Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-98/1327-2		

4. Title and Subtitle	5. Report Date
LAND VALUE AND LAND USE EFFECTS OF ELEVATED, DEPRESSED, AND AT-GRADE LEVEL FREEWAYS IN TEXAS	July 1997
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Carol A. Lewis, Jesse L. Buffington, Sharada R. Vadali, and Ronald E. Goodwin	Research Report 1327-2

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Study No. 0-1327

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin, Texas 78763-5080	Interim: September 1992—August 1996
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.
Research Study Title: Social, Economic, and Environmental Effects of Elevated and Depressed Freeways

16. Abstract

To answer questions being raised by abutting residents and businesses about proposed elevated and/or depressed freeway improvements in the urban and suburban areas of Texas, a four-year study has been conducted to estimate the social, economic, and environmental effects of such freeway designs. Eight existing, two under-construction, and one approved-for-construction freeway sections have been studied on a before-, during-, and after-construction basis. The sections selected for study range from being predominantly residential suburban areas to predominantly commercial-industrial downtown areas. The specific effects of the study estimated for each study section include: (1) social impacts: population changes, neighborhood, accessibility, and neighborhood cohesion; (2) economic impacts: relocation and mitigation costs, business sales, property uses and values, tax revenues, employment and income, and user costs; and (3) environmental impacts: aesthetics, drainage and erosion, noise and air pollution, vibration, and hazardous spills. The literature review and a survey of highway agencies in other states were used to determine the appropriate procedures or models and mitigation measures to implement in estimating the social, economic, and environmental impacts of elevated and depressed freeways.

The results of the study, presented in six separate reports according to types of effect, can be used by highway planning and designing engineers to prepare environmental statements and documents of the expected social, economic, and environmental impacts of proposed elevated and depressed freeway projects. Also, the results can be disseminated at the public hearings for a proposed project. This report presents the findings of the land value and use effects of elevated, depressed, and at-grade level freeways. The findings from prior studies indicate that freeway grade level differences in abutting land values are significant for certain land uses. However, these differences are negative or positive, depending upon the type of abutting land use. The results of this study confirm those findings.

17. Key Words	18. Distribution Statement
Traffic, Grade Level, Elevated, Depressed, At-Grade Combination or Double, Impacts, Effects, Distance, Freeway Study Sections, Mitigation, Walls and Barriers, Aesthetics, Land Values, Land Uses, Zoning Ordinances, City, Urban, Suburban	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	150	

LAND VALUE AND LAND USE EFFECTS OF ELEVATED, DEPRESSED, AND AT-GRADE LEVEL FREEWAYS IN TEXAS

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Sponsored by the
Texas Department of Transportation
In Cooperation with
U.S. Department of Transportation
Federal Highway Administration

July 1997

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IMPLEMENTATION STATEMENT

The findings of this study can be used by TxDOT to improve its procedures for estimating and evaluating land value and use effects from proposed elevated, depressed and at-grade freeways. The findings indicate that the grade level differences in abutting land values and uses are significant in certain circumstances. All things being equal, the specific grade level designs of each freeway study section do affect land values enough for transportation planners and design engineers to carefully consider which freeway grade level is most feasible for the dominant abutting land use being encountered. The findings of this study will be useful in planning and conducting public hearings. Also, the findings can be incorporated into environmental impact statements.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented. The contents do not necessarily reflect the views or policies of the Texas Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. It is not intended for construction, bidding, or permit purposes.

ACKNOWLEDGMENT

The authors want to thank Mr. Jon Underwood, Director, Research and Technology Transfer Office, and staff members Lana Ashley and Klaus Alkier for assistance in handling TxDOT administrative matters pertaining to the study. Special thanks are given to the TxDOT technical panel members, Joe B. Thompson, Project Director, Melissa Neeley, Peggy D. Thurin, and John P. Kelly, Original Project Director, for providing oversight and direction to the study. The research team is especially appreciative of the many TxDOT district personnel for their help in the selection of study sections and responding to various data requests during the life of this study. These personnel are named by their respective districts or organizations as follows:

Dallas District:

Richard H. Rawles, Jr., Former Director of Construction; Gary W. Taylor, Project Manager of North Central Project Office; and Terry L. May, District Right-of-way Engineer, and the Dallas Area Appraisal District.

Houston District:

Hans C. Olavson, Director of District Transportation Planning; Dennis W. Warren, Director of Construction; and Thomas N. Lou, Assistant to Director of Transportation and Planning, and the Houston/Harris County Appraisal District.

Harris County Toll Road Authority:

Wesley E. Freise, Executive Director.

Lubbock District:

Carl R. Utley, District Engineer; V.G. Chetty, Former Deputy District Engineer; John E. Rantz, Director of Operations and Construction; Steven P. Warren, Director of Transportation Planning and Development; Ted Copeland, Traffic Engineer; Mike Craig, Assistant District Design Engineer; Davis Melton, Environmental Coordinator; and Claude C. Kneisley, Right-of-way Supervisor, and the Lubbock Appraisal District.

San Antonio District:

John P. Kelly, District Engineer; Julie Brown, Director of Transportation Planning and Development; Mary T. Richards, Environmental Coordinator; Gilbert G. Gavia, District Design Engineer; Felix A. Lemra, District Design Section; and Herbie L. Belvin, District Right-of-way Administrator. Additional thanks to the San Antonio Appraisal District.

The authors also wish to acknowledge the Federal Highway Administration for providing funding and technical support for the study.

Other members of the Texas Transportation Institute gave valuable assistance to the study. Dr. W.F. McFarland, Research Economist and Head of the Transportation Economics Program, gave administrative support. Thanks are due Mr. Alan G. Nelson, Student Worker, for his hard work in data entry and reduction and Mrs. Cheryl Kruse, Secretary for the Transportation Economics Program, who took care of much of the paperwork for the study and also assisted with the data entry. Thanks are due Diana G. Wallace, Assistant Research Specialist; Stephen E. Ranft, Research Associate; Darrell W. Borchardt, Associate Research Engineer; and Paul A. Hawkins, Assistant Research Scientist, for their help in collecting all of the traffic data needed for this study.

Thanks are due the Center for Transportation Training and Research staff - particularly, Naomi W. Ledé and Lei Yu for professional consultation; Khosro Godazi for technical assistance; Zhe Shen, Barney McCoy, and Terrance Mims for data collection and entry; Raquelle R. Wooten for computer mapping production; and DeLinda Marzette for editorial support.

Lastly, thanks are due Ms. Linda Pedro and Mr. Mack Lindsey of the Research Division of the Texas State Comptroller's Office for their help in furnishing business gross sales and state sales tax data needed for this study.

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SUMMARY

The Texas Department of Transportation is continually upgrading the existing highway system in the state, especially in urban and suburban areas. Such freeway improvements are made at varying grade levels, i.e., at-grade, elevated, and depressed, depending on terrain, land use, and other variables. The current trend in design is toward elevated and depressed sections to gain additional lanes. Even though many sections of the elevated and depressed freeways have been built over the years, questions are still raised by abutting or nearby residents and businesses about the possible negative impacts of such freeways. The literature regarding land value impacts from freeways indicates that freeway grade has a consistent influence on land value, with properties adjacent to at-grade and depressed sections at higher values than elevated properties. Previous studies found that land use contributes to values, with commercial, industrial, and institutional uses favored over residential use. Further, it has been documented that properties suffer during the freeway construction stage, but values generally return to pre-construction levels after the fifth year of operation.

A study was conducted of freeway sections in Houston, San Antonio, Lubbock, and Dallas, Texas, to determine the effect of freeway grade on land value. The findings support the trends reported in previous literature but also offer additional insight. The "life cycle effect," that freeway land value is impacted by construction but rebounds thereafter, was confirmed through this analysis. Also consistent with findings from previous studies, commercial, institutional, and industrial uses tend to have higher values compared to other land uses. Regarding grade level, in the aggregate, the findings support that elevated values are less and show smaller percentage increases over pre-construction rates than properties at-grade or depressed. This study shows, however, that some residential and commercial parcels next to elevated freeways show stable to increasing values when compared to sections at other grades.

INTRODUCTION

STUDY PROBLEM STATEMENT

The Texas Department of Transportation (TxDOT) is continually upgrading the existing highway system in the state, especially in urban and suburban areas. This upgrading involves improving existing highways or freeways on the existing route or on a new route which parallels the old route (or bypassing the central city). Such freeway improvements are made at varying grade levels, i.e., at-grade, elevated grade, and depressed grade, depending on the terrain, land use, and other factors. The choice of grade level at a particular point may be an attempt to mitigate negative noise and aesthetic impacts on a residential neighborhood within available financial bounds. The current trend in design is toward elevated and depressed sections to gain additional lanes. The elevated sections may be either earthen or bridge in form. Sections of each type of grade level have been built over the years since the late 1950s. Many are over twenty years old. However, quite a few sections have been built during the last five to ten years, and some sections are either under construction or in the planning stages.

Even though many sections of elevated and depressed freeways have been built over the years in the state, more and more questions are being raised by abutting or nearby residents and businesses about the possible negative impacts of such freeways. In recent years, stiff resistance has been given to the proposed elevated section of the Dallas North Central Expressway and more recently to the proposed elevated or depressed section of U.S. Highway 287 in Wichita Falls. Also, the elevated sections of U.S. Highway 183 now under construction in Austin have caused similar concerns.

Any highway improvement, regardless of grade level, not only impacts users but also impacts abutting and nearby property owners, businesses, and residents in some manner. Even the whole city or community may be impacted in some way during and after construction. Elevated and depressed freeway designs raise particular questions concerning noise and air quality impacts, but vibration in moving vehicles and/or in structures, and flooding of depressed freeways are additional concerns. The recent flooding of a depressed section of I-10 in Houston dramatized the latter problem. Soil erosion, at the

point of drainage discharge, can also cause a problem. Aesthetic qualities of elevated and depressed sections are also matters of concern.

Impacts that result from elevated and depressed freeway improvements can be classified into three major types: (1) social, (2) economic, and (3) environmental. A partial list of the specific impacts of each of the major types is given below. The social impacts are: population changes, neighborhood accessibility, neighborhood cohesion, and community services. The economic impacts are: relocation and mitigation costs, business sales, land uses and property values, tax revenues, employment and income, and user costs. The environmental impacts are: aesthetics, drainage and erosion, air quality, noise and vibration, and hazardous spills.

A preliminary search of the literature reveals very few case studies that have measured many of the social, economic, and environmental impacts of depressed and elevated freeways, especially those in Texas. Therefore, the highway decision-makers have very little relevant impact data to write and support the environmental assessment statements and to present at public hearings for proposed elevated and depressed sections of existing or proposed freeways.

STUDY OBJECTIVES

The general objective of the study is to determine the social, economic, and environmental effects of elevated and depressed freeways in urban and suburban areas. The more specific objectives of the study are listed below.

1. Determine the appropriate estimating procedures or models and mitigation measures to be used in this study to estimate the social, economic, and environmental effects of elevated and depressed freeways.
2. Estimate the social, economic, and environmental effects of several existing, contracted, and proposed elevated and depressed freeway sections situated in urban areas of Texas, and recommend a final set of impact estimating procedures for use by TxDOT.

SELECTION OF FREEWAY STUDY SECTIONS

At the beginning of this study, researchers conducted a survey of all of TxDOT's districts in order to locate all of the elevated and depressed freeway sections which were at least 0.805 kilometers (one-half mile) long that were planned, under construction, or recently constructed during the last ten years. (Copies of the survey forms appear in Appendix 1.) In the survey, the researchers asked for TxDOT to indicate the location (downtown or suburban), abutting land use, and age (less than five years or more than five years) of each qualifying freeway section. Later, a determination was made whether each freeway section was on an existing highway route or a new location. These were considered primary characteristics to be used in selecting the freeway study sections.

A total of thirty freeways (eleven elevated and nineteen depressed) were identified and reported by the TxDOT districts. Of these, twelve (six elevated and six depressed) were planned; three (one elevated and two depressed) were under construction; and fifteen (four elevated and eleven depressed) were recently constructed. Each of the thirty candidate study sections were personally inspected by a TTI researcher team accompanied by a TxDOT district official.

With the help of TxDOT's study panel members, eleven freeway sections were identified for study; two (one elevated and one depressed) were planned; two (one elevated and one depressed) were under construction; and seven (three elevated and four depressed) were built. Of the seven already built, three (two elevated and one depressed) were less than four years old, and four (one elevated and three depressed) were over four years old.

LOCATION AND CHARACTERISTICS OF STUDY FREEWAY SECTIONS

Table 1 shows the selected study sections: type of grade level, location, abutting land use, and age. As can be seen, an attempt was made to have a fairly good mix of study sections representing different types of location, stages of construction, freeway ages, and land uses for each of the study grade levels.

The eleven study sections are located in four Texas cities: Dallas, Houston, Lubbock, and San Antonio with one depressed section on U.S. Highway 75 in Dallas; one depressed section on the Sam Houston Tollway in Houston; and four sections in Lubbock.

Two of these are located on I-27 (one elevated and one depressed), and two are located on the planned East-West Freeway (U.S. Highways 62/82), one elevated and one depressed. Figures 1 through 4 show the specific location of the study sections within the four cities, respectively.

Tables 2 and 3 show other important characteristics of each study section by study grade level. Some of these characteristics are used in evaluating the different impacts considered under this study.

TYPICAL CROSS-SECTIONAL DESIGN OF STUDY FREEWAY SECTIONS

Figures 5 through 9 show the typical cross-sectional designs of the study freeway sections. There are some variations in cross-sectional design through each study section, depending on the specific location. For instance, only one of the cross-sections shows the on and off ramp designs or the variation in the number of main lanes or frontage road lanes throughout the study section.

GENERAL METHODOLOGY AND DATA SOURCES

The general methodology planned for this study was to conduct a "before and after" construction period comparative analysis across time, supplemented with a cross-sectional analysis at one point-in-time. The eight completed freeway study sections lend themselves easily to both analyses. The three others can be used to provide current before and/or construction period data to supplement these analyses. For instance, the two study sections still under construction, at time of selection, can be used to study some of the construction effects of each grade level. The two planned study sections can be used to estimate anticipatory effects by grade level.

The before and after analysis can compare the elevated freeway sections with depressed freeway sections to ascertain any significant differences in various types of impact elements, (i.e., air pollution, noise pollution, business activity, neighborhood cohesion, etc.). The one point-in-time analysis can compare current level unit values of each impact element to determine significant differences between elevated and depressed freeway grade levels. For either of these analytical approaches, elevated study sections can

be compared with depressed study sections; also these two grade levels can be compared with adjacent or nearby at-grade level sections. The at-grade sections, when available, can serve as a control or base section.

Sources of data used in the study ranged from a review of the literature to "on-site" data collection. The prior studies found in the literature, as well as data obtained from a national survey of state transportation agencies, helped the different methodologies used in the study. The data obtained to estimate the effects of the different impact elements came from the literature, national survey, United States Census Bureau, Texas State Comptroller and Employment Commission, TxDOT, Environmental Impact Statements (EIS) of each of the study sections, and city criss-cross directories. In addition, the study team conducted site surveys of businesses and residents, traffic volumes and composition, air and noise levels, drainage, erosion, and other environmental conditions.

REPORTS OF FINDINGS

Since this study involves the study of many different impact elements, the findings are presented in several reports by type of impact. The reports are as follows:

- Research Report 1327-1:
  Social and Economic Effects of Elevated and Depressed Freeways in Texas
- Research Report 1327-2:
  Land Value and Use Effects of Elevated and Depressed Freeways in Texas
- Research Report 1327-3:
  Noise Pollution Effects of Elevated and Depressed Freeways in Texas
- Research Report 1327-4:
  Air Pollution Effects of Elevated and Depressed Freeways in Texas
- Research Report 1327-5:
  Drainage, Erosion, Hazardous Spill, Vibration and Aesthetic Effects of Elevated and Depressed Freeways in Texas
- Research Report 1327-6F:
  Social, Economic and Environmental Effects of Elevated and Depressed Freeways in Texas

Research Report 1327-1 contains a summary of the findings from the national survey of state transportation agencies, the Texas survey of TxDOT districts, a description of the cities, and areas of the cities where the freeway study sections are located. This report, Research Report 1327-2, contains the findings on the effects of elevated and depressed freeways on land values and uses.

Table 1. Freeway Sections Selected for Study by Type of Grade Level Design and Key Characteristics

TYPE OF DESIGN/Number/ STATUS	CITY & HIGHWAY Type/Number	ROUTE LOCATION	SECTION LOCATION	ABUT LAND USE
Elevated Sections				
No. 11- Planned	Lubbock U.S. 62/82	Existing	Suburban	Res/Com
No. 8-Built Under 4 Yrs	Lubbock I-27	New	Downtown	Com/Ind
Depressed Sections				
No. 10-Planned	Lubbock U.S. 82	Existing	Downtown	Com/Pub/ Res
No. 7-Under Construction	Dallas U.S. 75	Existing	Downtown & Suburban	Com/Res
No. 9-Built Under 4 Yrs	Lubbock I-27	New	Suburban	Res/Com
No. 5-Built Under 4 Yrs	San Antonio U.S. 281	Existing	Suburban	Vacant/ Res/Com
No. 1-Built Over 4 Yrs[1]	San Antonio I- 35	Existing	Downtown	Res/Com
No. 6-Built Over 4 Yrs	Sam Houston Tollway	New	Suburban	Res/Com
Combination Elevated & Depressed Sections				
No. 2-Built Under 4 Yrs	San Antonio I-35	Existing	Downtown	Res/Com
No. 3-Built Under 4 Yrs	San Antonio I- 10	Existing	Downtown	Res/Com
No. 4-Built Over 4 Yrs	San Antonio I-10/35	Existing	Downtown	Com/Ind

[1]No basic grade level change in this section, but adjacent to a new elevated/depressed section having feeder ramps extending into this section.

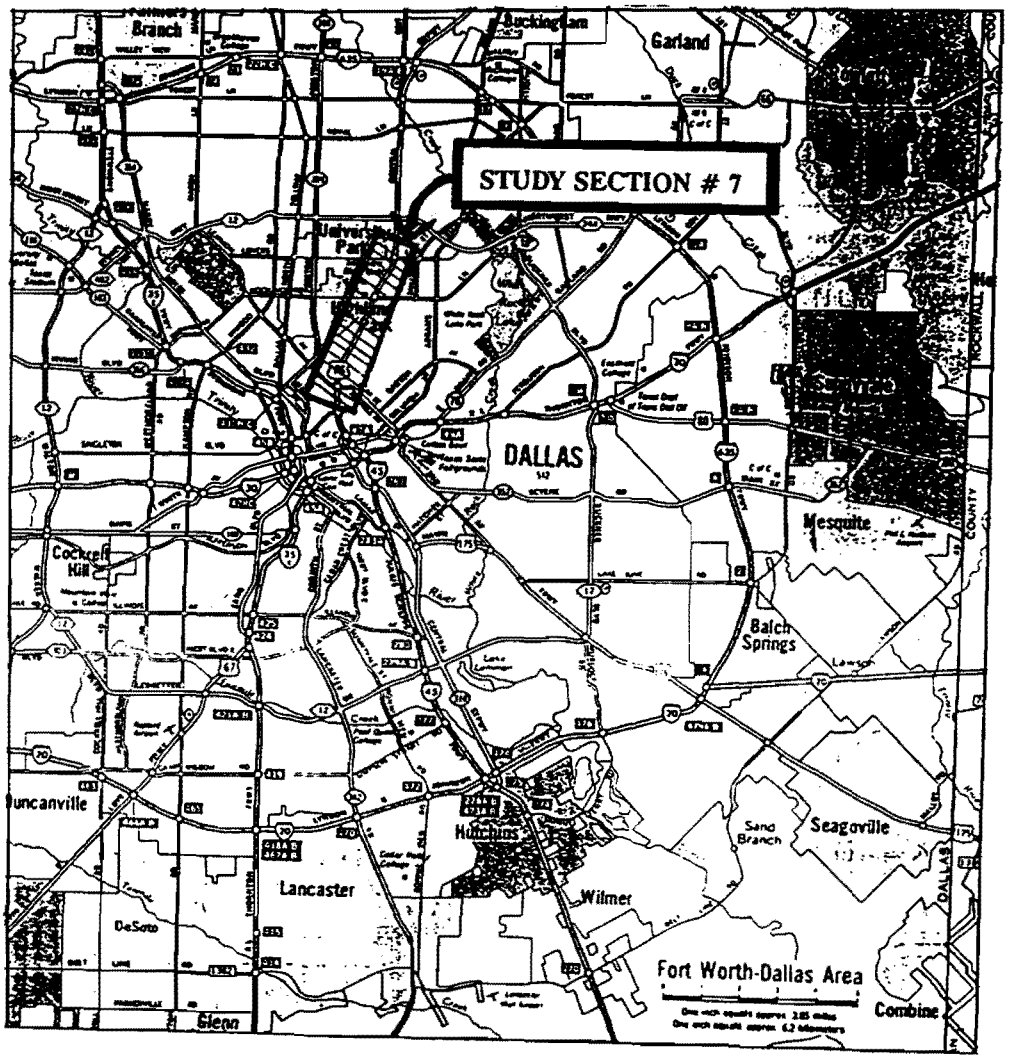


Figure 1. Location of Study Section 7 on U.S. Highway 75 (Central Expressway) Near Downtown Dallas

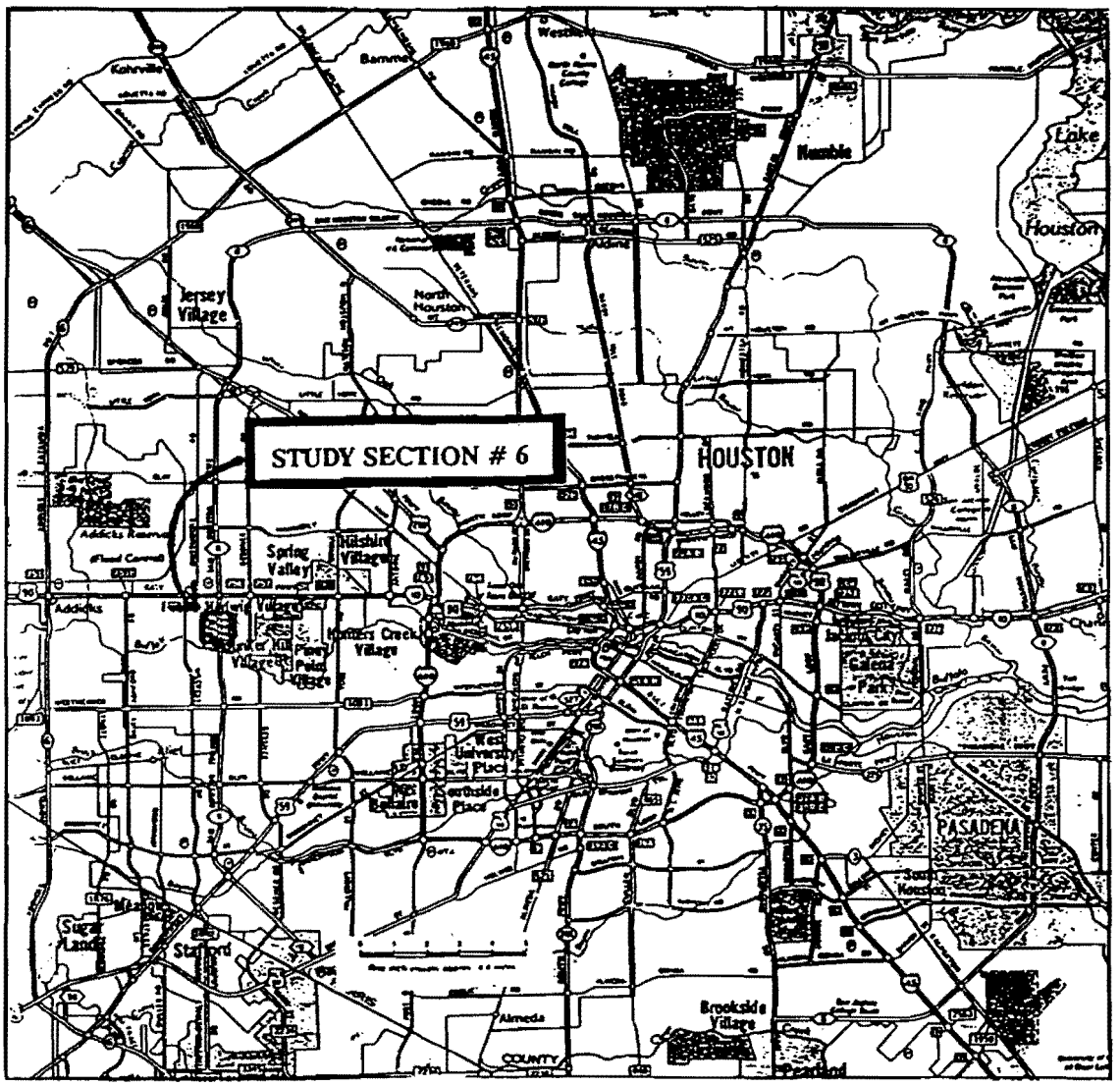


Figure 2. Location of Study Section 6 on the Sam Houston Tollway in Southwestern Houston

