APPENDIX I
Exhibit 4

LAND VALUE MODELING IN RURAL COMMUNITIES

by

Lidvard Skorpa
(Graduate Research Assistant)

Richard Dodge

C. Michael Walton

(Principal Investigators)

Report

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PREFACE

This study attempts to review and experiment with appropriate modeling techniques for describing and explaining variation in land values within small rural communities affected by changes in the interurban transportation systems which serve them. As a test case, data from one community, Sealy, Texas, have been used to construct regression models with land value as the dependent variable and with numerous community characteristics and time-related factors as independent variables.

The study has three objectives:

1. to describe the variation in land value in one community over a twenty-year period;
2. to develop appropriate indices and modeling techniques which could have general application to other small communities; and,
3. to identify the areas where further research and evaluation are required.

In keeping with these objectives, the study represents a preliminary step, and thus it offers a basis for further work rather than a set of final conclusions.

Initially, an effort was made to develop a single model for variation in land values. However, it was concluded eventually that a series of local models would be of greater value than one general model for all categories of land use. It was also recognized that the number of variables originally included may be reduced.

The next phase in this study will involve performing a sensitivity analysis on the form given the independent variables, the development of a series of local models (for different categories of land use and parcel location), and the analysis of individual transactions which seem to be unaccounted for by the initial models.

For transportation planning to be effective, it requires an understanding of how changes in an existing system will affect a community. The effect on land values is important not only because of their direct bearing on a community's fiscal structure and economic development, but also because of the psychological weight which people attach to an externally induced change in property values. It is hoped that this study will contribute to the general understanding in the field as well as provide potential direction for future research.

The substance of this study was originally submitted as a master's thesis in Civil Engineering at the University of Texas at Austin in 1974.

Lidvard Skorpa
Richard Dodge
C. Michael Walton

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ABSTRACT

Investment in transportation systems has mainly been directed at the goal of reducing the cost of travel and increasing user benefits. This has been considered the best way to enhance production activities and thereby growth within the sphere of influence of the transportation system. In the recent years, however, the need for studies of all facets of transportation impact has been stressed, but until now impact studies have not been able to reveal the complex cause/effect relationship that exists between growth and development in a rural community and changes in the transportation system.

This report concentrates on the impact on land values. It discusses why land values can be used as an indicator of community impact and evaluates a technique for modeling land values in a rural community. The technique is used in a case study of Sealy, Texas.

Land value is expressed as a function of factors describing characteristics both of the transportation system provided and the community itself. Indices are evaluated in order to measure or rank qualitative levels of the factors, and the best regression models are found by regression analysis.

In the case study a total of 611 land transactions in Sealy, Texas, are analyzed. These transactions took place between 1955 and 1973, throughout the entire community. Conclusions about how variance in land values can best be described are drawn, and areas where future research is needed are specified. For the convenience of the reader an annotated list of previous studies is included.

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CHAPTER I. INTRODUCTION

Transportation facilities are constructed for the benefit of people. The facility is not a goal in itself; it has to serve actual needs and desires in order to justify the spending of public or private funds. During the planning process, transportation demand, construction and operation costs, annoyances, damages, and benefits have to be evaluated in order to find the best solution in terms of mode, location and design. However, all of the different factors will vary according to who are considered to be the group of people influenced in some way by the facility. In this project, the people considered are those living in a rural community with some degree of connection to the interurban transportation system.

The effect of changes in the transportation system on a defined area or group of people is frequently referred to as "transportation impact." Yet there is no exact definition of transportation impact. Most previous impact studies have concentrated on economic impact, but the term may be used to describe any kind of effect. In this study, transportation impact on a community will be defined as the community response both to the transportation system as it exists at a particular time and to changes in that system. According to this definition, impact in the broadest sense includes any type of influence from the transportation system, whether it is to be measured quantitatively or qualitatively. The term may also be used in a narrower sense, when so defined, describing a specific community response, e.g., changes in the land value distribution.

A change in the transportation system does not necessarily result in any change in the community. Transportation provides a potential or stimulus to change, and response will depend upon many factors. One important factor is the nature of existing human resources in and outside the area. Thus, there should be a differentiation between "potential for development" and "impact," the latter being dependent on the existence of the former.

This also implies that a great variance might be expected in any statistical analysis of community impact as long as the human factor cannot be included in the analysis. With equal "potential" for growth and development in a number of communities, the impact in terms of response might be expected to vary considerably according to the human resources in each community. No technique whereby all human resources or potential responses can be measured is known to the authors.

The term <u>impact</u> implies a change, but the impact cannot be said to be positive or negative without specifying who is affected and under what criteria it is measured. A positive impact is generally the case when the change implies a desirable response in the community. If one of the responses in a community to changes in the transportation system is an increase in land values, then the impact on land values is positive only if an increase in land values is desirable from the viewpoint of the community.

Even if one assumes that a given change represents a benefit to the community, another problem arises which should be noted here. It is usual in impact studies to separate user and non-user benefits. Since the residents of a community usually constitute a minority of the users, the non-user benefits might be considered to be of greater importance. However, non-user benefits are the more difficult to define, and some researchers claim that all non-user benefits are derived from user benefits. At present no one has been able fully to prove or refute this view.[1*] For the purpose of this study, it will be assumed that non-user benefits <u>may</u> be separated from the sum of user benefits, subject, however, to the foregoing reservations.

This particular study is a part of a comprehensive research project called "The Influence on the Rural Environment of Interurban Transportation Systems" under the auspices of the Council for Advanced Transportation Studies, The University of Texas at Austin, sponsored by the U. S. Department of Transportation. The overall methodology for the entire research project involves two phases:

1. A case study phase to develop a descriptive model; and,
2. A general study phase to verify and expand the results from the case study phase.

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[*] Footnotes are listed at the end of each chapter.

This paper is a part of the case study phase of one specific subject -- land values. The ultimate goal is to evaluate a descriptive model for land values in a given community with specific characteristics and served by a specific transportation system. No general model can be evaluated from such a case study as every community has its own characteristics in terms of resources, traditions, economy, and so on, and each is served by a transportation system with specific development characteristics. The land value model from this case study, however, could possibly be refined and expanded to a general descriptive model in the general study phase.

The purpose of the case study phase is not only to evaluate the descriptive model, but also to identify appropriate techniques to be used in similar studies. This identification may be considered to be as important as evaluating the model itself. Consequently, it is also a study of what information is generally desired, what information is generally available in rural communities, and what adjustments in study techniques are necessary given the available information.

The descriptive model in this case study phase will be given the form of a function. The dependent variable will be land value; the independent variables will be the different factors causing land value to vary: use, location, access, and so on. In addition, a specific technique will be used for evaluating the regression model to be analyzed. Before the regression models are set up an available program package for statistical analysis will be used to find the most significant factors in the data set and the interaction between them. Thus the model potentially should explain why and how land value varies from one parcel to another. Because of the human factor involved in all land evaluation, depending on the individual seller or buyer, such a mathematical model is not expected to be anything but a general expression for what an objective value of a specific piece of land should be, based on real life observations in a specific area.

FOOTNOTES

[1]For a discussion of the nature of transportation impact and of the problems involved in separating user and non-user benefits, see A. S. Lang, "Evaluation of Highway Impact," Highway Research Board, Bulletin 268 (1960), National Academy of Sciences, pp. 105-119.

CHAPTER II. LAND VALUES AND TRANSPORTATION EFFECTS ON COMMUNITIES

LAND VALUES

In order to understand why land values vary and how they are influenced by changes in the community or in the transportation system, it is necessary to have some basic knowledge of land values and how to measure them.

Basic Principles of Land Value

A piece of land does not have any value unless it satisfies someone's specific needs or desires. Land has a value when an individual desires it and can use it according to his needs. The value is fundamentally based on the elements of utility, scarcity, access, and purchasing power of the buyer. Generally land values are related to the potential for future land use and also the economics of the neighborhood, the community and the region.

The value is related to supply and demand. The demand is related to the potential for a specific category of land use. This potential may derive from the existing situation or from an anticipated future situation. Thus the buyer and seller may set the value as the present worth of future anticipated benefits derived from the ownership and use of property, and not according to what comparable properties have sold for in the past.

The effect of any change which might influence land values is not always immediate. Usually, a neighborhood tends to reach a reasonable degree of conformity with regard to land use and socio-economic characteristics. This tends to make property values uniform and to act as a buffer against change, whether induced internally or externally. Sub-division and deed restrictions may also prevent changes in land use and land value that might otherwise occur.

Measurements of Land Value

There might be said to be two ways of measuring land value. When a transaction takes place, the value of a parcel can be defined as the actual sales price. At any other time, the value will have to be determined by an appraisal, i.e., an estimate or opinion of the value.

The most commonly used evaluation technique is the "market data comparison approach," employed for both public and private assessment purposes.[1] In using this technique, the appraiser examines previous land sales and offerings presently on the market. These data are then compared and adjusted for such factors as time of sale, location, topography, size of tract, accessibility, demand for available sites, future land use, etc.

Another valuation technique is the "income approach" in which the value is based on the "capitalization of the net annual income derived from projections of the gross income; from these are deducted real estate expenses and vacancy reserves."[2] This method, too, should reflect the market demand for a property at a given location and time, which conversely reflects changes in the economic trend, community characteristics, and the transportation system.

Evaluation of Land Value Approaches

In this study, the changes and variation in land values are to be used as measures of the combined influence of community characteristics and the transportation system. Therefore, it is important to use an expression for land value that reflects the real value as it varies with time and with changes in use and location relative to the existing transportation system. Appraised market value such as that used for tax assessment might be taken as a measure of real value since appraisers take time, location, and other factors into consideration. However, there is one major fallacy in this approach. The appraised land value reflects the appraiser's evaluation of how a piece of property differs from a supposedly comparable property and how these differences influence the market value. In other words, the appraiser actually estimates the value by making assumptions about the very aspects of the cause/effect relationship which this study seeks to define. Appraised land values thus would bias the statistical analysis designed to determine the actual cause/effect relationship.

For this reason only market values from actual transactions will be used in the analysis. Thus, the data will not be influenced by any presumption about which factors are important or how they influence land values. Unfortunately the sales will reflect factors which are irrelevant in this study, like family-relationship between buyer and seller, forced sales and so on, where the actual sales price is not the actual market value.[3]

LAND VALUE AS AN INDIRECT INDICATOR OF IMPACT

Land values are to some extent affected directly by changes in the transportation system. Indirectly, however, they will reflect the many facets of impact on the community. Even though the impact on a specific community characteristic is not of economic character, the impact might have measurable economic consequences. Land value might be an indicator of non-economic impact also. For example, if one aspect of the social impact is increased housing segregation, this will have an influence on the distribution of land values within the residential land use category. As the total community impact is the sum of different types of impact in different locations, land value as an indicator might be used to describe both individual parcels and the entire community.

Indication of Overall Effect

The total land value in a community generally will reflect the economic characteristics of the area. Expressed in terms of dollars per capita or units per area at different times, it might be used to describe the changes which have occurred or the vitality of the community relative to that of other communities. Changes relative to the general land value trend in the area might indicate whether the community is doing "better" or "worse" than the rest of the region. When land use changes to a "better" use, e.g., from agricultural to industrial or commercial, this is generally reflected in land values. Thus a change from an agricultural economic base to an industrial or manufacturing base possibly caused by changes in transportation system can result in an increase in total land values in the area. In other cases, the increase may be localized, or there may even be a net decrease in land values in the community as a whole.

Indication of Spatial Effect

When new transportation facilities are constructed, more land is usually opened for development, thus increasing the supply. If there is no change in demand, or if demand for certain land use categories is merely transferred from one area to another, land values may actually decrease or, in net terms, remain unchanged. In studying individual parcels or neighborhoods, one may assume that changes in land use and land values may reveal the spatial distribution of the total effect. Local changes in both land use and intensity together will determine the growth pattern in the community.

For example, highway-related commercial activities seem to depend upon a location close to the highways with good visibility and accessibility. If the highway facility changes location, these activities will also have to change location. In small communities this consequently means a transfer of an existing activity. Thus, by comparing changes of land values for different categories of land use, the effect of the transportation system change on each land use category may be revealed. The spatial distribution of each land use category will reflect this land use category's dependence upon accessibility to and the quality of the transportation system.

Indication of Social Effect

Changes in social conditions in the community will also be reflected in land values. Shifting social status in a neighborhood may cause land values to decrease or increase. Such a change in social conditions might be a consequence of changes in overall economic structure in the community which again might be an impact from the change in the transportation system. Disruption of a neighborhood, dislocation and so on may cause a shift in residential location of social groups, and thereby influence land values.

DIRECT EFFECTS ON THE COMMUNITY TAX BASE OF CHANGES IN LAND VALUES

It should be expected that changes in land values would have a direct bearing on the annual total tax revenue. However, this is not always the case. Two factors determine whether a change in land values will affect tax revenue: the tax rate and frequency of re-assessment.

As long as the tax rate is lower than the legal maximum tax rate, the total tax revenue is mainly determined by the needs of the budget. Total revenue has to balance total expenditures, and this consideration will determine the amount needed from taxes on local real estate. Both tax rate and total assessed land values might in this case be subject to political manipulation and have no influence at all on the final total tax revenue. In the case of maximum legal tax rates, on the other hand, the total income from local property taxes will be directly proportional to the total assessed property values within the community. Any change in total assessed land values thus may influence the tax income and the economic viability of the community depending on whether the assessed values are adjusted in order to reflect the real market values.

Right-of-way for railroads is subject to local taxes, but no taxes are paid for land when acquired for public roads. This may be a considerable part of a city, frequently ranging from 20 to 25% of the total area. Almost any kind of improvement of the transportation system includes additional taking of right-of-way for the facility. Thus less land is taxed, and, in the case of maximum legal tax rates, the result is a reduction in total tax revenue, unless otherwise compensated for. Perhaps the most frequently used way of compensating for this loss is to extend the community limits, and thus add taxable land.

In some cases the local government has to pay a part of or the entire cost for purchase of right-of-way as needed for improvement of the transportation system. In order to have a net economic gain (when only expenses of right-of-way and loss of revenue from real estate are considered), the increase in annual taxes has to be equal to or greater than the annual amortization of the expenses of right-of-way purchase. It should be noted that the entire purchase of right-of-way has to be finished some years before the main increase in value of the adjacent properties takes place and before there can be an increase in tax revenue caused by the impact of the improvement of the facility.

The intent of this brief discussion has been to show that there is no given answer as to whether or not changes in the real land values, caused by a change in the transportation system, have a direct effect upon local tax revenue. Taxation of real estate is to a high degree a question of local policy and of the need for revenues from taxation. If taxation is based on the real value of the land at a given time, then any fluctuation in land values will be reflected in the tax incomes. However, taxation policies can also be used to stimulate or force a desired land use pattern and are therefore not exclusively a way of providing revenues for public expenditures in the community.

The purposes of this chapter have been to outline and evaluate techniques of measuring land value and to suggest the potential usefulness of land value studies in the general area of transportation impact research. Potentially, changes in land value can serve as indirect indicators of other kinds of impact as well as directly affect the fiscal resources of a community. The next chapter will consider the results and techniques of previous research efforts as a prelude to the proposed methodology for this study.

FOOTNOTES

[1]Stanley F. Miller, Jr., "Effects of Proposed Highway Improvements on Property Values," National Cooperative Highway Research Program Report No. 114, Highway Research Board (1971), p.7.

[2]Ibid., pp. 7-8.

[3]As other discussions of impact on land value indicate, the "true value" of all land within an impacted area is difficult to determine or even define. (See, e.g., the discussion by Paul Zickefoose in "Economic Survey of Raton, New Mexico," New Mexico State Highway Department, Bulletin 37, May, 1968, pp. 39-40.) In choosing to base the measurement of land value on sales data alone, one must ignore the fact that land which is not sold also has a value. Sales prices may cause either under-estimates or over-estimates of property values, depending on the economic situation. For example, if only the marginally effected properties in an area change hands, sales prices can under-represent true value; on the other hand, if only the most viable are sold, sales prices can exaggerate average property values.

Nevertheless, since land value is a function of supply and demand, sales prices are indicators of a real market situation for land in a given category. Thus it may be said that although sales price is not an adequate indicator of "latent" or "unrealized" value, it does serve as a description of the actual market at a given time.

CHAPTER III. PREVIOUS RESEARCH

A complete review of the literature has been prepared previously and issued as a Research Report of this project.[1] The review focuses on impact on land use and land values and contains a detailed discussion of the methodologies used in previous research projects. No specific findings will be discussed here, but it is necessary to provide brief comment on the findings and methodologies most commonly used.

So far, practically all of the impact studies deal exclusively with the effect of interurban highways, mainly the interstate system and with the effect of circumferential or through routes in urban areas. Thus limited-access highways have received the most attention. Highway improvements studied are in most cases construction of new highways. Most of the previous research has concentrated on new interchange areas or bypass routes, locations where the most obvious changes take place. The primary investigators of highway impact are state and federal highway agencies and universities.

COMMENTS ON THE FINDINGS

The impact studies reviewed concentrate on impact from highway improvement. Even though the private automobile is the major mode of transportation today, these studies cannot reveal any information about the consequences of changes in air, rail or bus services. The studies show clearly that highway improvements have a significant impact, and usually a positive impact, on the areas along the facility, but not one of the studies reviewed evaluates the consequences of a reduction in service, as has been the case with rail service in most areas during the last two decades.

The previous highway impact studies provide a wealth of information, but some of their limitations should be noted. Many studies are more directed towards showing an impact, and the magnitude of the impact, than examining the cause/effect relationship. These studies are of great value in showing the impact of the investment in highway improvement, and consequently they justify the spending of public funds in terms of "non-highway user" cost and benefits. However, they are of less value as a tool for highway or community planners, as they cannot be used to predict impact of future changes in the highway system in a particular community. All of them support general observations about the development of adjacent land, the increase in business activity and increasing land values close to the new facility, but few of them are aimed at showing the impact on the community as an entire unit.

The fact that each community has its own characteristics in terms of economic and human resources, geographical location, etc., makes it difficult to use observed highway impact in one community to forecast impact of highway improvement in another community. This is possible only in the cases where community characteristics are included in the study, which is, unfortunately not generally done.

COMMENTS ON THE METHODOLOGIES USED

Different methodologies have been used to study impact of highway improvement, each of them having advantages and disadvantages. The most simple and most frequently used is the "before and after" technique. Here the impact simply is measured as the difference between the values of the characteristics studied before and the values after the changes. The major disadvantage is very obvious: the technique cannot relate the measured effect to a specific cause. With observations only at two time periods very little information is revealed about changes in the trend of the studied characteristics, and it is not possible to show the long term effect.

In an effort to isolate the effect of the highway improvement, the before-and-after technique is often combined with the "survey-control area" technique. However, in practice, the survey-control area technique has severe inherent limitations. The major problem is to find a control area which is similar to the survey area, in every respect except the influence of the highway improvement. This requirement is almost impossible to meet since the spatial distribution of the highway impact is not known in advance, and the entire area may be influenced in some way. Construction of a new facility may have a negative effect some distance from the facility where the control area has usually been chosen, thus causing the measured positive impact in the areas adjacent to the facility to be higher than the actual effect. If a valid control area could be found, there is no warranty that the study of the limited survey and control areas would give reliable information about the effect on a larger area, e.g., an integral small community. Consequently it is very questionable that this technique can be used to isolate the highway-induced impact on an area.

The "before and after" technique is also combined with a "multiple regression" technique in order to reveal cause/effect relationships behind the changes that took place between the two periods. This methodology requires more information about non-highway related factors, as highway related effect cannot be isolated before the analysis starts. In practice, it has been impossible to include all relevant factors in the analysis, partly because of the lack of information and partly because of lack of knowledge about how to determine the relevancy of, and how to quantify qualitative factors. However, these limitations do not apply to the methodology as such, but rather to its present state of development.

Techniques other than the above mentioned are also used in previous studies. The "case study" approach usually deals with rather detailed analysis of single events that have taken place nearby a highway facility. By examining selected cases with emphasis on their relationship to the highway, the case studies may indicate the variety and the extent of significant relationships attributable to the highway, but the results of such studies cannot be generalized and applied to other situations.

This brief discussion of the most commonly used methodologies in the previous transportation impact studies has revealed several shortcomings which should be observed when reviewing the findings from different studies. For future studies, the methodology should be carefully chosen according to the character of the study. The many shortcomings, however, clearly indicate the need for refined procedures when planning more comprehensive impact studies.

COMMENTS ON MODELING EFFORTS

Very little effort has been made to model the impact of highway improvement. This is probably caused by the complex cause/effect relationship between highway improvement and community characteristics and also by the fact that many important variables are qualitative or not quantifiable. As modeling efforts in most cases depend upon information for previous years from local records, available data may limit the number of different factors included in the analysis.

Mathematical models have been used to describe the influence on land development and land values of highway improvement. The modeling efforts have concentrated on regression models. Models describing changes in land values caused by highway improvements seem to have been the most successful, but these, too, have severe limitations.

As an example, one previous study will be discussed.[2] Two different sets of data, one from Indiana and another from Florida, were used to run a regression analysis of the change in land value as a function of different variables. The predictor variables included in this study were:

1. Parcel size (acres)
2. Time elapsed between completion of highway improvement and sale of parcel (months)
3. Type of highway improvement (interstate, primary or secondary highway)
4. Type of land use (residential, commercial, agricultural or vacant)
5. Type of area (urban, urban fringe or rural)
6. Type of access control (full, partial or none)

All but four of the 100 parcels in the Florida data included interstate highways with full access control. The regression analysis showed that the variables included in the regression equations gave an R^2 varying from 0.24 to 0.46 depending upon the form of the regression equation. Consequently, at most only 46% of the change in land values could be explained by the above mentioned variables.

The Indiana data (30 parcels) indicated a much stronger relation between change in land values and the independent variables. The regression analysis gave an R^2 of 0.87 and a coefficient of variation of 110%. Since some classes of the variables contained only a few observations, the regression equation is not presented as a reliable predictive model. According to the analysis, the type of highway improvement is the most important variable, followed by type of area, land use type, type of access control, time elasped after highway improvement, and size of parcel.

Even though the model based on the Indiana data rendered a relatively high correlation (R^2), the small number of transactions included in the analysis reduces the reliability of the model. Land values in general are not described by the model, as only the change in value was analyzed. Also, the model fails to include changes in land use and seems to be limited to cases where a new highway facility is constructed. Another consideration was the fact that this study was limited to "remainder parcels" which sold some time after the highway improvement. No information is available about the factors that influence an owner's decision to sell or not to sell a remainder parcel. The model, consequently, is not of general use for describing the changes in value of parcels adjacent to or in the proximity of highway improvement.

The study methodology outlined in the next chapter is dependent upon previous research. Both the limitations and the progress of other studies have been the source of the method to be developed and tested in this case study.

FOOTNOTES

[1]Lidvard Skorpa, Richard Dodge, C. Michael Walton and John Huddleston, "Transportation Impact Research: A Review of Previous Studies and a Recommended Methodology for the Study of Rural Communities," Council for Advanced Transportation Studies, University of Texas at Austin.

[2]Edward I. Isibor, "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels," Joint Highway Research Project, Purdue University.

CHAPTER IV. STUDY METHODOLOGY

WORKING HYPOTHESIS

The working hypothesis for this study is that land values generally reflect certain qualities of each property in an area. It is further assumed that this relationship may be described as a functional relationship between the factors in a set of the most significant qualities and characteristics of the parcel and the area. Hopefully, therefore, a study of a number of factors over a long enough time period will yield information about which factors are the most significant, how they can be used to model the functional relationship, and what are the parameters in a descriptive land value model for a certain area. The model is assumed to be general in terms of the factors needed to describe the property and its qualities, but it is specific for one area in terms of the parameters in the model. Thus, if the parameters for one specific community are known, the model will describe land value for any property in that area. At least, it is assumed that the land value of a group of properties, e.g.,those with the same land use, can be described in a model.

More specifically, the hypothesis is that land value can generally be expressed as a function of qualitative or quantitative characteristics of the parcel, the community, existing or planned transportation system, and time. Empirical studies of land values and the corresponding factors should, hopefully, give the necessary information to evaluate such a descriptive model.

STUDY REQUIREMENTS

For a comprehensive study of the relationship between land use or land values and changes in transportation system, a series of requirements have to be met. These requirements deal mainly with the study area, the transportation system, and time.

1. Study area: The study area must include the entire community in order to determine the total effect on the community. In addition the methodology must make it possible to study the spatial distribution of the effects within the community. In order to study the cause/effect relationship in detail, information must be gathered and analyzed based on the individual properties.

The analysis should be based on real, comparable land values. To eliminate any subjective influence by the researchers, only market values as obtained in land property transactions should be used.

As transportation system characteristics in most cases are correlated with community characteristics, the study must include the factors needed to describe the specific community.

2. Transportation systems: The transportation system considered must include all transportation modes available in the study area during the study period. Also, the study should consider both regional/statewide systems and the local system in the area down to the accessibility to the parcels included in the study. Both increases and decreases in transportation services in the study period must be included. The analysis must include a sufficient number of factors describing the transportation system.

3. Time: The study period must be long enough to include important changes both in the community and the transportation system. Not only physical or operational changes should be considered, but also decisions about future changes in transportation services.

   The study should be continuous over time to show variation as a change of the trend, not merely single indications of the state before and the state after the change took place.

METHODOLOGY TO BE USED

This study is one part of a more comprehensive study of various categories of transportation impact on a small city in a rural area. Consequently the methodology used in this study has to be chosen in such a way that the results from this particular study can be tied to the results from the other separate studies in the research project to form one general comprehensive study. However, above all the methodology in this particular study must be able to reveal information about the specific study subject: changes in land value.

Specific Methodology

The community selected in the research project for the case study phase is Sealy, Texas, located in the highway corridor between Houston and San Antonio. The specific techniques to be used in this study will have to meet the requirements for study methodology listed previously. Thus the entire community will have to be included in the study area. This includes not only what is inside the city limits, but also the areas adjacent to the community potentially influenced by the changes in transportation system. This area is shown in Figure 4.1. As no "survey-control area" technique is involved, there is

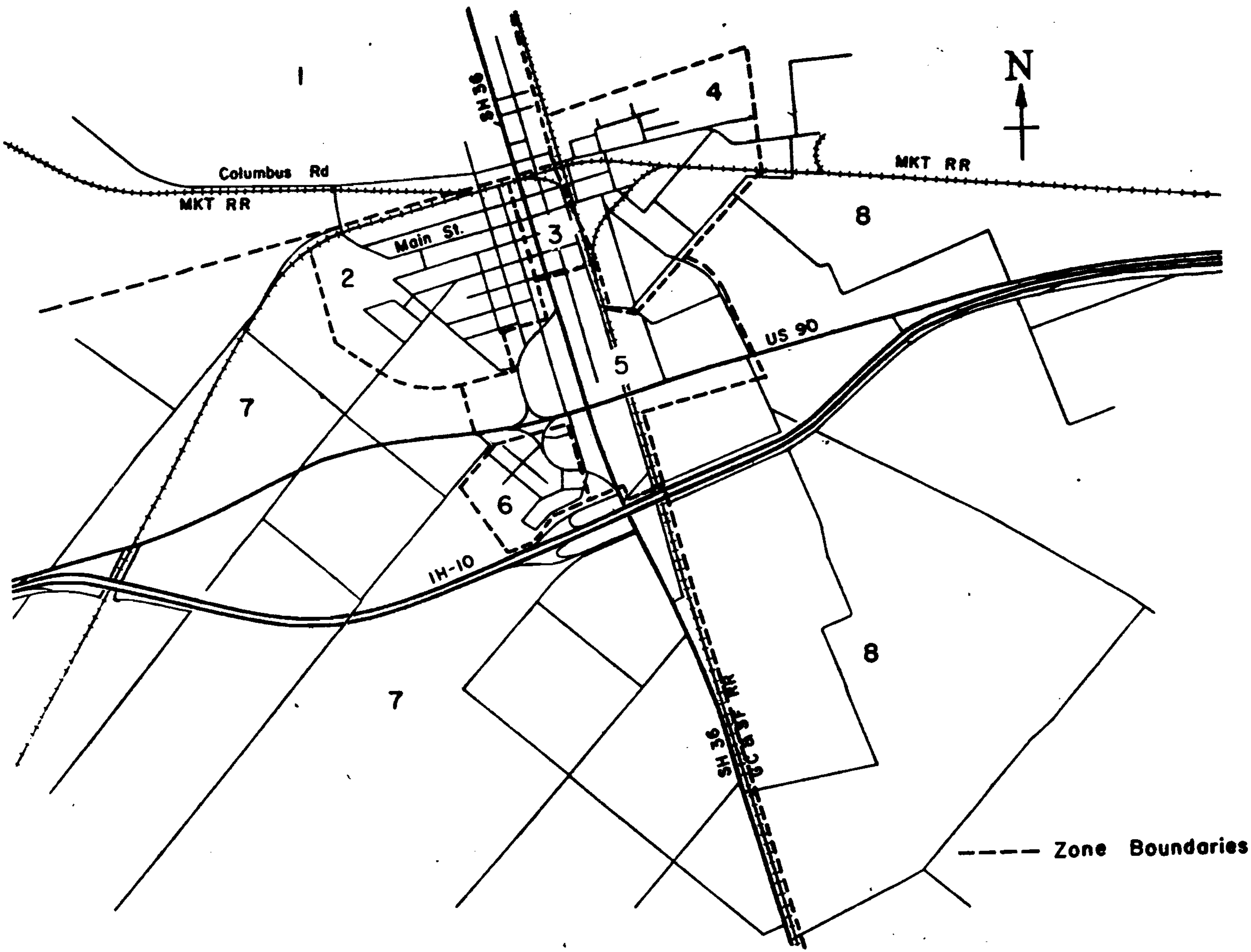


FIGURE 4.1. STUDY AREA, SEALY, TEXAS

just one geographical area examined in the study. However, in order to find the spatial distribution within the study area, the information will, with the exception of some area-wide variables, be tied to each individual property transaction studied. This will make it possible, by selection of the information to be entered in the statistical analysis, to study the property transactions with a set of common specified qualities or location. This can easily be done by means of a computer when the complete information from the case study is stored on tape in an appropriate data management system.

A rather detailed description of the existing transportation system for each period of time will be included. This information will be related partly to each property transaction and partly to the entire community. All factors that are common for the entire community, e.g., development stages of Interstate 10 from Houston to San Antonio and changes in railway services, will be included as functions of the time when the transaction took place. Information describing each particular parcel's connection to the interurban transportation system will be related to the individual transaction studied.

As the "survey-control area" technique is not involved, and the study does not deal only with repeated sales, the transportation impact on the community may be determined only by including in the model factors describing community characteristics. These factors are also included because of the close relationship between transportation development and community characteristics. With this technique transportation impact may not necessarily be explicitly expressed in the model, but the form of the model and the parameters may implicitly show the importance of the provided transportation system.

The study will be continuous in time over the entire 19 year study period. Each property transaction will be related to elapsed time after major decisions or actions in community or transportation development. Thus, the continuous trend in land values over the study period will be examined. Figure 4.2 shows the continuous study approach. To make corrections for general changes in the purchasing power of the dollar, each transaction will be adjusted according to the Consumer Price Index for the region.

