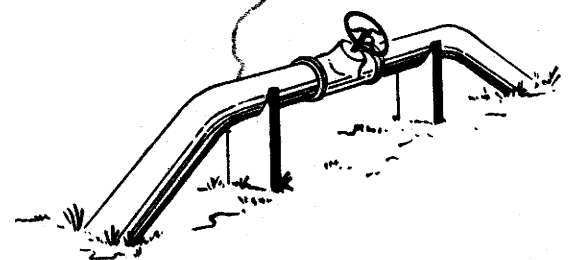
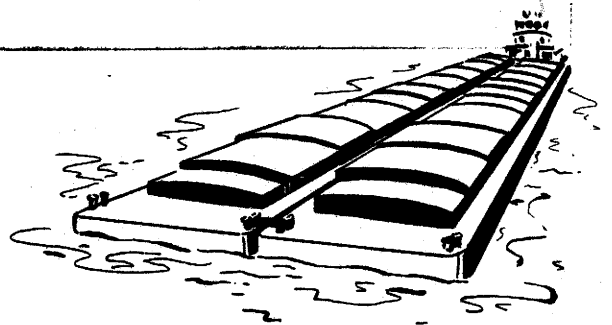
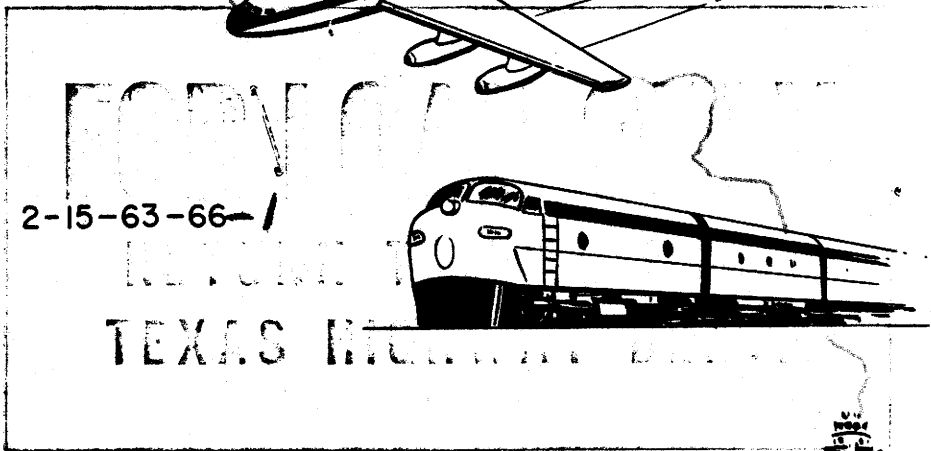
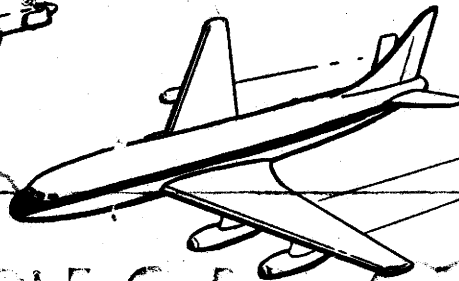
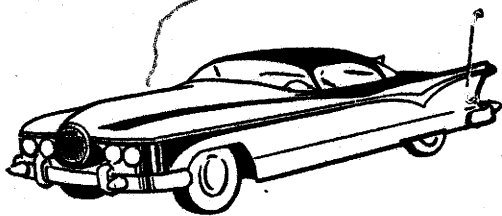


FRONTAGE ROADS AND ECONOMIC DEVELOPMENT

AN INTERIM PROGRESS REPORT

BY HOY A. RICHARDS
AND
WILLIAM H. ALLIO

HPR-1(5), RESEARCH PROJECT 2-15-63-66-1



Texas
Transportation
Institute

FRONTAGE ROADS AND ECONOMIC DEVELOPMENT

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By

**Hoy A. Richards
And
William H. Allio**

**Submitted to the Texas Highway Department and the
U. S. Bureau of Public Roads**

November 5, 1965

FOREWORD

This interim report has been prepared at the request of the Texas Highway Department and the U. S. Bureau of Public Roads. The report is necessarily tentative in nature and is confined primarily to the presentation of tabulated data. The report does include, however, some selected information from periodic progress reports and a Masters Degree Thesis by James P. Miller entitled, Location Theory and the Location of Industry Along the Interstate Highway.

It should be pointed out that all assumptions and conclusions stated in the interim report are subject to modification during the final stages of the analysis.

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INTRODUCTION

The incorporation of frontage roads, as an integral part of highway facilities, has become of increasing importance to state and local officials. But, the additional expense of constructing a frontage road may be considerable over the construction of a facility without frontage roads, therefore, the problem becomes one of evaluating the alternative systems in terms of economic and sociological justification.

Since the Texas Highway Department is charged with the responsibility of acquiring rights of way in the most efficient manner possible, the problem of access control is of extreme importance to them. Knowledge of the effects a frontage road, or the lack of a frontage road, will have on the remainders of abutting properties will be invaluable to the appraiser in making his estimates. All too often, these estimates are based on too little or no factual information. For this reason it is considered of critical importance to develop at least a minimum level of reliable factual information to serve as guidelines for appraisal purposes.

Perhaps one of the most interesting facets of frontage roads, or the lack of frontage, is the effects they have on industrial development or the location of industrial firms. The Interstate System is more than an adequate, orderly, safe means of transporting people and goods; it exerts considerable economic impact upon the local area in which they locate; it opens previously inaccessible property for industrial or other land use development. A better understanding of the types of industrial sites that may develop along this facility, and the industries which are most likely to choose these sites for the location of a plant, should be of

value to those who are concerned with the problems of land use and right of way acquisition.

This interim report will present some of the facets and preliminary findings of data relative to this problem. The data have been obtained by interviews of 284 randomly selected industrial firms and from 256 mail questionnaires returned by owner-managers of plants located along the Texas Interstate Highway System.

STATEMENT OF PROJECT OBJECTIVES

When completed, the objectives of this study will furnish specific information for right of way appraisers to use in evaluating the potential effects of frontage roads, or a lack of frontage roads, on industrial or other land use development along the Interstate Highway System.

To complete the major objective, the following sub-objectives have been pursued at various levels of intensity. These are:

1. To measure the differences in the rate of industrial-commercial growth between areas or communities with and without frontage roads.
2. To determine the "pulling power" of the Interstate System, and the extent to which this pulling power is influenced by frontage roads.
3. To determine the rates of change in land use development between areas served by frontage roads and those without.
4. To determine benefits and advantages derived from the proximity of the plant to the highway facility and to isolate the effect that frontage roads may have had on the location.
5. To evaluate the original factors in the plant site selection in

relation to the advantages or disadvantages experienced by the plant since locating near the facility.

6. To examine the different sociological implications inherent in the frontage road versus no frontage road programs.

PLAN OF RESEARCH

The Federal Highway Act of 1956, initiating the start of the National System of Interstate and Defense Highways in the United States, was instrumental in the selection of a beginning date for this research study. The year 1956 was selected as the point of beginning since it coincided with the initial construction of over 3,000 miles of the Interstate program for Texas. Due to project requirements, the date January 1, 1964, was chosen as the cut-off date. These eight years provided a sufficient period of time in which both highway construction and industrial development have progressed satisfactorily for observation and study.

Sample Design

One of the first objectives of the sample design was to categorize and classify each segment of the Interstate Highway System in Texas as to its status of construction, with or without frontage roads. This objective was met by coding specific information provided by the Planning Survey Division of the Texas Highway Department in their publication, Status of Improvements to the Interstate Highway System, January 1, 1964. (A map of the Status of Improvements to the Interstate System, January 1, 1964, can be seen in Figure 1.1, Appendix A.) From this source the following coded information relative to the status of the 3,000 mile Interstate System was placed on punch cards: Interstate route number, date construction began or was completed, city code, county code, and of the

utmost importance, the status¹ of the facility and frontage roads within each segment. These data were mandatory for the construction of the basic identification card.

According to the status book, Table 1.2 illustrates the overall mileage of each Interstate Highway in this study. It should be pointed out in regard to this table, that a perfect ratio of highways to frontage roads would be 2:1. In other words, every mile of highway facility would be complemented with two miles of frontage roads. It is obvious from Table 1.2, that frontage roads have not been constructed along with the total highway facility. However, the table indicates that almost 70% of this states' Interstate Highways, completed or under construction, includes frontage road access. For instance, one of the major difficulties thus far, has been in trying to locate suitable "no frontage roads" study areas with industrial development. This problem is magnified in the large cosmopolitan cities where a large percentage of the total state's manufacturing industry is located, and 80% of the highways are constructed with frontage roads.