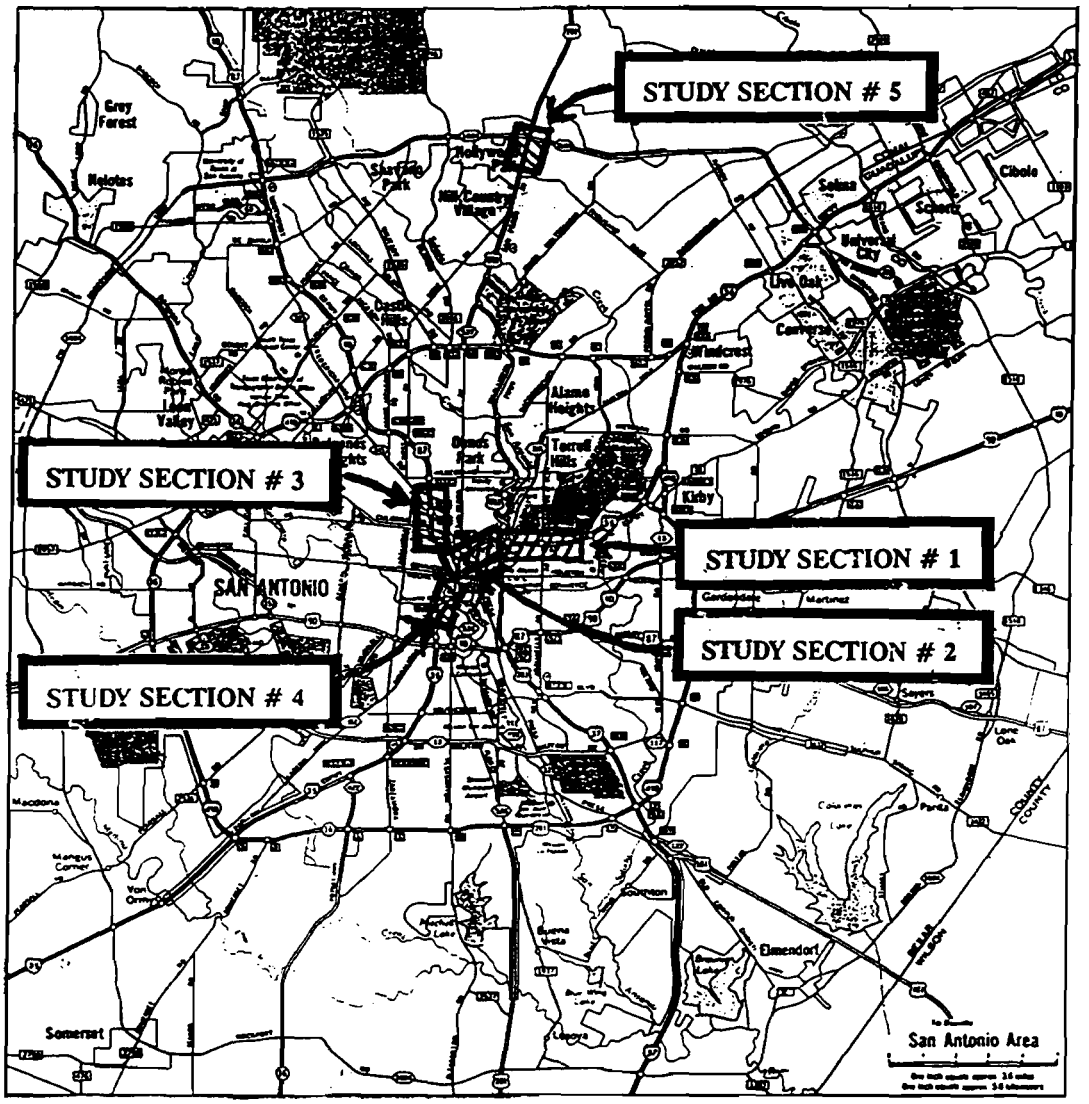


Figure 3. Location of Study Sections 1-5 on I-10/35, 35, and U.S. Highway 281 in San Antonio

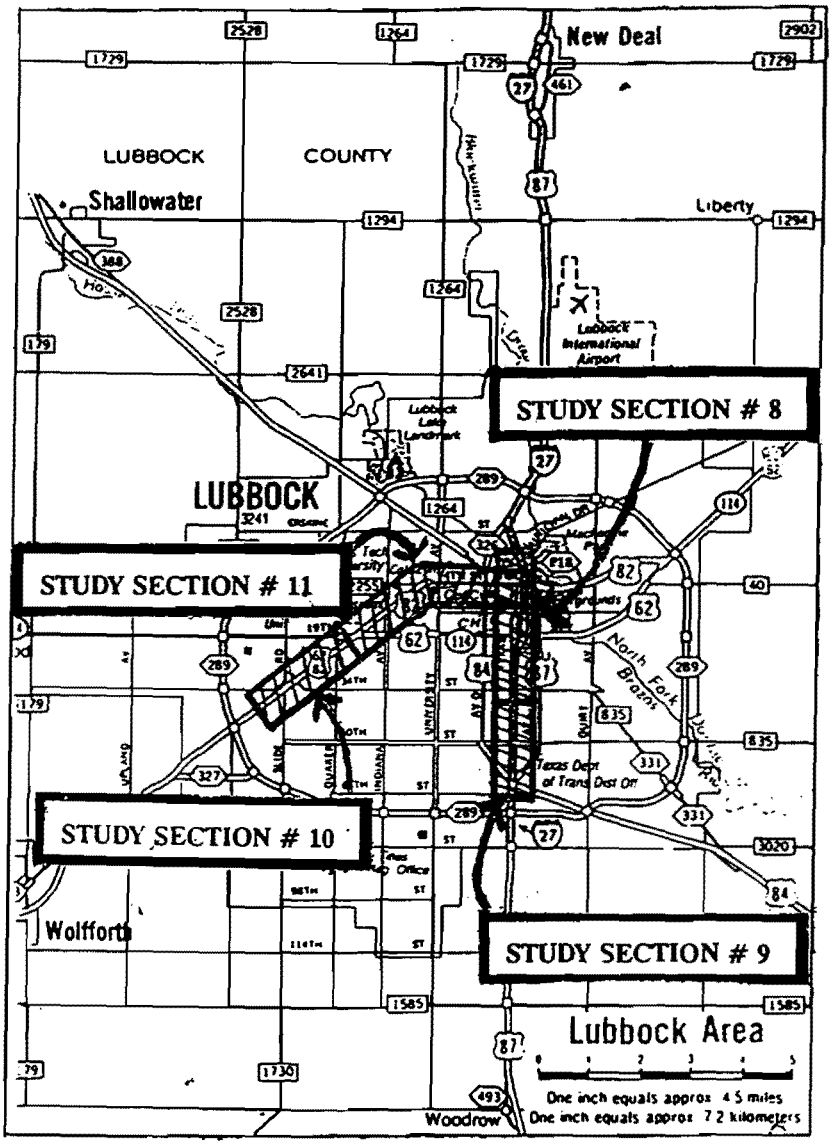


Figure 4. Location of Study Sections 8-11 on I-27 and U.S. Highways 62/82 (Proposed East-West Freeway) in Lubbock

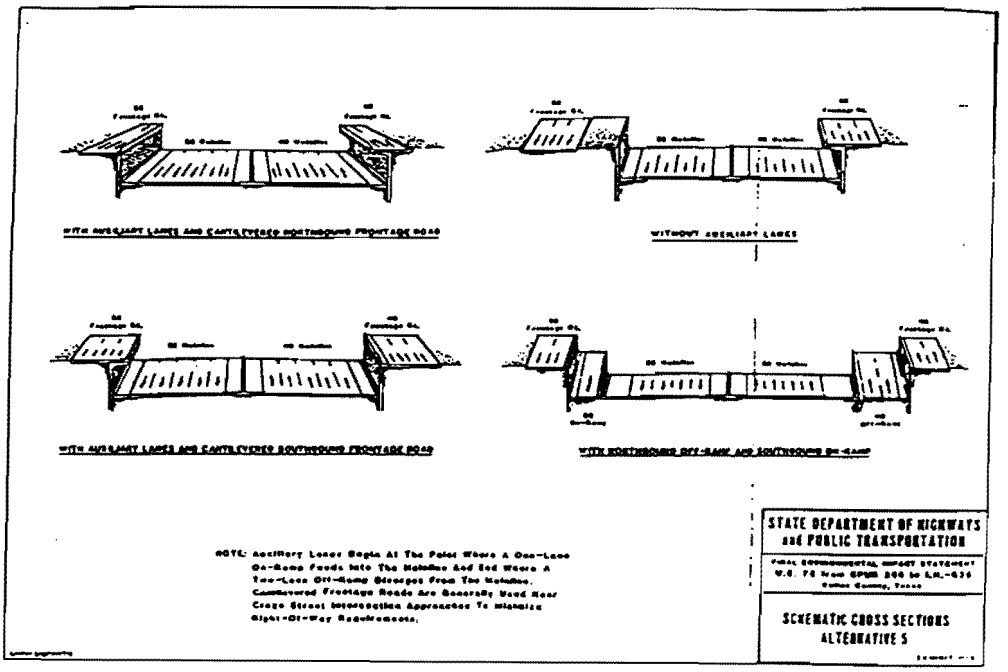
Table 2. Study Freeway Sections by Age, Grade Level Before, Length, Grade Level Depth, Right-of-Way Width, Type of Main Lane Access and ADT*

STUDY NO./ TYPE OF GRADE LEVEL AFTER CONSTRUCTION	AGE AFTER (yrs)	GRADE LEVEL BEFORE	LENGTH AFTER km(mi)	GRADE LEVEL HEIGHT/DEPTH m(ft)		RIGHT-OF-WAY WIDTH m(ft)		TYPE OF ACCESS TO MAIN LANES		ADT	
				BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
Elevated/Combination Elevated & Depressed											
No. 2 I-35-San Antonio	1	depressed	2.01(1.25)	-4.6(-15)	+6.1(+20)	64.0(210)	70.7(232)	full	limited	75,600	188,300
No. 3 I-10- San Antonio	3	depressed	2.96(1.84)	0(0)	+6.1(+20)	65.5(215)	74.7(245)	limited	limited	94,100	198,500
No. 4 I-10/35- San Antonio	6	elevated/ depressed	2.28(1.42)	+6.1(+20)	+6.1(+20)	61.0(200)	76.2(250)	limited	limited	79,800	186,500
No. 8 I-27- Lubbock	3	at-grade	3.02(1.88)	0(0)	5.5(+18)	38.1(125)	121.9(400)	full	limited	42,352	77,350
No. 10 U.S. 62/82- Lubbock	0	at-grade	2.32(1.44)	0(0)	+6.4(+21)	53.6(176)	97.5(320)	full	limited	22,493	52,533
Depressed											
No. 6 Sam Houston Beltway- Houston	6	at-grade	2.09(1.30)	0(0)	-5.2(-17)	91.4(300)	91.4(300)	full	limited	84,000	168,000
No. 7 U.S. 75-Dallas	0	at-grade	6.47(4.02)	0(0)	-6.7(-22)	67.1(220)	85.3(280)	limited	limited	155,000	217,700
No. 9 I-27- Lubbock	3	at-grade	4.84(3.01)	0(0)	-5.2(-17)	38.1(125)	121.9(400)	full	limited	42,356	77,350
No. 11 U.S. 62/82- Lubbock	0	at-grade	2.56(4.12)	0(0)	-6.7(-22)	53.7(176)	102.1(335)	full	limited	22,656	34,483
No. 1 I-35- San Antonio	10	depressed	2.22(1.38)	-4.6(-15)	-4.6(-15)	91.4(300)	91.4(300)	limited	limited	50,000	150,000
No. 5 U.S.281- San Antonio	5	at-grade	2.85(1.77)	0(0)	-6.4(-21)	91.4(300)	91.4(300)	full	limited	12,700	94,000

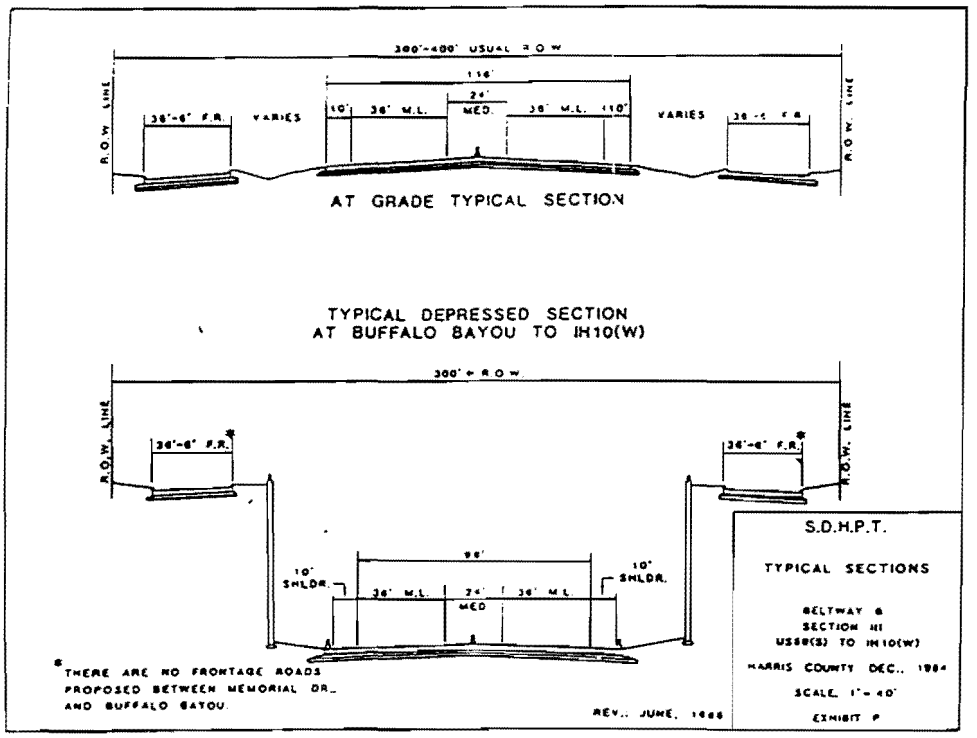
* Note: Tables indicate study sections only. At-grade control sections are not designated here.

Table 3. Study Freeway Sections by Number of Structures, Crossing Streets, Main Lanes, On Ramps and Off Ramps

STUDY NO./ TYPE OF GRADE LEVEL AFTER CONSTRUCTION	STRUCTURES (NO.)		CROSSING STREETS (NO.)		MAIN LANES (NO.)		ON RAMPS (NO.)		OFF RAMPS (NO.)	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
Elevated/Combination Elevated & Depressed										
No. 2 I-35 -San Antonio	11	12	11	11	4	10	4	8	6	8
No. 3 I-10 - San Antonio	9	11	6	6	4	10	3	6	5	6
No. 4 I-10/35 - San Antonio	6	8	8	8	6	10	4	6	4	3
No. 8 I-27 - Lubbock	2	6	21	6	4	6	0	4	0	3
No. 10 U.S. 62/82 - Lubbock	2	4	5	3	4	6	0	3	0	3
Depressed										
No. 6 Sam Houston Beltway-Houston	0	3	7	3	4	6	0	2	0	2
No. 7 U.S.75 - Dallas	13	14	13	13	4	8	16	5	16	5
No. 9 I-27 - Lubbock	0	7	11	4	4	6	0	2	0	2
No. 11 U.S. 62/82 - Lubbock	4	21	22	15	4	6	0	8	0	8
No. 1 I-35 - San Antonio	9	9	7	7	6	6	3	3	3	3
No. 5 U.S. 281 - San Antonio	1	2	2	2	4	6	0	3	0	3

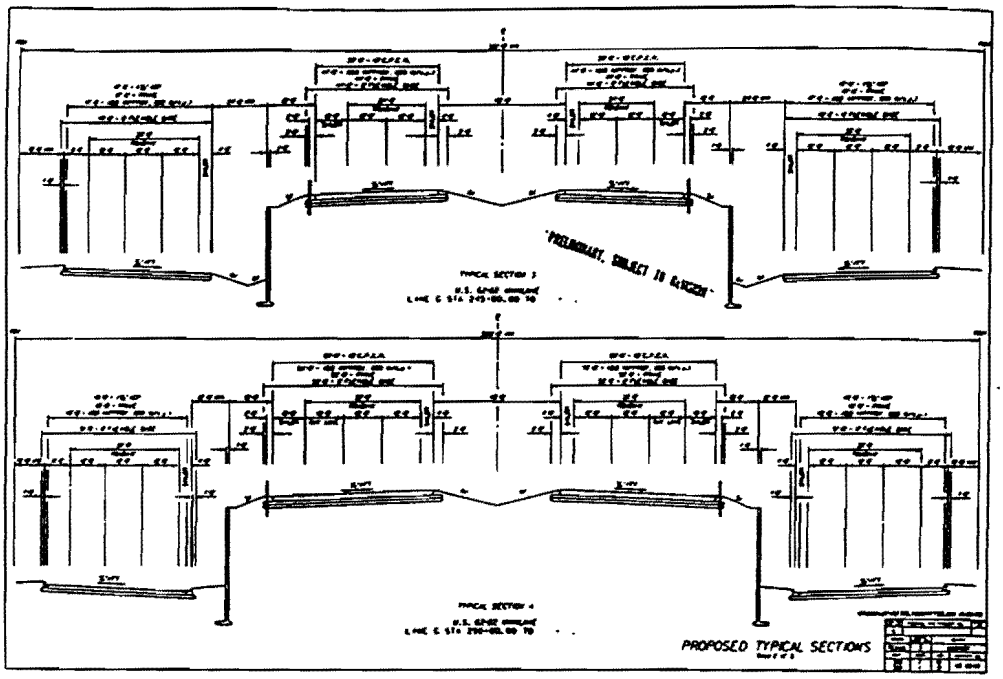


U. S. Highway 75 Section # 7, Dallas

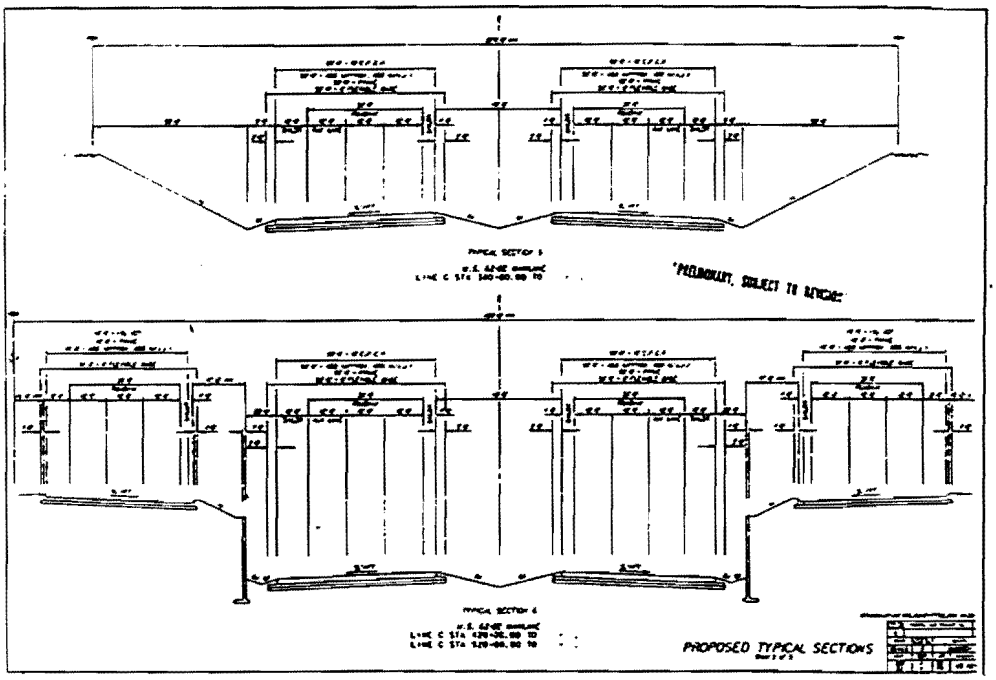


Sam Houston Tollway Section # 6, Houston

Figure 5. Typical Cross-sectional Design of Depressed Study Sections on U.S. Highway 75 in Dallas, Texas, and Sam Houston Tollway in Houston, Texas

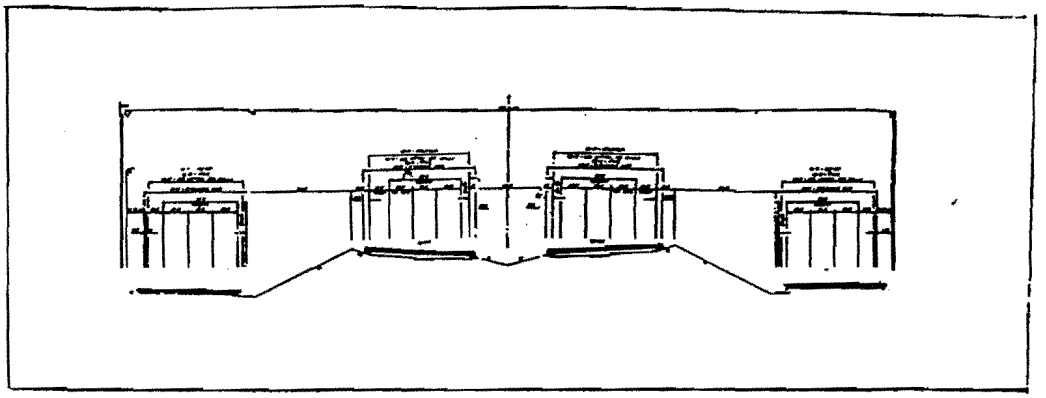


Elevated Section # 10

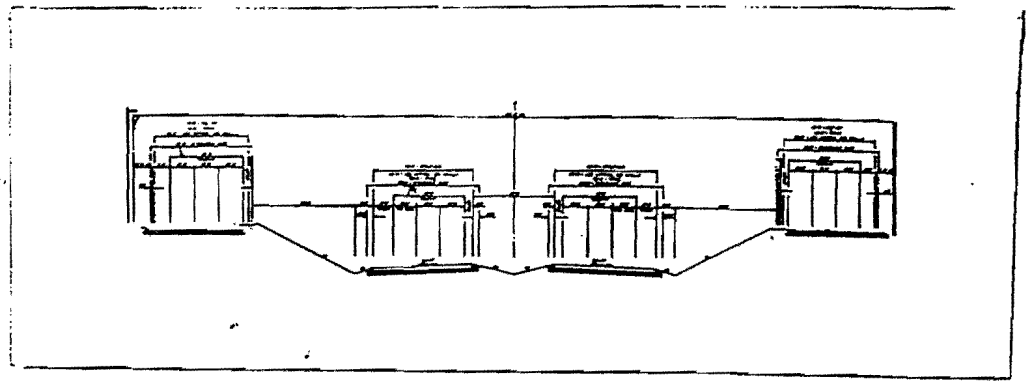


Depressed Section # 11

Figure 6. Typical Cross-sectional Design of the Depressed and Elevated Study Sections on the Planned East-West Freeway in Lubbock, Texas