The descriptive model for land values will be derived in two steps of statistical analysis, determining, first, which factors are the most significant, and secondly, what function of these factors can best describe the cause/effect relationship between land values and changes in transportation system. A standard statistical computer program will be used to find which factors, and what

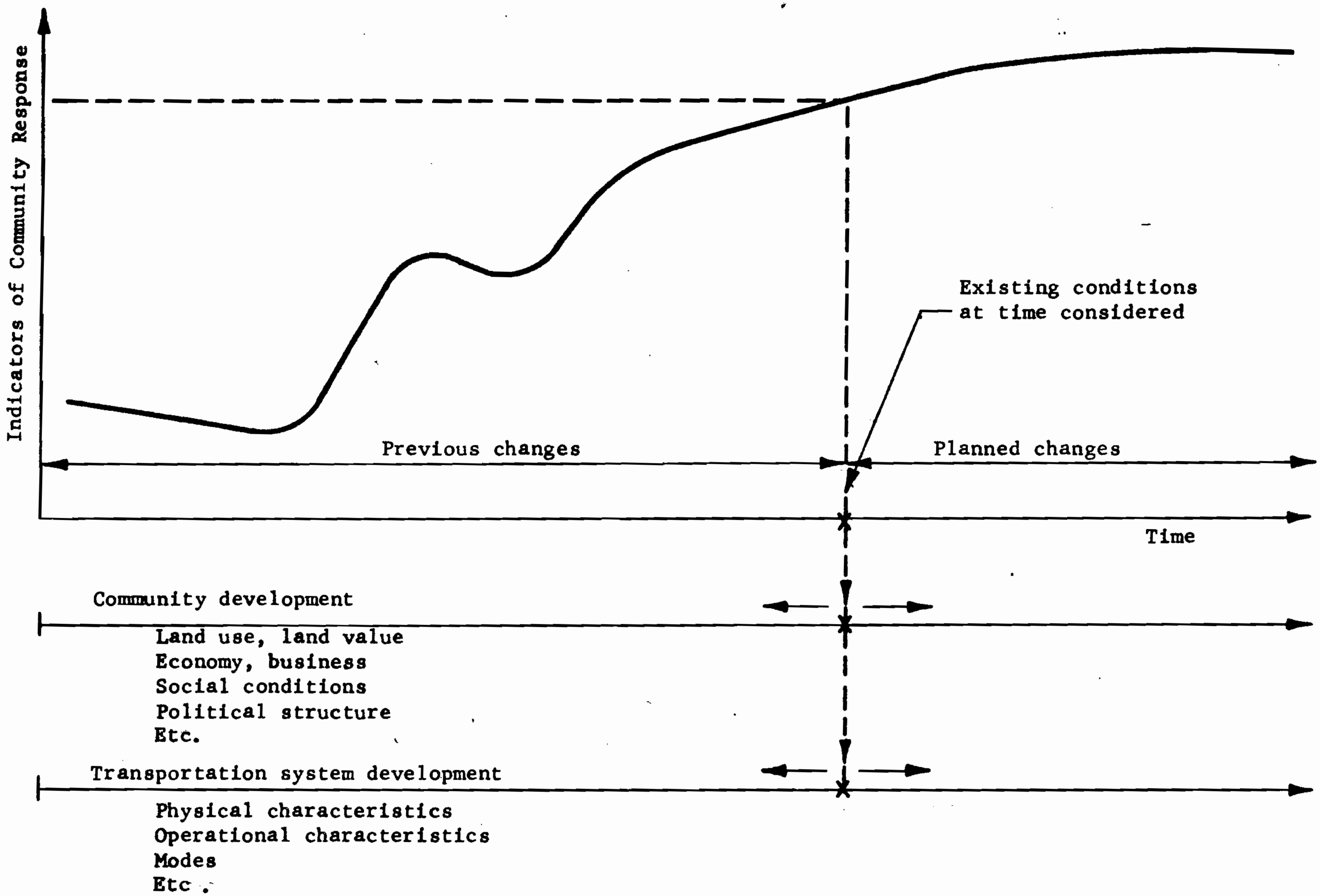


FIGURE 4.2. CONTINUOUS STUDY APPROACH

levels of these have the most influence on land values. Also interaction between the factors will be revealed. When this step is completed, multiple regression analysis will be used to determine which model, out of several possible models, can best describe the observed variations in land values in the study area over the study period.

As only information from one community is used in the empirical evaluation of the model, the model derived from this case study cannot be claimed to be of general character. Nevertheless, even though the model at this time will be used strictly as a descriptive model, it has a general form that would make it easy to use as a predictive model as well. In order to use the model for predicting land values, one would suppose a case where no transportation change had occurred. Then such factors as land use and population growth would be predicted for the "do nothing" situation and entered in the model. The total impact from any actual change in the transportation system on land values could then be measured as the difference between the areas under the "change" and "no change" curves for land value. This is illustrated in Figure 4.3.

Study Procedure

A study according to the methodology as outlined may be divided into six major steps as shown in Figure 4.4.

1. Evaluation of descriptive models for the factors to be included. Because the different factors may be either quantitative or qualitative, or a combination of several characteristics, some will have to be expressed in terms of indices or levels of quality. To determine the value of the indices or levels, descriptive models will have to be evaluated for the individual parcel, the entire community, and the interurban and local transportation system. The evaluation of these descriptive models, mainly because of limited time and resources available, will have to be based on experience from other studies and on subjective judgement about the relative importance of the factors involved.

2. Collection and processing of the necessary information, based on what is available in the selected community. The data processing will include calculation of indices and levels of quality according to the descriptive models.

3. Statistical analysis of the information by means of the AID program package. This is a statistical evaluation of the importance of the different factors according to homogeneous "sub-spaces" in the data, and consequently not biased by any assumed model.

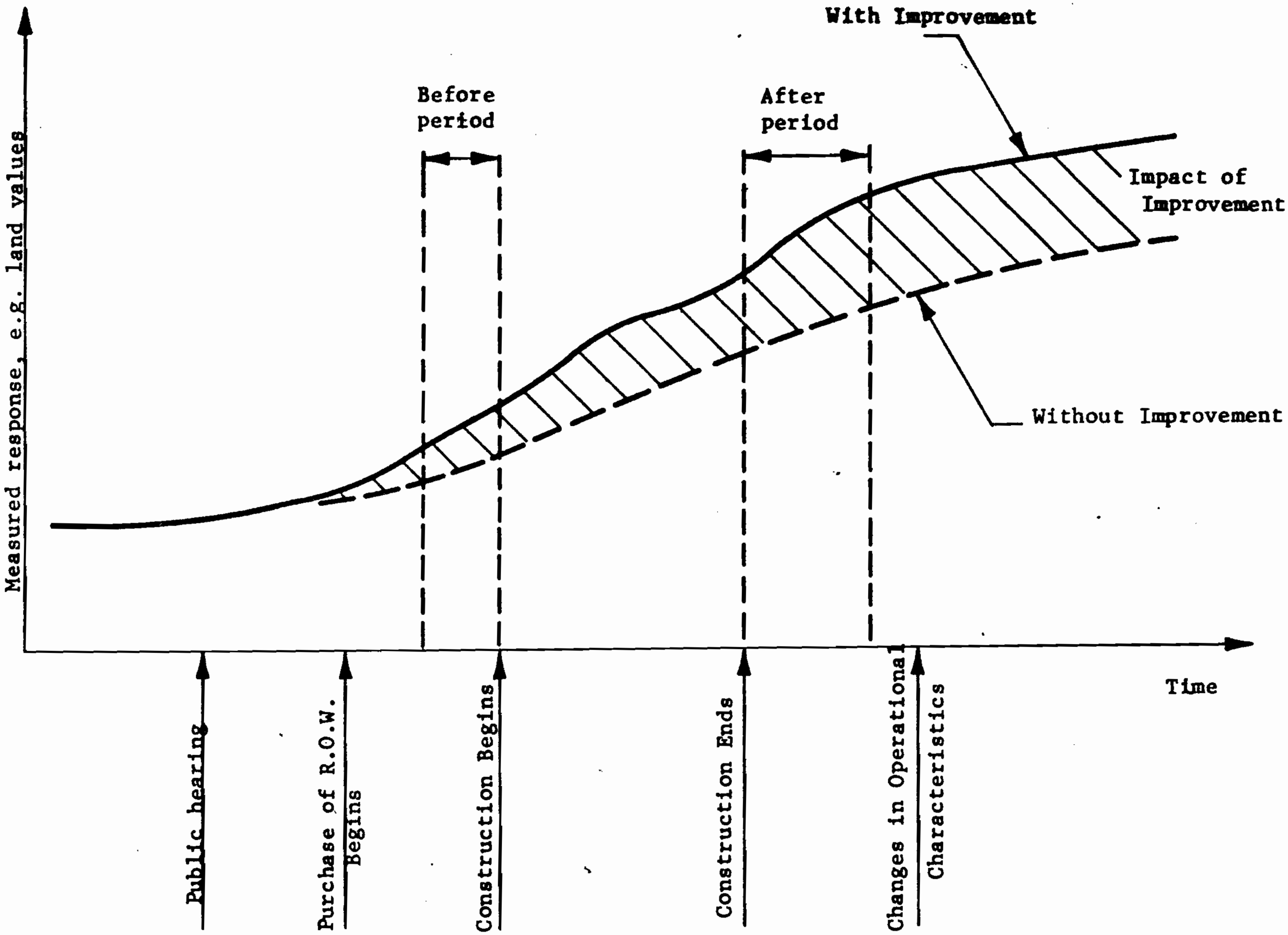


FIGURE 4.3. POSSIBLE EFFECT OF DIFFERENT PHASES IN HIGHWAY IMPROVEMENT

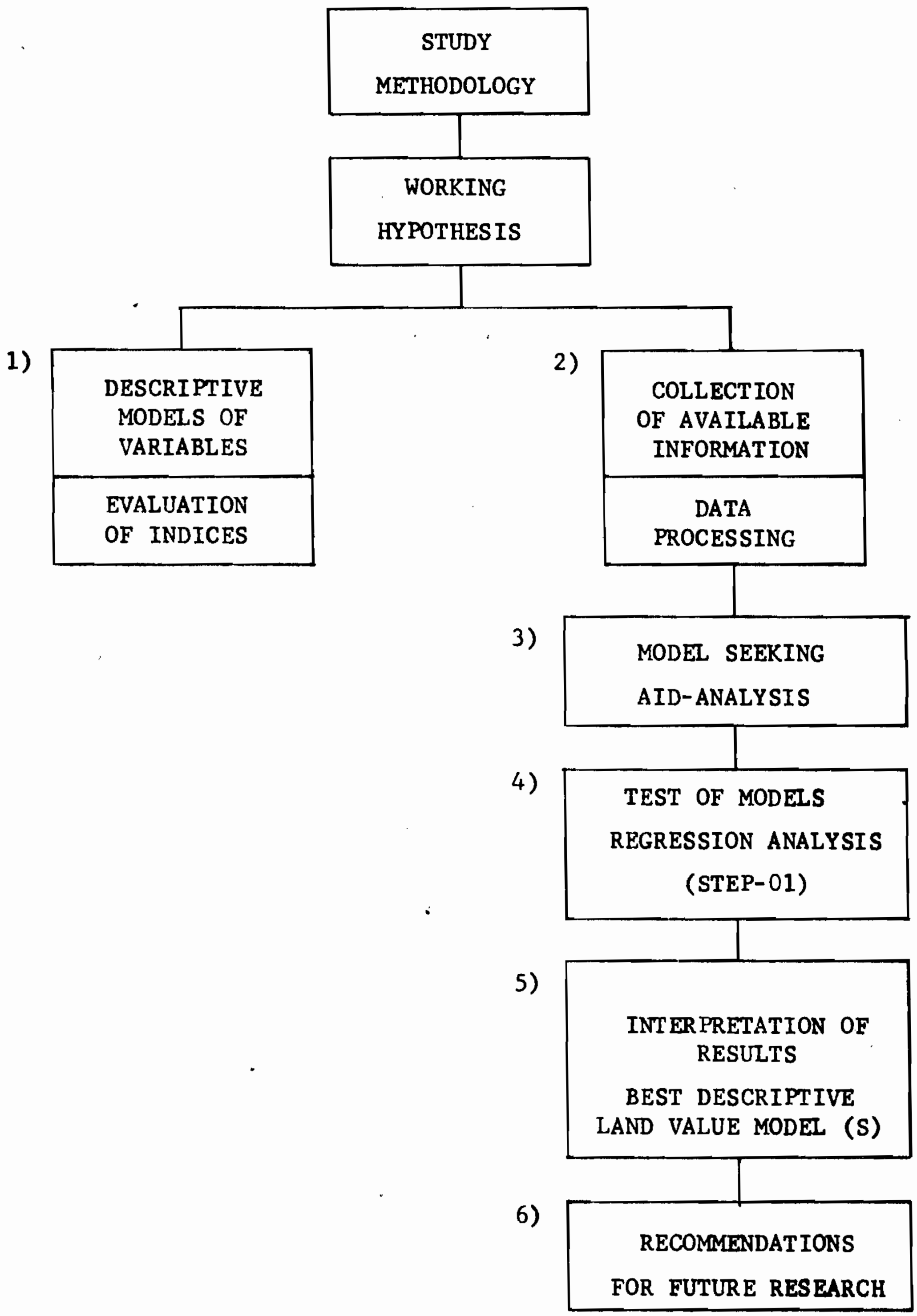


FIGURE 4.4 STUDY PROCEDURES

4. Multiple linear regression analysis by means of the STEP-01 program package. In this step the forms of the model will have to be assumed, and the "best" model in terms of statistical criteria can be found.

5. Interpretation of the research from the analysis and selection of the "best model." The findings must be checked against results from previous research and discrepancies explained. A descriptive model for land value in the community studied, and its limitations can be presented.

6. As a final step the experience from this case study should be summarized and recommendations for the general study phase outlined.

CHAPTER V. DESCRIPTIVE MODELS OF VARIABLES

The term "descriptive model" will be used describing the qualities and characteristics of a composite variable or a set of variables. The use of models, or indices, to express variables is necessitated by the complexity of the many factors influencing land values. In order to get an easily understandable expression for variation in land values, it will be helpful to group logically-related factors in sets of indices. This has been judged a feasible technique when it is necessary to combine quantitative and qualitative terms, assigning ratings and weights to different factors according to their importance.

In this part of the study, the most significant characteristics of the transportation system and of the community to be included in the analysis of land values must be determined. This step is very important since no statistical analysis can be better than the input data. Each of the individual variables has to be expressed in a meaningful way in order to reveal both their significance and the true cause/effect relationship between the factors and land values. The evaluation and testing of these indices is suggested as the subject for a separate study. Being a part of the land value study, this step cannot be given the desired degree of attention. It is hoped, however, that the different analysis in this study will reveal any major shortcoming of the indices and consequently make it easier to refine the indices to be used in the later general study phase.

In this continuous study of market land values, it is reasonable to focus the attention on two major subjects, each consisting of two parts:

1. The transportation system serving the community
    a. The interurban transportation system
    b. The local transportation system
2. The community
    a. Area-wide community characteristics
    b. Individual parcel characteristics

This grouping of the individual factors in the cause/effect relationship will make it easier to handle the complex problem. As the task of this study is not to prove an impact on the community caused by a preordained set of factors, the first task is to determine what factors should be included. The experience from previous impact studies, however, has made it possible to make a preliminary selection of factors.

DESCRIPTION OF THE INTERURBAN TRANSPORTATION SYSTEM

The history of development of rural communities has a close connection to the development of the transportation system. Rural cities, being focal points for marketing of agricultural products, grew up along existing interurban transportation systems. For rural cities the two most important transportation modes are normally railroad and automobile. Although some rural areas are served by air transport, interurban air traffic is not at present of major significance in many rural areas. This is particularly true in our study. The increasing importance of air travel has had its impact on small communities, as in the cases where regional air terminals are located in rural areas, and any future shift in interurban travel from rail or highway to air may have great impact, especially in currently inaccessible areas.

Consequently, all transportation modes serving in, or having previously served the area, must be included in such a study. Because not all modes are important in every case, and in order to simplify the description of the interurban transportation system, it seems reasonable to describe each mode separately. This will also make it easier to see the connection between the community development and the impact from changes in individual modes. The descriptive model for each mode must be able to describe physical and operational characteristics at a given time, as well as changes in these characteristics over time.

The demand for different transportation modes compared to the actual supply at any given time may be critical for a small community. In most cases, demand will be reflected in the actual use of the different facilities. However, a transportation system serving mainly interurban traffic may not necessarily serve the individual community's demand for a regional transportation system. There is no current information concerning the transportation demand in the case study area. For this reason it will be assumed that throughout the study period the existing supply of transportation facilities has always exceeded the demand.

Quality of Interurban Highway Facilities

This index is meant to express the quality of a highway corridor as experienced by an interurban driver or passenger. To a large extent this index will also express the level of service for long distance traffic with origin or destination in the community, as this traffic tends to use the primary highway system. Entering this index in the analysis will possibly show whether or not the community impact from the highway facility is influenced by the quality of the facility as well as its presence and relative location.

General Requirements for the Index. The quality of the interurban highway corridor in most cases varies over time. Due to the continuous wear on the highways, seasonal climatic variations and specific maintenance procedures, there may be a cyclic variation in the quality. In addition, there usually will be an ongoing improvement of the corridor in terms of upgrading existing facilities and construction of new ones. Some conditions not fully explained in terms of the physical characteristics of the highway may also influence the quality of the facility. The best example of such a condition is the roadside development which directly influences facilities with no or partial access control.

Consequently, the model for the interurban highway quality index in principle should meet the following requirements in describing physical and operational characteristics:

1. Be able to describe any type of facility;
2. Be able to describe changes in provided service, including both improvement and reduction in service over time; and,
3. Be able to describe the entire route, not a section only.

A number of factors may be used to describe physical and operational characteristics of a highway facility. The three most commonly used are speed, capacity and traffic volume. The reason for using these characteristics is that they are affected by several other characteristics including design features and traffic characteristics. These three characteristics may also be used to derive an expression of the "level of service" provided by a specific facility at a given time. Generally it will be found that neither the physical nor the operational characteristics alone can provide a complete description of the quality of a facility as experienced by the user.

The physical characteristics are dependent on the actual design of the facility. These characteristics include horizontal and vertical alignment (as determined by curvatures and grades), sight distances, lane width and number of lanes, shoulders and lateral clearances, separation of traffic lanes, type of pavement surface, interchange spacing, access control, and special safety features.

Operational characteristics also have a close connection to the actual design. Characteristics like speed, driving economy and safety are perhaps the ones with the closest connection. Other characteristics are riding quality, traffic volumes, freedom to maneuver, traffic interruptions, changes in legal speed limits, and traffic composition in terms of percentage of truck traffic and the ratio between local and long distance traffic. Most of these characteristics can be measured in quantitative terms, but characteristics like freedom to maneuver or riding quality may largely depend on the subjective judgement of the individual driver.

<u>Evaluation of the Form of the Index</u>. The term "level of service" is established in the Highway Capacity Manual.[1] This measure of the quality of the driving conditions is mainly based on two criteria, speed and volume/capacity ratio. Thus both physical and operational characteristics are included. This expression for the quality of the driving conditions on a facility at a given time is well established, and it seems reasonable to base the interurban highway quality index in this study on level of service. However, this term alone is not sufficient, and different correction factors will be proposed in order to account for other important factors.

A variety of correction factors may be added depending on the actual study. Such factors may include facility type, pavement riding quality, roadside development, level of maintenance, climatic conditions and so on. The most important factor seems to be facility type. It is evident that different facility types, e.g., divided and undivided, have different qualities even though the level of service might be the same. Both highway links in this study, U.S. 90 and IH 10 between San Antonio and Houston, have been operational during part of the period at level of service B. In spite of this, IH 10 must be considered a facility of higher quality than U.S. 90. One major source of contrast between different types of facilities is different accident rates. The lower the accident rate, the higher is the quality of the facility. The classification in "highway type" will also generally describe access control. However, for facilities with no or partial access control, the degree of roadside development will have to be taken into account since it will effect the ratio between local and through traffic, speed reductions, and accident rates. Information about the riding quality of the route is not included in this study, as the pavement serviceability index is currently being evaluated.

For this particular study the final highway quality index will be based on level of service, highway facility type and roadside development. The general form will be:

$$I_{route} = I_{LS} \cdot I_{FT} \cdot I_{RD}$$

where I_{route} = interurban highway route quality index

I_{LS} = index describing "level of service"

I_{FT} = index describing facility type

I_{RD} = index describing roadside development

According to this model, all of the partial indices are given equal weight. However, in determining each of them, the relative influence of each factor is determined by the values chosen.

Variation of Indices over Time. Each of the indices will have to be given a form appropriate to describe improvement of the route over time. Graphically this is shown in Figure 5.1. This simplified figure does not show reduction in quality due to increased traffic volume, temporary reduction during the construction period, deterioration of the surface, and so on. The quality index at a given time, I_D, will depend on the percent of completion, D, of the new facility (or the improvement at that time). When the new facility replaces the old, I_D may be expressed as $I_D = (1\text{-}D)\ I_{OLD} + D \cdot I_{NEW}$. When a new facility comes in addition to the old, I_D may be expressed as $I_D = I_{OLD} + D \cdot I_{NEW}$. Degree of completion may be measured in different ways; in this particular study the number of miles completed will be used.

Partial Index, Level of Services. In order to use the six levels of service as evaluated in the Highway Capacity Manual as an index, each level has to be assigned a certain value. A proposed set of values is shown in Table 5.1.

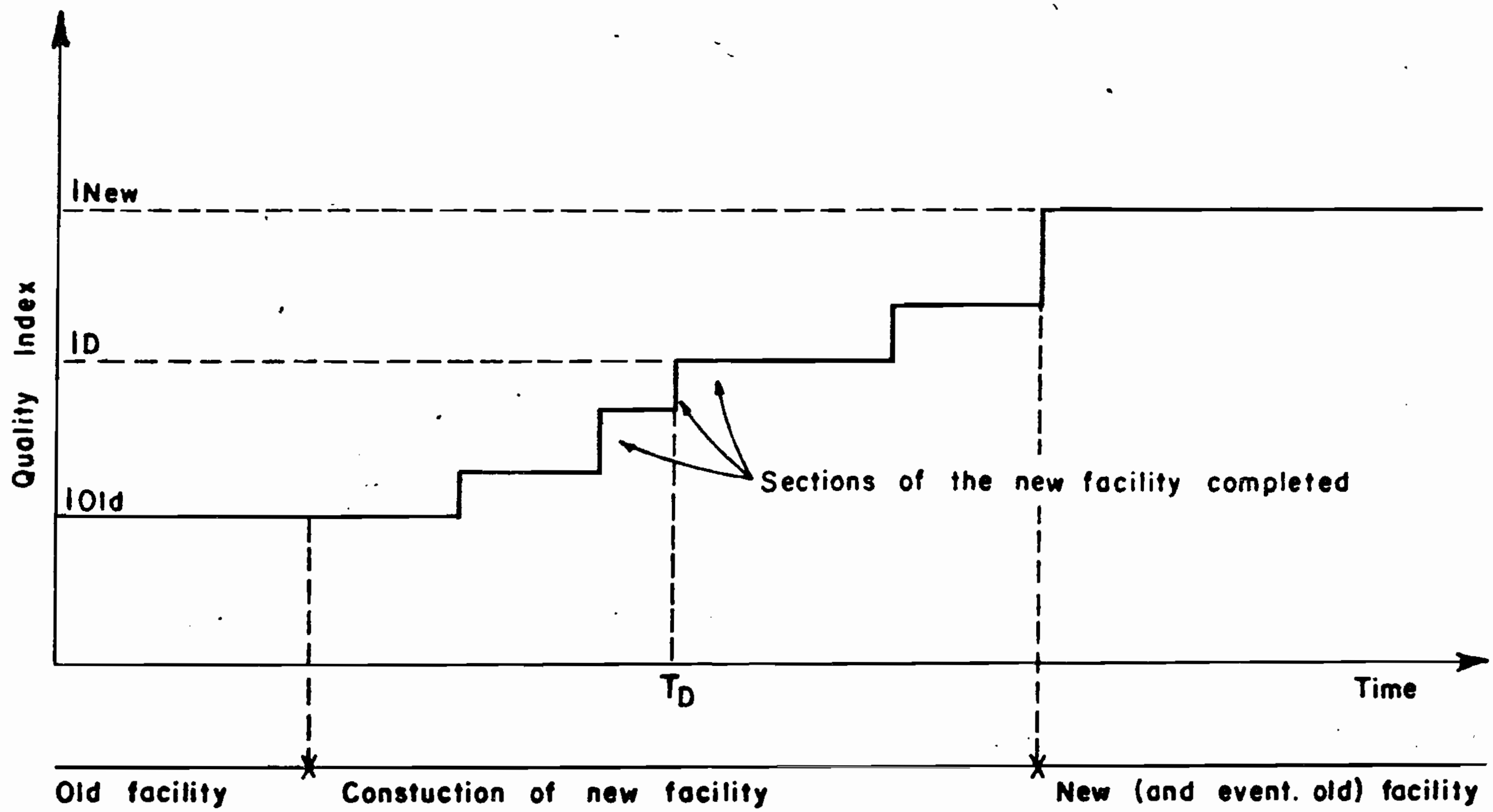


FIGURE 5.1.: VARIATION IN QUALITY INDEX OVER TIME
FOR INTERURBAN HIGHWAY ROUTE

TABLE 5.1.

PROPOSED INDICES, I_{LS}, FOR DIFFERENT LEVELS OF SERVICE ON INTERURBAN HIGHWAY ROUTE

Level of Service as Defined in HCM	Proposed Index, I_{LS}
A	1.0
B	0.9
C	0.75
D	0.5
E	0.25
F	0.05

The indices should express the relative difference in driving conditions as experienced by the average driver. One way of determining the indices, therefore, would be to let a panel of drivers rate driving conditions under varying levels of services on the same facility. This is beyond the scope of this particular study, and the proposed indices are evaluated on the basis of the general description of the different levels of service as given in the Highway Capacity Manual and general driver experience.

The degree of freedom to maneuver is considered to be the most important quality in rating level of service. The superior driver condition, level of service A, with no or little restrictions in maneuverability due to presence of other vehicles, is given the value 1.0. Level of service F, with extremely bad driver conditions due to forced flow, is given the value 0.05. The other levels of service will be somewhere in between these two extremes. Level of service B gives the driver reasonable freedom to choose speed and lane, and there is little restriction due to other drivers. For this reason, this level of service is rated 0.90. Level of service E, with volumes near the capacity of the highway, represents driving conditions wherein the individual driver has very little or no freedom to choose his own speed. Compared to the index for level of service A, this driving condition is rated 0.25, thereby assuming that the conditions under level of service A generally can be judged four times better than the conditions under level of service E. Levels of service C and D represent the conditions between level of service B and level of service E. The indices chosen are 0.75 and 0.5 for level of service C and D respectively.

Partial Index, Facility Type. The most obvious difference between a two-lane and a divided four-lane highway facility might be capacity. However, capacity is implicitly included in level of service and will consequently not be used to distinguish between different types of highway facilities. For this reason the evaluation of an index to characterize facility type mainly will be based on safety considerations. Since such characteristics as driving economy and driving comfort are different for various types of facilities, they will be included as far as possible.

Traffic accident records from all over the nation show a substantial difference in accident rates, expressed in terms of accidents per 100 million vehicle miles, for different types of highways. Table 5.2 shows the most characteristic differences.

TABLE 5.2

ACCIDENT RATES ON RURAL HIGHWAYS RELATED TO DESIGN STANDARDS.
(SOURCE: SOLOMON: "ACCIDENTS ON RURAL HIGHWAYS RELATED TO SPEED DRIVER AND VEHICLE." BPR, USSPC. JULY 1964.)

Facility Type	Rate, total reported accidents
Freeway	1.00
Divided, controlled access (1)	1.69
Four-lane, divided (2)	2.91
Four-lane undivided	4.09
Two-lane	2.38

1) Primarily four-lane roads
2) No access control

As can be seen, a freeway may generally be considered almost 2.5 times as safe as a two-lane facility Also, facilities with controlled access show a lower accident rate than highways with no access control. Consequently it seems reasonable to differentiate between both facility types in terms of whether the facility is divided or undivided, the number of lanes, and the degree of access control.

Driving cost is mainly a function of highway design. Generally the cost decreases with increase in design standard. A freeway in most cases is designed with better horizontal and vertical alignment than a two-lane facility and thus has lower operating costs. In addition, traffic flow generally is smoother, which also contributes to lower driving expenses. Frequent traffic interruptions on a two-lane facility with no or little access control causes the driver to be alert all the time. Compared to a high class freeway, a two-lane road has less driver comfort. For these reasons the facility type index will be proposed as a modified expression of the relative accident rates. The proposed indices are shown in Table 5.3.

TABLE 5.3 PROPOSED INDICES, I_{FT}, FOR DIFFERENT TYPES OF INTERURBAN HIGHWAY FACILITIES

	Facility Type		Access Control		
			Full	Partial	None
Divided	Freeway		1.0	-	-
	Primary	4 lanes	0.8	0.6	0.4
Un-divided	Primary	4 lanes	-	0.5	0.35
		2 lanes	-	0.3	0.25
	Secondary	2 lanes	-	0.25	0.2

The proposed modification reduces the relative quality of a two-lane facility compared to a freeway from 1/2.5 to 1/4. Depending on access control and separation of lanes for traffic of opposite direction, other primary roads are rated in the range from 0.25 to 1.00. The modifications should be based on calculations of differences in driving costs for various types of facilities, and different sets should be made for different types of terrain. The values chosen in this particular study are subjectively derived and should consequently not be considered of general character.

Partial Index, Roadside Development. To adjust for the influence of roadside development on roads with partial or no access control, the following simple formula is proposed:

$$I_{RD} = \frac{K-N}{K}$$

where I_{RD} = roadside influence index

N = number of cities the highway originally passes through

K = constant

As the other partial indices are multiplied by this index in order to find the resulting highway route quality index, I_{RD} has to be 1.0 when there is no roadside development, which is normally the case when $N = 0$. The value of the constant, K, will have to be based on a judgement of the individual route, size of the cities and so on. For this particular study $K = 50$ is chosen. In Sealy the old U.S. 90 passed through ten small cities between San Antonio and Houston. This reduces by a factor of 0.8 the quality of U.S. 90 compared to a hypothetical interurban route, identical to the real U.S. 90 in terms of design and traffic volumes, but bypassing all the cities enroute. To reduce the influence from roadside development the constant, K, would have to be increased.

Interurban Highway Use

Traffic volumes and traffic composition are parts of the operational characteristics of a highway. These characteristics are two of the factors determining level of service and are, consequently, implicitly expressed in the interurban highway route quality index. These two characteristics, however, are considered to be of importance in more than the determination of the quality of the interurban route. The continuous flow of potential customers for goods and services is perhaps of greater importance for the communities along the highway than the quality of the route by itself. The interurban travelers may increase the demand for goods and services beyond that created by the inhabitants in the area. The specific location of these potential customers will have an influence on the location and intensity of business activities and consequently on land values in the area.

Generally it can be said that the potential demand increases as the traffic volume increases. Traffic volume on the highway facility may therefore be considered the most important characteristic. Such other traffic characteristics as distribution of vehicle types and trip purpose probably also affect the degree of influence exerted on business activities by long distance travelers.

The role of highways in the movement of goods has been increasing over the last decade. The number of trucking companies serving the area and the total volume of freight are important aspects of the total level of service provided by the transportation system. In order to simplify this particular study, it is assumed that the provided freight services have developed at the same rate as the increase in total traffic volume on the interurban highway route.

No information about Origin-Destination for the traffic on U.S. 90/IH 10 in the vicinity of Sealy is available. In this particular study highway use will, therefore, be expressed in terms of total average daily traffic volume. The traffic volume varies over the route according to the variation in local traffic using the interurban facility. To get an approximate figure for the average traffic volume over the route, traffic volumes crossing the county line between Colorado and Austin Counties, approximately 7 miles west of Sealy, will be used.

Interurban Public Transportation Services

The only public transportation services available in Sealy during the study period are rail and bus. These two transportation modes have different characteristics and history of development. Although separate indices should be used for each of them, in principle, the two indices may have the same form. Both modes operate on fixed schedules along certain routes. Rail routes are fixed by location of tracks, while bus routes follow existing highways. Bus routes consequently have a greater flexibility in serving the existing demand at a given time. Four factors are considered relevant to a description of provided public transportation services: type of service, frequency, number of routes serving the community, and relative travel speed.

Bus Service Index. There has been no change in bus service to Sealy during the study period in terms of number of routes or number of daily stops. Travel speed has increased because of highway improvement, and the freight service on buses has also been improved. These changes, however, are considered to have had a minor effect since the number of routes and frequencies are constant. Being a constant over time, this index will have no effect in the regression analysis. For this reason, no bus service index is included.