Another objective in developing the sample design was to identify and catalog all manufacturing industries locating within areas of Interstate Highway System influence between January 1, 1956, and January 1, 1964. The basic data to meet this objective were obtained from the Bureau of Business Research at the University of Texas. The Bureau provided data address cards for 2,331 manufacturing industries with the following information available for each firm: name and mail address, number of employees when production began, and the major product by Standard

¹The length of each segment varied from less than one mile to more than 30 miles, depending upon the status of improvements to that particular section of the facility; however, the average segment is approximately three miles long.

TABLE 1.2
OVERALL GROUP ANALYSIS BY STATUS OF INTERSTATE HIGHWAY SYSTEM
JANUARY 1, 1964

	HIGHWAY				FRONTAGE ROADS				
	Interstate	Complete	Under Construction	Program	Total	Complete	Under Construction	Program	Total
10	237.1	75.9	564.8	877.8	313.2	40.4			353.6
20	273.6	125.4	236.9	635.9	307.5	109.2			416.7
30	77.1	44.0	49.0	170.1	130.7	71.5			202.2
35 & 35E	337.4	54.6	112.5	504.5	554.5	65.4			619.9
35W	21.5	12.3	50.6	84.4	33.9	21.1			55.0
37	4.9	2.4	134.9	142.2	4.5	4.8			9.3
40	94.0	15.4	68.2	177.6	22.1	20.6			42.7
45	171.2	34.5	78.8	284.5	260.9	42.4			303.3
410	24.5	14.0	.6	39.1	50.4	11.1			61.5
610	10.2	15.0	13.3	38.5	26.7	20.0			46.7
635			40.4	40.4					
820	20.0	7.9	7.1	35.0	31.1	7.5			38.6
TOTAL	1271.5	401.4	1357.1	3030.0	1735.5	414.0			2149.5

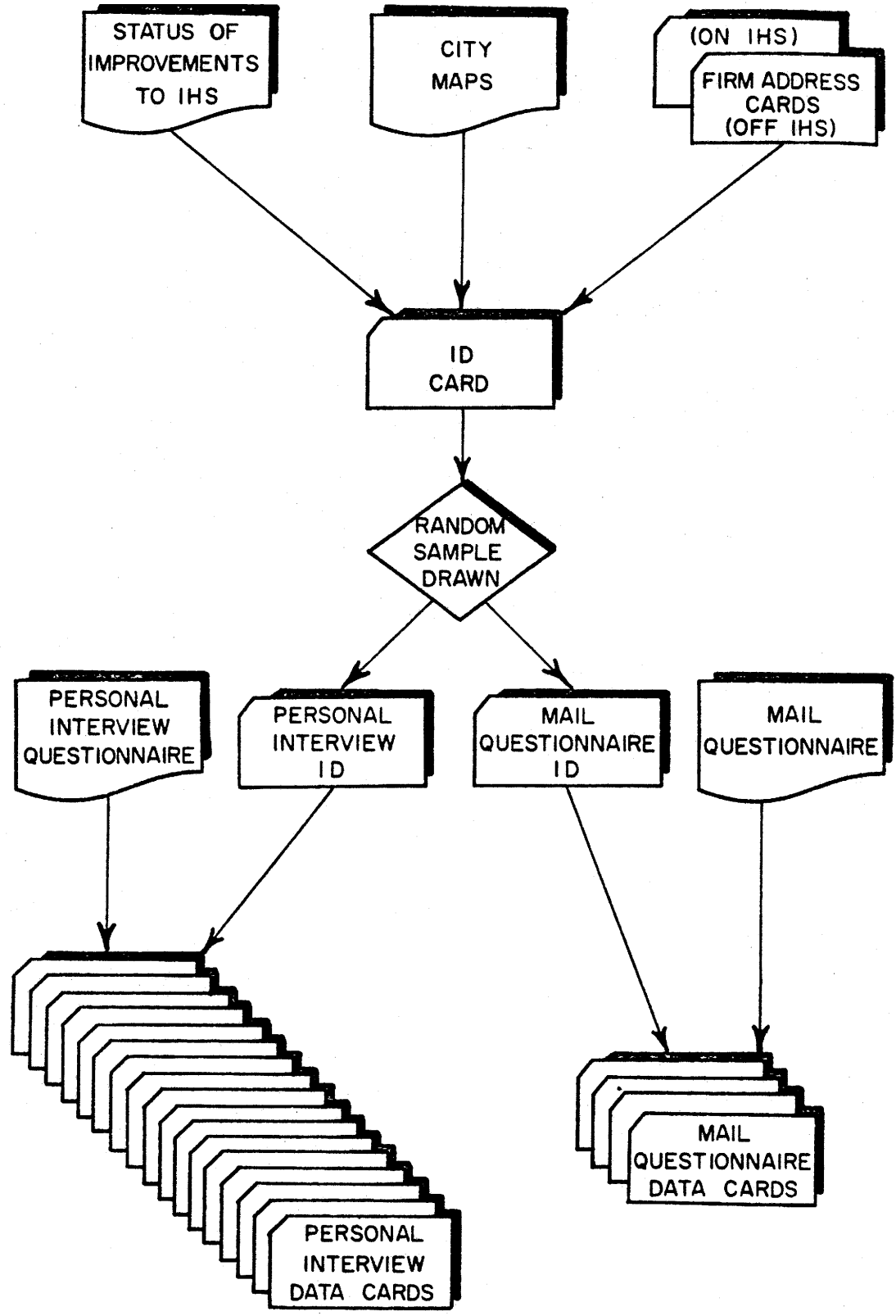
Industrial Classification. (Table 1.11 shows distribution of total manufacturing industries by Standard Industrial Classification.)

The 2,331 manufacturing industry group was broken down into two major groups. One group contains 1,495 firms, or 64 percent of the total universe, locating in areas serviced by the Interstate System; while the other group consists of 836 firms, or 36 percent, locating in areas which have not been programmed for service by the Interstate System. (Maps illustrating the distribution of these major groups can be found in the Appendix A, Figure 1.4 and 1.5.) This is not to say that the Interstate Highway factor is significant at this point, or even considered in the selection of a plant site; however, it does provide a measure by which specific areas for study were selected.

By utilizing the firm address cards received from the Bureau of Business Research, the 1,495 industries locating in areas serviced by the Interstate were plotted on appropriate city maps, as near to their actual location as scaling techniques would permit. After each firm's location was plotted, the following data were coded from the maps: The distance the firm was located from highway, railroad, and water (if applicable); type of street or highway location; type of access to Interstate Highway from plant site; location of the firm with respect to the city; and location of firm with respect to railroad and Interstate Highway.

The development of an identification punch card for each of the 1,495 firms was accomplished in order to provide for multi-purpose retrieval and listings of all pertinent data relative to the selection of the sample firms. The Flow Chart for Development of Input Data (Figure 1.6) illustrates the importance of the three basic sets of data, the status card, the city maps, and the firm address, in the development of the Identification card.

FIGURE 1.6



FLOW DIAGRAM FOR DEVELOPMENT OF INPUT DATA

Sample Selection

Rather than select firms at random from the total universe, consultants from the University's Statistical Institute suggested that more meaningful data could be obtained by stratification of the samples. Therefore, the universe, or Identification card deck, was divided into distinctive homogeneous classes or strata and the sample was drawn at random from each of the following specified classes:

1. Frontage roads, no frontage roads, or programmed construction,
2. Standard Industrial Classification for manufacturing firms regrouped into 11 major categories,
3. Size of city in which they had located, and
4. Distance from the nearest Interstate facility.

An examination of the Cell Chart (Figure 1.7) demonstrates grouping representing 495 individual cells. Of this group, 230 cells were empty, with over 100 of the empty cells appearing in three city sizes; large city, city, and rural area. It should be mentioned that the 15 firms in these city sizes, under the category "Interstate Highway without Frontage Roads," were withdrawn from the sample selection in order that more intensive "special" consideration could be shown the entire group. It appears significant that only 15 firms or 6.4% of the total 232 firms would choose locations in these city sizes.

Other cells throughout the Cell Chart were represented by from one to 84 firms. The following criteria were used to draw the sample firms:

1. From each cell represented by one or more firms, a single firm was drawn at random;
2. From each cell represented by more than five firms, a second random selection was made;

3. From each cell with more than 20 firms, a ten percent proportional sample was drawn at random; and
4. Wherever possible, alternates were selected for each sample firm.