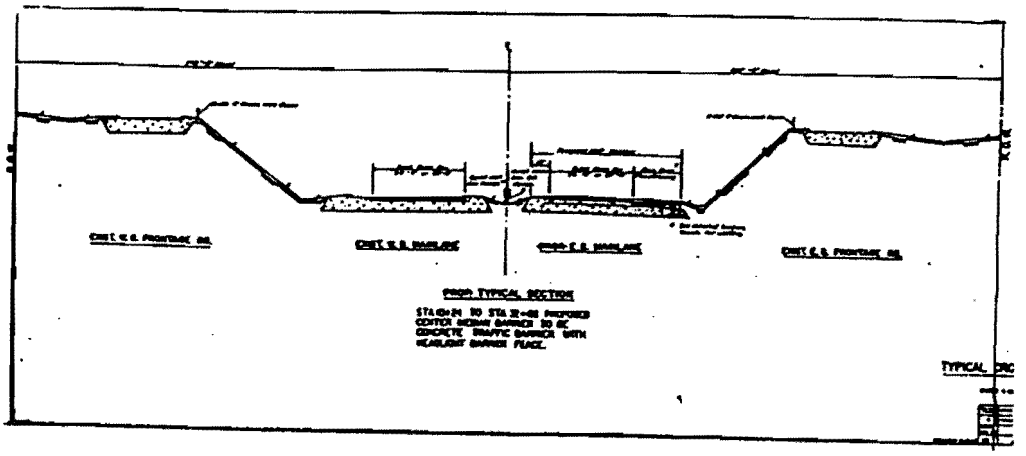


Elevated Section # 8

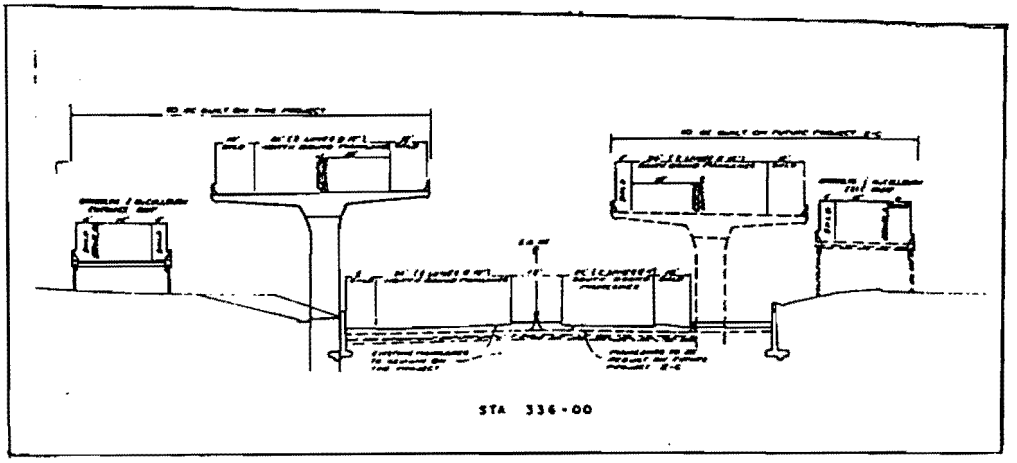


Depressed Section # 9

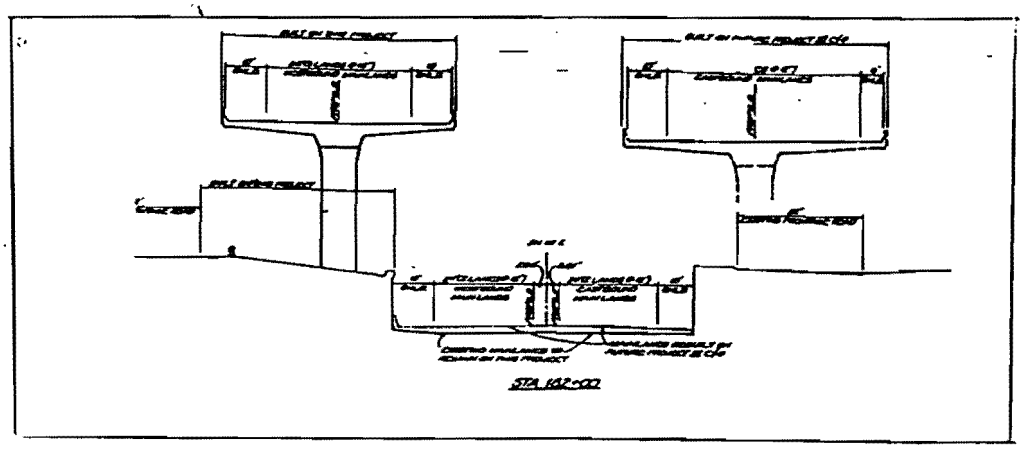
Figure 7. Typical Cross-sectional Design of the Elevated and Depressed Study Sections on I-27 in Lubbock, Texas



I.H. 35 Section # 1

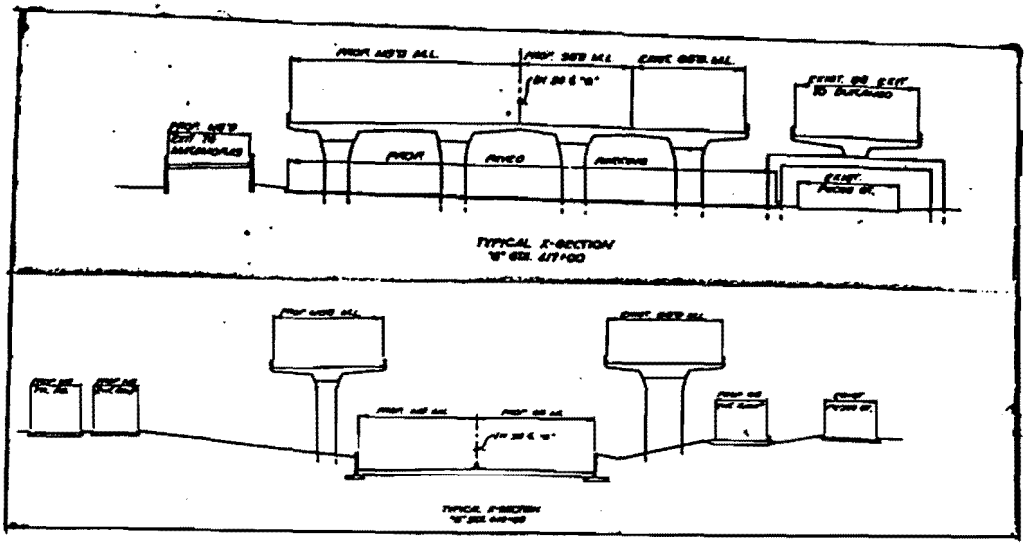


I.H. 35 Section # 2

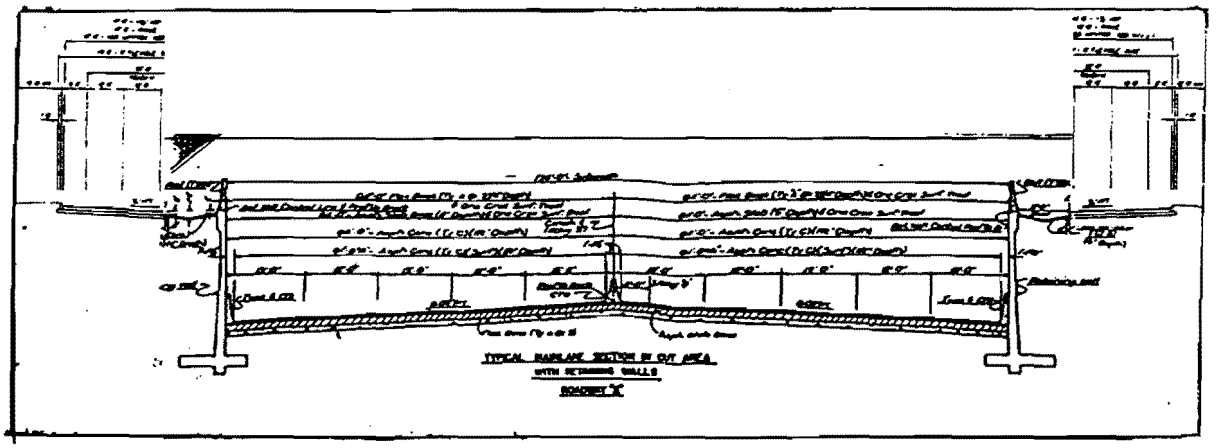


I-10 Section # 3

Figure 8. Typical Cross-sectional Design of the Combination Elevated/Depressed Study Sections on I-10 and I-35 in San Antonio, Texas



I.H. 35 Section # 4



U. S. Highway 281 Section # 5

Figure 9. Typical Cross-sectional Design of the Depressed Study Sections on U.S. Highway 281 and I-35 in San Antonio, Texas

BACKGROUND AND LITERATURE REVIEW

Examination of the literature shows that studies of freeway impacts on adjacent and peripheral properties were initiated as early as the mid-1950s. These studies analyzed changes in land use and land values from the perspective of properties adjacent to and removed from the facility. Some studies focused on the freeway elevation, while some did not. In large measure, however, the previous research indicates that the construction of a freeway and its grade influence adjacent property values. In cases where the freeway opens major travel corridors and improves travel, adjacent owners consider the facility to positively impact their land values. However, the literature does not generally explore the relationship or magnitude of other variables.

Land value is derived by a variety of variables which include, but are not limited to, location and accessibility, overall economic health of the locale, growth rates, and subsequent demand for various types of property (Miller, Jr., 1978). For those parcels that are adjacent to a freeway, the elevation affects values generally due to visual and noise effects; those properties removed from the freeway experience a lesser influence on property values than those that are adjacent (Langley, Jr., 1981). A differentiation in values exists also for properties that are adjacent to the freeway as a result of the type of land use and the grade of the freeway. Commercial land uses typically command higher values than residential uses. Sites next to depressed sections of freeway are expected to have higher values than those next to at-grade sections, and elevated sections are anticipated to have lesser value than properties in at-grade and depressed sections.

NATIONAL OVERVIEW

The impact of highway improvements on property values in the state of Washington was the central point of research conducted by Palmquist (TRR 887). The study assessed the change in property values near the freeway compared to values removed from the freeway. It

was found that benefits accrued to property values when the residents utilized the freeway to commute. The benefits ranged from a 12%-15% increase in value depending on the particular freeway under review (Tomassik, 1987). In contrast, when residents proximate to the facility did not travel the freeway for the work trip, there was little or no change in property value. Further, the houses adjacent to the freeway did not appreciate to the same degree as those houses that were somewhat removed from the freeway. Commercial and industrial values increased relative to study control sections by roughly 17%.

In order to maintain or increase the value of property adjacent to a freeway, certain features need to be addressed during construction of a facility. For instance, the Draft Environmental Impact Statement for a widening project (U.S. 54) in Kansas included a pedestrian overpass which would maintain the accessibility for walking traffic upon completion of the facility. While the pedestrian option may not be consequential for all communities, it may be an important option to preserve the basic character of some communities, thus contributing an item of value to those properties adjacent to the freeway. Freeway related studies conducted in Arizona found that the inclusion of appropriate mitigating techniques were followed by increases in property values proximate to new freeways (Tomassik, 1987).

Downs (1982) adds credence to the importance of the physical design of the facility as a contributing variable to adjacent properties' decrease, maintenance, or increase in value. He writes that the physical design of the transportation facility definitely affects the value of land. He further notes that an artery will not influence land values unless other economic variables are operating in tandem. Downs found that several characteristics can be found which affect the value of land adjacent to a transportation facility. The higher land use categories are associated with higher values than lower land use types. That is, commercial property can be expected to exhibit greater value than residential. In addition, vacant land adjacent to development will increase more rapidly in price than improved land. Importantly, the research notes that governmental decisions and public policy can influence

the land value response. Strong land use controls that restrict lower value uses or that create standards that encourage high value development create a market for more expensive land uses. Tomassik (1987) concurs with this perspective after analyzing freeways in Arizona and finding that the facilities create an incentive for market change but do not cause that change. In fact, development was controllable by strong land use planning.

Another key subject covered by Downs' research is that the stage of construction impacts the value of property. He notes several time periods which influence land values, beginning with the route selection and planning periods, clearance, displacements and constructions periods, and lastly the early and mature operation periods. Property often decreases in value during pre-construction and construction but regains its worth after several years. Other work found that the variation in residential prices was no longer observable after the freeway had been in place for five years (Tomassik, op. cit.).

Of the freeway gradations, the depressed section is often considered to be most desirable because the noise is absorbed and the visual impact of the freeway is lessened. Survey responses in Arizona in the Tomassik research showed that the depressed section was preferred. This premise is confirmed by Buffington et. al. in an examination of residents located adjacent to freeways in Houston, Texas.

Institute of Transportation Engineers designed a study (1976) to examine the relative importance of three categories in determining the perception of freeways: environmental, community, and commerce/industry. They learned that the environmental areas of noise, air, and visual affect exerted the greatest influence on the perception of the freeway, and that the community variables of vehicular and pedestrian circulation have the largest impact for commerce and industry. They also found that population increased around the facilities, although the mean educational level decreased and the racial composition and employment classifications changed. This study was instrumental in showing that the presence or absence of an elevated or depressed structure does not halt residential development or habitation of

existing structures. Further, it confirmed that emphasis on noise, air quality, and visual impacts is well placed.

TEXAS FOCUS

A collection of previous studies has concentrated on projects in Dallas, Bryan/College Station, and Houston. These studies have often employed models which were descriptive in nature, showing the relationship between land use and land value, land use and traffic, and land use and urban development (Buffington et al., 1978). One example of the early studies addressing this question is the 1957 study by William G. Adkins which assesses the effects of a 13.99 kilometer segment of the North Central Expressway (Dallas) on land values and land use. This study also assesses the attitudes of businessmen and property owners affected by the freeway. This research examined three contiguous bands adjacent to the freeway. In this work, the land use assessment served as a backdrop to the land value changes. The study indicated that, as expected, values adjacent to the freeway were higher than non-adjacent property values. Individuals who responded to a survey about their properties were generally favorable regarding the freeway construction, with most indicating that their property values had increased. Further, business owners experienced growth and overall improvement in travel accessibility .

Later work led by Buffington (1981) examined highway impacts by whether new construction was in urban, suburban, or rural locations. Suburban locations exhibited the greatest gain in property values and in development due to improved access. Commercial developments were found to cluster near the interchanges, with residential developments occurring between the commercial clusters. For urban areas, the "life cycle stage" of the community had the primary influence on the changes that were observed; in areas where there was little or no vacant land, the impact of the freeway on development or values was insignificant. This study also found that urban area highway improvements stimulated an

increase in property values for undeveloped land and commercial areas but seemed to cause a slight decrease in residential values.

MULTIMODAL INFLUENCES

A review of another elevated mode, rail, in an urban setting provides some elements of similarity by which we might structure this analysis. Work by Silver et al. indicates that the effects of an elevated facility from the perspective of the neighborhood should be viewed from a land use, traffic, urban renewal, and environmental standpoint. Other rail studies have found that the existing condition and strength of the neighborhood exert an intervening influence on the relationship between elevated facilities and adjacent properties. That is, strong stable neighborhoods with increasing property values experienced continued increases when transportation access was improved, regardless of facility elevation. Moderately priced communities maintained their value under that circumstance. However, adjacent properties that were experiencing decreasing values were unaffected by the construction of the elevated facility and continued to experience deflating values (METRO Technical Working Paper, 1988).

SYNOPSIS OF STUDIES

Overall, the studies have pointed to a set of variables as relevant for analysis of the basic research question. These included a basic assessment of the character of the neighborhoods, relevant zoning or land use controls, land values, and socio-demographic characteristics. Prior studies have noted that impacts may be short-term, intermediate-term, or long-term. They have been explanatory and provided techniques to allow predictive applications of the findings. The impacts have been social, environmental, or economic. Additional variables, including general economic health of the city, type of land use and land use controls, and prior land values act to influence the economic and social effects of freeway facilities on adjacent properties. Freeway grade need not negatively impact adjacent land

values when the highest and best use is recognized. It is, therefore, critical that officials recognize which land uses can maintain and increase value regardless of freeway elevation (Ashley and Berard, 1965).

RESEARCH THRUST AND THESIS

The basic research questions to be addressed in this section of the study are whether freeway grade impacts a cadre of social and economic variables. Several freeway sections in Texas were identified which represented elevated and depressed construction in urban and suburban locales. The primary characteristics to be studied include the following:

- Demographic characteristics from prior year to after project completion utilizing population, income, and ethnicity for 1980 and 1990;
- The use of existing structures, including average household size and vacancy rates;
- Changes in land use categories; and
- Land values for 3-5 years prior to freeway construction (depending on data available) and for the most recent year available (1994). The presence or absence of a strong land use policy in the city will be examined as an important policy characteristic.

It is important to note that demographic or land value changes may also occur in response to influences by variables in the general market. Thus, there will be some portion of changes in land values or social characteristics that has not been included in this analysis. For example, the population of Texas, like that of the United States as a whole, is becoming more ethnically diverse. The populations of each of the urban areas in question can be expected to have more African-Americans, Hispanics, and Asians when comparing the 1980 and 1990 data. The principal thesis is that freeway elevation does influence land value, with the depressed condition being the preferred condition, the at-grade representing a neutral influence, and the elevated structures representing the most negative effects across all categories under investigation.

In all cases, sections which are largely at-grade will be designated as control sections. These sections will then serve as the base of comparison for the elevated and depressed freeway sections along the same route. Based on a review of literature, it is anticipated that the following will occur:

- Population will be roughly the same in residential areas before and after freeway construction. It is not anticipated that this effect will be sensitive to freeway grade.
- Mean household size and mean vacancy rates will be higher than citywide means; also these mean values will be higher at locations adjacent to elevated structures than at-grade and depressed structures.
- It is not anticipated that freeway grade will cause a change in land use.
- Land values in depressed sections are expected to be higher than land values adjacent to elevated structures. Both elevated and depressed land values are expected to have increased less than citywide totals for residential, but increased more than citywide totals for commercial. That is, both elevated and depressed land will be expected to have increased in value relative to the base year. However, depressed values will have increased more than elevated and at-grade values. Elevated values are expected to be lower than at-grade values.

METHODOLOGY

The study team solicited recommendations from District Engineers across Texas on candidate freeway sections to include in the research. Desired sections were elevated, depressed, or combined (elevated and depressed), in urban and suburban settings, and in varying stages of development or operation. Four cities, including several freeway sections, were identified as representing the range of conditions required for analysis. Each freeway had some elevated, depressed, and at-grade portions. Data were collected from the four cities selected which included land values in a year prior to the freeway construction and the most current value for each tract adjacent to the roadway. Also, researchers assembled census

level data for 1980 and 1990, the two principal years relevant for comparison with the land value data.

STUDY LIMITATIONS

The study design called for 1980 data as the point of comparison for current values in San Antonio. However, the defined areas were not combined under a unified appraisal district in 1980. Thus, appraisals were conducted independently by the city of San Antonio and Bexar County, and methodologies were not the same. Therefore, the prior year data were not conducted on the same basis and would not have been suitable for the longitudinal analysis. Appraisals from 1983 provided the first year that a set of appraisals could be obtained that would yield the reliability to be used as the base year. It is not anticipated that a great variation in values occurred between 1980 and 1983, but it must be recognized that the earlier year may have some variations from the data utilized.

Data collection required the assistance of the appraisal districts in the four cities included in the study. These individuals were extremely helpful in acquiring the archived data and in directing the study team in the retrieval of data that were accessible to the public. The study design called for appraised values, on an annual basis, for each property value in each city. The annual data would have provided a data set which would have increased tracking of interim shifts in property values. Thus, the degree of potential measurement error may be larger than intended in the original study design. However, such collection would have required even greater blocks of time from appraisal district personnel or financial resources outside the parameters of this study. Four or more years of data were available for Houston and Lubbock; however, only two years were obtained for Dallas and San Antonio. The difference in data collection was due to the accessibility of records available through each appraisal district.

MAJOR FINDINGS

It should be recognized that the freeway sections in Texas cities have differing characteristics. Houston, San Antonio, Lubbock, and Dallas reflect their individual economic, policy, cultural, and historical trends. Further, the freeway sections included in the study are bordered by a variety of land uses, ethnic representations, and are in urban and suburban parts of these cities. Special circumstances that can be identified will be included for consideration along with the numerical evaluations.

HOUSTON

Study Area Description

The city of Houston began as a real estate venture when the Allen brothers of New York bought 6642 acres of land adjacent to Buffalo Bayou in 1836. The city has one of the largest ports in the world and is considered the world's "Energy Capital." Houston has developed as a center for the oil and petrochemical industries due to its central location and proximity to the country's oil and natural gas fields. Houston is also known as "Space City" for the three decades of space and lunar expeditions from Johnson Space Center.

Houston covers 1543 km^2 (596.1 mi^2) of territory and exercises development control over an additional 3367 km^2 (1300 mi^2) of extra-territorial jurisdiction (ETJ). Houston's population is approximately 1.5 million, an increase of 15% since 1986.

Houston is a diverse city, composed of 41% White, 27% Black, 28% Hispanic, and 4% Asian and American Indian. Houston has attracted people from all over the world. More than 50 ethnic and heritage organizations are active in Houston. Ancestral diversity is exemplified by the 60+ foreign languages and over 100 countries of origin identified among students in the Houston Independent School District.

Houston experienced tremendous growth in the late 1970s and early 1980s. Just over 3.4 million m^2 (37.3 million ft^2) of leasable office space was built outside downtown

Houston's Central Business District. This constituted almost 75% of total office space constructed during the decade. Industrial uses are generally located along the Ship Channel, spreading eastward adjacent to rail lines that radiate from the Port of Houston. During the 1970s, there was rapid residential construction activity followed by annexation in the north, west, and far southwest which accounted for a large increase in single family land use acreage during the boom. The largest land use in the city is single-family residential and accounts for 20.5% of Houston's area (The Houston Almanac, 1994). Multi-family replacement of older single family housing took place inside Loop 610. Many multi-family complexes were built on outlying areas of lower land costs but with convenient access to a freeway. Development in the 1990s has been targeted for higher income tenants and are three-story rather than two-story construction. Density ranges from 8 to 14 hectare, with common areas offering recreation. High rise condominiums are generally located on the periphery of affluent residential areas such as the Medical Center, Galleria, and Memorial areas. Despite the trend toward decentralization of the city's population, the areas with the highest employment concentrations tend to have intense development.

Today, Houston's land use pattern reveals a Central Business District encircled by freeways that also radiate from this downtown loop. Two highway loops (I-610 and Beltway 8), as well as a proposed third loop (Grand Parkway), encircle the Houston area. Outside the downtown loop, the Inner Loop (Loop 610) surrounds the oldest, most intensively developed area, Houston's inner-city. New development and revitalization are occurring in many areas inside the Inner Loop. The Outer Loop (Beltway 8) and even larger loop of the proposed Grand Parkway are opening up undeveloped land in the outer regions of the city. Throughout Houston, intersecting thoroughfares and freeways have provided strategic locations for other commercial establishments, shopping malls, and business centers.