Rail Service Index. While highway-related services have increased, rail services in most areas have declined sharply the last two decades. Reduced traffic volumes have resulted in abandonment of routes and reduced service on still existing routes. In order to describe the reduction in provided rail services the following index will be proposed:

$$I_R = \sum_{\text{routes}} \cdot \sum_{\substack{\text{types of}\\ \text{service}}} R \cdot F$$

where I_R = rail service index

R = type of service available

F = frequency of stops in the community

The two different types of services provided by the railroad are passenger and freight traffic. The relative importance of these services may have changed over time, but in order to simplify, each type will be given a certain weight for the entire study period. Passenger traffic is assumed to have been of the greatest importance for the community of the two types of service provided. This conclusion is reached on the basis of interviews with railroad employees and the local reaction to changes in the services as expressed in the local newspaper. In this particular study, the values $R = 2$ and $R = 1$ are used respectively for passenger and freight services.

The frequency of the provided service can be measured in terms of number of daily stops in each direction on each route. One daily stop in each direction is considered a minimum requirement for any service provided, and the following values for frequency are chosen to represent the difference in service:

More than one stop daily:	$F = 2$
One stop daily:	$F = 1$
Less than one stop daily:	$F = 0$

This grouping is based on the actual frequencies on the lines serving Sealy in the study period, and the same values are assumed for both types of services.

Connection to Nearest SMSA

No information is available about the existing connection between Sealy and the surrounding urban areas over the study period in terms of origin and destination, number of daily commuters, trade, recreational activities and so on. The connection may be said to have two aspects: the dependence upon services outside the community and the ease with which they can be reached. As the demand is not known, the index should express how changes in the transportation system have influenced the effort needed to reach the services.

Houston is the dominating urban center in the area, and for that reason only the connection to Houston will be included in the index for this case study, It should be stressed that this index is not included in the analysis only because of Sealy's dependence upon services in Houston. It might be of equal importance to take into consideration the possibilities for people in Houston to fulfill their needs and desires in Sealy. These needs and desires may include opportunities for housing, land ownership, business expansion and recreational activities. The ease of travelling between Sealy and Houston, may be expressed in terms of available modes, travel time and possible capacity restraint. Private automobile and bus may be considered together the most important modes during the study period. For both of them, travel time is a function of the improvement of the highway route between Sealy and Houston. As there has been no capacity restraint during the time period under consideration, the average travel time in minutes will be used as an index of the connection between Sealy and Houston in this study.

DESCRIPTION OF THE LOCAL TRANSPORTATION SYSTEM

In most of the small cities in rural America no local public transportation is available. In individual communities, walking and bicycling may be of significance, but these would be exceptions rather than the general case. Consequently the private automobile may be considered the predominant mode of local transportation, and the different indices will refer primarily to accessibility by automobile and driving conditions.

Connection between Community and Interurban Transportation Systems

This index should describe the connection between the local and the interurban transportation system and be able to reflect all major changes. Traditionally bus and rail services have had a very good connection to the community in terms of location to central activities. In most cities the bus and the railroad depots are located within, or very close to the CBD. The connection to the rail system is usually inflexible, since railroad depots have a fixed location, regardless of the direction of city growth. In Sealy neither existing bus nor railroad depots have changed location during the study period. For this reason no index is included for connection to public transportation facilities.

Influence of Highway Connection. A community's connection to the interurban highway facilities, on the other hand, is likely to change when improvements of the facility are undertaken. In the extreme case where no physical connection between a new facility and the community exists at all, the influence on the relative spatial distribution of land value may be negligible. However, there may still be an effect in terms of changes in absolute land values or changes of the normal land value trend. This is illustrated in Figure 5.2.

A possible change in the spatial distribution of land values in the case of a good connection to the new highway facility is also shown in Figure 5.2. Because of the attraction from the new facility, location of central activities tends to shift over toward the new facility. This may result in an increase in land values adjacent to the new highway and a decrease in land values on the other side of the city. Thus the new facility tends to cause a specific change in normal development patterns.

Design of Highway Connection. Many factors will possibly affect the actual changes of the connection in each individual case. The two most obvious factors to be included in the connection index are distance between the new facility and the community, and the actual design of the connection. The design of the connection will include both interchange type and degree of access from the adjacent land. Some of the more common types of interchanges are sketched on Figure 5.3. The two at-grade interchanges, here called types A and type B, are the only ones where there is a direct conflict between local and through traffic. Consequently these two types reduce the quality of traffic conditions of the interurban highway drastically. However, these two interchange types allow all turning movements and give good access to the highway facility. Interchange B on the figure is the better of the two, as crossing traffic on the main highway is kept to a minimum.

The interchange types C, D, and E in Figure 5.3 are all grade-separated, and there is no direct conflict between local and through traffic. The degree of access varies for the three types. The grade-separated Y-interchange, type E, gives good access in one direction, but no access in the other direction.

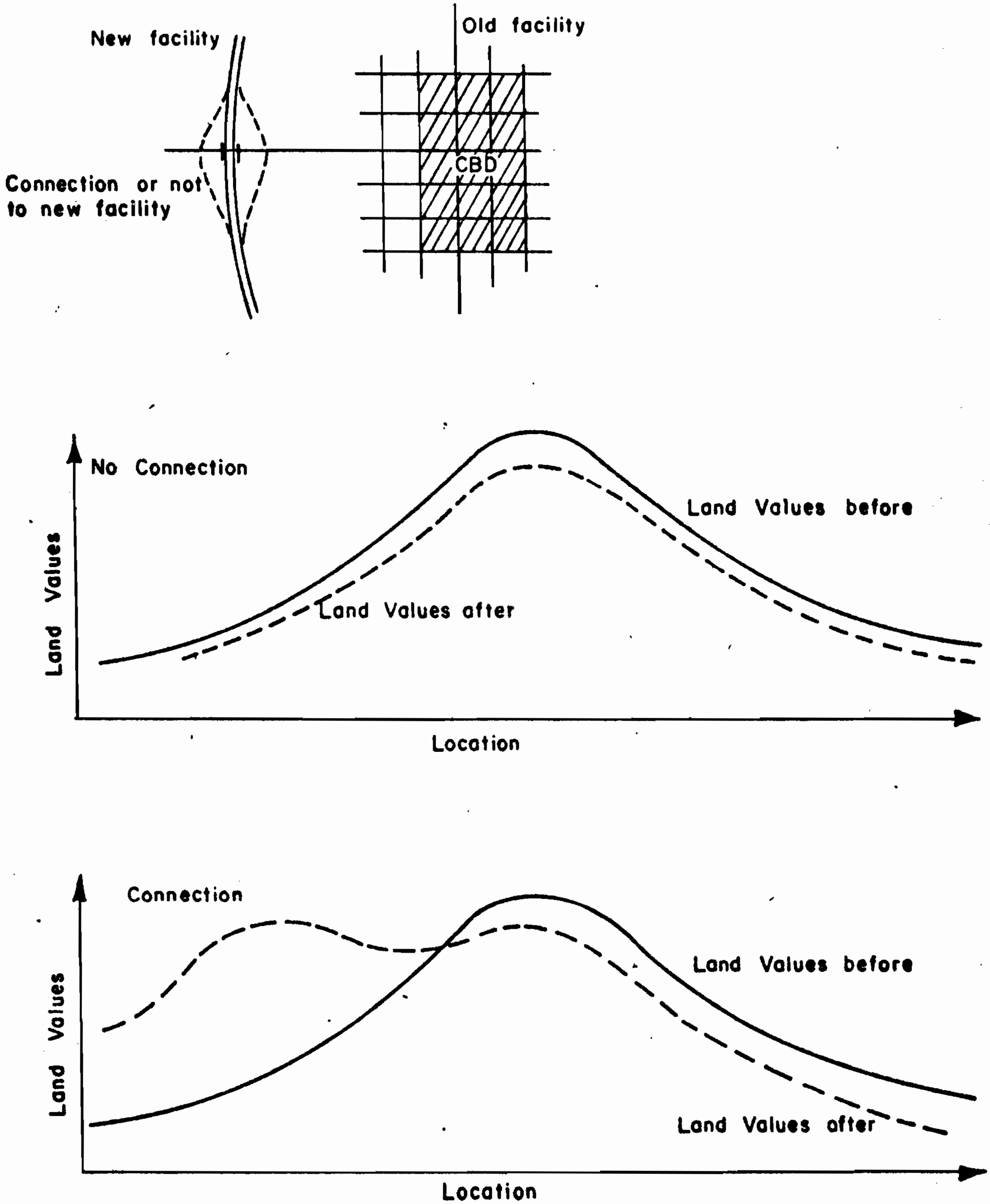


FIGURE 5.2 INFLUENCE ON SPATIAL DISTRIBUTION OF LAND VALUES BY DEGREE OF CONNECTION TO NEW FACILITY

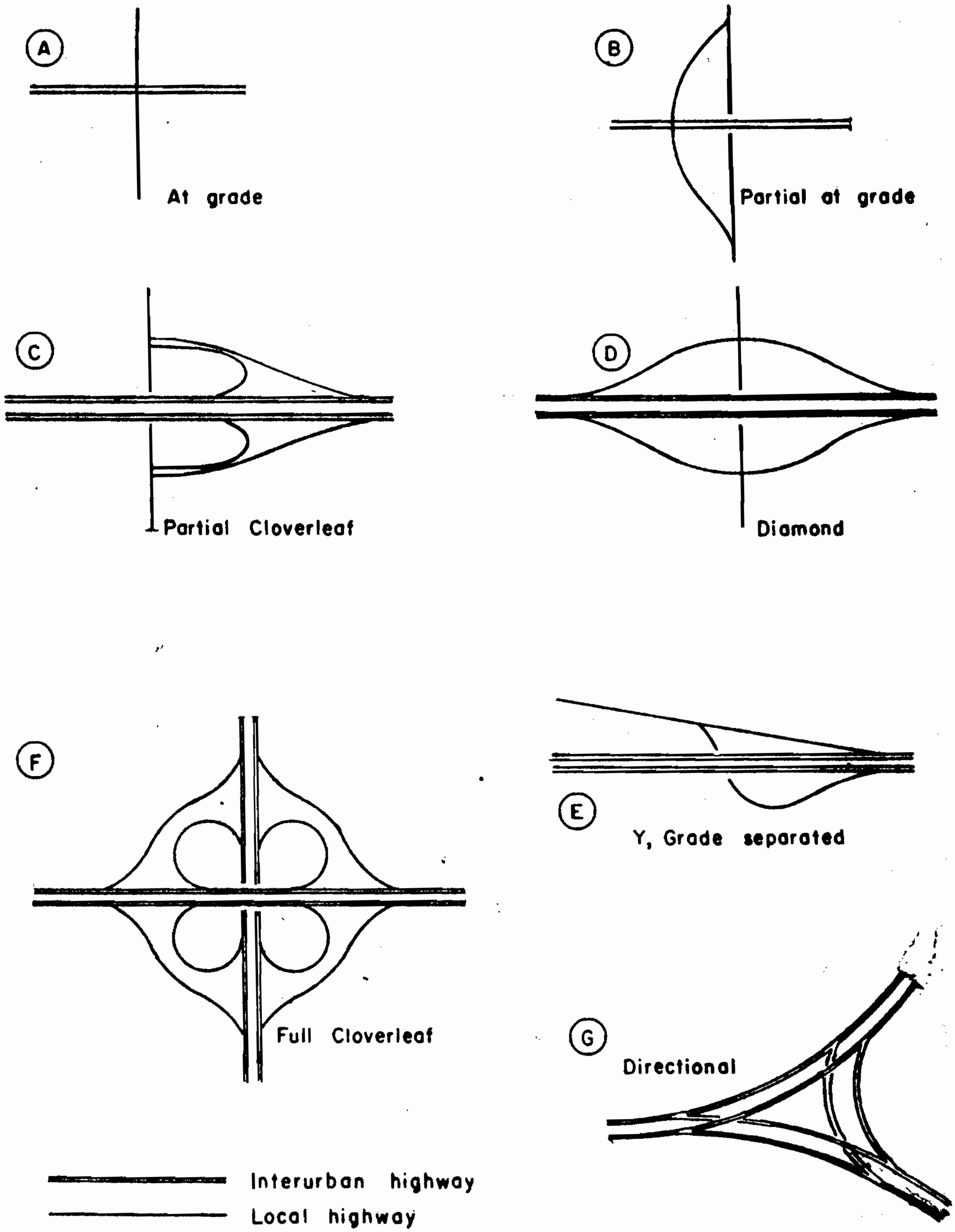


FIGURE 5.3. DIFFERENT TYPES OF INTERCHANGES

This type is commonly used where a new bypass route takes off from the old route. Types C and D provide for all turning movements. Diamond interchange type D gives the most direct access to that quadrant of the interchange first approached on the driver's right. The ramps of the diamond provide more accessibility to this quadrant than the partial cloverleaf.

Interchange types F and G are normally used for interchanges between two major highways. With the ramps connected to the local arterial network, the full cloverleaf, type F, gives very good access. On the contrary, directional interchanges, see type G, usually give no access to either highway from adjacent land.

The degree of access is also a function of access control on the major highway. Most two-lane rural highways have no access control and consequently provide direct access to all adjacent properties. Four-lane divided interurban highway facilities usually have full access control. However, access from adjacent properties to a freeway may be provided by means of frontage roads. Continuous frontage road along a freeway can provide very good access to abutting land.

Highway Connection Index

Given the above considerations, it is expected that four important factors in the highway connection index will be 1) number of interchanges, 2) interchange type, 3) distance from the community and 4) degree of access control to the facility. Although no single case study can explain the effect of different combinations of these features, a general form for a connection index is proposed and used to describe the connections between Sealy and U.S. 90 and Sealy and I.H. 10.

To simplify the index, interchange types are divided into two categories: at-grade and grade-separated. (Even though different types of grade-separated interchanges considered individually may provide different degrees of connection, the effect of all interchanges serving the community is not considered dependent on the design of an individual interchange). The degree of access to the highway is assessed subjectively according to one of three levels. The level in each case depends on the kind of access control, the existence or lack of frontage roads, and the presence of any natural barriers. Distance to the community is rated according to whether or not the facility is within or outside a one mile radius of the CBD area.

Thus, the general index proposed for highway connection takes the following form:

$$I_c = \frac{N}{2} (A+G) + D$$

where

I_c = connection index

N = number of interchanges

A = degree of access to the highway

good = 3

fair = 2

bad = 1

G = interchange type

at grade = 1

grade separated = 2

D = distance rating

1 - outside a one mile radius

2 - within a one mile radius

(The number of interchanges is divided by two simply to adjust for the relative importance of this factor).

The following calculations were made for the two highway connections in Sealy:

$$\text{U.S. } 90 \quad \frac{5}{2} (2+1) + 2 = 9.5$$

$$\text{I.H. } 10 \quad \frac{3}{2} (1+2) + 1 = 5.5$$

General Local Traffic Conditions

For some communities changes in the local traffic conditions may be more important for land use and land values than changes in the interurban facilities. This index is meant to describe the overall conditions for local traffic in the area, and not accessibility to any specific property or activity. Several characteristics may be included describing the changes due to local improvements as well as changes due to improvements on the interurban highway. Surfacing of the streets, traffic routing and signing, parking regulations, street widening and so on are all examples of local improvements. Reduced traffic congestion due to removal of through traffic is an example of an important change due to improvements of the major highway.

Generally there will be little information available about long term changes in local traffic conditions. If traffic volumes on the major facilities and the local street network are known, these, compared to street and interchange capacities, may be used for an index. Another possible characteristic to be used is the variation in traffic accident rates in the area. Generally improvements of the traffic conditions will result in a decrease in the number of traffic accidents. Traffic accidents on the local street network will frequently result in property damages, injuries, and fatalities. The number of accidents may consequently have a direct psychological effect upon the local population, in addition to being an indicator of the local traffic condition. The change in trend over a time period rather than the absolute number each year is expected to possibly affect land uses and land values.

For this particular study the overall local traffic conditions will be assigned to one of three subjectively rated qualitative levels according to changes in the trend in total number of reported traffic accidents on SH-36 and U.S. 90 in Sealy.

Individual Parcel Accessibility

Urban land theories[2] usually attribute variation in land values to variation in location and accessibility. Three different terms for the individual parcel accessibility may be considered to have the most important bearing upon changes in land values. These are accessibility to the central business district (CBD), to public transportation terminals, and to the major interurban highway facility. Generally accessibility is measured in terms of travel time between two points. For this study, however, it is found more appropriate to describe accessibility as a function of distance and adjustment factors. This information can easily be obtained from maps, aerial photographs and inspection of the area. Also, this makes it possible to include more considerations than driving time in the accessibility index.

The indices for accessibility are meant to give the relative difference in accessibility for the individual parcels in the community. Consequently they are not expected to be the best description of the accessibility to one given parcel in absolute terms.

Accessibility to CBD-Area. Traditionally the CBD-area in small rural cities has been a very distinct and limited area. To some degree this has changed over the last decade, but in most cases one area is still the major focal point for local trips. The adjusted distance between the parcel under consideration and the border of a defined CBD-area will be proposed for this index. Shortest distance measured along existing streets will be used. The adjustment factor will have to take care of delays caused by intersections, railroad crossings, and the effect of the type of street surface. There should in principle be different adjustment factors for each individual parcel. However, as this would require detailed information about the street network over the entire study period, a set of three different factors will be used. This set will describe three qualitative levels, the appropriate level being determined by a subjective judgement of the shortest route. The values 0.8, 1.0 and 1.2 are proposed for the corresponding levels good, fair and bad conditions along the measured route. The proposed index for accessibility to CBD will consequently take the form:

$$I_{CBD} = D_{CBD} \cdot A_p$$

where I_{CBD} = accessibility index

D_{CBD} = shortest distance to CBD-area

A_p = adjustment factor for the parcel.

<u>Accessibility to Public Transportation Terminals</u>. Bus and railroad depots are the transfer points between different modes of transportation and also between intercity and local trips. Accessibility to these two terminals may therefore be considered an important link in the public transportation system.

Accessibility to each of these two terminals will be expressed by distance from the parcel under consideration and an adjustment factor as explained above. It is not known which one of the two terminals is the most important. Being located relatively close to each other in Sealy, the average value will be proposed. Thus the index will be:

$$I_{PT} = (D_{BD} + D_{RD}) \cdot A_p / 2$$

where I_{PT} = accessibility index

D_{BD} = distance to bus depot

D_{RD} = distance to railroad depot

A_p = street adjustment factor for the parcel

<u>Accessibility to interurban highway.</u> While the two previous accessibility indices were mainly for local travel, this index has to describe how easy it is to locate and reach the considered parcel for a highway traveler not familiar with the local street network. Consequently accessibility to the interurban highway will not be a question only of a simple adjustment in the distance between the parcel and the highway facility.

It is felt that three characteristics are the most important: distance, interchange type, and parcel location relative to the off ramp. Distance will be measured from the parcel under consideration to the nearest interchange on the existing interurban highway facility at the time of sale. Distance is measured along major streets from the parcel to the interchange. No adjustment factor for the street conditions is used since a considerable part of this trip will be on the local highway. The rationale behind the different ways of measuring distance to CBD and to highway interchange is the possible difference in local versus non-local travelers in the two cases. Traffic to the parcel from the highway is expected to be more non-local than traffic from the CBD-area and will tend to follow major streets.

Interchange type for the nearest highway interchange in each case will to a large extent affect accessibility from the highway route, as well as access to the highway. Referring to Figure 5.3, the interchanges may be divided into three classes, describing the possibility for, and ease of turning movements. As shown interchange types A, B, C, D, and F provide all turning movements at the interchange, but the partial cloverleaf, and grade separated Y, type E, is considered less convenient than the other types because they do not provide all turning movements. The three proposed classifications of interchange types, and corresponding levels of quality, T. are:

All turning movements (at grade, full cloverleaf, diamond)	= 3
All turning movements, partial cloverleaf	= 2
Restricted turning movements	= 1

Location of a parcel relative to the off ramp will be used to describe how easy a parcel is to locate when leaving the interurban highway. This characteristic will partly be a function of visibility from the interurban highway, interchange quadrant, and location relative to the local highway. Good visibility is considered important as is location to the local highway. The highest quality level includes parcels located in the two first right-hand quadrants on grade-separated interchanges and those located on either side near at grade interchanges. Table 5.4 shows proposed quality levels, L:

TABLE 5.4 — QUALITY LEVELS OF PARCEL LOCATION RELATIVE TO OFF-RAMPS

Parcel Location		Visibility			
		Good		Bad	
		Quadrant		Quadrant	
		good	fair	good	fair
Location to Local Highway	good	4	3	2	1
	bad	2	2	1	1

Table 5.4 cannot show all possible locations, and hence subjective judgements about the specific locations will have to be used.

The following index for accessibility to the interurban highway facility will be used:

$$I_{HWY} = (T + L) \;/\; (D_{HWY} + 1)$$

where I_{HWY} = accessibility index

T = interchange type classification

L = quality of parcel location

D_{HWY} = distance to nearest interchange

Thus this index will fall in the range

$$0 < I_{HWY} \leq 7.0$$

DESCRIPTION OF THE COMMUNITY

To date a simple way of describing the community factors affecting land value has not been developed. Economic and social characteristics are perhaps the most important aspects of a community because they describe the kind and intensity of activities as well as human resources and the possibilities for turning potential for growth and development into reality. However, because of the lack of descriptive techniques for dealing with these two important factors, and also because of the lack of information about economic and social conditions in Sealy at this time, these community characteristics cannot be included in the analysis of land values.

Some community characteristics are common for the entire area, others are related to neighborhoods, and some have to be related to individual parcels. In order to explain the spatial variation of land values in the community each characteristic must be related to its smallest unit and not to any area-wide average. In this particular study most of the characteristics examined have to be related to each individual parcel, and they are therefore listed under "description of the individual parcel."

Population Growth Rate

This characteristic is considered common for the entire study area as there is no available information about how the population in different neighborhoods or subdivisions has varied over the study period. Generally an increase in population growth rate results in a higher demand for housing. This may affect land values in existing residential areas, but also increase the annual amount of agricultural or vacant land developed for housing. In addition to population growth it is important to know the distribution according to sex and age, as this distribution to a high degree affects the demand for housing. Population growth also affects the demand for goods and services, thereby affecting business and social activities and possibly influencing land values for certain land use categories.

Because of available population data for Sealy, only population growth rate will be included in this study. Since market values are functions of the existing supply and demand at a given time, actual growth rate in each specific year will be used in the analysis.

Neighborhood Quality

Usually a community is comprised of distinct neighborhood areas. The boundaries for these neighborhoods may be created by natural or man-made barriers and by the tendency for people of the same social and economic status to cluster together. Because of difference in needs and desires, and purchasing power, land values are expected to vary according to varying neighborhood characteristics. It is a known phenomenon that land values in a neighborhood are sensitive to changes in social and economic status and the general appearance of the properties.

The age of the neighborhood and maintenance of area will generally influence land values. This factor is, however, closely connected to the social conditions. Consequently neighborhood quality may be classified in terms of social status and appearance of the properties. Appearance will have to be based on a subjective judgement of the age of the neighborhood, the homogenity of land use, and the visual impact of the properties. A proposed index for neighborhood quality is shown in Table 5.5.

TABLE 5.5 NEIGHBORHOOD QUALITY INDEX FOR RESIDENTIAL AREAS
(Rating 4 is the highest quality)

Social Status	Appearance		
	Good	Fair	Bad
High income	4	3	---
Medium income	3	2	2
Low income	---	1	1

The indicated neighborhood quality index in Table 5.5 applies especially to residential areas. For land uses like commercial and industrial the rating will have to be based mainly on appearance. For agricultural land use social status and appearance are expected to be of little significance. In this case the index should express the property's potential to be turned into a higher land use class.

DESCRIPTION OF INDIVIDUAL PARCELS

Land Value

In this study land value is defined as market value unless otherwise stated. As the data in this study are collected from actual transactions, the market value for the parcel is obtained. This value is the result of negotiations between buyer and seller according to the desires and needs and the actual supply and demand. To get an expression for the market value at any particular time, a parcel of land may be appraised. However, this is a highly theoretical value as long as there is no demand for the parcel in terms of a buyer.

To make the different transactions comparable, the value will be expressed in terms of a unit price, dollars per acre. The most common unit in a CBD-area is dollars per square foot, but it is more appropriate to use the same unit for all transactions. Also, as the purchasing power of the dollar has been subject to change over time, adjustment will be made according to changes in the Consumer Price Index. The index for the Houston area is used, which should reflect the changes in Sealy. The general Consumer Price Index is used, as no specific index for land values is available. The base year chosen is 1950, and the unit prices are stated in 1950 constant dollars. Table A5.1 in the Appendix shows the actual changes in the Consumer Price Index during the study period.

Size

Previous research has shown that the size of the parcel has an influence on the unit price. Size of the parcel is easily measured with one acre used as the unit. It is common practice in most trades that quantity has an influence on the unit price, but in the case of land transactions the sub-division into smaller parcels is expected to be especially important. Consequently it could be desirable to know the degree of sub-division in addition to the actual size. However, since sub-division into smaller lots can mean change to a better land use, it is felt that the information about land use before and after the transaction yields the same information; therefore, size expressed in acres is included in the analysis.

Land Use

Land is in most cases acquired to fulfill a certain need or desire of the buyer. This need or desire is generally reflected in land use. Usually a change in land use of a parcel follows a change in ownership. It might also be a result of an owner's attempt to maximize his net return from the given parcel of land as times and economic conditions change.

To account for changes in land use, land use before and after each transaction will be included in the analysis. Land use before will be the use at the time of transaction, since this tends to reflect the previous owner's judgement of "best use." Land use after the change in ownership will be the last land use before the next transaction or current land use if there is no later change in ownership. Land use immediately after the transaction will not be included because the buyer's long term plans for utilization of the parcel in most cases will determine how much he is willing to pay for the land.

Land use can be classified in a number of ways according to the actual purpose of the study. It is desirable to use standard specifications as far as possible, such as the "Standard Land Use Coding Manual,"[3] but it is felt that a special classification is preferable for this particular study. Previous impact studies seem to indicate that highway related activities should be separated as one land use group and also that the number of groups should be limited. Even though a detailed land use survey showing all land use activities as specified in the coding manual would be desirable, there is no detailed information about the changes in land use over the study period. Consequently the land use categories were made as simple as possible.

According to the general experience from previous impact studies seven classes will be used:

1. Public land. All land owned by the public serving public needs. Another important characteristic of this land use group is that it is not likely that a parcel will be sold to a private party again.
2. Agricultural. All land used for agricultural purposes.
3. Vacant. All land held for future use, and at the time considered not utilized or occupied for any specific purpose. May or may not have structures on it.
4. Industrial. All land used for industrial or manufacturing purposes.
5. Residential. Land occupied for any type of residential development.
6. Non-highway commercial. All types of commercial land use more directed towards the local public than the highway travelers.
7. Highway commercial. Land used for commercial services mainly serving the highway travelers.

The ranking of categories should be chosen to reflect the general level of market value, and the relative weight of the different categories determined for each individual study case. In cases when the activities on a parcel include more than one category, the "highest" land use according to the ranking chosen for this study will be used. Consequently large residential lots where there is some agricultural activity will be classified residential. Studies of the information gathered in Sealy give some indication of what the relative ranking for land use possibly should be. The average land value for each land use category, over the entire study area and the entire study period, is shown in Table 5.6. The wide variation may be caused partly by some systematic variation in other variables, and a less extreme variation in the relative weights for each use category has been chosen. The chosen weights are also shown in Table 5.6. The observations for public land use were too few to draw any conclusions about the relative rank for that category, but the observed values generally were in the same range as for vacant lots.

TABLE 5.6

CHOSEN RELATIVE RANKING WEIGHTS AND OBSERVED DIFFERENCES IN AVERAGE LAND VALUES PER LAND USE CATEGORY

Land Use Category	Chosen Ranking Weight	Land Use Before Transaction	Land Use After Transaction
Public	3	--	4.9
Agricultural	1	1.4	0.9
Vacant	3	6.6	6.5
Industrial	4	19.2	9.4
Residential	5	28.3	18.6
Non-highway commercial	8	71.6	65.3
Highway commercial	7	49.2	36.3

Site Quality

This is a qualitative measurement which to a large extent depends on the actual use and individual judgement of the parcel. Some characteristics, however, might be of general interest. The shape of a parcel is of great importance to the owner. Generally a rectangular shape will give the most economical utilization of a lot as long as it is not too narrow. Irregular shape with narrow angles is usually a disadvantage. The common practice in land appraising is the use of different rates for different parts of bigger lots, the rate declining the more distant from the street or the highway. Thus the unit price will decrease with the decreasing ratio of frontage length/parcel size. As in many cases there is no information available about the actual frontage length, therefore a classification will not be based on actual measured frontage length/parcel size-ratio. The location of a lot in the block is also of significanct importance. Generally the value of the lot increases with increasing front length, the highest value being assessed for a corner lot. Also the slope on the parcel may be crucial for the desirable land use. Other important characteristics may be exposure to flooding, soil conditions, noise level, vegetation and so on.

For this study, it is not possible to collect information about all the above-mentioned factors for each parcel. In order to simplify without completely neglecting site quality, each parcel will be classified according to one out of three levels based on a subjective judgement. The three levels used are: good, fair, and poor, and the corresponding relative values are three, two, and one. The classification will mainly be based on shape, frontage length/parcel size-ratio, and location in the block.

Date of Transaction

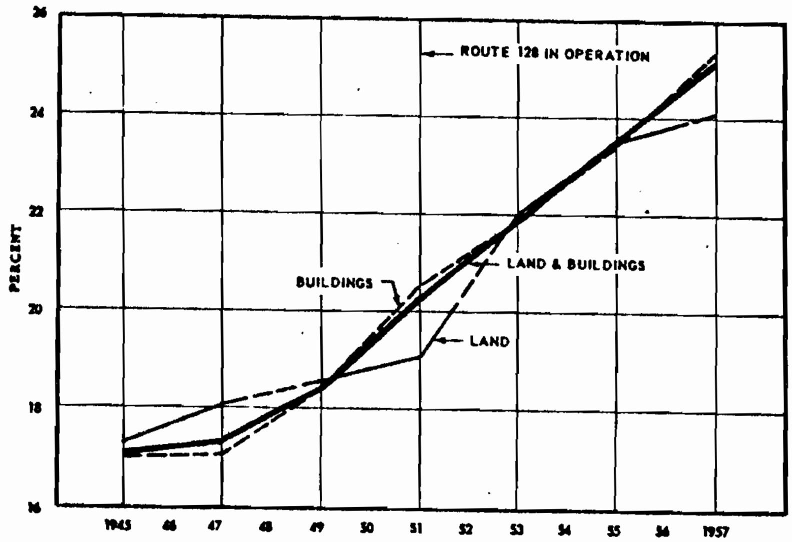
The date for each land transaction included in the study is recorded. The actual time in itself is not the most important factor; what is of interest is the time between changes, in terms of decisions or actions, in the transportation system or community characteristics and the time of the transaction. In this particular study there are four major changes in the transportation system giving rise to questions in which time is an important factor. First, did the announcement of the new bypass route, IH 10, cause any change in the land value pattern? Did the acquiring of land to right-of-way for the new IH 10 cause any changes? Has there been any measurable change since the opening of the new highway facility? Did the sharp decrease in railroad services cause any change in the land value pattern? In order to get an answer to these questions, four variables, expressing time elapsed after each of these changes in the transportation system will be included in the analysis.

Improvements

In addition to use, land may be classified as improved or unimproved depending upon whether or not there is a structure on it. This study deals with land values, but, except for open land, it has not been possible to find the market value for the land alone. Any attempt to separate values for land and structures for improved lots would be based on an unknown degree of accuracy, and this might influence the results from the statistical analysis. The relative proportion between value for land and improvement will vary widely. However, it is assumed that there is an overall relationship between land value and market value, as more money may be used for improvement and structures the more valuable is the land. This assumption is supported by findings from a study on Route 128 around Boston.[4] This study found that, as an overall picture, the value of both land and buildings increased at an approximate equal rate over the study period. The findings from the study are shown in Figure 5.4.

