A STUDY OF INTERSTATE HIGHWAYS, FRONTAGE ROADS AND INDUSTRY LOCATION

By

Hoy A. Richards, James P. Miller
and William H. Allio

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FOREWORD

At the time this study was undertaken the state of Texas was deeply involved in the design and construction of the Interstate Highway System. It was widely recognized that this massive facility would have a significant impact upon both the present and future economy of the state. The exact nature and extent of this impact however, could not be accurately estimated on the basis of previous experience with older type facilities.

This study is part of an overall research program designed to provide information to the Highway Department to assist them in their decision-making concerning new highways. The purpose of this particular study was to determine the influence that the Interstate Highway System of Texas has had on the location of industrial activity within geographic areas serviced by the facility. More specifically it was intended to provide information about the importance of frontage roads on industrial plant location.

As the study progressed, it became clear that a direct comparison between highway sections with frontage roads and those without frontage roads would not be possible. There were not enough sections built without frontage roads to make a statistically reliable comparison possible in each of the categories. Instead the study was reoriented to an analysis of the influence of the Interstate System on plant location in general with every effort being made to isolate and examine the differences between sections with and without frontage roads.

It is felt that this analysis furnishes information that is critically needed by highway planners, designers and administrators. It helps answer the questions "How many, what kind and where will industrial plants locate along the Interstate Highway System" and "How do frontage roads influence these decisions."

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Continual refinement in plant location theory has in recent years been supplemented by empirical investigation of factors affecting actual location decisions. A review of location theory and selected empirical studies has revealed that the factors recognized by location theorists are susceptible to empirical verification. These factors were especially useful, as theoretical criteria, to the development of an empirical model for the analysis of survey data gathered during the course of this study.

In general there is considerable variation among the various types of location factors influencing plant site selection according to the different characteristics of the firms in the survey. For example, there is a tendency for site selections involving branch plants, new plants, plants with more than 24 employees, and plants with annual gross sales in excess of $500,000 to be primarily influenced by either transportation cost or market considerations. On the other hand, site selections involving non-branch plants, plants with less than 24 employees, plants with gross sales less than $500,000 annually and relocated plants are found to be primarily influenced by either production cost or intangible factors.

The primary factors influencing most plant locations included in the sample were cost factors. The revenue-increasing factor, which usually implies access to customers, was important in only thirty five plant location decisions. The purely personal factor influenced sixty four location decisions. Proximity to the owner-manager's home and the availability of industrial property that had already been purchased or leased were the more important intangible influences.

There was some tendency for plants distributing products regionally as opposed to locally, to locate on the basis of transportation considerations. In general, there is a tendency for industries producing non-durable goods to be influenced by either transportation or market factors in selecting plant locations, while durable goods industries tend to consider either production costs or intangible factors as primary location factors.

It may be concluded from this study that transportation factors are generally considered as having secondary influence upon plant location while production and market factors are given primary consideration in location decisions.

Concerning the type of investigation used in finding and selecting the plant site; non-branch plants, relocated plants, plants with small employment, plants with low annual sales volume, and plants distributing locally tended to be located on the basis of a personal investigation by a plant official. The larger plants and branch plants, without regard to size, are usually located by either an intra-company committee or with some type of outside assistance.

Although a few plant officials stated that they would not seek a site similar to the one they now occupy, if the opportunity were available, most plant officials interviewed were satisfied with their current plant location. The disadvantages most frequently associated with the present plant locations were largely in reference to the lack of suitable production factors (building, site characteristics, etc.) and the lack of transportation services and facilities, while market and intangible factors were less frequently mentioned as disadvantages.

Interstate Highways and Frontage Roads as Factors in Industrial Location

As a result of this investigation and an analysis of the finding, the following generalizations and conclusions in regard to Interstate Highways and frontage roads as factors in industrial plant location decisions have been prepared.

The relative importance of frontage vs non-frontage areas to study firms in the selection of plant sites categorized by those firms locating before construction of the facility and those locating after the facility had been completed may be seen in the fact that while 68 percent of the firms locating prior to interstate construction chose frontage road locations, 75 percent of the firms locating after the interstate was completed selected sites in areas where the facility has been constructed with frontage roads. Firms locating after construction of the Interstate Highway have placed considerable importance upon the facility, and its accessibility by way of frontage roads, in plant location decisions. Just as important, from the standpoint of future development, firms locating prior to the completion of Interstate Highway construction that now have a facility with frontage road access serving their area, have experienced significant changes in the availability of transportation services to their site many of which may be attributed to the availability of frontage roads.

Approximately 70 percent of all industrial locations occurring during the study period may be accounted for in Texas' four large metropolitan cities. Frontage road locations accounted for seven out of ten of these

locations. In satellite communities surrounding the large metropolitan cities, frontage road locations represent only 35 percent of all firms locating in this city size category. A significantly higher proportion of the firms locating in the smaller cities ranked the Interstate Highway above all other facilities than did those who chose the metropolitan areas. The importance that firms, located in the smaller cities, placed upon highways and streets is revealed by the fact that three out of four firms locating in these cities made an evaluation of these facilities prior to their location, while one of three firms locating in the metropolitan areas conducted this type study. Although more than one half of the study firms located in the "fringe" area of the city, the city zone has had little or no effect upon the location of these firms when measured by status of Interstate Highway construction i.e., with or without frontage roads within the zones.

During the period 221 of the 1,495 industrial firms included in the universe, selected plant sites within less than one-half mile of an interstate facility having frontage road access. However, only 38 of these firms were located on properties abutting frontage roads with direct access to the facility by way of the frontage road. Highways, other than Interstate Highways, provided access to the facility for approximately 46 percent of the study firms. With the exception of the direct access firms, status of Interstate Highway construction i.e., with or without frontage roads, has little or no effect upon the selection of a particular site by type of highway or street access the plant has to the Interstate Highway.

Although firms locating within one-half mile of the Interstate Highway ranked this facility higher than all other highways and streets as important to their location, there appears to be no significant trend for firms to select plant sites either nearer or further away from the facility

based solely upon the availability of frontage road access.

Approximately two-thirds of the firms locating during the study period chose sites within one-half mile of the railroad. Firms locating beyond one half mile of the railroad tend to be oriented toward the non-frontage and programmed areas. Only ten percent of the study firms chose sites that would require the crossing of the Interstate Highway to have railroad access to the plant. In general the findings suggest that non-frontage road locations made their strongest showing in the least desirable industrial areas. Owned and leased firms were equally divided in the non-frontage area. However, there is a trend for leased firms to be oriented toward frontage road areas while firms who own their plant sites are more prevalent in the programmed areas suggesting that some consideration has been given the future development of the Interstate Highway System by the plant owners. Although statistical analysis do not indicate a significant difference between owned and leased firms, in the selection of frontage and non-frontage plant sites, analysis does indicate that a significantly larger proportion of the firms who purchased plant sites evaluated highway and streets serving the site, prior to their location, than did those firms leasing plant facilities.

Sixty-three percent of the study firms may be classified as having been relocated from a previous site. Findings do not indicate that these firms differ from new firms in the importance that is placed upon the construction of the Interstate Highway, with or without frontage roads, in the selection of a particular plant site.

Non-frontage and programmed areas indicate little attraction for branch plants although the officials of these plants rank the Interstate Highway over all other highways and streets in relative importance to

their plant site. Main plants ranked highways, other than Interstate, and streets as being of primary importance to their current site. However other findings suggest that firms in this category are experiencing significant changes in transportation service which will increase the importance of the Interstate Highway in future location decisions.

Firms distributing their products to local markets make up a large proportion of the programmed area locations. It was found that as product distribution increases in scope, industrial sites in non-frontage road areas become more attractive, programmed areas become less attractive and frontage road areas indicate no particular effect. A relatively small proportion of the firms distributing their products locally conducted studies to determine the availability of streets and highways to the plant site; while a higher percentage of the firms distributing their products on regional and national basis made detailed evaluations.

Firms having annual sales of less than $250,000 tend to be located in areas serviced by the Interstate with frontage roads. In general as annual sales increase non-frontage road locations become more attractive as industrial sites. Size of employment tends to contribute to the importance of the Interstate Highway to individual plants. Plants with small employment tend to rank highways, other than Interstate Highways, as most important to their plant location while the Interstate Highway is ranked first among firms with more than 50 employees.

Findings in this study suggest that plants located in frontage road areas differ significantly from plants located in non-frontage and programmed areas by type of transportation servicing the plant and by volume of automobile trip generation.

INTRODUCTION

The construction of the Interstate Highway System has brought about significant changes in the traditional array of locational factors considered in the selection of industrial sites. In particular, among the transportation factors of plant location, highways and trucks are playing an increasing role in their importance to industrial development.

Construction of the Interstate has opened up land for industrial development that was previously inaccessible by any mode of transportation. Just as important, the construction of the facility has also provided highway access to properties with previous rail and/or water accessibility making these areas now prime industrial site locations.

Although interchanges have always been an integral part of the Interstate System by providing access to other highways and streets, frontage roads are becoming more important as the need for more frequent access to the facility increases. Industry can be expected to choose sites along or within easy access to entrance points to the interstate facility since these sites, even though sometimes located outside established industrial areas or in small cities, have all the advantages of accessibility to suppliers, related industries, markets, etc. that a similar plant may have in the large metropolitan areas. The opening of new interstate routes makes available large tracts of land which provide not only needed room for expansion, but also room for parking. Also additional space for motor carrier docks tend to encourage efficient highway transportation service.

However, the growing attractiveness of interstate abutting properties for commercial and residential use is causing the price of these lands to increase sharply. Industrial manufacturers are faced with the choice of substituting high cost abutting locations for lower cost properties which may be located some distance from the facility. This tendency of the interstate highway to increase property values may in fact be a deterrent rather than an asset to industrial development, suggests an executive of a large Chamber of Commerce In Texas.

As industry seeks industrial sites located near the interstate highway having the "best" access available, how important is frontage road access to the plant location specialist? Obviously, direct access may no longer be the most important factor in the selection of a particular industrial location. For example, related street access may now become an integral part of the location decision. Other locational factors also change their significance, in their order of importance to the overall site selection.

This report is being presented in three sections. The first section is primarily a review of plant location theory and is included here in order to provide a basic background.

Section II describes the nature of the location process and the manner in which decisions are made in regard to industrial plant site selection.

Section III brings together background and descriptive material, developed in the initial phases of the study, to provide an investigative approach to the relative significance of the Interstate Highway System in Texas to the selection of specific industrial plant sites.

To study this rather new relationship of industrial sites to the location of the interstate facility, whether completed with or without frontage road access, a broader band of Interstate Highway influence than just abutting properties must be analyzed. For this reason, the data included in this study have been obtained by personal interviews of 284 industrial firms randomly selected from a stratified universe of 1,495 manufacturing plants locating within five miles of the Texas Interstate Highway System during the period from January 1, 1956 to January 1, 1964. All interviews were conducted during the period from June 1, 1964 through December, 1965.

STATEMENT OF OBJECTIVES

Given the restrictions in accomplishing the objectives as outlined in the original project proposal, as described in the Foreword, the primary objective of this report is to furnish specific information for use in evaluating the potential effects of frontage roads, or a lack of frontage roads, on industrial development along the Interstate Highway System.

To complete the major objective, the following sub-objectives were accomplished during the course of this study. These were:

(1) 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 interstate facility.

(2) To determine whether there are operational or physical characteristic differences between industrial firms that have located in areas serviced by the Interstate Highway System constructed with frontage roads and those locating along the Interstate Highway System constructed without frontage road access.

(3) To determine benefits and advantages derived from the proximity of the industrial plant to the Interstate Highway facility and to evaluate the effect that frontage roads may have had on the location decision.

SCOPE OF THE STUDY

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 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 allocated to

Texas. Due to project requirements, the date January 1, 1964, was chosen as the cut-off date. It was assumed that these eight years would provide a sufficient period of time in which both Interstate Highway construction and industrial development, in areas serviced by the facility, had progressed sufficiently for observation and study. Only industrial firms locating within five miles of the interstate facility during the period from January 1, 1956 through August 3, 1963 are included in the study.

SECTION I

REVIEW OF PLANT LOCATION CONCEPTS

One important function of location theory has been identifying the basic economic factors that influence industrial location. A continuous development in the theory of location has resulted in a general system of classification in which all location factors are grouped under one of three broad categories--either cost factors, demand factors, or intangible factors. In the development of location theory, each of these factors has been identified by different location theorists as essential to an understanding of plant location.

Cost Factors. In his theory of location, Von Thunen was concerned primarily with agricultural locations. His theory, nevertheless, is applicable to manufacturing locations. Locational cost differences were considered to be due to land rent and transportation costs at alternative sites. Von Thunen's theory essentially states that the cost of producing (growing)agricultural products varies inversely with transportation costs, which vary proportionately with the distance from a given market center. [1]

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[1] For a discussion of Von Thunen's Der Isolierte Staat . . ., see M. L. Greenhut, Plant Location in Theory and Practice (Chapel Hill: University of North Carolina Press, 1956), p. 6.

Von Thunen assumes a uniform homogeneous plane which signifies that labor and capital are the same in unit cost and productivity at all locations. Under this assumption, land rent and transportation cost are co-determinants of location.

It is of interest to note that Von Thunen, in emphasizing these cost factors, failed to recognize the importance of the demand factor in location.

Another German location theorist, Alfred Weber, has advanced a theory of industrial location.[2] Though procedurally opposite of Von Thunen, Weber's theory also emphasizes cost factors.

Weber's theory is based upon three general factors of location: transportation cost, labor cost, and agglomerative forces. He defines the agglomerative factor as, "an advantage or cheapening of production or marketing which results from the fact that production is carried on to some considerable extent at one place. . ."[3]

Weber regards transportation and labor cost as general regional influences while agglomerating advantages (external economies of scale) are general local forces in the location of industry. Industry tends to concentrate within a region because of agglomerative consid-

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[2] C. J. Frederich (trans) Alfred Weber's Theory of Plant Location (Chicago: University of Chicago Press, 1928), pp. 20-23.

[3] Ibid., p. 126

erations; for example, cost and service advantages associated with locating in proximity to related industry and a concentration of customers. On the other hand, industry is attracted to certain regions because of low transportation or labor costs.

Weber recognized that the basic problem in plant location--either in selecting the plant site or in understanding a locational trend--involved the substitution of spatial cost factors to arrive at the least cost location. The optimum plant location is determined by substituting the following costs in least-cost combination: (1) transport costs, which include the cost of shipping and the different costs of fuel and raw materials at different sites, plus the agglomerating factors (proximity to auxiliary industries, marketing advantages); and (2) non-transport costs, which include the cost of labor and the land costs (rental, police and fire protection, etc.).

Weber's theory, however, assumed constant demand and he omitted institutional factors. These omissions rendered his theory incomplete and resulted in an inadequate explanation of plant location, especially within a capitalistic economy.

Edgar M. Hoover offers a more refined approach to understanding the forces in plant location.[4] While recognizing the influence of

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[4]Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill, 1948), pp. 58-61.

market areas and demand determinants, Hoover, like Weber, concentrates on the cost determinants, Hoover, like Weber, concentrates on the cost determinants of location--especially institutional costs.

He separates locational cost factors into two groups, transportation and production factors. Transportation factors are the costs of procuring the raw material and distributing the final product. Production cost factors include agglomerative factors, labor, land, and a wide spectrum of institutional considerations, such as geographical differences in taxes, utility costs, labor markets, and banking facilities. This inclusion of institutional factors represents a significant departure from Weber's approach. Hoover's analysis is less confined, for he is interested in all location factors that influence plant location rather than overly generalized regional factors. His analysis, therefore, is more penetrating than that of Weber.

Hoover's major contributions to the refinement of location theory are: (1) by modifying Weber's assumption that freight costs increase proportionately with distance in pointing out that freight cost increases <u>disproportionately</u> with distance because: (a) long haul shipments absorb proportionately less terminal expense than short hauls, (b) competing modes--rail and water versus motor carriers--have encouraged lower freight rates, and (c) high volume shipments characterize long hauls with resulting lower per unit rates; (2) a more penetrating analysis of Weber's agglomerative factor by expanding it to include such considerations as: better transfer services, a broader, more flexible labor market, better fire and police protection, low insurance and utility rates, and the availability of auxiliary services; and (3)

the clear distinction between transportation and production costs as they influence plant location.

Hoover recognizes that certain institutional costs along with the traditional transportation and labor cost factors vary significantly among alternative plant locations and are, therefore, important considerations. Moreover, the transportation cost factor is given special emphasis.

All three Weberian locational factors--transportation, labor, and agglomeration--are recognized by Hoover as subject to institutional "distortion." For example, the transportation factor is significantly distorted by both technology and combined public and private rate-making practices.

Greenhut has pointed out that Hoover's theory is very similar to Weber's in that both emphasize the minimum cost location. In comparing their approach, he observes that:

> The locational choice is again a problem of substitution among costs: now production cost and transportation cost, the ultimate being the minimizing of these expenses. In choosing from among alternative sites the Hoover adjustment is fundamentally one of a little higher transportation cost in exchange for a reduction in processing burdens . . .[5]

Greenhut further observes that Hoover's greatest weakness was his failure to more intensively analyze the effect of market demand upon plant location. This will be discussed in the following section.

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[5]M. L. Greenhut, Plant Location in Theory and Practice (Chapel Hill: University of North Carolina Press, 1956), p. 20.

The importance of the demand factor. Both Weber and Hoover have emphasized the overall importance of transportation and production costs in the location of industry. If one accepts that these costs are geographically variable while the market to be serviced is defined as constant, the location problem reduces to finding a plant site within a given market where total costs are minimum. It is important to recognize, however, that a site selected on the basis of minimum cost considerations is not necessarily the optimum location. Consideration must also be given to the extent of market (the number of potential customers) at any given location. As Symkay relates:

> In reality, market areas are at least geographically variable in terms of size, population density, purchasing power, consumer preferences, and competitive activity. In order to maximize profits, the firm must adjust its total market effort to accommodate the character of each market served.[6]

Chamberlin was one of the first economic theorists to recognize the impact of spatial considerations upon the extent of a firm's market. He recognized that the firm's potential market depended to a large extent on its location near potential customers where they could be served with efficiency and convenience. The location of a branch plant, for example, would not only entail minimizing costs (transportation and production) but would also determine the greatest number of customers that could be served conveniently and efficiently. The ultimate goal of the locating firm is to secure "spatial monopoly."

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[6]Edward H. Symkay, D. J. Bowersox, and Frank H. Mossman, Physical Distribution Management (New York: McMillan, 1961), p. 152.

Chamberlin writes:

> The availability of a commodity at one location rather than at another being of consequence to purchasers, we may regard these goods as differentiated spatially and may apply the term "spatial monopoly" to that control over supply which is a seller's by virtue of his particular location. Other things being equal, those who find their place of business most convenient to their homes, their habitual shopping tours, their goings and comings from business or from any other pursuit, will trade with him in preference to accepting more or less imperfect substitutes in the form of identical goods at more distant places; just as, in the case of trade-market articles and of goods qualitatively differentiated, buyers are led to prefer one variety over another by differences in their personal tastes, needs, or income.[7]

At another point, in discussing location as influenced by urban rent costs, he points out that "rent is not paid in order to save transportation charges. It is paid in order to secure a larger volume of sales."[8] Alternately stated, he is saying that the primary location factor influencing urban site-selection is the market; that the existing and potential demand for the firm's product as it varies from location to location is reflected by variation in the leasing costs.

Greenhut reaffirms this view and explicitly recognizes the demand factor as at least equally important in plant location as cost factors. As he relates, "the concepts of market area and variability of consumer demand per seller's location require a broader approach to location

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[7]Edward H. Chamberlin, The Theory of Monopolistic Competition (Cambridge, Massachusetts: Harvard University Press, 1933, second printing, 1958), pp. 62-63.

[8]Ibid., p. 152.

theory than a purely cost analysis."[9] He further points out that demand influences plant location by: (1) forcing plants to disperse to minimize freight costs in order to deliver their goods to certain buyers at lower prices than can be achieved by rivals; and (2) forcing plants to disperse to reduce travel time to the customer and thereby compete more effectively on service. In both instances, demand within a certain geographical area has encouraged the location in that area.

The location in market area "A", for example, as opposed to an alternative location in market area "B" results in greater long run profits because greater unit revenue, relative to unit cost, is realized by encouraging greater product demand through efficient customer service and lower prices due to lower freight costs. Market "B" may offer a location where processing costs (labor, taxes, etc.) are lower than in market area "A", yet "A" offers the optimum location in terms of minimum combined transportation and production costs relative to the existing and potential market.

This type of analysis is often presented graphically to describe the spatial adjustment of a locating plant once the Weberian assumption of a fixed market is discarded; i.e., constant demand is no longer assumed. The assumptions normally include: (1) a uniform geographical dispersion of customers; (2) freight rates that are linear with distance; and (3) customers which have, within the defined market area, identical

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[9]Greenhut, Plant Location in Theory and Practice, p. 140; See also M. L. Greenhut: "When is the Demand Factor of Location Important?", Land Economics, Vol. XL, No. 2, May 1964, p. 176.

preferences for the product offered; i.e., their preference or demand for the product is limited only by their "indifference."[10] This indifference is influenced only by the delivered price of the product, which in turn, is determined by the transportation cost as a linear function of the unit distance to the customer.

Under these assumptions the analysis of plant location is placed in the proper spatial framework in which the relative influences of cost and demand upon alternative locations are isolated for theoretical investigation. In effect, space is treated as variable under static time conditions. To maximize long-run profits, firms actively compete for those plant sites that will give them a competitive advantage in terms of transportation cost savings and customer service advantages. Many branch plants, for example, are located in peripheral market areas to take advantage of the lower transportation cost and service advantages that accrue at these sites. While processing costs may be, and usually are, higher at these peripheral locations, the branch plant is nevertheless located there because of favorable demand. Moreover, the peripheral branch plant will operate efficiently by selling at competitive prices (mill price plus transportation costs) to a small market. This profitable fringe location, however, ceases to be determinant when either non-price competition (product differentiation) or various discriminatory practices (basing point pricing) are introduced into the framework.

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[10] See Symkay et al, op. cit., pp. 152-153; also M. L. Greenhut, op. cit., Chapter VI.

To conclude this section, the demand factor has been recognized as an important determining factor in plant location depending upon the firm's particular market requirements (importance of customer service) and the influence of competitor's location (expansion of existing or potential market by locating in proximity to peripheral area customers).

