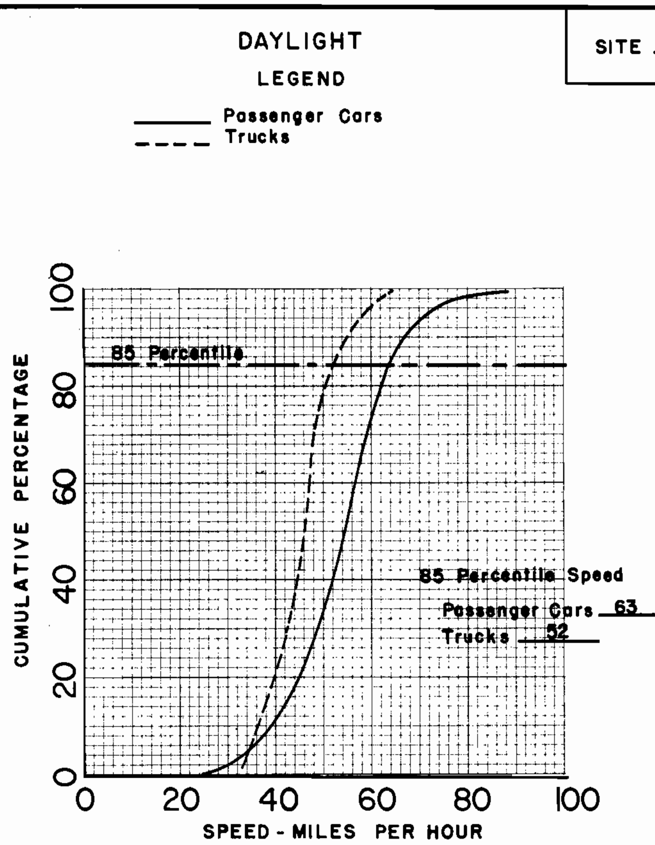
NIGHT

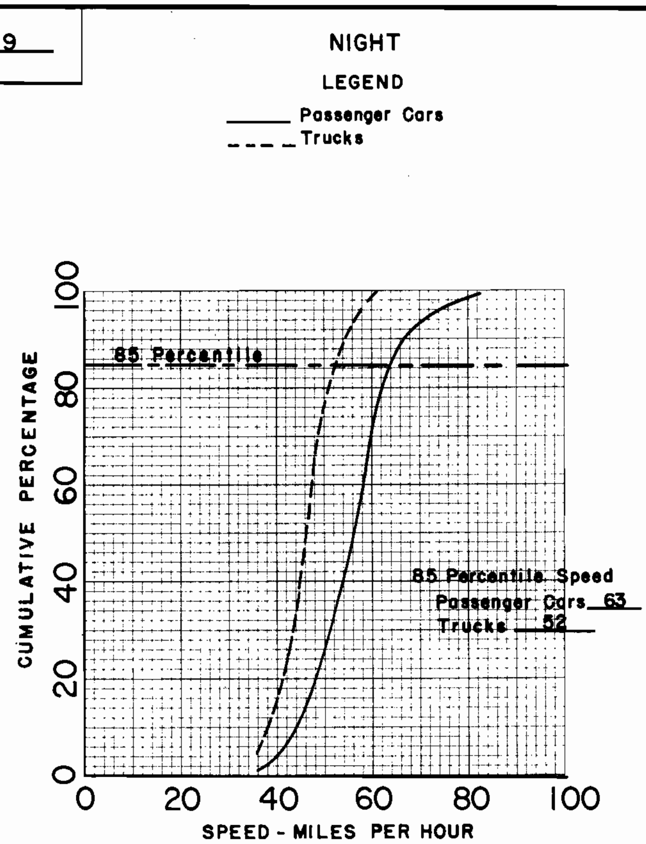
LEGEND

——— Passenger Cars
– – – – Trucks