The information gathered in Sealy makes it possible to study the relationship between unit market value ($/acre) for improved and unimproved parcels in the community. By plotting land value for improved and unimproved parcels with common characteristics, it is possible to see a clear general trend. The result is plotted in Figure 5.5. The common characteristics include both spatial distribution, social conditions, parcel characteristics, and time of sale. As can be seen from the figure, unit values for unimproved parcels were generally in the range of 20 percent of the corresponding value for improved parcels. This result is important for the analysis in this study. As both land and improvements have experienced the same changes in value due to changes in other factors, they do not have to be analyzed separately.

It is evident, however, that the accuracy with which the model can describe land value for the individual parcel will suffer from the lack of a qualitative index for improvements. Such an index could have been included for current transactions as the structures could have been visually inspected. For earlier transactions, it would be impossible to include an improvement quality rating with a reasonable degree of accuracy. For this reason the only differentiation made will be between "improved" and "unimproved" parcels.



Assessed values in the adjacent Band Area of Lexington expressed as a percentage of assessed values in the entire town.

FIGURE 5.4

VARIATION IN ASSESSED VALUES FOR LAND AND FOR BUILDINGS IN AN AREA ADJACENT TO A NEW HIGHWAY FACILITY

(SOURCE: BONE, A. J. and Wohl, M.: "MASSACHUSETTS ROUTE 128 IMPACT STUDY," HRB - BULLETIN 227, pp. 21-49, 1959).

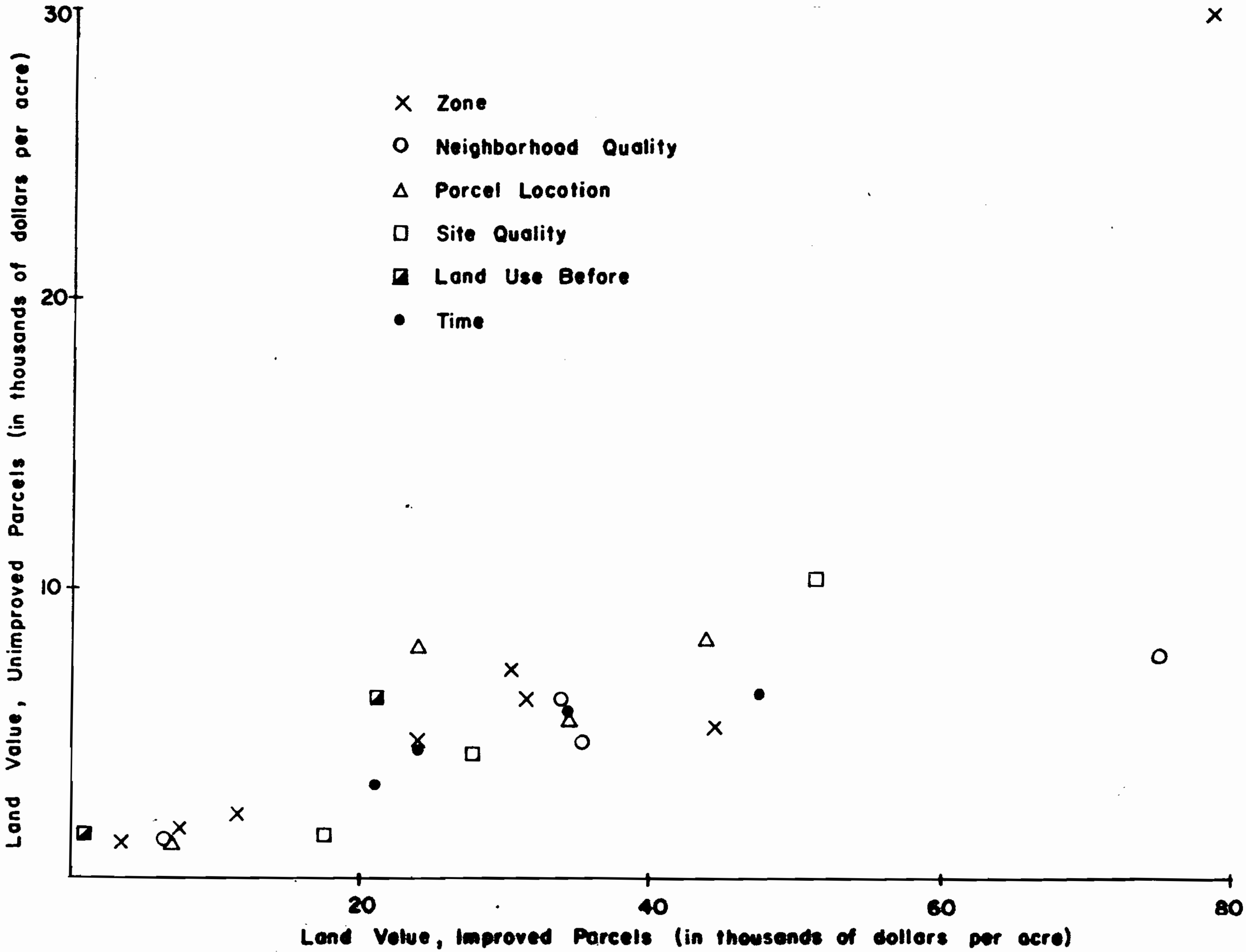


FIGURE 5.5.: COMPARISON OF LAND VALUES FOR IMPROVED AND UN-IMPROVED PARCELS, SEALY

Summary

The indices proposed in this chapter are meant to describe the various aspects of the community, the transportation system, and the individual parcels of land which interact to influence land value. They should *not* be regarded as an exhaustive set of variables, but rather as tentative groupings of those variables which are thought *a priori* to be of potential significance. The subsequent analysis should indicate their usefulness as descriptive indices in a particular case, as well as the need for refinement of the forms proposed and the need for the addition of other factors not accounted for in this initial phase of model development. Thus, though they are proposed in a general form, these indices are to be regarded as of hypothetical value for testing in specific cases.

FOOTNOTES

[1] For detailed information about the term "level of service," see pp. 78-87 in "Highway Capacity Manual 1965," *Highway Research Board Special Report 87*.

[2] As an example, see Johann H. von Thünen, *Der Isolierte Staat in Beziehung auf Landwirtschaft und Nationalokonomie*, Hamburg, 1826.

[3] A standard system for identifying and coding land use activities is given in "Standard Land Use Coding Manual," U. S. Department of Transportation.

[4] A. J. Bone and Martin Wohl, "Massachusetts Route 128 Impact Study," Highway Research Board *Bulletin 227*, pp. 21-49.

CHAPTER VI. AVAILABLE INFORMATION

Studies of small cities frequently suffer from inadequate public records, as the bookkeeping system is often insufficient. This was also the case in the study of Sealy. Some important information consequently had to be gathered from private sources, from studies of aerial photographs, and by visual inspection. Much of the information sought concerned qualitative levels, and these had to be subjectively determined according to the procedures outlined in the previous chapter.

LAND TRANSACTIONS

Sources and Information

The most important factor in this study is land value. Different sources have been used in previous studies of land values, including assessed value for tax purposes, revenue stamps on deeds, and sales prices from deeds. Most studies have concluded that these sources cannot be used reliably to describe market value. In this study the possibilities for using assessed value for tax purposes were examined first. Records from the Austin County Tax Collector, spanning the period 1950 - 1972, were microfilmed, and the changes in value over the study period for a majority of the properties within the city limits were studied. The records, unfortunately, apparently failed to reflect the changes in land values, and because of a lack of specific procedures for reassessment, it was felt that this source could not be used in order to determine market value.

However, the private Bellville Abstract and Title Insurance Company made their files on owners' title policies in Sealy available to the researchers. No information for the time period 1950 - 1955 is available. For this reason the study period in this particular study was changed from 1950 - 1970 to 1955 - 1973. The change in the original study period does not present any problem in the fulfillment of the study requirements presented previously (Chapter IV.). The extension from 1970 to 1973 is in fact desirable in order to examine the long term effects of the construction of IH 10, bypassing Sealy. While information about every individual parcel in the community could be obtained from the County Tax Collector's Records, the abstract company's records yield information about a limited number of properties. The information available, however, may be considered to yield the exact sales price from the transactions included in the records, making it possible to base the analysis on

SAMPLING OF INFORMATION

If information about market value for each individual parcel sold during the entire study period had been available, an appropriate group could have been chosen to assure a statistically valid sample. A sample has to be representative for an entire population of events, in terms of distribution, mean and variance. In order to reveal the cause/effect relationship between land values and other given factors, the sample should include events representing all combinations and levels of factors chosen as independent variables. The great number of variables included in this study would require an extensive sample which could not be gathered with the time and resources available.

In terms of numbers, the maximum limit for the sample is the total number of transactions in the study area over the entire study period. This sample would reveal complete information about changes in market value in the study area. However, there is no requirement for buyer or seller to record the actual price when a transaction takes place. Due to limited resources in this study, the most complete sample is the total set of transactions where the actual sales price is known and where all of the other factors included in the analysis can be determined with reasonable accuracy.

The only readily available source of market land values was the record of title policies from Bellville Abstract and Title Company. The information recorded included the names of the buyer and seller, price, date of transaction, and, in most cases, the size of parcel and the subdivision in which it was located. In this study the names of the grantor and grantee are kept confidential and have only been used to locate supplementary information when needed. Not all of the transactions recorded in the owners' title policies could be used as it was not possible to determine the exact location of all property or the value of some of the other characteristics needed. Consequently the sample is chosen according to the information available, and not according to any sampling technique. This fact will tend to reduce the reliability of the model to be developed, as the social and economic characteristics of seller or buyer may influence who takes out an owner's title insurance policy.

VERIFICATION OF SAMPLE

A total of 611 property transactions is included in the sample. It was not possible to list all transactions that have taken place in the study area over the study period, and therefore, the sample is not known as a percentage of total number of transactions. A study of transfers of ownership in most areas of Sealy was made from the County Tax Assessor's Records. This study indicates that the sample includes about 10 percent of all land transfers[1] in the time period 1955 - 1959, 25 percent in the period 1960 - 1964, and 50 percent in the period 1965 - 1970. Table A.6.1. in the Appendix shows the figures for each subdivision. The most important changes in the transportation system took place after 1960, and the sample size is considered sufficient for this most important part of the study period. Table A.6.2. shows the yearly distribution of the transactions included in the sample.

Table A.6.3. in the Appendix shows the distribution of transactions over time periods and by categories of land use. As can be seen, there is a fairly even distribution for all land use groups, except for public and industrial land uses. Because only one sale of public owned land is included, no conclusion can be drawn about this category. Table A.6.4. shows the distribution of transactions of improved and unimproved parcels over time periods. The total sample is split on 305 unimproved and 306 improved parcels.

In order to find the spatial distribution of the sample over the study area, the transactions are listed according to zones (see Figure 4.1) in Table A.6.5. The table indicates that all zones have a fairly good representation. Table A.6.6. shows the distribution according to neighborhood quality index, which partly expresses social conditions. Here, too, each category has a fairly good representation.

It is not possible to state the validity of the sample in statistical terms. However, as the subgroupings of the sample according to important characteristics show, the sample is fairly representative for the different characteristics of the study area throughout the entire study period. Thus the sample is considered valid for use in an evaluation of the cause/effect relationship between land values and changes in transportation system and community characteristics.

TRANSPORTATION SYSTEM

Interurban Highway Route

Information about the highway route between San Antonio and Houston has been obtained from the Texas Highway Department, partly from the District Engineers in Districts 12, 13, and 15, and partly from the main headquarters in Austin. The information covers both physical and operational characteristics over the entire study period.

Physical Characteristics

U.S. 90 was the major interurban highway route at the beginning of the study period. Except for a 12-mile section between Houston and Addix, U.S. 90 was a two-lane facility primarily constructed with concrete pavement varying in width from 20 to 22 feet. The shoulders were 5 - 7 feet wide, and the alignment had grades up to five percent and horizontal curves up to 3°. Sight distance was restricted on numerous sections, and there were extensive no-passing zones. Railroad underpasses had vertical clearances as low as 14'0", and there was one at grade railroad crossing. The highway passed through ten cities with populations of about 1000 or more; Seguin, Luling, Waelder, Flatonia, Schulenburg, Weimar, Columbus, Sealy, Brookshire and Katy. There was no access control to the highway.

The construction of IH 10 lasted until 1972, when the new facility had replaced U.S. 90 over the entire route. The information gathered includes date for the start and end of construction on each highway section. Thus the degree of completion of the new facility at any given time can easily be found. Degree of completion is here defined as the length of new facility open to traffic in each time period, divided by total highway corridor length. Table A.6.7. and Figure A.6.1. in the Appendix show when construction was finished on the different sections of IH 10, degrees of completion, and number of cities not bypassed.

IH 10 is a four-lane divided highway facility. The traffic lanes are 12 feet wide, and the paved shoulders are ten feet wide on the right side and a minimum of four feet on the left side. Horizontal curvature is restricted to 3°, and the grades are limited to three percent. All grade separations have a minimum clearance of 16'0". All interchanges are grade separated, and there is full access control over the entire route. Frontage roads are provided when required in order to provide access to abutting properties.

While average values are used for characteristics of the highway route as a whole, the characteristics of the section passing through or bypassing Sealy are subject to more detailed analysis. Three different references in time are expected to be of importance for the trend in land development and land values: the dates when the location of the new facility was known, when purchase of right-of-way started, and when construction of the bypass route was completed. The respective years are 1958, 1959, and 1967.

The physical connection between the interurban facility and the community changed extensively when the access-controlled IH 10 replaced the old U.S. 90. Calculations of the "connection to highway" index (see Chapter V) results in the value 9.5 for U.S. 90, and 5.5 for IH 10, expressing that Sealy had a more direct physical connection to U.S. 90 than to the new IH 10. Figure 4.1 shows the highway system in Sealy.

Operational Characteristics

The available information on traffic volumes covers stations along the entire route, each station with traffic counts every third year. The traffic volume varies along the route at a given time. In order to simplify, traffic volume for the highway route is represented by the traffic volume in a given section. Studies of traffic variation along the route showed that the station on the county line between Austin and Colorado counties represents fairly well an average for the route and is used in this study to represent traffic volume on U.S. 90/IH 10 between San Antonio and Houston. Figure A.6.2. in the Appendix shows the variation in traffic volume over time. Speed observations at a location nine miles west of Sealy during the period 1964 - 1973 reveal a steady increase in average speed. As seen on Figure A.6.3. in the Appendix, the opening of IH 10 did not result in an abnormally high increase in the average speed for all vehicles.

Average level of service for the sections of U.S. 90 and IH 10 in operation are calculated according to the traffic volume of the route, average speed, and geometric design averages. These calculations show that the sections of U.S. 90 in use operated under level of service B except for the two years 1970 and 1971. IH 10 has operated under level of service A except for 1972 and 1973 when level of service dropped to B. The index "Quality of Interurban Highway Route" is evaluated in Chapter V. Table A6.8 and Figure A6.4 in the Appendix show the variation in this index over the period 1955 - 1973. The index varies from 0.25 in 1955 to 0.90 in 1973. A drop in the index in 1970 is mainly caused by the drop in level of service from B to C on the remaining sections of the two-lane U.S. 90.

The index "Connection to Nearest SMSA" (see Chapter V) is defined as travel time in minutes between Sealy and the nearest main shopping centers in Houston. For the period 1955 to 1967, the interchange between IH 10 and IH 45 is used as point of destination in Houston; from 1968 to the present, the distance is measured to a point 6 miles west of the interchange to reflect the development of the major shopping centers in the western part of Houston. Speed development is based on the actual speed survey on U.S. 90/IH 10 in the period 1964 - 1973 and speed trends as given for two-lane facilities in AASHO Blue-book for the period 1955 - 1964.[6] The calculated travel time between Sealy and Houston over the entire study period is given in Table A6.8 in the Appendix.

Public Transportation

Today, interurban commercial bus service is the only mode of public transportation serving passenger traffic in Sealy. No information is available about the number of bus passengers. The number of routes serving Sealy and the number of daily stops have, according to local sources, not changed over the study period. The 1973 bus schedule for Sealy is shown in Table A6.9 in the Appendix.

Information about railroad services was obtained from several sources. The information, however, is restricted to those routes having stops in Sealy and the number of daily stops. As yet no information about passenger or freight volumes has been obtained. The last passenger train stopped in Sealy in 1968. Freight services, however, are still available on a daily basis. The rail service index as explained in Chapter V has been calculated from the available information. As shown in Table A6.10 in the Appendix, this index varies from 10 in 1955 to 1 in 1973, clearly indicating the reduction of railroad services available to the community during the last two decades.

Local Traffic Condition

All information about traffic volumes on the local street and highway network in Sealy was obtained from the Texas Highway Department. The city has not made any survey of traffic conditions. Before 1965, the Texas

Highway Department traffic counts did not include any station within the city limits; consequently there is no information available about traffic volumes on any street in the first half of the study period. However, some features are evident. Figure 6.1 shows traffic volumes from 1956, 1965 and 1967 where available. As can be seen from the figure, there has been a steady increase in traffic volumes in the area over the study period, except for the section of U.S. 90 passing through Sealy. Opening of the IH 10 bypass route reduced the 1967 traffic volumes on U.S. 90 to less than half of the 1965 traffic level. Other parts of the local network were also affected by the bypass route.

As discussed in Chapter V, the number of traffic accidents in the area reflects the local traffic conditions. The Texas Highway Department keeps records over all registered traffic accidents on all roads under their jurisdiction, including those within city limits. Thus records for U.S. 90 and SH 36 are available. Because of the way the accidents are located over the study period, records from a 12.6 mile section of SH 36 and a 4.1-mile section of U.S. 90 are included in this study in order to make the figures comparable over time. Accidents on the bypass route of IH 10 are not considered because the amount of local traffic there is relatively small and no pedestrians are involved.

The number of registered fatal and injury traffic accidents on the local parts of U.S. 90 and SH 36 are shown on Figure A6.5 in the Appendix. Up until 1961 the number of accidents is fairly constant, then seems to increase sharply until 1967. The general trend after 1967 seems to be a decreasing number of accidents. These considerations of the accident trend have led to the conclusion that the relative local traffic conditions over the study period may be characterized as fair in the period 1955 - 1961, bad between 1961 and 1967, and good after 1967.

There is not enough available information about street surfacing, maintenance level and parking conditions to include these factors in the analysis.

COMMUNITY CHARACTERISTICS

Area-wide Characteristics

The population in Sealy has been steadily increasing over the study period. Between 1955 and 1970 the annual growth in absolute figures was fairly

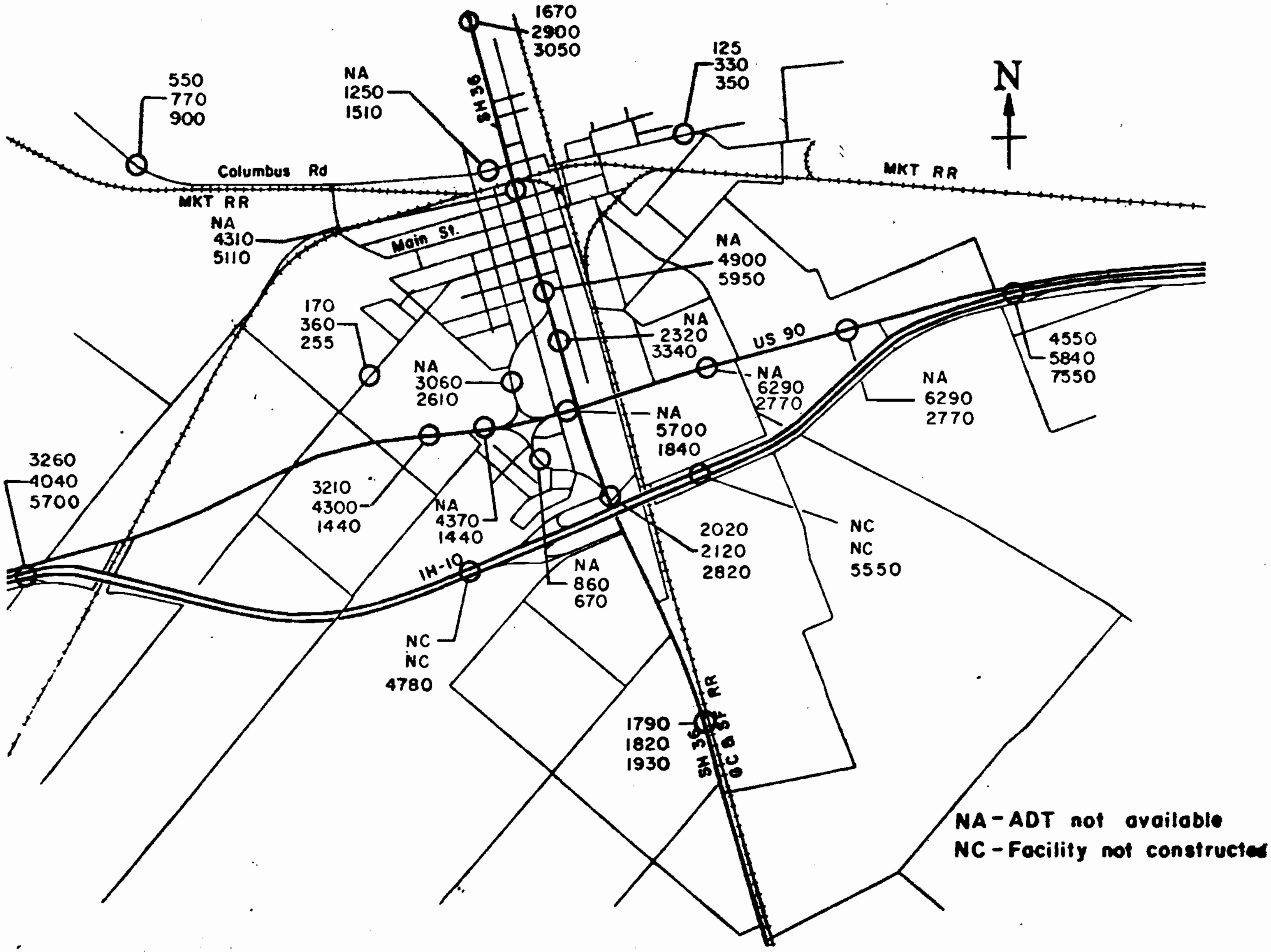


FIGURE 6.1.: TRAFFIC VOLUMES, SEALY
ADT 1956, 1965, 1967

constant, varying slightly around 38 per year. Thus, the growth rate decreased slightly over time. No exact population figures later than 1970 are available. The figures used in this study for 1971, 1972 and 1973 are based on a population forecast made by the Texas Industrial Commission, which is also the source for the population figures for the period 1955 to 1970. Table A6.11 in the Appendix shows the variation in population over the study period in absolute and relative figures.

Rating of the neighborhoods was made by subjective judgement after visual inspection. Studies of aerial photograph from 1960 did not indicate any change in the index for any of the developed areas at that time. For this reason the index for a specific area is kept constant over the entire study period. Figure A6.6 shows the neighborhood indices used in this study. Average land values for all transactions within each neighborhood index group are shown in Table A6.6. There seems to be a general non-linear increase in average land values for index groups 1 to 3, but a drop in values for index group 4. This is probably caused by a higher percentage of unimproved parcels in this group than in the other groups Differences in predominant land use also influence the grand average for each group, but this is not taken into account in Table A6.6.

The index for relative parcel location, which is a part of the composite highway accessibility index, is also based on subjective judgement. This index will usually have different values for a specific parcel in the periods before and after opening of IH 10. The most accessible areas from the inter-urban highway facility are given the score 4, the least accessible the score 1. Maps, aerial photographs and visual inspection have provided the necessary background for the ranking of the areas. The ranking of the different areas before and after the opening of IH 10 is shown on Figure A6.7 in the Appendix. Average land values for each index group are shown in Table A6.12. Except for the highest accessibility group, average values increase with increasing accessibility. Chosen values for the "Street Adjustment Factor," as described in Chapter V, are shown in Figure A6.8 for the different streets and roads in Sealy.

Individual Parcel Characteristics

Most of the community characteristics have to be related directly to each individual parcel. The information gathered includes the absolute location expressed by X and Y coordinates in a defined grid system and the name of the street which the parcel fronts. The coordinates make it possible to plot a picture of the spatial distribution of any information; the identification of front streets makes it possible to analyze those properties which abut certain streets or highways. In order to find the location relative to the CBD-area and transportation facilities, expressed by accessibility indices, absolute street distances have been measured. The base map for the city area and aerial photographs were used to obtain all information about parcel location.

Site quality was mainly determined by means of the base map, showing major sub-divisions and property lines, plats of sub-divisions, and deed descriptions of individual parcels. The average land value for each group ranking by site quality as given in Table A6.13 in the Appendix shows that the value generally increases with an increase in the quality index, as defined in Chapter V.

Information about size and improvement is mainly obtained from deed descriptions, aerial photographs and visual inspection. An improvement is counted as any man-made structure on the parcel which was considered to have had any significant influence on the final sales price. As shown in Table A6.5 there is a very significant difference in average land values for improved and unimproved parcels.

Classification of land use according to the land use definitions in Chapter V is also based on visual inspection and aerial photographs. A majority of the transactions included in this study represent property sold for residential purposes. The most obvious shift in land use is from vacant to residential land use. Average land values for each land-use group are shown in Table A6.14 in the Appendix. As can be seen, agricultural land has the lowest average unit price. The Table gives only average values, and the effect of improvement and other factors is not accounted for.

FOOTNOTES

[1]The figures obtained from the tax assessor's records represent all <u>transfers</u> of ownership, including inheritances, deeds of gift, etc. The figures from the title policies all represent bona fide sales. Thus the percentages are conservative estimates of the actual sample size since the total number of bona fide sales in Sealy is not known.

CHAPTER VII. MODEL SEEKING

Having a data set with a great number of variables, where it is not known whether there exists a linear relationship between the dependent and the independent variables, it is desirable to have a model-seeking technique available. In a case like this, the model may fall in one of two categories:

1) Continuous linear model
2) Binary (discrete) model

Both models have the general form

$$Y = \sum b_i X_i + \epsilon$$

where
- Y = dependent variable
- b_i = coefficient
- X_i = independent (predictor) variable, or function of variables
- ϵ = error term

The difference between the models lies in the determination of the value of the coefficient. While in the continuous linear model "b_i" is a constant applied over the entire space of the predictor, "b_i" in the binary model is a constant only for the values of the predictor falling in subgroup "i". Consequently the binary models avoid the averaging of the effects represented by a particular coefficient.

Even though there probably is not a continuous linear relationship between the dependent variable and the predictor variables in a "real world" problem like variation in land values, it is desirable to use a linear model because it is so much simpler to apply. However,as a tradeoff between the two models, different linear models may be applied on different subgroups of the data set. Each subgroup should be homogeneous as far as possible with respect to the effect of each predictor variable. Consequently, before any linear regression analysis is performed, the entire data set should be examined to show linearity or homogeneous subspaces.

DESCRIPTION OF "THE AUTOMATIC INTERACTION DETECTION (AID) TECHNIQUE"

The AID technique, as described by Gooch,[1] is a model-seeking technique which will reveal the structure of a given data set. Contrary to regression analysis, no specific structure is presumed. The technique implies stepwise one-way analysis-of-variance procedures to find the variables and the levels of value in the dependent variables.

Different levels of the values of each predictor variable have to be specified in advance, and each observation of the predictor falling within the range for a particular level is considered to fall within the same subgroup. Each subgroup may consist of one or more levels of a particular predictor. To split a group into new subgroups the "between groups sum of squares" for all possible combinations of subgroups within that particular group is calculated, and the subgroups which maximize the ratio between the "between groups sum of squares" and "total sum of squares" are formed. Consequently each group is split according to the predictor and the categories (levels) of that particular predictor variable which can explain the most of the unexplained variation in the dependent variable in the original group.

Through this sucessive splitting of the total data set into homogeneous subgroups, the AID-technique reveals the structure of the data in such a way that conclusions can be drawn about the relationship between the different predictor variables. As a visual display of the results, an "AID-tree" showing the splitting into subgroups can be drawn. Figure 7.1 shows the simplified version of the AID-tree for the data set in this study.

RESULT OF AID-ANALYSIS

In order to perform any analysis by means of the AID 4 UT program, each predictor has to be categorized. There are no specific rules for how to categorize the predictors, but as a general guideline five to seven categories should be the maximum. The segmentation of the predictors used in this analysis is shown in Table A7.1 in the Appendix. Because of the nature of some of the predictor values, the recommended number of categories is exceeded for a third

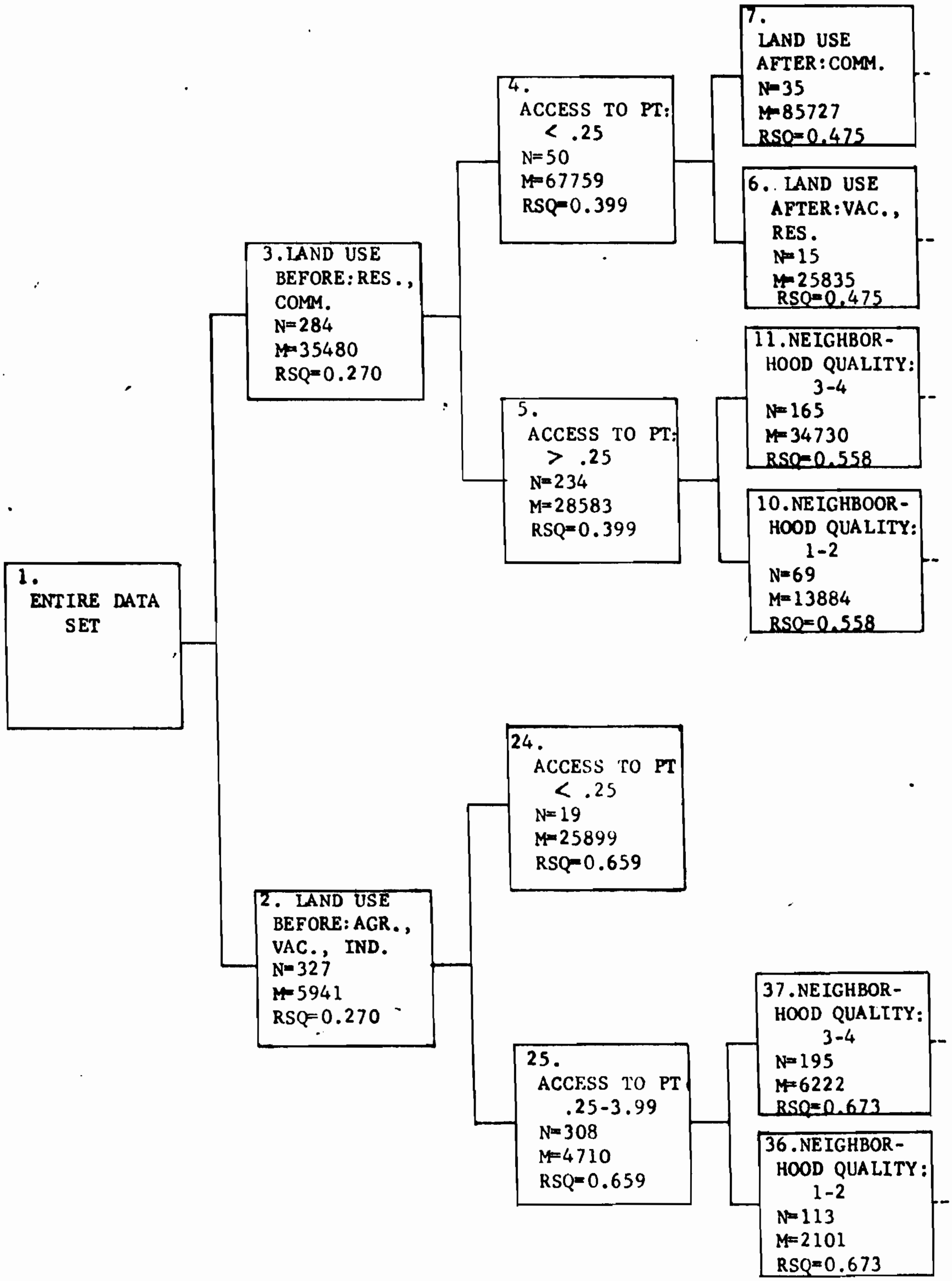


FIGURE 7.1. SIMPLIFIED AID TREE. 611 OBSERVATIONS FOR LAND VALUES IN SEALY

of the predictors. As all of the predictors in the regression analysis will be treated as continuous variables, only monotonic splits of the groups were allowed in the AID-analysis.