Houston enjoys excellent transportation access. The automobile is the most common means of transportation. Roadway transportation is handled by freeways, tollways, and high occupancy vehicle lanes, thoroughfares, and other rural roadways. Harris County serves as

the hub of the region's roadway system, where interstate highways I-10 (Katy Freeway) and I-45 (Gulf Freeway) converge. Houston has the most extensive freeway and toll road system in the Southwest. Other highways serving metropolitan Houston are I-610 (the Loop), Beltway 8 (Sam Houston Toll Road), U.S. 59 (Eastex Freeway; Southwest Freeway), and SH-225 (LaPorte Freeway). The proposed Grand Parkway will encircle Houston at a radius of 40 to 56 km (25 to 30 mi) from the city centers. A portion of Beltway 8 is located on the west side of the city and has been renamed the Sam Houston Tollway. The area of the tollway between I-10 and Westheimer has been identified for intensive study as part of this research. The area is described more fully below.

Freeway Description

The Sam Houston Tollway opened for operation in 1989. The tollway is elevated from I-10 to approximately Kimberly Lane, where the structure transitions to depressed sections and continues to Traviata Avenue; at this point the structure rises to cross Rumel Creek and Buffalo Bayou. After crossing the creek and bayou, the freeway returns to at-grade to the study terminus at Westheimer (Figure 10). Traffic volumes of 106,530 vehicles daily are recorded on the Sam Houston Tollway south of I-10. At-grade sections near the study sections were identified for control sections. The Houston control section is slightly north of Briar Forest to slightly north of Westheimer (approximately 1.2 kilometers [.74 mi]).

Socio-Economic Assessment

The population for the city of Houston experienced a 2% increase from 1980 to 1990. During the same period, the study area recorded an increase in population of 16%, and a 6% increase in population density. There were no significant increases in the city's or the study area's average persons per household. The racial composition of the study area recorded substantial population increases in both the African-American and Hispanic groups of 75%

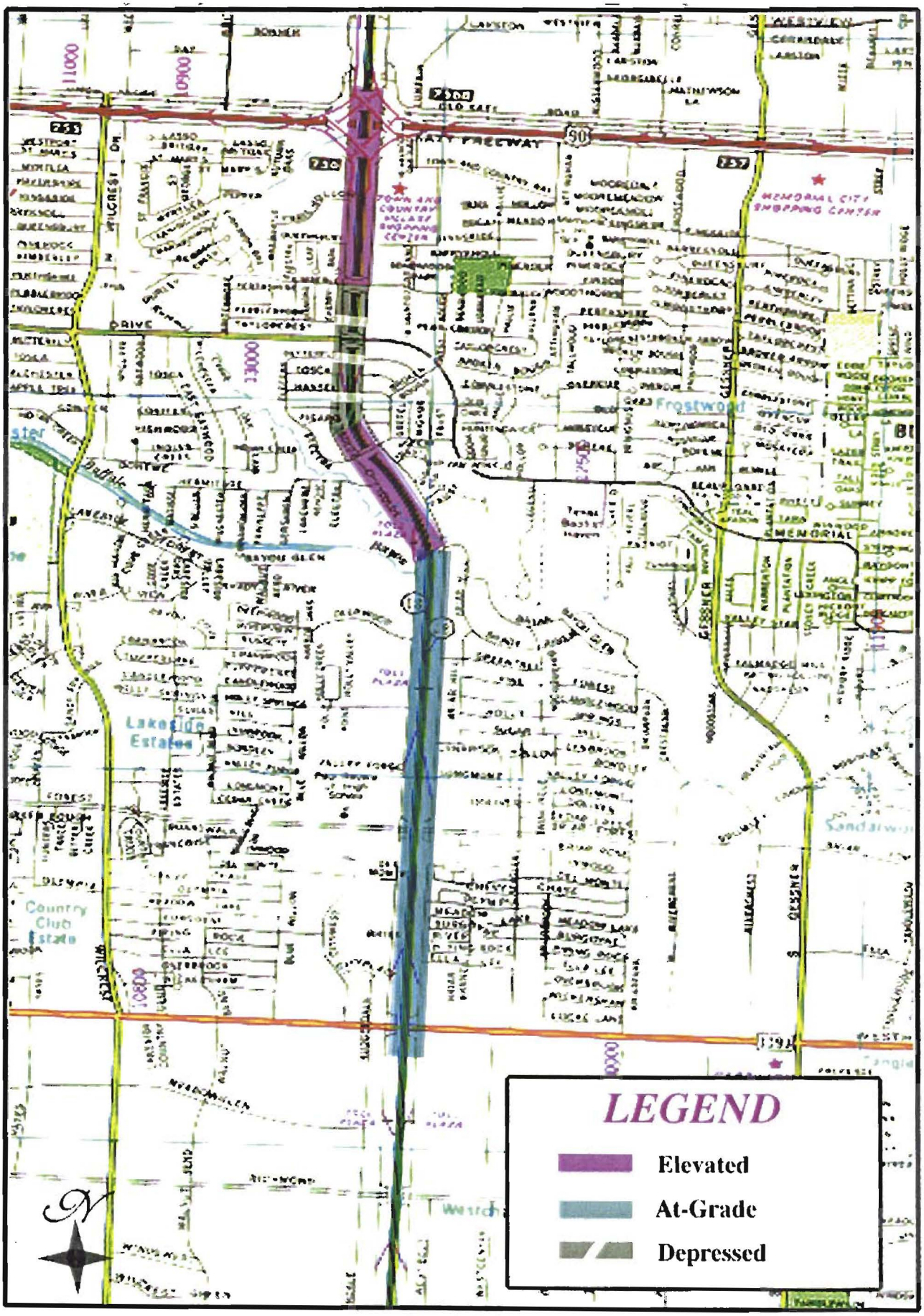


Figure 10. Sam Houston Tollway Elevation Map

and 63%, respectively. However, city wide numbers reflect a less than 1% change in the population of African-Americans, and only an increase of 36% in Hispanics. A dramatic decrease of 47% was experienced in the group White/Other. This is compared to a smaller 22% decrease in this group citywide.

In 1980, the city had a vacancy rate of 11% and by 1990, that figure grew to 15%, an increase of 27% over the 10 year period. The study area also had a vacancy rate of 11% for 1980, but only increased 21% to a vacancy rate of 14%.

Land Use

The area that parallels the Sam Houston Tollway is primarily a mix of single and multi-family residential and commercial land uses (Figure 11). Buffalo Bayou runs through the study area, and the property north and south of the bayou are in the flood plain and not developed. This property is owned by public agencies and is not included as taxable. Note also that the northern boundary of the project is a major interchange unlike any other in the study. The meeting of interstate I-10 and the Sam Houston Tollway is comprised of a multi-level interchange with on-off and toll ramps of four levels. This multi-level interchange is generally credited with having a multiplicative impact on land values, particularly the commercial values adjacent to the interchange. This influence was particularly felt during and soon after construction of the tollway in the mid 1980s. Nearest the interchange of Sam Houston Tollway and I-10, a large shopping mall, a chain hotel, and other commercial uses occupy the southeast quadrant. The southwest quadrant has townhouses extending approximately 2 km (1.2 mi). Thereafter, both sides of the tollway are a mix of single-family, multi-family, and commercial land uses. Land value data from 1982 and 1994 provided at least 231 useable accounts for each year. Roughly one-half of the parcels are depressed, with one-fourth elevated and one-fourth at-grade. Residential land uses account for 80% of the parcels; approximately 19% are commercial. The vacant, industrial, and

institutional uses combined make up roughly 1% of the total properties (see Appendix 2). See Figure 11-Sam Houston Tollway Land Use Map.

Land Value Assessment

The data are analyzed by assessing the means and by viewing the range of property values; that is, the lowest and highest per square meter value for each grade or land use. While not reported in this section, land values in Houston and in the study area were increasing rapidly between the early to mid-1980s. In fact, a particularly large increase occurred between 1982 and 1986. However, the latter year paralleled the beginning of a recession in the oil-based economy of Houston. That recession, along with the freeway construction, contributed to a decrease in value for most properties in Harris County when the middle 1980s are compared to later years. Some local property experts suggest the market in the early 1980s may have been inflated, and the economic downturn led to more appropriate market conditions.

Range of Values

Table 4 displays the high and low land values per square meter by freeway grade and land use. The range of values is broad within the 1982 (before construction) and 1994 (after construction) time periods. In 1982, values ranged from a low of $1.22 per square meter to a high of $301.31 per square meter; the values after construction range from $5.34 per square meter to $228.83 per square meter. When comparing the before and after data, all but one category (the high value for depressed parcels) increased after the freeway construction. Observation of the range of values by land use category shows that properties in all categories increased in value with the exception of the high end commercial property. Note, the industrial land uses present in 1983 did not exist by 1994.

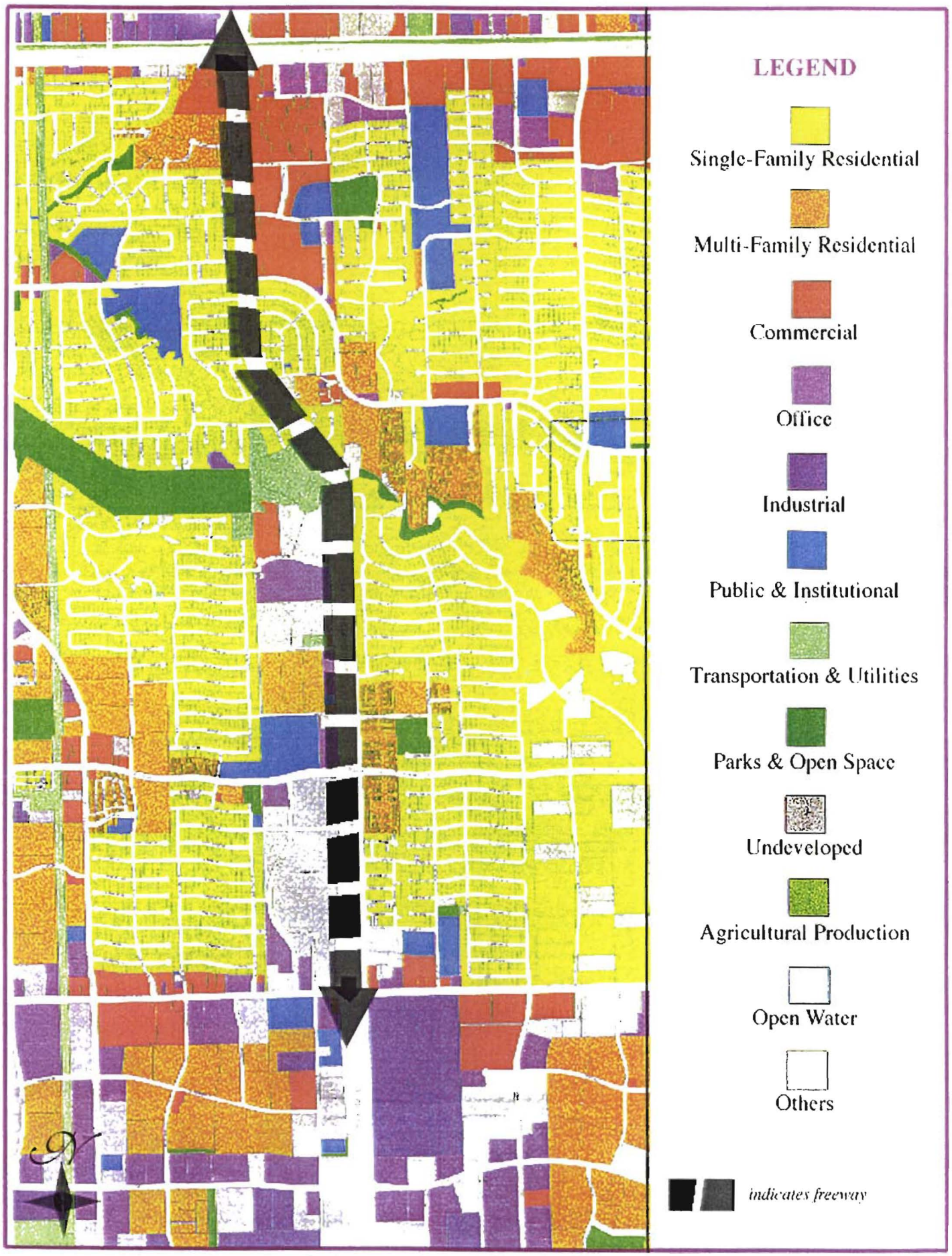


Figure 11. Sam Houston Tollway Land Use Map

Table 4. Sam Houston Tollway
Range of Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1982) CONSTRUCTION		AFTER (1994) CONSTRUCTION	
	Lowest	Highest	Lowest	Highest
At-Grade	$ 5.47	$ 15.61	$37.91	$178.59
Elevated	1.22	46.93	8.14	183.06
Depressed	1.34	301.31 *	5.34	228.83
Residential	1.22	68.65	5.34	228.83
Commercial	10.54	301.31	45.16	228.83
Industrial**	12.37	12.37	Ø	Ø
Institutional**	14.44	14.44	56.82	56.82
Vacant	10.62	13.67	71.15	77.03

** One commercial parcel was valued to set the high end rate for this category.*

*** There were only three industrial cases and four institutional cases noted in this freeway section; each represented a different year, indicating the unstable and minimal nature of these land uses in this part of the city.*

Mean Values

The mean land values are depicted in Table 5, *Sam Houston Tollway Mean Values.* In general, the at-grade and elevated values experienced a similar increase at over 82%. These findings are expected in that the values have generally increased relative to the before and after analysis for a freeway that has been in operation more than five years. The actual values for 1994 only show a $8.56 range across all three grades, ranging from $72.77 to 81.33 per square meter.

The assessment by land use category also shows most values, residential, commercial, institutional, and vacant, increasing compared to 1982 (the exception is the industrial category because Harris County appraisals showed no value in 1994 for that land use category). The residential and vacant properties experienced the greatest increases at 79.24%

and 83.40%. The highest absolute dollar value for 1994 is observed in the commercial category, as expected.

The increase in land values for properties adjacent to the freeway are particularly impressive when viewed against a Harris County base with a total market value of $132 billion in 1982; this inflates to a 1994 value of $177 billion. The total market value for 1994 was $173 billion, representing a decrease of 2.4% in Harris County property values. Thus, the properties adjacent to the freeways out-performed county totals. This study is not structured to definitively delineate or measure the full range of variables contributing to property value changes. The strong showing of these parcels may be due, in part, to increased accessibility. However, other variables, such as neighbor character or nearby employment opportunities could also be contributing to the observed values. In this instance, these data show that the presence of the freeway does not negatively impact property values, particularly when viewed against county totals.

Table 5. Sam Houston Tollway
Mean Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1982) CONSTRUCTION	AFTER (1994) CONSTRUCTION	PERCENT CHANGE
At-Grade	$ 12.77	$ 72.77	+82.45%
Elevated	14.23	80.30	+82.28%
Depressed	21.06	81.33	+74.11%
Residential	16.12	77.65	+79.24%
Commercial	23.54	88.34	+73.35%
Industrial	12.37	Ø	Ø
Institutional	14.44	56.82	+74.59%
Vacant	12.30	74.09	+83.40%

SAN ANTONIO

San Antonio is located in the southern portion of the state, roughly 240 km (150 mi) from the Mexican border, and the influence of Hispanic culture is a strong contributor to the city's character. Of the city's total population, more than half possess Spanish surnames or are Spanish speaking. The city is known for its abundance of military bases, including Kelly, Randolph, Lackland, Brooks, Ft. Sam Houston, and Camp Bullis, which are major contributors to the local economy. In the last two decades, the city's population has increased 37.5% to 800,000 compared to the county's population increase of 3.2%. The growth is consistent with the national trend that indicates population increases in the south and western United States. The state of Texas is noted as one of the five fastest growing states in the Union. These increases have intensified the number of automobiles on the road. The San Antonio area is served by several radial freeways and two circumferential loops.

Study Area Description

Two freeway sections were assessed in San Antonio, a combination of I-35 and I-10, which is referred to as the "Y", and U.S. 281 in suburban San Antonio. The south end of the "Y" is adjacent to downtown near the established commercial, industrial, and residential core. Included in the area are breweries, multi-story banks, a medical complex, churches, a large apartment complex, and commercial offices. Recreation in the area is focused on the city parks and other public spaces. Columbus Park has been renovated and is well used by many of the adjacent neighborhoods. There are also some recently landscaped areas along San Pedro Creek. Major streets in the area from east to west are the north-south arterials of Broadway, McCullough, Main, San Pedro, Flores, and Zarzamora. The major east-west arterials are Houston, Commerce, Buena Vista, Martin, and Fredericksburg Road running in a northwesterly-southeasterly direction. The streets and freeways reflect aged construction. They tend to be narrower and lack a grid system that is considered more desirable in an urban area.

Recreation in the area of the transportation corridor is limited mainly to city parks. Columbus Park is centered around Boccie Courts housing complex and St. Francisco Di Paola Church. This church was the religious and social center of San Antonio's Italian community. The park has been rebuilt and enhanced and is well used by many of the adjacent neighborhoods. There are also some areas along San Pedro Creek that have been recently landscaped. The U.S. 281 freeway area was sparsely developed prior to the construction of the freeway. Previously, the four-lane, divided urban highway had at-grade crossings and was known as the McAllister Freeway. The area had pockets of typical suburban single-family homes. Several churches were within one or two blocks of the freeway. The area began to undergo rapid change as this research neared its conclusion. Vacant parcels began to be developed into commercial tracts. The principal arteries around U.S. 281 are Blanco, Bitters, Heimer, Redland Road, and Bulverde Avenue. Several commercial and residential dwellings are on the west side of U.S. 281, from Bitters Road to Loop 1604 through the towns of Hill Country Village and Hollywood Park.

Freeway Description

The "Y" study section begins at I-10 and Kings Highway and is principally elevated (although a small segment is at-grade) to Fredericksburg; from Fredericksburg to Frio, the freeway is double decked, with an elevated and a depressed section (Figure 12). Between Frio and approaching the intersection with I-10, the structure comes to grade, then rises to elevated at the I-10 / I-35 intersection. Continuing along the I-35 study section, the structure is double decked for a segment until reaching Broadway. From that point, the structure is primarily depressed to Walters, although some segments are at-grade.

Bitters Road to Loop 1604 set the limits for U.S. 281 in this research. The freeway is principally at-grade from Bitters Road to Thousand Oaks; the structure is elevated at Thousand Oaks, then descends to depressed to the study end at Loop 1604. The San Antonio

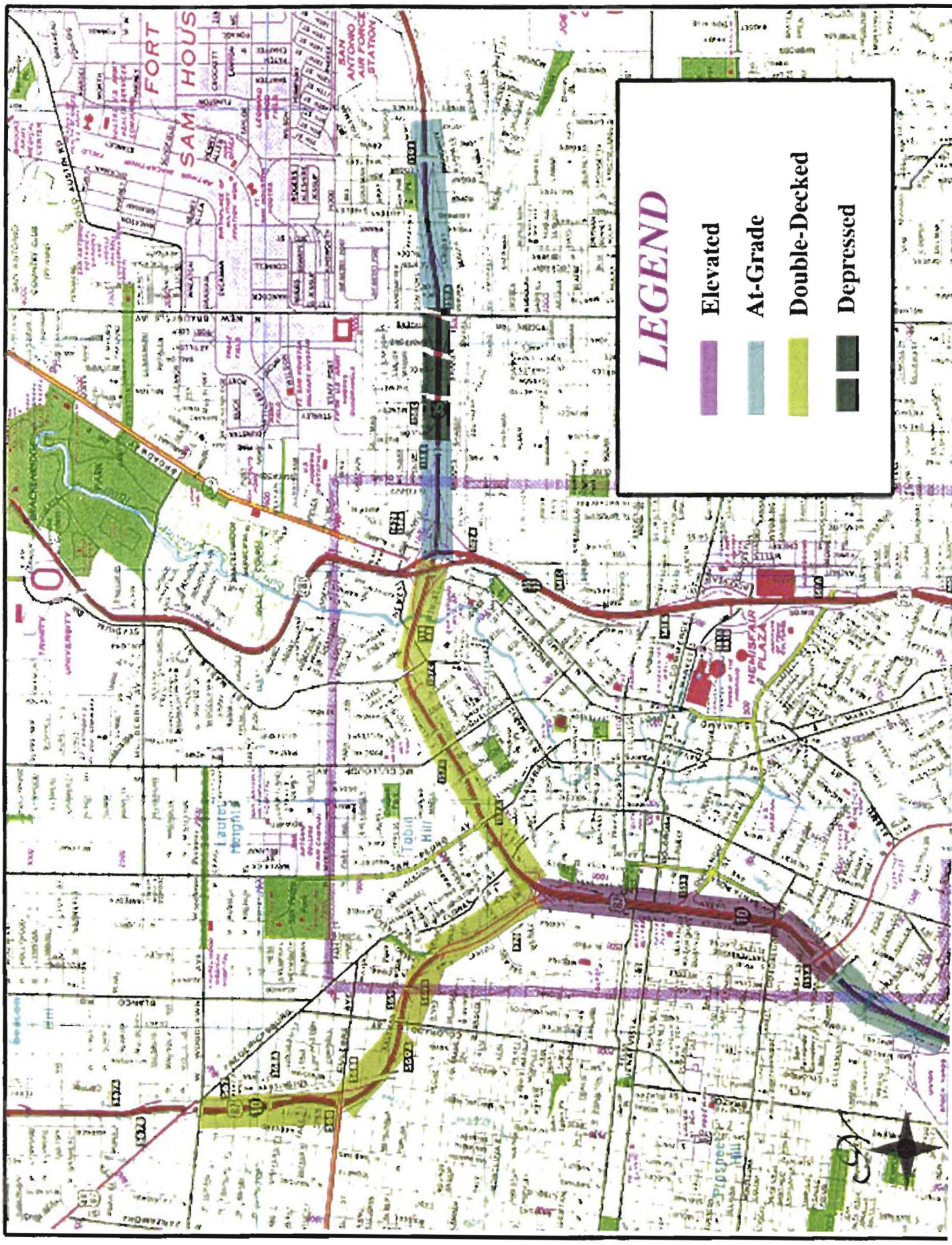


Figure 12a. San Antonio Urban Elevation Map

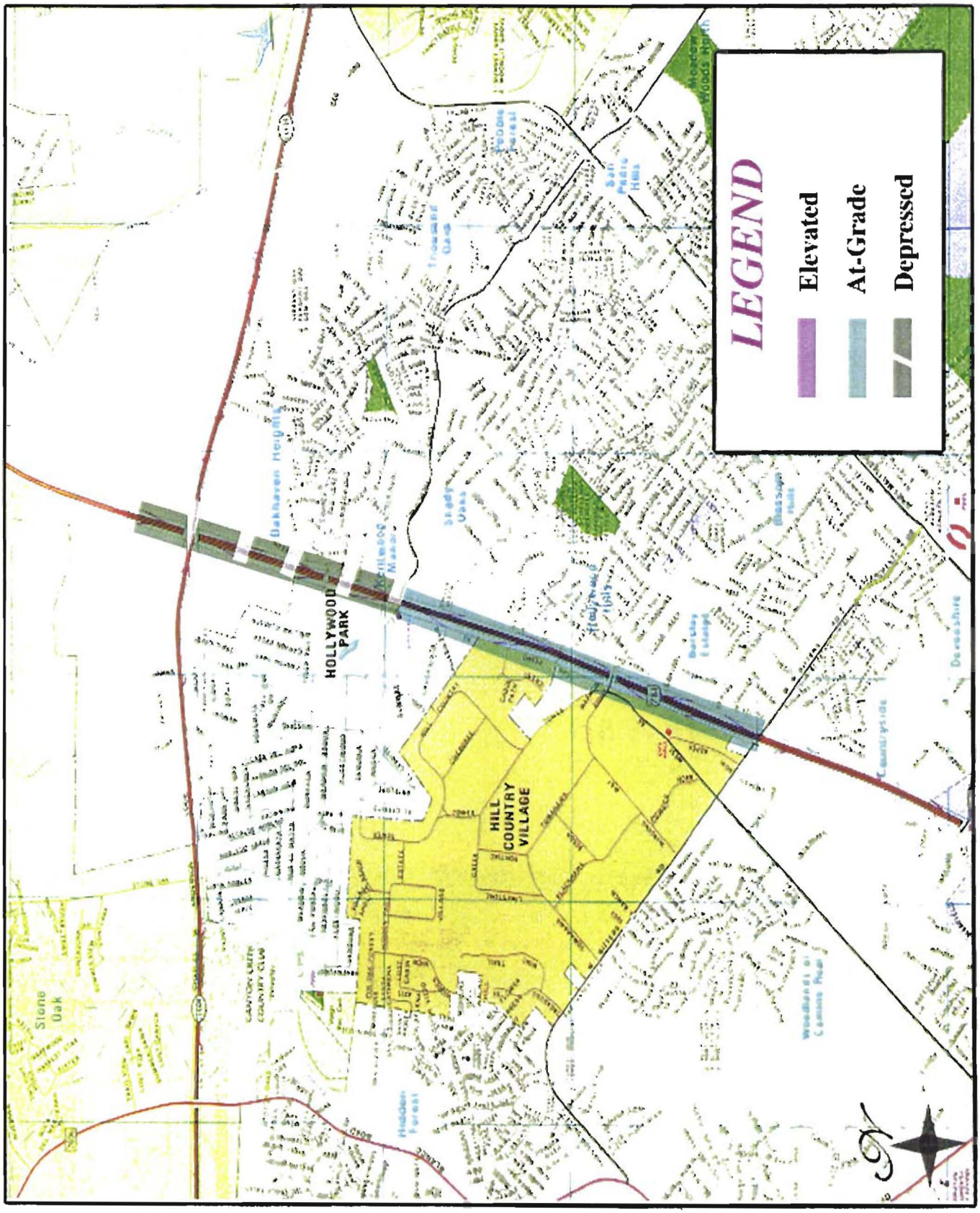


Figure 12b. San Antonio Suburban Elevation Map

control sections are along U.S. 281 north of Thousand Oaks to L1604 and between Walters and Broadway, a distance of 2.25 km (1.4 mi).