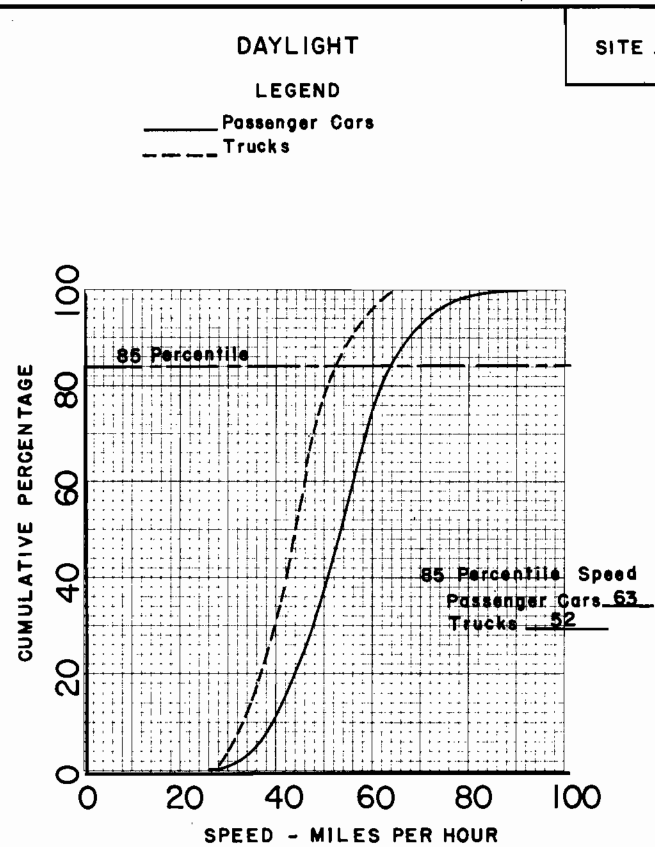


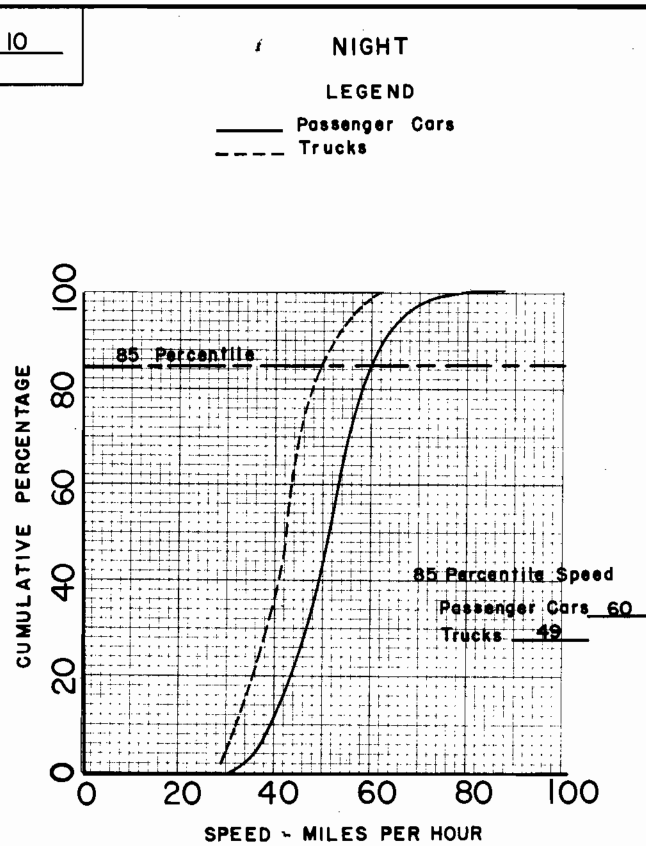
SITE 9





SITE 10