As can be seen from Figure 7.1, the data set first splits on the predictor "land use before transaction." From this it can be concluded that land use is the single predictor which can explain most of the variation in land value. The two most significant categories of this variable include 1) public, agricultural, vacant and industrial land use, and 2) residential and commercial land use. While the average land value for the first group is $5,941/acre, the average is $35,480/acre for the second group.

Figure 7.1 also shows a linear interaction between the two predictors "land use before transaction" and "access to public transportation (PT) terminals." As can be seen, both groups of land use split on access to PT, and in both of the splits the smaller values of access to PT constitute the "upper case." Whether the value of access to PT is more or less than 0.25 is the most significant two-group split of this predictor. Consequently the data set indicates a significant drop in land values when distance to PT exceeds 0.2 - 0.3 miles. It should be noted that in this study access to PT in most cases expresses the same relation as access to CBD because of the central location of bus depot and railroad station.

In order to show in detail how each of the two major branches splits further, detailed "trees" are shown in Figures 7.2 and 7.3.

<u>Splits of Group 2; Public, Agricultural, Vacant And Industrial Land Uses</u>
(Figure 7.2)

This branch of the AID-tree shows a linear interaction between the predictors "neighborhood quality" and "access to PT" and also partly between "access to PT" and "time after railroad decrease." No other linear interaction is indicated.

The effect of the predictor "neighborhood quality" as indicated in the split of group 25 is as expected; the higher the ranking, the higher the average land value. This is also the case for "site quality" in the split of group 44. Both groups 36 and 37 split on "access to PT." Even though the categories of the predictor are not exactly the same in the two splits, there is a general

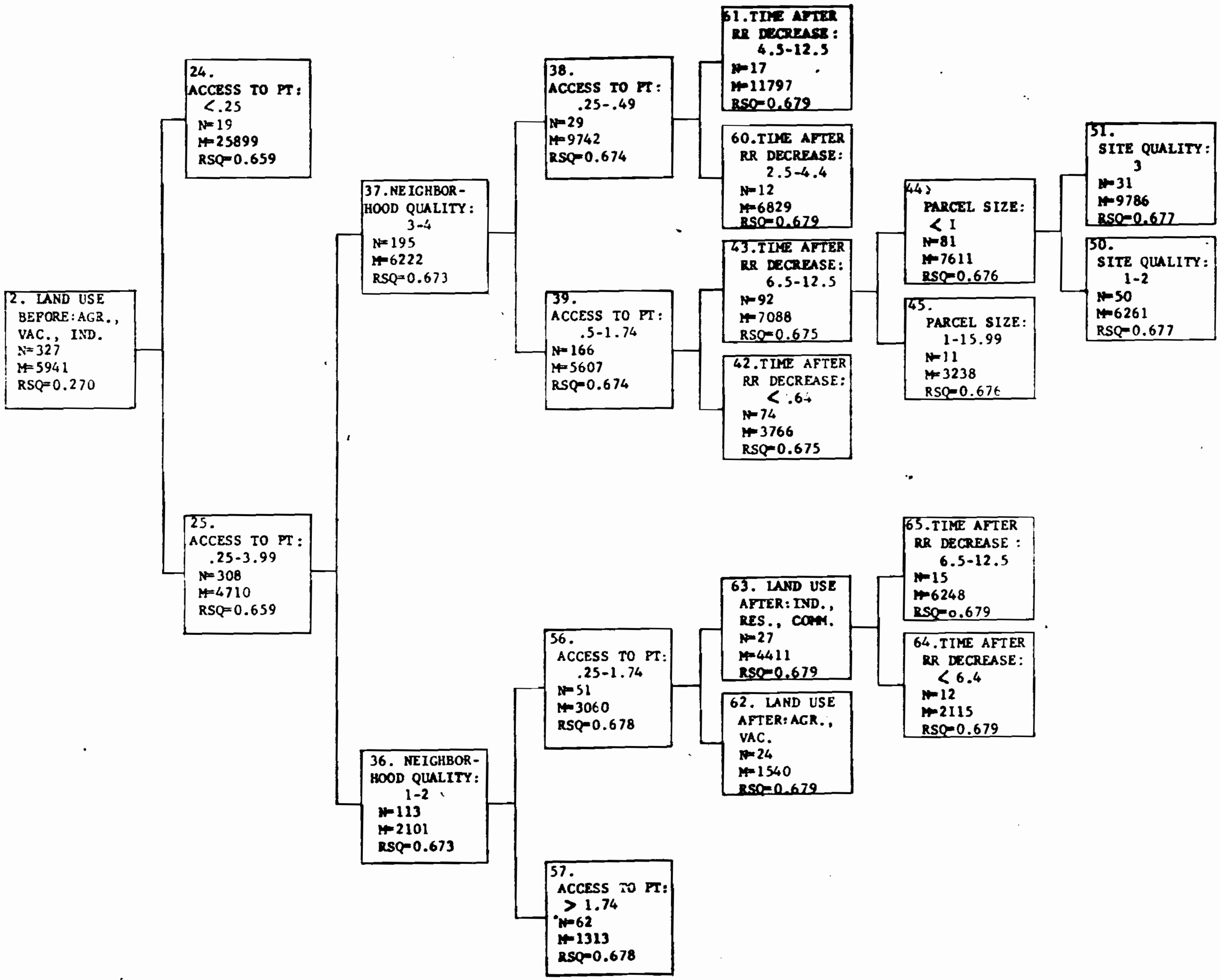


FIGURE 7.2. SPLITTING OF GROUP 2; AGRICULTURAL, VACANT AND INDUSTRIAL LAND USES

decrease in average land value with increasing value for the predictor (i.e., increasing distance to PT). Together with the splits of groups 2 and 3 this indicates a fairly linear effect of the predictor over its entire range.

The splits on "time after railroad decrease" (groups 38,39 and 63) indicate that average land values were higher the longer the elapsed time between the major decrease in railroad services and the date of the transaction. This might indicate that a 4 - 6 year period was needed to recover from a negative effect of the change in quality of railroad services, but the result might also reflect a more general time effect since transactions before 1961 are coded zero instead of being excluded from the group. The split of group 43 on parcel size shows that the critical value of size, in terms of variation in effect from this predictor, is about one acre.

Splits of Group 3: Residential and Commercial Land Use (Figure 7.3)

According to the split from the AID-analysis, there is no continuous linear interaction between the different predictor variables in this part of the tree. Each predictor is split on two different predictors, showing that on different levels of one particular predictor, there is interaction with other predictors. While "land use after transaction" can best explain the difference when "access to PT" is less than 0.25, "neighborhood quality" is at the most significant predictor for further splitting when "access to PT" exceeds 0.25. The split of group 4 shows that land values generally are higher for commercial land use after transaction than for other categories of land use.

Groups 7 and 11 split on "time after highway bypass," and in both groups the upper cases contain an elapsed time period of 4.5 - 6.5 years. It is thus apparent that for the 200 transactions included in groups 7 and 11, there has been a significant increase in land values during the two last years. It is not possible to draw any conclusions about the transactions which took place between 1967, the year the by-pass opened, and 1971 because the lower cases include all transactions between 1955 and 1971 in one group. Two groups, 8 and 16, split on "site quality." As expected, in both cases a site quality ranking of 3 constitutes the upper case, indicating that the better the site quality, the higher the land value.

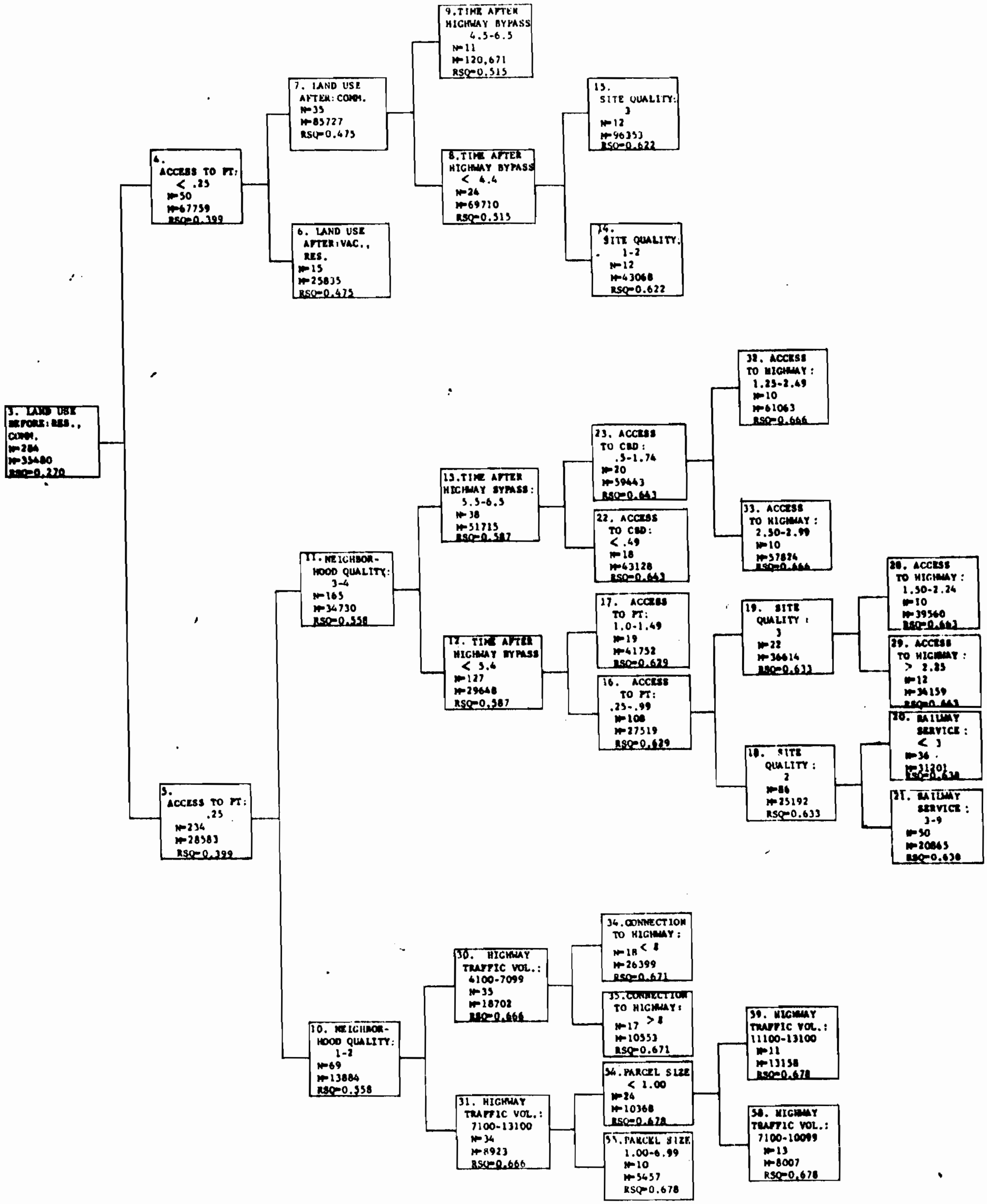


FIGURE 7.3. SPLITTING OF GROUP 3; RESIDENTIAL AND COMMERCIAL LAND USES

Also expected is the effect of neighborhood quality as shown in the split of group 5, where the average land value for ratings 3 and 4 is significantly higher than for ratings 1 and 2.

A very special effect of access to PT is shown on the transactions in group 12. For some not readily explainable reason, average land values are lower when the predictor variable falls between 0.25 and 0.99 than for greater values. The same effect is also reflected in the split of group 13 on "access to CBD." The only plausible reason for this phenomenon is that most of the new development in Sealy during the last two decades has taken place in the central areas and in the outskirts of the city. While the effect of "highway traffic volume" is unclear due to the different splits of groups 10 and 54, the effect of the predictor "access to highway" seems to be quite contrary to what should be expected. The relatively small number of transactions in groups 19 and 23 may be a contributing reason, but it is more reasonable to assume that the index as evaluated in Chapter V may not fully describe accessibility to the highway. Also the split of group 18 on "railraod service index," indicating decreasing land values with increasing quality of the railroad service provided, is very suspicious, but not readily explainable.

CONCLUSION OF AID-ANALYSIS

The structure of the data set, as revealed by the AID-analysis, shows that there is no simple overall relationship between land value expressed as a unit price and the different factors assumed to influence it. As long as the sample of land transactions is considered to be valid, this indicates either that there is a very complex interaction between the predictors or that some important factors are not included in the analysis.

Even though the analysis indicates linear interaction between some predictors, the overall relationship between the predictors is non-linear in character. A linear interaction between land use before the transaction and access to PT is present over the entire data set. In addition, access to PT has a linear interaction with neighborhood quality in two major subgroups (groups 5 and 25), including 92 percent of the observations. This leads to the conclusion that land use before, access to PT and neighborhood quality are the only predictors between which there is a linear interaction. The interaction between all other combinations of predictors is of non-linear character. Consequently it can be assumed that one general linear model cannot describe the variation in land values with a reasonable degree of accuracy. In a case like this, a binary model would be more appropriate.

The AID-tree gives an indication of how the subgroups in a binary model could be defined. However, before subgroups are defined, the eventual effect of the rather arbitrarily chosen categories of the predictors should be examined. A binary model according to the split from the performed AID-analysis would not be able to explain more than about 68 percent of the total variation in land value. The correlation coefficient (R^2) is rather low, indicating that a substantial part of the variation in the sample of land transactions cannot be explained by the predictor variables included in this study.

The low expected value of R^2 for a binary model, and the indication of some linear effect, makes it reasonable to concentrate the modeling effort on linear models in order to simplify the model. As a tradeoff, linear models for different major subgroups may be examined. However, because of lack of homogeneity within the major subgroups, this is not expected to increase R^2 very much, but the absolute value of the residuals will be reduced.

The AID-analysis fails to show clearly the structures of possible linear regression models. It is obvious that configural terms of the variables will have to be included, but the form of these terms is not evident. Consequently the value of the AID-analysis for the further model evaluation in this case is somewhat limited. The major advantage of the AID-analysis is therefore the visual display of the structure of the data set, which reveals the characteristics of the effect of the different levels of the many predictors.

FOOTNOTES

[1]For a detailed description of the "Automatic Interaction Detection Technique," see Lawrence Lee Gooch, "Policy Capturing with Local Models: The Application of the AID Technique in Modeling Judgement," Dissertation, University of Texas at Austin.

CHAPTER VIII. REGRESSION ANALYSIS

DESCRIPTION OF STEP-01

The Step-01 program package is used to test possible regression models. STEP-01 performs stepwise linear regression. For each step one new variable may be added to the regression equation, or one variable already entered dropped from the equation, depending on partial F-test[1] of each individual independent variable. In order to enter, the F-value for a particular variable must exceed a specified level. If the partial F-value for any of the variables already entered on any step decreases below a specified level, this particular variable is removed from the equation. The partial F-test is performed in order to assure that the coefficient for the variable is significantly different from zero. Based on judgement alone, the F-level used for inclusion or removal of the variable was set at a level of 2.0 in this study.

Two major criteria are commonly used when evaluating a regression model; the coefficient of correlation, R^2,[2] and the coefficient of variation, C.V.[3]. Both of these are usually expressed in percent. The coefficient of correlation is calculated from the formula

$$R^2 = \left(\frac{\text{sum of squares due to regression}}{\text{total sum of squares about the mean}} \right).$$

R^2 expresses how much of the total variation in the dependent variable (in this study, land values) is explained by the regression model and is a measure of how successful the regression model is. R^2 will vary between 0% and 100%, and the closer R^2 is to 100% the better the regression equation is. The coefficient of variation is the ratio between a standard deviation and a corresponding mean value. In this study this coefficient expresses the relative accuracy with which the model can describe the land value of each parcel included in the study.

TEST OF POSSIBLE MODELS

According to the results from the AID-analysis, local models should possibly be evaluated for major subgroups of the data set. For this reason five different data groups are analyzed individually:

1. The entire data set, 611 observations (denoted R).
2. Improved parcels, 306 observations (denoted I).
3. Unimproved parcels, 305 observations (denoted U).
4. Residential and commercial land use, 284 observations (denoted RC).
5. Agricultural, public, vacant and industrial land use, 327 observations (denoted AV).

Different models were tested for each data group in order to find the best model to describe variation in land value. The great number of independent variables makes it possible to include an almost infinite number of cross-product terms in the analysis, and the final models are a result of trial and error testing of possible combinations of the individual variables.

Main Effect Models

As a first effort, a model including all variables in the first power was tested. The correlation between dependent and independent variables for each of the data groups is shown in Table A8.1 in the appendix, together with the correlation matrix model R6, Table A8.2. The summary table shows mainly that the correlation coefficients of the individual variables do not vary much for the different data groups. Because of interaction between the different predictor variables, it is difficult to draw any conclusion about the relative importance and the cause/effect relationship of each variable.

A summary of the best regression models for each data group is given in Table 8.1. As can be seen, the variance in land value cannot be satisfactorily described in a first order model. With a R^2 varying from 33 to 45 percent, and a coefficient of variation as high as 108 percent, all of these models are unacceptable for descriptive purposes.

Configural Effect Models

The characteristics of the predictor variables as revealed in the AID-analysis were helpful in determining the form of the cross-product terms to be included in the regression models. These models were evaluated by a stepwise adding and deleting of terms in the regression models. Table A8.3 in the Appendix shows which variables were included in cross-product terms, but the actual form and power of these terms varied in the different models. Generally

TABLE 8.1

SUMMARY OF REGRESSION ANALYSIS

	Model	Sample		Regression Model		
		Mean	Standard Deviation	R^2 Percent	C.V. Percent	No. of Variables
	R 1	19672	28375	45.13	108.1	14
Main	I 1	33058	32515	32.80	81.4	5
Effects	U 1	5614	6596	37.49	94.2	8
Models	R C 1	35707	34874	38.48	77.5	6
	A V 1	5864	7284	39.32	98.2	8
	R 6	19672	28375	70.45	79.5	17
Configural	I 4	33058	32515	63.83	60.2	11
Effect	U 4	5614	6596	74.97	59.6	9
Models	R C 6	35707	34874	62.88	60.8	11
	A V 6	5864	7284	79.32	58.1	17
Configural Effect Models, Reduced Data sets *	R 6 - 3	14530	18947	87.31	47.6	25
	I 5 - 3	28402	24498	79.27	40.3	13
	U 5 - 3	4676	5229	93.70	28.6	10

*Reduced data set contains 90% of the original data set.

cross-product terms including land use before transaction, improvement, access to PT, site quality and neighborhood quality proved to be of importance in the regression equation.

Tables A8.4 - A8.8 show the best regression model reached for each data group. A summary of each regression model is given in Table 8.1. Generally, it can be said that the introduction of cross-product terms improved the models considerably. Except for a few single variables, these terms dominate in the resulting regression models. Local models improved the most, as was expected because of the nonlinear interaction between the independent variables.

EVALUATION OF BEST MODEL(S)

The evaluation of the "best" model is mainly based on comparisons of the coefficient of correlation and the coefficient of variation for each model. For practical reasons, however, it is also important to keep the model as simple as possible. Consequently a simpler model might be considered the "best" model even though R^2 and C.V. might not be quite as good as for a very complex model.

Comparisons between Models.

In this case the choice of model(s) includes three possibilities:

1. The R model alone;
2. The I and U models (two local models, one for improved and one for unimproved parcels); and,
3. The RC and AV models (two local models, one for residential and commercial land uses, and one for agricultural, vacant and industrial land uses).

In order to find the best descriptive model(s) for land values the three possibilities must be compared in terms of accuracy and simplicity. The procedure used is a comparison of the two sets of local models, and then a comparison of the best two local models and the single model, R.

Comparing the two sets of local models it is apparent from Table 8.1 that there is not much difference in terms of R^2 and C.V. The AV model has a R^2 of 79.3%, and can explain 4.3% more of the variance in land values than can the U model. The coefficient of variance is also slightly better for the AV model. Comparing the RC and I models, it can be seen that they have practically the same R^2 and C.V. However, the RC and AV models include 17 and 11 terms of variables, while the I and U models on the other hand include 9 and 11 terms of variables. Consequently the I and U models are the simplest of the two sets of local models. Because of the low degree of accuracy (high C.V.) in both sets, the difference in R^2 is of little importance. Thus the I and U models are considered to constitute the best set of local models.

Comparing the R model to the I and U models, the R^2 (70.5%) for the R-model might be considered equivalent to or better than the R^2's for the I and U models. However, while the C.V. for the local models lie around 60%, the C.V. for the R-model is 79.5%. All of these C.V. values are much higher than desirable, and this might reduce the importance of this measure of value. The R model scores high in simplicity in terms of being one model instead of two different models for two categories of parcels, but it is rather complex in its inclusion of 17 term variables.

Consequently the regression analysis reveals both advantages and disadvantages with one single model compared to two local models, and the choice has to be based on a subjective judgement. Since the overall purpose of this project is to evaluate the impact on the community of changes in transportation system, it is desirable that the model(s) indicate whether different factors have different influences on different categories of properties. In this respect a set of two local models may be preferable.

The Best Set of Descriptive Models.

As a conclusion of this evaluation of the regression models, the two local models (I4 and U4) are considered the best models to describe the variation in land values in this study.

The best model for improved parcels has the form:

Unit land value Y [1)] = 15892.29

- 7274.74 · (land use after)
- 5188.39 · (time after bypass completed)
+ 185.28 · (land use before/parcel size)
+ 0.80894 · (land use after · traffic volume)
+ 681.33 · (land use after/access to PT)
+ 0.44335 · (access to highway · traffic volume)
+ 2651.62 · $(\text{neighborhood quality})^2$
+ 19382.36 · $\log_{10}$ (1/ parcel size)
- 13647.91 · $\log_{10} (\text{land use after/access to PT})^2$
+ 81.92 · $(\text{land use before} \cdot \text{site quality})^2$

The best model for unimproved parcels has the form:

Unit land value $Y^{1)}$ = - 17168.16

$$
\begin{aligned}
&+ 136.47 \cdot \text{(time when transaction took place)} \\
&+ 3198.27 \cdot \text{(site quality)} \\
&+ 263.03 \cdot \text{(land use after/access to PT)} \\
&- 106.21 \cdot \text{(access to highway)}^2 \\
&+ 156.86 \cdot \text{(neighborhood quality)}^2 \\
&- 23.359 \cdot \text{(land use before)}^3 \\
&+ 666.70 \cdot \text{(1 / parcel size)} \\
&+ 1309.13 \cdot \text{(1 / access to PT)} \\
&+ 12.337 \cdot \frac{\text{(access to highway)}^3 \cdot \text{traffic volume}}{\text{(connection to SMSA)}^2}
\end{aligned}
$$

---

1) Unit price in constant dollars, base 1950, and "time" as number of years after 1900 with decimal fraction (i.e. 66.5).

EXAMINING THE BEST MODELS

The coefficients of variation are much higher than should be expected from regression models with an R^2 value of 64% - 75%. If a small number of the observations contain values out of the normal range, the model may not be able to describe the land value for these observations with any reasonable degree of accuracy. Thus a few observations may have a significant influence on the coefficient of variation.

A number of extreme observations in the order of 10 percent of the total data set, were removed from the analysis, and the old regression models were tested on the reduced data set. The new models are shown in Table A8.9 - A8.11 in the Appendix. As the summary table in Table 8.1 shows, the removal had a very significant effect upon the R^2 and C.V. Generally R^2 increased 17% and C.V. was reduced 20% - 30%. A further examination shows that the average land value for these observations is higher than the average for the rest of the data set. No reason, however, was found to judge these observations as invalid. It is therefore concluded that the models based on the entire data set should be considered the best models.

Other land value studies also show a very high coefficient of variation. A modeling effort based on a limited number of transactions of parcels abutting a highway shows values of the coefficient of variation in the range of 110% or more.[4] Consequently the reduction to the range of 60% for the C.V. in this study may be considered a further step in evaluating a reliable technique to describe influence on land values of changes in the transportation system.

INTERPRETATION OF RESULTS

The regression analysis show that the variation in land values can be described by functions of factors related to transportation system and community characteristics. The regression models should not, however, be used to draw any conclusion about the cause/effect relationship between the different factors. Because of the non-linear interaction between the factors, cause/effect relationship cannot be revealed in a linear model. Consequently no conclusion should be drawn based on the sign or the size of the coefficient for each term of variables.

The analysis shows that it is possible to describe changes in the trend of land values over time and the spatial distribution of land values by a certain number of factors related to the transportation system and the community itself. The F-to-remove-value in the regression equation gives an indication of the relative importance of the terms included, but because of correlation between the terms this cannot be used to calculate how much of the total R^2 is caused by each individual term. The single factor which alone can explain most of the variance in land value for improved lots is "land use before/parcel size," giving an R^2 of 37.7%. For unimproved parcels the term "land use after/access to PT," when used alone, can explain 49.7% of the variance in land value. This indicates a difference in importance of land use for improved and unimproved parcels. While existing land use seems to be the most important for improved parcels, the potential for future use seems to be the most important when determining land value of unimproved parcels.

According to the best models, only 10 different factors have to be recorded in order to describe variation in land values. These factors to be recorded for each transaction are:

- Time when transaction took place,
- Land use before transaction,
- Land use after transaction,
- Parcel size,

Site quality index,

Neighborhood quality index,

Access to public transportation terminals,

Access to interurban highway route,

Traffic volumes on interurban highway, and

Time after completion of bypass route.

It cannot be said that these are the only factors that have to be recorded in other studies of land values, but it seems to be clear that the number of factors to be recorded can be reduced. However, the large coefficient of variance might indicate that one (or more) important factors need be included in the analysis.

Because of the large coefficient of variation in the models, they should not be used to describe any single transaction. The result from this study, however, indicates that as the technique is further refined, descriptive models can possibly be used to describe individual parcels with a desired degree of accuracy.

FOOTNOTES

[1] For a detailed discussion of the F-test, see Norman Draper and Harry Smith, "Applied Regression Analysis," p. 119, John Wiley & Sons, Inc., New York, 1966.

[2] For more details about the coefficient of correlation, R^2, see Norman Draper and Harry Smith, "Applied Regression Analysis" p. 117.

[3] An explanation of the coefficient of variation can be found in Irwin Miller and John E. Freund, "Probability and Statistics for Engineers" p.119, Prentice Hall, Inc., Englewood Cliffs, New Jersey, 1965.

[4] See tables 5 to 24 of Edward I. Isibor, "Modeling the Impact of Highway Improvement on the Value of Adjacent Land Parcels," Joint Highway Research Project, Purdue University, 1969.

CHAPTER IX. CONCLUSIONS AND RECOMMENDATIONS

SUMMARY AND CONCLUSIONS

In previous years, major transportation decisions have been based mainly on analysis of user benefits. Recently, however, transportation planners have increasingly recognized the importance of the impact of transportation changes on non-users and on the surrounding environment. It is also realized that changes in interurban transportation systems might have a determining influence on the growth and development pattern of small rural communities located in the vicinity of these facilities. The overall objective of this research project is to provide insight into the influence of transportation development on such rural communities and to provide a rationale for future transportation decision-making. Accomplishment of this objective will assist the residents of rural communities, particularly their decision makers, in evaluating the consequences of changes in the transportation system, and will also be of value to state and regional governments in the planning process.

This report deals with only one of the many facets of transportation impact: the impact of transportation on land values. The aim is to develop and evaluate a model which can be used to describe the variation in land values caused by changes in the transportation system. Realizing that the effect also depends on characteristics of the community itself, the model was structured to include community characteristics as well as transportation system characteristics.

Previous studies have shown that there is an effect of highway improvement on the value of adjacent land parcels. However, relatively few of the previous studies have been aimed at showing a cause/effect relationship between land values and changes in the transportation system. Since most of the studies have been limited to examining land values in the vicinity of the transportation facility, they have not described the effect on the entire community. Another major shortcoming with most of the previous impact studies is that they have been based on the assumption that transportation-related effects can be identified and disassociated from the effect of other factors.

The methodology chosen for this particular study differs from the previous studies in several ways:

1. All transportation modes serving the community are included;
2. The entire community area is surveyed and examined;
3. The study period is long enough to include important changes in both the transportation system and the community; and,
4. No presumption is made that transportation effects can be isolated.

The basic assumption in this study is that the value (expressed in dollars per acre) of an individual parcel may be described as a function of the transportation system characteristics, community characteristics, and time. The evaluation of the model includes four major tasks:

1. Selection of those factors which should be included in the study;
2. Evaluation of ways to measure them;
3. Testing which factors had a significant impact on the variation in land value; and,
4. Determination of the final form of the model.

While the first and second tasks were of general character, a case study of land values obtained from land transactions in Sealy, Texas, was used for statistical testing of a proposed model. A total of 21 variables were included in the analysis. The following variables were included for each transaction:

Time when transaction took place.
Size of the parcel.
Improvements on the parcel.
Land use before the transaction.
Land use after the transaction.
Site quality index.
Accessibility to CBD-area.
Accessibility to public transportation terminals.
Accessibility to interurban highway route.
Neighborhood quality index.
Quality index for highway route.
Traffic volumes on highway route.
Rail service index.
Local traffic conditions.

Connection between Sealy and the highway route.

Connection between Sealy and Houston.

Population growth factor.

Time elapsed after designation of the bypass route.

Time elapsed after purchase of the right-of-way.

Time elapsed after major reduction in rail services.

Time elapsed after completion of bypass route.

Since several of the factors describe qualitative characteristics, indices were developed for classifying or grading these factors into qualitative levels. Generally, this procedure seemed to be useful in explaining certain variations in land values. Procedures for describing quantifiable characteristics were also evaluated, usually in the form of indices. It was not possible to go into depth in the evaluation of these indices, and the techniques probably need to be further refined. Indices such as "connection to interurban highway," "interurban highway quality," "connection to nearest SMSA," "railroad service index," and "local traffic conditions" were not fully evaluated in the case study phase. Techniques for testing the variables and possible models included model-seeking and regression analysis. Program packages under the names of AID 4UT and STEP01 that were available at the University of Texas at Austin Computation Center were used for the statistical analyses.

This study has shown that the basis for establishing land values is very important. Previous studies have also found that the tax assessor's records generally do not provide adequate information about real market values of real estate. Market value should be established from actual sales. One possible way to obtain a sample of sales prices might be through local title insurance companies as was the case in this study.

In this case study, sales price reflected the total property value including both land and buildings. No appropriate technique to separate the value of the improvements from the value of the land was found; consequently, the unit land value analyzed in this study includes both. Analysis of improved versus unimproved parcels, however, showed that a linear relationship between land value for improved and unimproved parcels existed in the case study of Sealy, Texas. However, research to develop a technique for a classification of the worth of improvements seems to be necessary in order to refine the descriptive models for land values. In determining the other factors related to each transaction (e.g., size, location, accessibility, land use) information sources such as deed descriptions, aerial photographs, plats and back issues of the local phone directory have proven valuable.

The study has shown that the variation in land values can probably be described by a limited number of factors. The best descriptive models for land values in Sealy as found from this case study contain 10 of the predictor variables included in the analysis. These factors are:

Time when transaction took place.
Land use before the transaction.
Land use after transaction.
Size of the parcel.
Site quality index.
Neighborhood quality index.
Accessibility to public transportation terminals.
Accessibility to interurban highway route.
Traffic volumes on interurban highway.
Time elapsed after completion of bypass.

The case study indicates that the number of variables can perhaps be reduced in future studies without significant effect on the model. In the general study phase, however, a rather large number should probably be included in order to reveal any deficiencies in this limited study.