Socio-Economic Assessment

In San Antonio, a comparison was made between the city baseline, and the urban (I-35 / I-10) and suburban (U.S.281) study areas. In 1980, the suburban study area was so sparsely populated it had a population density of less than one person per 2.6 km^2 (1 mi^2). By 1990, the population density in the suburban study area had grown to 745 persons per 2.6 km^2 (1 mi^2), and city officials estimate this figure has continued to increase dramatically since the 1990 data were reported. The population increased by 76% in the suburban study area, while the increases in the urban study area and city baseline were 16% each. The city experienced a decrease from 3 to 2.8 in the average persons per household category, while the urban study area remained constant at roughly 2.4 persons per household in 1980 and 1990. The 1990 suburban study area persons per household figure was also lower than the city's at 2.5 persons per household.

San Antonio experienced decreases in two of the three racial categories. From 1980 to 1990, the categories *African-Americans* and *White/Other* decreased as a percentage of the entire population by almost 7% and 4%, respectively, while the Hispanic racial group experienced an increase in their proportion of the population of 3%. Despite the decreases noted in percentage terms, the number in each ethnic group increased in the urban study area. For instance, in 1980, census tracts of the urban study area show that the groups *White/Other* and *African-Americans* had less than 400 people, but by 1990, the African-American population had grown to over 5000 individuals, and those classified as *White/Other* had increased to nearly 7000. The Hispanic racial group registered the greatest increase, from roughly 11,000 in the urban area in 1980, to over 50,000 by 1990. In the suburban study area, no ethnic groups were identified in the 1980 census; however,

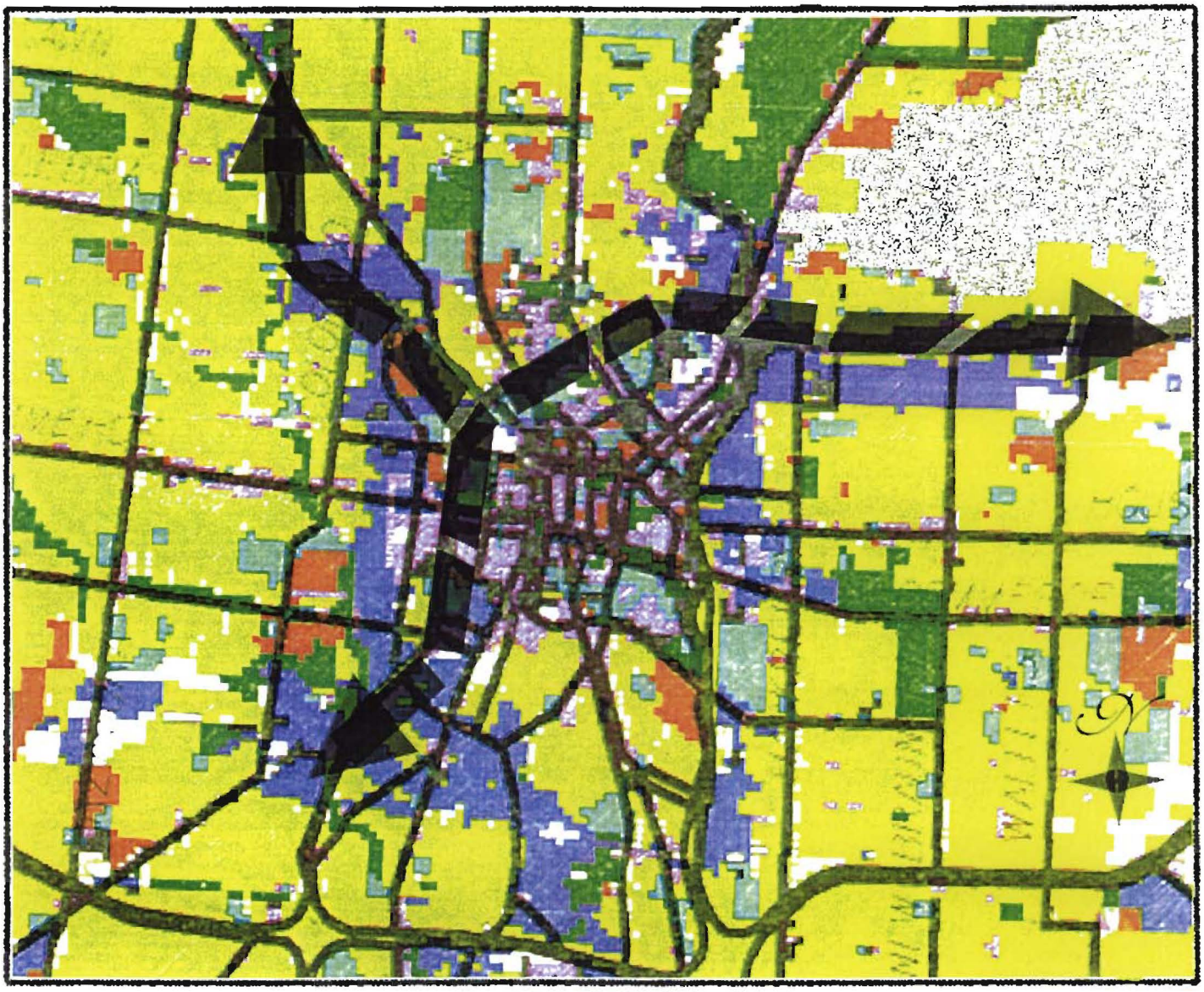
by 1990 the group *White/Other* had a population of over 27,500, *Hispanics* numbered 6310, and *African-Americans* equaled 507.

The vacancy rates for the city were 7% in 1980 but increased to over 10% by 1990. The urban study area experienced a similar increase from 11% to 14%, while the suburban study area experienced a dramatic decrease of 40% to approximately 7% in 1990. This decrease can most likely be attributed to the building of new housing in the suburban study area.

Land Use

The study section is characterized by a mix of land uses (Figure 13). The southernmost land on the west side of the freeway, in the vicinity of South Laredo, is somewhat under-developed compared to other portions of the study area. The east side is a mix of stockyards, small retail, and light manufacturing. Moving north, the development on the west side intensifies with motels, multi-family and single-family housing, commercial, and institutional uses. Although many structures show signs of age and are not well maintained, the west side of I-35 / I-10 has an area of newly constructed single-family housing. From I-10 and Fredericksburg Road to the I-10 / I-35 interchange, there are mainly machinery manufacturers and wholesale distribution centers. Although a large area has been cleared for future development, the section of I-35 between its interchanges, with I-10 on the west and Broadway on the east, is primarily residential.

The housing in the areas adjacent to these transportation corridors is varied. Along I-35, between its interchange with I-37 and U.S. 281 and the I-10 connection to the south, are older homes that at one time were spacious single-family dwellings. Many of these have now been subdivided into multi-family units and rented out as apartments. Along I-10, north of its jointly designated section with I-35, some of the single-family residences have been well maintained.



LEGEND

Industrial
Light and Heavy Industries

Commercial
Retail and Wholesale Businesses, Offices

Residential
Subdivisions, Concentrations of Rural Dwellings, Mobile Homes

High Density Residential
Apartments, Condominiums, Hotels, Motels

Military
Military Installations

Services
Institutional, Cultural, Recreationsal Uses

Open Space
Parks, Cemeteries, Open Space Surrounding Other Uses, Restricted Areas

Vacant

Transportation
Parking Lots/Structures, Major Roads and Railway Rights of Way

indicates freeway

Figure 13a. San Antonio Urban Land Use Map

LEGEND

Industrial
Light and Heavy Industries

Commercial
Retail and Wholesale Businesses, Offices

Residential
Subdivisions, Concentrations of Rural Dwellings, Mobile Homes

High Density Residential
Apartments, Condominiums, Hotels, Motels

Military
Military Installations

Agriculture

Services
Institutional, Cultural, Recreationsal Uses

Open Space
Parks, Cemeteries, Open Space Surrounding Other Uses, Restricted Areas

Vacant

Transportation
Parking Lots/Structures, Major Roads and Railway Rights of Way

Extractive
Quarries, Sand and Gravel Pits

indicates freeway

Figure 13b. San Antonio Suburban Land Use Map

Land Value Assessment

The "throat" of the "Y" from the I-10 / I-35 intersection to Durango is largely elevated, although the main lanes go into depressed sections to pass under major cross streets. Bitters Road to Loop 1604 set the limits for U.S. 281 in this research. The freeway is principally at-grade from Bitters Road to Thousand Oaks; the structure is elevated at Thousand Oaks, then descends to depressed to the study end at Loop 1604. The review of land value changes for U.S. 281 and I-35 / I-10 can be viewed against a background in which total market values for Bexar County increased approximately 6.85% from $33.8 billion in 1983 ($ 1994) to $36.1 billion in 1994. When reviewing the property values, it should be noted that the character of development is very different in the two San Antonio study areas. The "Y" is in the core urban area near downtown, while U.S. 281 is in a rapidly growing suburb that was largely undeveloped in the early 1980s. The following sections show the range of values for the two areas and then the mean values. The urban "Y" assessment included 325 cases for each year. Only eight valid properties existed for U.S. 281 in 1980, but the number of properties increased to 354 by 1990.

Range of Values

In the I-35 / I-10 area, the highest value at-grade increased for elevated and depressed sections relative to 1983, while the lowest values all decreased. Both high and low end values decreased for properties adjacent to the double decked section. Table 6 reflects the land values per square meter for the double decked section before and after freeway construction. When assessing the data by land use categories, note that the institutional values increased materially; high end industrial also increased. Residential remained essentially stable. The vacant and industrial properties decreased in value.

The section of U.S. 281 included in this research is either at-grade or depressed. The at-grade property shows an increase in value because the accounts paralleling the freeway in 1994 were non-existent in 1983. The land was divided, and previous records were not

readily available. As in the "Y" section, the residential properties exhibit the highest per meter value, followed by commercial parcels.

Mean Values

The values in the at-grade sections of the "Y" increased 15% between 1983 and 1994 ($ 1994). These values can be compared to a 3% increase in the elevated section and a 4% increase in the double-decked section. A 9% decrease occurred for properties in the depressed section (Table 8). Contrary to expectations, the properties in the double-decked and elevated sections had the highest absolute mean value, while the properties in the depressed section had the lowest absolute value. This finding is attributable to the utilization of higher value properties as non-residential; institutional property has the highest value.

The mean value for the property adjacent to depressed sections along U.S. 281 increased 70.02% and showed a higher value per square meter than the at-grade section. As expected, the now residential land uses showed the highest values.

Table 6. San Antonio I-35 / I-10 Urban "Y"
Range of Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION		AFTER (1994) CONSTRUCTION	
	Lowest	Highest	Lowest	Highest
At-grade	$ 9.32	$ 25.14	$ 5.64	$ 53.89
Elevated	14.63	114.49	2.29	161.47
Depressed	.66	72.06	.45	83.53
Double Decked	2.69	279.96	1.70	170.29
Residential	.66	169.40	.46	170.29
Commercial	3.07	279.96	.45	154.23
Industrial	8.80	52.57	8.54	86.15
Institutional	8.78	50.22	86.09	113.15
Vacant	19.94	113.02	7.69	86.13

Table 7. San Antonio U.S. 281
Range of Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION		AFTER (1994) CONSTRUCTION	
	Lowest	Highest	Lowest	Highest
At-grade	$ (1)	$ (1)	$ 14.95	$ 20.21
Elevated	(3)	(3)	(3)	(3)
Depressed	.08	13.37	19.64	80.37
Residential	(1)	(1)	14.95	34.24
Commercial	.08	13.37	1.69	122.72
Industrial	(1)	(1)	63.00	63.00
Institutional	(2)	(2)	69.20	69.46
Vacant	(1)	(1)	20.21	80.37

(1) There was no value reported for this land use in 1983. Many property values were unavailable for U.S. 281 in 1983 because prior to freeway construction, the alignment was different and was formed by a combination of San Pedro Avenue and the old highway. Also, many account numbers did not exist in 1983 and were likely reduced from very large parcels after the freeway was constructed. These prior year records were not in the possession of the Bexar County Appraisal District. Therefore, it was not possible to trace the current account numbers and link them to prior year account numbers.
(2) Square meter was not reported, so calculation could not be done.
(3) There is no elevated section in the U.S. 281 study corridor.

Table 8. San Antonio I-35 / I-10 Urban "Y"
Mean Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION	AFTER (1994) CONSTRUCTION	PERCENT CHANGE
At-grade	$ 14.79	$ 17.34	+15%
Elevated	38.76	40.06	+ 3%
Depressed	17.24	15.82	+ 9%
Double Decked	45.57	47.61	+ 4%
Residential	20.38	22.80	+11%
Commercial	33.11	39.06	+15%
Industrial	31.40	26.21	-20%
Institutional	39.59	99.62	+60%
Vacant	46.85	41.99	-12%

Table 9. San Antonio U.S. 281
Mean Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION	AFTER (1994) CONSTRUCTION	PERCENT CHANGE
At-grade	$ 0	$ 43.09	+ 100%
Elevated	(1)	(1)	(1)
Depressed	20.65	68.88	+ 70.02%
Residential	0	23.74	+ 100%
Commercial	20.65	61.67	+ 66.52%
Industrial	0	63.00	+ 100%
Institutional	0	69.46	0
Vacant	0	50.29	+ 100%

(1) There is no elevated section in the U.S. 281 study corridor.

LUBBOCK

Study Area Description

Lubbock is located in the center of a semi-arid geographic region known as the Southern High Plains of the Texas Panhandle. Lubbock's terrain is relatively flat, with very little natural slope. The only exception is the Yellowhouse Canyon, which contains a tributary of the Brazos River. A number of dry lakes dot the land surface, serving as natural drainage and storage areas.

Lubbock has been known for many years as the "Hub City" of the South Plains since it is the major distribution center for the region. The city is surrounded by vast amounts of rich agricultural land. Agricultural products and related industries contribute a large portion of the city's economic base.

The existing traffic distribution system within Lubbock consists of primarily a north-south, east-west grid pattern with major thoroughfares located at 1.6 km (1 mi) intervals. Three major U.S. highways serve the city: U.S. 62 and U.S. 82, running east and west; U.S. 84 traveling northwest to southeast; and I-27, with a north-south alignment. The Central Business District in Lubbock has been slowly changing from a retail district to a center for financial institutions, governmental offices, and professional office space. There are currently no high-speed, large-volume transportation facilities serving the Central Business District from the east or west. City officials considered the absence of such a facility as a deterrent for downtown redevelopment, since safe and efficient access to and from the Central Business District is essential to continuing vitality and growth. The reconstruction and upgrading of U.S. 62 / 82 into a major freeway is planned to address this deficiency.

Approximately 12% of the Lubbock work force is employed in the Central Business District, while present commercial and residential growth trends are to the south and southwest. As these suburban areas continue to grow, I-27 will become increasingly important for travel to and from the core urban area. The opening of I-27 has reduced travel time for trips between the Central Business District and outlying areas of the city.

Two freeway sections are included in this study for Lubbock, I-27 and the proposed U.S. 62 / 82. The I-27 corridor became operational in 1992, and U.S. 62 / 82 freeway was announced in July 1995. Right-of-way purchase is currently underway for U.S. 62 / 82; thus, the review of land values paralleling this corridor reflect the values from the mid-1980s compared to pending announcement of freeway construction and initial right-of-way acquisition. When this study was initiated, the researchers anticipated that U.S. 62 / 82 would be in construction and would reflect land value responses immediately after right-of-way acquisition. However, the construction has not proceeded as rapidly as expected, and only a partial land acquisition has occurred. The data presented in this section regarding Lubbock U.S. 62 / 82 should be viewed from that perspective. Also, as in each of the other study corridors, the unique social and economic conditions of Lubbock also affect the land value.

Freeway Descriptions

The review of the I-27 freeway begins at Loop 289 North and extends south to 114th Street. From the northern limit at Loop 289, the structure is elevated to 38th Street. From 38th Street to slightly south of 66th Street, the freeway is depressed. After crossing over Loop 289 South, the structure comes to grade and is at-grade to 114th Street. A short section of Loop 289 West was included to strengthen the at-grade control sections. The maximum traffic volume is slightly north of the I-27 intersection, with South Loop 289 at 52,000 vehicles daily.

Because the right-of-way for U.S. 62 / 82 is currently being purchased, the route for the future freeway will be described. The southwestern extent of the study area is defined by the Lubbock city limit, which is roughly at Milwaukee Avenue. The freeway will continue in a northeasterly direction paralleling U.S. 62 / 82, alternately named Brownfield Road. The freeway will cross the downtown area along 4th Street; the research for this study ends at the western edge of MacKenzie State Park (Figure 14).

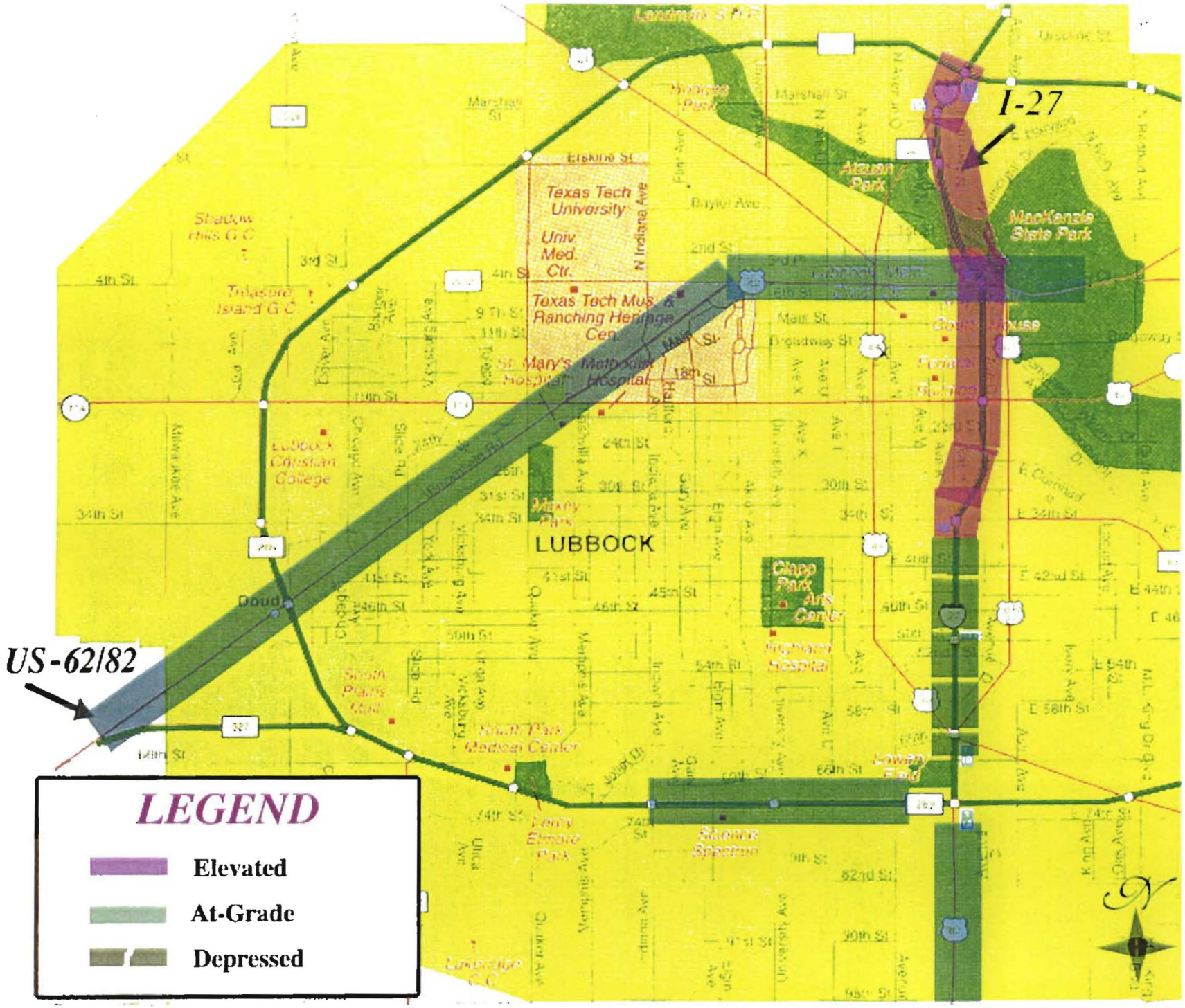


Figure 14. Lubbock I-27 Elevation Map

Socio-Economic Assessment

Many of the census tracts for the Lubbock study areas, I-27 and U.S. 62 / 82 (which is in the land acquisition phase) are in common. Thus, the study area reference is for both freeways. In Lubbock, the city population increased by 6.5%, while the average persons per household decreased from 2.7 to 2.6 persons per household. In contrast, the study area experienced a 9% decrease in population and a decrease in average persons per household of 3.3 in 1980 to 3.1 in 1990. The study area also experienced an increase of 11% in vacancy rates during the period 1980 to 1990, compared to the nearly 18% increase for the city as a whole. Lubbock, as a whole, experienced increases in two of the three racial categories: Hispanics (16%) and African-Americans (3%). The group *White/Other* increased in raw numbers by almost 1700, but as a percentage of the entire city population, this group decreased by almost 6%. However, the racial mix in the study area did not follow the city pattern: African-Americans decreased by 75%; Hispanics increased (26%) as did White/Other (9.5%).

Land Use

Land use within the I-27 corridor is now urban in character. Statistics indicate a continual overall decrease in residential habitation and a transition to commercial development within the corridor. This corridor also includes industrial uses. In fact, most motor freight terminals in Lubbock are located within .8 km (.5 mi) of the corridor. These freight terminals along with other industrial uses parallel both sides of I-27 near its northern terminus with Loop 289 North. Continuing south, public use and park areas border the freeway to slightly south of Parkway Drive. A small single family residential neighborhood is contiguous to the west side of the freeway and adjacent to the Parkway, while public space is designated south of the Parkway on the east. Continuing south, industrial and commercial properties border both sides of the freeway to approximately 46th Street, although a small residential area interrupts that flow on the east side at approximately 35th Street. From that point to U.S. 84

and U.S. 87, the predominant land use is residential. Commercial and industrial uses begin and continue to south of Loop 289 South. Residential and commercial properties make up the study corridor to 114th Street. Property adjacent to U.S. 62 / 82 corridor is primarily commercial and industrial, with single family residential neighborhoods behind the commercial and industrial frontage, from its southern boundary to 18th Street. The corridor passes through Texas Tech University, crossing downtown at 4th Street, and ends at Parkway Drive (Figure 14).