Greenhut's general theory of plant location and the intangible factor. Melvin Greenhut's general theory is essentially an integration of the two general location factors--cost and demand--into a complete theory of plant location.[11] Greenhut recognizes that a firm's market requirements combined with the influence of the competitor's location will influence plant location as much as cost.

His general theory of location is essentially a general equilibrium theory in which transportation cost, production cost, and demand in the market are viewed as the key variables. The final solution is the optimum location of all firms within a theoretical region. Under the fundamental postulate of profit maximization, the location of each plant is determined at the site where transportation and processing costs are minimum and sales are maximum (MR = MC).

Greenhut mentions that location factors are divisible into three broad groups: demand, cost and purely personal considerations (intangible factors). From these factors he has developed the following listing:

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[11] M. L. Greenhut, "A General Theory of Plant Location," Metraeconomica, Vol. VII, 1955.

The demand factors include:

(1) The shape of the demand curve.
(2) The location of competitors.
(3) The competitiveness of the industry in location and price.
(4) The significance of proximity, type, and speed of service.
(5) The extent of market area.
(6) The relationship between personal contacts and sales.

The cost factors include:

(1) The cost of land.
(2) The cost of labor and management.
(3) The cost of materials and equipment.
(4) The cost of transportation.

The purely personal factors include:

The extent to which the minimax principle outweighs the quest for maximum profits. This principle includes:
(1) The importance of psychic income (size of plant).
(2) Environmental preferences.
(3) The security motive.[12]

According to Greenhut, these factors are essential to a systematic explanation of plant location in a capitalistic economy regardless of the time period under consideration; i.e., in the short run or long run. They are an attempt to describe the basic forces in industrial location. Moreover, every rational plant location involves balancing these factors (purely personal) must be considered to complete the theoretical explanation of plant location.

The purely personal or intangible factor describes at least three types of location decisions. The first is influenced by psychic income considerations. For example, the location decision-maker may, in selecting a non-profit maximizing plant location, be choosing personal satisfaction over financial reward. Greenhut has pointed out, however, that

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[12]Greenhut, Plant Location in Theory and Practice, pp. 279-281.

even this type location decision may become profitable in the long run by the owner-manager charging a lower imputed cost for his services and by improving his productivity because of greater satisfaction and contentment.

The second type of purely personal location decision is characterized by a strong environmental preference for a particular location. An example would be when a site-selection is limited to the owner-manager's hometown to be near friends and family.

Finally, the purely personal factors may describe the location decision when security is important. The owner-manager may select an inefficient location because there is either more assurance of an adequate profit or the relative security of home satisfaction. The more efficient location in terms of greater sales volume and lower production cost is considered a greater gamble.

This section has been devoted to a review of the fundamental factors underlying all plant location as recognized in location theory. The next section will review some recent empirical attempts to determine the actual significance of these factors.

Location Factors as Revealed by Empirical Study

Greenhut's case study. For empirical study, Greenhut has reduced the multitude of factors that influence plant site-selection to the following categories:

(1) Cost Factors
(2) Demand Factors
(3) Revenue-Increasing Factors
(4) Cost-Reducing Factors

(5) Personal Factors
    a. Revenue Increasing
    b. Cost Reducing
(6) Purely Personal Factors[13]

This broad system of classification may be used as an "empirical model" and conforms to Greenhut's maximum profit theory of plant location.

Greenhut defines these major factors as follows: (1) Cost factors refer to the overall expenses that enter into the final delivered cost of the product; e.g., labor costs, transportation costs, and processing costs such as raw materials and utilities; also important are land cost, capital cost, insurance cost, depreciation cost, and advertising cost. (2) Demand factors refer exclusively to forces which influence the attempt of an entrepreneur to exclude rivals from segments of the market; e.g., locational competitiveness of firms influences proximate location to customers. This factor describes the attempt to gain monopolistic control over customers by location. (3) Cost-reducing factors refer to certain "cost savings" that arise from locating in proximity to population and industrial centers. This is essentially the Weberian agglomerative factor that was discussed in the first section. In delineating this factor, Greenhut is attempting to distinguish between the savings that accrue at certain locations due to the availability of certain factors and the cost of the locational factor per se. These factors include: the availability of various services, e.g., the quick repair and replacement of machinery; the availability of ready capital

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[13]Greenhut, Plant Location in Theory and Practice, pp. 167-170.

adequate transportation terminals; and the availability of alternative modes. (4) Revenue-increasing factors refer to those forces that enhance market demand. These factors are also associated with agglomeration but with respect to sales. They include, for example, the need for quick delivery due to buyer capriciousness and the need to be in close contact with the customer. (5) Personal cost-reducing factors and (6) Personal revenue-increasing factors refer to either a cost saving or gain that is available at certain locations where personal relationships between buyers and sellers have developed; i.e., the location is influenced by reputation and good will. And finally (6) Purely personal factors refer to psychic income gains at certain locations.

Greenhut attempted to determine the relative importance of these factors by interviewing the owner-managers of eight small manufacturing firms in Alabama. These case studies revealed that five of these firms were located in deference to some personal factor.

According to Greenhut, these results have some implication for location theory. In five of the plant locations there was little evidence that demand and cost determinants influenced the decision. This would not empirically substantiate the assumption that plant location decisions are motivated by the desire for maximum profit. However, as Greenhut relates:

> If psychic income is to be included as a location factor, it is apparent that a sample of eight can hardly be classified as a sufficient one; further, the force which caused the location of these firms can scarcely be proof of the relative importance of location factors . . .[14]

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[14]M. L. Greenhut, "A General Theory of Plant Location," Metraeconomica, Vol. VII, 1955, p. 63.

A survey of plant locations in Florida. Using a different approach, Greenhut later attempted by survey methods to determine the reasons for recent plant locations in Florida.[15] This study differed from the Alabama case studies by concentrating on factors that bring the firm to a certain state rather than a specific location.

The study was based upon Greenhut's "empirical model" which was discussed in the preceding section. Each respondent (plant official) was asked to give his reason for selecting Florida for his plant's location.

The findings of the survey show that 488 of the 752 plants locating in Florida in 1956 and 1957 cited access to markets or anticipation of market growth as the primary factor. These results apparently reaffirm, in one respect, Greenhut's contention that demand is an important locational factor, especially at the regional level.

Transportation costs were next in importance as a regional factor. The purely personal factor was operative only as a factor in selecting from alternative sites after the primary cost or demand factors had influenced the plant to locate in Florida.

The University of Michigan studies. Two studies of particular interest have been conducted by the Survey Research Center at the University of Michigan.[16] Both studies involved depth interviewing executives from manufacturing plants with over 100 employees.

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[15]M. L. Greenhut, "Observations of Motives to Industry Location," Southern Economic Journal, October, 1951, Vol. 18, pp. 227-228.

[16]George Katona and James Morgan, "The Quantitative Study of Factors Determining Business Decisions," Quarterly Journal of Economics, Vol. 66, 1952, pp. 67-90.

In the first study, the four major factors influencing the location were found to be distance to markets, distance to materials, prevailing wage rates, and workers productivity.[17]

In the second study, which was based upon personal interviews with 239 executives, personal reasons representing the role of personal ties to the community and historical accident were mentioned frequently as factors in the original choice of location.[18] This study's findings further indicate that locational factors vary according to the type of decision and the firm's characteristics. For example, larger firms, apparently because they base location decisions on very thorough investigations and calculations, are less influenced by personal considerations than small firms. Recently located firms, irrespective of size, also seem to base their location decision more on cost and demand factors than personal reasons. Also, the location decision that involves an expansion of the facility (a branch plant) is more apt to be "genuine and rational" because cost and demand factors are usually prime considerations.

In their analysis of these surveys, Katona and Morgan claim that depth interviewing alone permits identification of the truly important factors in plant location.[19] They point out, that only by employing the survey method is it possible to determine the significance of all locational factors including such intangible factors of community

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[17]University of Michigan Survey Research Center, Institute for Social Research, Industrial Mobility in Michigan (Ann Arbor: University of Michigan, December, 1950).

[18]Eva Mueller, Arnold Wilken, and Margaret Wood, Institute of Social Research, Location Decisions and Industrial Mobility in Michigan, 1961 (Ann Arbor: University of Michigan, 1961).

[19]Katona and Morgan, op. cit., pp. 67-90.

characteristics and attitudes; managerial preference for hometown environment; and executive attitudes toward labor conditions, taxes, legal climate, etc.

The Hartford, Connecticut, study. The importance of the personal factor in the location of small manufacturing plants was the object of a recent survey conducted in Connecticut.[20] The final report was based upon personal interviews with plant officials from a sample of 662 firms that had recently located in the metropolitan area surrounding Hartford, Connecticut. Eighty-three usable interviews were selected from the sample for analysis.

In interviewing these officials, an effort was made to determine the "level of location decision." Three levels of decision were designated: (1) the primary level, which involves the consideration of broad locational factors that influence location among regions; for example, the cost of labor may induce management to think of 5 or 6 states in the southern region; (2) the secondary level, which entails consideration of those factors that influence the choice of location among several communities within a region; e.g., the existence of suitable transportation facilities, tax advantages, etc.; and (3) the tertiary or site-selection level, which relates to factors that vary from site to site within a city. Examples of these would include such items as drainage, soil conditions, and road surface parking conditions. By distinguishing among the various levels of location decision, the authors believe that

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[20] W. N. Kinnard and Zenon S. Malinowski, Personal Factors Influencing Small Manufacturing Plant Location, prepared by the University of Connecticut under the SBA management research grant program (Storrs: University of Connecticut, June, 1961).

a more meaningful tabulation of factor significance is possible.

Kinnard and Malinowski, in developing a framework for classifying the survey's results, have utilized Greenhut's classification model in which all factors fall into, essentially, three factor groups: demand or market, cost, and "non-economic." The latter group is of particular interest to the authors, and they define it much in the same manner as Greenhut:

> . . . non-economic factors which influence plant location include regional predilections, environmental preferences, town or state loyalties, and personal desires for such other "non-economic" ends as proximity to family, security, and cultural and social advantages.[21]

Among small manufacturing plant locations, the survey indicates that personal factors play an obvious but secondary role in the actual selection of the site. At this level, 45% of the executives interviewed mentioned personal factors in selecting the site while only 16% rated them most important. At the secondary level (selecting a city), both transportation and personal considerations dominated the replies. And finally at the primary level, the executives thought that proximity to customers and, to a lesser extent, personal attachments were important in selecting Connecticut over other states. The final conclusion is that personal factors play a dominant role in the location of small manufacturing firms at the tertiary and secondary levels of decision.

The authors, however, have some misgivings about the data used in the study. Three limitations were mentioned with respect to the

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[21] Ibid., p. 6.

nonobjectivity of the response: first, the respondent may be offering theoretically sound motives rather than actual motives; second, the reasons for location may have been operative at a different decision level than suggested; and third, reliance on memory may result in faulty response.

An urban area study. In a mail questionnaire survey of 950 manufacturing plants located in Milwaukee County, Wisconsin, Stefaniak has attempted to determine the relative importance of locational costs within an urban area.[22] The author employs the Haig "cost of friction" approach, pointing out that it is a more appropriate analytical framework for urban area investigation than that provided by the regional cost analysis of Weber and Hoover.

The "cost of friction" is essentially an attempt to explain the cost factors influencing the location of a firm within an urban area. A firm's location is, in effect, governed by its relative cost position at different possible sites. Its cost position, in turn, is determined by the interaction of site rentals (land cost) and transportation costs. Assuming that a plant's location is determined where costs are minimized relative to the largest accessible market, transportation costs and rental costs are optimally combined. For example, a plant with all its market concentrated in the core area of the city will locate there if the expected higher land cost is not prohibitive relative to the cost

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[22]Norbert J. Stefaniak, Industrial Location Within an Urban Area, A Case Study of the Locational Characteristics of 950 Manufacturing Plants in Milwaukee County (Madison: University of Wisconsin, School of Commerce, Bureau of Business Research and Service, 1962).

of overcoming spatial friction (transportation) at a more distant alternative location where the rent is lower. In effect, unit rent costs are being substituted for unit transportation costs because the firm stands to profit by being more accessible to customers.

Stefaniak's study entailed the classification of 950 Milwaukee manufacturing firms according to 37 different "locational measurements." These plants were grouped by Standard Industrial Classification and "measured" in terms of land area, land assessment, parking, employee size, truck traffic, nuisance, labor, suppliers' and customers' location along with many other characteristics. A large portion of the data was obtained from secondary sources and the rest by mail questionnaire.

In summarizing salient findings, Stefaniak concludes that: (1) market accessibility is definitely a factor in urban plant location; the larger plants producing for the local area tend to locate in the central area, while the exporting plant will tend to locate in the peripheral areas to avoid traffic congestion; (2) larger firms producing heavy products require rail service, but there is a tendency for other manufacturers to locate at sites without a rail siding; (3) plants employing largely female or unskilled workers tend to locate in the city's central area where public transportation is available; and (4) most larger plants seek out lower cost land in the peripheral areas. Also, most of the plants that leased buildings or land sites were located in the central area of the city.[23]

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[23] Ibid., p. 79.

Studies concerned with the highway factor. Since a portion of this study will be concerned with determining the significance of the highway in plant location, a review of previous investigations concerned with the highway factor will be pertinent.

In addition to determining the role of the personal factor in small plant location, as reviewed above, Malinowski and Kinnard were concerned with the highway as a factor in small plant locations.[24]

Seventy-six manufacturing plants that recently located in the Hartford, Connecticut, area were interviewed to determine the significance of highways and highway proximity in their site-selections. An additional 124 plants replied to a mail questionnaire.

The findings indicate that: (1) it is the network of existing roads, rather than any one special highway or road, that influences the locational decision; (2) highways and highway access do not rank high among reasons given for either selecting the present site, leaving the previous location, or selecting a new hypothetical location; (3) "good access" is measured differently by firms depending upon their operational requirements--it meant everything from direct entry to the highway to a site two miles away from the nearest highway; (4) access is usually measured in terms of travel time as opposed to linear distance; (5) the larger firms are more "sensitive" to highway access as a location factor--they either tend to place great weight on highways as a location factor

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[24] W. N. Kinnard, Jr., and Zenon S. Malinowski, Highways as a Factor in Small Manufacturing Plant Location Decisions, prepared by the University of Connecticut under the SBA management research grant program (Storrs: University of Connecticut, 1961).

or ignore them completely; (6) highways usually enter into the location decisions at the secondary (choice of city) or tertiary (choice of site within a city) level; and (7) in general, the highway factor receives relatively little consideration in location because most plant officials take them as a "given datum."[25]

In conclusion, the authors are convinced that the sample survey technique is a useful method for studying plant location. They conclude that:

> The real significance for areas other than the Hartford Economic Area lies in the indication that considerably more can be learned about the needs, behavior patterns, and locational decision making of manufacturing firms in any region, through relatively straight forward interviewing and analysis.[26]

In a national mail survey conducted by the American Trucking Association to determine the factors influencing recent plant location, highway proximity was mentioned more frequently than any other factor (72% of the respondents).[27] Other important factors included: the labor supply, availability of suitable land, and proximity to markets.

These results would seem to contradict the findings of the Connecticut Study in which highways were at most a secondary consideration in the location of small plants within an urban area. However, the two studies differed vastly in scope and method.

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[25] Ibid., pp. 86-90.

[26] Ibid., p. 92.

[27] James F. McCarthy, Highways, Trucks and New Industry, prepared by the Department of Research and Transportation Economics, American Trucking Association, Inc., May, 1963.

Summary

Continual refinement in plant location theory has in recent years been supplemented by empirical investigation of factors affecting actual location. A review of location theory and recent empirical studies has revealed that the factors recognized by location theorists are susceptible to empirical verification, especially by survey methods.

This section of the report has examined the development of location factors as theoretical criteria to provide an empirical model for the analysis of survey data in the present study.

It was pointed out that Weber, Hoover, and Greenhut have attempted to delineate the essential factors influencing industrial location. Greenhut, however, has developed a list of locational factors that not only influence regional location, but also community and actual site-selection. The "empirical model" to be used in this report is essentially Greenhut's locational factor listing.

It was apparent from the results obtained in various studies concerned with determining the actual factors considered in plant location that intangible factors, alternately referred to as "personal," "non-pecuniary," and "non-economic" reasons, were relatively important. A high incidence of plants have apparently been located on the basis of such presumably non-pecuniary reasons as environmental preferences, town or state loyalties, security, and the cultural and social advantages of a particular community.

SECTION II

PLANT LOCATION PROCESSES AND DECISIONS IN TEXAS

The primary purpose for the presentation of the discussion included in this section of the report is to describe the nature of the location process and the manner in which decisions are made in regard to industrial plant site selection.

The review of plant location concepts, presented in Section I, provided a basis for the design of the empirical model that was used in the study to delineate the essential factors influencing industrial plant location along the Interstate Highway System of Texas.

THE MODEL

In answering the question, "Would you mind telling me what caused you to locate at this site?", approximately 284 plant officials gave a multitude of reasons which reflect little more than unrelated thought processes. In a study based on interviews and questionnaires, it is very difficult to present the response in meaningful form. It is, therefore, necessary to design a "model" or, for the present study, a system for classifying the response.

As pointed out in the previous section, the model used in this study is an adaptation of a general system for classifying location factors obtained in a survey conducted in Florida by M. L. Greenhut.[1] The model was designed by Greenhut to serve as a reference point for his study. It conformed to the maximum profit theory of plant location in that both cost and demand factors were considered as relevant spatial variables.

The model developed for this study divides location factors into three main classes: demand factors, cost factors and intangible factors. These major classes include the following sub-classes:

A) Cost

   1) Transportation factors

   2) Production factors

   3) Cost-reducing factors

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[1] M. L. Greenhut, "An Empirical Model and a Survey: New Plant Locations in Florida," Review of Economics and Statistics, Vol 35, November, 1959, pp. 433-438.

B) Demand

1) Location of competitors

2) Market requirements

3) Revenue-Increasing factors

C) Intangible

1) Personal revenue-increasing factors

2) Personal cost-reducing factors

3) Purely personal factors

4) Inertia

5) State and local encouragement

6) Community characteristics

Once the large number of actual reasons are classified according to this model, it is possible to determine the pattern, if any, among the firms in the survey by industry group, size of operation, etc. Furthermore, it will be possible to determine what plants have been located in deference to cost and demand factors as opposed to intangible considerations. As we discussed in the first section, this type of analysis will have implication for the fundamental assumption in plant location theory: that a plant selects a location in deference to spatial cost and revenue variables, alone.

Cost Factors of Location refer to the overall expenses that enter into the final product cost. They include all production costs, such as the cost of raw materials, labor, utilities, capital, land, taxes, etc. A plant mentioning these factors as important in its location is usually dependent upon those productive factors that vary in cost among

alternative sites. Rent costs, for example, vary considerably from site to site primarily because of the immobility of intensively used land. If land were as mobile as labor, rental costs would cease to be a significant spatial cost variable; i.e., land costs would not be a very significant variable in plant location.

Transportation Costs refer to all costs associated with the shipment and receipt of goods. This cost usually varies considerably from location to location depending upon the importance of shipping to the locating plant's operation. Plants locating near the raw material source are usually attempting to reduce transportation costs.

Cost-Reducing Factors refer to certain gains that arise essentially from either locating in industrial areas (agglomerating) or away from them (deglomerating). This general factor is important in many plant locations and would include an exhaustive list of locational considerations. It refers especially to the "availability" of cost factors that reflect advantages in agglomeration or deglomeration. The cost-reducing factor is distinguishable from the cost factor per se in emphasizing the relationship between physical distance and costs other than in terms of transportation costs. For example, the availability of "suitable" land, labor, utilities, capital, building, machinery, replacement and repair services, transportation services (truck, rail, or water) and facilities (highways and streets) all reflect the cost-reducing factor. The availability of these factors at certain locations result in a cost-saving. The actual prices of each factor at alternative locations, however, are a different consideration and reflect the cost factor.

Demand Factors of Location are important in the location decisions of firms that attempt to exclude competitors from a certain market by locating at the most strategic point in the market area. When market requirements of the firm are such that it attempts to gain a monopolistic control over a certain market area by virtue of its location, demand--as opposed to cost--is a determining factor. The demand factor usually encompasses such reasons as "proximity to a potential or existing market."

The Revenue-Increasing Factor, on the other hand, refers to increase in sales that result from gaining quick and efficient access to a particular market which may be one customer or many customers located, for example, in a specific city rather than scattered over a large market area.

Intangible Factors of Location refer to all factors (reasons) that cannot be conveniently classified as cost or demand influences. These include the personal factor, inertia, state and local encouragement, and community characteristics.

Some personal considerations reflect economic advantage. Should cost savings, or sales increases, arise because the manager has located the plant close to personal friends who are either important customers or suppliers, the advantage may be defined as Personal Cost-Reducing or Revenue-Increasing.

The Purely Personal Factor, on the other hand, is reserved to explain the site-selection made in deference to some personal whim of the owner/manager. For example, the site may have been selected because it was his hometown or native state. By selecting a hometown location, the owner/manager may experience greater contentment and security. While this con-

sideration may result in greater profits or, in some cases, cost efficiencies because of greater sales effort or productivity, it is usually classified as an intangible determinant and non-pecuniary in nature.

In general, the purely personal factor is reserved to explain all non-profit motives for selecting the plant site. It is usually limited to some regional, state, or hometown predilection of the owner/manager.

Inertia is a term used in economic psychology to explain the type of business decision that is habitual. Many plant location decisions reflect this influence. In this type of decision there is usually no consideration of alternative locations. For example, many plants are located in buildings or on sites that were purchased or leased prior to any consideration of relocating or locating. It should be classified as an intangible factor since no alternative locations could be evaluated in terms of spatial cost or revenue advantages.

State and Local Encouragement may refer to cost advantages that are offered by different communities to attract the firm; e.g., local property tax exemptions. In most cases, however, it refers to the "selling job" of a Chamber of Commerce or an industrial foundation. This type of influence cannot be defined as a spatial cost or demand determinant.

Community Characteristics are also an intangible influence in that they cannot be conveniently reduced to cost and revenue factors. These include such considerations as the desirability of a particular community because of its attitude toward business, the availability of adequate recreational and educational facilities, "labor climate," etc.