The random selection resulted in a sample of 632 firms (including alternates) of which 284 were eventually contacted by personal interview. Figure 1.8 is a map of the State of Texas showing the distribution of these personal interview firms by their geographic location with respect to Interstate Highway routes.

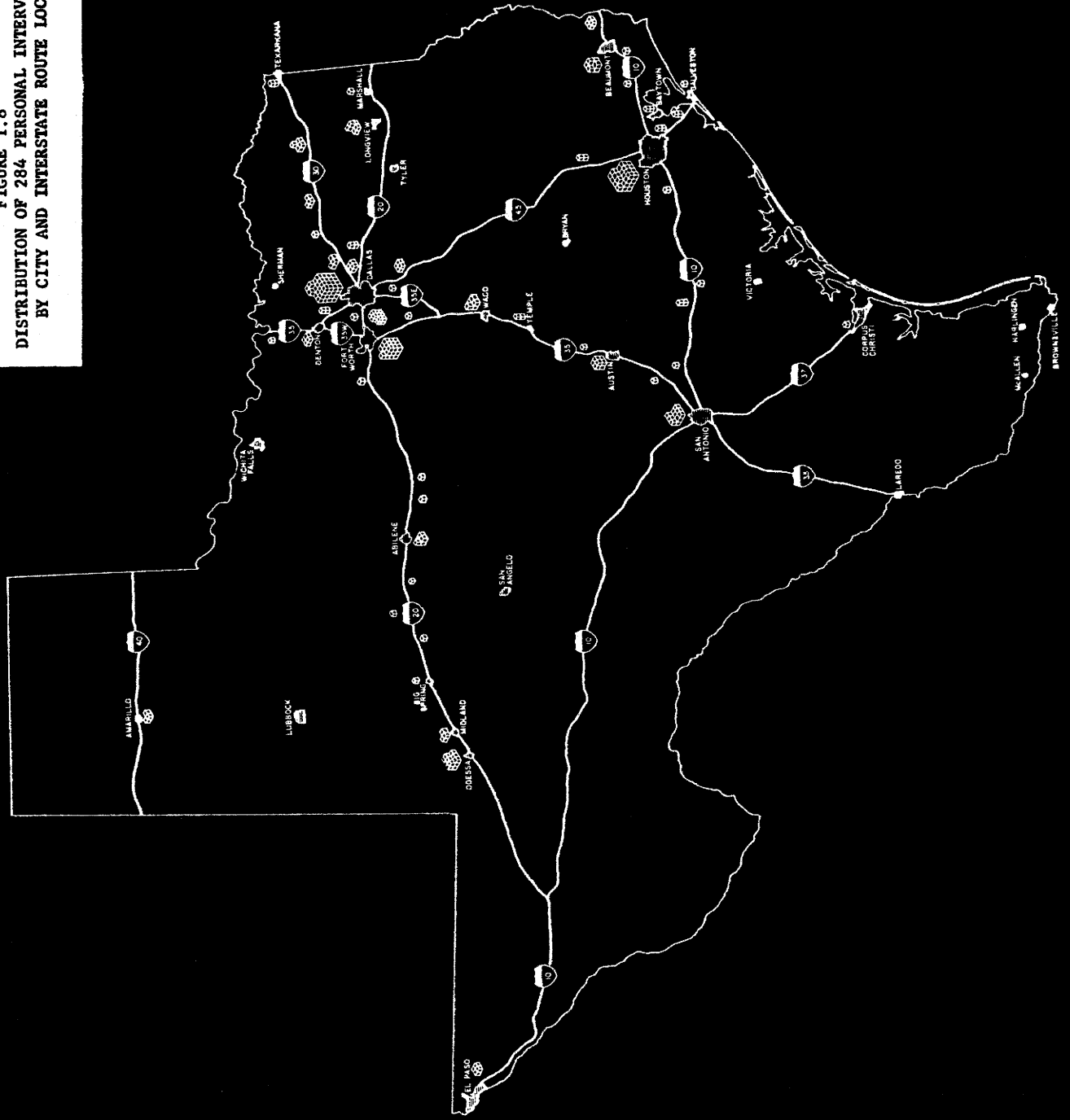
Since coding of the firms' address cards had been accomplished by Interstate route, city, and county code, it was then possible to schedule personal interviews by the most efficient route possible. For example, automatic data processing made possible the organization and listing of the most economical interview itinerary for each group of firms assigned to the field interviewers. In addition, this procedure also provided for alternative firms to be listed with each sample firm, thereby making available to the interviewer an immediate alternate in the event the sample firm interview could not be completed.

Personal Interview Questionnaire Design

The design of a questionnaire to be used in the personal interview of sample firms was based upon the requirement to obtain specific information concerning:

1. General locational factors considered in making the site selection;
2. Relative importance of transportation facilities to the firm's operation;

FIGURE 1.8
DISTRIBUTION OF 284 PERSONAL INTERVIEW FIRMS
BY CITY AND INTERSTATE ROUTE LOCATION



3. Shipping characteristics of the many and varied industrial firms and their effect on the Interstate System;
4. Specific importance of the highway relative to other transportation facilities available to the plant site; and
5. Importance of access from the plant site to the available transportation facilities.

In general, the questionnaire was designed to reveal pertinent "qualitative" information to associate with the tabulated pre-interview "quantitative" data concerning the physical and operational characteristics of the firm. By necessity, the questionnaire was rather lengthy in that probing-type questions, directed toward the owner/manager or executive who was responsible for the site selection, made up a larger portion of the schedule. Before going into the field to interview the selected sample firms, interview techniques and questionnaires were pre-tested for reliability and completeness in several cities throughout the state.

Mail Questionnaire Design

From experience received in the personal interviews, a questionnaire was developed and mailed to all non-retail industries located in areas of influence of the Interstate System, not previously selected as a primary or alternate for personal interview. The principal objective of this questionnaire was to provide control data to be utilized in the statistical analysis of data obtained by personal interview. Throughout this report data from the mail questionnaire are compared to personal interview data in an attempt to measure representativeness of various characteristics of the interviewed firms. These data will play

a significant role in the final analysis of this project. Figure 1.9 is a map of the State of Texas showing the geographic distribution of 256 returned mail questionnaires by city and Interstate Highway route location. Table 1.10 of Appendix B provides a complete breakdown of the total universe of 2,331 firms by the manner in which they were treated in the design of this project.

Interview Firms by Standard Industrial Classification

The distribution of personal interview sample firms by Standard Industrial Classification is of particular interest since the total universe was stratified on this basis prior to sampling. Table 1.11 illustrates the distribution of all manufacturing firms within the categories of total universe, personal interviews, and mail questionnaires. A measure of the representativeness of the stratified random sample is seen in the similar distribution of Standard Industrial Classifications within both the personal interview group and the mail questionnaire group when compared to the total universe. A pictorial representation of the geographic distribution of the personal interview firms by Standard Industrial Classifications is shown in Figure 1.12 of Appendix A.

Status of Improvements to IHS

Since the distribution of industries by Interstate Highway status of construction, with or without frontage roads, was one of the primary factors used in the stratification of the universe, it is possible to determine from the Cell Chart (Figure 1.7), the number of site selections within the category "Interstate Highway Without Frontage Roads". Of the 1,364*

* Only 1,364 non-retail industries were reported by the Bureau of Business Research through September, 1963. The complete listing of 1,495 firms was not made up until March, 1964.