Land Value Assessment

This research examined more than 250 properties along I-27 and 272 properties adjacent to U.S. 62 / 82. Approximately 60% of the properties along I-27 are residential; 33% are commercial, and 5% industrial. The parcels are evenly distributed with 33% each at-grade, elevated, and depressed. The I-27 freeway has been operational since 1992 and has not yet matured. Thus, overall land values have not returned to pre-construction levels. Further, the overall market conditions for Lubbock may not have been optimal for redevelopment. Total market value for all Lubbock properties was unavailable for 1987, so pure comparison of values for the study corridor against the citywide base cannot be made. However, the total market values were available for 1988 and were $4.8 billion (which inflates to $6.7 billion in $1990) and $4.9 billion in 1990. It can be seen that values for this brief period reflect probably declining, and at best, stable values for the city of Lubbock overall.

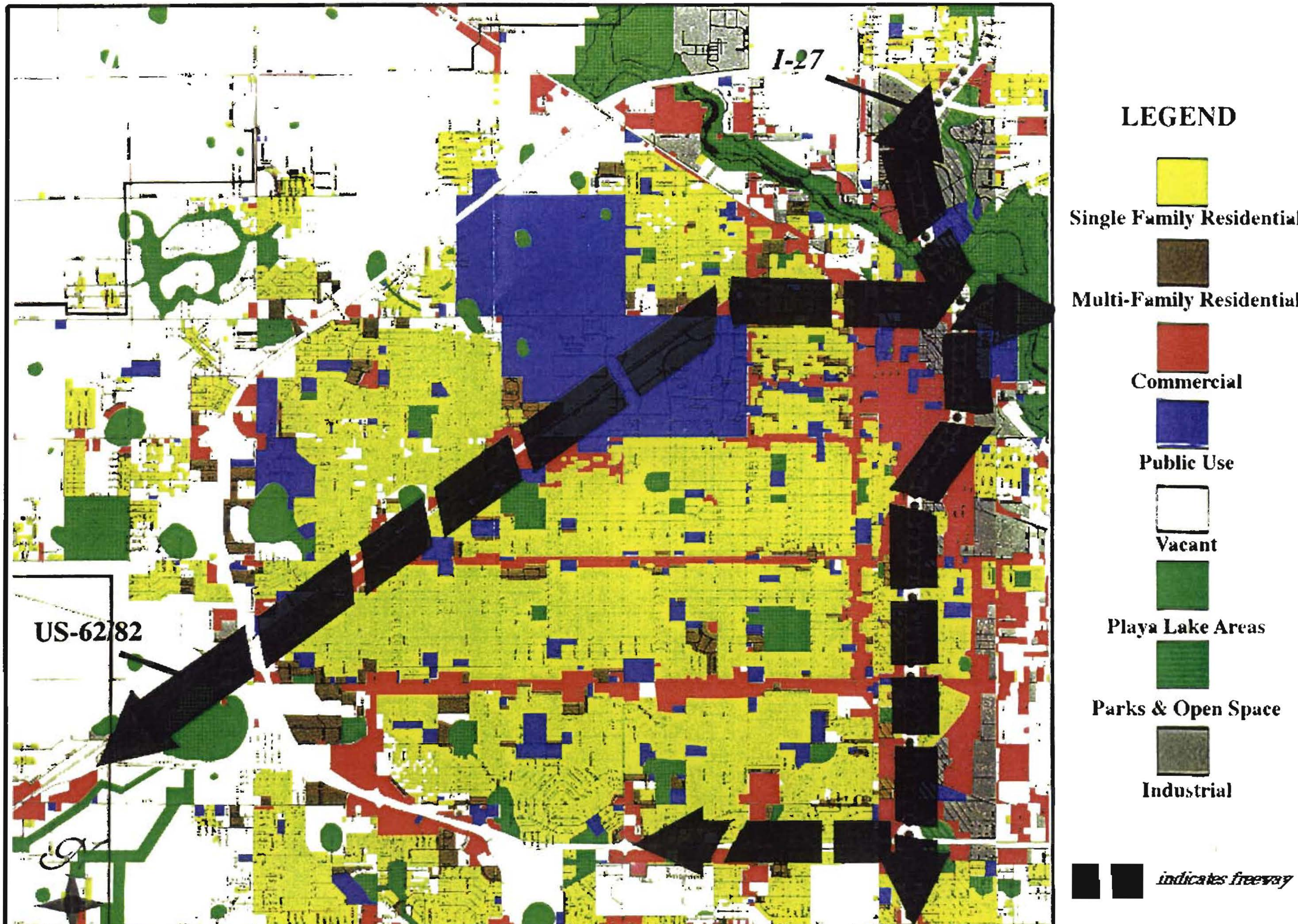


Figure 15. Lubbock I-27 Land Use Map

Range of Values

Table 10 shows the range of land values for 1983 and 1994 for properties adjacent to I-27. Most values have decreased compared to the pre-construction year. The exception is the lowest value for elevated properties. Contrary to expectations, this value increased, whereas, property values adjacent to at-grade and depressed freeway sections dropped. Interestingly, the 1994 low value for at-grade and elevated is the same, *and* for elevated and depressed, it is the same. The same data categorized by land use show that only the low end commercial had an increase in value per square meter between the two time periods. Interestingly, the high end commercial had the greatest decrease, followed by the other land uses.

Table 10. Lubbock I-27
Range of Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION		AFTER (1994) CONSTRUCTION	
	Lowest	Highest	Lowest	Highest
At-grade	$ 1.17	$ 79.47	$ .81	$ 31.25
Elevated	.48	30.87	.81	26.91
Depressed	2.86	47.16	.65	26.91
Residential	2.24	22.63	1.41	21.53
Commercial	.48	79.47	.65	31.25
Industrial	2.84	17.35	2.73	10.76
Institutional	4.90	4.90	2.15	3.31
Vacant	1.17	4.90	.81	2.48

Mean Values

The mean values for at-grade parcels adjacent to I-27 decreased 36.14% between 1983 and 1994 (Table 11). This decrease was less than the percentage decrease for depressed properties, which experienced a 62.19% and 19% decrease. Contrary to expectation, the elevated decreased the least at 19.93%. Mean values in the elevated section have the highest absolute value. Review by land use categories shows that only the institutional properties saw an increase in mean values at 12.66%. All other categories experienced decreases of at least 33.38%. The vacant properties experienced the largest decrease.

Table 11. Lubbock I-27
Mean Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION	AFTER (1994) CONSTRUCTION	% CHANGE
At-grade	$ 8.74	$ 6.42	- 36.14%
Elevated	9.99	8.33	- 19.93%
Depressed	8.58	5.29	- 62.19%
Residential	7.70	5.04	- 52.78%
Commercial	12.05	10.71	- 12.51%
Industrial	8.40	5.92	- 41.89%
Institutional	4.90	2.73	- 79.49%
Vacant	3.04	1.64	- 85.37%

U.S. 62 / 82

The analysis for property along U.S. 62 / 82 shows the value before activity began for freeway construction compared to any changes in value while right-of-way is being purchased. Please recall that the official notification was provided in July 1995. Therefore, data collection focused on 1987 and 1996 land values. At this point, the highway is at-grade. The mean value shows a decreasing trend for the corridor between 1987 and 1996, falling 17.14% per square meter. Because Lubbock represents one city in the early right-of-way purchasing stage, generalizations about land value responses to this stage of construction are not made. A larger data base including additional cities, preferably further into the acquisition process, would provide a more extensive and reliable data base. Even then, the assessment of land values in the right-of-way acquisition stage will be subject to varying project scheduling streams. For instance, construction may begin for some projects while acquisition is continuing. Others, as this Lubbock freeway, may proceed very slowly, with the acquisition occurring over years. Depending on the construction staging plan, it may be appropriate to consider right-of-way and construction land values as one stage.

Multi-Year Analysis

A master's thesis conducted as a part of this research analyzed the I-27 corridor on a more extensive multi-year data set covering 1983-1994. The findings from this work are consistent with the assessments in the previous section, although some increases in value were observed during brief periods within the ten years. Overall however, mean values of property adjacent to the elevated section declined steadily over the entire study period. Property adjacent to the depressed section had periods of decline from 1983-1986, stabilization from 1987-1990, and decline from 1990-1994. Commercial property adjacent to the at-grade section was stable from 1983 to 1990, rose from that time to 1993, and declined over the next year. For residential land at-grade, values increased slightly from 1983 to 1985, decreased in 1986, then remained stable to 1991. Residential properties adjacent to depressed sections

exhibited the same trend during this time. Both at-grade and depressed residential properties experienced a sharp decrease in 1992. The following year, at-grade values rose to pre-construction levels, while depressed residential property values fell even further. The test of significance showed that statistically significant differences exist in the before and after land values for land uses at all grades (Scurry, 1995). Table 12 summarizes the findings from the annual land value and land use data.

Table 12. Cumulative Percent Change in 1983-1994 Land Value and Land Uses

Grade Level	Commercial	Residential	Industrial	Total Average
Depressed	-25%	-71.6%	Ø	-48.30%
Elevated	-37.9%	-30.3%	-27.9%	-32.03%
At-Grade	-21.2%	-22.9%	Ø	-22.1%

DALLAS

Study Area Description

This study examines the area adjacent to the reconstruction of U.S. 75 (North Central Expressway) from downtown to I-635 (Lyndon B. Johnson Freeway) in Dallas, Texas. The project corridor is approximately 14.7 km (9.2 mi) long and extends from just north of the Dallas Central Business District (CBD) through Highland Park and University Park to just south of Richardson. This corridor varies from those previously examined in that it is in the midst of reconstruction. Completion is anticipated in the year 2000, and consequently, it is important to note that all land value data reflect this transitional state.

Pressure is expected on land values as a result of the freeway construction. However, the reconstructed freeway is expected to help stimulate the continued revitalization of the Dallas CBD because of the improved radial access.

The existing North Central Expressway project corridor is in a period of emerging trends and economic activity. During the last several years, the expressway's residential areas have been under transitional pressures. Redevelopment pressure from high-rise offices, retail centers, and large scale regional activity centers has caused some significant changes along the corridor.

The population growth within the expressway corridor is not expected to keep pace with the city of Dallas. The cities of Richardson and Plano have been the fastest growing areas in the study area, with respect to population. In summary, population trends within the project area are expected to remain stabilized, with low nominal annual increases. It should also be noted that the cities of Dallas, Highland Park, University Park, Richardson, and Plano represent over 35 % of the population in the urban area, which includes all of Dallas and Tarrant counties as well as portions of Denton, Collin, Rockwell, Kaufman, Ellis, Johnson, and Parker counties.

Daily traffic volumes are among the highest in the state at 179,000 vehicles slightly north of Spur 366, 154,000 slightly south of Loop 12, and 126,000 .4 km (1/4 mi) south of Loop 635 (1995 Annual ADT).

Freeway Description

The study area is bounded on the south by the intersection of U.S. 75 and Spur 366; from this point to just prior to Haskell, the structure is elevated. The freeway descends traveling under Haskell. Also, from Mockingbird to Park Lane, the freeway is principally depressed; from Park Lane to the northern terminus at I-635, the structure is principally at-grade but rises on approach to major streets and is elevated over cross streets (Figure 16). This latter section serves as the control for comparison purposes.

Socio-Economic Assessment

Between 1980 and 1990, the population for the city of Dallas increased by 10%, and the average persons per household remained constant at a ratio of 2.5. The population and average persons per household for the North Central Expressway study area increased by 18% and 3%, which is more than the city as a whole. Further, there was a significant increase of 32% in the study area's population density. Dallas experienced a 34% increase in vacancy rates, from 7% in 1980 to 11% in 1990. Conversely, the vacancy rates in the study area decreased 15%, from 13% to 11% during the same period. Unlike Houston, the city of Dallas and its study area experienced little change in the population of African-Americans. In actuality, the city baseline remained essentially stable, decreasing by 1%. The Hispanic population increased in the city by 41% and in the study area by 38%, while the White/Other racial category decreased by 17% and 14 % for the city and study area.

The average range of median household annual income along the North Central Expressway corridor is between $10,000 and $50,000. In the southern project area around

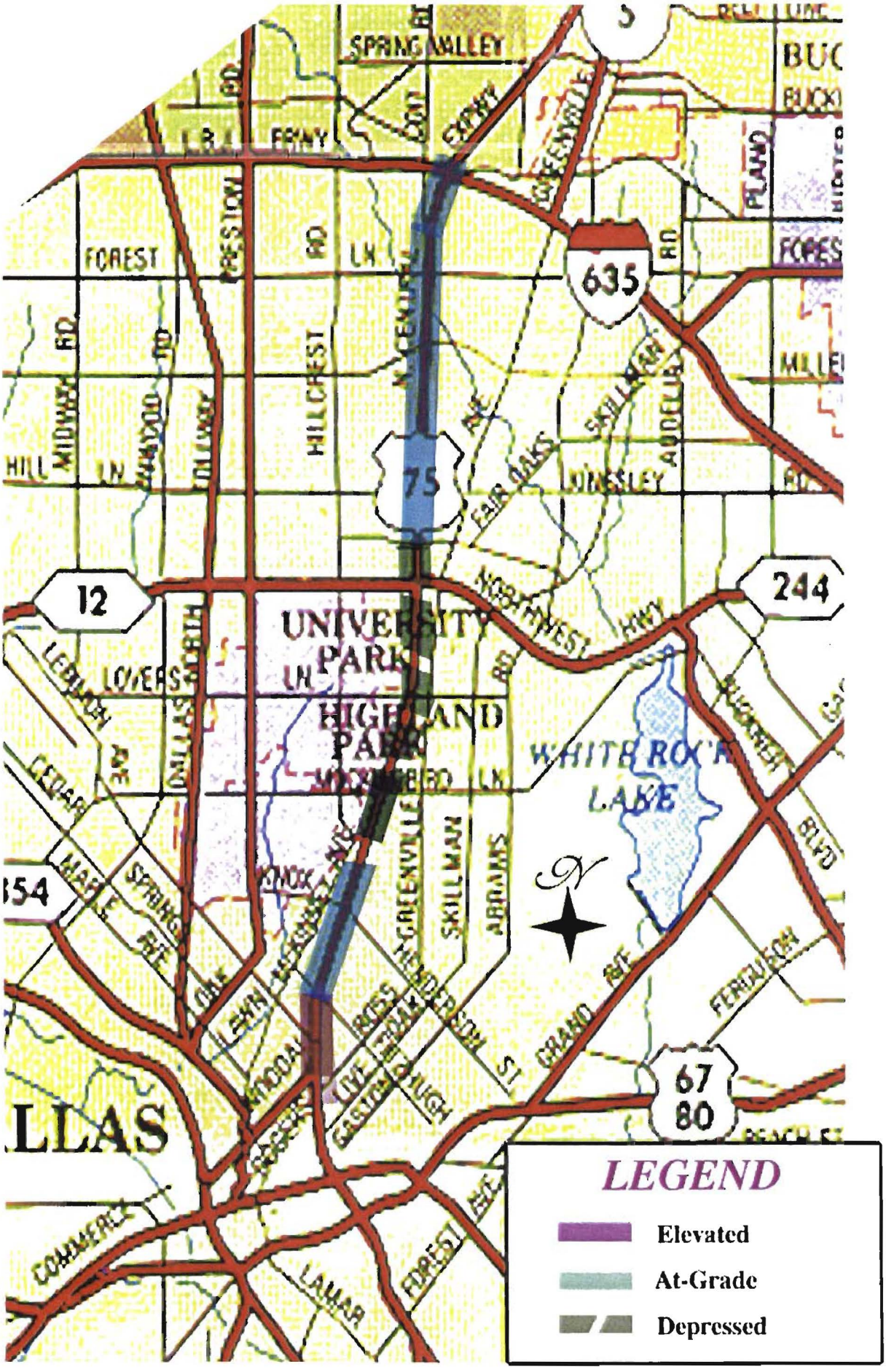


Figure 16. Dallas North Central Expressway Elevation Map

Roseland Homes, the median household income is less than $10,000 a year, while in the Park Cities and "M Streets," the annual income ranges between $30,000 and $50,000+. North of Northwest Highway, annual median household income ranges from $10,000 to $50,000+, with the higher income household typically on the west side of the expressway.

Land Use

Land use along the project corridor varies from light industrial in the northern end to residential, retail/commercial, and park facilities spread along the length of the corridor. The industrial sites are found at the northern end of the corridor by Forest Lane and the Lyndon B. Johnson Freeway. Although the corridor lies within a highly developed retail, commercial, and residential area of Dallas County, adjacent areas also include significant recreational and institutional use.

The commercial sites include auto-oriented retail, shopping centers, single-office buildings and office parks, and several hotels/motels. The frontage of the North Central Expressway has almost 1.1 million m^2 (12 million ft^2) of office space existing or under construction and .23 million m^2 (.5 million ft^2) of existing retail space. The project area north of Mockingbird Lane has the most recently developed portions of the corridor, and this area reflects a decidedly different land use mix than the southern area. The primary structures along the expressway in this area are high-rise office towers and large commercial and retail structures, such as the Northpark Mall. Set back from the fronting structures are large multi-family apartments and condominiums.

Dense residential areas, both single-family and multi-family, are directly adjacent to the right-of-way near downtown and University Park. Also north of Northwest Highway, there are pockets of multi-family housing along the right-of-way. The corridor passes through neighborhoods of townhouses and apartments in East Dallas and Vickery, reaching densities of over 12000 people per km^2 (7500 people per mi^2). Highland Park and University Park are known as "Park Cities." They are predominantly residential, with relatively small populations.

The Park Cities are located predominantly on the west side of the North Central Expressway between Knox Street and Northwest Highway. The smaller cities of Highland Park and University Park are considered to be "prestigious" neighborhoods. University Park includes Southern Methodist University and the surrounding residential area.

The areas to the west of North Central Expressway from Fitzhugh to Northwest Highway contain some of the most sought after residential areas in Dallas (Figure 17).

Land Value Assessment

There were 194 useable accounts obtained for 1985 and 204 for 1994 to evaluate the properties along Dallas' North Central Expressway. Over 20% are residential, 50% commercial, roughly 25% are vacant, and the remainder are industrial, institutional, or some other category. Note that the assessment of this section presents the effect of construction on land prices during the construction phase.

Range of Values

Table 12 shows the range of values for the two time periods by proposed freeway grade and land use category. Decreases are observed for at-grade and depressed properties. Note that properties adjacent to at-grade sections have a higher value per square meter than properties that are depressed. From a land use perspective, the same pattern of decreasing values is seen, with two interesting exceptions: the lowest value for commercial property has risen, and the highest value for vacant properties has remained stable. Thus, parcels available for development have defied the decreasing trend. This finding is consistent with several other studies regarding impact of construction on land values. Because the freeway is under construction and the pre-construction and post-construction grades are different, impact of grade is not as relevant to the changes observed in the value as for other cities in this study. These data will be useful should future researchers assess this question once the North

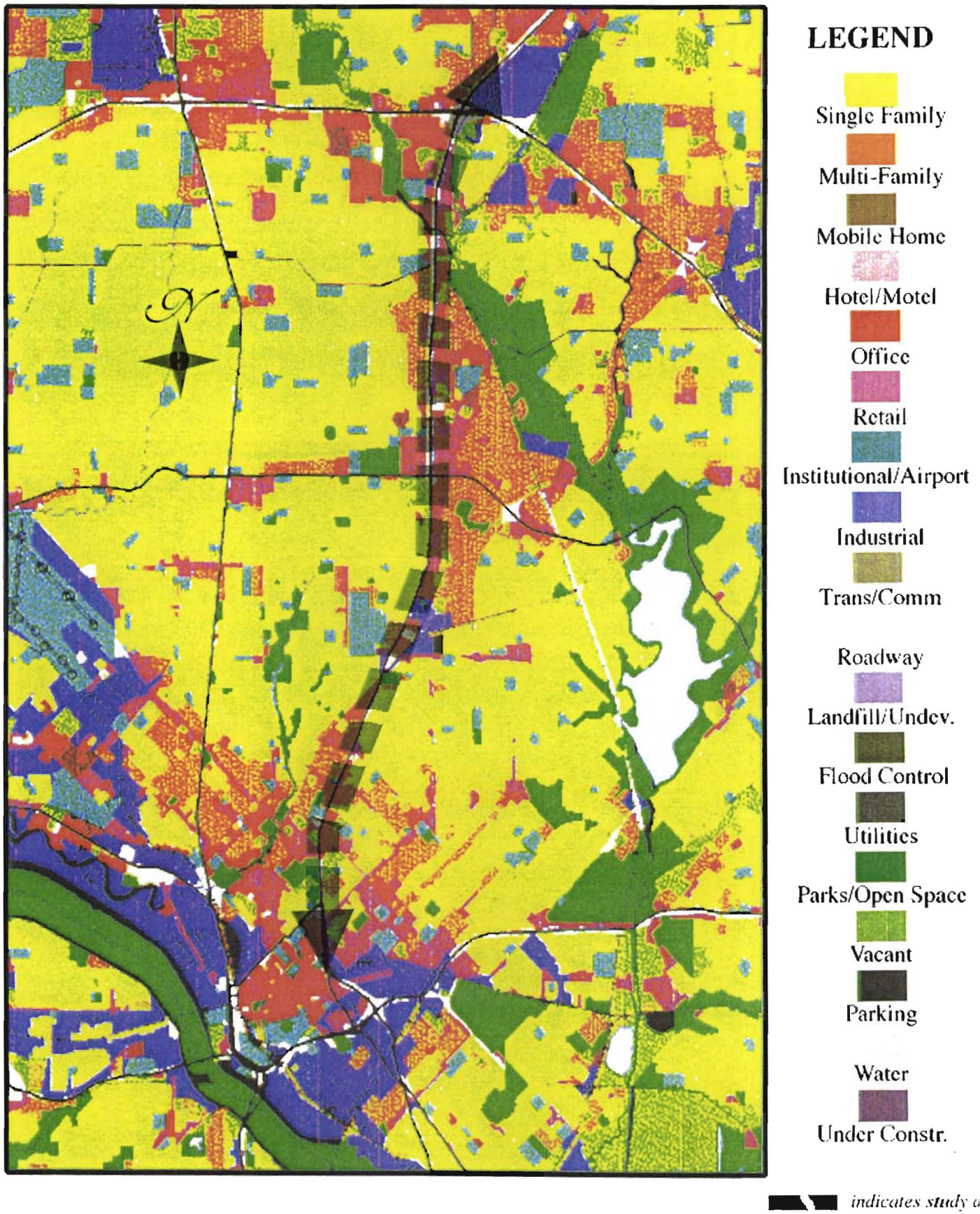


Figure 17. Dallas North Central Expressway Land Use Map

Central Expressway reconstruction has been completed. Several key points should be considered in assessing the value of properties adjacent to the North Central Expressway. First, the freeway is under construction; values are known to be negatively impacted during this phase of a project. Second, a comparison of total land values representing all properties in Dallas County decreased during the period of study. The Dallas County Appraisal District reports a 1985 aggregate value of $37.0 billion ($1994) and $29.0 billion in 1994, a decrease of 27.5%. It may therefore be expected that land values along North Central will reflect this decrease, as well as a negative value due to the construction process.

Mean Value

Consistent with the range of values section, mean values decreased between 1985 and 1994 along North Central Expressway (Table 14). Values in the depressed section experienced the largest decrease at -161.35%. The decrease for the at-grade section was 78.06%. The values reflect the anticipated pattern, with the properties in the elevated section having the lowest absolute value; the at-grade properties have the highest value. then elevated property values. From a land use perspective, the commercial parcels experienced the greatest decrease. The residential properties decreased the least.