There is no presumption that these locational factors mutually exclude all the actual reasons given for selecting a plant location. Many

reasons "overlap" into several different categories. Moreover, a most difficult task is to distinguish between the true intangible factor consideration and the actual cost and revenue factors that are spatially variable.

It is important to recognize that cost and demand factors are really important in all plant locations. The location decision that is made on some personal basis is usually under some cost or demand constraint. A plant site is selected only if it is anticipated that minimum requirements of market access, production, and transportation will be satisfied within the immediate area. A decision-maker will select his hometown for his plant operation for personal reasons only if market and production costs permit a minimum standard of operation. While "personal reasons" appear important in many plant site-selections, they may be only a "sufficient" condition along with the "necessary" condition of market and cost in a general explanation of the forces in plant location.

This "empirical model," however, does reflect the general locational variables usually considered in the theory of industrial location. The intangible factors have been included to determine their significance relative to the cost and demand factors in actual plant locations.

Coding the Response

Before presenting the results of the survey, the method used in coding each general factor will be explained by referring to actual interviews.

A new plant employing five people and producing office furniture has selected a particular location because of low rent. This factor is

classified as production costs. Rent cost on a building is a good example of spatial cost. Suitable existing buildings are not ubiquitous. The rental cost, therefore, will vary from area to area and consequently influences the location of many plants. The small manufacturing firm starting out in business is particularly sensitive to this factor because short-run rental costs must be minimized to operate efficiently, if at all.

The cost-reducing factor is evident in those location decisions that are influenced by the availability of some cost-saving production factor such as a suitable existing building with machinery. A medium size plant producing pre-stressed concrete materials has selected a location because a similar operation had existed there. The savings that resulted in purchasing the existing facility are of a cost-reducing nature.

A branch plant of a major computer corporation located in Dallas because, according to the manager, "we bought out a company of similar operation that produced a check-sorting device. The plant was purchased to strengthen our production in check-sorting devices which has always been weak." This is another example of a plant that was located in deference to a cost-reducing factor.

The demand factor was important in the site-selection of a paper box manufacturer with 30 employees. The owner stated that the plant was located in a certain city because, "it was centrally located from the standpoint of transportation facilities." Another firm producing transformers with 27 employees located in Dallas because it is, "centrally located to the Southwest market area . . . we can ship in any direction by truck

and give any customer overnight service." Both cases reflect a consideration of the firms' market requirements and are therefore classified as demand factors.

Revenue-increasing factors were important in selecting the location for a large producer of acetylene gas. This plant was located next to a large customer in order to pipe acetylene directly to his plant. Another large manufacturer of extruded rubber products located in the Houston area, "because the headquarters of our customer's companies are all based in the Houston area." A manufacturer of plastic marine accessories selected a Grand Prairie site "basically to get closer to customers . . ." Each of these reasons were coded as revenue-increasing factors because in each case there was an attempt to gain better physical access to customers.

Many plants were located in the manager's hometown as either a personal preference or because a plant's reputation had been established there. This type of locational preference is classified as a purely personal factor, since there is no direct financial inducement involved; e.g., lower transportation and production costs or greater revenue by locating in proximity to a large market.

Inertia is an attempt to explain the type of location decision that is limited to a particular site because it was purchased or leased prior to any consideration to select a new site. Thus, a small burial vault manufacturer has recently located on property that the owner purchased in 1947. In another case, the plant was relocated in a particular city because of prior leasing commitments. In both of these plant locations, there was no attempt to investigate alternative plant sites.

Limited evidence of state and local encouragement is apparent in some plant locations, especially in those cases where there was either financial inducement or a strong "selling job" by the local Chamber of Commerce or industrial foundation.

Community characteristics are important considerations in many plant locations. Aside from the availability of recreational and educational facilities, the attitude of the community toward business may loom as an important factor. A large manufacturer of oil and wheel seals relocated in an East Texas community because of the "attitudes of the people and the community."

NATURE OF THE LOCATION PROCESS

This section is essentially a presentation and analysis of certain responses to the questionnaire discussed in the previous section. Responses to some of the questions in this questionnaire are pertinent to the investigation of factors influencing actual plant location decisions. The nature of the location process in the present context refers to a combination, (2) the type of official involved in the location decision, (3) the method by which the plant site was discovered and selected, (4) the extent of alternative site considerations, (5) an evaluation of the location, and (6) the disadvantages associated with the present location.

In each of these areas the response has been classified into discrete categories before tabulation.

Reasons for Selecting the Plant Site

Table 1 shows a tabulation of all factors or reasons mentioned in response to the question, "Would you mind telling me what caused you to locate at this site?" In the survey, two hundred eighty-four plant officials throughout Texas were encouraged to express their reasons for locating at a specific site. There was no attempt to provide a list of locational factors from which the plant official could select those factors deemed important in selecting the location. Consequently, the response was spontaneous.

TABLE 1
REASONS FOR THE PLANT LOCATION
(All Mentions Within Each Category Counted)

Reasons	Number of Mentions		Percent of Total Mentions	
Production Factors				
Land and Building Costs		81		7.1%
Capital Costs		16		1.4
Taxes		14		1.2
Labor Costs		12		1.0
Utility Costs		4		.3
Availability of Land		148		12.9
Availability of Building or Existing Plant		114		9.9
Availability of Labor		42		3.7
Availability of Utilities		11		1.0
Availability of Services		4		.3
Total		446		38.8%
Transportation Factors				
Availability of Transportation Service and Facilities				
Roadways and Trucking	86		7.5%	
All Types	58		5.1	
Rail	22		1.9	
		166		14.5
Proximity to Raw Materials		66		5.7
Transportation Costs		31		2.7
Total		263		22.9
Market Factors				
Access to Customers		110		9.6
Market Area		67		5.8
Market Potential		42		3.6
Advertising Value of Site		18		1.6
Location of Competitors		14		1.2
Customer Traffic Near Site		9		.8
Total		260		22.6
Intangible Factors				
Personal Factors				
Psychic Income	82		7.2	
Inertia	37		3.2	
Cost Reducing	15		1.3	
		134		11.7
Community Characteristics		25		2.2
Total		159		13.9
State and Local Encouragement		20		1.8
TOTAL		1148		100.0%

The reasons most frequently mentioned by the respondents were conveniently categorized as production factors. Almost 39% of the total number of reasons mentioned by all the respondents were of this type. Next in frequency of mention were transportation factors (22.9%). These factors were considered slightly more often than market factors, which comprised 22.6% of the total mentions. Intangible factors (13.9%) and state and local encouragement (1.8%) were apparently less frequently considered by plant officials.

Factors mentioned. The reason most frequently given by the decision-maker was usually in reference to the availability of the site and/or building. Approximately 22.8% of all the reasons given were in this category. The availability of "suitable" labor, utilities, and services were considered less frequently.

In Table 1 the "availability" of certain productive factors in necessary amounts is distinguished from the actual costs of these factors at alternative locations. It is interesting to note that plant officials in the sample were more influenced by the availability of certain productive factors (27.8% of the total number of mentions) than the actual unit cost of these factors (11.0%) at the site selected.

With reference to the labor factor, for example, such considerations as the prevailing wage level, cheap semi-skilled labor, and the avoidance of high wages were given less frequently than such reasons as proximity to professional and technical labor, area labor market, availability of trained labor, and availability of unskilled labor.

With reference to utilities, low cost utilities were mentioned less than access to utilities or the availability of city water and adequate sewage disposal.

While rental cost or purchase price of the building and/or site was mentioned frequently (7.1%), the availability of suitable land and/or building was considered even more important. Such reasons as reasonable rent, appropriate real estate costs, reasonable land prices, etc., were mentioned less than the availability of a suitable site, building, or existing plant facility.

The next important consideration was the transportation factor. Again, the more common reply was in reference to the "availability" of transportation services and facilities (14.5%). The availability of adequate physical access and truck service from the plant site was frequently mentioned, especially with reference to the highway facility (7.5%). In a large number of interviews, however, reference was made to the availability of all types of suitable transportation services and facilities including rail and water (6.0%).

Proximity to raw materials and suppliers and transportation cost was mentioned by only a few officials as a factor. On the other hand, such considerations as access to raw materials and proximity to suppliers were mentioned frequently by the plant officials.

Market factors were mentioned with slightly less frequency than transportation factors (22.6% of the total mentions). The most important consideration was accessibility to customers. This type of consideration is distinguished from a consideration of the market area. Such reasons as proximity to existing market, geographical center of the market, lack of competition in market area, and market potential in Texas refer to market area considerations. On the other hand, to provide better service to the customer; to supply a specific industrial plant; and to locate in

the center of a metropolitan area all imply improvement of access to the customer.

State and local encouragement was relatively insignificant in influencing the plant location (1.8%). While a few plant officials did indicate some financial inducement by community groups as an important influence, most encouragement was of a non-financial nature; e.g., the "selling job" of the Chamber of Commerce.

Intangible factors referring to community characteristics and personal reasons were mentioned with surprising frequency. Community characteristics were usually in reference to the labor climate and business attitudes of the community (2.2%).

Personal factors (19.7% of the total mentions) were frequently mentioned by owner-managers who were interested in establishing the plant in their hometown because of established reputation or to be near family and friends. Another common consideration was the ownership of the plant site by a member of the family prior to the establishment of the new plant. In most of these cases, there was no consideration of an alternative site. The decision, therefore, was to remain in the same local area (Inertia--7.5%).

Some of the personal reasons for staying in the hometown may result in cost savings or increases in sales because of favorable financing through a friend or proximity to helpful business associates (cost-reducing/revenue-increasing factors--1.3%).

Which Factors Were Most Important?

After the respondents had mentioned all of the reasons for selecting the plant location, they were asked to indicate which reasons they considered most important. These primary or "first-rank" factors are presented in Table 1 . In this analysis, production factors appear to be the most important of the primary considerations. This category includes 34.8 percent of the total number of primary reasons.

Market factors apparently are also important as a primary factor in locating the plant. These factors comprise 27.9 percent of the total number of primary reasons. It is interesting to note that intangible factors increased in importance as a primary consideration. This category included 13.9 percent of the total number of all reasons mentioned and was fourth in our list of categories in Table 1 . However, it ranks third as a primary factor with 22.2 percent of the total number of reasons mentioned in Table 2 . Transportation factors, however, declined in importance from a second-ranked factor on the basis of total mentions (22.9%) to a fourth-ranked factor on the basis of primary considerations (13.3%). State and local encouragement remained at the same level of importance.

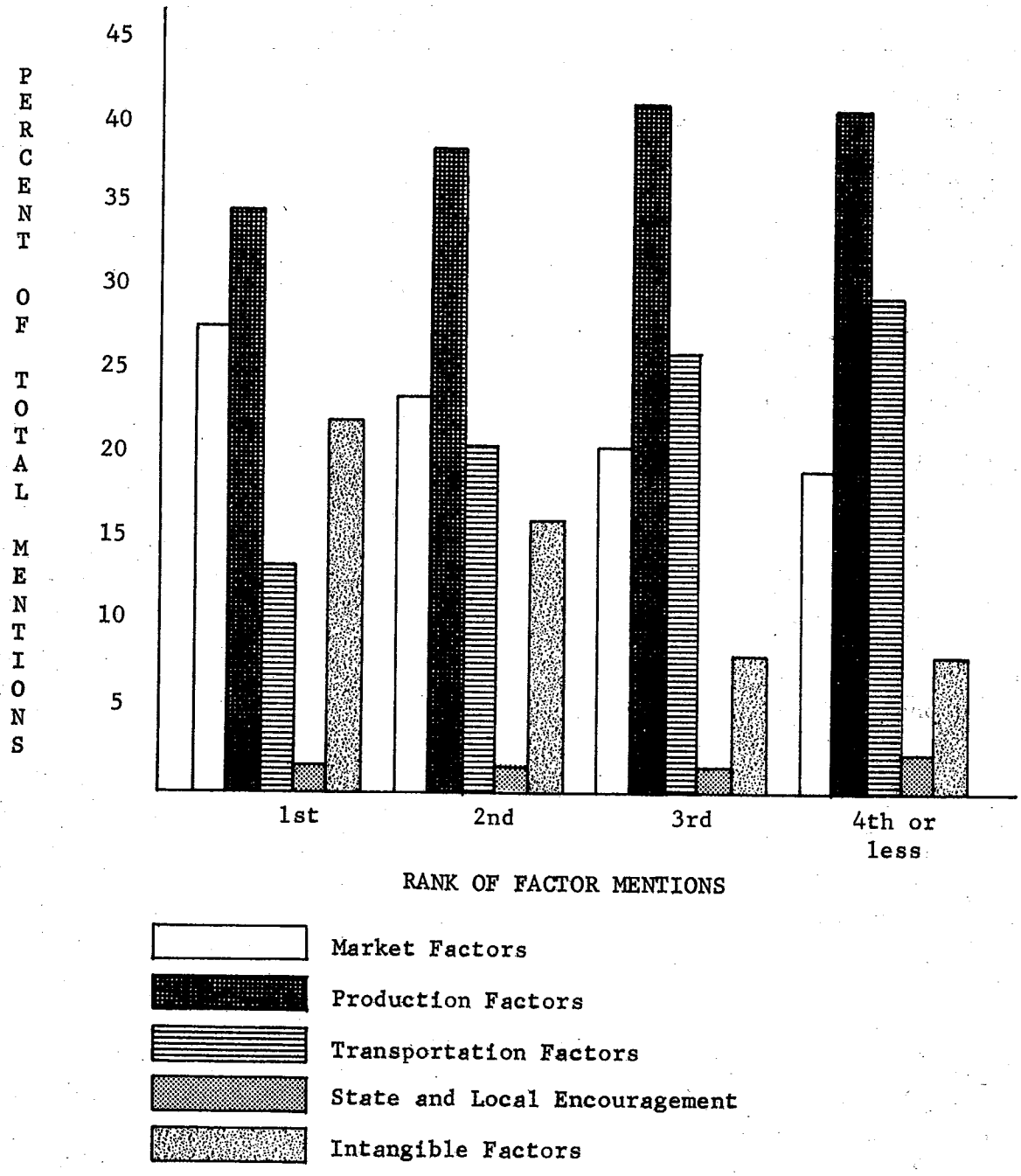
Most important factor mentions. Availability of building and machinery loomed as an important factor in the response. The availability of a suitable existing building or an existing plant facility was mentioned by 45 plant officials (16.1%) as the most important consideration in selecting their plant's location.

Another important factor was the availability of a suitable land site which was mentioned by 10% of the firms in the sample.

TABLE 2
MOST IMPORTANT REASONS FOR THE PLANT LOCATION
(Only One Mention Within Each Category Counted)

Reason	Number of Mentions		Percent of Total Mentions	
Production Factors				
Land and Building Costs		19		6.8%
Capital Costs		2		.8
Labor Costs		0		0
Utility Costs		0		0
Taxes		0		0
Availability of Building or Existing Plant		45		16.1
Availability of Land		28		10.0
Availability of Labor		3		1.0
Availability of Services		0		0
Availability of Utilities		0		0
Total		97		34.8%
Market Factors				
Access to Customers		39		13.9
Market Area		20		7.2
Market Potential		8		2.8
Advertising Value of Site		5		1.7
Customer Traffic Near Site		4		1.5
Location of Competitors		2		.8
Total		78		27.9
Intangible Factors				
Personal Factors				
Psychic Income	30		10.8%	
Inertia	21		7.5	
Cost Reducing	4		1.4	
		55		19.7
Community Characteristics		7		2.5
Total		62		22.2
Transportation Factors				
Availability of Transportation Services and Facilities				
Roadways and Trucking	13		4.7	
All Types	3		1.1	
Rail	2		.7	
		18		6.5
Proximity to Raw Materials		16		5.7
Transportation Costs		3		1.1
Total		37		13.3
State and Local Encouragement		5		1.8
TOTAL		279		100.0%

Figure 1
RANKING OF ALL REASONS FOR SELECTING PLANT LOCATION[a]



[a] This 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.

It is noteworthy that the production cost consideration (purchase price or leasing cost of the site and/or building, wage level, taxes, etc.) was not an important primary factor. Rather, the availability of these factors was, in many cases (76 firms), the most important locational determinant.

The most important market consideration was accessibility to customers. This category included 13.9 percent of the total number of reasons. The existing or potential market area was less frequently mentioned as the most important reason for selecting a particular location. A few plants were located at specific sites because of the physical attractiveness to the customer (1.7%). The location of competitors, although an important consideration in location theory, was an insignificant consideration in the survey (0.8%).

Intangible factors were a primary influence in 62 plant locations (22.2%). Personal factors were mentioned by 19.7 percent of the respondents, while community characteristics were a primary consideration in only 2.5 percent of the plant locations.

Many plants were located in the owner-manager's hometown for personal reasons. This factor was usually a primary consideration. In some of these locations other factors were not even considered. This would account for the large number of personal factors that were listed as primary considerations relative to the total mentioned.

Transportation factors were primary factors when either the availability of transportation services and facilities or proximity to raw materials or suppliers was necessary for the plant's efficient operation. Approximately 6.5 percent of the plants in the sample were oriented to

particular sites because of the supply of suitable transportation services and facilities. The quality of highways and street access and trucking services were mentioned by 4.7 percent of the plants as a primary locational factor. Transportation costs were the most important factor in only 1.1 percent of the location decisions.

State and local encouragement was relatively insignificant as a primary locational factor. This category included only 1.8 percent of the total number of primary reasons.

Ranking of all reasons for the plant location. Most of the respondents attempted to rank at least three factors that were important in selecting their plant's location. Many ranked as many as five factors. In Figure 1, it is possible 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 the 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. State and local encouragement occur more frequently as second and third-rank factors.

Conclusions from adjusted tabulations. In Figure 1 the results indicate that market and intangible factors are usually primary locational considerations, whereas transportation factors are usually important only as a secondary consideration. Other plant locations were primarily influenced by some personal reason or better accessibility to

customers. In most of the plant locations, the availability of suitable transportation facilities and services was mentioned as a factor but not as a primary consideration.

Production factors were commonly mentioned at all levels of consideration. There was some tendency for these factors to be mentioned more frequently as a secondary consideration.

The individual factors mentioned most frequently were the availability of transportation services and facilities, availability of suitable land site, personal factors, and access to customers--in that order. The most important locational factors--in order of frequency mentioned--were personal factors, availability of building and machinery, access to customers, and availability of suitable land site.

Importance of costs. An attempt was made to check the consistency of the respondents in determining the importance of cost in selecting the plant location. Table 3 shows the distribution of response to the question, "In choosing this site, what kind of costs were you particularly trying to keep down?"

According to Table 3 40% of the plant officials in the sample stated that their decision to locate the plant at a specific location was not significantly influenced by production, transportation, or any other type of cost. Forty-three percent, however, did mention some type of production cost as an important influence. The most frequently mentioned production costs were, in order of importance, rent, real estate costs, taxes, and labor. Transportation costs were also a frequent consideration, having been mentioned by 14% of the plant officials. A few officials did not care to specify any particular cost.

TABLE 3

INFLUENCE OF COSTS UPON THE LOCATION DECISION

Type of Cost	Number of Plants	Percentage
No Costs	114	40%
Production Costs	123	43
Transportation Costs	39	14
All Cost	8	3
TOTAL	284	100%

It is important to recognize that in those decisions in which cost was not an apparent factor, certain "enabling" factors were often mentioned instead. Thus, the availability of production factors (land, building, and equipment) and transportation facilities and services often superceded the actual cost consideration.

Also, it is interesting to note that both transportation and production costs were mentioned with less frequency in Table 1 than in Table 3. Production costs comprised 10.9% of the total mentions while transportation costs were mentioned even less frequently (2.7%). In Table 3 these costs were mentioned by 43% and 14% of the plant officials respectively.

This may indicate some inconsistency in the response. It is, however, also possible that many plant officials could not or would not make a distinction between the "availability" of production factors and the production cost per se.

Who Made the Location Decision?

The majority of the plants in the sample were relatively small, and, consequently, the location decision was usually made by either the owner or president. Table 4 gives the distribution of decision-makers by their title or position. It is apparent that the majority of location decisions were made by one individual. Those decisions that did involve several company officials (board of directors, president with other officials, etc.) were usually larger plant locations.

TABLE 4

TITLE OR POSITION OF LOCATION DECISION-MAKER

Title	Number of Plants	Percentage
President	90	32%
Owner	70	25
Manager	13	5
Vice-President	10	3
Board of Directors	10	3
President with other officials	17	6
Owner with other officials	11	4
Vice President with other officials	10	3
Manager with other officials	11	4
Other company officials	42	15
TOTAL	284	100%

How Did You Happen to Find This Location?

Thirty-three percent of the plants in the sample were located after only a personal investigation by the decision-maker (See Table 5). This type of investigation usually involved no outside assistance. The responsible plant official made the site-selection after a personal survey of the available sites.

TABLE 5

USE OF OUTSIDE ASSISTANCE

Method of Finding Site	Number of Plants		Percentage	
No Outside Assistance	92		33%	
Personal Investigation		92		33%
Outside Assistance	106		37	
Chamber of Commerce		21		7
Real Estate Agency		23		8
Personal Contacts		24		9
Other Means		32		11
Intra-Company Committee	6		2	
No Investigation	23		8	
No Response	63		22	
TOTAL	284		100%	

Other officials stated that some outside assistance, usually a Chamber of Commerce or real estate agent, was used in finding the location. This type of investigation was made by a tool and die manufacturer prior to selecting a site in a small urban area city. A portion of the actual interview is presented below:

> Who made the location study?
> Mr. X and his financial backers.
>
> Can you give me a brief description of the study?
> We wrote various Chambers of Commerce in different sections of Texas. We then assimilated all the information into a report and drew up a map marking potential industrial concentrations. The various industrial areas in Texas were compared to determine where there was potential for tool and die shops. We then presented the study to other members of the board. These other members and myself then came to Dallas to physically investigate the various sites. We selected a Mesquite site and contacted the real estate agency for leasing arrangements.

What specific things were considered?
(1) State right-to-work laws, (2) proximity to industrial concentration, (3) proximity to skilled dependable machinists and tool and die workers, (4) market potential, (5) room for expansion, and (6) ease of access to market.

A thorough investigation of this type was rarely encountered in the survey; however, thirty-five percent of the responding plant officials did make use of some outside assistance.

Several plants were located on the basis of advice by personal contacts; e.g., business associates and friends.