Because of the complexity of the relationship between all the factors that influence land values, a model-seeking technique was used to reveal the possible structures included in the data set. The "Automatic Interaction Detection" (AID) technique proved useful in showing the interaction between the variables included in the analysis and in defining homogeneous subspaces of the data. The analysis of land values in Sealy showed that, with a few exceptions, there was a non-linear interaction between the predictor variables. The study indicated that a binary model was preferable to a general linear model. As a trade off, local models for homogeneous subspaces of the data set were used in the case study.

A stepwise regression technique was used to test possible models for describing land values. Two models, one for improved and one for unimproved parcels, were found to be the best procedure for describing land values in an entire community. The models explained 63.8% of the variation in the land value (ie. R^2 63.8%) with a coefficient of variation, C.V., of 60.2% for improved parcels, and corresponding R^2 = 75.0% and C.V. = 59.6% for unimproved parcels.

The difference in R^2 for the two models might be rooted in the fact that the quality of the improvements was not included. No explanation for the high coefficient of variation is offered. The analysis might possibly indicate that significant predictor variables were missing in this study. Because of the lack of appropriate techniques to describe economic, political, and social conditions in the community, such factors were not included at this point. Future phases in the overall research project will evaluate these conditions for use in the analysis.

The models developed from the case study do not adequately explain the complex cause/effect relationship that exists between land values and changes in transportation systems. However, the analysis shows which factors were the most important in describing the variation in a sample of land values in Sealy. The most important factors found in this study were land use before and after the transaction, size of the parcel, access to the central area (CBD and public transportation terminals), site quality index, neighborhood quality index, access to the interurban highway, and traffic volume.

Even though the accuracy with which the value of an individual parcel of land was described is lower than desired, this case study shows that it is possible to model the variation in land values in an entire community and over a substantial period of time which includes major changes in the transportation system. This study might be considered a first step towards the development of a model which can describe land values in a rural community with an acceptable degree of accuracy. Inclusion of other appropriate factors and further refinement of the techniques will possibly lead to the development of a reliable predictive model.

RECOMMENDATIONS FOR FURTHER RESEARCH

A substantial data base was gathered in this study, and it is readily available for further analysis. Further research on this data base will include sensitivity analysis of the predictor variables and more complete analysis of the spatial variation within the community. The stored information may be analyzed to reveal possible differences in the variation in land values between zones, land use categories, location along the interurban highway versus other locations, and land ownership.

In the general study phase, major emphasis of the land value studies should be given to three subjects:

1. Further refinement of the techniques to describe quantitative and qualitative predictor variables already included in the analysis.
2. Development of a technique to separate the value of land and improvements or possibly to classify the quality of the improvement.
3. Development of a technique to include economic, political, social and ownership characteristics in the analysis.

On a state or nation-wide level, an effort should be made to create a data bank where all gathered information can be stored and made available for research teams and governmental agencies. The first step would be to develop general methodologies for data gathering and establish structures for the data bases in order to assure comparability between the different studies. Ideally this will facilitate future research efforts and provide sufficient data to enhance other programs such as land use planning and policy development.

APPENDIX I. TABLES

TABLE A5.1

CONSUMER PRICE INDEX
1950 - 1974

HOUSTON AREA

BASE YEAR 1950

Year	CPI	Year	CPI
1950	100.0	1962	122.0
1950.5	104.0	1962.5	122.6
1951	108.0	1963	123.2
1951.5	108.7	1963.5	124.2
1952	109.3	1964	125.1
1952.5	110.0	1964.5	125.8
1953	110.7	1965	126.6
1953.5	110.7	1965.5	128.4
1954	110.6	1966	130.2
1954.5	110.3	1966.5	131.8
1955	109.9	1967	133.5
1955.5	110.8	1967.5	136.4
1956	111.6	1968	139.3
1956.5	113.4	1968.5	143.8
1957	115.1	1969	148.2
1957.5	116.1	1969.5	152.1
1958	117.1	1970	155.9
1958.5	117.6	1970.5	158.4
1959	118.0	1971	161.0
1959.5	118.6	1971.5	163.9
1960	119.1	1972	166.8
1960.5	119.5	1972.5	171.1
1961	119.8	1973	175.4*)
1961.5	120.9	1973.5	

*) Not enough information to split into half-year periods.

TABLE A6.1

LAND TRANSFERS RECORDED BY COUNTY TAX ASSESSOR

AND

LAND SALES RECORDED BY

BELLVILLE ABSTRACT AND TITLE INSURANCE COMPANY

IN CERTAIN SUBDIVISIONS IN SEALY

Subdivision	Original Owners, 1955	Number of Transfers and Transactions*					
		1955 - 59		1960 - 64		1965 - 70	
		CTA	BAT	CTA	BAT	CTA	BAT
Sealy Town Site (CBD)	86	31	0	12	10	34	16
Sealy Town Site (West)	†	11	1	27	9	45	13
West End Addn.	92	26	4	27	8	47	29
South End Addn.	103	38	5	31	5	56	25
S. E. Subdivision	40	37	5	33	6	55	25
Don Ell Krampitz	1	-	-	19	5	41	17
Carolyn Meadows	1	-	-	13	8	11	10
		143	15	162	51	289	135

*CTA = County Tax Assessor

BAT = Bellville Abstract and Title Insurance Company

†Not determined

TABLE A6.2

YEARLY DISTRIBUTION OF THE TRANSACTIONS INCLUDED IN THE STUDY, AND AVERAGE LAND VALUES

Year	Number of Transactions	Average Land Value for all Transactions ($/acre)*
1955	4	15507
1956	10	6022
1957	9	15623
1958	5	22426
1959	11	7434
1960	15	18227
1961	20	7800
1962	12	15023
1963	26	12433
1964	30	11603
1965	34	13451
1966	49	25031
1967	45	19936
1968	45	18777
1969	38	17082
1970	55	19159
1971	70	16925
1972	67	29264
1973	66	30172

* Constant dollars, base year = 1950.

TABLE A6.3

NUMBER OF TRANSACTIONS AND AVERAGE LAND VALUES PER TIME PERIOD AND LAND USE GROUP

Land Use Before	1955 - 1959		1960 - 1964		1965 - 1969		1970 - 1973	
Group	No.	Average Land Value	No.	Average Land Value	No.	Average Land Value	No.	Average Land Value
Public	0	-	0	-	1	34777	0	-
Agricultural	6	1651	12	552	17	2031	31	1296
Vacant	15	3762	52	5456	95	6325	91	8017
Industrial	0	-	0	-	5	17089	2	24475
Residential	15	19544	26	21230	81	28463	108	31021
Non-Hwy. Commercial	0	-	9	30360	9	83163	23	83210
Hwy. Commercial	3	33756	4	41381	3	88485	3	35934

Land value = Constant dollars, (base 1950) per acre.

TABLE A6.4

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUES AND STANDARD DEVIATION FOR DIFFERENT TIME PERIODS

	All Transactions		Unimproved Parcels			Improved Parcels		
Time Period	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
55-59	39	11814	20	3272	1996	19	20806	UV
60-64	103	12437	62	4668	6802	41	42187	UV
65-70	211	19313	110	5765	6849	101	34069	UV
71-73	258	23995	113	6315	6584	145	37772	UV

UV: Undefined Value," System 2K. "
Land values in constant dollars (base 1950) per acre.

TABLE A6.5

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER ZONE, AND FOR TOTAL AREA

	All Transactions		Unimproved Parcels			Improved Parcels		
Zone	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	78	13540	42	4817	5352	36	23716	UV
2	148	18363	77	7327	3321	71	30331	UV
3	50	69711	9	29899	6729	41	78450	UV
4	49	7212	22	2096	2646	27	11200	9703
5	113	20896	48	66258	7779	65	31705	UV
6	76	22969	42	5342	2731	34	44744	UV
7	57	3829	36	1707	3486	21	7468	8481
8	40	1864	29	1201	915	11	3611	3218
Total Area	611	19652	305	5583		306	33676	

UV: Undefined,"System 2K"
Land value in constant dollars (base 1950) per acre.

TABLE A6.6

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER NEIGHBORHOOD RANKING GROUP

Neighborhood Quality Index	All Transactions		Unimproved Parcels			Improved Parcels		
	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	33	4221	16	1399	969	17	6876	3695
2	195	20157	96	4600	8339	99	35278	UV
3	331	21543	147	6034	UV	184	33934	UV
4	52	15449	46	7646	1687	6	75268	UV

UV: Undefined Value,"System 2K"

Land value in constant dollars (base 1950) per acre.

TABLE A6.7
COMPLETION OF IH-10
SAN ANTONIO - HOUSTON

Year	Miles Completed	Cummulative Miles Completed	Cummulative Degree of Completion	Cities Not Bypassed
1955	12.1	12.1	0.065	10
1956	-	12.1	0.065	10
1957	-	12.1	0.065	10
1958	-	12.1	0.065	10
1959	4.8	16.9	0.091	10
1960	-	16.9	0.091	10
1961	-	16.9	0.091	10
1962	17.8	34.7	0.187	10
1963	-	34.7	0.187	10
1964	10.5	45.2	0.244	9
1965	-	45.2	0.244	9
1966	30.7	75.9	0.410	9
1967	21.0	96.9	0.523	6
1968	13.9	110.8	0.599	5
1969	16.4	127.2	0.688	3
1970	6.4	133.6	0.723	3
1971	26.3	159.9	0.865	2
1972	24.8	184.7	1.000	0
1973	-	184.7	1.000	0

TABLE A6.8

AREAWIDE VARIABLES

LAND VALUE STUDY, SEALY

	Variable						
Year	Quality Index of Interurban Highway	Highway Use	Rail Service Index	Connection to Highway	Connection to Houston	Population Growth	Local Traffic Conditions
1955	0.253	3320	10	9.5	46	1.86	2
1956	0.253	3220	10	9.5	46	1.83	2
1957	0.253	3170	7	9.5	45	1.80	2
1958	0.253	3140	5	9.5	45	1.76	2
1959	0.264	3100	5	9.5	44	1.73	2
1960	0.264	3130	5	9.5	44	1.66	2
1961	0.264	3170	3	9.5	43	1.59	1
1962	0.318	3210	3	9.5	42	1.40	1
1963	03.18	3370	3	9.5	42	1.38	1
1964	0.355	3540	3	9.5	41	1.40	1
1965	0.355	3710	3	9.5	41	1.43	1
1966	0.453	4550	3	9.5	40	1.44	1
1967	0.556	5450	3	5.5	40	1.42	3
1968	0.622	6250	3	5.5	34	1.44	3
1969	0.713	7050	1	5.5	36	1.46	3
1970	0.703	7890	1	5.5	34	1.44	3
1971	0.845	9780	1	5.5	33	1.69*	3
1972	0.900	11660	1	5.5	32	1.46*	3
1973	0.900	13550	1	5.5	33	1.71*	3

* Population Growth Projected

TABLE A6.9

BUS SERVICES, SEALY (1973)

Kerrville/Greyhound

Route: Houston - Austin

To Austin	To Houston
10:10 AM	9:55 AM
5:15 PM	3:50 PM
8:10 PM	9:35 PM

Continental

Route: Houston - San Antonio

To San Antonio	To Houston
11:35 AM	1:08 PM
8:10 PM	11:23 PM

Central

Route: Galveston - Waco

To Waco	To Galveston
1:35 PM	4:35 PM

Note: No express bus stops in Sealy.

TABLE A6.10

RAILWAY SERVICES, SEALY *)

NUMBER OF DAILY STOPS (EACH DIRECTION), AND SERVICE INDEX

	Type of Service		Railway
Year	Passenger **)	Freight	Service Index
1955	4	2	10
1956	4	2	10
1957	3	1	7
1958	2	1	5
1959	2	1	5
1960	2	1	5
1961	1	1	3
1962	1	1	3
1963	1	1	3
1964	1	1	3
1965	1	1	3
1966	1	1	3
1967	1	1	3
1968	1	1	3
1969	-	1	1
1970	-	1	1
1971	-	1	1
1972	-	1	1
1973	-	1	1

*) Information mainly from "Official Guide of the Railways", and local newspaper.

**) Sante Fe Routes:
Sealy - Matagorda (passenger and freight) until 1957
Houston - Clovis - California (passenger) until 1969
Houston - Brownwood (passenger) until 1969
Missouri, Kansas, and Texas RR ("KATY") Routes:
Dallas/Ft. Worth - Houston (passenger) until 1958

TABLE A6.11

POPULATION GROWTH IN SEALY

Year	Population *)	Absolute Population Growth **)	Population Growth Rate **)
1950	1942	-	-
1954	2095	-	-
1955	2134	39	1.86
1956	2173	39	1.83
1957	2212	39	1.80
1958	2251	39	1.76
1959	2290	39	1.73
1960	2328	38	1.66
1961	2365	37	1.59
1962	2398	33	1.40
1963	2431	33	1.38
1964	2465	34	1.40
1965	2500	35	1.43
1966	2536	36	1.44
1967	3572	36	1.42
1968	2609	37	1.44
1969	2647	38	1.46
1970	2685	38	1.44
1971	2730	45	1.69
1972	2775	40	1.46
1973	2822	47	1.71

*) Linear interpretation when years missing. Population forecast for 1971-73.

**) Population growth from previous year to year considered.

TABLE A6.12

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER RELATIVE PARCEL LOCATION RANKING GROUP

Relative Parcel Location Index	All Transactions		Unimproved Parcels			Improved Parcels		
	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	37	3392	22	1259	976	15	6519	4623
2	490	20119	241	5539	UV	249	34239	UV
3	61	28085	27	8219	UV	34	43861	UV
4	23	13503	15	8022	12834	8	23777	14295

UV: Undefined Value,"System 2K"
Land values in constant dollars (base 1950) per acre.

TABLE A6.13

NUMBER OF TRANSACTIONS, AVERAGE LAND VALUE AND STANDARD DEVIATION PER SITE QUALITY RANKING GROUP

Site Quality Index	All Transactions		Unimproved Parcels			Improved Parcels		
	No.	Average Land Value	No.	Average Land Value	Standard Deviation	No.	Average Land Value	Standard Deviation
1	7	13187	2	1488	1986	5	17867	27153
2	457	15892	233	4283	4842	224	27969	UV
3	147	31649	70	10026	UV	77	51306	UV

UV: Undefined Value,"System 2K."
Land value in constant dollars (base 1950) per acre.

TABLE A6.14

NUMBER OF TRANSACTIONS AND AVERAGE LAND VALUE PER LAND USE GROUP

Land Use		Before Transaction		After Transaction	
Group	Relative Weight	No.	Average Land Value	No.	Average Land Value
Public	3	1	34777	4	4931
Agricultural	1	66	1382	34	852
Vacant	3	253	6603	97	6496
Industrial	4	7	19199	13	9424
Residential	5	230	28265	393	18566
Non-highway Commercial	8	41	71599	47	65428
Hwy. Commercial	7	13	49235	23	36295

Land value in constant dollars (base 1950) per acre.

TABLE A7.1

SEGMENTATION OF PREDICTORS FOR AID-ANALYSIS

Predictor: No. of Variable	Predictor: Name	No. of Categories	Interval Length
2	Time	9	2 Years
3	Parcel size	40	1 Acre
4	Improvement	2	
5	Land Use Before	6	1
6	Land Use After	6	1
7	Site Quality	3	1
8	Access to CBD	16	0.25
9	Access to PT	16	0.25
10	Access to Highway	25	0.25
11	Neighborhood Quality	4	1
12	Highway Quality	4	0.300
13	Highway Traffic Volume	9	1000 ADT
14	Railway Service	5	3
15	Local Traffic Conditions	3	1
16	Connection to Highway	2	
17	Connection to SMSA	5	3 Minutes
18	Population Growth Rate	4	0.20%
19	Time After Bypass Known	7	2 Years
20	Time After Purchase ROW	7	2 Years
21	Time After Rail Decrease	6	2 Years
22	Time After Highway Bypass	6	1 Year

TABLE A8.1

SUMMARY, CORRELATION BETWEEN DEPENDENT
AND
INDEPENDENT VARIABLES (IN THOUSANDS)

	R 1	I 1	U 1	R C 1	A V 1
TIME	168	163	132	184	139
SIZE	-163	-199	-215	-272	-225
IMP	495	-	-	- 3	217
LUB	614	451	374	433	352
LUA	474	427	337	425	287
SITEQ	233	287	370	295	369
ACC - CBD	-319	-278	-418	-232	-433
ACC - PT	-324	-281	-419	-237	-435
ACC- HWY	- 28	- 4	58	- 28	5
NEIGH Q	56	181	208	125	146
HWY Q	166	143	127	167	125
TRAF V	179	168	122	191	129
RAIL Q	-116	-123	- 84	-137	- 85
LOCAL	105	63	56	76	49
C - HWY	-120	- 91	- 81	-105	- 75
C - SMSA	-148	-133	-111	-157	-123
POPLN	14	- 28	- 7	- 31	- 43
T KNOW	158	163	131	185	183
T ROW	172	163	130	185	137
T RAIL	174	161	127	185	134
T BYPS	166	142	101	167	111

CORRELATION MATRIX

VARIABLE NUMBER	1 LVALUE	2 TIME	3 SIZE	4 IMPR	5 LUB	6 LUA	7 SITEQ	8 ACCCBD	9 ACCPT	10 ACCHWY	11 NEIGHQ
1	1.000	.168	-.163	.495	.614	.474	.233	-.319	-.324	-.028	.056
2		1.000	.062	.103	.048	-.008	.037	.049	.048	-.551	.025
3			1.000	-.146	-.371	-.472	-.118	.482	.478	-.054	-.221
4				1.000	.753	.413	.014	-.268	-.273	-.057	-.103
5					1.000	.754	.104	-.510	-.514	.001	.017
6						1.000	.143	-.480	-.481	.052	.092
7							1.000	-.197	-.195	.061	.160
8								1.000	.999	.096	-.261
9									1.000	.096	-.247
10										1.000	.077
11											1.000

VARIABLE NUMBER	12 HWYQ	13 TRAFV	14 RAILQ	15 LOCAL	16 C-HWY	17 C-SMSA	18 POPLN	19 T-KNOW	20 T-ROW	21 T-RAIL	22 T-IH-10
1	.166	.179	-.116	.105	-.120	-.148	.014	.158	.172	.174	.166
2	.952	.890	-.888	.707	-.834	-.949	-.020	.959	.994	.982	.855
3	.059	.056	-.071	.045	-.054	-.061	-.013	.064	.062	.061	.062
4	.118	.114	-.059	.114	-.106	-.099	.070	.097	.110	.118	.117
5	.043	.051	-.042	.006	-.012	-.041	.016	.047	.048	.050	.057
6	-.018	-.008	.002	-.055	.050	.010	-.013	-.007	-.007	-.009	.002
7	.040	.040	.010	.039	-.042	-.042	.014	.042	.040	.042	.025
8	.064	.058	-.025	.064	-.060	-.060	.033	.036	.055	.060	.063
9	.064	.059	-.024	.066	-.061	-.060	.035	.035	.055	.060	.064
10	-.531	-.467	.496	-.443	.513	.552	.061	-.527	-.551	-.542	-.456
11	.037	.048	-.033	.035	-.024	-.031	.060	.023	.026	.031	.046
12	1.000	.955	-.781	.825	-.887	-.959	.192	.929	.969	.982	.933
13		1.000	-.699	.736	-.776	-.885	.345	.872	.913	.935	.983
14			1.000	-.491	.661	.815	.193	-.832	-.847	-.810	-.695
15				1.000	-.962	-.779	.238	.701	.739	.774	.714
16					1.000	.867	-.080	-.814	-.850	-.861	-.742
17						1.000	-.056	-.914	-.955	-.956	-.873
18							1.000	.014	.034	.103	.384
19								1.000	.961	.954	.840
20									1.000	.995	.881
21										1.000	.906
22											1.000

TABLE A8.2

CORRELATION MATRIX, MODEL R1

TABLE A8.3

VARIABLES INCLUDED IN CROSS-PRODUCT TERMS AND TRANSGENERATION
(Form of Transgeneration or Power of
Cross-Products Not Shown)

	VARIABLE	TIME	SIZE	IMPR	LUB	LUA	SITEQ	ACC - CBD	ACC - PT	ACC - HWY	NEIGH Q	HWY Q	TRAFV	RAIL Q	LOCAL	C - HWY	C - SMSA	POPLN	T - KNOW	T - ROW	T - RAIL	T - IH -10	OTHER
2	TIME																						X
3	SIZE		X	X	X		X																
4	IMPR				X		X		X	X			X		X		X		X				
5	LUB				X	X	X		X	X	X		X	X	X	X	X			X	X	X	
6	LUA				X								X										
7	SITEQ								X	X	X		X		X	X							X
8	ACC - CBD																						
9	ACC - PT											X		X			X						X
10	ACC - HWY									X		X	X				X		X			X	
11	NEIGH Q										X	X					X	X				X	X
12	HWY Q												X		X								
13	TRAFV														X	X							X
14	RAIL Q													X									X
15	LOCAL																						
16	C - HWY																						
17	C - SMSA																						X
18	POPLN																						
19	T - KNOW																		X				
20	T - ROW																						
21	T - RAIL																				X		
22	T - IH - 10																					X	

1) Includes adding constants, lg_{10} - transgeneration and inverse-transgeneration.

STEP NUMBER 29
VARIABLE REMOVED 30

MULTIPLE R	.8394	
R SQUARED	.7045	C.V. = 79.5%
STD. ERROR FOR RESIDUALS	15643.4674	

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	17	*6020*1*2696.3105	2035448*923.3124	83.1752
RESIDUAL	593	*5117817245.3457	24471A072.9264	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		116814.93039		
IMPR	4	-22908.27323	10401.13485	4.8509
LUB	5	-20667.29380	3002.85704	47.3694
SITEW	7	-13762.80842	3700.97580	13.8287
ACCCBD	8	-6610.93640	2779.93031	5.6553
POPLN	18	-29795.45206	5658.40617	27.7276
IMPLUB	24	6280.35313	1455.41979	18.6205
ICSMSA	28	-1186623.34727	*9475.90147	9.2825
LUBSIZ	31	257.27692	38.75766	44.0643
LUBAHW	32	368.08090	171.86097	4.5870
LUBSIQ	33	5966.23229	1099.91960	29.4224
RQACPT	39	915.78532	177.15071	26.7240
HQACPT	40	6718.13118	981.57258	46.8438
IMPNW	47	13479.90887	1545.84775	76.0397
SQIMP	48	-9149.47785	4167.92647	4.8190
TRFLUB	49	.58589	.09362	39.1667
LGSIZE	51	-5383.82689	1764.94841	9.3050
LGACPT	52	38325.32445	8959.98836	18.2960

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.01869	.0912	.2069
SIZE	3	.04736	.4263	1.3304
LUA	6	.00331	.3517	.0065
ACCPT	9	-.00166	.0016	.0016
ACCHWY	10	-.03107	.1604	.5722
NEIGHQ	11	.01162	.4181	.0799
HWYW	12	-.02805	.0515	.4661
TRAFV	13	-.02794	.0680	.4624
RAILQ	14	-.01894	.2376	.2124
LOCAL	15	-.01941	.3255	.2231
C-HWY	16	.01625	.2415	.1563
C-SMSA	17	-.03198	.0031	.6060
T-KNOW	19	-.01612	.1584	.1539
T-ROW	20	.00503	.0625	.0150
T-RAIL	21	.00514	.0758	.0157
T-IMIU	22	-.03674	.0738	.8003
SIZLUB	23	.05051	.3539	1.5145
LUBSQ	25	.01210	.0245	.0866
ISIZE	26	-.03271	.0430	.6339
IACCPT	27	.02329	.0190	.3213
CTIME	29	.01869	.0912	.2069
IMPSIZ	30	.04548	.0573	1.2272
LUBRLQ	34	-.02775	.1612	.4563
LUBRL	35	.05449	.0343	1.7633
LUBNHQ	36	-.00543	.0794	.0174
LUATRV	37	-.00926	.1182	.0508
SQACHW	38	.00919	.1406	.0500

TABLE A8.4

REGRESSION MODEL R6

STEP NUMBER 16
VARIABLE ENTERED 36

MULTIPLE R .7990
R SQUARED .6383 C.V. = 60.2%
STD. ERROR FOR RESIDUALS 19887.4940

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	10	31367184667.273	2031367184 6.7292	51.3604
RESIDUAL	291	5094113021.9287	395512415.8829	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		15892.28762		
LUA	5	-7274.73644	1949.79721	13.9205
TBYPS	21	-5188.39391	1585.25137	10.7120
LUBSIZ	22	185.28198	61.83826	8.9774
LUATRF	32	.80894	.19616	17.0025
LUAAPT	33	601.82779	110.70768	34.1311
ACHTRF	36	.44335	.24665	3.2311
NONQ	40	2652.61927	453.29442	34.2444
LGISIZ	50	19382.35727	3841.67861	25.4549
LGLAPT	53	-13647.90693	3025.52627	20.3484
LUBSQ2	56	81.91945	13.43405	37.1844

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.07177	.2390	1.5017
SIZE	3	.04923	.3321	.7046
LUB	4	-.01051	.1332	.0320
SITEQ	6	-.01477	.3268	.0633
ACBD	7	-.01421	.1329	.0585
APT	8	-.00454	.1223	.0060
AHWY	9	-.00457	.2080	.0060
NEIGHQ	10	-.05707	.0218	.9475
HWYQ	11	.03426	.1094	.3409
TRAFV	12	.04069	.0200	.4810
RAILQ	13	-.04550	.4873	.6016
LOCAL	14	-.00415	.4599	.0050
CHWY	15	-.01481	.4227	.0637
CSMSA	16	-.03852	.2277	.4310
POPLN	17	-.08941	.8145	2.3369
TKNOW	18	.07040	.2095	1.4446
TROW	19	.07285	.1910	1.5472
TRAIL	20	.07907	.1434	1.8243
LUBLUB	23	-.01633	.1331	.0774

TABLE A8.5

REGRESSION MODEL I4

STEP NUMBER 13
VARIABLE ENTERED 35

MULTIPLE R	.8658	
R SQUARED	.7497	C.V. = 59.6%
STD. ERROR FOR RESIDUALS	3350.7363	

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	9	9784678845.1965	1087186538.3552	96.8330
RESIDUAL	291	3267183257.6344	11227433.8750	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		-17168.16452		
TIME	2	135.47683	59.68781	5.1518
SITEW	6	3198.27199	475.27117	45.2843
LUAAPT	33	263.02789	52.86808	24.7524
AHW2	35	-106.21512	40.55947	6.8579
NQNQ	40	156.86569	53.38092	8.6354
LUB3	43	-23.35955	8.59695	7.3831
ISIZE	46	666.69561	116.78811	32.5880
IAPT	49	1309.13675	259.73526	25.4044
AHTRF3	55	12.33707	1.69303	53.1000

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
SIZE	3	.01694	.8041	.0833
LUB	4	-.00163	.3842	.0008
LUA	5	-.00131	.5601	.0005
ACBD	7	.04865	.4919	.6873
APT	8	.05730	.4919	.9554
AHWY	9	.08074	.0473	1.9031
NEIGHQ	10	.03191	.0287	.2956
HWYQ	11	.03864	.0938	.4335
TRAFV	12	.02392	.2040	.1660
RAILQ	13	.02311	.2354	.1550
LOCAL	14	-.00129	.4798	.0005
CHWY	15	.00098	.2942	.0003
CSMSA	16	.01839	.0958	.0981
POPLN	17	.01855	.9724	.0998
TKNOW	18	.00513	.0050	.0076
TROW	19	.00191	.0114	.0011
TRAIL	20	.00929	.0349	.0250
TBYPS	21	.02626	.2711	.2000
LUBSIZ	22	.02784	.0124	.2249
LUBLUB	23	-.00163	.1125	.0008
LUBLUA	24	-.03118	.3047	.2822
LUBSQ	25	.02152	.2733	.1344
LUBAPT	26	.03700	.0093	.3974
LUBAHW	27	.03798	.2787	.4188
LUBNQ	28	.02503	.1182	.1818
LUBCSM	29	.00345	.3245	.0035
LUBTKN	30	.01583	.1637	.0727
LUALUA	31	.02528	.4390	.1856
LUATRF	32	-.01249	.3680	.0453

TABLE A8.6

REGRESSION MODEL U4

STEP NUMBER 17
VARIABLE REMOVED 36

MULTIPLE R .7930
R SQUARED .6288 C.V. = 60.8%
STD. ERROR FOR RESIDUALS 21679.9952

ANALYSIS OF VARIANCE

	DF SUM OF SQUARES MEAN SQUARE	F RATIO
REGRESSION	11*3382692136.96291398426557.9056	41.2751
RESIDUAL	268*595432 6634.8589 469978830.7271	

VARIABLES IN EQUATION

VARIABLE	COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =	-35960.19446		
ACCCBD 8	-12671.15115	6868.58246	3.4033
HWYQ 12	-82300.37454	22606.42257	13.2538
SIZLUB 23	1650.52380	644.27037	6.5631
LUBSQ 33	2187.00411	454.87988	23.1156
LUATRV 37	28.62549	15.12324	3.5827
RQACPT 39	1184.16841	289.01207	16.7878
HQACPT 40	11429.76682	1673.95525	46.6216
IMPKNO 46	4012.82188	982.61471	16.6776
HWYQSQ 50	2863.40237	484.37627	34.9461
LGSIZE 51	-45952.48381	7733.21094	35.3100
LGACPT 52	84388.71214	17490.91388	23.2779

VARIABLES NOT IN EQUATION

VARIABLE	PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME 2	-.02175	.0256	.1264
SIZE 3	.02240	.0084	.1340
IMPR 4	.05992	.5901	.9620
LUB 5	-.03022	.2139	.2441
LUA 6	-.03733	.2296	.3726
SITEQ 7	-.01588	.2263	.0674
ACCPT 9	.01912	.0022	.0976
ACCHWY 10	.06637	.4870	1.1815
NEIGHQ 11	-.01865	.0247	.0929
TRAFV 13	-.00165	.0445	.0007
RAILQ 14	-.00556	.1753	.0082
LOCAL 15	.02090	.2640	.1167
C-HWY 16	-.01031	.1904	.0284
C-SMSA 17	.02279	.0644	.1387
POPLN 18	-.06606	.5358	1.1704
T-KNOW 19	-.05992	.0189	.9620
T-ROW 20	-.06110	.0166	1.0005
T-RAIL 21	-.04138	.0133	.4581
T-IHIO 22	-.05065	.0736	.6867
IMPLUB 24	.01081	.2789	.0312
LUBSC 25	-.03491	.2127	.3258
ISIZE 26	.04896	.2491	.6416
IACCPT 27	.00287	.0226	.0022
ICSMSA 28	-.01883	.0686	.0947
CTIME 29	-.02175	.0256	.1264
IMPSIZ 30	.05975	.2676	.9567
LUBSIZ 31	.05549	.2924	.8245
LUBAHW 32	.05741	.4593	.8828

TABLE A8.7

REGRESSION MODEL RC6

STEP NUMBER 23
VARIABLE ENTERED 30

MULTIPLE R .8906
R SQUARED .7932
STD. ERROR FOR RESIDUALS 3403.7374

C.V. = 58.1%

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	17	13507918020.3226	794583412.9602	68.5847
RESIDUAL	304	3521970218.7004	11585428.3510	

VARIABLES IN EQUATION

INTERCEPT = -29271.66752

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
IMPR	4	6209.51542	3210.82509	3.7401
LUA	6	315.19194	149.85551	4.4239
ACCCBD	8	-16695.67734	5488.80434	9.2524
ACCPT	9	20159.95075	5795.27098	12.1013
ACCHWY	10	-7833.77294	1967.75171	15.8490
C-SMSA	17	461.58605	157.35756	8.6046
IMPLUB	24	2880.25969	628.86841	20.9770
IACCPT	27	1520.98688	397.91083	14.6110
IMPSIZ	30	366.59129	225.42577	2.6446
SQACHW	38	769.14866	155.82436	24.3641
AHCSM	43	344612.01130	95779.21496	12.9455
AHTRFV	44	12.10667	5.95731	4.1300
SQSIZ	45	320.51992	51.36641	38.9360
SQIMP	48	-4422.55866	1547.09685	8.1717
HWYQSQ	50	171.27266	61.33734	7.7970
LGACPT	52	-12057.59186	3879.89702	9.6579
LGTRFV	53	-15270.57170	4934.82216	9.5756