Table 13. Dallas North Central Expressway
Range of Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1983) CONSTRUCTION		AFTER (1994) CONSTRUCTION	
	Lowest	Highest	Lowest	Highest
At-grade	$ 1.4	$ 2,648.24	$ 0.22	$ 1,383.01
Elevated	(1)	(1)	18.35	131.35
Depressed	2.96	2,829.74	1.44	1,028.51
Residential	2.96	224.59	1.44	165.99
Commercial	1.4	2,829.74	4.22	1,383.01
Industrial	140.37	237.83	33.2	138.06
Institutional	N/A	N/A	N/A	N/A
Vacant	42.11	1,011.46	0.22	1,028.51

(1) These account numbers were unreported in the dataset provided by the Dallas County Appraisal District.

Table 14. Dallas North Central Expressway
Mean Values (Land Value/Sq. Meter in $1994)

FREEWAY LEVEL/ LAND USE	BEFORE (1985) CONSTRUCTION	AFTER (1994) CONSTRUCTION	% CHANGE
At-grade	$ 257.97	$ 144.88	$ -78.06
Elevated	N/A	59.02	100
Depressed	280.64	1407.38	-161.35
Residential	20.59	13.14	-56.70
Commercial	378.18	164.63	-129.72
Industrial	189.10	97.94	-93.08
Institutional	N/A	N/A	N/A
Vacant	307.77	144.88	-112.43

LAND VALUE INDEX MODEL

The purpose of this section is to evaluate the pre-construction and post-construction behavior of the land values on elevated, depressed, and at-grade sections of the freeway utilizing an economic, linear regression approach. A "land value index" model provides the basis by which the freeway grades and land uses are examined. It was expected that yearly changes in land value for elevated and depressed sections would differ significantly from each other and from changes recorded for at-grade sections. Each combination of components, as shown below, represents a distinct variable. For instance, an at-grade, residential property in 1982 is treated as one variable; an elevated, residential property in 1982 is a second variable; or an at-grade, residential property in 1994 is a third variable. In that manner, the number of variables for the specific city varies as follows:

Variables = number of freeway grades (three for Houston, Dallas, and Lubbock and four for San Antonio as double-decked is added), number of land use categories, number of years of available data

$$^{*}\ \mathrm{Ln}\ (L_{i\tau}) = \sum_{j}\sum_{k}\sum_{\ell} (T_j * U_k * Elev_{\ell}) + U_{i\tau}$$

$L_{i\tau}$ = *Land value per square foot for a given parcel*

τ = *Time period*

U_k = *Dummy for land use type.* k

T_j = *Dummy for time period, j*

$Elev_{\ell}$ = *Dummy for freeway elevation,* ℓ

Individual account number dummies are also included in the equation whenever significant, to account for omitted variables. The model does not, however, establish a causal relationship between "grade level of freeway constructed" and "land values." The indices for the pre-construction year (the base year) were normalized to 100. The change

* Individual account dummies were included in the regression in order to span or parcel specific factors and to increase the explanatory power of the regression equation.

in the index for a given grade and land use in the post-construction year was the increment in the coefficient of that variable. The calculation of the indices from the coefficients of the variables is included in Appendix 2.

For all cities, the regression confirmed the findings in the range of values and mean values review for raw data: that freeway grade cannot always be positively correlated with land value and that no conclusive trends can be consistently confirmed regarding land use, grade, and land value. To facilitate development of the indices, the output was standardized by using the first year coefficient as the base year (either 1982 or 1985) with a value of 100. The land value indices are shown in Table 15.

Given the number of hypotheses that can be evaluated using the regression methodology, the research team selected several key premises to test for each city. These premises were based on the strength of the raw data available and the principal research question regarding variations in property values according to freeway grade level. For instance, in 1994 fewer than 3% percent of the properties in Houston, suburban San Antonio, or Dallas were found to be in the industrial and institutional categories. Therefore, hypotheses shown in the tables of significance do not specifically address the institutional and industrial properties in those cities.

Houston

The findings indicate that irrespective of freeway grade level, all land values adjacent to the Sam Houston Tollway increased over 1982 levels. As noted in the mean value analysis, properties have decreased from pre-construction highs in 1986. Figures 18 to 20 display the relationships of the property values by grade and by land use according to the index which sets the base year (1982) at 100. The residential values are competitive with commercial values in the elevated and the depressed sections. Table 16 shows the results of tests of significance conducted for key hypotheses. It was found that there was no significant variation in the residential and vacant properties across grades in the year 1994. Also, the value of properties that are at-grade are not significantly different across land use categories. The variation in value was significant for commercial properties after

construction, with the depressed values being the lowest; whereas, elevated and at-grade values remained roughly the same.

San Antonio

The San Antonio freeway sections under examination became operational between 1986 and 1994. Therefore, when the data were collected, some of the sections were considered mature while others were almost new. The regression analysis for San Antonio combines the urban (I-10 / I-35) and suburban (U.S. 281) sections. Many variables showed "stable-to-increasing" property values during the evaluation period. According to the land value indices, many land use categories increased in value, including commercial at all grades, residential elevated, and institutional (elevated and double-decked). In contrast, residential properties in depressed sections, vacant properties in double-decked sections, and industrial properties at all grade levels showed decreases (Figures 21and 29).

The findings from the indices and significance from the regression are summarized in Table 17. The data tend to indicate no significant, consistent, or systematic relationship between grade level and land values. When the land use category was correlated with land value by grade, the same pattern existed. Findings, therefore, are inconclusive relative to whether the grade of the freeway, in and of itself, exerts a consistent negative influence on values for at-grade, elevated, or depressed freeways.

Table 15. Land Value Indices Calculation

City	Grade	Year	Residential	Commercial	Industrial	Institutional	Vacant
Houston							
	At Grade	1982	100	100	100	100	100
		1986	264	264	258	NA	278
		1993	227	228	236	220	255
		1994	239	241	NA	244	NA
	Elevated	1982	100	100	NA	NA	100
		1986	261	267	NA	NA	249
		1993	230	240	NA	NA	239
		1994	239	237	NA	NA	246
	Depressed	1982	100	100	NA	NA	NA
		1986	250	236	NA	NA	NA
		1993	208	163	NA	NA	NA
		1994	215	192	NA	NA	NA
Lubbock							
	At Grade	1983	100	100	NA	100	100
		1994	75	88	NA	61	47
	Elevated	1983	100	100	100	NA	NA
		1994	81	86	62	NA	NA
	Depressed	1993	100	100	NA	NA	NA
		1994	47	95	NA	NA	NA
San Antonio	(281 + Y Project)						
	At Grade	1983	100	100	NA	NA	NA
		1994	99.5	142.8	NA	NA	NA
	Elevated	1983	100	100	100	100	100
		1994	133.9	115.5	77.9	129.5	105.1
	Depressed	1983	100	100	NA	NA	NA
		1994	83.6	125.9	NA	NA	NA
San Ant.							
	Dbl. Deck	1983	100	100	100	100	100
		1994	106.4	112.9	73.5	274.2	28.3
Dallas							
	At Grade	1985	100	100	100	NA	100
		1994	80.5	29.4	-22.1	NA	108.5
	Elevated	1985	NA	NA	NA	NA	NA
		1994	NA	NA	NA	NA	NA
	Depressed	1985	100	100	100	NA	100
		1994	27.7	34.5	54.5	NA	-14.5

Table 16. Houston Test of Significance
(F - Test of Significance)

HYPOTHESIS	P-VALUE	VALUE	REJECT	CANNOT REJECT	FINDINGS
Residential properties adjacent to at-grade, elevated, or depressed sections had equal values in 1994.	.844 $F_{2,680}$ $F_{2,680}$	.17		*	The values for residential properties were not statistically different across grade levels.
Commercial properties adjacent to at-grade, elevated or depressed sections had equal value in 1994.	.009 $F_{2,680}$	4.74	*		The variations in commercial property were statistically different across grade levels.
All at-grade properties have the same land values in 1994.	.871 $F_{4,680}$	.14		*	Difference between property values at grade are insignificant regardless of land use.

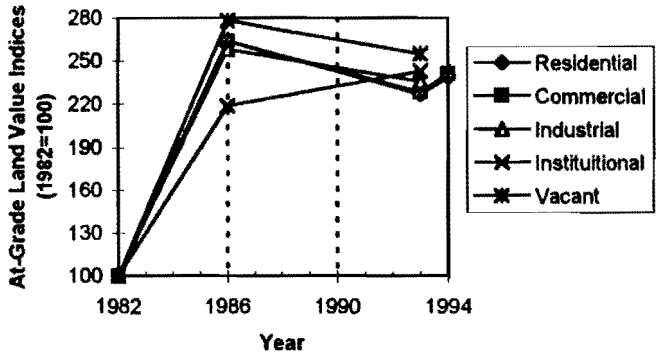


Figure 18. Sam Houston Tollway At-Grade Land Value Indices

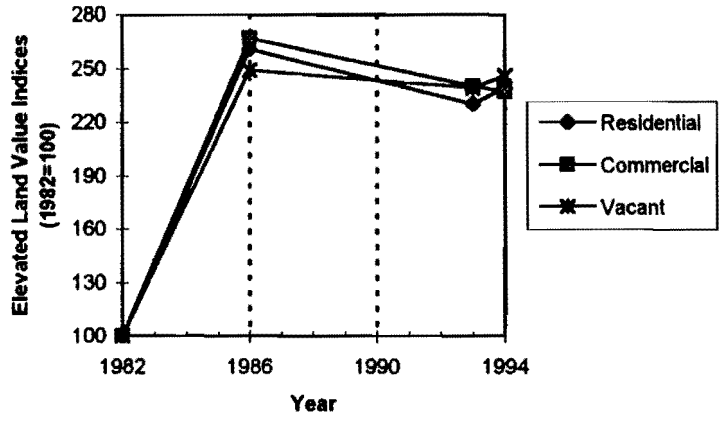


Figure 19. Sam Houston Tollway Elevated Land Value Indices

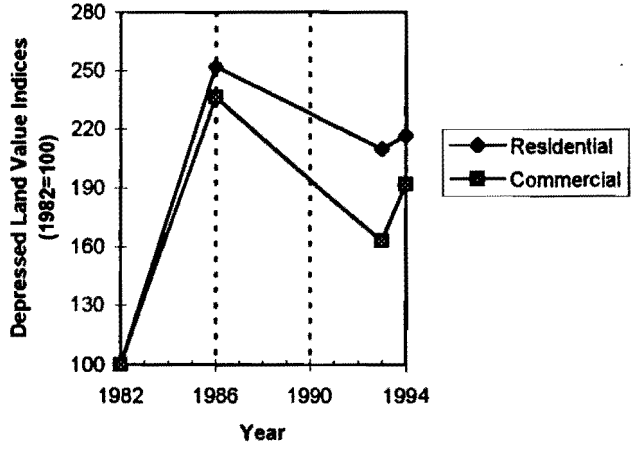


Figure 20. Sam Houston Tollway Depressed Land Value Indices

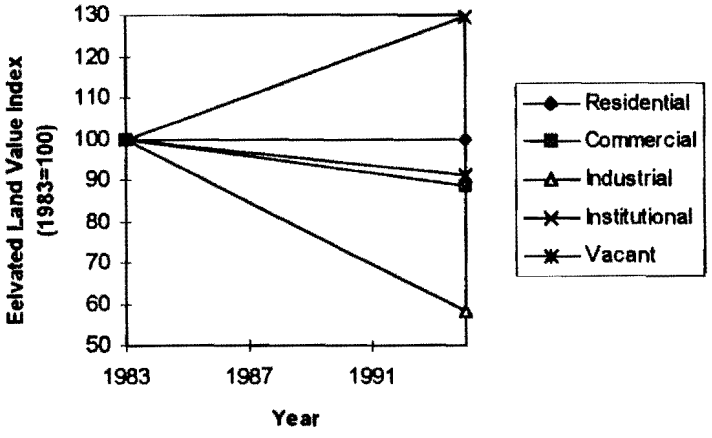


Figure 21. San Antonio Elevated Land Value Indices

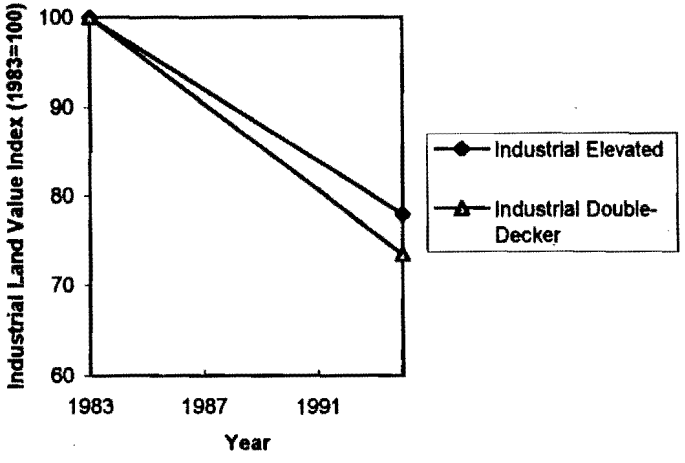


Figure 22. San Antonio Industrial Land Value Indices

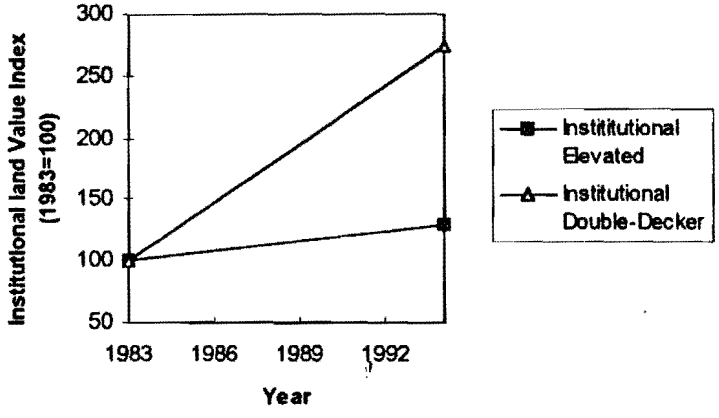


Figure 23. San Antonio Institutional Land Value Indices

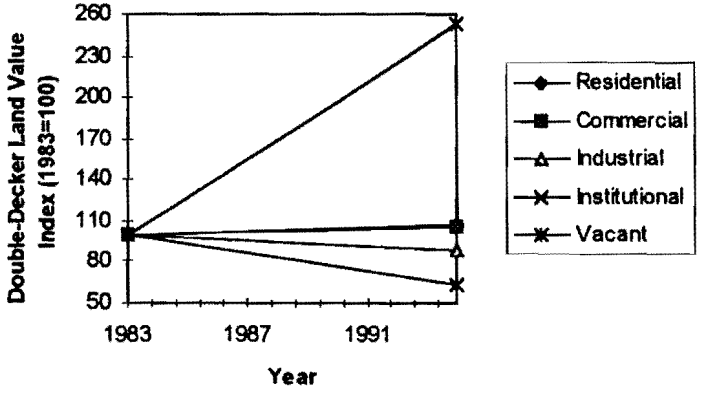


Figure 24. San Antonio Double-Decked Land Value Indices

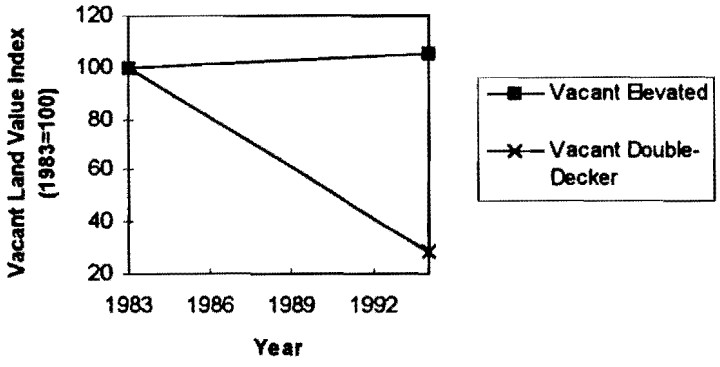


Figure 25. San Antonio Vacant Land Value Indices

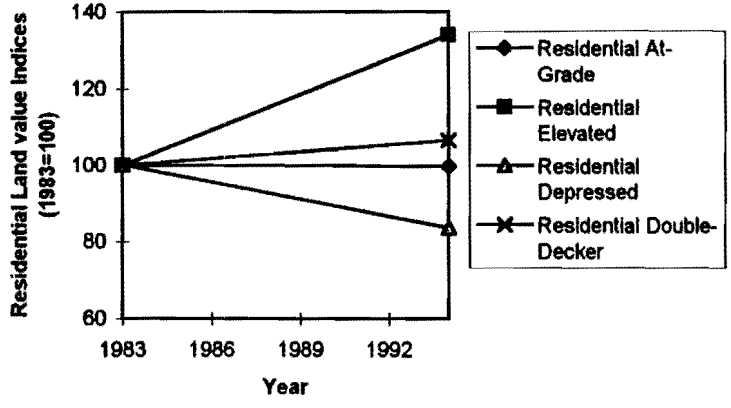


Figure 26. San Antonio Residential Land Value Indices

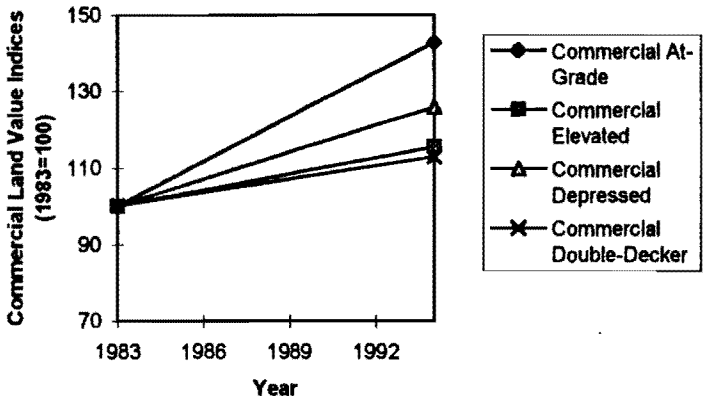


Figure 27. San Antonio Commercial Land Value Indices

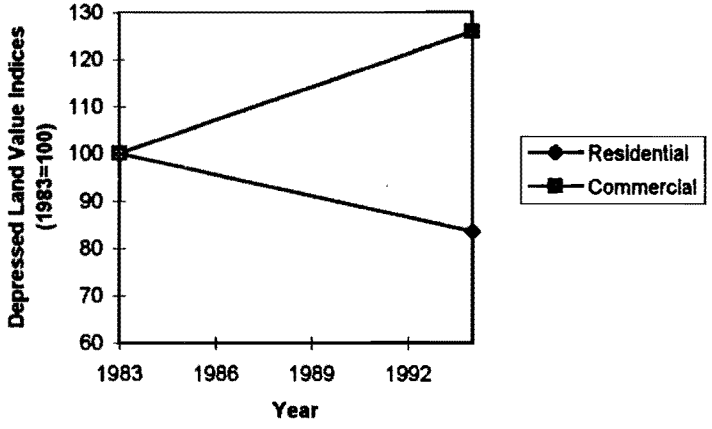


Figure 28. San Antonio Depressed Land Value Indices

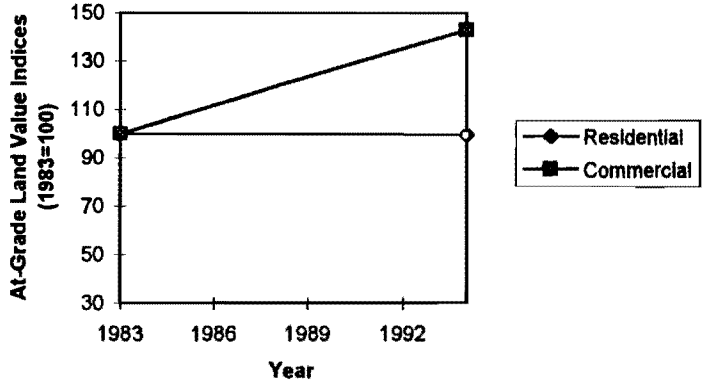


Figure 29. San Antonio At-Grade Land Value Indices

Table 17. San Antonio Test of Significance
(F - Test of Significance)

HYPOTHESIS	VALUE	P-VALUE	REJECT	CANNOT REJECT	FINDINGS
There is no difference in value for properties adjacent to at-grade sections regardless of land use.	1.39 $F_{3,214}$	.246		*	There is no significant difference in value for at-grade properties with different land uses.
There is no difference in value for properties adjacent to elevated sections regardless of land use.	1.43 $F_{4,214}$	.22		*	There is no significant variation in values of properties adjacent to elevated properties despite land use.
There is no difference in value for properties adjacent to depressed sections regardless of land use.	5.78 $F_{1,214}$	.02	*		This hypothesis is rejected and shows there are variations in values across land uses in depressed sections.
There is no difference in value for properties adjacent to double decked freeways regardless of land use.	2.89 $F_{4,214}$	.02	*		There is a difference in property value adjacent to doubled-decked freeways by land use.
There is no difference across grade levels for residential properties	6.11 $F_{3,214}$	.0005	*		There is a difference for residential properties across grade levels.
There is no difference across grades for commercial properties.	.9836 $F_{3,214}$	.402		*	There is a difference for commercial properties across grade levels.

Dallas

Several key points appear to influence the hypothesis testing for the property values along North Central Expressway. First, the residential and industrial properties are all in sections that are constructed at-grade. Therefore, grade level comparisons were not made for these land uses. Also, it should be noted that the freeway grades shown are the levels *before* the new construction. Many grade changes will occur as the reconstruction is being completed. As such, field observation at the time of this writing may not be in tandem with the land uses recorded at the beginning of this study. As noted in the mean and range analyses, property values at all grades and for all land uses have decreased during the construction period. Figures 30 to 35, reflecting the indices and regression analysis, show that the magnitude of the decreases is roughly the same for all at-grade land uses. Table 18 reveals that there is a statistical difference between commercial and residential at-grade properties. However, the analysis shows no statistically significant difference in land values for various land uses in the depressed and elevated sections. Since freeway construction is still in progress, this finding is not conclusive. Changes in land value for various land uses could be altered upon completion of the depressed and elevated sections.

Lubbock

The land value indices for Lubbock show decreasing values for all land uses (Figures 36 to 40). It should be noted that the I-27 freeway did not open until 1991; construction was underway in the late 1980s. Decreases in land value were occurring in the early 1980s, even before the construction began. As noted in the previous section, the total market value for property in Lubbock decreased slightly during the study period. It may be that the decreased value observed along I-27 is due to intervening variables other than the freeway itself. The test of significance, found in Table 19, reveals that residential values vary statistically by grade, with residential elevated values being highest and residential depressed being the lowest. Grade level was not significantly different for commercial properties.