In the larger plant locations, an intra-company committee was often responsible for making the site-selection. A large building products corporation made this type of investigation prior to selecting a small town for a sizeable branch plant operation. The plant manager, in this investigation, headed a site survey team which gathered information from railroads, local Chambers of Commerce, and utility companies. This preliminary information was correlated by various corporate departments prior to a field survey of possible sites. In the final stage of the investigation, the site survey team worked very closely with local power utility companies in selecting alternative sites. These alternative sites were ultimately presented to the home office for the final decision. However, several plants were located on property that had already been purchased or leased by the newly located firm. In these instances, no investigation was required since no alternative sites were considered.

Were Alternative Sites Considered?

Not all plant officials in the sample seriously considered alternative plant sites before making a decision. For example, in the response to the question, "Did you consider alternative sites?"

Slightly more than half of the firms revealed that at least one alternative plant location was considered. However, there remains a sizeable portion of the plants, that did not consider sites other than the one chosen for their plant location.

Many of the decision-makers who did consider other sites looked at more than one other site. Of the 139 responding firms, 34 percent considered one additional site, 16 percent considered two, 23 percent considered three, and 24 percent considered four.

Most of these alternative sites were located within the same city (56%). Table 6 gives the distribution of where these alternative sites were located.

TABLE 6

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[a]	100%

[a]65 firms did not respond.

It is apparent from Table 6 that very few firms (8%) made a regional location decision. Indeed, most of the firms did not consider any location outside a particular city or metropolitan area. Forty-three plants, however, were located after a consideration of at least one other city in Texas. It is, therefore, evident that the most common location

decision in the sample was made at the secondary or tertiary level. This would have implication for the type of factors influencing these plant locations. Regional locational factors would not be as important as those factors that influence location in a particular city or at a particular site. This may partially explain the importance of production factors as a factor in site-selection among the sample plants. Such tertiary considerations as the availability of a suitable building or land site were more common that such regional factors as market proximity and transportation costs.

Evaluation of the Plant Site

In answering the question, "If you had the decision of plant site-selection to make, would you choose this again?," most plant officials responded in the affirmative. Fifty-six officials or twenty percent of the total number in the sample, however, would not select their present plant site again. Moreover, 177, or over 62 percent of the responding officials mentioned at least one disadvantage associated with their present location.

Disadvantages associated with the plant location. Table 7 provides a list of all disadvantages that were associated with the site-selection. These disadvantages have been classified in the same categories as the reasons for selecting the site given in Table 1.

In Table 7, it is apparent that an unsuitable quantity, quality, or cost of some production factor was mentioned more frequently by plant officials than any other major factor (43.4%). Either the site or the building has proven unsuitable for the plant operation (27.1%). Taxes

TABLE 7
DISADVANTAGES OF PLANT SITE[a]
(All Mentions Within Each Category Counted)

Disadvantages	Number of Mentions		Percent of Total Mentions	
Production Factors				
Land and Building Costs	8		2.8%	
Taxes	6		2.1	
Labor Costs	3		1.0	
Capital Costs	1		.3	
Utility Costs	0		0	
Unsuitable Site	58		20.4	
Unsuitable Building	19		6.7	
Utilities Supply	13		4.5	
Services Supply	9		3.2	
Labor Supply and Productivity	7		2.4	
Total		124		43.4%
Transportation Factors				
Transportation Services and Facilities	16	5.6%		
All Types	55	19.2		
Roadways and Trucking Service	13	4.6		
Rail				
Total		84	29.4	
Distance to Raw Materials or Suppliers		13	4.5	
Transportation Costs		9	3.2	
Total				37.1
Market Factors				
Access to Customers		11	3.9	
Market Area		7	2.4	
Advertising Value of Site		6	2.1	
Customer Traffic Near Site		1	.3	
Market Potential		4	1.4	
Proximity to Competitors		4	1.4	
Total		33		11.5
Intangible Factors				
Personal Factors - undesirable location		11	3.9	
Community Characteristics		11	3.9	
Total		22		7.7
State and Local Encouragement		1		.3
TOTAL		286		100.0%

[a]177 of the 284 plants in the sample responded.

and the lack of utilities were also frequently mentioned as disadvantages.

The lack of adequate transportation facilities and service was mentioned more than any other factor (29.4%). Respondents usually mentioned the lack of trucking service or poor road access (19.2%) and the lack of rail service; e.g., no rail siding available (4.6%).

Market factors were mentioned as a disadvantage by only a few firms. Under this category, poor access to customers was frequently given as a disadvantage (3.9%).

Intangible factor disadvantages were usually in reference to the undesirability of a certain city or site. A few officials were dissatisfied with either the general attitude of the community or the physical characteristics of either the site or area surrounding the site.

Evaluation of the plant location with respect to the nearest competitor's location. An interesting check on consistency in the response involved asking each respondent to evaluate his location by comparing it with the location of his nearest competitor. Only 10% of the responding plant officials considered their location was worse than their nearest competitor's site. Thirty-two percent stated that their present site was better, while approximately the same number said their location was about equal with their nearest competitor's location.

A chi-square test of independence on the response data presented in Table 8 shows that plant officials were apparently not significantly influenced by the distance from their competitor's plant site in making an evaluation. Distance from the competitor apparently had little influence upon the type of response. The proportion of plant officials who could not evaluate their nearest competitor's location was approxi-

mately the same regardless of the distance separating the two plants' locations.

It is noteworthy that most officials evaluated their competitor's location in terms of market and transportation factors. The evaluation frequently involved such observations as, "better access to customer than competitor," "this location is more centrally located to the market than competitor," and "competitor is closer to raw materials." Less consideration was given to production and intangible factors in making an evaluation.

TABLE 8

EVALUATION OF PRESENT PLANT SITE WITH RESPECT TO NEAREST COMPETITOR'S SITE

Distance from competitor in miles	How would you compare your location with competitor's location? Doesn't Know	Better	Worse	Equal	Sample Size
0 to 10 miles	36	51	14	53	154
11 to 100 miles	13	21	7	19	60
Over 100 miles	19	13	5	14	51
TOTAL	68	85	26	86	265[a]

Chi-square = 5.14 with 6 degrees of freedom; P less than .70.

[a]17 plants did not respond.

TABLE 9
CHARACTERISTICS OF SAMPLE

Characteristics	Number of Sample
Total Moves	279[a]
Type of Plant	
Branch Plant	74
Non-Branch Plant	205
Type of Location	
New Plant	183
Relocated Plant	96
Size of Employment	
24 and Over	110
Under 24	169
Annual Gross Sales[b]	
$500,000 and Over	100
Under $500,000	150
Distribution of Product	
Regional and International	167
Local and State	112
Tenancy	
Own	158
Rent	121
Major Industrial Classification	
Durable Goods	157
Non-Durable Goods	122

[a]Five plants did not give any reason for selecting the plant location.

[b]Of the responding plants, 29 officials would not or could not give their annual gross sales.

ANALYSIS OF LOCATIONAL FACTOR RESPONSE

The purpose of this section of the report is to analyze the factors influencing plant location by classifying each location decision according to the model discussed in the previous section. After evaluating the response from interviews with the decision-makers responsible for the plant location, it was assumed that each decision was primarily influenced by one of three general locational factors. These factors are as follows: (1) cost factors, which were a primary influence in the location of 116 plants; (2) market factors which influenced 86 plant locations; and (3) intangible factors which were an important consideration in 77 plant locations. The method for classifying each location decision according to these factors was explained in the preceding section.

The analysis of plant location decisions involves isolating the characteristics of those decisions that were particularly sensitive to certain locational factor considerations. The first task is to divide the plants in the sample according to certain characteristics. Then an analysis will be made of the variation of the location factor response with the chi-square test.

The problem is, essentially, to determine the size, product, and other facts about the plant operation and compare these with the type of general location factors that influenced management's decision in selecting a site.

This section will also be concerned with the different types of investigations used by management prior to selecting a site. This is followed by an analysis of the circumstances surrounding the unsatisfactory plant site-selection.

Variation in the Factors Considered to be Important In the Choice of Plant Location

Table 9 shows the distribution of sample plants according to different characteristics of the plant operation and location. These include the type of plant, type of location, size of employment, annual gross sales, market area, tenancy, and industry group. The distribution of sample plants according to each of these characteristics is divided into two categories and compared with the major factors influencing the site-selection.

The chi-square test. The analysis involves dividing the sample plants into two discrete groups, as shown in Table 9. These groups are divided again according to the major factors that have influenced each plant's location. Factors considered to be important in the choice of plant location have been categorized as follows:[1]

1. Transportation Cost
2. Production Cost
3. Market Factors
4. Intangible Factors

Applying the four factors as listed above, to each dichotomy in Table 9, a series of tables was developed for analysis purposes. Each table was tested for independence through use of the chi-square test.

It is hypothesized that if the 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

---

1) The complete classification of location factors developed for use in this study are shown in Figure 6, Appendix.

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, the 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.

From the results obtained in Table 10, the chi-square results indicate that there is a significant difference between branch and non-branch plants in major location factors considered in plant site selection. Therefore, branch and non-branch plant locations decisions are influenced by different locational requirements. A higher proportion of branch plant locations in the sample tended to be influenced by either transportation cost or market requirements, while non-branch locations included a higher ratio of plants that considered either production cost or intangible factors.

TABLE 10

CHI-SQUARE TEST OF INDEPENDENCE ON THE LOCATION FACTORS CONSIDERED BY BRANCH VERSUS NON-BRANCH PLANTS

Location Factor	Branch	Non-Branch	Total
Transportation Cost	12	17	29
Production Cost	15	72	87
Market Factor	38	48	86
Intangible Factor	9	68	77
TOTAL	74	205	279

Chi-square = 29.59 with 3 d.f.; P less than 0.001.

A significant chi-square in Table 11 tends to confirm relative differences in the major factor requirements of plants with more than 24 employees when compared with plants with less than 24 employees. A higher proportion of the plants with more than 24 employees considered transportation cost and market factors. Production cost and intangible factors were relatively more important to plants with less than 24 employees.

TABLE 11

CHI-SQUARE TEST OF INDEPENDENCE ON THE LOCATION FACTORS CONSIDERED BY PLANTS WITH OVER 24 EMPLOYEES VERSUS PLANTS WITH UNDER 24 EMPLOYEES

Location Factor	24 and Over	Under 24	Total
Transportation Cost	17	12	29
Production Cost	30	57	87
Market Factors	41	45	86
Intangible Factors	22	55	77
TOTAL	110	169	279

Chi-square = 11.61 with 3 d.f.; P less than 0.01.

Table 12 is particularly interesting in that a very significant chi-square apparently indicates that plants with over $500,000 annual gross sales tend to be more concerned with different locational factors than plants with gross sales under $500,000 per year. Firms with larger sales volume were proportionately more influenced by either transportation cost or market factors. Firms with smaller sales volume tend to consider either production cost or intangible factors as most important to selecting a plant site.

TABLE 12

CHI-SQUARE TEST OF INDEPENDENCE ON THE LOCATION FACTORS CONSIDERED BY PLANTS ACCORDING TO THEIR ANNUAL GROSS SALES

Location Factor	Over $500,000	Under $500,000	Total
Transportation Cost	14	9	23
Production Cost	24	58	82
Market Factors	43	31	74
Intangible Factors	19	52	71
TOTAL	100	150	250

Chi-square = 23.40 with 3 d.f.; P less than 0.001.

Non-significant chi-square results in Table 13 and Table 14 indicate that the market area and tenancy arrangement has little implication for the type of location factors considered in selecting a plant site. It is noteworthy, however, that in those plant locations involving leasing rather than purchasing the site, a higher proportion of plants were primarily concerned with some production cost; e.g., rental cost, while lower proportion of plant locations involving the purchase of a site were primarily influenced by production cost; e.g., purchase price.

TABLE 13

CHI-SQUARE TEST OF INDEPENDENCE ON THE LOCATION FACTORS CONSIDERED BY PLANTS ACCORDING TO THEIR MARKET AREA

Location Factor	Regional & National	Local & State	Total
Transportation Cost	21	8	29
Production Cost	48	39	87
Market Factors	54	32	86
Intangible Factors	44	33	77
TOTAL	167	112	279

Chi-square = 3.24 with 3 d.f.; P less than 0.50.

TABLE 14

CHI-SQUARE TEST OF INDEPENDENCE ON THE LOCATION FACTORS CONSIDERED BY PLANTS ACCORDING TO TENANCY

Location Factor	Own	Rent	Total
Transportation Cost	21	8	29
Production Cost	43	44	87
Market Factors	50	36	86
Intangible Factors	44	33	77
TOTAL	158	121	279

Chi-square = 4.88 with 3 d.f.; P less than 0.20.

Plants that considered both the market and cost in site selection.

In the review of location theory, it was pointed out that optimum plant location is to be gained only if both the market and cost (transportation and production) are considered. In this section an attempt is made to determine what circumstances accompany those plant locations in which both cost and the market factors were mentioned by the plant official as

significant factors in the location decision.

Of the 279 plant officials that gave reasons for selecting a new site, 169 responded that they considered either production, transportation or cost reducing factors along with the market factor in selecting a plant site. The remaining 110 plants were located on the basis of only one of these factors.

In Table 15 significant chi-square results tend to confirm a difference in the type of factors considered in branch and non-branch plant location decisions. In particular, a higher proportion of branch plants tend to consider both cost and market in making a site-selection than non-branch plants.

TABLE 15

CHI-SQUARE TEST OF INDEPENDENCE ON THE TYPE OF LOCATION FACTORS CONSIDERED BY BRANCH VERSUS NON-BRANCH PLANTS

Location Factor	Branch	Non-branch	Total
Cost or Market	28	141	169
Cost and Market	46	64	110
TOTAL	75	205	279

Chi-square = 21.80 with 1 d.f.; P less than 0.001.

It is apparent from Table 16 that a higher proportion of officials from plants with annual gross sales over $500,000 tend to consider both cost and the market rather than only one of these factors in selecting a site.

TABLE 16

CHI-SQUARE TEST OF INDEPENDENCE ON THE TYPE OF FACTORS CONSIDERED ACCORDING TO ANNUAL GROSS SALES OF THE PLANT

Location Factor	Over $500,000	Under $500,000	Total
Cost or Market	45	107	152
Cost and Market	55	43	98
TOTAL	100	150	250

Chi-square = 16.62 with 1 d.f.; P less than 0.001.

In other tests, it was determined that tenancy, market area, employment size, and type of location (new or relocated plant) have little influence on whether both market and cost factors are considered in selecting the plant location. The chi-square results in each of these analyses were non-significant.

Variation in locational factor response according to industry group.

Table 17 provides a list of the sample plants according to major industry groups. While the major two-digit standard industrial classification offers only a very broad classification of industry by product type, it does make sufficient distinction between certain industries, particularly with reference to the type of factors considered in selecting a new plant location. For example, those 17 plants which are classified as printing and publishing (SIC 27) were usually small concerns which tended to locate near the downtown business area. The operation of this type of plant is usually characterized by frequent shipments in small lots to many customers that are located nearby. Consequently, none of these plants mentioned transportation costs as a factor in selecting their plant site.

TABLE 17
PRIMARY FACTORS INFLUENCING THE PLANT LOCATION
BY MAJOR INDUSTRY GROUP

Major SIC[a]	Transportation	Production	Market	Intangible	Total
13	1	1	1	--	3
20	4	5	7	9	25
22	--	--	2	--	2
23	1	4	2	1	8
24	2	10	--	4	16
25	1	4	2	6	13
26	1	1	7	5	14
27	--	6	5	5	16
28	8	5	9	2	24
29	1	--	2	--	3
30	1	10	5	2	18
32	5	8	8	3	24
33	--	2	--	3	5
34	1	14	12	12	39
35	2	8	11	8	29
36	--	2	5	4	11
37	--	2	5	6	13
38	1	2	2	2	7
39	--	3	1	5	9
TOTAL	29	87	86	77	279

[a]Major SIC refers to major 2 digit standard industrial classification. These are SIC: 13 (Crude Petroleum), 20 (Food), 22 (Textiles), 23 (Apparel), 24 (Lumber), 25 (Furniture), 26 (Paper), 27 (Printing), 28 (Chemicals), 29 (Petroleum Refining), 30 (Rubber and Plastics), 32 (Stone, Clay, and Glass), 33 (Primary Metals), 34 (Fabricated Metals), 35 (Machinery), 36 (Electrical Machinery), 37 (Transportation Equipment), 38 (Instruments), and 39 (Miscellaneous Manufacturing).

Most of these plants, however, did consider some production factor--the availability of a suitable building--or the market, particularly access to customers.

In an effort to reduce transportation costs, chemical plants (SIC 28) usually select sites near their raw material source. As shown in Table 29, eight of the 24 chemical plant locations were primarily influenced by transportation costs considerations in the selection of the site.

While the data of Table 17 offers many interesting comparisons among industry groups of the different locational factors influencing plant site-selection, a more compact and meaningful analysis is presented in Table 18. In this table, all the plants by major industry groups are divided into durable and non-durable product manufacturers. With these groups further divided according to the primary factor influence in plant site-selection.

The chi-square analysis of Table 18 indicates no significant variation among major locational factors considered by those plants producing durable goods when compared with the plants producing non-durable goods.

TABLE 18

CHI-SQUARE TEST OF INDEPENDENCE ON THE TYPE OF FACTORS CONSIDERED BY PLANTS PRODUCING DURABLE GOODS VERSUS PLANTS PRODUCING NON-DURABLE GOODS[a]

Location Factor	Durables	Non-Durables	Total
Transportation Cost	12	17	29
Production Cost	52	35	87
Market Factors	45	41	86
Intangible Factors	48	29	77
TOTAL	157	122	279

Chi-square = 4.74 with 3 d.f.; P less than 0.20.

Durable producing industry groups (according to major 2 digit SIC) are: 24 (Lumber), 25 (Furniture), 32 (Stone, Clay, and Glass), 33 (Metals), 34 Fabricated Metals), 35 (Machinery), 36 (Electrical Machinery), 37 (Transportation Equipment), 38 (Instruments). Non-durable industries include the following major 2 digit SIC groups: 13 (Crude Petroleum), 20 (Food), 22 (Textiles), 23 (Apparel), 26 (Paper), 27 (Printing), 28 (Chemicals), 29 (Refining), 30 (Rubber and Plastics).

Variation in the Type of Investigation

An important process in plant location is the investigation that precedes the actual site-selection. In the present study, 193 plant officials gave sufficient information about their methods for finding and selecting their plant locations to enable such investigations to be classified in Table 19.

TABLE 19

TYPE OF INVESTIGATION PRECEDING SITE-SELECTION

Type of Investigation	Number of Plants
No Response	91
Personal (No help)	97
Personal (Outside help)	28
Intra-Company Committee	33
Made by Public Utility	5
Made by Real Estate Agency	19
Made by Chamber of Commerce or Industrial Foundation	11
TOTAL	284

In Table 20, the variation in the type of investigation is considered between branch and non-branch plant locations. It is very apparent that branch plants tend to rely on intra-company committees in finding and selecting the site, while personal investigations are more apparent in non-branch plant locations. Significant chi-square results confirm both of these observations.

TABLE 20

CHI-SQUARE TEST OF INDEPENDENCE ON THE TYPE OF INVESTIGATION USED BY BRANCH VERSUS NON-BRANCH PLANTS

Location Factor	Branch	Non-Branch	Total
Personal (No help)	7	90	97
Personal (Outside help)	10	18	28
Intra-Company Committee	26	7	33
Made by Public Utility	3	2	5
Made by Real Estate Agency	4	15	19
Made by Chamber of Commerce	4	7	11
TOTAL	54	139	193

Chi-square = 67.24 with 5 d.f.; P less than 0.001.

Further chi-square tests on the type of location (new vs. relocated plants), employment size, sales volume, and market area of distribution all indicate significant variation in the type of investigation. Relocated plants tend to rely more on the personal investigation than new plants. Plants with less than 24 employees tend to be located on the basis of a personal investigation by some plant official with no outside help. This type of investigation is also apparent among plants that gross sales less than $500,000 annually. Plants that distribute their product regionally tend to rely less upon personal investigations without outside help.

Dissatisfaction with the Site Selection

Approximately one out of five responding plant officials considered their present plant location to be unsatisfactory. The following series of chi-square tests show that the plant official's evaluation of the

plant site-selection varied little according to the type of factors considered, the type of investigation, and the nature of the plant operation in general.

In Table 21 the non-significant chi-square results indicate that satisfaction or dissatisfaction with current plant location is not dependent upon major location factors.

TABLE 21

CHI-SQUARE TEST OF INDEPENDENCE ON THE SATISFACTORY VERSUS THE UNSATISFACTORY PLANT LOCATION ACCORDING TO THE ORIGINAL LOCATION FACTORS CONSIDERED

Location Factor	Satisfactory	Unsatisfactory	Total
Transportation Cost	22	4	26
Production Cost	64	22	86
Market Factors	69	14	83
Intangible Factors	65	11	76
TOTAL	220	51	271

Chi-square = 3.92 with 3 d.f.; P less than 0.50.

Although twenty of the thirty-eight plant officials who considered their current location to be unsatisfactory, the result of the chi-square analysis shown in Table 22 indicates that the types of investigation employed by both the satisfied and dissatisfied plants were not insignificantly different proportion.

TABLE 22

CHI-SQUARE TEST OF INDEPENDENCE ON THE SATISFACTORY VERSUS THE UNSATISFACTORY PLANT LOCATION ACCORDING TO THE TYPE OF SITE INVESTIGATION

Type of Investigation	Satisfactory	Unsatisfactory	Total
Personal (No help)	76	20	96
Personal (Outside help)	22	5	27
Intra-Company Committee	28	4	32
Made by Public Utility	5	0	5
Made by Real Estate Agency	13	6	19
Made by Chamber of Commerce or Industrial Foundation	9	2	11
TOTAL	152	38	190

Chi-square = 4.12 with 5 d.f.; P less than 0.70.

A significant chi-square in Table 23 indicates that a statical significant higher proportion of the firms that lease rather than own their plant sites were dissatisfied with their current location. In fact, more than 50 percent of the unsatisfactory locations were found among the lease firms.

TABLE 23

CHI-SQUARE TEST OF INDEPENDENCE ON THE SATISFACTORY VERSUS THE UNSATISFACTORY LOCATION BY TENANCY

Evaluation of Site	Satisfactory	Unsatisfactory	Total
Own	131	23	154
Rent	93	28	121
TOTAL	224	51	275

Chi-square = 3.02 with 1 d.f.; P less than 0.10.