FIGURE 1.9
DISTRIBUTION OF 256 MAIL QUESTIONNAIRE FIRMS
BY CITY AND INTERSTATE HIGHWAY ROUTE

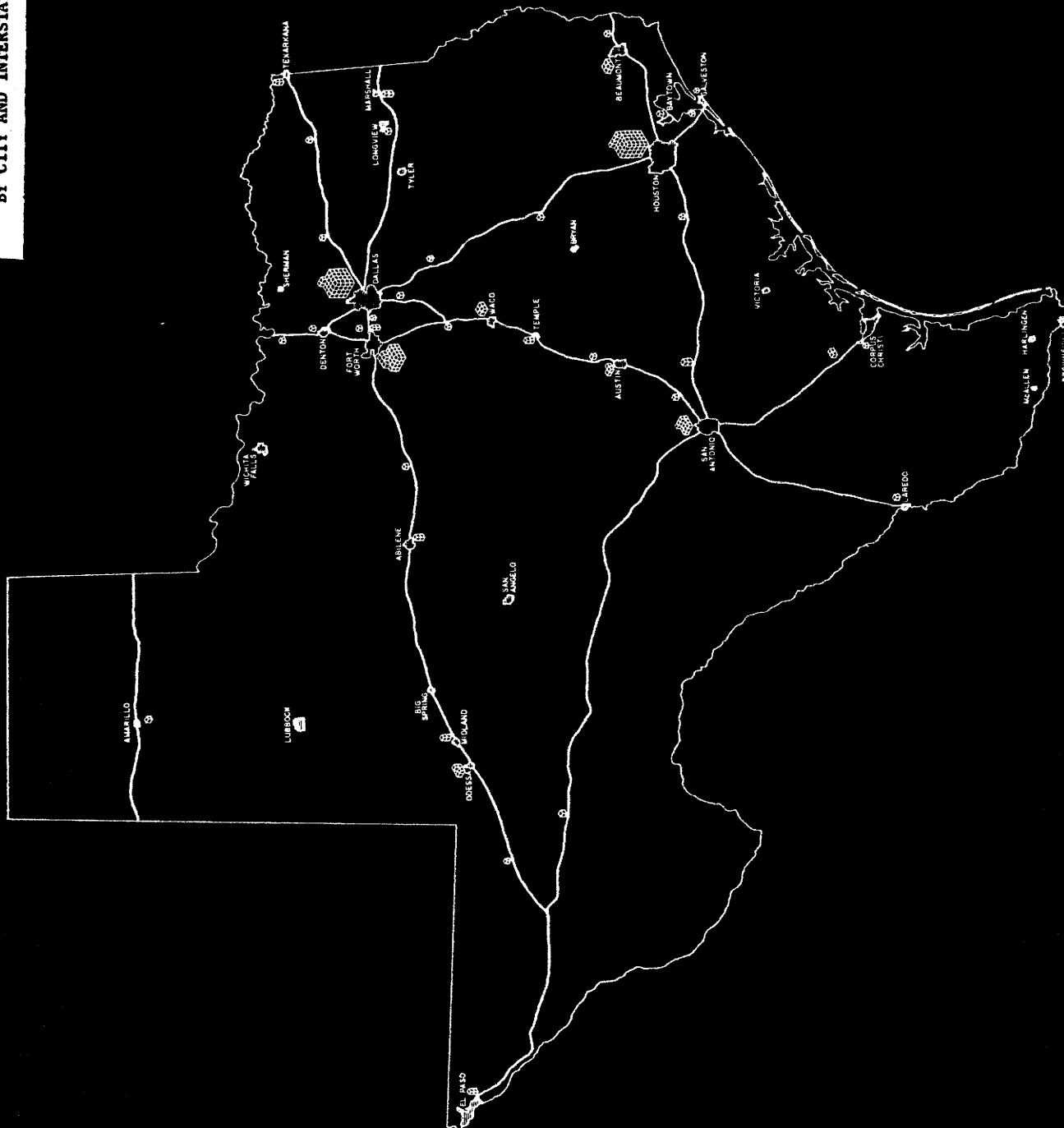


TABLE 1.11

DISTRIBUTION OF MANUFACTURING PLANTS LOCATING IN TEXAS
 FROM JAN. 1, 1956, TO JAN. 1, 1964
 BY MAJOR TWO DIGIT STANDARD INDUSTRIAL CLASSIFICATION

Major SIC (2 Digit)	Total Plants	Percent of Total	Total Universe	Percent of Total	Personal Interviews	Percent of Total	Mail Questionnaire	Percent of Total
13 Crude Petroleum	82	3.52	9	.60	3	1.05	1	0.39
19 Ordnance	4	.18	3	.20	--	--	--	--
20 Food	223	9.57	103	6.89	26	9.15	12	4.69
22 Textiles	17	.73	7	.47	2	.70	1	0.39
23 Apparel	112	4.80	59	3.95	9	3.16	9	3.51
24 Lumber	129	5.53	71	4.75	16	5.63	11	4.30
25 Furniture	100	4.29	67	4.48	13	4.57	10	3.91
26 Paper	54	2.32	44	2.94	14	4.92	8	3.12
27 Printing	191	8.19	140	9.36	16	5.62	17	6.64
28 Chemicals	198	8.49	130	8.70	24	8.45	32	12.50
29 Refining	25	1.07	14	.94	3	1.05	3	1.17
30 Rubber/Plastics	93	3.99	71	4.75	19	6.69	16	6.25
31 Leather	14	.60	6	.40	--	--	1	0.39
32 Stone/Clay/Glass	226	9.70	111	7.42	25	8.80	8	3.12
33 Primary Metals	32	1.37	20	1.34	5	1.76	6	2.34
34 Fabricated Metals	294	12.62	224	14.99	40	14.08	44	17.20
35 Machinery	218	9.35	166	11.11	29	10.21	39	15.24
36 Electrical Machinery	105	4.50	87	5.52	11	3.87	20	7.82
37 Transportation Equipment	86	3.69	59	3.95	13	4.57	3	1.17
38 Instruments	35	1.50	32	2.14	7	2.46	6	2.34
39 Miscellaneous	93	3.90	72	4.82	9	3.16	9	3.51
Total	2,331	100.00	1,495	100.00	284	100.00	256	100.00

firms having an opportunity to be selected for personal interview, 926, or approximately 68%, are located in areas serviced by the Interstate program "with frontage roads", while only 232 firms, approximately 17%, selected sites in areas serviced by the Interstate program, but "without frontage roads". The remaining 206 firms were classified within the "Interstate Highway Programmed" category.

It would appear to be significant that the larger percentage (68%) of firms in the total universe located in areas serviced by the Interstate program "with frontage roads", but, while this tends to be a trend, consideration should be given to the Interstate program specifications. For example, one of the objectives of the National System of Interstate and Defense Highways is to connect the principal industrial centers of the nation, and the State of Texas is no exception. Of the 32 cities with population over 25,000 shown on the maps in Appendix A, 22 cities are serviced by the Interstate System; and in these cities is where the large percentage of this states' manufacturing industry is located. For instance, the four cosmopolitan cities of Dallas, Fort Worth, Houston, and San Antonio account for 40.6% of the total manufacturing industry. Therefore, it must be concluded that the location of the Interstate Highway System, designed to encompass these cities, was in fact influenced by industrial development.

Tables 1.13 and 1.14 provide a distribution of 284 personal interview sample firms and 256 returned mail questionnaire firms by city size and status of Interstate Highway construction. From this table a comparison of specific categories of industrial site locations may be made. For example, where Interstate Highways are completed or under construction within city size 1 it is noted that 63 firms were personally interviewed

TABLE 1.13

284 PERSONAL INTERVIEW SAMPLE FIRMS' LOCATION BY
CITY SIZE AND STATUS OF IMPROVEMENT TO IHS

Status	City Size								Total	Percent of Total
	1	2	3	4	5	6	7	8		
Complete with frontage roads	57	19	19	1	11	5	18		130	45.77
Under construction with frontage roads	6	2	8		3	2			21	7.40
Complete without frontage roads	17	21			1				39	13.73
Under construction without frontage roads	17	1				1			19	6.69
No construction (Programmed)	17	15	20	3	6	1	10	3	75	26.41
Total	114	58	47	4	21	9	28	3	284	100.00

TABLE 1.14

256 MAIL QUESTIONNAIRE FIRMS' LOCATION BY CITY
SIZE & STATUS OF IMPROVEMENTS TO IHS

Status	City Size								Total	Percent of Total
	1	2	3	4	5	6	7	8		
Complete with frontage roads	130	6	13	1	3	4			157	61.33
Under construction with frontage roads	12		2		2	2	1		19	7.42
Complete without frontage roads	5	4					2		11	4.30
Under construction without frontage roads	16	1	1	1		1			20	7.81
No construction (Programmed)	24	7	8	2	1	1	6		49	19.14
Total	187	18	24	4	6	8	9		256	100.00

while 142 firms returned completed mail questionnaires. Again this points to the significance of stratification when the objective is to obtain representative data from the total universe. By observing the category "complete without frontage roads" it can readily be seen that stratification of the universe forced several observations into the personal interview sample, while the volunteer response to the mail questionnaire produced only five observations.

In summary, the purpose of this section has been to explain the methodology employed in the present study. The significance of the design of the sample and questionnaire for personal interviews to obtain sufficient, but representative data has been discussed at length. The purpose of the mail questionnaire as a control for statistical analysis was also discussed. Some comparisons of the firms observed from both the personal interview and mail questionnaire group have been made in order that the tentative findings reported in the next section, may be given more meaning.