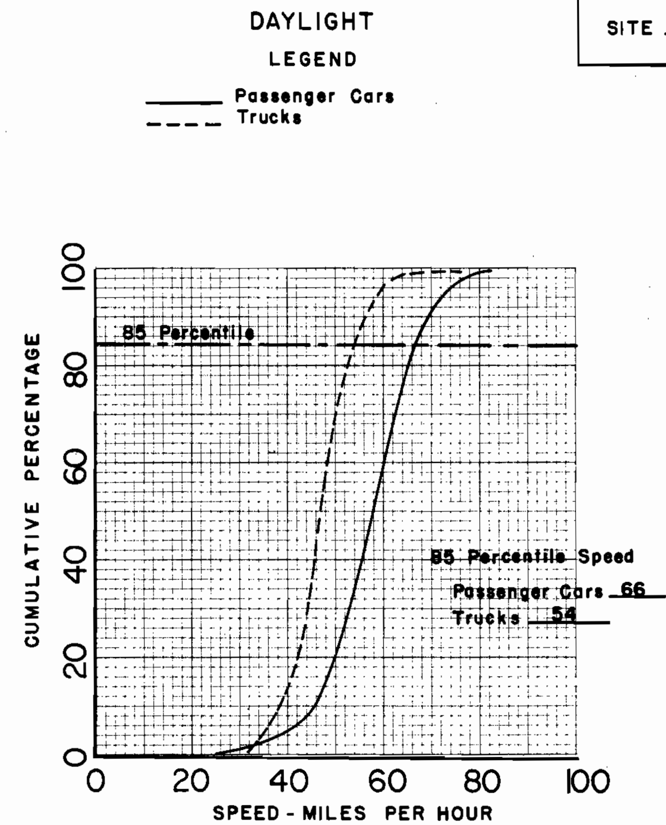


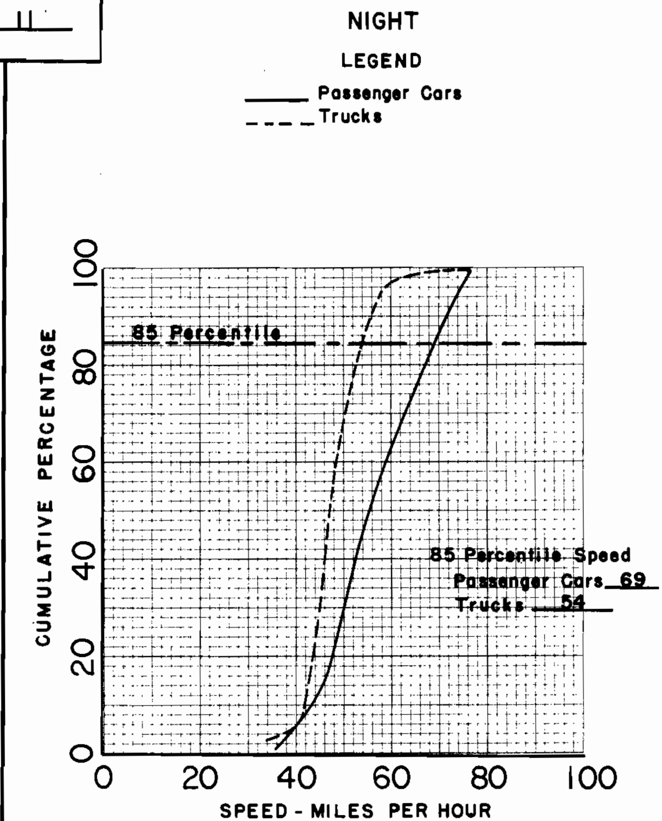
TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