The chi-square in Table 24 indicates that a significantly higher ratio of new plants were located on unsatisfactory sites as evaluated by 51 plant officials. Proportionately less of the officials from relocated plants were dissatisfied with their site-selection.

Further chi-square tests revealed that the evaluation of the plant location did not vary significantly among plants with different annual gross sales, market areas, and employment size.

TABLE 24

CHI-SQUARE TEST OF INDEPENDENCE ON THE SATISFACTORY LOCATION VERSUS THE UNSATISFACTORY LOCATION BY THE TYPE OF LOCATION

Evaluation of Site	Satisfactory	Unsatisfactory	Total
New	140	40	180
Relocated	84	11	95
TOTAL	224	51	275

Chi-square = 4.66 with 1 d.f.; P less than .05.

SUMMARY AND CONCLUSIONS

This study has been an attempt to delineate the important variables in plant location by interviewing the decision maker. The pattern of industrial location in areas serviced by the interstate highway in Texas is apparently determined by a multitude of factors depending upon individual plant locational requirements. It was determined that the basic locational requirements of production cost, transportation cost, market, and intangible considerations vary according to the size of plant, type of product, and other characteristics of the plant operation.

As a result of this investigation and the analysis of the findings, the following generalizations and conclusions were reached:

(1) In general, only one major location factor tended to dominate the plant location decision; e.g., cost (transportation and production), demand, or some intangible factor.

(2) However, there was a strong tendency for branch plants and plants with over $500,000 annual gross sales to have considered both spatially variable costs and marketing differences in selecting a plant location.

(3) In a general tabulation of the type of factors that were considered in selecting the plant location, it was found that:

(a) the market (access to customers), production factors (availability of suitable site and/or building), and intangible factors (community characteristics and personal reasons) tended to be important as a primary consideration in selecting a plant location while

transportation factors (availability of suitable transportation facilities and services) were more important as a secondary consideration;

(b) intangible factors--personal reasons and community characteristics--were the primary influence in 62 plant location decisions.

(3) Additional findings indicate that:

(a) most plant location decisions were made by one individual who was either the owner or president of the firm;

(b) outside assistance was used about as frequently as a personal investigation with no outside help in finding the site;

(c) approximately half of the firms in the sample considered alternative sites which are primarily in Texas;

(d) only 51 plant officials were dissatisfied with their site selection while mentioning such disadvantages as the lack of suitable production (building, site, labor, etc.) and transportation (highway services and facilities) factors more than market related factors.

(4) In analyzing the variation in location behavior patterns by type or size of plant, it was determined that:

(a) the primary factors influencing the plant locations covered in the sample were cost factors (116 plants), demand factors (86 plants), and intangible factors (49 plants);

(b) a high proportion of plants with the following characteristics were located on the basis of some transportation cost or market factor: branch plant, over $500,000 annual gross sales, over 24 employees, and a new operation;

(c) small plants, especially non-branch plants, and relocated plants tend to have been located on the basis of some production cost or intangible factor;

(d) the primary factors considered by plants within different industries--as determined by major two-digit standard industrial classification--varied considerably; however, there was no significant variation in the type of locational factors influencing durable goods' producers as opposed to non-durable manufacturers;

(e) non-branch plants, relocated plants, plants with reletively small employment and sales volume, and plants with local product distribution tend to have been located on the basis of a personal investigation with limited outside assistance usually from a real estate agency;

(f) branch plants, new plants, and plants with relatively high sales volume and employment tend to have been located by either an intra-company committee or with some outside assistance.

(g) a higher proportion of new plants (as opposed to relocated plants) and plants that lease (rather than own) tend to be located on unsatisfactory site according

to the plant official.

(5) Plant officials tend to rank the interstate highway as more important to their plant operation than other types of roads. In general:

(a) plant officials that ranked the interstate highway first were from branch plants: located within 0.4 miles of the nearest interstate highway, having more than 50 employees, having a regional market distribution, and locating in non-metropolitan areas;

(b) plant officials that ranked some other road facility--usually city streets and expressways or state and U. S. highways--as more important were from non-branch plants: located more than 0.4 miles from the interstate highway, located within a metropolitan area, and with a local market distribution.

Relationship of Findings to Theory and Practice

Theory. This portion of the study offers little more than "common sense" conclusions. It does, however, tend to substantiate what previously had been conjecture or surmise concerning the fundamental "forces" in plant location according to certain theorists; e.g., Weber, Hoover, Greenhut. If nothing else, the findings represent some verification of the fundamental location factors that have been isolated in past deductive analyses.

The study's findings indicate that to some extent spatial cost and demand factors were recognized in almost every location decision. Of

necessity, most plants have been located under some basic cost and demand constraint; i.e., each plant must have considered to some extent the anticipated market and cost at the site selected. However, not all plant officials specifically mentioned both factors as important in their location decision.

A majority of the plant officials either mentioned only one dominant cost factor, demand factor, or mentioned neither factor, referring to some intangible influence instead. If the latter factor has been correctly delineated, there is substantial evidence that many plant locations are a result of some personal bias of the owner/manager or some other non-pecuniary consideration; e.g., community characteristics.

The fact that non-pecuniary motives are relatively significant in plant location adds weight to M. L. Greenhut's contention that location theory lacks generality under the assumption that plant location decisions are motivated solely by the drive to maximize pecuniary profits. It should be pointed out, however, that recent theoretical reformulation of the "rationality assumption" to include the element of uncertainty renders this finding untenable as empirical evidence or irrationality. Unfortunately, there was no attempt to probe the plant official motivated by some intangible influence in selecting a plant site to determine the extent to which his decision was either a "wild gamble" or extremely conservative with little probability of success. Many of the plant location decisions influenced by intangible considerations may indeed have been very rational when analyzed in this manner.

SECTION III

PLANT LOCATION AND THE INTERSTATE HIGHWAY SYSTEM IN TEXAS

The purpose of this section of the report is to bring together the relationship between theory of location process, as summarized in Section II with the practice of industrial location actively along the Interstate Highway System of Texas, as described in Section III in order to evaluate the potential effects of Interstate Highway System construction, with or without frontage roads on industrial development within Texas.

As a result of the procedures that were followed in a study of location decisions making processes. Among industrial plant officials seeking sites along the Interstate Highway System of Texas a relatively large data base was established. To convey a more meaningful analysis of the data obtained during the course of the study only those data which provide statistical reliable inference have been included in this report. Other data are available for review and analysis upon request by appropriate agencies.

Interstate Highway System Classification

One of the first objectives in the design of the sample for the selection of study firms was to categorize and classify each segment of the Interstate Highway System in Texas according to frontage road construction. This objective was met by coding specific information relative to the status of Interstate Highway construction provided by the Planning Survey Division of the Texas Highway Department. A map of the Status of Improvements to the Interstate Highway as of January 1, 1964, is shown in Figure 25. From this source coded information relative to the status of the 3,000 mile Interstate System was placed on punch cards. These data included the Interstate route number, date construction began

or was completed, city code, county code and the status of construction of the facility and frontage roads within each segment.[1] These data were essential to the development of the identification card that would be completed for each industrial firm locating along the designated Interstate Highway system during the period 1956-1964.

Table 25 illustrates the overall mileage of each Interstate Highway included in the study. It should be pointed out in regard to this table, that if there were frontage roads on both sides of the primary facility, the ratio of highways to frontage roads would be 1:2. In other words, every mile of highway facility would be complemented with two miles of frontage roads.

[1]The 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.

Figure 2
Texas Highway Department, Planning and Survey Division
Status of Improvements

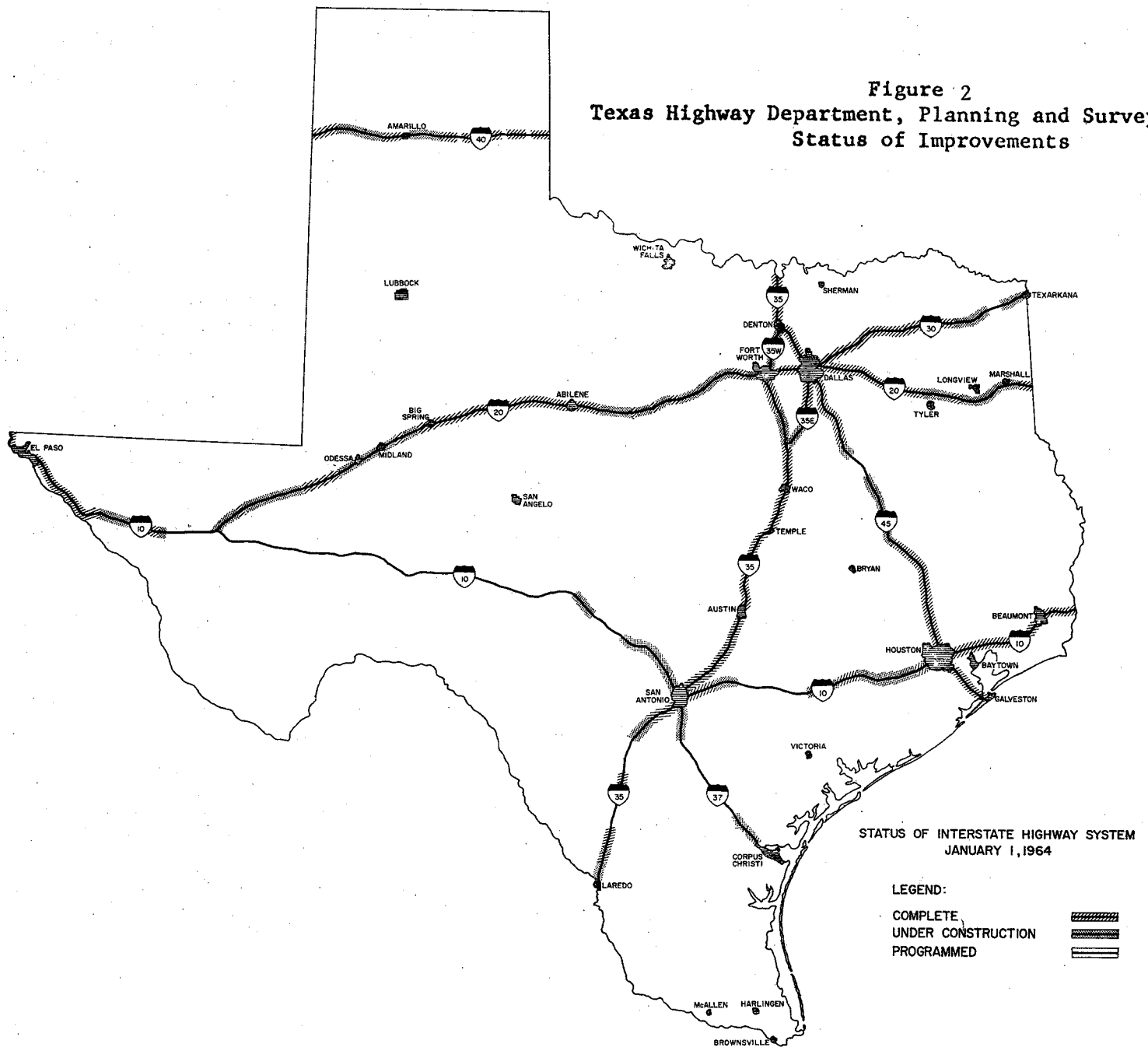


TABLE 25

Texas Status of Improvements to the Interstate System
(in miles and tenths of miles)

	PRIMARY FACILITY				FRONTAGE ROADS			
Interstate	Complete	Under Construction	Programmed	Total	Complete	Under Construction	Programmed [1]	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 [2]	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

1) Frontage road mileage in programmed area not available
2) Includes IH 35E

Source: Texas Highway Department, Planning Survey Division, January 1, 1964.

It is obvious from this table that frontage roads have not been constructed along the total highway facility. However, the table does indicate that almost 70% of the Texas Interstate Highways, completed or under construction, included frontage road access. One of the major difficulties in the design of the study is related to the location of suitable "non-frontage" study areas where industrial development had occurred. This problem was magnified in the large metropolitan cities where a high percentage of the state's manufacturing industry is located. For example, study data indicate that approximately 80% of the interstate facilities in metropolitan areas are constructed with frontage roads.

A second major objective in the design of sampling procedures was to identify and catalog all manufacturing industries locating within areas serviced by the Interstate Highway during the study period. 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 which had selected sites along the Interstate Highway routes during the study period. The following information was made available for each firm: 1) name and mailing address; 2) number of employees; 3) date when production began; and 4) major product by Standard Industrial Classification.

The 2,331 address cards were then sub-divided into two major groups. One group was made up of 1,495 firms, or 65 percent of the total universe, which had located in areas serviced by the designated Interstate System, while the other group consisted of 836 firms, or 35 percent of the universe, locating in areas which have not been programmed to be included in the Interstate System. At this point this is not to say that the

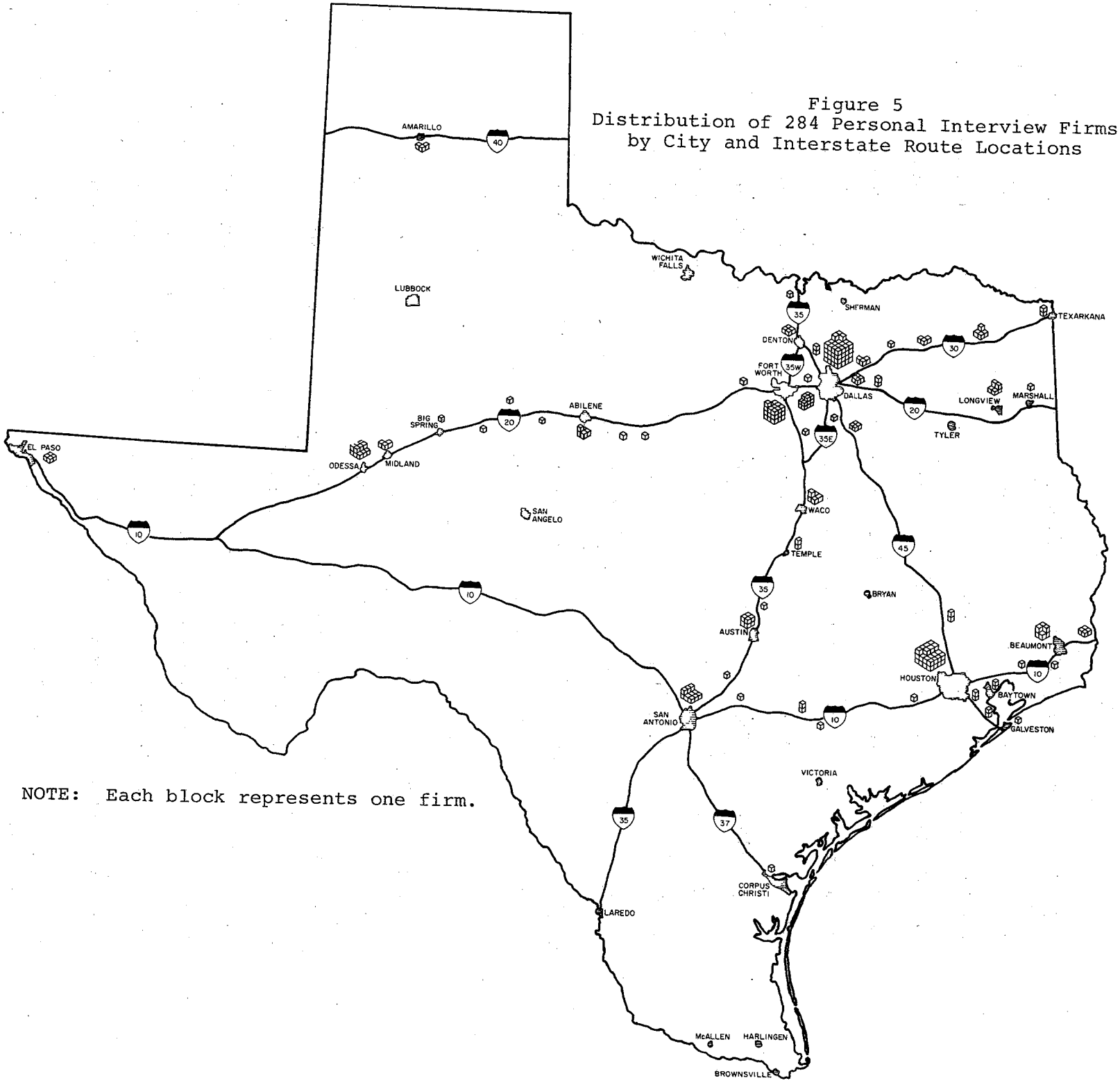
Interstate Highway is a significant factor in the selection of a plant site; however, it does provide a measure by which specific areas for study were selected.

The 1,495 industries locating in areas serviced by the Interstate were plotted on Texas Highway Department, city and county 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: 1) distance the firm was located from highway, railroad, and water (if applicable); 2) type of street or highway location; 3) type of access to Interstate Highway from plant site; 4) location of the firm with respect to the city; and 5) location of firm with respect to railroad and Interstate Highway. This information was then coded and keypunched to provide an identification punch card for each of the 1,495 firms. This was done in order to provide for multi-purpose retrieval and listings of all pertinent data relative to the selection of the sample firms. The distribution of these 1,495 firms by their geographic location with respect to Interstate Highway routes is shown in Figure 3.

DESIGN OF THE SAMPLE

Rather than select firms at random from the total universe, it was decided that more meaningful data could be obtained by employing stratified random sampling techniques. Therefore, the universe was divided into distinctive homogeneous classes (or strata) and the sample was drawn at random from each of the specified classes. This approach seemed more desirable because it made possible the ability to distinguish between classes that differ among and between themselves with respect to a stated characteristic. For example, the primary reason given by these firms

Figure 5
Distribution of 284 Personal Interview Firms
by City and Interstate Route Locations



NOTE: Each block represents one firm.

for selecting their respective locations may then be statistically analyzed among the various strata.

Firms were stratified on the basis of whether they had frontage road access, the size of the city in which they had located, their distance from the nearest interstate highway, and by Standard Industrial Classification.

Figure 4 is the Cell Chart used in the selection of the study firms. An examination of this chart reveals that only 1,364 firms were included in the sample design. Although 1,495 firms located in the study area during the period from January 1956 to January 1964, at the time the sample was drawn, data were not available for the 131 firms locating during the last four months of 1963.

It is also to be noted from Figure 4 that over 200 cells were empty, with almost one half of the empty cells occurring in the smaller cities where the Interstate Highway has been constructed without frontage roads.

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

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.

Figure 4

CELL CHART*

A STRATIFICATION OF ALL MANUFACTURING FIRMS LOCATING IN TEXAS BETWEEN JANUARY, 1956 — SEPTEMBER, 1963 ON THE INTERSTATE HIGHWAY SYSTEM

STATUS	INTERSTATE HIGHWAY WITH FRONTAGE ROADS															INTERSTATE HIGHWAY WITHOUT FRONTAGE ROADS															INTERSTATE HIGHWAY PROGRAMMED															TOTAL
CITY SIZE	1			2			3			4			5			1			2			3			4			5			1			2			3			4			5			
DISTANCE FROM INTERSTATE HIGHWAY SYSTEM	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
FOOD & KINDRED PRODUCTS	5	19	4				1	15	2	2	2	2		4	1	1	7	1		1	1	1									1		1	1		1	2	4		2	2		3	9		95
APPAREL & PAPER	7	29	4	1	1	1	1	4	1		2	1	1	5		5	7	2			2									1				1		1	3					3		83
WOOD & FURNITURE	16	36	10	1	1	2		7	1	2	2	7	1	7		3	8	2	1	1	4		1				1	1				1		1	1		2	2	2		1	1	1		128
PRINTING & PUBLISHING	13	37	4	1	2	3	2	4	4		1	1				2	5	2		1	2										3				1	3	4	1			1	2		99
CHEMICAL	14	27	7	2	3	11	2	2	3	1	3	7		3	1	6	7	2		1		1	1								1	1		1	2		2	7	3			1	4	1	127
RUBBER	7	26	7			1	2			3	1	1		1		4	5	1	2	1	1												3			1				1	1		69
STONE, CLAY, & GLASS	11	10	7	1	2	4	2	10	4	5	3	1		2	2	4	6	1			4			1	1		1	1				1		1	1		6	1			3	4	4	104
METALS	32	74	21	2	3	6	4	13	2	1	1	7	2	3		3	13	2		7	5	1									1	1		5	1	1	7	10	3	1			2		234
MACHINERY	29	84	20	1		1	3	7	5	4	1	2		1	1	7	16	4	2	3	10	1							1	2		1	2	2	11	4	1	4	9			1		3		243
TRANSPORTATION EQUIPMENT	7	14	5			2		1	4		3	1	1		1		4		1	3	5												1			1	2			1				57
MISCELLANEOUS MANUFACTURING	10	32	8	3		3	1	8	2	1	2	3	1	1	3	8	6	4	2	2	7									1	1		4			5	4		1		1	1		125
TOTALS	151	388	97	12	12	34	18	71	28	19	21	33	6	27	9	43	84	21	8	20	41	4	2	1	1	0	2	2	1	2	4	9	5	4	29	8	8	42	36	8	4	3	11	30	5	1364

* THIS CHART USED TO SELECT PERSONAL INTERVIEW SAMPLE FIRMS

The random selection resulted in a sample of 632 firms (including alternates) of which 284 were eventually contacted by personal interview. Figure 5 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.