TENTATIVE FINDINGS

Location Characteristics of the Firms Included in the Study

The distribution of firms selected for personal interview from eight city size classifications, shown in table 2.1, is the result of the manner in which the total universe of firms was stratified for sampling purposes. Since the large cities included in the first categories of this classification represent the major industrial centers of Texas and are also served by the Interstate Highway, it is obvious that the largest number of firms would appear in this group. As discussed previously, the purpose of stratifying the universe was to obtain representation from all types, sizes and locations of industrial firms. An example of what could have happened without this procedure is indicated by the voluntary response to the mail questionnaire. While 73 percent of the returned mail questionnaires were from firms located in the "cosmopolitan" city, stratification limited this number to approximately 40 percent of the total personal interview sample.

TABLE 2.1

COMPARISON OF THE DISTRIBUTION OF COMPLETED MAIL AND PERSONAL INTERVIEW QUESTIONNAIRES BY CITY SIZE

City Size	Personal Interview	Percent of Total	Mail Questionnaire	Percent of Total
Cosmopolitan	114	40.1	187	73.1
Metropolitan	58	20.4	18	7.0
Large City	47	16.5	24	9.4
City	4	1.4	4	1.6
Small City	21	7.4	6	2.3
Town	9	3.2	8	3.1
Village	28	9.9	9	3.5
Rural	3	1.1	--	--
Total	284	100.0	256	100.0

A second characteristic of the firms to be studied was their location with respect to the Interstate Highway. It may be recalled that this factor was also used as a criterion in selecting the sample of firms to be interviewed. Table 2.2 shows the location of personally interviewed firms, as selected by the sample, with respect to their proximity to the Interstate Highway, stated in one-half mile increments.

The distribution of mail questionnaire firms, by distance from the Interstate, is also shown in table 2.2. It is to be noted that the distribution of response from the control (mail questionnaire) and personal interview firms is fairly evenly distributed by distance categories. Therefore, it may be assumed that, although the personal interview sample was stratified by distance from the Interstate, it does approximate the distribution of all firms within the universe by distance from this highway facility.

TABLE 2.2
LOCATION OF MAIL AND PERSONAL INTERVIEW FIRMS BY
DISTANCE FROM THE INTERSTATE HIGHWAY

Distance from Interstate (in miles)	Personal Interview	Percent of Total	Mail Questionnaire	Percent of Total
0.00 - 0.49	81	28.5	62	24.2
0.50 - 0.99	49	17.3	64	25.0
1.00 - 1.49	36	12.7	40	15.6
1.50 - 1.99	18	6.3	35	13.7
2.00 - 2.49	12	4.2	16	6.3
2.50 - 2.99	19	6.7	10	3.9
3.00 - 3.99	27	9.5	10	3.9
4.00 - 4.99	16	5.6	6	2.3
5.00 - Over	26	9.2	13	5.1
Total	284	100.0	256	100.0

A measure of the relative size of the responding firms, based upon number of employees, is shown in table 2.3. It is interesting to note that the percentage distribution of both the mail and personal interview firms, by employment, does not vary more than 5 percent within any employment classification. The fact that the sample was not stratified by size of employment makes this equality of distribution quite important. Since the personal interview group was selected at random with respect to firm size, and the mail questionnaire group depended upon voluntary response, the assumption that a representative sample of plant size, measured by employment, has been accomplished by both interview techniques is given considerable confidence. This table does, however, point up a possible need for additional interviews of larger firms prior to the completion of the project.

TABLE 2.3
DISTRIBUTION OF MAIL AND PERSONAL INTERVIEW
QUESTIONNAIRES BY EMPLOYMENT
OF RESPONDING FIRMS

Number of Employees	Number of Plants and Percent of Total			
	Personal Interviews	Percent of Total	Mail Questionnaire	Percent of Total
Under - 8	76	26.7	81	31.7
9 - 24	88	31.0	79	30.2
25 - 49	57	20.0	24	16.6
50 - 99	25	8.8	25	9.9
100 - 249	17	6.0	17	6.7
250 - 499	7	2.5	4	1.6
500 - 999	2	0.7	3	1.3
1000 - 4,999	2	0.7	--	--
Over - 5,000	1	0.4	--	--
No Response	9	3.2	5	2.0
Total	284	100.0	256	100.0

Other characteristics of the sample also indicate representativeness. Although the personal interview sample was not stratified by type of plant location, tenancy, market area distribution, or annual gross sales volume, it does cover the component groups involved in these categories rather well.

The distribution of mail and personal interview firms, by type of location, appears to be somewhat different between the two groups. For example, table 2.4 indicates that approximately 63 percent of the personal interview firms were new locations (either a new plant or a new branch plant of an established firm) while 53 percent of the control group may be classified in this manner. Preliminary findings show that plants with less than 24 employees tend to fall into the new or new branch plant category while the larger plants are generally identified with the relocated group. One explanation may be that the relocated plants include firms which had grown large enough to seek alternative sites for expanded operations while the new plants interviewed have not yet exceeded the requirements of their original plant site. Based upon these preliminary findings, the impact that highway access may have upon the location of these two categories of firms is worth further investigation.

TABLE 2.4

DISTRIBUTION OF MAIL AND PERSONAL INTERVIEW FIRMS
BY TYPE OF PLANT LOCATION

Type of Location	Personal Interview		Mail Questionnaire*	
	Total	Percent of Total	Total	Percent of Total
New	121	42.6	80	34.2
New Branch	57	20.1	44	18.8
Relocated	88	31.0	83	35.5
Relocated Branch	18	6.3	27	11.5
Total	284	100.0	234	100.0

*22 firms did not respond to this question.

Differences in plant ownership by respondents to the mail and personal interviews is shown in table 2.5. The fact that a 16 percent differential exists between tenancy of these two groups may be partially explained by the relatively greater response to the mail questionnaire by firms located in the large cities. Since a large percentage of the firms located in cities of more than 100,000 population have less than 24 employees and are generally classified as having new or new branch plant locations it may be assumed that a high incidence of "leased" firms would appear in this group. This assumption is supported by the fact that 66 of 144 (58%) personal interview firms located in the largest city classification were leased while 124 of 187 (66%) returning mail questionnaires from the same city classification were from owner-managers of leased facilities. Preliminary analysis tends to indicate that tenancy may be a significant factor in determining management's willingness to select industrial sites on or near the Interstate Highway facility.

TABLE 2.5

DISTRIBUTION OF MAIL AND PERSONAL INTERVIEW
FIRMS BY TYPE OF TENANCY

Tenancy	Personal Interview		Mail Questionnaire	
	Number of Firms	Percent	Number of Firms	Percent
Own	161	56.7	104	40.6
Lease	123	43.3	152	59.4
Total	284	100.0	256	100.0

The distribution of the 284 personal interview sample plants by annual gross sales provide further evidence of the frequency of small plants locations mentioned previously. Approximately 55 percent of the plants interviewed had annual gross sales of less than \$500,000 in 1964 (see table 2.6 below).

TABLE 2.6

DISTRIBUTION OF PLANTS IN PERSONAL INTERVIEW
SAMPLE BY ANNUAL GROSS SALES FOR 1964

1964 Gross Sales	Number of Plants	Percent of Total
Under \$ 100,000	56	19.7
101,000 - 250,000	55	19.3
251,000 - 500,000	44	15.4
501,000 - 1,000,000	29	10.2
1,001,000 - 5,000,000	54	19.0
Over - 5,000,000	17	5.9
No Response	29	10.2
Total	284	100.0

According to table 2.7 the market area of distribution for the 284 personal interview firms indicate that at least 92 percent of the firms distribute their products to other than local areas. In addition the table shows that, due to the nature of their markets, 74 percent of the plants interviewed depend, to some extent, upon state and regional highways for the marketing of their products.