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.02485	.0807	.1873
SIZE	3	.02132	.5917	.1378
LUB	5	-.04708	.3929	.6730
SITEQ	7	-.03979	.1622	.4806
NEIGHQ	11	-.05677	.0177	.9796
HWYQ	12	.03084	.0272	.2886
TRAFV	13	.02602	.0288	.2053
RAILQ	14	-.01858	.3248	.1047
LOCAL	15	-.04961	.3228	.7476
C-HWY	16	.04775	.2111	.6925
POPLN	18	-.03344	.4990	.3393
T-KNOW	19	.02726	.0686	.2253
T-ROW	20	.02577	.0633	.2014
T-RAIL	21	.02486	.0500	.1874
T-IH10	22	.02898	.0651	.2546
SIZLUB	23	.02653	.5956	.2134
LUBSQ	25	-.03355	.3685	.3414
ISIZE	26	.02624	.0468	.2088
ICSMSA	28	.02581	.0039	.2020
CTIME	29	.02485	.0807	.1873
LUBSIZ	31	.02036	.0527	.1257
LUBAHW	32	-.05699	.2382	.9873
LUBSQ	33	-.06351	.3189	1.2272
LUBRLQ	34	-.06634	.3953	1.3395
LUBTRL	35	.01660	.1841	.0835
LUBNHQ	36	-.03647	.1165	.4035
LUATRV	37	-.03395	.0855	.3497

TABLE A8.8

REGRESSION MODEL AV6

STEP NUMBER 37
VARIABLE ENTERED 6

MULTIPLE R .9344
R SQUARED .8731 C.V. = 47.6%
STD. ERROR FOR RESIDUALS 6910.2637

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	25	[illegible]1138849750.2734	6845553990.0109	143.3571
RESIDUAL	521	24878659089.9861	47751744.8944	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		59094.15934		
IMPR	4	-17971.91794	5057.00260	12.6300
LUB	5	-15187.39022	1627.15217	87.1184
LUA	6	493.72198	324.06452	2.3211
SITEQ	7	-15349.20615	2312.77511	44.0459
NEIGHQ	11	4100.82669	820.56206	24.9758
POPLN	18	-13042.99714	2770.76940	22.1592
T-KNOW	19	-968.30063	176.51223	30.0934
IMPLUB	24	5014.06472	777.59752	41.5786
ISIZE	26	-4150.04221	818.10677	25.7327
LUBSIZ	31	825.65632	79.75534	107.1714
LUBAHW	32	909.75729	181.45404	25.1373
LUBSQ	33	4026.71739	604.02495	44.4419
LUBTRL	35	398.57255	57.53794	47.9851
SQACHW	38	1438.23409	488.81656	8.6570
HQACPT	40	2377.17707	600.70379	15.6604
NQACPT	41	-2339.89106	415.17866	31.7630
CSMAPT	42	174.30267	20.86407	69.7927
AHCSM	43	-289334.86777	55972.28330	26.7212
AHTRFV	44	46.52793	11.67030	15.8951
SQSIZ	45	1142.88793	293.02055	15.2129
IMPNQ	47	9090.47662	1022.22833	79.0820
SQIMP	48	-5288.82254	2038.86252	6.7289
LGSIZE	51	-1964.70496	1234.04093	2.5348
LGACPT	52	5032.64541	2362.64307	4.5373
LUB3	54	-46.77612	9.55625	23.9593

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	-.01548	.0450	.1246
SIZE	3	.01599	.3188	.1330
ACCCRD	8	-.03771	.0521	.7406
ACCPT	9	-.04410	.0470	1.0133
ACCHWY	10	-.01498	.0068	.1168
HWYQ	12	-.00425	.0557	.0094
TRAFV	13	-.02688	.0574	.3760
RAILQ	14	.01044	.2485	.0567
LOCAL	15	.01453	.3621	.1098
C-HWY	16	-.01523	.2613	.1206
C-SMSA	17	.00367	.1046	.0070
T-ROW	20	-.01291	.0376	.0867
T-RAIL	21	-.00892	.0390	.0414
T-IH10	22	-.05337	.0934	1.4852
SIZLUB	23	.04118	.2374	.8834
LUBSQ	25	-.01490	.0003	.1154
IACCPT	27	.02250	.0006	.2635
ICSMSA	28	-.01153	.1166	.0691
CTIME	29	-.01548	.0450	.1246
IMPSIZ	30	.03579	.0970	.6669
LUBRLQ	34	.02701	.1761	.3797
LUBNHQ	36	-.00856	.0075	.0381
LUATRV	37	-.06020	.0577	1.8913
RQACPT	39	.00253	.0774	.0033
IMPKNQ	46	.01260	.0839	.0826
TRFLUB	49	-.02079	.0291	.2248
HWYQSQ	50	.02554	.0222	.3395
LGTRFV	53	.00032	.0448	.0001
LGRLQ	55	.01749	.1969	.1592

F-LEVEL OR TOLERANCE INSUFFICIENT FOR FURTHER COMPUTATION

TABLE A8.9

REGRESSION MODEL R6-3

STEP NUMBER 17
VARIABLE REMOVED 22

MULTIPLE R .8903
R SQUARED .7927 C.V. = 40.3%
STD. ERROR FOR RESIDUALS 11427.6231

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	13	*0822736243.4375	1063287403.3413	77.0598
RESIDUAL	262	34214729331.4725	130590569.9675	

VARIABLES IN EQUATION

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
INTERCEPT =		-25091.13749		
SIZE	3	521.20422	215.07393	5.8727
CSMSA	16	1128.77974	360.27712	9.8162
POPLN	17	-15416.95842	6554.83587	5.5319
LUBSW	25	-1707.88806	925.40560	3.4061
ACHTRF	36	52.08708	15.53147	11.2469
NQAPT	42	-2235.37148	357.05584	39.1947
NWTRFV	43	149.89748	14.39017	108.5068
SQAPT	44	1368.16596	342.35867	15.9704
ISIZE	46	791.77851	330.61090	5.7355
LAAPT2	48	3.77550	.53032	50.6841
LGISIZ	50	19588.74839	3200.40918	37.4630
SWTBP	51	-1261.85213	349.54931	13.0317
LUBSW2	56	114.62631	32.21521	12.6604

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	-.04996	.0714	.6530
LUB	4	-.00963	.1447	.0242
LUA	5	-.01089	.2481	.0310
SITEQ	6	.02047	.2676	.1094
ACBD	7	.07384	.3478	1.4309
APT	8	.07103	.3389	1.3236
AHWY	9	-.06409	.1898	1.0765
NEIGHW	10	.03718	.2261	.3612
HWYQ	11	.00209	.0430	.0011
TRAFV	12	-.02307	.0518	.1390
RAILQ	13	.01746	.2272	.0796
LOCAL	14	.07154	.3692	1.3428
CHWY	15	-.06470	.2550	1.0972
TKNOW	18	-.05176	.0643	.7010
THOW	19	-.04259	.0615	.4743
TRAIL	20	-.02150	.0546	.1207
TBYPS	21	-.03477	.0383	.3159
LUBSIZ	22	-.08601	.0257	1.9454
LUBLUB	23	-.02643	.1853	.1824
LUBLUA	24	-.02367	.1879	.1463
LUBAPT	26	-.01215	.0316	.0385

TABLE A8.10

REGRESSION MODEL U5-3

STEP NUMBER 14
VARIABLE REMOVED 52

MULTIPLE R .9680
R SQUARED .9370
STD. ERROR FOR RESIDUALS 1337.6052

C.V. = 28.6%

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE	F RATIO
REGRESSION	10	6916047514.6716	691604751.4672	386.5468
RESIDUAL	260	465188771.9966	1789187.5846	

VARIABLES IN EQUATION

INTERCEPT = -7151.88631

VARIABLE		COEFFICIENT	STD. ERROR	F TO REMOVE
POPLN	17	1895.07108	676.41612	7.8492
LUBSIZ	22	-131.11956	40.95969	10.2476
LBAPT2	29	-1.58974	.37411	18.0579
LUBTKN	30	46.76546	7.62812	37.5851
SQISIZ	38	536.53570	52.38137	104.9165
NQNQ	40	216.39129	25.09481	74.3552
ACHTRF	45	.01382	.00396	12.1553
IAPT	49	2721.99600	183.85046	219.2025
LGIAPT	51	-4410.53246	641.09582	47.3300
LAAPT2	54	2.14695	.30044	51.0651

VARIABLES NOT IN EQUATION

VARIABLE		PARTIAL CORR.	TOLERANCE	F TO ENTER
TIME	2	.04435	.2560	.5104
SIZE	3	.03954	.7504	.4056
LUB	4	-.06449	.3586	1.0817
LUA	5	-.03293	.6689	.2812
SITEQ	6	.02748	.3743	.1958
ACBD	7	-.05531	.0465	.7948
APT	8	-.02192	.0401	.1245
AHWY	9	-.05260	.4554	.7187
NEIGHQ	10	-.06610	.0249	1.1365
HWYQ	11	.06131	.2936	.9772
TRAFV	12	.04392	.2629	.5005
RAILQ	13	-.03480	.4381	.3140
LOCAL	14	.04442	.5529	.5120
CHWY	15	-.05706	.4780	.8460
CSMSA	16	-.03202	.3276	.2659
TKNOW	18	.04452	.2499	.5143
TROW	19	.04440	.2485	.5115
TRAIL	20	.04212	.2510	.4604
TRYPS	21	.03073	.2912	.2448
NQAPT	23	-.01528	.0318	.0605
LUBLUA	24	-.04355	.3769	.4921
LUBSQ	25	-.02172	.3876	.1223
LUBAPT	26	-.03503	.0042	.3182
LUBAHW	27	-.04789	.6272	.5954
LUBNQ	28	-.05105	.1226	.6767
LUALUA	31	-.03011	.6221	.2351
LUATRF	32	.00935	.2865	.0226
LUAAPT	33	.01329	.0268	.0457
ACBD2	34	-.02867	.1633	.2130
AHW2	35	-.06199	.5333	.9990

TABLE A8.11

REGRESSION MODEL U5-3

APPENDIX II. FIGURES

Location	Length Miles	Year Opened
Loop 13	4.8	59
FM 1516	8.7	62
Bexasr 1 Guadalupe C.L.	9.1	62
W. Seguin	8.9	68
E. Seguin	17.6	71
Guadalupe Caldwell C.L.	6.0	72
Caldwell Gonzales C.L.	18.7	72
US 90	8.7	71
N. Flatonia	6.4	70
FM 2238	6.1	69
US 77	5.0	68
Fayette/ Colorado C.L.	10.3	69
Glidden	10.5	64
FM 102	20.3	66
SH 36	21.0	67
Fort Bend/ Harris C.L.	10.3	66
Addix	12.1	55
IH 45		