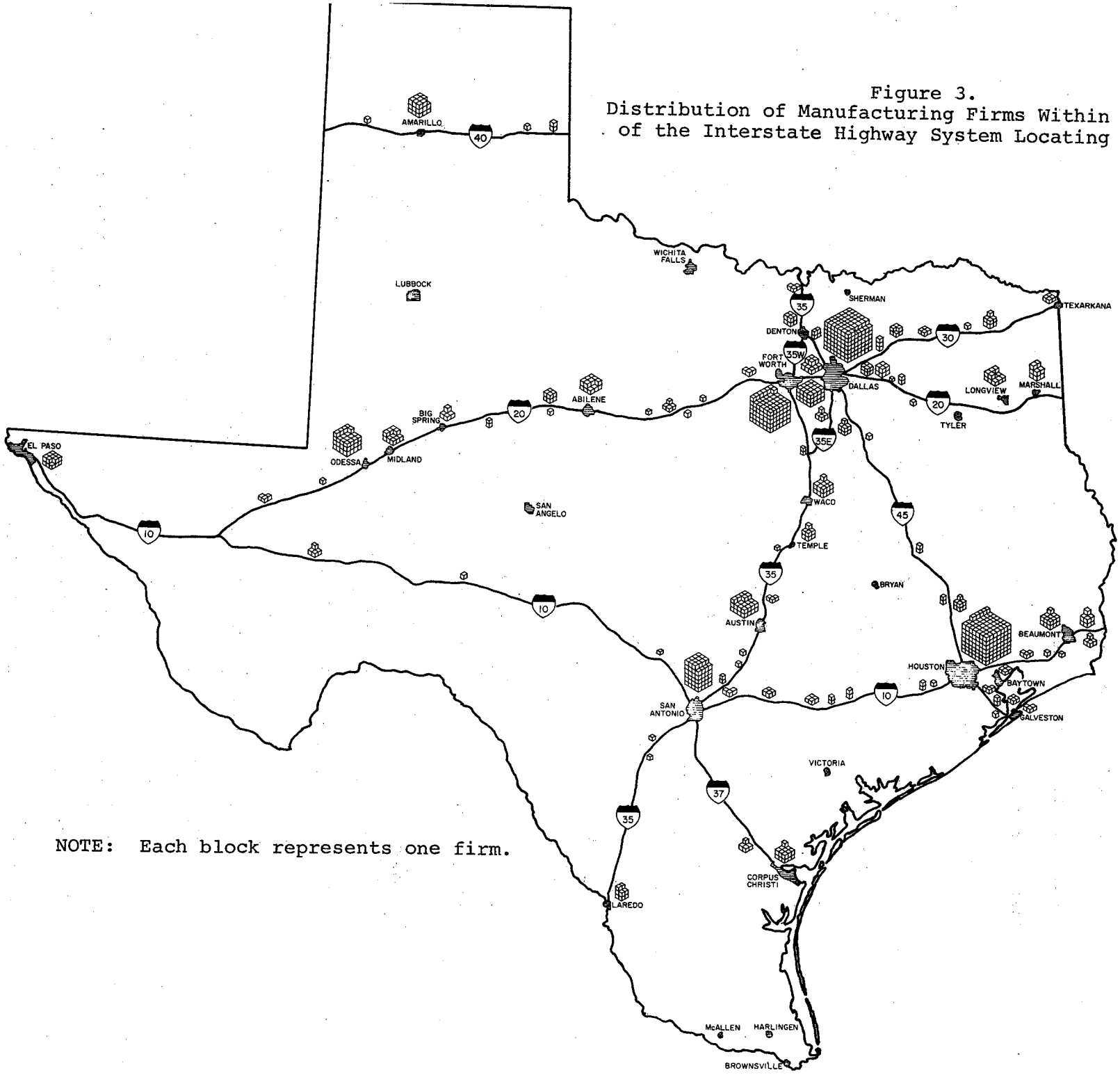
CHARACTERISTICS OF THE UNIVERSE

Tables 26 through 28 show the distribution of firms by city size, distance located from the Interstate Highway and Industrial Classification. Since these three classifications are used in the stratification of the universe it should be of value to point out some of the more significant facts that appear when groupings are made by arranging the firms as to the status of the Interstate Highway at the time the study was conducted.

City Size

As seen in Table 26 approximately 58 percent of the study firms located in one of the four large metropolitan cities of Texas. When the satellite city firms are added to this group, the total number of metropolitan firms represent approximately 70 percent of all industrial locations occurring during the study period. The heaviest concentration of non-frontage road locations appear in the satellite city group while the lightest is in the 50 to 100 thousand population category. Frontage road locations accounted for approximately seven out of ten locations in the metropolitan cities. However, in the satellite communities surrounding the large metropolitan cities, frontage road locations represent only 35 percent of all firms locating in this city size category. Although the two smallest city size groups accounted for only 30 percent of all industrial locations, it is significant that more than one half

Figure 3.
Distribution of Manufacturing Firms Within Influence of the Interstate Highway System Locating in Texas



NOTE: Each block represents one firm.

Table 26
Distribution of Firms in the Universe By
Size of City in Which Plant is Located

Status of IHS	Metropolitan City[1] Number	Percent	Satellite City[2] Number	Percent	Large City[3] Number	Percent	Small City[4] Number	Percent	TOTAL Number	Percent
With Frontage Roads	605	(69.5)	62	(35.4)	125	(53.0)	133	(62.1)	925	(61.9)
Without Frontage Roads	165	(19.0)	73	(41.7)	7	(3.0)	33	(15.4)	278	(18.6)
Programmed	100	(11.5)	40	(22.9)	104	(44.0)	48	(22.5)	292	(19.5)
TOTAL	870	(100.0)	175	(100.0)	236	(100.0)	214	(100.0)	1495	(100.0)

Table 27
Distribution of Firms in the Universe By
Distance from IHS (In Miles)

Status of IHS	Less Than 0.5 Number	Percent	0.6 - 1.0 Number	Percent	1.1 - 2.5 Number	Percent	2.6 - 5.0 Number	Percent	TOTAL Number	Percent
With Frontage Roads	221	(59.1)	194	(60.8)	321	(68.3)	189	(56.9)	925	(61.9)
Without Frontage Roads	85	(22.7)	61	(19.1)	56	(11.9)	76	(22.9)	278	(18.6)
Programmed	68	(18.2)	64	(20.1)	93	(19.8)	67	(20.2)	292	(19.5)
TOTAL	374	(100.0)	319	(100.0)	470	(100.0)	332	(100.0)	1495	(100.0)

1) Metropolitan City:
includes only Fort Worth, Dallas, Houston, San Antonio

2) Satellite City:
includes all small cities within these four metropolitan areas

3) Large City:
includes all cities over 50,000 population not included in either the Metropolitan or Satellite Category

4) Small City:
includes all urban areas with less than 50,000 population

of the firms locating in programmed areas chose this city size for the location of their plants.

Distance from Interstate Highway System

Firms locating less than one half mile from the Interstate Highway either completed, under construction, or programmed accounted for one out of four of all firms locating during the study period. From Table 27 it may be seen that the most frequent distance category chosen for a plant site was between 1.1 and 2.5 miles. There seems to be no significant trend for firms to select plant locations, either nearer or further away from the facility, based solely upon the availability of frontage road access. However there does appear to be a similarity between the distribution of firms locating in programmed and non-frontage road areas.

Industrial Classification

Approximately 70 percent of the plants may be classified as light industrial manufacturing concerns. Data contained in Table 28 indicates that the distribution of both classes of firms, by status of the Interstate Highway, is not significantly different from the distribution of all firms. Therefore, it appears that there is little consideration given to the status of Interstate Highway construction as it may affect the selection of a site by either the light or heavy industrial concerns.

Table
Distribution of Firms in The Universe
By Industrial Classification

	Light		Heavy		TOTAL	
Status of IHS	Number	Percent	Number	Percent	Number	Percent
With Frontage Roads	652	(62.8)	273	(59.9)	925	(61.9)
Without Frontage Roads	199	(19.2)	79	(17.3)	278	(18.6)
Programmed	188	(18.0)	104	(22.8)	292	(19.5)
TOTAL	1039	(100.0)	456	(100.0)	1495	(100.0)

In summary, with the exception of two city sizes (satellite and large city), the stratification of the universe by city size, distance located from the Interstate Highway, and industrial classification produces groups of firms which are distributed approximately in the same proportion, within the categories of with frontage roads and without frontage roads as may be found in the total universe.

CHARACTERISTICS OF THE SAMPLE

Some indication as to the representativeness of the sample firms may be seen from the data presented in Table 29. By comparing the percent of total sample representation within each Standard Industrial Classification, with the percent of total firms locating during the study period and those included only in the universe of firms locating during the study period, only slight differences are noted.

For example, fabricated metals plants (SIC 34) represented 12.6 percent of total plant locations occurring during the study period. These same firms also accounted for 15 percent of the firms included in the universe and 14.1 percent of sample firms.

Other characteristics of the sample also indicate representativeness. For example, although the sample was not stratified by size of employment, market area of distribution, type of plant location, city size of location, and annual gross sales volume, the sample does cover the component groups involved in these categories rather well.

The distribution of plants by size of employment indicates that plants with relatively small employment comprise a large percentage of the sample firms. As seen from Table 30 approximately 61 percent of the plants included in the survey employed less than 24 people.

Table 29
Distribution of Manufacturing Plants Locating in Texas
From Jan. 1, 1956, to Jan. 1, 1964
By Major Two Digit Standard Industrial Classification

Major SIC		Total Plants Locating in Texas	Percent of Total	Total Universe	Percent of Total	Total Sample Plants	Percent of Total
13	Crude Petroleum	82	3.5	9	0.6	3	1.1
19	Ordinance	4	0.2	3	0.2	NR*	NR
20	Food	223	9.6	103	6.9	26	9.1
22	Textiles	17	0.7	7	0.5	2	0.7
23	Apparel	112	4.8	59	4.0	9	3.2
24	Lumber	129	5.5	71	4.8	16	5.6
25	Furniture	100	4.3	67	4.5	13	4.6
26	Paper	54	2.3	44	3.0	14	4.9
27	Printing	191	8.2	140	9.4	16	5.6
28	Chemicals	198	8.5	130	8.7	24	8.4
29	Refining	25	1.1	14	0.9	3	1.1
30	Rubber/Plastics	93	4.0	71	4.8	19	6.7
31	Leather	14	0.6	6	0.4	NR	NR
32	Stone/Clay/Glass	226	9.7	111	7.4	25	8.8
33	Primary Metals	32	1.4	20	1.4	5	1.7
34	Fabricated Metals	294	12.6	224	15.0	40	14.1
35	Machinery	218	9.4	166	11.1	29	10.2
36	Electrical Machinery	105	4.5	87	5.5	11	3.9
37	Transportation Equipment	86	3.7	59	4.0	13	4.6
38	Instruments	35	1.5	32	2.1	7	2.5
39	Miscellaneous	93	3.9	72	4.8	9	3.2
	TOTAL	2,331	100.0	1,495	100.0	284	100.0

*NR -- no response.

Table 30
Distribution of Plants in the Sample
By Size of Employment

Number of Employees	Number Of Plants	Percent of Total
Under 8	84	30%
8 to 24	89	31
25 to 49	57	20
50 to 99	25	9
100 to 249	17	6
Over 249	12	4
TOTAL	284	100%

The large number of small plants employing less than 24 workers is partially explained by the type of location. Data from Table 31 indicates that more than 40 percent of the plant locations in the sample involved new plant operations that had not begun to expand their business. An additional 20 percent of the plants were classified as new branch plants indicating that this group may also be in the initial stages of plant operation.

Table 31
Distribution of Plants in the Sample
By Type of Location

Type of Location	Number of Plants	Proportion of Plants
New Plant	121	43%
Relocated Plant	88	31
New Branch Plant	57	20
Relocated Branch Plant	18	6
TOTAL	284	100%

Table 32 shows the distribution of plants in the sample by annual gross sales. The fact that over 60 percent of the study plants had annual gross sales of less than 500,000 suggests further evidence of the frequency of small plant locations.

Table 32
Distribution of Plants in the Sample By
Annual Gross Sales Volume in 1964

Annual Sales Volume	Number of Plants	Proportion of Plants
No Response	29	10.2%
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
TOTAL	284	100.0%

The distribution of plant locations by city size is of particular interest since the sample was stratified on this basis. The large percentage of plants locating in metropolitan cities is largely due to the specifications placed upon the universe. It may be recalled from an earlier statement of the scope of the study, that only those firms that had located within cities served by the interstate highway were to be included in the universe of study firms. Moreover, only those plants that were located within approximately five road miles of the nearest interstate highway were to be included. The data indicate that the majority of recent plant locations have been in metropolitan areas served by the interstate highway. Table 33 shows the distribution of firms by city classification. The data included in this table indicate that 60 percent of the sample firms located either in the metropolitan city or the satellite city of one of the large metropolitan areas.

Table 34 shows that 65 percent of the plants in the survey distribute their product over at least a regional market area while only 8 per-

cent of the study firms identified local areas as their total area of product distribution.

Table 33
Distribution of Plant Locations by City Size

City Class	Number of Plants	Proportion of Plants
Metropolitan City	114	40%
Satellite City	58	20
Large City	47	17
Small City	65	23
TOTAL	284	100%

Table 34
Distribution of Plants in the Sample By Market Area of Distribution

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

Location of Sample Firms

The size and area of the city in which a firm chooses a plant site is to some degree influenced by the availability of street and highway access to that area. To measure this effect several tables, grouping the sample firms by status of interstate highway construction and plant site location, have been prepared.

When the sample firms were categorized by the size of the city in which they located, some measure of the significance of frontage roads

to firms located in various city sizes is noted. For example, Table 35 indicates that approximately 55 percent of the sample firms locating in the metropolitan and large city classes chose areas with frontage road access. However, the satellite and small city classes were not as evenly distributed. Only two sample firms, in the small city category, chose non-frontage areas for the location of their plant while 39 firms in this city size category selected areas with frontage road access. In the satellite city size non-frontage locations exceeded frontage location by only a single firm.

Table 36 shows that slightly more than 50 percent of the sample firms were located in areas serviced by frontage roads. However, only 46 of the 284 sample firms located within one half mile of an interstate facility having frontage road access. Except in the distance category six tenths of a mile to one mile the distribution of sample firms in each distance category, by availability of frontage roads, does not differ appreciably from the distribution of all firms locating during the study period.

Firms that may be classified as light manufacturing industries accounted for 186 (or 65 percent) of the 284 sample firms. Table 37 shows only slight differences between the distribution of light and heavy industries in areas where the Interstate Highway is constructed with frontage roads, without frontage roads or was only programmed for construction at the time the study was made.

Table 37 provides a distribution of sample firms by city zones and type of Interstate Highway construction. It may be observed from this table that city zones have little or no effect upon the distribution of plant location included in the sample. Also the percentage of firms

Table 35
Distribution of Firms in the Sample
By Distance from Interstate Highway
(In Miles)

Status of IHS	Less than 0.5 Number	Percent	0.6-1.0 Number	Percent	1.1-2.5 Number	Percent	2.6-5.0 Number	Percent	TOTAL Number	Percent
With Frontage Roads	46	(56.8)	20	(40.8)	39	(59.1)	46	(52.3)	151	(53.2)
Without Frontage Roads	16	(19.8)	12	(24.5)	10	(15.2)	20	(22.7)	58	(20.4)
Programmed	19	(23.4)	17	(34.7)	17	(25.7)	22	(25.0)	75	(26.4)
TOTAL	81	(100.0)	49	(100.0)	66	(100.0)	88	(100.0)	284	(100.0)

Table 36
Distribution of Firms in the Sample
By Size of City in Which Plant is Located

Status of IHS	Metropolitan City Number	Percent	Satellite City Number	Percent	Large City Number	Percent	Small City Number	Percent	TOTAL Number	Percent
With Frontage Roads	63	(55.3)	21	(36.2)	28	(54.9)	39	(63.9)	151	(53.2)
Without Frontage Roads	34	(29.8)	22	(37.9)	--	-----	2	(3.3)	58	(20.4)
Programmed	17	(14.9)	15	(25.9)	23	(45.1)	20	(32.8)	75	(26.4)
TOTAL	114	(100.0)	58	(100.0)	51	(100.0)	61	(100.0)	284	(100.0)

Table 37
Distribution of Firms in The Sample
By Industrial Classification

Status of IHS	Light Number	Light Percent	Heavy[1] Number	Heavy[1] Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	102	(54.8)	49	(50.0)	151	(53.2)
Without Frontage Roads	38	(20.4)	20	(20.4)	58	(20.4)
Programmed	46	(24.8)	29	(29.6)	75	(26.4)
TOTAL	186	(100.0)	98	(100.0)	284	(100.0)

1) Heavy industry is defined as those industries which manufacture goods from raw materials and certain semi-finished products.

Table 38
Distribution of Firms in The Sample
By Zone of City in Which Plant is Located*

Status of IHS	Intermediate[1] Number	Intermediate[1] Percent	Fringe[2] Number	Fringe[2] Percent	Outer[3] Number	Outer[3] Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	39	(51.3)	82	(53.6)	29	(54.7)	150	(53.2)
Without Frontage Roads	17	(22.4)	31	(20.3)	10	(18.9)	58	(20.4)
Programmed	20	(26.3)	40	(26.1)	14	(26.4)	74	(26.4)
TOTAL	76	(100.0)	153	(100.0)	53	(100.0)	282	(100.0)

*Two firms were not coded for this analysis

1) Intermediate zone:
generally defined as the high density street area of the city (excluding the downtown business district).

2) Fringe zone:
The low density street area of the city bordered by the city limits.

3) Outer zone:
Areas outside the city limits but contiguous to the city.

selecting sites serviced by the Interstate Highway with frontage roads, without frontage roads, and in programmed areas varies insignificantly within city zones, between city zones and between the totals.

The type of street or highway serving the locations chosen by the sample firms is indicated in Table 39. More than one half of the firms located on secondary city streets while only nine firms actually chose sites located directly on the Interstate Highway. The abutting Interstate Highway locations represent less than four percent of the sample firms, however, this group also accounted for less than three percent of the total universe. In fact, only 38 of the 1,495 firms locating during the study period selected sites directly on the Interstate Highway.

Although more than one out of two firms located on secondary city streets less than one out of five had access by way of these streets to the Interstate Highway. Highways, other than the interstate, provided access to the interstate for approximately 46 percent of the study firms. Table 40 shows that with the exception of those firms having direct Interstate Highway access, the status of Interstate Highway construction has little or no effect upon the type of access the firms have to the facility in the selection of particular plant sites.

Only one out of four of the 1,495 firms locating plants during the study period selected sites within one half mile of the Interstate Highway. However, two out of three of the 1,495 firms located within one half mile of a railroad. As shown in Table 41 sampling produced 205 firms locating within one half mile of the railroad. This represents approximately 72 percent of the total study firms. Although firms locating within one half mile of the railroad appear to be distributed in the same proportion as the total sample, by status of the interstate highway

Table 39
Distribution of Firms in the Sample
By Type of Street or Highway Location

Status of IHS	Secondary City Street Number	Secondary City Street Percent	Primary City Street Number	Primary City Street Percent	Interstate Highway Number	Interstate Highway Percent	Other Highway Number	Other Highway Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	77	(50.3)	41	(53.2)	9	(100.0)	24	(54.5)	151	(53.2)
Without Frontage Roads	37	(24.2)	12	(15.6)	--	---	9	(20.5)	58	(20.4)
Programmed	39	(25.5)	24	(31.2)	--	---	11	(25.0)	74	(26.4)
TOTAL	153	(100.0)	77	(100.0)	9	(100.0)	44	(100.0)	283*	(100.0)

*One firm could not be classified.

Table 40
Distribution of Firms in the Sample
By Type of Interstate Highway Access

Status of IHS	Secondary City Street Number	Secondary City Street Percent	Primary City Street Number	Primary City Street Percent	Interstate Highway Number	Interstate Highway Percent	Other Highway Number	Other Highway Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	26	(54.2)	53	(54.1)	6	(100.0)	66	(51.2)	151	(53.7)
Without Frontage Roads	9	(18.7)	19	(19.4)	--	---	30	(23.2)	58	(20.6)
Programmed	13	(27.1)	26	(26.5)	--	---	33	(25.6)	72	(25.7)
TOTAL	48	(100.0)	98	(100.0)	6	(100.0)	129	(100.0)	281*	(100.0)

*Three firms could not be classified.

those locating beyond one mile tend to be oriented toward the without frontage and programmed areas. This fact is also observed in the universe where approximately 46 percent of the firms locating more than one mile from the railroad chose non-frontage and programmed areas.

Considering transportation as a primary location factor the "best" location for an industrial firm is generally accepted to be one that provides ready access to both highway and rail transportation services. As seen from Table 42, approximately 90 percent of the sample firms chose locations that would provide this type of access to rail and/or highways. Only ten percent of the firms located at sites where it would be necessary to cross the Interstate Highway in order to have access to railroad facilities. The same relationships are found in the universe where only 130 of the 1,495 firms chose to cross the Interstate Highway for railroad access. It is also interesting to note from Table 42 that although those firms located in areas without frontage roads represented slightly more than twenty percent of the study firms they accounted for more than thirty-five percent of those firms locating where it was necessary to cross the Interstate Highway to have railroad access. Of the 107 study firms located between the Interstate Highway and the railroad the without frontage road group included only fourteen percent of these firms.

Plant Ownership and Organization

More than one half of the sample firms indicated that they owned the site at which their plants are operated. Table 43 provides data relative to the distribution of the owned and leased firms by type of Interstate Highway construction. It may be observed from this table that

a relatively higher proportion of firms who lease their facilities sought frontage road locations while there were twice as many owned firms as there were leased category firms selecting programmed areas as plant sites. Approximately the same number of owned and leased firms located in the non-frontage areas.

Table 41
Distribution of Firms in The Sample
By Distance From Railroad
(In Miles)

Status of IHS	Less Than 0.5 Number	Percent	0.6-1.0 Number	Percent	1.1-2.5 Number	Percent	2.6-5.0 Number	Percent	TOTAL Number	Percent
With Frontage Roads	112	(54.6)	22	(59.5)	12	(40.0)	5	(41.7)	151	(53.2)
Without Frontage Roads	43	(21.0)	5	(13.5)	10	(33.3)	--	---	58	(20.4)
Programmed	50	(24.4)	10	(27.0)	8	(26.7)	7	(58.3)	75	(26.4)
TOTAL	205	(100.0)	37	(100.0)	30	(100.0)	12	(100.0)	284	(100.0)

Table 42
Distribution of Firms in The Sample
By Plant Location with Respect to Railroad and Interstate Highway

Status of IHS	Plant Between Railroad and IHS Number	Percent	Railroad Between IHS and Plant Number	Percent	IHS Between Railroad and Plant Number	Percent	Where Railroad Intersects IHS Number	Percent	TOTAL Number	Percent
With Frontage Roads	56	(52.3)	43	(53.8)	13	(46.4)	39	(56.5)	151	(53.2)
Without Frontage Roads	15	(14.0)	20	(25.0)	10	(35.7)	13	(18.8)	58	(20.4)
Programmed	36	(33.7)	17	(21.2)	5	(17.9)	17	(24.7)	75	(26.4)
TOTAL	107	(100.0)	80	(100.0)	28	(100.0)	69	(100.0)	284	(100.0)

Table 43
Distribution of Firms in the Sample
By Plant Ownership

Status of IHS	Owned Number	Owned Percent	Leased Number	Leased Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	79	(49.1)	72	(58.5)	151	(53.2)
Without Frontage Roads	30	(18.6)	28	(22.8	58	(20.4)
Programmed	52	(32.3)	23	(18.7)	75	(26.4)
TOTAL	161	(100.0)	123	(100.0)	284	(100.0)

Although Table 44 shows that approximately two of three study firms were new plants, rather than relocated facilities, it does not reveal any significant differences in the proportion of new and relocated plants selecting sites based upon Interstate Highway construction.