TALBE 2.7

DISTRIBUTION OF PLANTS IN PERSONAL INTERVIEW
SAMPLE BY MARKET AREA

Market Area	Number of Plants	Percent of Total
Local	23	8%
District	40	14
County	25	9
State	26	9
Regional	75	26
National	61	22
International	34	17
Total	284	100%

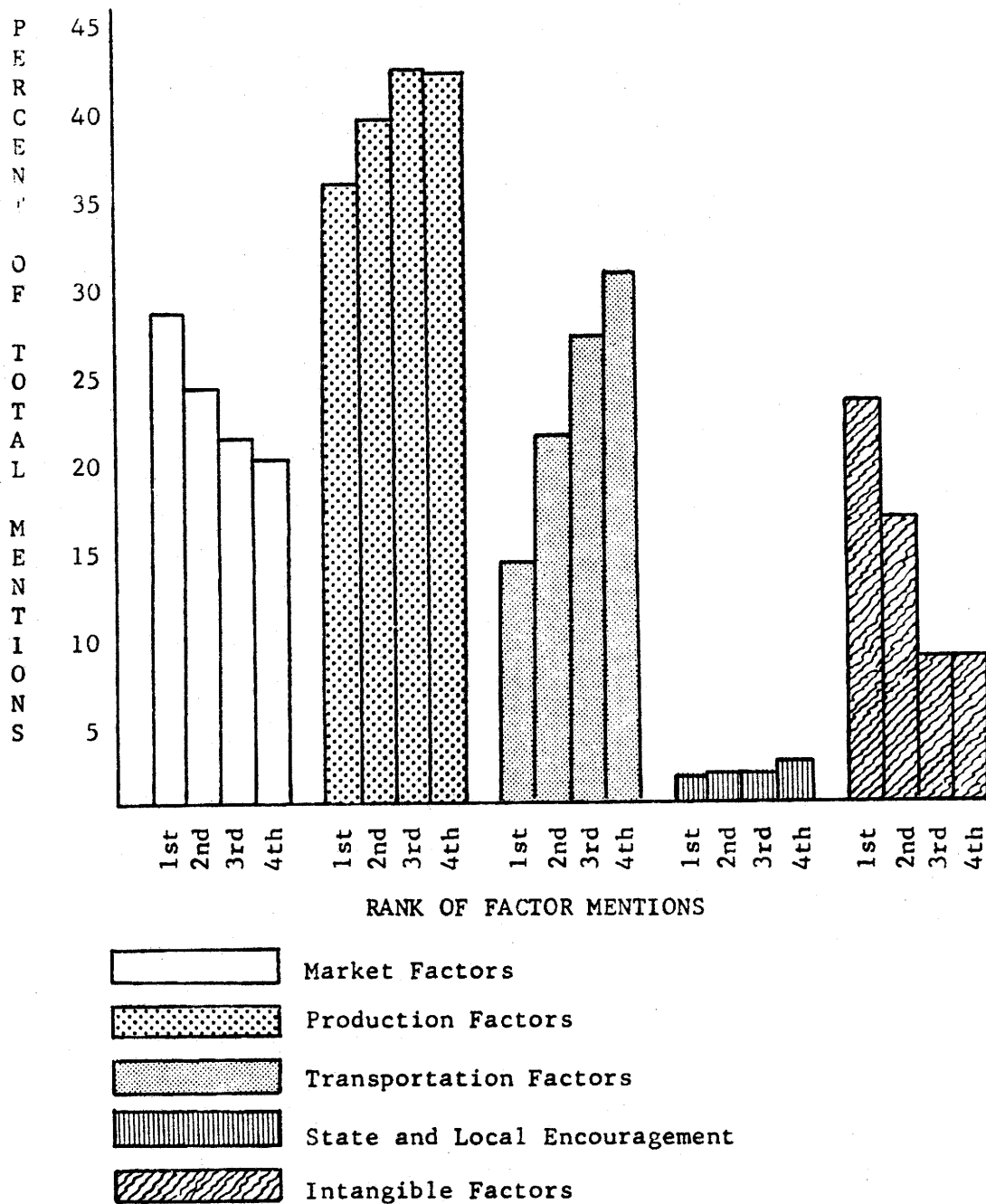
The preceding tables indicate that the primary objective of the stratified random sample design have been accomplished. In addition, the response to the mail questionnaire suggest that specific controls may be utilized in the analysis of certain data. These two facts should contribute to a more meaningful interpretation of the reported data.

The Location Process

In an attempt to determine those locational factors that were considered in the selection of a particular industrial site, each of the respondents were asked the question, "What caused you to locate at this site"? Although the questionnaire included a list of major locational factors to be used as a reference by the interviewer, it was not made available to the interviewee. As a result only the respondent's verbatim statements, as to the factors deemed important in selecting the plant site, were recorded. Later when these factors had been coded and machine processed they were treated to a categorization of locational factors which was developed in the Miller Thesis. The result of this treatment is shown in Figure 3.1. Most respondents attempted to rank at least three factors that they considered to be important in locating their plant. Many, however, ranked as many as five factors.

Figure 3.1 provides an opportunity to compare the relative frequency of the major locational factors according to the ranking of the respondents. Market factors appear more frequently as a primary factor than as a secondary or tertiary consideration. Intangible factors are also more frequently considered primary than secondary determinants in site selection. Transportation factors, on the other hand, are mentioned more frequently as a second and third-rank factor than as a primary factor. There does not, however, appear to be much variation in the frequency of production factor mentions as they are ranked, while state and local encouragement occur more frequently as second and third-rank factors. Throughout the analysis of the data all firms will be classified as to the five location factors listed in Figure 3.1. An attempt is being made to measure the

FIGURE 3.1

RANKING OF ALL REASONS FOR SELECTING PLANT LOCATION^a

^aThis chart is based upon 1148 total mentions that were categorized into five major factor groups. The rank of each factor mention was original with the responding plant official.

influence of the Interstate Highway System, with and without the construction of frontage roads, upon locational decisions of officials of these five industrial classifications. At this writing this particular analysis has just begun, therefore, nothing substantial can be reported at this time.

The extent to which the management of a firm investigates a possible industrial site prior to its decision to locate a plant should indicate that some degree of consideration has been given to street and highway accessibility. It was somewhat disappointing to learn that approximately 48 percent of the sample firms interviewed made no attempt to carry out a formal or informal survey of the site prior to its selection for the location of a plant. Only 34 percent of those who did conduct surveys considered their approach sophisticated enough to be considered a formal survey. In all but approximately 10 percent of plants, these studies were conducted by representatives of the firm without outside assistance from private, community, or governmental groups. In more than 90 percent of the firms where surveys were conducted the respondents indicated that the decision to locate was based upon the results of the survey.

Approximately 50 percent of the respondents indicated that they did consider alternative sites prior to their decision to locate. Table 3.2 shows a breakdown of the alternative sites considered.

TABLE 3.2
LOCATION OF ALTERNATIVE SITES

Location	Number of Plants	Percentage
Within same City	66	56%
In other cities	43	36
In other states	10	8
Total	119*	100%

*63 firms did not consider alternative sites or did not know if alternative sites were considered.

The Highway as a Factor in Plant Location

At this point, rather than analyze the influence of the network of all highways upon plant location, this report will concentrate on the significance of the Interstate Highway as measured by the respondents to the personal interviews. Previous studies of the highway as a factor in plant location conclude that most small plants, and in fact many large concerns, are not significantly influenced by the location of Interstate Highway facilities per se. Thus far, the results of this study tend to bear out this observation. For example, when respondents were asked if any attempt was made to evaluate the type and class of highways or streets available to the plant site, prior to their location decision, 48 percent answered no; 43 percent answered yes; and the remaining 9 percent did not know whether or not an evaluation of this factor had been attempted. However, when these same respondents were asked to rank the current importance of Interstate Highways, relative to other road facilities, the Interstate facility was ranked highest in importance.

By comparing the different mean ranks Table 4.1 shows the relative importance of each road facility. As indicated in the table the road facilities were ranked by the respondents in the following order of importance: (1) Interstate Highways, (2) Intra-city streets, (3) U. S. Highways, (4) State Highways, (5) Loop highways and (6) Farm to market roads. The importance of intra-city streets among the sample plants can possibly be explained by the large number of small firms that were located in metropolitan areas where most of the product distribution was to the local area.

TABLE 4.1
THE IMPORTANCE OF SIX TYPES OF ROAD FACILITIES
TO THE PLANT'S OPERATION

Type of Road	1st	2nd	3rd	4th	5th	6th	Mean Rank
Interstate Highways	81	49	61	26	13	14	2.52
Intra-city Streets	109	30	30	19	36	29	2.72
U. S. Highways	30	53	71	56	24	4	3.01
State Highways	28	56	78	52	29	1	3.23
Loop Highways	17	71	32	43	54	11	3.35
FM Roads	8	16	22	35	33	113	4.80

Note: In those instances where facilities were ranked equally the data have been excluded from the table.

The type of plant location and the importance of Interstate Highways.

What are the characteristics of those plants that tend to rank the Interstate Highway as the most important type of road facility to their shipping operation? The following tables show variation in the importance of Interstate Highways to the plant operation among the sample plants according to access distance, employment size, market area, etc. Significant variation in these characteristics according to the chi-square test of independence offers some indication of the type of plant operation whose owner/manager considers the Interstate Highway more important than other road facilities.