CUMULATIVE SPEED CURVES

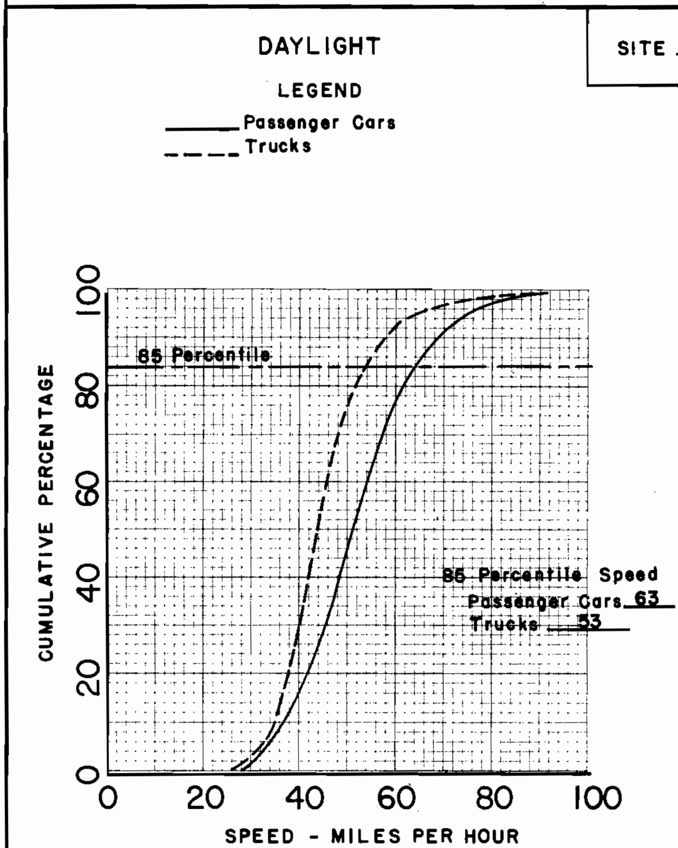
Road Design Division Texas Highway Department March 1957

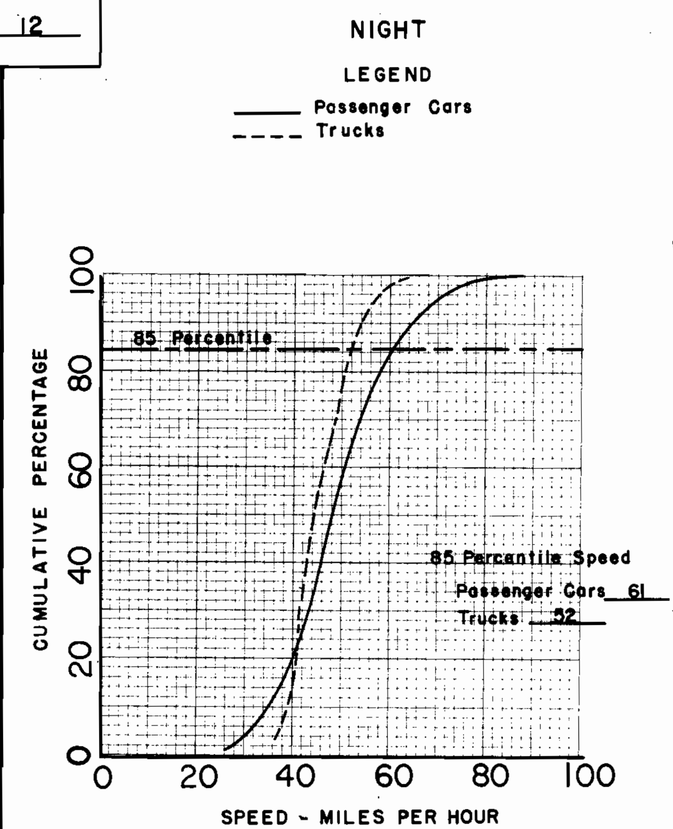
SITE 11





SITE 12





TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

CUMULATIVE SPEED CURVES

Road Design Division Texas Highway Department March 1957

SITE 1

LANE WIDTH 11.5'

SHOULDER WIDTH 9.0'

SHOULDER TYPE — SEALED

SITE 2

LANE WIDTH 22.0'

SHOULDER WIDTH 8.0'

SHOULDER TYPE — GRAVEL

TRAFFIC BEHAVIOR ON
TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS
OF ROADS SITES

Road Design Division Texas Highway Department March 1957

SITE 3 | SHOULDER WIDTH 3.0'

LANE WIDTH 17.0' | SHOULDER TYPE — SEALED

SITE 4 | SHOULDER WIDTH 6.0'