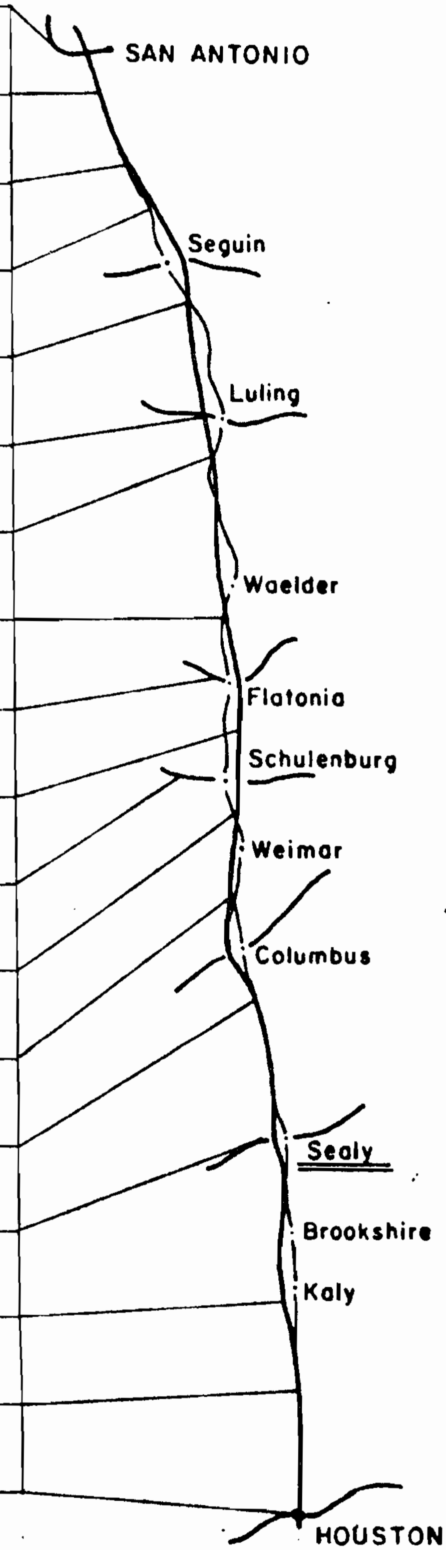


FIGURE A6.1. COMPLETION OF IH 10

SAN ANTONIO - HOUSTON

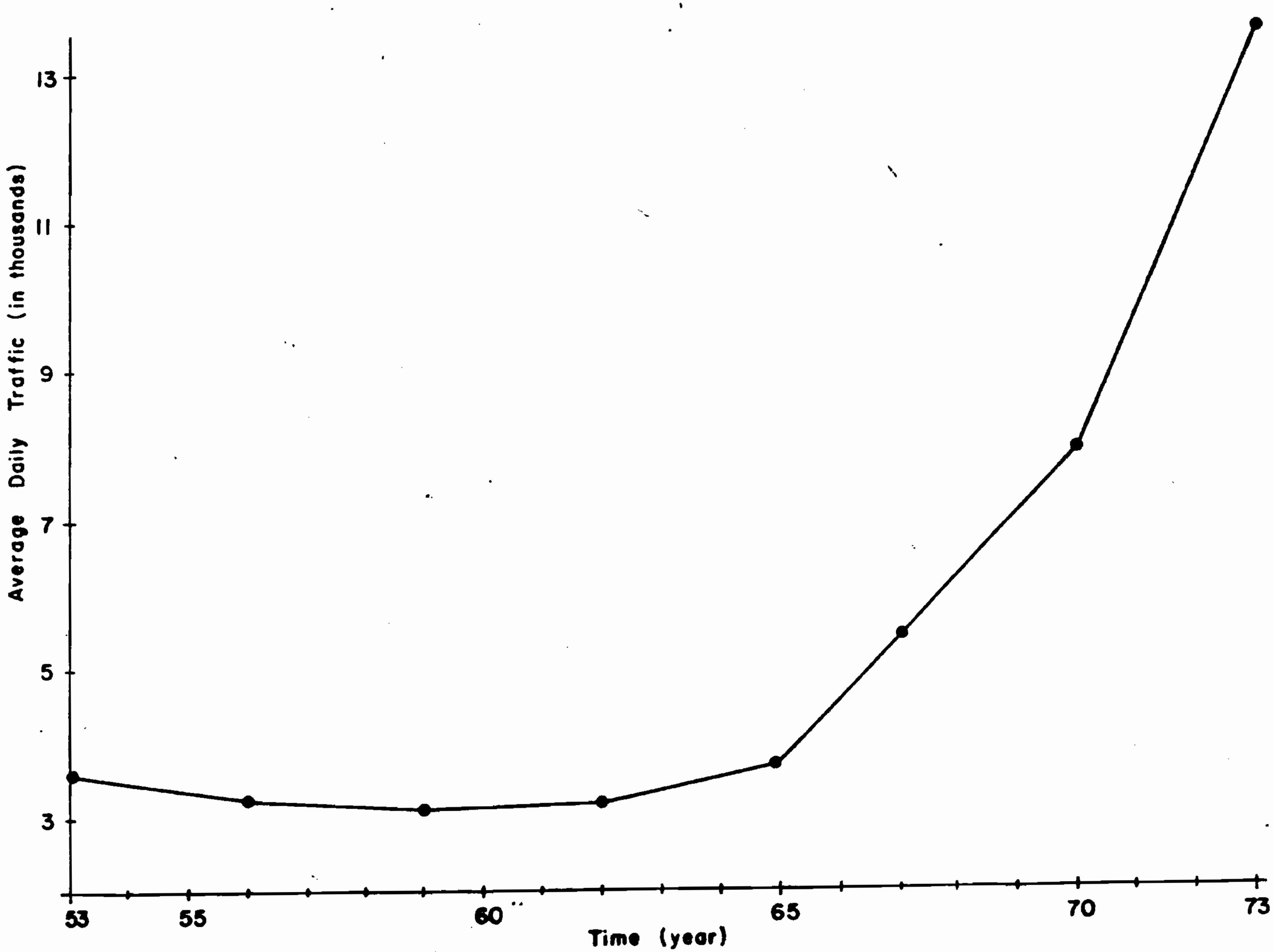


FIGURE A6.2: TRAFFIC VOLUMES, US 90/IH 10 SAN ANTONIO - HOUSTON
AUSTIN COUNTY LINE, WEST

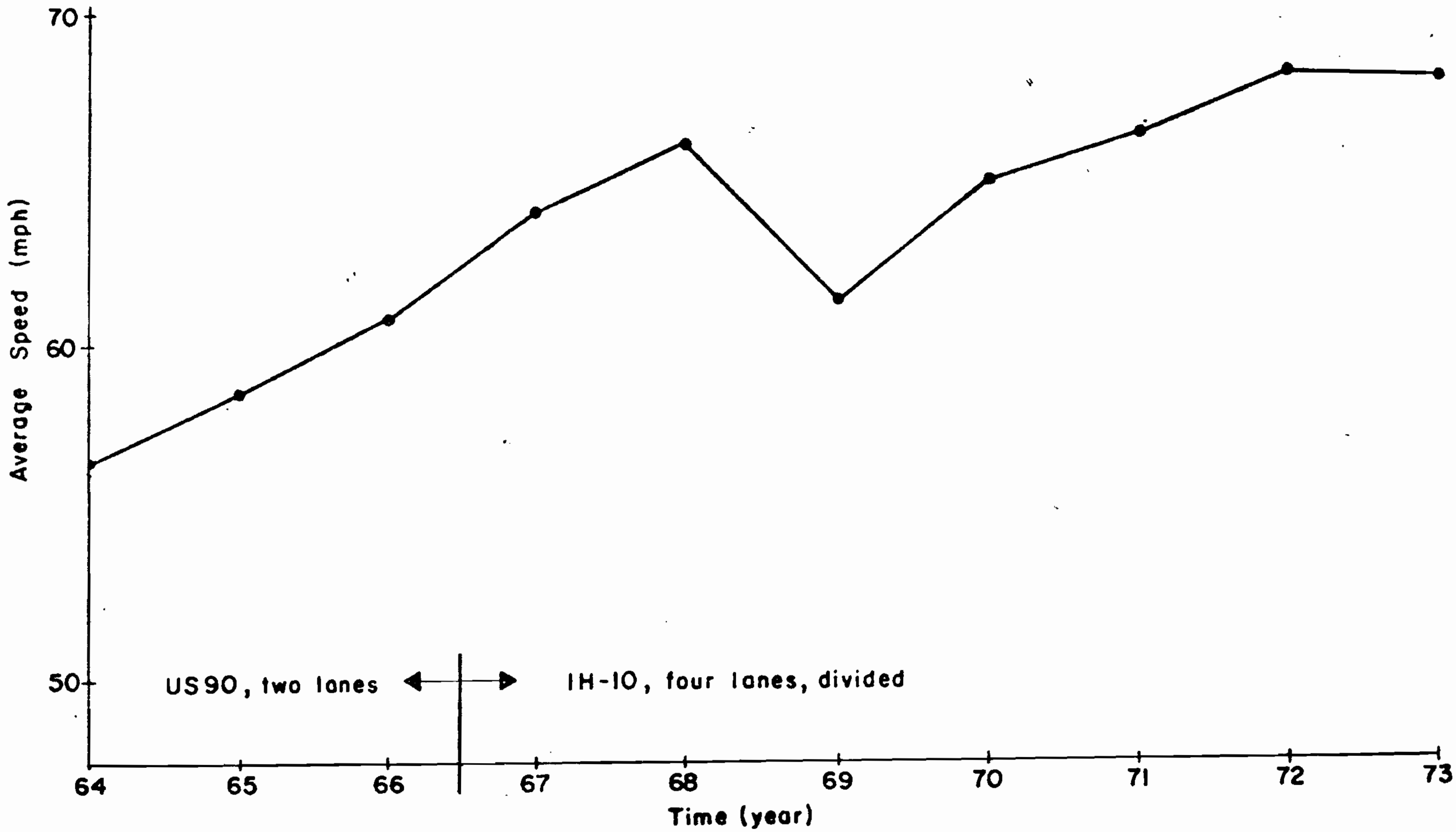


FIGURE A6.3.: SPEED VARIATION ON US 90/IH 10,
9 MILES WEST OF SEALY
1964 - 1973

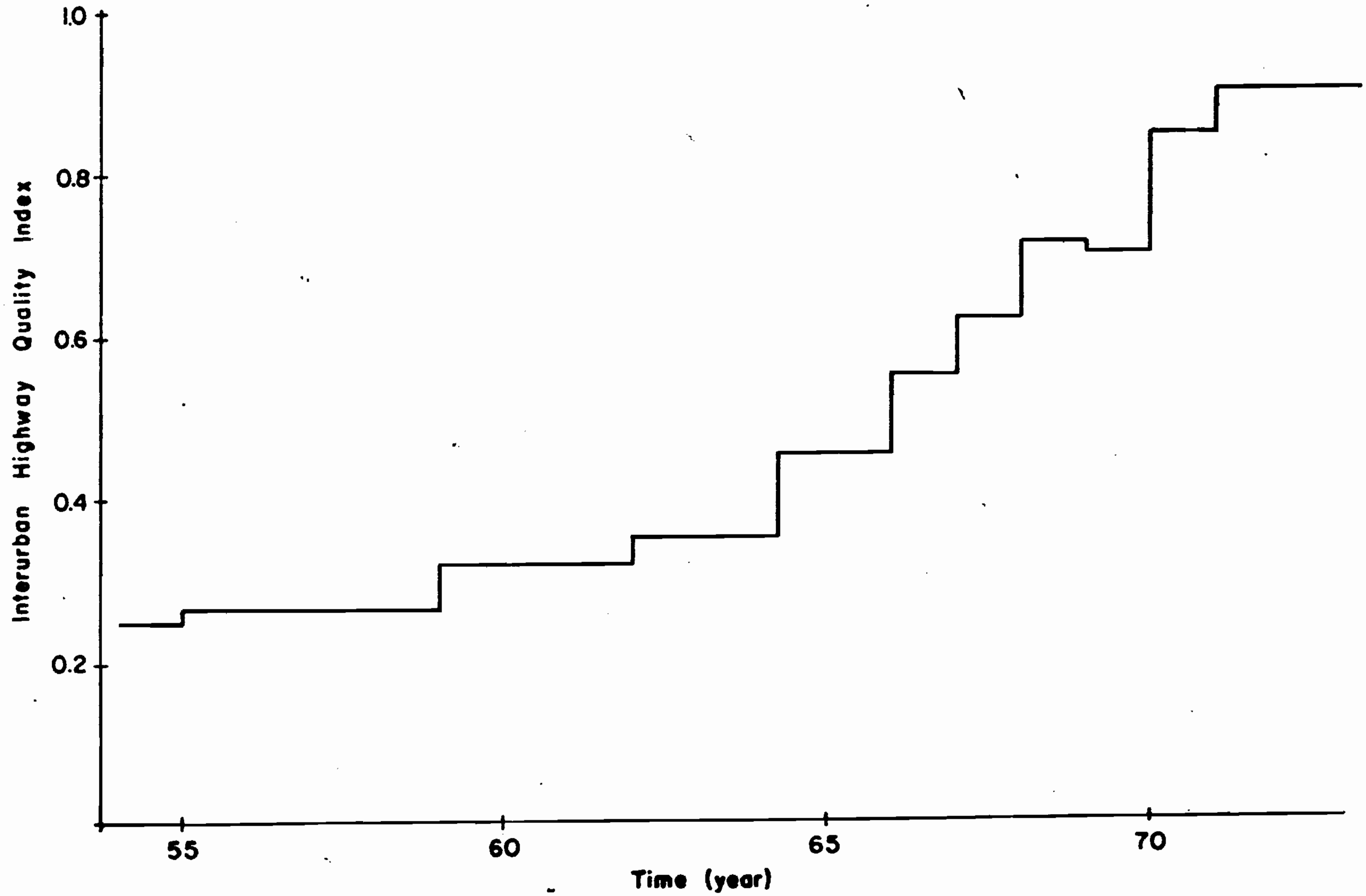


FIGURE A6.4: INTERURBAN HIGHWAY ROUTE QUALITY INDEX,

US 90/IH 10 SAN ANTONIO - HOUSTON

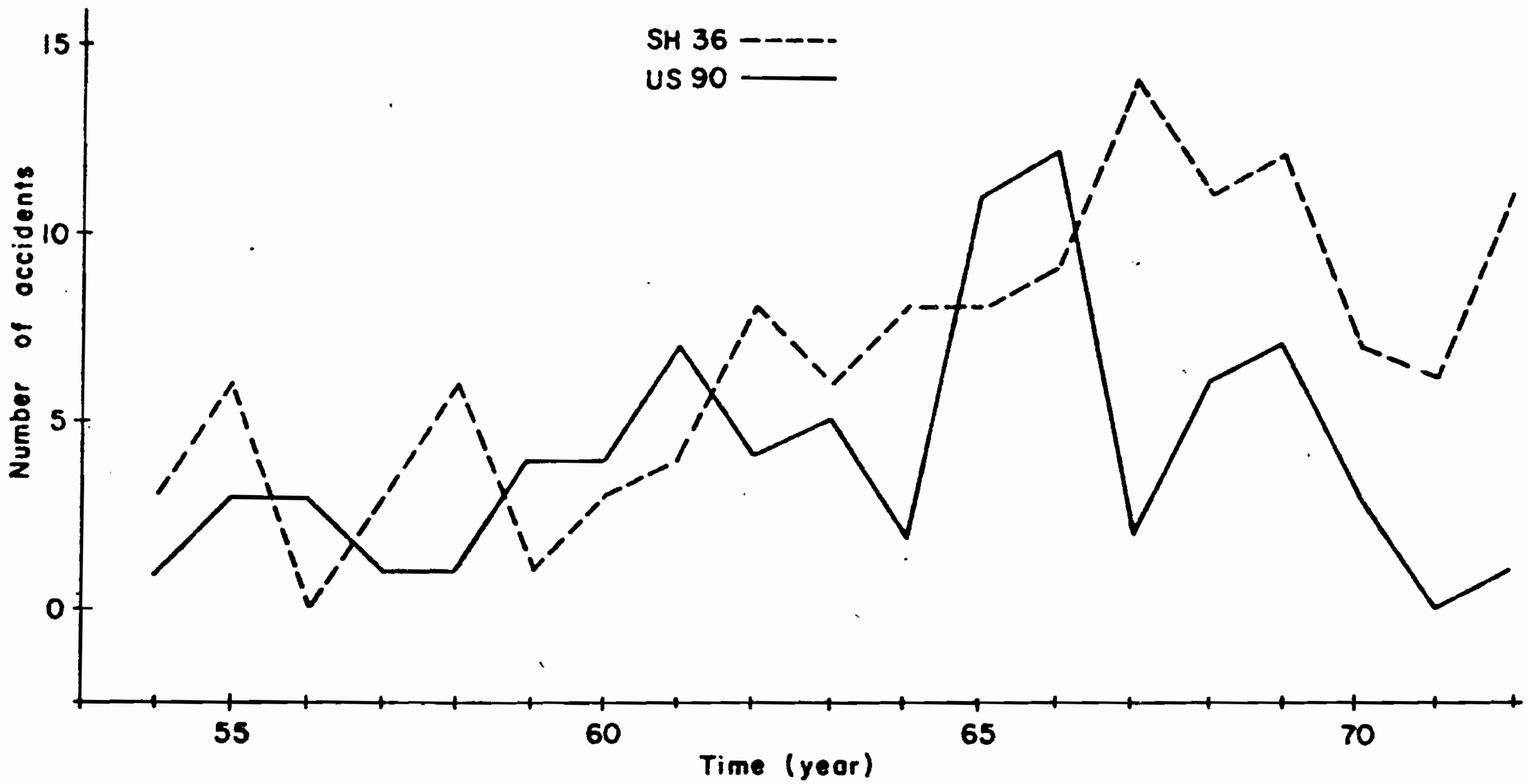


FIGURE A6.5.: NUMBER OF REGISTERED FATAL AND INJUROUS TRAFFIC ACCIDENTS

INCLUDES 12.6 MILES ON SH36 AND 3.1 MILES ON US 90 IN SEALY

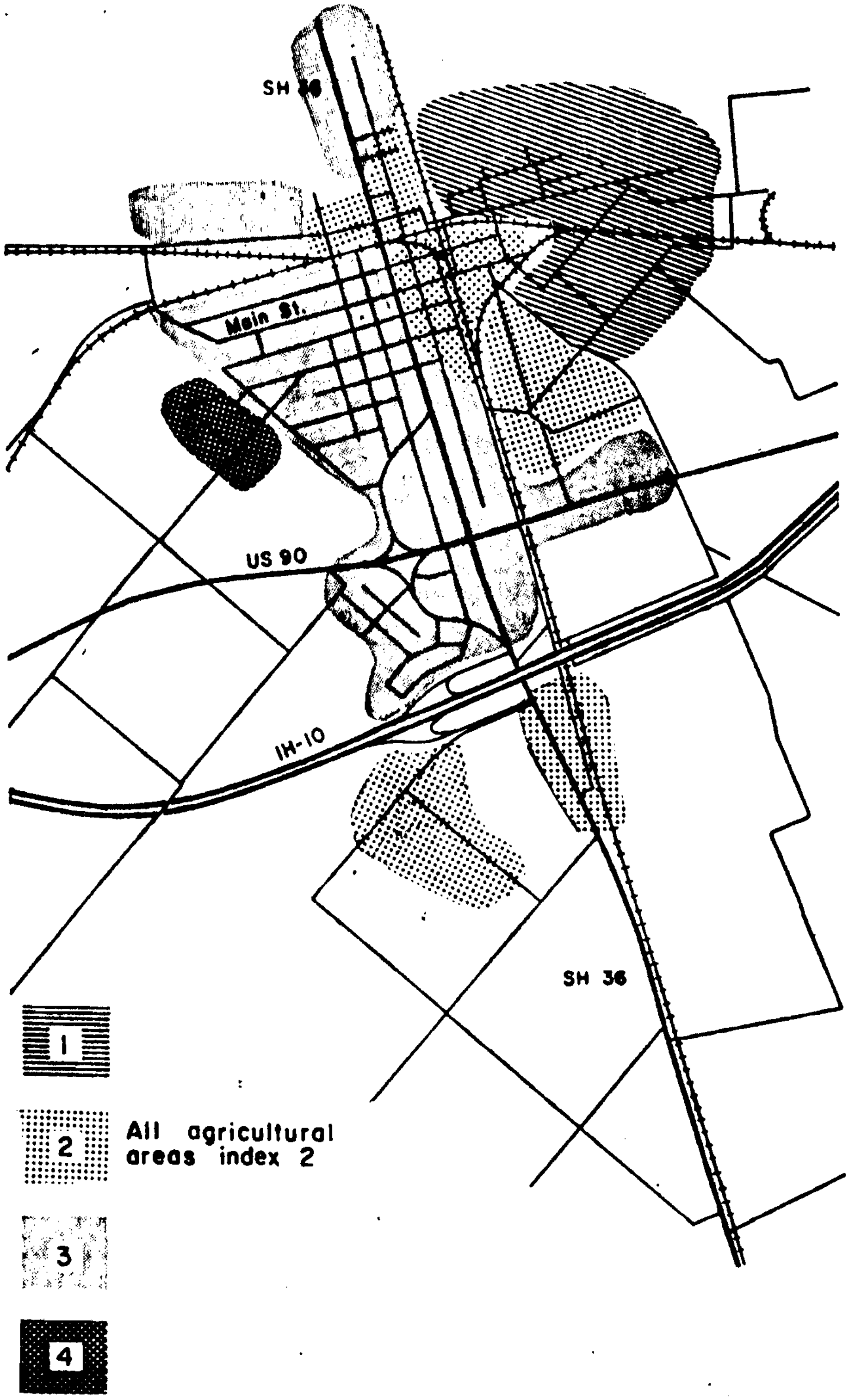


FIGURE A6.6.: NEIGHBORHOOD QUALITY INDICES, SEALY

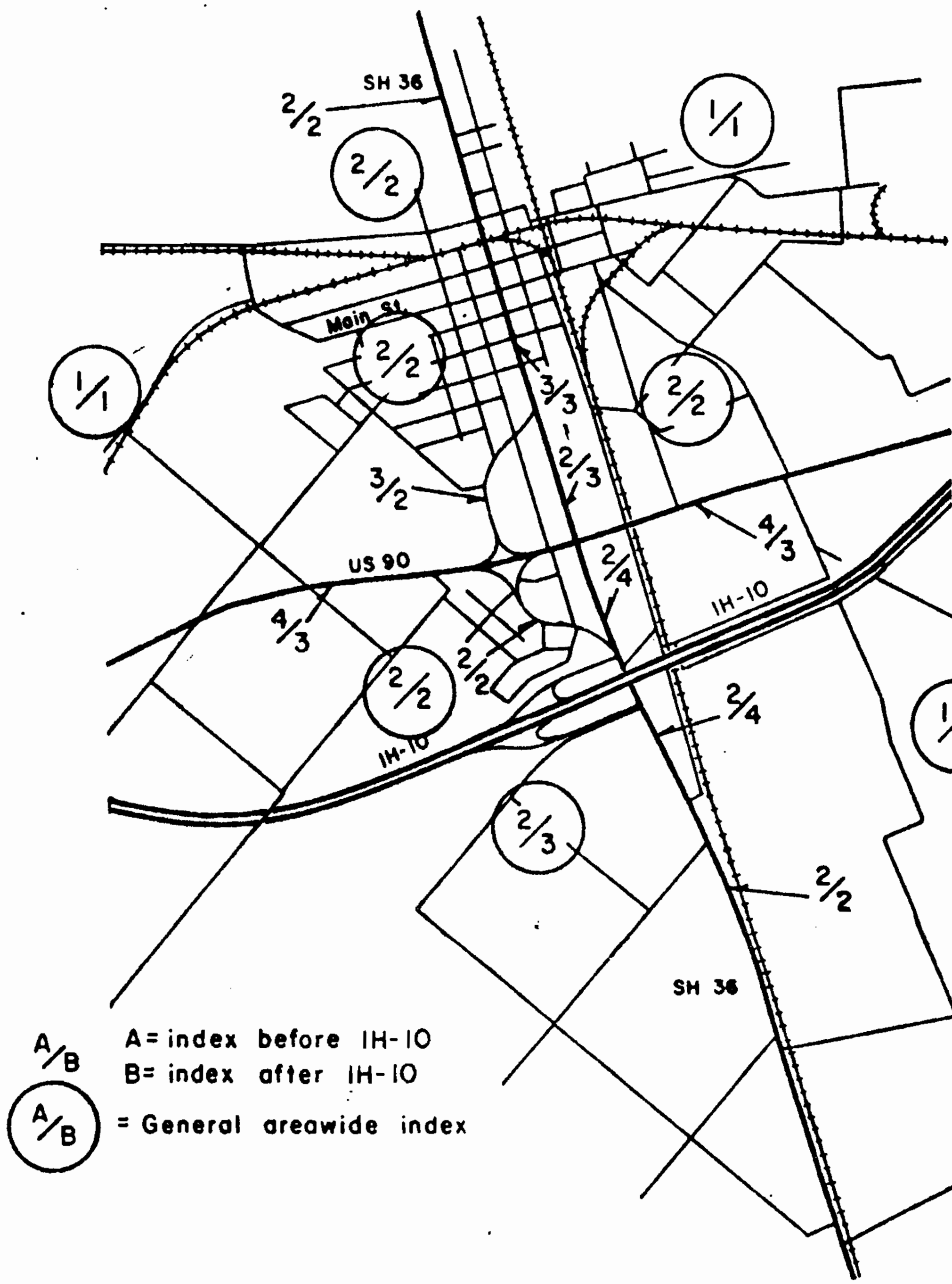


FIGURE A6.7.: RELATIVE PARCEL LOCATION RATINGS, SEALY

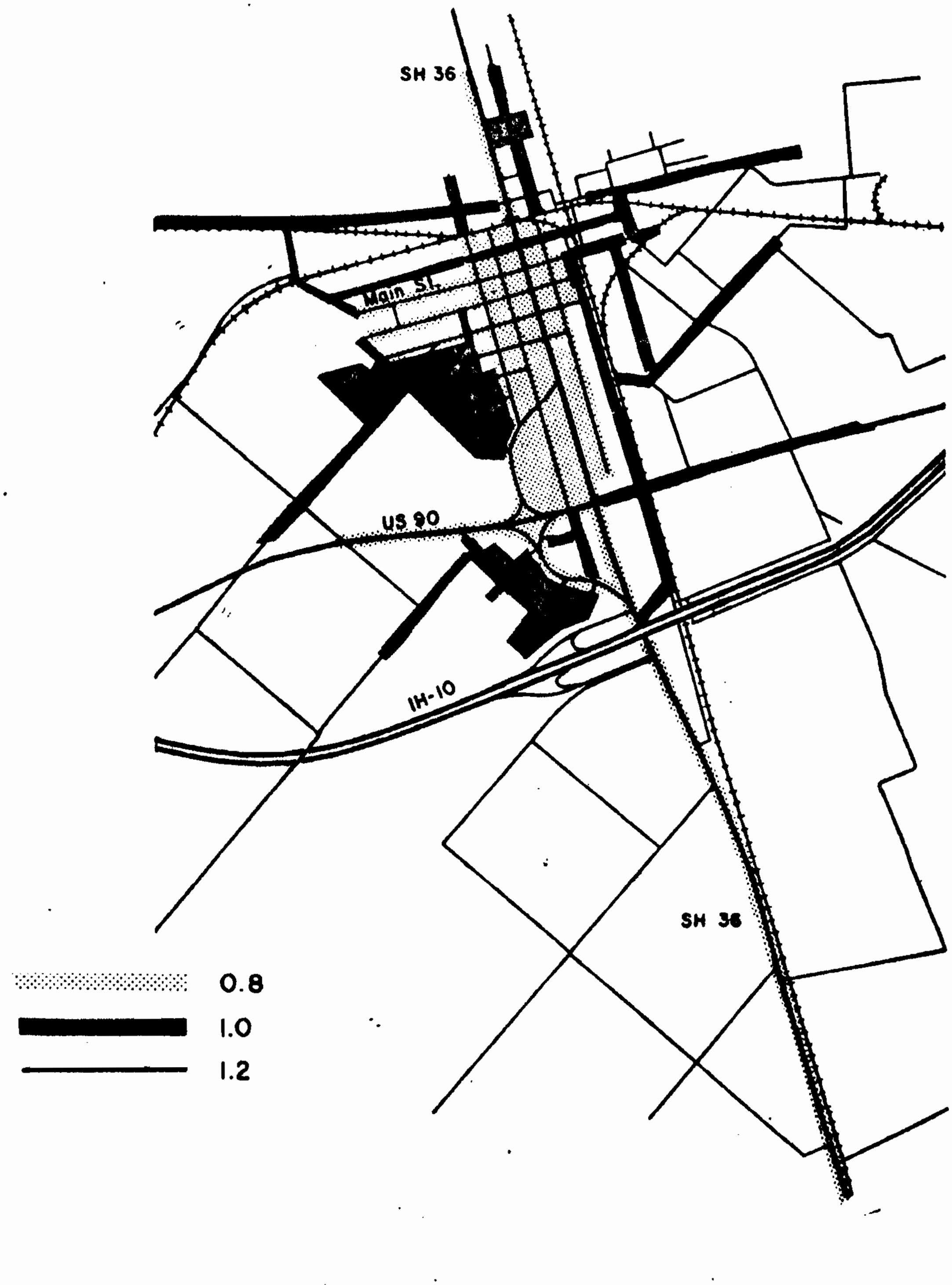


FIGURE A6.8.: STREET ADJUSTMENT FACTORS, SEALY

ANNOTATED LIST OF RESEARCH REPORTS

Ashley, R. H., and W. F. Berard. "Interchange Development Along 180 Miles of I-94." Highway Research Record No. 96, Highway Research Board (1967), pp 46-58.

A study of land use related to interchange type (full, partial and closed interchanges) and interchange location (major city, secondary city, small town, rural) (Michigan). Also examines land value and gallonage for service stations.

Babcock, W. F., and S. Khasnabis. "Land Use Changes and Traffic Generation On Controlled Access Highways in North Carolina." North Carolina State University at Raleigh, 1971, pp 1-20.

A study of 221 interchanges along a total of 550 miles of controlled access freeway in North Carolina. Investigation of land development and land use in the interchanges for urban, suburban and rural areas.

Bardwell, G. E., and P. R. Merry. "Measuring the Economic Impact of a Limited-Access Highway on Communities, Land Use, and Land Value." Bulletin 268, Highway Research Board (1960), pp 37-73.

Study of the influence of U.S. 85 and U.S. 87 on business activity and land values in certain bypassed Colorado communities. Business activity expressed by sales tax collections, land values by sales price per acre. Land values seems to decline with increasing distance from an urban community.

Beimborn, E. A., B. P. Nedwek, and C. R. Ryan. "An Evaluation of the Feasibility of Social Diagnostic Techniques in the Transportation Planning Process." Highway Research Record 410, Highway Research Board (1972).

Survey (questionnaire) which shows demographic characteristics, attitudes towards transportation services, attitudes towards non-transportation services, and analysis of freeway support and opposition to a freeway project in Milwaukee.

Bone, A. J., and M. Wohl. "Massachusetts Route 128 Impact Study." Bulletin 227, Highway Research Board (1959).

The principal impact of route 128 (circumferencing Boston about 60 miles from CBD) has been the channeling of industrial development into the towns through which it passes. Residential development has also been stimulated in areas along the highway.

Bouchard, R. J., E. L. Lehr, M. J. Redding, and G. R. Thomas. "Techniques for Considering Social, Economic, and Environmental Factors in Planning Transportation Systems." Highway Research Record No. 410 (1972), pp 1-7.

Use of an "urban planning matrix" as a tool in the comprehensive transportation planning process. Nothing is explained about how to find the value of the different factors which are the elements in the matrix.

Bowersox, Donald J. "Influence of Highways on Selection of Six Industrial Locations." Bulletin 268, Highway Research Board (1960), pp 13-28.

A group of industrial firms were interviewed about the importance of location adjacent to freeway access. The influence of highway facilities on the selection of these plants was considered as important, but not critical (Michigan).

Buffington, J. L., and H. G. Meuth. "Economic Impact Restudy, Temple, Texas." Texas Transportation Institute, Bulletin 27 (1964).

Restudy of the economic impact of the new bypass route of IH35, Temple. This study includes a second "after construction period" - otherwise it is the same as a previous study, TTI Bulletin No. 14 (1960).

Buffington, J. L. "Economic Impact Study, Rural Area East of Houston, Texas." Texas Transportation Institute, Bulletin 37 (1967).

The economic impact of IH10 on a rural area, about 15 miles east of Houston, Texas. Changes in land values, land use, and business activity.

________________. "Economic Impact Study, Chambers County, Texas." Texas Transportation Institute, Bulletin 39 (1967).

A study of the economic impact in a study area in Chambers County, Texas, along a 14 mile-long section of IH10. There was no other route before the construction of IH10, and land use was agricultural. The study includes changes in land values, land use and business activity.

________________. "Economic Impact Study, Huntsville, Texas." Texas Transportation Institute, Bulletin 38 (1967).

A study of the impact of IH45 on Huntsville, Texas. Influence on land values, land use, business activity, travel patterns and general community development.

________________. "Economic Impact Study, Conroe, Texas." Texas Transportation Institute, Bulletin 40 (1967).

A study of economic impact of IH45 on Conroe, Texas. Includes land values, land use, business activity, travel patterns, and general community development.

________________. "Economic Impact Study, Waxahachie, Texas." Texas Transportation Institute, Bulletin 35 (1966).

An economic impact study of IH35E on Waxahachie, south of Dallas. Includes changes in land values, land use, business activity and other economic considerations.

________________. "Economic Impact Study, Merkel, Texas." Texas Transportation Institute, Bulletin 36 (1966).

Brinton, Jr. J. H., and J. N. Bloom. "Effect of Highway Landscape Development on Nearby Property." National Cooperative Highway Research Program, Report No. 75 (1969).

Physical disturbance (noise, vibration) on 800 properties adjacent to highway is analyzed to find the correlation to differences in property values. Concludes that sound from trucks is the most objectionable highway disturbance to residential areas.

Burke, D. E., J. L. Buffington, H. G. Meuth, W. G. Adkins, and D. Schafer. "Attitudes, Opinions, and Expectations of Businessmen in a Planned Freeway Corridor." Texas Transportation Institute, Study 2-1-71-148, Research Report 148-2.

Discussion of how businessmen obtain information about a freeway project, their attitudes (pro vs. con), preferences with regard to freeway location and design, and expectations about how the freeway will affect their business decision-making.

Charles River Associates, Inc. "Measurement of the Effects of Transportation Changes." National Technical Information Service Report PB-213 491 (September, 1972).

The report discusses methodologies used in previous studies, analyzes the problem of measuring urban transportation impacts. Also discussion of the theory of transportation impact, relevant variables, and guidance to existing sources of information (data).

Cribbins, P. D., W. T. Hill, and H. O. Seagraves. "Economic Impact of Selected Sections of Interstate Routes on Land Value and Use." Highway Research Record No. 75, Highway Research Board (1965), pp 1-31.

An effort to find the influence on land value and use by use of multiple regression techniques. Great variations for different sites. Land value = f (size of parcel, year of sale, vacant -non-vacant land use, rural-urban land use, subdivision, roadside, alternate roadway, distance to right-of-way, distance to CBD, distance to access.

Dansereau, H. Kirk. "Five Years of Highway Research: A Sociological Perspective." Highway Research Record No. 75, Highway Research Board (1965), pp 76-81.

Discusses various highway-community relationships, namely, population, changes in levels of linving as measured by a social class rating, community values as evidenced to an extent by attitudes expressed, and degree of community organization as ascertained through use of an Index of Community Complexity. Sites studied in Pennsylvania - Monroeville (Pittsburgh), Blairsville (Indiana County) and four interchanges near York.

Dansereau, H. K., R. A. Rehberg, and J. R. Maiolo. "Specified Social Determinants of Attitudes Toward Community Planning and Zoning." Pennsylvania State University (1966).

Study of attitudes toward planning and zoning in interchange communities, and identification of some factors related to differences in those attitudes.

Ellis, Raymond H. "Toward Measurement of the Community Consequences of Urban Freeways." Highway Research Record No. 229, Highway Research Board (1968), pp 38-52.

This article proposes a strategy for quantitative estimation of community consequences of urban freeways. Discussion about how to consider community consequences and transportation impact on the existing community linkages.

Ellis. R. H., and R. D. Worral. "Towards Measurement of Community Impact: The Utilization of Longitudinal Travel Data to Define Residential Linkages." Highway Research Record No. 277, Highway Research Board (1969), pp 25-39.

An effort to present a methodology for using residential linkages as a strategy for measuring community impact of transportation projects.

Eyerly, Raymond W. "Land Use and Land Value in Four Interchange Communities: An Interim Report on the York Study." The Pennsylvania State University, 1968.

The study included all properties within two miles of the interchanges. It investigates the rate of formation of new properties, types of land uses, and changing land values.

Fabbroni, Lawrence P. "Land Use Development at Interstate Interchanges in Indiana." Joint Highway Research Project, Purdue University, Project C-36-70D, May, 1973, pp 1-85 and appendices.

Brief review of past research in this area: collects data from 102 interchanges along 8 interstate sections and makes an effort to set up a model to determine the extent of land use development along crossroads (1 mile to each side). More detailed studies of 10 intersections and discussion of available planning tools which might have been used in one of the "case areas."

Fleishman, Edward R. "The Impact After Seven Years of a Highway Improvement in a Small City." Joint Highway Research Project C-36-64D, Purdue University, May, 1968.

Study from Lafayette, Indiana (population 62,000 in 1967), considering changes in traffic patterns, accidents, travel times, and to some degree land use, values, due to construction of a new bridge over Wabash River.

Franklin, William D. "The Effect of Access on Right of Way Costs and the Determination of Special Benefits. Texas Transportation Institute, Research Report No. 82-1F (1968).

The effects of granted access contrasted with non-access on amount paid for damages connected with property acquisition.

Frey, J. C., H. K. Dansereau, R. D. Pashek, and A. Twark. "Land Use Planning and the Interchange Community." Bulletin 327, Highway Research Board (1962).

Discussion of land-use adjustment at interchange locations and importance of land-use regulations and control in preserving highway efficiency. No methodology to predict development which will take place at the interchange.

Garrison, William L. "Land Uses in the Vicinity of Freeway Interchanges." University of Washington, December 1961.

Discussion of simulation models of interchange - urban growth and development, a deterministic land development model, and the problems of estimation of supply and demand in the vicinity of freeway interchanges.

Goldberg, Michael A. "Economics of Transportation Corridors: Further Empirical Analysis." Highway Research Record 410, Highway Research Board (1972), pp 37-51.

Study of 325 properties within 0.2 mile of the Trans-Canada Highway (Vancouver). Showed that even the properties closest to the freeway only increased at a compound annual rate of 2.85 percent net inflation (properties in Richmond as a whole 5.23 percent net inflation).

Greenbie, B. B. "Interchange Planning in Rural Area." Traffic Quarterly, April, 1970, pp 265-278.

Example of interchnge area planning (1-90 and 1-74) in Monroe County, Wisconsin.

Grossman, D. A., and M. R. Levin. "Area Development and Highway Transportation." Highway Research Record 16, Highway Research Board (1963).

Discussion of "distressed" areas in the light of Area Redevelopment Act of 1961.

Holshouser, E. C. "An Investigation of Some Economic Effects of Two Kentucky Bypasses: The Methodology." Bulletin 268, Highway Research Board (1960), pp 74-79.

One bypass provided free access, the other limited access. The belt-line had positive influence mainly within 1/4 mile of the facility, the effect of the limit access expressway reached 2-3 miles. Discussion of methodologies: survey-control area comparison, case study method, multiple regression analysis, projected land use-value relationship approach.

Horwood, Edgar M. "Freeway Impact on Municipal Land Planning Effort." Bulletin 268, Highway Research Board (1960), pp 1-12.

A discussion of some factors which impose limitations on the city planning and highway development processes.

Isibor, Edward I. "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels." Joint Highway Research Project C-36-64G, Purdue University, (December, 1969).

Use of regression analysis to find a model for change in land value as a function of size, time after construction, type of highway, type of land use, type of area, and type of access control. Only adjacent parcels (from two right-of-way studies, Florida and Indiana) included in the study.

Jordan, Jack D. "Final Report on Studies of Right of Way Remainders." Texas Highway Department, 1970.

Analysis of 300 remainder properties from Right of Way taking. Relationship of dollar amount of appraised damages to actual damages or enhancements.

Kahn, H. M., and A. Kriken. "Social Characteristics of Neighborhoods as Indicators of the Effects of Highway Improvements." Marshall Kaplan, Gans, and Kahn, San Francisco, California.

Study of the social impact of highways on neighborhoods (4 cases), where a predictive "Social Feasibility Model" was developed. The model is based on secondary data. No quantitative measurement of the degree of impact.

Kemp, Barbara H. "Social Impact of a Highway on an Urban Community." Highway Research Record No. 75, Highway Research Board (1965), pp 92-102.

Discusses the effects of a loop through D. C. on those who would have to move and those who would remain in the area and to formulate programs to reduce possible harmful effects on the people concerned.

Kiley, Edward V. "Highways as a Factor in Industrial Location." Highway Research Record No. 75, Highway Research Board (1965), pp 48-52.

Survey of 4,150 industrial establishments, by American Trucking Association. Included all states. Proximity to highways was found to be one of the most frequently mentioned location factors.

Klein, G. E., et al. "Methods of Evaluation of the Effects of Transportation Systems on Community Values." Stanford Research Institute, April, 1971.

An effort to develop methods of identifying, measuring and valuating selected community attributes that are affected by transportation system changes. Looks into the effects of accessibility to services, property development, relocation, disruption, and noise and air pollution.

Lang, A. S., and M. Wohl. "Evaluation of Highway Impact", Bulletin 268, Highway Research Board (1960), pp 105-119.

The authors state that "there is no logical basis for assuming highway improvements can produce any net economic benefits over and above user (vehicular) benefits." Secondary benefits such as increase in land values, etc., however, are of importance in the over-all picture of land-use development. Followed by a discussion of the arguments by Sidney Goldstein, Bureau of Public Roads.

Levin, David R. "Informal Notes on Sociological Effects of Highways." Highway Research Record No. 75, Highway Research Board (1965), pp 82-84.

Raises questions on the degree transportation and sociology are related. Also, some considerations a transportation planner should look at. Concerned mainly with urban transportation.

Levin, D. R. "The Highway Interchange Land-Use Problem." Bulletin 288, Highway Research Board (1961), pp 1-24.

Rather general discussion of development at freeway interchanges, land use problem at the interchange, types of land associated with interchanges, land use and access control.

Long, Gale A, Gary D. Long, and Raymond W. Hooker. "A Corridor Land Use Study: The Impact of an Interstate Highway on Land Values, Private Investment and Land Use in Southwestern Wyoming." Division of Business and Economic Research, University of Wyoming, October, 1970.

Land value in city outskirts rose, while it tended to decrease a little in CBD. Induced private investment only the first years after completion.

Longley, J. W., and B. T. Goley. "A Statistical Evaluation of the Influence of Highways on Rural Land Values in the United States." Bulletin 327, Highway Research Board (1962), pp 21-55.

Analysis of 5,000 rural land sales, to determine existing differences in land values by type of road as to price per acre and distance from nearest trading center. Distance to nearest trading center seems to be most significant.

McKain, W. C. "Community Response to Highway Improvement." Highway Research Record No. 96, Highway Research Board (1965), pp 19-23.

The Connecticut Turnpike had a favorable impact on many towns, while others in the same area were left relatively untouched. Discussion of possible social and employment factors; labor force does not readily improve its skills, communities may tend to resist change, and a crisis approach to social action.

Miller, Stanley F., Jr. "Effects of Proposed Highway Improvements on Property Values." National Cooperative Highway Research Program, Report 114 (1971).

Basic principles of real estate values, valuation practices and procedures, factors causing enhancement or diminuation of value, and legal considerations.

Meuth, H. G. "Right of Way Effects of Controlled Access Type Highway on a Ranching Area in Madison County, Texas." Texas Transportation Institute, Research Report 58-4 (1968).

The study describes changes in land tenure, land use, income and travel patterns of th operators affected by acquisition of right of way and construction of IH45 in Madison County.

Meuth, H. G., and J. L. Buffington. "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Ellis County, Texas." Texas Transportation Institute, Research Report 58-5 (1969).

Changes in kind and intensity of rural land use, number of farm and ranch units, cost of adjustment to new farm and operating conditions, and changes in farm income, due to acquisition of right of way and construction of IH35 in an intensive farming area, Ellis County.

Meuth, H. G. "Right of Way Effects of Controlled Access Type Highway on a Farming Area in Colorado and Fayette Counties, Texas. Texas Transportation Institute, Research Report 58-6 (1970).

How operators in a diversified farming area were affected by, and how they adjusted to right of way acquisitions for IH70, in Colorado and Fayette Counties. (Land value, land use, travel patterns, and income, etc.)

National Center for Highway Research. "A Review of Transportation Aspects of Land-Use Control." National Cooperative Highway Research Program, Report No. 31 (1966).

Mainly a literature review on the subject of the relationships between land-use control, traffic generation and transportation systems in urban areas. Chapters: Urban Structure, Land-use Control, Land-use Stability, The Highway System, Highway Functional Classification, Access Controls, Highway Design Control, Traffic Generation, Freeway Interchanges.

Ohio Department of Highways. "Factors Influencing Land Development-Subdivision Development Study." September, 1970.

Study of 16 subdivisions in different locations to freeways. Average percentage of sales per month used as a measure of success and analyzed on the background of freeway exposure of lots, distance to CBD-area, commercial influence, etc.

Pendleton, W. C. "Relation of Highway Accessibility to Urban Real Estate Values." Highway Research Record No. 16, Highway Research Board (1963).

A study of Washington metropolitan area showed that sales prices set in the real estate market do reflect accessibility differences.

Pillsbury, Warren A. "Economics of Highway Location: A Critique of Collateral Effect Analysis." Highway Research Record No. 75, Highway Research Board (1965), pp 53-61.

Discussion of different methods for economic analysis of possible highway locations. Highway economic impact may be one factor in the analysis, but nothing is said about how to calculate economic effect in a highway corridor.

Raup, P. M. "The Land Use Map Versus the Land Value Map - A Dichotomy." Bulletin 227, Highway Research Board (1959), pp 83-88.

Discussion of the sequence of changes in land-use and land values. Land values may express anticipated development, and not the actual changes. Also discussion of a mapping technique for land use and land values.

Sauerlender, O. H., R. B. Donaldson, and R. D. Twark. "Factors That Influence Economic Development at Non-urban Interchange Locations." The Pennsylvania State University, 1967.

The development in 36 typical interchanges in Pennsylvania was analyzed on the background of the characteristics of each interchange and the surrounding region. Indicates factors that should be useful as predictors of development.

Skorpa, L., Dodge, R., Walton, C. M. and Huddleston, J. "Transportation Impact Research: A Review of Previous Studies and a Recommended Methodology for the Study of Rural Communities." The University of Texas at Austin, 1974.

Spears, John D., and Charles G. Smith. "Final Report on a Study of the Land Development and Utilization in Interchange Areas Adjacent to Interstate 40 in Tennessee." University of Tennessee, July, 1970.

Study of adjacent properties to 74 interchanges on I-40 between Memphis and Knoxville, with listing of tracts, property sales and land uses. Summary of interchange development in different groups of interchanges.

Stein, Martin M. "Highway Interchange Area Development - Some Recent Findings." Public Roads Vol. 35, No. 11 (December, 1969), pp 241-250.

The study of 332 interchanges in 16 states shows that interchange land development is affected both by type of intersecting road and by the relative accessibility of the interchange quadrants.

Stover, V. G., W. G. Adkins, and J. C. Goodknight. "Guidelines for Medical and Marginal Access Control on Major Roadways." National Cooperative Highway Research Program, Report 93 (1970).

One of the chapters, "Highways and Economic Development," summarizes previous research about economic impact on land values in interchanges, bypass effect, etc.

Stroup, R. H., and L. A. Vargha. "Economic Impact of Secondary Road Improvements." Highway Research Record No. 16, Highway Research Board (1963), pp 1-13.

The study may show that there is a relationship between changes in retail business and road improvement. The geographic dispersion of business may be expressed as a function of population density, per capita income and proportions of farms on all-weather roads. Rural area (six counties) in Kentucky.

Stroup, R. H., L. A. Vargha, and R. K. Main. "Predicting the Economic Impact of Alternate Interstate Route Locations." Bulletin 327, Highway Research Board (1962), pp 67-72.

Report of a study method used in an examination of the comparative economic impact of three alternative routes for 1-65, Kentucky.
Use of the concept of an economically "neutral" road, against which the three alternative routes are compared (on the basis of access, visibility of establishment, development potential, etc.)

Texas Aeronautics Commission. "Importance of a Modern Airport, Austin, Texas, 1965."

Attitude survey among towns and small communities in Texas about how important they consider an airport to be.

Texas Transportation Institute. "Economic Effects of Bypasses and Freeways." Bibliography.

Listing and short description of 38 papers and studies about economic effect of highways.

Thiel, Floyd I. "Social Effects of Modern Highway Transportation." Bulletin 327, Highway Research Board (1962), pp 1-20.

Discussion of some ways in which highways affect the way of living. Effect on population mobility, residences, relocation, employment conditions, public services, education, rural employment and improvement (reference to a study, Montana), recreation, etc.

____________. "Seminar on Sociological Effects of Highway Transportation, Introductory Remarks." Highway Research Record No. 75, Highway Research Board (1965), p 75.

Five different articles, dealing with sociological effects and (one article) trip generation.

____________. "Highway Interchange Area Development." Public Roads Vol. 33, No. 8 (June, 1965), pp 153-166.

About controlling the development in interchange areas. Includes discussion of development problems, available means of controls, application of control, space needs at interchanges, and techniques to implement interchange planning.

U. S. Congress. "Final Report of the Highway Cost Allocation Study." House Document No. 72, 87th Congress, 1st Session, January 1961.

Mainly summary of changes in land values from previous highway impact studies.

U. S. Department of Transportation. "Benefits of Interstate Highways." Federal Highway Administration, U. S. Department of Transportation, June 1970.

Summary of user and non-user benefits from interstate highways. General economic and community benefits: land use and value, industrial and commercial effect, non-work opportunities, opportunities for community change, etc.

U. S. Department of Transportation. "Economic and Social Effect of Highways." Federal Highway Administration, U. S. Department of Transportation, 1972.

Review of 200 studies of the economic and social effects of highways, a narrative discussion of the studies and abstract of 178 studies.

U. S. Department of Transportation. "Guide for Highway Impact Studies." Federal Highway Administration, 1973.

States the need for impact studies and indicates types of studies that may be especially appropriate in identifying social and economic effects. Lists and describes socioeconomic studies proposed, studies in progress, and studies recently completed.

Vargha, Louis A. "Highway Bypasses, Natural Barriers, and Community Growth in Michigan." Bulletin 268, Highway Research Board (1960), pp 29-36.

The freeway as a physical barrier.

Vaughan, C. M. "Development Aspects of Kentucky's Toll Roads." American Society of Mechanical Engineering Publication 73-ICT-19 (1973).

The study uses the analysis of covariance to separate the rate of change in manufacturing employment and personal per capita income in those counties which have limited access highways, toll roads and interstates, from those countries which have neither of the aforementioned.

Vogt, Ivers & Associates. "Social and Economic Factors Affecting Intercity Travel." National Cooperative Highway Research Program Report 70 (1969).

Warner, A. E. "The Impact of Highways on Land Uses and Property Values." Michigan State University, March, 1958.

A Review of current studies with bibliography.

Wheat, Leonhard F. "The Effect of Modern Highways on Urban Manufacturing Growth." Highway Research Record No. 277, Highway Research Board (1969), pp 9-24.

Nationwide study of manufacturing growth in 212 cities (population 10,000-50,000), 106 "freeway-cities" (< 7 miles from freeway) and 106 "non-freeway-cities" (>16 miles from freeway). The study findings indicate that modern highways do significantly affect manufacturing growth, but not in all situations. Freeway-cities grew faster only in regions where traffic flow along regular highways is seriously impeeded. The study also considers effect of air service, rail, waterways, and distance to freeway.

Wootan, C. V. and H. G. Meuth. "Economic Impact Study, Temple Texas." Texas Transportation Institute, Bulletin 14 (1960).

Study of the economic impact of the new by-pass route for IH 35, Temple, Texas. The study area is located along a section (3 miles) of the new IH 35. Changes in land values compared to a control area; changes in land use along the new route; and changes in business activity along the new and old route.

Wynn, F. Houston. "Who Makes the Trips? Notes on an Exploratory Investigation of One-Worker Households in Chattonooga." Highway Research Record No. 75, Highway Research Board (1965), pp 84-91.

Studies question: given shorter working days and/or shorter working weeks - how will this affect future urban travel demands?

Zinkefoose, Paul W. "Economic Survey of Anthony. New Mexico - Texas." New Mexico State University, Bulletin No. 41 (May, 1970).

Study of the impact of highway relocation in a small town having practically no economic data. More or less a general description of the effect.