It is hypothesized that if two categories are independent, the contents of the individual cells should be proportional to the frequencies exhibited by the border totals. The test criterion (chi-square) is reported for each table, together with an evaluation of the probability that such value could arise due to chance alone. In the following series of tests, variation from the expected frequency exhibited by the border totals will be designated and discussed as "significant" if the probability

of no variation is less than 0.10. It is recognized that this specification is arbitrary but necessary in discussing significant variation among the important locational factors.

A significant chi-square in Table 4.2 indicates a higher proportion of plants locating within 0.4 miles of the Interstate Highway System tend to rank this facility higher than any other type of road. On the other hand, plants locating over 1.5 miles from this facility tended to rank some other road facility as more important to their shipping operation.

TABLE 4.2

THE IMPORTANCE OF THE INTERSTATE HIGHWAY ACCORDING
TO THE ACCESS DISTANCE FROM THE PLANT SITE

Access Distance to Nearest Interstate (Highway)	Number of Plants Ranking Interstate Highway:		Total
	Primary	Secondary	
0.0 - 0.4 miles	30	45	75
0.5 - 0.9	11	34	45
1.0 - 1.5	14	21	35
Over 1.5	26	86	111
Total	81	186	267 ^a

Chi-square = 8.10 with 3 d.f.; P less than .05.

^a17 plants did not respond.

Table 4.3 shows that a higher ratio of plants with more than 49 employees tend to rank the Interstate Highway as more important to their operation than any other type of road facility. Plants with fewer employees tend to rank State highways, U. S. highways, city streets, etc., higher than Interstate Highways.

TABLE 4.3

THE IMPORTANCE OF THE INTERSTATE HIGHWAY ACCORDING
TO THE EMPLOYMENT SIZE OF PLANT

Employment Size of Plant	Number of Plants Ranking Interstate Highway:		Total
	Primary	Secondary	
Under 8	18	62	80
8 - 24	25	59	84
25 - 49	14	38	52
50 - 99	12	12	24
100 - 249	10	6	16
Over 249	2	9	11
Total	81	186	267

Chi-square = 15.61 with 5 d.f.; P less than .01.

In Table 4.4 a significant chi-square tends to confirm that a higher proportion of plants that distribute their product locally as opposed to on a state or regional basis consider the Interstate Highway secondary to other road facilities. As pointed out previously many of these small plants were located in larger cities where their distribution was confined to the immediate metropolitan area.

TABLE 4.4

THE IMPORTANCE OF INTERSTATE HIGHWAYS ACCORDING
TO THE MARKET AREA

Market Area	Number of Plants Ranking Interstate Highway:		Total
	Primary	Secondary	
Local	3	19	22
County	11	49	60
State	9	16	25
Regional	24	49	73
National	23	35	58
International	11	18	29
Total	81	186	267

Chi-square = 10.73 with 5 d.f.; less than .01.

The significant chi-square in Table 4.5 indicates that a significantly higher proportion of branch plants tend to rank the Interstate Highway higher than any other type of road facility. Non-branch plants tended to consider other facilities as more important. Two factors seem to contribute to the importance of the Interstate Highway to branch plants. First, branch plants are generally located to take advantage of expanding market areas. The extended markets require greater length of haul in the distribution of the firms product. The advantage of high speed controlled access facilities tend to be of more importance as the market area (area of distribution) is extended. Secondly, branch plants use a higher percent of private truck transportation than commercial. Tentative findings have shown that firms using their own trucks are much more sensitive to the type of highway facility that serves their plant and market area than those who use commercial trucks. In most instances the firms that relied heavily upon commercial truck transportation considered highway access and location to be a problem of the commercial trucks rather than one that could be associated with their plant.

TABLE 4.5

THE IMPORTANCE OF INTERSTATE HIGHWAYS ACCORDING
TO THE TYPE OF PLANT LOCATION

Type of Plant Location	Number of Plants Ranking Interstate Highway:		Total
	Primary	Secondary	
New Plant	32	82	114
Relocated Plant	19	66	85
New Branch Plant	20	32	52
Relocated Branch Plant	10	6	16
Total	81	186	267

Chi-square = 13.95 with 3 d.f.; P less than .01.

Table 4.6 represents a significantly higher proportion of plants locating in metropolitan areas that tend to rank some other type of road facility more important than the Interstate Highway. Again, city streets and expressways were much more important to these plants partially due to the fact that most of the urban area plant operations covered in the sample tended to be small with highly localized market areas.

TABLE 4.6
THE IMPORTANCE OF INTERSTATE HIGHWAYS ACCORDING
TO CITY SIZE OF PLANT LOCATION

Size of City in Which Plant has Located	Number of Plants Ranking Interstate Highway:		Total
	Primary	Secondary	
Metropolitan City	41	122	163
50,000 to Metropolitan	13	35	48
Small City and Rural	27	29	56
Total	81	186	267

Chi-square = 10.78 with 2 d.f.; P less than .01.

In response to the more indirect questioning concerning the reasons for selecting a particular site, few officials mentioned highways or streets as primary factors. Many more, however, referred to this factor as a secondary consideration. Most respondents mentioned the availability of trucking services rather than highway access per se. The highway factor, therefore, has special meaning for different plants. In particular, plants that ship by common carrier rather than private trucks tend to be less sensitive to the type and class of highway access.

The Importance of Access

One of the most significant objectives of the project is to study the

importance of highway access as it bears on management's decision to select a given industrial site for the location of a manufacturing firm. Several questions relating to this particular objective were included in the personal interview. However, preliminary analysis of the response to these questions indicate that additional information must be obtained in order to provide a thoroughly reliable approach to this objective. Although weakness of current data for an analysis of this particular objective have been indicated, the specific areas in which additional information should be obtained have been isolated in this phase of the project.

To the plant official, time is considered the most significant measure of access to highway facilities. Table 4.7 shows the respondents measure of the relative importance of time to other access availability factors.

TABLE 4.7

IMPORTANCE OF ACCESS TO HIGHWAY FACILITIES

Factor	Number of Plants	Percentage
Time	159	56.0
Distance	23	8.1
Availability	69	24.3
Time & Distance	16	5.6
Time & Availability	6	2.1
No Response	11	3.9
Total	284	100.0%

When asked if their current access to highway facilities was adequate 83 percent of the respondents answered yes. Of the 44 who did not feel that they had adequate access, 27 associated the Interstate Highway, in particular, with their problem.

Lack of satisfaction with frontage roads in the immediate plant area was of primary concern to 16 of these 27 firms. However, most of this dissatisfaction centered around a need for two-way traffic on the frontage road rather than the lack of construction of such facilities.

SUMMARY

As a result of this limited investigation and the analysis of tentative data the following generalization may be stated:

1. Although the personal interview sample was drawn from a stratified population, control data indicate that the sample is representative of the total universe when such characteristics as plant size, type of plant location, market area of distribution, gross sales and location by distance from the Interstate Highway considered.
2. The survey method employed in the collection of data from the sample firms has definite limitations, however, a realistic attempt has been made to reduce many of the errors normally associated with the survey method by designing a questionnaire that would provide sufficient and accurate data.
3. Less than 35 percent of the firms interviewed made a formal survey of the plant site prior to its selection for the location of a plant.
4. Market factors appear more frequently as a primary factor in a decision to locate a plant than does production factors, transportation factors, or intangible factors.
5. A high percentage of small plants (less than 24 employees) are located in the larger cities. Generally speaking, these firms

are operating in leased facilities rather than having plant ownership.

6. Preliminary findings show that small plants tend to fall into the "new" or "new branch plant" category while the larger plants tend to make up the relocated plant group.
7. Approximately 92 percent of the firms interviewed, distribute their products to other than local areas. In addition, 74 percent of the sample firms depend, to some extent, upon state and regional highways for the marketing of their products.
8. The sample firms ranked importance of highway and street facilities to their plant location in the following order of importance: (1) Interstate Highways, (2) Intra-city streets, (3) U. S. Highways, (4) State Highways, (5) Loop Highways and (6) Farm to market roads.
9. To the plant official, time is considered the most significant measure of access to highway facilities. In particular, plants that ship by common carrier rather than private trucks tend to be less sensitive to the type and class of highway access available.
10. In general, plant officials that ranked Interstate Highways more important than other types of roads or streets were from branch plants that were: (1) located within 0.4 miles of the Interstate Highways having more than 50 employees; (2) at least a regional market distribution, and (3) located in cities of less than 50,000 population.