Table 44
Distribution of Firms in the Sample
By Type of Plant Location

Status of IHS	New Number	New Percent	Relocated Number	Relocated Percent	TOTAL Number	TOTAL Percent
With Frontage Roads	97	(54.5)	54	(50.9)	151	(53.2)
Without Frontage Roads	34	(19.1)	24	(22.6)	58	(20.4)
Programmed	47	(26.4)	28	(26.5)	75	(26.4)
TOTAL	178	(100.0)	106	(100.0)	284	(100.0)

Firms who were establishing main plants accounted for almost 75 percent of the study firms. Table 45 indicates that branch plants tended to be oriented toward the Interstate Highway constructed with frontage roads. In fact, non-frontage road and programmed areas indicate little attraction for these particular types of plants.

Type of Business Activity

Of the 225 firms that provided sales data, approximately 80 percent indicated annual sales of over one quarter of a million dollars. Table 46 reveals that those firms which have less than $250,000 annual

revenues tend to be located in areas serviced by Interstate Highways with frontage roads while as annual sales increase, areas without frontage roads tend to become more attractive.

Table 45
Distribution of Firms in The Sample
By Type of Plant Organization

Status of IHS	Main		Branch		TOTAL	
	Number	Percent	Number	Percent	Number	Percent
With Frontage Roads	108	(51.7)	43	(57.3)	151	(53.2)
Without Frontage Roads	44	(21.1)	14	(18.7)	58	(20.4)
Programmed	57	(27.2)	18	(24.0)	75	(26.4)
TOTAL	209	(100.0)	75	(100.0)	284	(100.0)

Firms distributing their products totally within the state accounted for 40 percent of the study firms. From Table 47 it may be noted that when compared to other product distribution classifications, a relatively higher percentage of these firms are located in programmed areas. Also, proportionally fewer of these firms locate in non-frontage areas when compared with those groups which distribute products on a regional and national basis. It would appear from this table that as product distribution increases in scope, industrial sites in non-frontage areas become more attractive, programmed areas become less attractive and frontage areas, although having variation, indicate no particular effect.

Table 47 provides for the distribution of study firms by the principal location factor considered in the selection of the plant site. In general, firms locating for market and production reasons tend to consider frontage road areas more significant than non-frontage and programmed areas but did not differentiate between programmed and non-frontage areas. On the other hand, firms locating for transportation and intangible reasons considered programmed areas relatively more

Table 46
Distribution of Firms in The Sample
By Volume of Sales

Status of IHS	No Response Number	Percent	Under $250,000 Number	Percent	$250,000-$500,000 Number	Percent	Over $500,000 Number	Percent	TOTAL Number	Percent
With Frontage Roads	14	(48.3)	36	(64.3)	51	(51.5)	50	(50.0)	151	(53.2)
Without Frontage Roads	6	(20.7)	7	(12.5)	19	(19.2)	26	(26.0)	58	(20.4)
Programmed	9	(31.0)	13	(23.2)	29	(29.3)	24	(24.0)	75	(26.4)
TOTAL	29	(100.0)	56	(100.0)	99	(100.0)	100	(100.0)	284	(100.0)

Table 47
Distribution of Firms in The Sample
By Distribution of Products

Status of IHS	Intrastate Number	Percent	Regional Number	Percent	National Number	Percent	TOTAL Number	Percent
With Frontage Roads	59	(51.7)	43	(57.4)	49	(51.6)	151	(53.2)
Without Frontage Roads	19	(16.7)	13	(17.3)	26	(27.4)	58	(20.4)
Programmed	37	(31.6)	19	(25.3)	20	(21.0)	75	(26.4)
TOTAL	115	(100.0)	75	(100.0)	95	(100.0)	284	(100.0)

Table 48
Distribution of Firms in The Sample
By Principal Location Factor*

Status of IHS	Market Number	Percent	Production Number	Percent	Transportation Number	Percent	Intangible Number	Percent	TOTAL Number	Percent
With Frontage Roads	48	(56.0)	49	(56.0)	14	(48.0)	39	(50.6)	150	(54.0)
Without Frontage Roads	21	(24.0)	19	(22.0)	5	(17.0)	11	(14.3)	56	(20.0)
Programmed	17	(20.0)	19	(22.0)	10	(35.0)	27	(35.1)	73	(26.0)
TOTAL	86	(100.0)	87	(100.0)	29	(100.0)	77	(100.0)	279	(100.0)

*Five firms did not report this factor

significant and non-frontage areas less significant than did the first two location factor categories.

Summary

The purpose of this section of the report has been to demonstrate the distribution of sample firms located in areas serviced by the Interstate Highway constructed with frontage roads, without frontage roads and in the programmed stage of development. In order to accomplish this goal, sample firms have been categorized into the general heading of; physical location, ownership and organization, and business activity.

From this brief analysis several hypotheses may be formulated relative to the significance of the construction of the Interstate Highway to industrial development within Texas. More specific hypotheses may also be put forth as to the importance of frontage roads to the location of industry on or near the Interstate Highway.

The remainder of this report will be devoted to the testing of the following hypotheses:

a. Industrial firms locating after Interstate Highway construction consider frontage roads to be more significant than those firms locating prior to Interstate Highway construction.

b. There is no significant difference between firms locating in frontage, non-frontage, and programmed areas of the Interstate by city size or zone.

c. There is no significant relationship between the type of street and highway location selected by the industrial plant and the availability of access to the Interstate Highway.

d. The distance plants locate from the Interstate Highway is not dependent upon the availability of frontage roads.

e. The selection of a specific industrial site that will provide adequate access to both highway and rail facilities is dependent upon the type of Interstate Highway construction available to the site.

f. There is no significant difference between owned and leased firms in the selection of frontage and non-frontage sites.

g. New and relocated plants do not differ in their consideration of the importance of status of Interstate Highway construction to the selection of industrial sites.

h. Main and branch plants differ significantly in their consideration of the importance of frontage road construction to the selection of an industrial site.

i. Firms locating in frontage and non-frontage areas differ significantly by size and type of business activity.

j. There is a significant difference between firms locating in frontage and non-frontage areas by type of motor transportation service utilized and automobile trip generation.

PERSONAL INTERVIEW QUESTIONNAIRE DESIGN

The design of a questionnaire 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 plant site location;
2. Relative importance of transportation facilities to the firm's operation;
3. Shipping characteristics of the various industrial firms and their effect on the Interstate Highway;
4. Specific importance of the interstate relative to other transportation facilities available to the plant site; and
5. The importance of access to the plant site.

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 the executive who was responsible for the site selection, made up a larger portion of the schedule. Before going into the field to interview the sample firms, interview techniques and questionnaires were pre-tested for reliability and completeness in several cities throughout the state.

ANALYSIS OF PERSONAL INTERVIEW RESPONSES

This section of the report will analyze responses to selected questions included in the personal interviews. The analysis of these

responses is critical to the acceptance or rejection of the hypotheses stated in the previous section.

The analysis involves isolating the characteristics of those firms that are particularly sensitive to the selection of industrial sites, based upon the availability of frontage road access. Since it is hypothesized that the three categories of the status of Interstate Highway construction are independent, the response to questions asked of these firms should be proportional to the frequency of the response of all firms. The test criterion chi-square is reported for each table along with a brief interpolation of the meaning and results of the analysis. In the following series of tests, variation from the expected frequency exhibited by the yes-no response will be designated and discussed as "significant" if the probability of no variation is less than 0.10.[2] It is recognized that this specification is arbitrary but necessary in discussing significant variation among localized factors.

Location Decision

From Table 49 it is noted that approximately one out of two sample firms either conducted studies or made surveys prior to their decision to choose their plant location. However, there appears to be no significant difference between the proportion of firms locating in frontage, non-frontage and programmed areas, who attempted to study the site, prior to their location decision.

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[2] In considering the number of degrees of freedom associated with the statistical analyses included in this section of the report a chi-square value of greater than 2.71 is significant at the 0.10 level.

Table 49
Location Studies
By Status of Interstate Highway Construction

Status of IHS	Were formal or informal studies conducted before the decision was made to locate at this site? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	66	71	137	1X2	0.001
2. Without Frontage Roads	24	27	51	1X3	0.012
3. Programmed	32	37	69	2X3	0.009
TOTAL	122	135	257		

Data from Table 50 indicates that approximately 53 percent of the study firms considered alternative sites. The chi-square test does not reveal a significant difference between Interstate Highway status groups responding to this question. However, it is apparent that when comparisons are made with other groups, a higher proportion of the firms locating in programmed areas considered alternative sites prior to their final decision. A further analysis of the response to this question suggests that 16 of the 23 firms in this category obtained their plant sites through leasing arrangements.

Table 50
Alternative Sites
By Status of Interstate Highway Construction

Status of IHS	Did you consider alternative industrial sites? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	72	68	140	1X2	0.010
2. Without Frontage Roads	27	25	52	1X3	0.225
3. Programmed	40	29	69	2X3	0.554
TOTAL	139	122	261		

Approximately 63 percent of the firms responding to this question indicated that there were disadvantages associated with their plant site.

However, from Table 51 there appears to be no significant difference between status of Interstate Highway categories in responding to this question.

Table 51
Disadvantage of Location
By Status of Interstate Highway Construction

Status of IHS	Are there any disadvantages associated with this location? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	95	54	149	1X2	0.004
2. Without Frontage Roads	36	22	58	1X3	0.017
3. Programmed	45	28	73	2X3	0.025
TOTAL	176	104	280		

When the firms were asked to identify the disadvantages associated with their location, over 52 percent of the responding non-frontage road firms indicated that transportation was their major disadvantage. Approximately 43 percent of the frontage road firms reported transportation disadvantages, while only 28 percent of the programmed area firms associated their disadvantages with transportation.

Many of the firms were aware of the disadvantage of the site at the time the plant location decision was made. Although not shown to be statistically different, Table 52 does indicate that non-frontage locations were relatively more aware of the disadvantage of the site than firms locating in frontage road and programmed areas.

Four out of five study firms indicated that they would select the same location if they had the decision to make again. From Table 53, it may be seen that there is no significant difference between Interstate Highway status categories in their response to this question.

Table 52
Awareness of Disadvantage of Location
By Status of Interstate Highway Construction

Status of IHS	Were you conscious of disadvantage of location at the time the site was selected? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	54	42	96	1X2	1.914
2. Without Frontage Roads	27	11	38	1X3	2.197
3. Programmed	22	20	42	2X3	0.055
TOTAL	103	73	176		

Table 53
Repeat of Site Selection
By Status of Interstate Highway Construction

Status of IHS	If you had the decision of plant site selection to make again, would you now choose this site? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	113	30	143	1X2	0.000
2. Without Frontage Roads	45	11	56	1X3	0.003
3. Programmed	57	15	72	2X3	0.023
TOTAL	215	56	271		

A further analysis of this question suggests that firms locating in the smaller cities are more satisfied with their location than the large city firms (Table 54). As may be expected, firms who own their plant site are considerably more satisfied with their location than those who are leasing.

Table 54
Repeat of Site Selection
By Size of City in Which Plant is Located·

City Size	If you had the decision of plant site selection to make again, would you now choose this site? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. Metropolitan	79	31	110	1X2	5.104
2. Satellite	48	6	54	1X4	2.873
3. Large	38	10	48	2X3	1.259
4. Small	50	9	59	3X4	0.233
TOTAL	215	56	271		

TRANSPORTATION SERVICES

In an attempt to determine the importance of transportation service, specifically highway oriented services, the sample firms were asked to respond to a series of questions relating to this subject. The response to three of these questions provides some insight as to the relative importance of transportation services to firms located in frontage, non-frontage and programmed areas.

As indicated in Table 55, firms locating in programmed areas have experienced less change in the availability of transportation service, since their location, than firms locating in areas where the Interstate Highway has been completed. It is particularly important that firms locating in areas without frontage road access have experienced a greater change in transportation services than have the frontage road and programmed area firms.

Other data suggest that main plants located in areas served by frontage roads, having ownership of their plant site and classified as heavy industries have experienced significantly larger changes in transportation services than those locating in areas not serviced by frontage roads.

Table 55
Changes in Transportation Services
By Status of Interstate Highway Construction

Status of IHS	Since your location here has there been an important change in the availability of transportation services? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	27	121	148	1X2	0.001
2. Without Frontage Roads	11	46	57	1X3	2.297
3. Programmed	7	67	74	2X3	1.865
TOTAL	45	234	279		

Eighty percent of the sample firms indicated satisfaction with shipping services currently available at their plant. It is also apparent from Table 56 , that there is no significant difference between frontage, non-frontage and programmed area firms in their degree of satisfaction with current shipping services.

Table 56
Adequacy of Shipping Services
By Status of Interstate Highway Construction

Status of IHS	Are you satisfied with the shipping service that you receive at this location? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	122	28	150	1X2	0.018
2. Without Frontage Roads	46	12	58	1X3	0.000
3. Programmed	59	14	73	2X3	0.008
TOTAL	227	54	281		

From Table 57 , it may be seen that approximately 16 percent of the firms predicted that in the future they would experience changes in the type of transportation currently being used by their company. Although a higher proportion of non-frontage road firms predicted a change in service than did those in the programmed areas, the chi-square test does not show a statistical difference between the two groups. Other data indicate that of the 27 frontage road firms predicting changes, twenty of them located prior to completion of the Interstate Highway. Also seven of the eleven non-frontage roads predicting changes in transportation service were located prior to the construction of the Interstate. Therefore, approximately 63 percent of the frontage and non-frontage road firms predicting changes in transportation service available to their plant site located prior to the Interstate Highway construction. It should also be

pointed out that none of the 22 firms that located more than two and one half miles from programmed Interstate Highway routes, revealed any immediate plans for changes in the type of transportation that would serve their plant.

Table 57
Changes in Transportation Requirements
By Status of Interstate Highway Construction

Status of IHS	Do you anticipate any specific change in the type of transportation to be required by your company in the near future? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	27	121	148	1X2	0.001
2. Without Frontage Roads	11	46	57	1X3	2.297
3. Programmed	7	67	74	2X3	1.865
TOTAL	45	234	279		

Adequacy of Highway and Street Access

Specific questions were asked of the study firms regarding the emphasis that was placed upon highways and streets during the location decision process. A look at the response to a few of these questions should indicate some measure of the importance of these facilities to various categories of industrial firms.

From Table 58 it may be seen that only 11 of the 280 responding firms indicated that, at the time the plant location decision was made, the adequacy of the highways and/or streets that serviced the plant site was in doubt. Further analysis of these data reveal that eight of the eleven firms responding negatively to this question are located on secondary city streets.

Less than one half of the sample firms actually made studies to determine the adequacy of highways and streets to their plant site. The

chi-square test shown in Table 59 indicates that a significantly higher proportion of the firms located in frontage road areas evaluated highways and streets available to the plant site than those locating in frontage and programmed areas.

Table 58
Adequacy of Highways and Streets
By Status of Interstate Highway Construction

Status of IHS	When you made the site selection, did you expect area highways and streets to be adequate for your purpose? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	143	7	150	1X2	0.000
2. Without Frontage Roads	55	2	57	1X3	0.068
3. Programmed	71	2	73	2X3	0.105
TOTAL	269	11	280		

Table 59
Study of Street and Highway Availability
By Status of Interstate Highway Construction

Status of IHS	Did you make any formal attempt to evaluate the type of highways and streets that were available to your plant site? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	77	66	143	1X2	3.396
2. Without Frontage Roads	20	33	53	1X3	0.090
3. Programmed	27	37	64		
TOTAL	124	136	260		

A further analysis of this question (Table 60) suggests that firms locating in the small cities were very much concerned with the availability of highways and streets to the plant site. The chi-square test is significant between city size four and all other city sizes.

Table 60
Study of Street and Highway Availability
By Size of City in Which Plant is Located

Status of IHS	Did you make any formal attempt to evaluate the type of highways and streets that were available to your plant site? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. Metropolitan	40	67	107	1X4	21.488
2. Satellite	23	30	53	2X4	11.310
3. Large	16	25	41	3X4	12.584
4. Small	45	14	59		
TOTAL	124	136	260		

A comparison of firms distributing their products locally with those distributing their products on a regional or national basis reveals that a relatively smaller proportion of the local market oriented firms undertook highway and street evaluation projects prior to the selection of a plant site. Approximately 55 percent of the firms owning their plant sites evaluated highways and streets prior to site selection while only 39 percent of those firms which lease their plant facilities indicated that studies of this type were conducted prior to selection of the plant site.

Access to all forms of transportation facilities does not present any significant problem to approximately 84 percent of the study firms. It is interesting to note from Table 61 that frontage and non-frontage firms both differ significantly from programmed area firms in their response to this question. Although programmed firms represent 26 percent of the sample firms, they account for less than 14 percent of the firms who are dissatisfied with their access to transportation facilities.

Table 61
Access to Transportation Facilities
By Status of Interstate Highway Construction

Status of IHS	Do you feel that you have adequate access to transportation facilities available to your plant? Yes	No	Firms Responding	Chi-Square Test Condition	Value
1. With Frontage Roads	123	27	150	1X2	0.000
2. Without Frontage Roads	46	11	57	1X3	2.648
3. Programmed	68	6	74	2X3	3.113
TOTAL	237	44	281		

A further analysis of these data indicate that five of the six dissatisfied programmed area firms own their plant site. Also, ten of the eleven dissatisfied non-frontage road firms are located in the metropolitan cities. Only 11 percent of the firms which rated intangible reasons as their primary factor in plant site selection are dissatisfied with transportation facility access. On the other hand, approximately 22 percent of the transportation oriented firms reported dissatisfaction with transportation facility access in response to this question.

IMPORTANCE OF THE INTERSTATE HIGHWAY

It may be recalled from Table 59 that when the study firm managements were asked if an attempt was made to evaluate the type and class of highways and streets available to the plant site, prior to their location decision, less than one half of the firms indicated that such studies had been conducted.

In an attempt to analyze the influence of the network of all highways upon plant location, the respondents were then asked to rank the current importance of interstate highways relative to all other highway and city street facilities. Table 62 shows that by comparing the mean ranks resulting from the response given by management of each study firm the procedure produced a ranking of street and highway facilities 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.

Table 62
Ranking of Streets and Highways
by Order of Importance to Each Study Firm

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
Farm to Market Roads	8	16	22	35	33	113	4.80

Although the mean rank comparison in Table 62 suggests that overall the interstate highway ranked higher among all study firms, it is significant that intra-city streets were ranked first by the largest

number of respondents. One other comparison that also seems significant to this analysis is the fact that although only 17 study firms ranked loop highways first in order of importance to their location, 71 firms ranked this facility second in order of importance. It is apparent from this analysis that the local community network of streets and highways continues to play a significant role in the selection of industrial sites.

Characteristics of the Firms With Regard to Interstate Highway Ranking

The following tables show variation in the importance of interstate highways to the characteristics of the study firms according to access distance, employment size, market areas, etc. Significant variation in these characteristics, measured by the chi-square test of independence, offers some indication as to the type of plant operation whose owner/manager considers the interstate highway of more importance than other streets and highways serving their plant site.

A significant chi-square in Table 63 indicates a higher proportion of plants, locating within one half mile of the interstate highway, tend to rank this facility higher than any other type of facility. On the other hand, plants locating over one and one half miles from the interstate highway tended to rank some other facility as being more important to their plant location.

Table 63
Ranking of Interstate Highway
by Distance from Interstate Highway

Distance from IHS	Primary	Secondary	Total
Less than 0.5 Miles	30	45	75
0.6--1.0	11	34	45
1.1--1.5	14	21	35
Over 1.5	26	86	112
TOTAL	81	186	267[a]

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

[a]17 plants did not respond.

Table 64 shows that a higher proportion of plants with more than 49 employees tend to rank the interstate highway as more important to their operation than any other type of facility. Plants with fewer employees tend to rank state highways, U. S. highways, city streets, etc., higher than interstate highways.

Table 64
Ranking of Interstate Highway
by Employment

Employment	Primary	Secondary	Total
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 65 a significant chi-square tends to confirm that a higher proportion of plants that distribute their product locally as opposed to a state or regional basis, consider the interstate highway secondary to other facilities. However, many of these small plants are

located in larger cities where their product distribution was confined to the immediate metropolitan area.

Table 65
Ranking of Interstate Highway
by Distribution of Product

Market Area	Primary	Secondary	Total
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.; P less than .01.

The significant chi-square in Table 66 indicates that a large proportion of branch plants tended to rank the interstate highway over all other facilities. Main plants generally considered other highways and local streets to be of greater importance to their plant sites.

Table 66
Ranking of Interstate Highway
by Type of Plant Organization

Type of Plant	Primary	Secondary	Total
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.

As seen in Table 67 a significantly higher proportion of the plants locating in metropolitan areas tended to rank streets and highways (other than interstate highways) as most important to their plant site. City streets and expressways were much more important to these

plants, again primarily due to the fact that urban area plants included in the sample were relatively small companies with highly localized market areas.

Table 67
Ranking of Interstate Highway
by City Size

City Size	Primary	Secondary	Total
Metropolitan*	41	122	163
Large	13	35	48
Small	27	29	56
TOTAL	81	186	267

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

*Includes satellite city.

A rank order analysis of the six major highway and street facilities, by status of Interstate Highway construction is shown in Table 68. Each study firm was asked to rank these six facilities in order of importance to their plant site. Frontage and non-frontage firms both ranked the Interstate Highway as the most important highway or street facility serving their plant site. These firms also ranked all other facilities in approximately the same order of importance. (Note the rank correlation coefficient of r = .886). However, programmed area firms did not rank highway and street facilities in the same order as ranked by either the frontage or non-frontage firms.

In response to more indirect questioning, concerning the reasons for selecting a particular site, few plant officials mentioned highways or streets as primary factors. Many more, however, referred to this factor as a secondary consideration in their decision to select a specific site.