LANE WIDTH 12.0' | SHOULDER TYPE — GRAVEL

TRAFFIC BEHAVIOR ON
TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF ROAD SITES

Road Design Division   Texas Highway Department   March 1957

SITE 5 | SHOULDER WIDTH 5.0'
LANE WIDTH 13.0' | SHOULDER TYPE — GRAVEL

SITE 6 | SHOULDER WIDTH 4.0'
LANE WIDTH 15.0' | SHOULDER TYPE — GRAVEL

SITE 7

LANE WIDTH 11.0'

SHOULDER WIDTH 4.0'

SHOULDER TYPE — GRASS

SITE 8

LANE WIDTH 13.5'

SHOULDER WIDTH 3.5'

SHOULDER TYPE — GRASS

TRAFFIC BEHAVIOR ON
TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS
OF ROAD SITES

Road Design Division Texas Highway Department March 1957

SITE 9 | SHOULDER WIDTH 4.9'

LANE WIDTH 14.1' | SHOULDER TYPE — GRASS

SITE 10 | SHOULDER WIDTH 3.0'

LANE WIDTH 15.1' | SHOULDER TYPE — GRAVEL

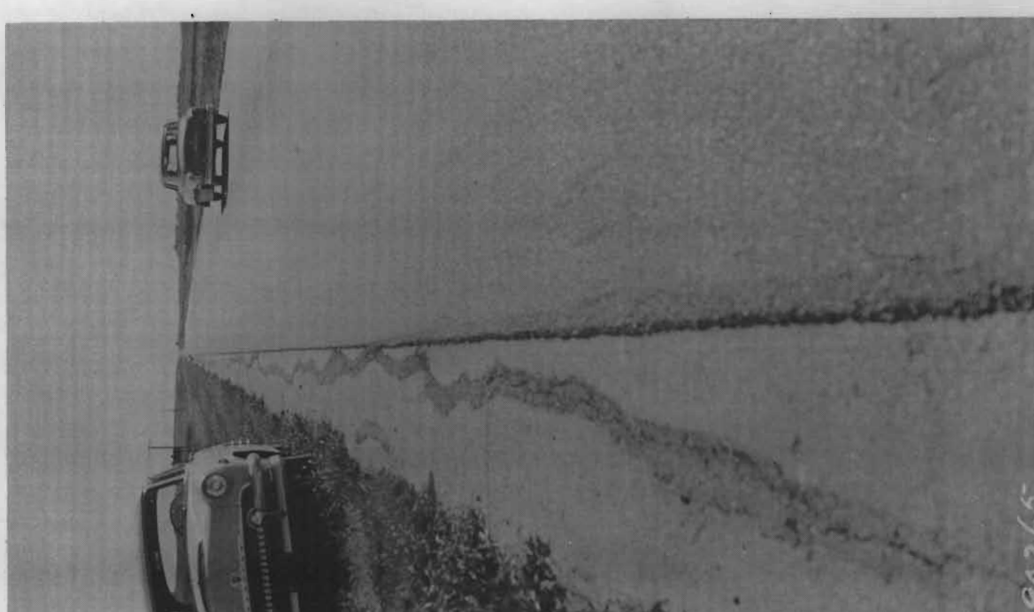
SITE 11 — SHOULDER WIDTH 7.0'

LANE WIDTH 10.0' — SHOULDER TYPE — SEALED

SITE 12 — SHOULDER WIDTH 0.0'

LANE WIDTH 19.1' — SHOULDER TYPE — NONE

SITE 50-A
LANE WIDTH 12.0'
SHOULDER WIDTH 8.0'
SHOULDER TYPE — SEALED



SITE 52-A
LANE WIDTH 12.0'
SHOULDER WIDTH 3.0'
SHOULDER TYPE — SEALED

TRAFFIC BEHAVIOR ON TWO-LANE RURAL HIGHWAYS IN TEXAS

PHOTOGRAPHS OF ROAD SITES

Road Design Division Texas Highway Department March 1957