APPENDIX A

FIGURE 1.5
DISTRIBUTION OF MANUFACTURING FIRMS OUTSIDE INFLUENCE
OF INTERSTATE HIGHWAY SYSTEM LOCATING IN TEXAS
BETWEEN JANUARY 1, 1956 AND JANUARY 1, 1964

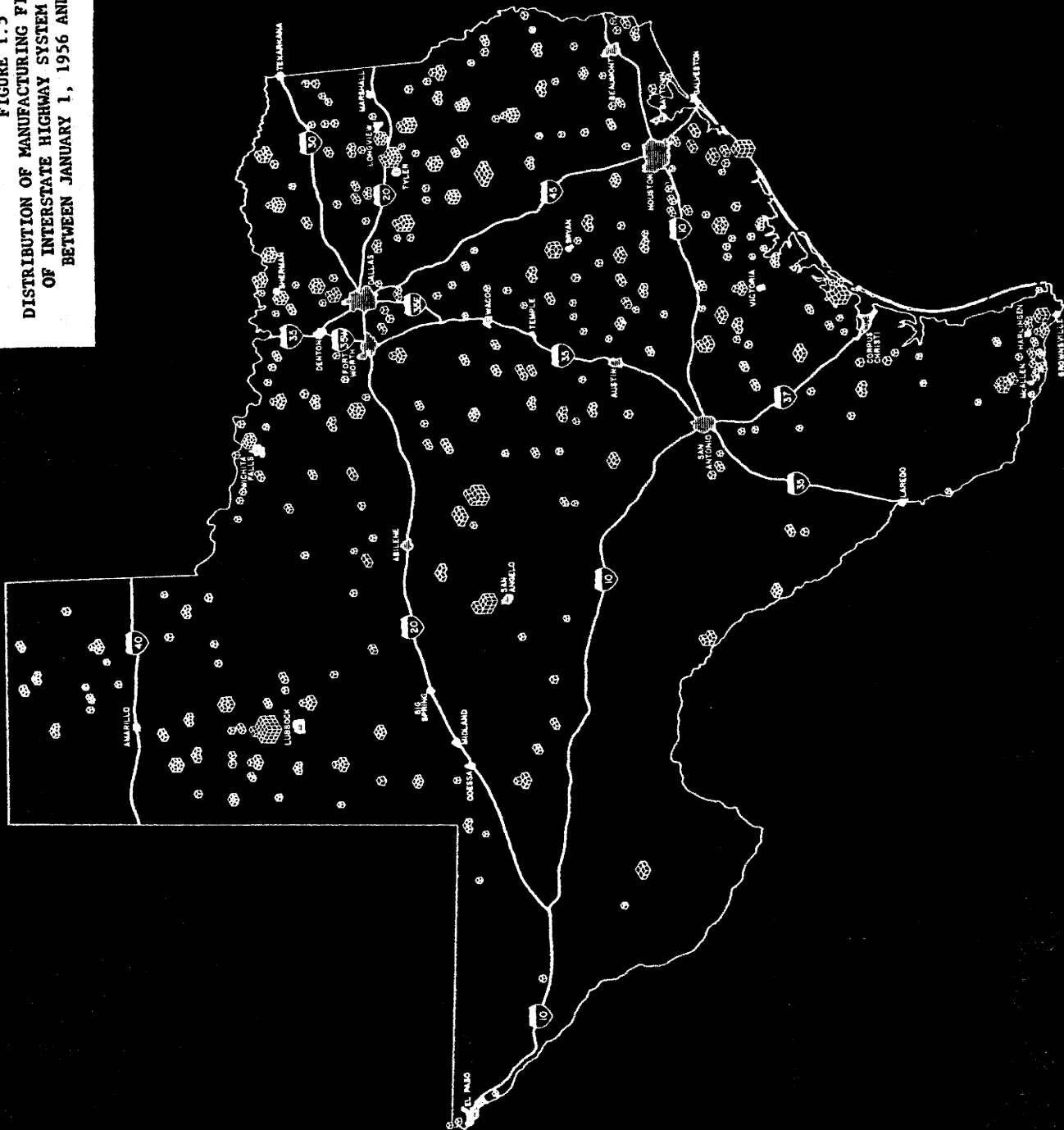
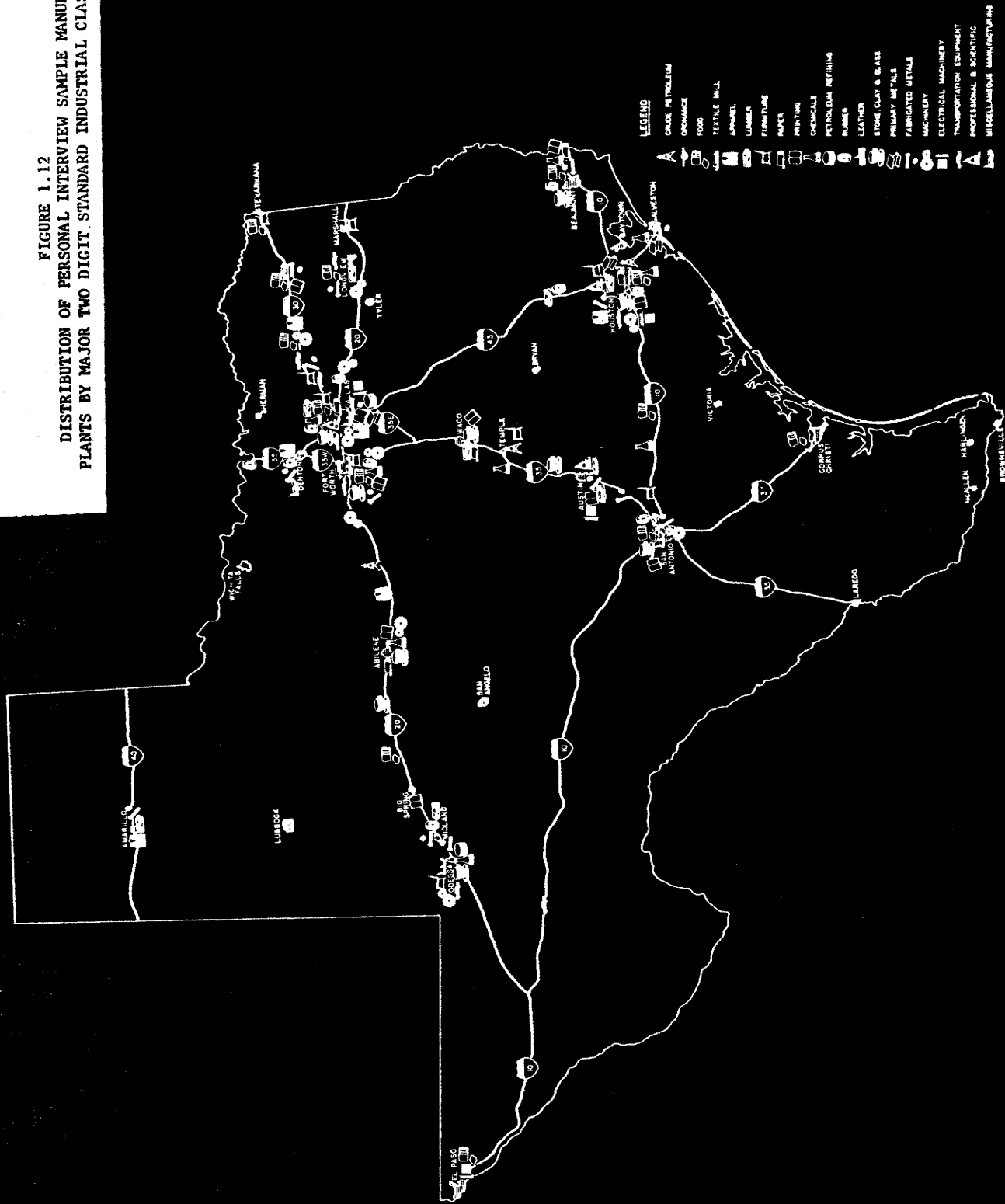


FIGURE 1.12
DISTRIBUTION OF PERSONAL INTERVIEW SAMPLE MANUFACTURING
PLANTS BY MAJOR TWO DIGIT STANDARD INDUSTRIAL CLASSIFICATION



APPENDIX B

TABLE 1.10
UNIVERSE DISTRIBUTION

Located on IHS		1,495 (64%)
Personal Interview		632 (27%)
Interviewed	284 (12%)	
Alternates	248 (11%)	
Out of Business	54 (02%)	
Refused	7 (01%)	
Deleted	39 (02%)	
Mail Questionnaire		863 (37%)
Returned	256 (11%)	
Non Returned	560 (24%)	
Out of Business	47 (02%)	
Located off IHS		836 (36%)
Non Mailed	818 (35%)	
Mailed	18 (01%)	
Total Universe		2,331 (100%)