Table 68

Ranking of Highways and Streets
By Status of IHS Construction

Type of Facility	Status of IHS Construction					
	With Frontage Roads		Without Frontage Roads		Programmed	
	Mean Rank	Overall Rank	Mean Rank	Overall Rank	Mean Rank	Overall Rank
Interstate Highways	2.42	1	2.31	1	2.93	4
Intra-city Streets	2.72	2	2.54	2	2.89	1
State Highways	3.01	3	3.10	4	2.92	3
U. S. Highways	3.07	4	3.00	3	2.90	2
Loop Highways	3.37	5	3.11	5	3.49	5
Farm to Market	4.83	6	4.96	6	4.96	6

Spearman's rank correlation coefficient:

With Frontage Roads vs Without Frontage Roads r = .886
With Frontage Roads vs Programmed r = .600
Without Frontage Roads vs Programmed r = .657

For example, most respondents mentioned the availability of trucking service rather than highway access *per se*. The highway factor, therefore seems to have special meaning for different plants. In particular, plants that ship by common carrier rather than by private trucks tend to be less sensitive to the type and class of highway access.

SHIPPING CHARACTERISTICS OF STUDY FIRMS

In order that variations in shipping characteristics between firms located in frontage, non-frontage and programmed areas could be measured, each of the sample firms was asked to provide data pertaining to the movement of goods to and from their plant. The following discussion is an attempt to relate these data according to the status of Interstate Highway construction near the plant at the time the interviews were completed.

Total Monthly Tonnage

From Tables 69 and 70 it appears significant that most raw materials received by the study firms are transported by either rail, water or pipeline. Also, since outbound tonnage exceeds inbound tonnage it is quite obvious that the availability of raw material at the plant site plays an important role in the location of a given industrial firm. For the purpose of this study the significance of highway transportation to the location of various classes of industrial firms is of major importance.

Referring again to Table 69 it may be seen that the total monthly inbound tonnage, by all modes of transportation, to plants included in the study is approximately 212 thousand tons. Trucks provide about 41 percent of this service while railroads handle slightly more than 25 percent of the total inbound tonnage. The remaining 34 percent of the tonnage is handled by water and pipeline carriers.

The average monthly inbound tonnage to study firms is shown to be approximately 852 tons. Although trucks haul more tonnage to the plants than either of the other three modes, the average monthly tonnage moved by truck to each plant is less than one half the mean average for all

modes. Truck tonnage distribution, by status of Interstate Highway construction, reveals that slightly more than 50 percent of the total tonnage is delivered to plants located in frontage road areas. Since the average tonnage to both frontage and non-frontage area plants is approximately equal, there appear to be no significant differences between these firms according to inbound shipping characteristics by truck.

An analysis of monthly outbound tonnage, by type of transportation service, (Table 70) indicates that the movement of goods from the sample

Table 69
Monthly Inbound Tonnage
By Type of Transportation Service

Status of IHS	Truck			Rail			Other*			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	45,143	(52.2)	364	30,761	(57.4)	655	34,011	(47.1)	1701	109,915	(51.8)	839
Without Frontage Roads	19,269	(22.3)	364	7,210	(13.4)	515	11,922	(16.5)	994	38,401	(18.1)	711
Programmed	22,019	(25.5)	350	15,649	(29.2)	559	26,248	(36.4)	2019	63,916	(30.1)	999
TOTAL	86,431	(100.0)	360	53,620	(100.0)	603	72,181	(100.0)	1536	212,232	(100.0)	852

*Includes both water and pipeline.

Table 70
Monthly Outbound Tonnage
By Type of Transportation Service

Status of IHS	Truck			Rail			Other*			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	94,370	(47.5)	749	28,771	(24.4)	1308	25,062	(60.8)	1319	148,203	(41.4)	1131
Without Frontage Roads	20,183	(10.2)	388	5,719	(4.9)	477	472	(1.2)	34	26,374	(7.4)	498
Programmed	84,076	(42.3)	1335	83,285	(70.7)	6940	15,654	(38.0)	1305	183,015	(51.2)	2816
TOTAL	198,629	(100.0)	824	117,775	(100.0)	2560	41,188	(100.0)	915	357,592	(100.0)	1436

*Includes both water and pipeline.

plants differs considerably from the inbound movements shown in Table 69 For example, trucks account for approximately 56 percent of the outbound monthly tonnage; rail approximately 33 percent; and water and pipelines about 11 percent. While rail and truck have increased their share of tonnage, as compared to inbound movements, water and pipelines share of the tonnage decreased from 34 percent of the inbound movements to approximately 12 percent of the total outbound tonnage. Of interest to this study is the fact that only slightly more than 7 percent of the total outbound tonnage from study firms originates at plants located in the non-frontage road areas. Also, when rail outbound tonnage is compared with rail inbound tonnage, the proportional distribution by status of interstate highway construction differs significantly.

The importance of truck service to plants located in areas serviced by frontage roads to the outbound movement of products of the study firms may be seen by comparing monthly inbound and outbound tonnage for this group of firms. Table 70 shows that the monthly outbound tonnage from firms located in frontage road areas is twice that of the inbound tonnage of the same group of firms, However, this table also reveals that firms located in non-frontage areas have approximately the same amount of tonnage moved from the plants or moved to the plant during the average month.

Monthly Truck Tonnage

Commercial motor carriers accounted for approximately 57 percent of the monthly inbound tonnage to the study firms. As shown in Table 71, the commercial carriers provide almost two thirds of the inbound truck service to firms located in the frontage road areas. Private

truck usage among frontage and non-frontage firms is not significantly different, however, these two categories of firms do tend to make greater use of private trucks than do programmed area firms.

Outbound truck tonnage distribution by status of Interstate Highway construction, is shown in Table 72. Differing significantly from comparable inbound movements, private trucks move approximately 70 percent of all outbound tonnage from the study firms. Only in the non-frontage category is there a decrease in the relative importance in private trucks between outbound and inbound movements.

Private trucks are used in the movement of approximately two thirds of the tonnage originating at plants located in frontage and programmed areas, while in non-frontage areas truck tonnage is about equally divided between private and commercial carrier.

Monthly Truck Trips

Tables 73 and 74 compare frequency of truck trips to pick up and deliver goods at the study plants, by status of Interstate Highway construction. Approximately 47 percent of all truck trips to deliver goods are made to firms located in frontage road areas. However, six out of ten of these trips are made by commercial trucks. Private carriers tend to provide a larger percentage of the truck delivery service to non-frontage areas while service to programmed areas is about equally divided between private and for-hire carriage.

By referring to Table 74, it may be seen that private trucks account for two out of three trips originating at the plant. Although the proportion of total truck trips to pick up goods do not differ

Table 71
Monthly Inbound Tonnage
By Type of Truck Service

Status of IHS	Private			For-Hire			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	13,915	(37.2)	1784	31,229	(63.7)	3123	45,144	(52.2)	3641
Without Frontage Roads	13,190	(35.2)	3879	6,069	(12.4)	1414	19,259	(22.3)	3636
Programmed	10,314	(27.6)	2516	11,705	(23.9)	2545	22,019	(25.5)	3495
TOTAL	37,419	(100.0)	2446	49,003	(100.0)	2593	86,422	(100.0)	3601

Table 72
Monthly Outbound Tonnage
By Type of Truck Service

Status of IHS	Private			For-Hire			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	60,443	(43.2)	6642	33,927	(57.7)	4841	94,370	(47.5)	7490
Without Frontage Roads	12,707	(9.1)	3851	7,468	(12.7)	1915	20,175	(10.2)	3881
Programmed	66,641	(47.7)	13328	17,435	(29.6)	5128	84,076	(42.3)	13345
TOTAL	139,791	(100.0)	8034	58,830	(100.0)	3845	198,621	(100.0)	8242

Table 73
Monthly Trips to Deliver Goods to Plants
By Type of Truck Service

Status of IHS	Private			For-Hire			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	5,350	(40.5)	622	8,144	(52.3)	684	13,494	(46.9)	937
Without Frontage Roads	4,726	(35.8)	1390	4,156	(26.7)	945	8,882	(30.9)	1615
Programmed	3,120	(23.7)	589	3,270	(21.0)	641	6,390	(22.2)	888
TOTAL	13,196	(100.0)	763	15,571	(100.0)	728	28,766	(100.0)	1062

Table 74
Monthly Trips to Pick-up Goods at Plants
By Type of Truck Service

Status of IHS	Private			For-Hire			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	13,774	(42.7)	1329	6,835	(39.0)	743	20,609	(41.4)	1462
Without Frontage Roads	7,335	(22.7)	1930	6,560	(37.4)	1491	13,895	(27.9)	2438
Programmed	11,167	(34.6)	2233	4,127	(23.6)	1146	15,294	(30.7)	2283
TOTAL	32,276	(100.0)	1681	17,522	(100.0)	1019	49,798	(100.0)	1879

significantly between private and for-hire motor service in the frontage area, there is considerable difference between the non-frontage and programmed firms in the utilization of this type transportation service.

Daily Vehicle Trips to Plants

There was an average of 85 vehicle trips each day to study firms with non-frontage and programmed area firms accounting for some 60 percent of the trips. All but 1.2 percent of the employees of firms included in this study traveled to work in private automobiles. There were no employees of firms located in programmed areas who traveled to and from work by public transportation. Table 75 shows that there are approximately 56 employee trips each day to the study plants. Visitors and other business trips account for an additional 15 automobile trips each day. It is interesting to note at this point that while employee trips to frontage road locations accounted for only 36.5 percent of the total employee trips, 46 percent of all other automobile trips were made to frontage road firms.

In summary, this section has attempted to evaluate the relative importance of the status of Interstate Highway construction in the originating and terminating of motor vehicle trips to industrial firms located on or near the Interstate Highway. In general it can be assumed that plants located in frontage road areas do differ significantly from plants located in non-frontage and programmed areas in the use of commercial and private truck service. Also, these locations seem to be more attractive to non-employee automobile trips than plant sites located in non-frontage and programmed areas.

Table 75
Daily Motor Vehicle Trips to Study Plants*
By Type of Vehicle

Status of IHS	Employees Auto			Other Auto			Truck			Total		
	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg	Total	Pct	Avg
With Frontage Roads	5,769	(36.5)	382	2,051	(46.0)	139	1,574	(43.4)	110	9,394	(39.3)	628
Without Frontage Roads	3,974	(25.1)	697	1,009	(22.6)	180	1,051	(29.0)	188	6,034	(25.2)	1059
Programmed	6,071	(38.4)	843	1,398	(31.4)	192	1,001	(27.6)	144	8,470	(35.5)	1148
TOTAL	15,814	(100.0)	563	4,458	(100.0)	157	3,626	(100.0)	135	23,898	(100.0)	847

*One firm having 8,000 employees was excluded from this analysis.

SUMMARY

The report has revealed that through relatively straightforward interviewing techniques it is possible to determine some of the more important factors influencing plant location decision within a given geographic area. Response from study firms suggests that manufacturing concerns with differing characteristics have located at different sites for different reasons, but generally reflect some consideration of objective economic criteria e. g., spatial differences in operating costs and marketing conditions, in their choice of a plant site.

In view of the magnitude of non-sampling error, it is rather meaningless to employ sophisticated statistical techniques to a study such as this. However, it is possible to organize the survey data in tabular form by enumeration according to different characteristics of the responding study firms. The chi-square analysis has been used, where applicable, as an efficient method for measuring differences that occur within and between categories of study firms in their response to the survey questionnaire.

As a result of this investigation and an analysis of the findings, the following generalizations and conclusions were reached:

(a) Firms locating after the construction of the Interstate Highway have placed considerable importance upon the facility, and its accessibility, in plant location decisions. Just as important, from the standpoint of future development, firms locating prior to Interstate Highway construction that now have a completed facility with frontage road access serving their area,have experienced significant changes in the availability of transportation services to their site. In addition, approximately 63 percent of the firms locating prior to the construction of the Interstate

Highway predicted that in the near future, they will make significant changes in the type of transportation currently utilized by their firms.

The relative importance of frontage vs non-frontage areas to study firms in the selection of plant sites categorized by those firms locating before construction of the facility and those locating after the facility had been completed may be seen in the fact that while 68 percent of the firms locating prior to interstate construction chose frontage road locations, 75 percent of the firms locating after the interstate was completed selected sites in areas where the facility has been constructed with frontage roads.

Based upon these and other findings, the proposition that industrial firms locating in areas serviced by the Interstate Highway after construction of the facility, consider frontage roads to be more significant than those firms locating in these areas prior to construction of the facility, has been accepted.

(b) Approximately 70 percent of all industrial locations occurring during the study period may be accounted for in Texas' four large metropolitan cities. Frontage road locations accounted for seven out of ten of these locations. However, in the satellite communities surrounding the large metropolitan cities, frontage road locations represent only 35 percent of all firms locating in this city size category. More than one half of the firms locating in programmed areas chose one of the two smaller city size categories for their location. When the study firms were asked to rank the relative importance of the Interstate Highway with all other highways and streets, a significantly higher proportion of the firms locating in the smaller cities ranked the Interstate Highway above all other facilities than did those who chose the metropolitan areas. The

importance that firms, located in the smaller cities, placed upon highways and streets is revealed by the fact that three out of four firms locating in these cities made an evaluation of these facilities prior to their location, while only one of three firms locating in the metropolitan areas conducted this type study.

Although more than one half of the study firms located in the "fringe" area of the city, the city zone has had little or no effect upon the location of these firms when measured by status of Interstate Highway construction within the zones. It is therefore concluded that there is a significant difference between firms located in frontage, non-frontage and programmed areas when compared according to city size; however, the selection of industrial sites based upon the status of Interstate Highway construction i.e. with or without frontage roads does not differ significantly between city zones.

(c) During the period 1956 through 1964 two hundred and twenty one of the 1,495 industrial firms, included in the Universe, selected plant sites within less than one half mile of an interstate facility having frontage road access. However, only 38 of these firms had direct access to the facility from the highway or street on which they were located. Highways, other than Interstate Highways, provided access to the facility for approximately 46 percent of the study firms. The findings indicate that with the exception of the direct access firms, status of Interstate Highway construction has little or no effect upon the selection of a particular site by type of highway or street access the plant has to the Interstate Highway.

(d) Although firms locating within one-half mile of the Interstate Highway ranked this facility higher than all other highways and streets in importance to their location, there appears to be no significant trend for firms to select plant sites either nearer or further away from the facility based solely upon the availability of frontage road access.

(e) Approximately two-thirds of the firms locating during the study period chose sites within one-half mile of the railroad. Although there appears to be no statistically significant difference in the proportion of these firms choosing frontage, non-frontage or programmed areas, firms locating beyond one-half mile of the railroad tend to be oriented toward the non-frontage and programmed areas.

Only ten percent of the study firms chose sites that would require the crossing of the Interstate highway to have railroad access to the plant. Other findings suggest that non-frontage road locations made their strongest showing in the least desirable industrial areas while their weakest showing was at the most desirable industrial location.

(f) Owned and leased firms were equally divided in the non-frontage area. However, there is a trend for leased firms to be oriented toward frontage road areas while firms who own their plant sites are more prevalent in the programmed areas. A significantly larger proportion of the firms who purchased plant sites evaluated highway and streets serving the site, prior to their location, than did those firms leasing their plant facilities. However, these and other findings do not indicate that there is a significant difference between owned and leased firms in the selection of frontage or non-frontage plant sites.

(g) Approximately 63 percent of the study firms may be classified as having been relocated from a previous site. Findings thus far do not indicate that these firms differ from new firms in the importance that is placed upon status of Interstate Highway construction in the selection of a particular plant site.

(h) Non-frontage and programmed areas indicate little attraction for branch plants. However, these plants did tend to rank the Interstate Highway over all other highways and streets in relative importance to their plant site. Although main plants ranked other highways and streets as being more important to their site, other findings indicate that these firms are experiencing transportation service changes that may increase the importance of the Interstate Highway in future location decisions. The findings suggest that at the time this study was conducted, main and branch plants did not differ significantly in their consideration of the importance of frontage road construction to the selection of an industrial site.

(i) Firms distributing their products to local markets make up a large proportion of the programmed area locations. However, as product distribution increases in scope, industrial sites in non-frontage road areas become more attractive, programmed areas become less attractive and frontage road areas, although having variation, indicate no particular effect.

From responses to the highway and street evaluation questions, it was found that a relatively small proportion of the firms distributing their products locally conducted studies to determine the availability of streets and highways to the plant site; while a higher percentage of the

firms distributing their products on regional and national basis made detailed evaluation.

Firms having less than $250,000 in annual sales revenue tend to be located in areas serviced by the Interstate Highway with frontage roads, while as annual sales increase non-frontage roads locations become more attractive as industrial sites.

Size of employment tends to contribute to the importance of the Interstate Highway to individual plants. Plants with small employment tend to rank highways, other than the Interstate Highway, as most important to their plant location while the Interstate Highway is ranked first among firms with more than 50 employees.

From these and other findings, it is apparent that firms locating in frontage and non-frontage areas differ significantly by size and type of business activity.

(j) In general, it can be assumed that plants located in frontage road areas do differ significantly from plants located in non-frontage and programmed areas by type of motor transportation servicing the plant and by volume of automobile trip generation.

APPENDIX A

FIGURE 6

REASONS FOR LOCATION

I. MARKET FACTORS

A. General

(1) Market Area (Existing)

- Proximity to market (to develop)
- Major market area
- Geographical center of Southwestern U. S.
- Geographical center of market
- Expansion of product types
- Sales estimate
- Profit estimate

(2) Market Area (Potential)

- Good market potentiality
- Large potential market in metropolitan area
- Market potential in state
- Desire to be near center of future industrial activity

(3) Location of Competitors

- Lack of competition in geographic area
- Competitive advantage due to location

B. Accessibility to Customers

- Located near construction sites which consumed product of plant
- Located near industrial customer
- Provide better service to customer (existing market)
- Near local merchandising area
- Near business district
- Center of metropolital area
- Location outside city -- easier to ship to customers outside city
- Convenience to customers and suppliers
- Accessible to metropolitan areas
- To supply a specific industrial plant
- Close to customers in a particular industry

C. Intangible Market Factors

(1) Advertising Value of Site

- Not in "hidden" industrial park
- Advertise business to IHS traffic
- Unique location provides easy eye access to plant
- Prestige location
- Advertising value
- Customer awareness
- Attractiveness of site

(2) Customer Traffic Near Site

- Street with heavy traffic
- Traffic flow past plant
- Accessible to walk-in customers

II. PRODUCTION FACTORS

A. Production Costs
(1) Labor Costs
Prevailing wage level
Avoid high wages
Cheap (semi-skilled) labor
Availability of medium-priced labor
(2) Land and Building Costs
Reasonable rent
Good purchasing arrangement
Good real estate investment
Good leasing arrangement
Appropriate real estate costs
Reasonable rent
Reasonable land prices
(3) Capital Costs
Favorable financing
Investment analysis
(4) Taxes
Favorable tax structure

B. Availability of Production Factors and Services
(1) Labor
Proximity to professional and technical labor
Area labor market
Trained labor available
Unskilled labor (dependable)
Skilled labor (tool makers)
To retain key employees
Desire non-union employees
Proximity to unskilled but trainable labor
(2) Utilities
Access to utilities
Industrial utility capital
Availability of city water
Adequate waste disposal
Available water supply
(3) Services
Access to postal services
Closer to services
Adequate communication service (mail & phone)
(4) Land
Room for expansion
Adequate parking area available
Zoning restrictions
Located in an industrial district
Geophysical characteristics of soil
Physical condition of site
Availability of suitable site
Availability of additional land near site
Availability of unimproved land for storing product

B. (4) continued:

Prefers to own site
Away from downtown business district
Located in remote area of city
Closer to city than previous location
Safety features of site
Desire to build new building to specifications
Purchased for potential industrial site
Within city limits or soon will be
Atmosphere conditions

(5) Building and Machinery

Suitable existing building
Suitable building not in need of repair
Suitable building large enough for operations
Availability of other buildings in area
Similar operation already at this site
Availability of air-conditioned building
Building could be insured
Good existing plant facility
Additional office space available
Special equipment in building
Specifications of existing building
Share facilities with another industry

III. TRANSPORTATION FACTORS

A. Transportation Cost

Availability of back-haul customers (reduction in back-haul expense)
Transportation costs
Cost of shipping by private truck
To avoid high transportation costs
Transportation rate

B. Proximity to Raw Materials/Suppliers

Proximity to raw material
Proximity to raw material (mining)
Proximity to raw material (processed)
Access to raw material
Proximity to supplier
Proximity to raw material (petroleum product)
Convenience to suppliers
Closer to suppliers of materials
Close to related industries

C. Availability of Transportation Service & Facilities

(1) All types

Availability of transportation services & facilities
Transportation service permits extension of service to other areas
Time savings in transportation

C. (1) continued:

Frequency of transportation service
Availability of public transportation

(2) Roadways and Trucking

Competitive trucking results in excellent service
Availability of pickup & delivery service (REA)
Availability of satisfactory IHS motor service (highway)
Adequate access to existing highway facilities
Accessibility to airport
Wanted to be on major highway
No traffic congestion--easy access
Conveniently located to expressway
Completion of the interstate highway
Access to employees
Access due to new highway in area
Access to new thoroughfares
Access to site
Access to particular city

(3) Water

Access to water transportation

(4) Truck (docking)

Truck docking facilities

(5) Rail

Rail siding available (rail service)
Located on major rail line

(6) Air

Availability of air freight

IV. STATE AND LOCAL ENCOURAGEMENT

Financing through industrial foundation
Financing with aid of C. of C.
State and local encouragement
Encouragement of utility company
Made utilities available
Local encouragement of city
Community encouragement

V. INTANGIBLE FACTORS

A. Community Characteristics

Labor climate favorable
Community characteristics
Adequate street identification (N/A)
Business attitudes of community
Population
Community attitudes
Availability of eating facilities
Availability of recreation facilities

B. Personal Factors

(1) Inertia

- Site owned by member of family
- Previous business at this site
- Site under lease prior to move
- Previous business in community

(2) Cost of Reducing/Revenue Increasing

- Nearness to other business ownership
- Near administrative office
- Favorable financing through individual
- Proximity to business associates

(3) Psychic Income

- Located in a specific city
- Located in a specific area of city
- Convenient to managers home
- Proximity to employees homes
- Desirable area of community
- Home of most employees
- Established reputation in community

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