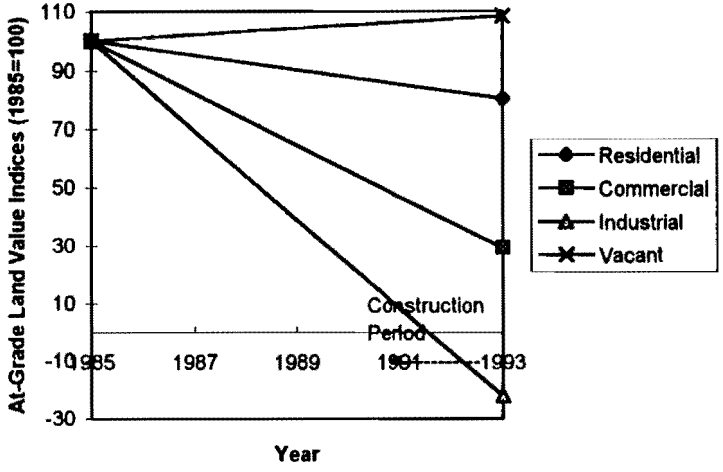


Figure 30. Dallas At-Grade Land Value Indices

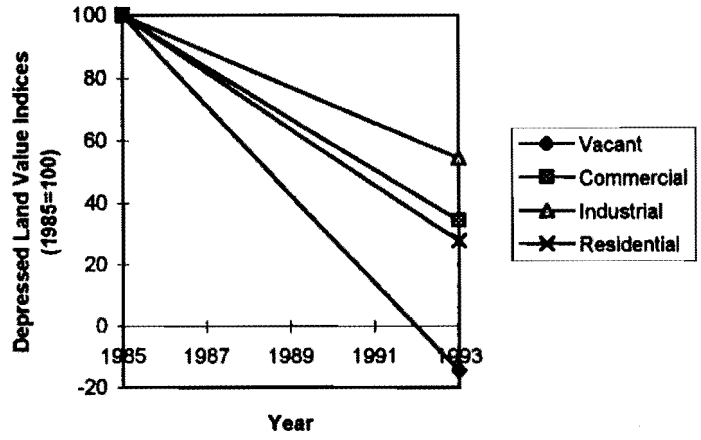


Figure 31. Dallas Depressed Land Value Indices

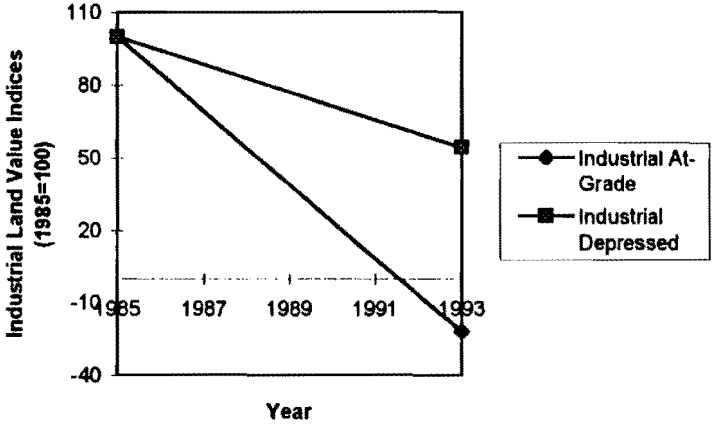


Figure 32. Dallas Industrial Land Value Indices

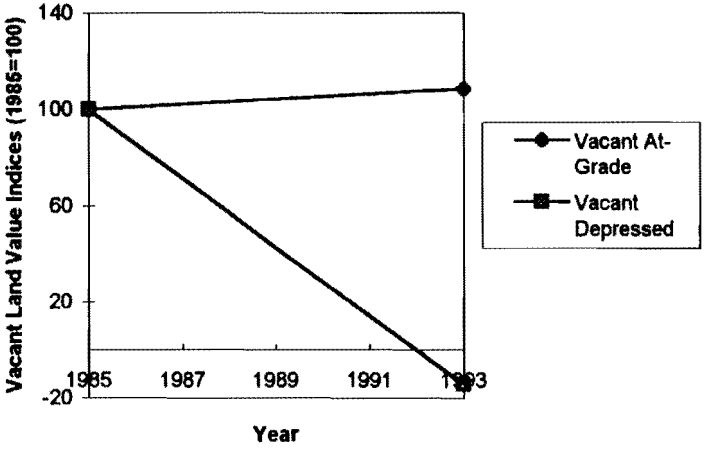


Figure 33. Dallas Vacant Land Value Indices

**Figures denote primary conditions. The absence of any grade or land use in a graph indicates there were not sufficient values in that category to determine a trend.*

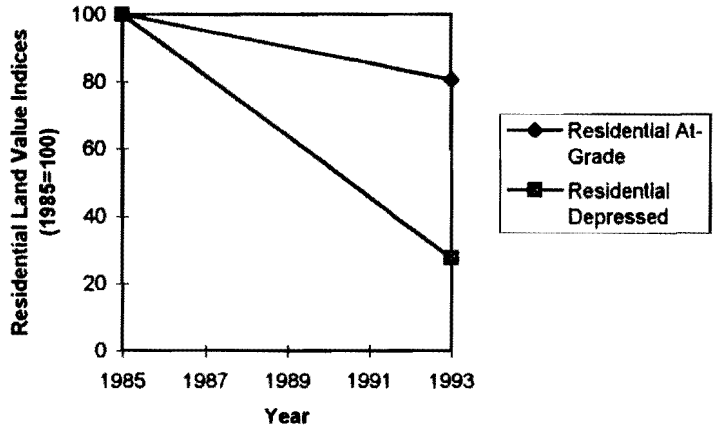


Figure 34. Dallas Residential Land Value Indices

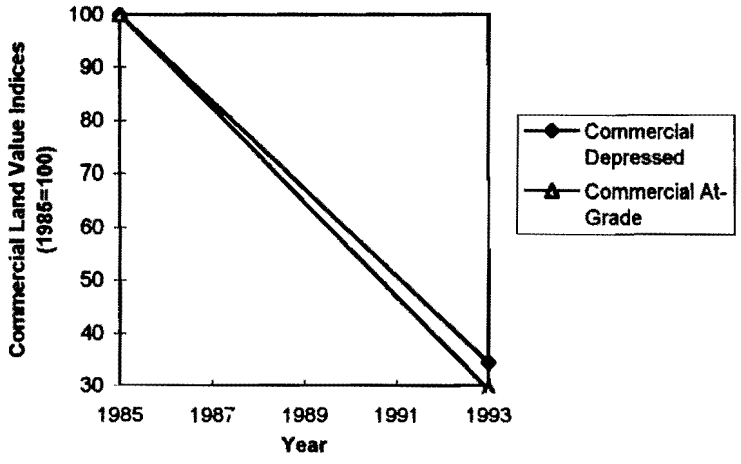


Figure 35. Dallas Commercial Land Value Indices

Table 18. Dallas Test of Significance
(F - Test of Significance)

HYPOTHESIS	VALUE	P-VALUE	REJECT	CANNOT REJECT	FINDINGS
There is no difference in land value at-grade regardless of land use.	.405 $F_{3,108}$	.749		*	There is no significant difference in land value for commercial or residential land at-grade.
There is no difference in elevated land value regardless of land use.	1.11 $F_{1,108}$	.29		*	There is no significant difference in land values in elevated sections across land uses.
There is no difference in land value regardless of land use in depressed sections.	8.70 $F_{3,108}$	.0001	*		There is a significant difference in land values in depressed sections across land uses.
There is no difference in commercial land values regardless of grade level.	.948 $F_{2,108}$	.391		*	Commercial land values do not vary by grade.
There is no difference in value for vacant land at different grades.	1.41 $F_{2,108}$	.249		*	Vacant land value does vary by grade.
There is no difference in value for residential land at different grades.	19.8 $F_{1,108}$	.0001	*		There is a significant difference in residential land values at different grades.

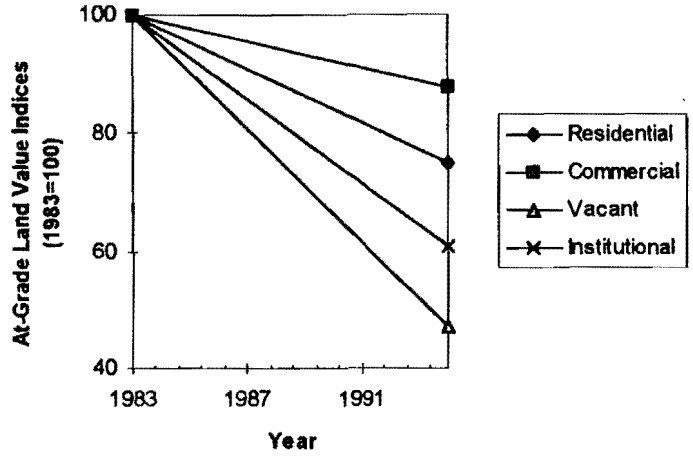


Figure 36. Lubbock At-Grade Land Value Indices

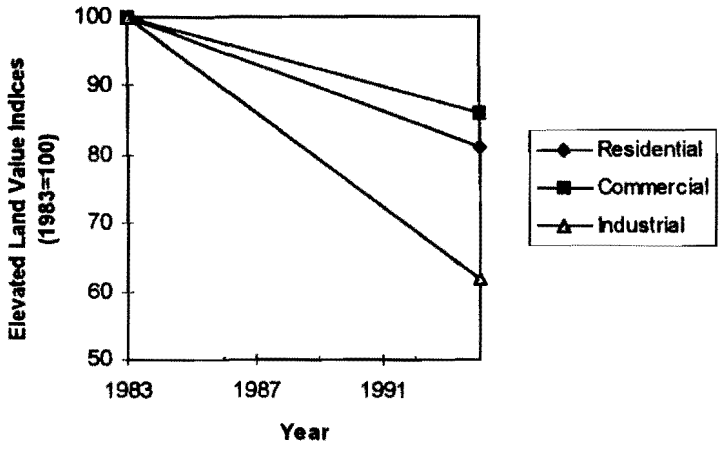


Figure 37. Lubbock Elevated Land Value Indices

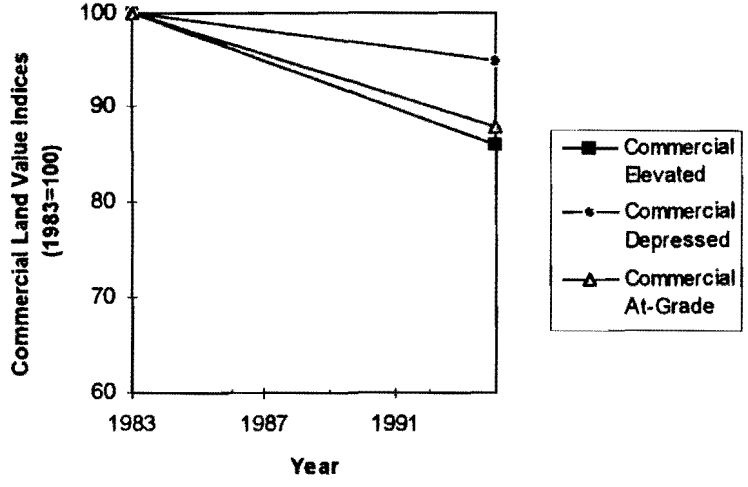


Figure 38. Lubbock Commercial Land Value Indices

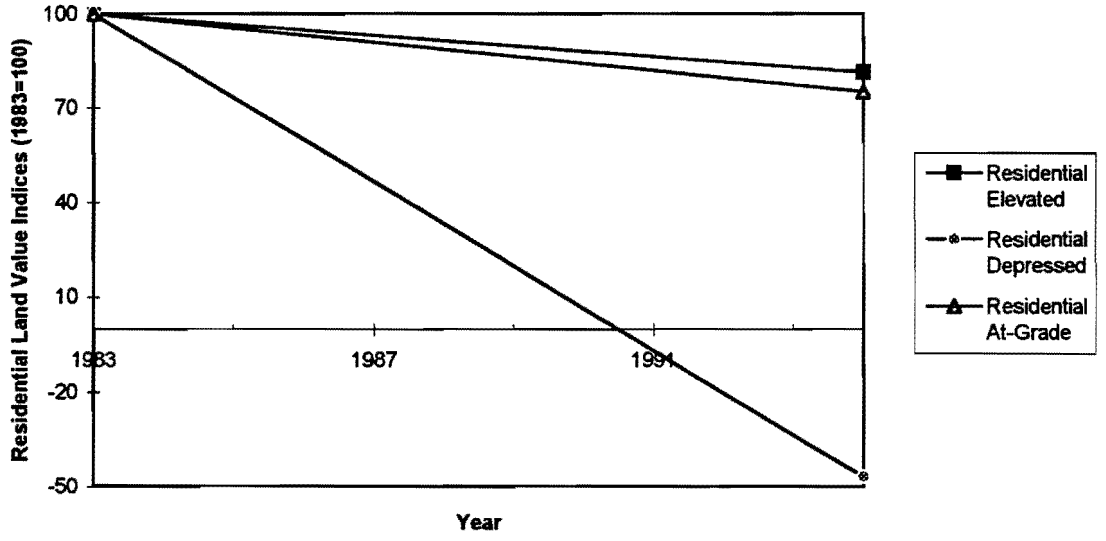


Figure 39. Lubbock Residential Land Value Indices

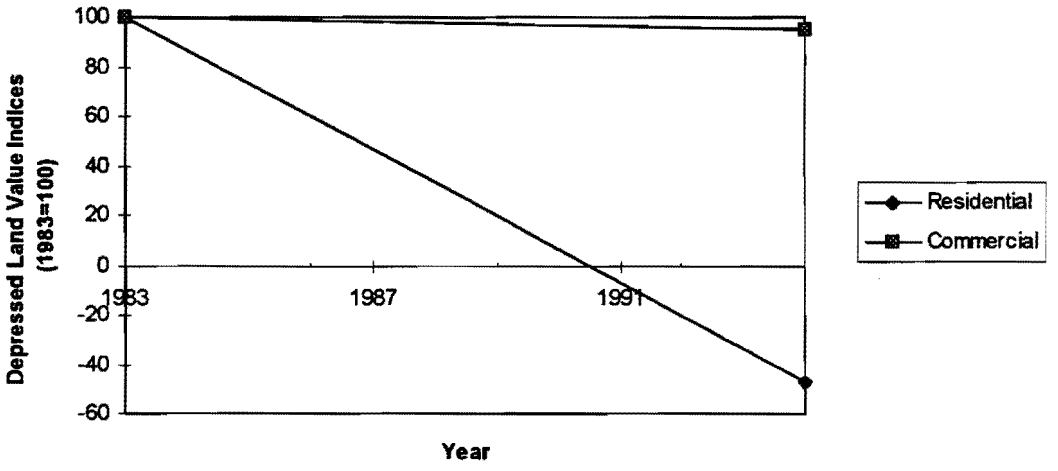


Figure 40. Lubbock Depressed Land Value Indices

Table 19. Lubbock Test of Significance
(F - Test of Significance)

HYPOTHESIS	P-VALUE	VALUE	REJECT	CANNOT REJECT	FINDINGS
There is no significant variation in residential value for residential properties across grade levels.	.0001 $F_{2,504}$	105.46	*		There is variation in value of properties across grades in 1994.
There is no significant variation in value for commercial properties across grade levels.	.1165 $F_{2,504}$	2.159		*	There is no statistically significant commercial variation across grades.
There is no difference in values of residential, commercial, or other at-land uses at-grade.	.0001 $F_{3,504}$	9.806	*		There is variation in values of residential, commercial, and other grade land use.
There is no difference in values of residential, commercial, or other uses for depressed freeways.	.0001 $F_{1,504}$	240.98	*		There is variation in values of various land uses next to land depressed freeways.
There is no difference in values of residential, commercial, or other land uses by elevated freeways.	.0001 $F_{2,504}$	20.35	*		There is variation in values of various land uses next to elevated freeways.

The findings summarized in Tables 16-19 show that freeway grade influences land values in some cases, but not in all cases. Likewise, the land use category sometimes correlated with land value by grade and other times did not. There is need to assess land values along freeway corridors under more controlled conditions. Since some correlations were possible, there is reason to suspect that intervening variables (not accounted for in the model) may provide some explanation for the negative influences.

SUMMARY OF MEAN ANALYSIS AND THE LAND VALUE INDEX MODEL

Assessment of the mean data from the four cities can be viewed from several perspectives, including the percentage change, averages by percentage change, value per square meter, and by the land value indices. On a percentage change basis, properties adjacent to at-grade sections of the mature freeways in Houston and San Antonio experienced more positive value changes than parcels adjacent to elevated sections, although the difference for Houston is minimal (Table 20). These findings are consistent with previous research.

Table 20. Means Analysis Percent Change Before and After By City By Grade

	% INCREASE OR % DECREASE			
Years Operational	**At-Grade**	**Elevated**	**Depressed**	**Double-Decked**
HOUSTON				
Harris County Totals 2.4%				
7 Years	82.45	82.28	74.11	*
SAN ANTONIO I-35/I-10 "Y" and U.S. 281				
Bexar County Totals 6.85%				
(Staged) 2-10 Years	15	3	47.53	4
LUBBOCK				
Lubbock County 26.87%				
4 Years	-36.14	-19.93	-62.19	*
DALLAS				
Dallas County -27.5%				
Under Construction	-78.06	*	-161.35	*
Average w/ DALLAS	-4.19	21.78	-25.48	
Average without DALLAS	20.43	21.78	19.82	

** Data not available in "before" construction period or freeway grade not applicable*

Depressed values in Houston did not perform as well as elevated or at-grade. More research is needed relative to land values in depressed areas of Houston. While all values in Lubbock decreased, those parcels adjacent to elevated parcels decreased the least. In Dallas, depressed parcels decreased more than at-grade parcels. It should be noted that freeway construction in Dallas was still in progress. In San Antonio, the percentage change in depressed values was higher than for elevated or at-grade properties. Averages of the values with the under-construction section included for Dallas show elevated land higher than at-grade land, followed by depressed properties. When Dallas is excluded, elevated parcels show the greatest percentage increase, while depressed properties tend to have a lower percentage increase when compared to elevated sections of the freeway.

The average percent change (Table 21) indicates that properties located in depressed sections had a higher performance in terms of land values than those parcels adjacent to the elevated sections in the study. Depressed sections had a 14.86% increase in the aggregate, while the doubled-decked sections remained positive at 4%. Elevated values appeared to experience a decrease in aggregate average value of 8.47%. When compared to at-grade, elevated and depressed sections were varied in terms of percent change. Land value adjacent to elevated parcels, though small in terms of aggregate average values, had a positive value. The depressed values and double-decked sections were more negative in value when compared to at-grade.

Another way to analyze grade level land value difference is by using the one-point-in-time (1994) approach. The data presented in Table 22 reflect the differences and mean square meter values by grade level for the after-construction year. According to this approach, the parcels next to depressed and elevated freeways show a slightly higher average value across all four cities than properties adjacent to at-grade sections. The at-grade properties have the lowest value per square meter, with elevated values 45.2% greater than at-grade and depressed values 44.94% greater than at-grade. The mean values

Table 21. Average Percent Change By Freeway Sections Selected for Study

STUDY SECTION	CITY	% INCREASE or DECREASE	GRADE AVERAGE
Depressed			
#1 and #5	San Antonio (I-35/I-10, U.S 281) *	47.53	
#6	Houston (Sam Houston Toll)	74.11	
#9	Lubbock (I-27)	-62.19	
Average Depressed			**19.81%**
Average At-Grade			**20.44%**
Difference (At-Grade to Depressed)			*-.63%*
Elevated			
#4	San Antonio (I-35/I-10)	3	
#8	Lubbock (I-27)	-19.93	
Average Elevated			**-8.47%**
Average At-Grade			**-10.57%**
Difference At-Grade to Elevated)			*2.1 %*
Double-Decked			
#2 and #3	San Antonio (I-35/I-10)	4	
Average Double-Decked			**4%**
Average At-Grade			**15%**
Difference (At-Grade to Double-Decked)			*-11%*

Note: Study Sections # 7 (Dallas), #10 and # 11 (Lubbock U. S. 62/82) not included because they are under construction or in right-of-way acquisition. Also not included is the elevated section of Houston because it was not an original study section and because of the influence of the intersection of the Tollway with I-10.

per square meter presented in this table show additional variation and different patterns when viewed by individual city. However, the results tend to confirm the percentage change findings in Tables 20 and 21 in that land next to elevated sections has experienced the greatest percentage increase.

Table 22. 1994 Mean Values/Sq. Meter By Grade

City	S. Houston Tollway	S. Antonio I-35/I-10	S. Antonio 281	Lubbock I-27	AVG	Difference Between At-Grade Base
GRADE LEVEL						
At-grade	$72.77	$17.34	43.09	6.42	$29.55	*
Elevated	80.30	40.06	*	8.33	42.90	$13.35 (45.2%)
Depressed	81.33	15.82	68.88	5.29	42.83	$13.28 (44.94%)
Average	**$78.13**	**$24.41**	**$55.99**	**$6.68**		

Table 23 provides a more in-depth breakdown based on the regression-based land value index model. For Houston, the residential indices were the same (139) for the elevated and at-grade freeway levels. There was no land value advantage or disadvantage for being elevated in comparison with at-grade control sections. In the case of the depressed grade level, the residential index value of 115 was significantly below the at-grade value of 139. Lubbock residential values also are surprising in that although all values are negative, suggesting a decline in land values per square meter, the residential

elevated values are highest, followed by at-grade and depressed values. Commercial values in Lubbock are not much different at-grade or elevated according to the index model (-12 and -14). The depressed commercial have the best position in the index model for Lubbock (-5).

Table 23. Before and After Land Value Index Summary
Change from Base Year (1)

GRADE	CITY	RES.	COM.	IND.	INST.	VAC.
At-grade						
	Houston	139	141	*	144	*
	S. Antonio	-.5	43			
	Lubbock	-25	-12	*	-39	-53
Average		*37.8*	*57.3*		*52.5*	*-53*
Elevated						
	Houston	139	137	*	*	146
	S. Antonio	133.9	15.5	77.9	129.5	105.1
	Lubbock	-19	-14	-38	*	*
Average		*84.6*	*46.2*	*19.9*	*29.5*	*75.6*
Depressed						
	Houston	115	92	*	*	*
	S. Antonio	-16.4	25.9			
	Lubbock	-53	-5	*	*	*
Average		*15.2*	*37.6*			

(1) 1994 index values from Table 15 minus base year value of 100.
** Data not available in "before" construction period or freeway grade not applicable.*

Residential and commercial land uses are represented in all cities and at all grades in Table 23. The indices are statistically significant across grade levels only for residential land in Lubbock and San Antonio. This infers that the Houston land value indices for elevated residential and depressed are not different from the at-grade index. In other words, there is no land value advantage or disadvantage for a residential property that is located adjacent

to a depressed or elevated section of the freeway in Houston. In the case of Lubbock and San Antonio, land values for residential properties adjacent to elevated freeways show the greatest appreciation.

Commercial land use coefficients are statistically significant only for Houston. The land values for properties adjacent to elevated sections show approximately a 45% greater increase than properties adjacent to depressed freeway sections. Properties adjacent to at-grade segments show the greatest increase overall. The analysis suggests that residential elevated properties and commercial at-grade properties exhibit the greatest increase in land values, followed by commercial elevated land.

Many areas of consistency exist between the land value index and the mean analysis, as shown in Table 24. For instance, in Houston, elevated land value changes before and after construction were similar or equal to changes for at-grade parcels. Also, elevated residential parcels in Lubbock (per the land value index) and land value for aggregate land uses (per the mean analysis) had better after-construction responses than at-grade land.

The land value and mean analysis show contrasting results for San Antonio, with the former indicating elevated property performed better than at-grade and the latter methodology reflecting the reverse. The depressed freeway assessments for the two methods concur for Houston, with the land adjacent to depressed sections having greater decreases in value than at-grade land. The residential land value index and the mean analysis also show depressed values having greater decreases after construction than at-grade parcels. The land value index and the mean analysis do not show the same pattern for depressed land in San Antonio. The land value index reflects depressed land

Table 24. Before and After Land Value Summary Difference Between Elevated and Depressed Sections Compared to At-Grade Base

		Land Value Indices*		Mean Analysis**
Difference Between At- Grade and:	*City*	*Res.*	*Com.*	*All Land Uses*
Elevated	Houston	0	-4	0
	S. Antonio	34	-27	-3
	Lubbock	6	-2	16
Depressed	Houston	-24	-49	-8
	S. Antonio	-16	-17	33
	Lubbock	-28	7	-26

* *Calculated from Table 23 (elevated or depressed land value index minus the at-grade value)*

** *Calculated from Table 20 (at grade percentage change minus elevated or depressed percentage change)*

performing less well than at-grade land; the mean analysis shows depressed land in San Antonio as having better increases than at-grade parcels. These variations in results may be due to the strong influence of values in the suburban U.S. 281 that are smoothed somewhat in the regression analysis.

An alternative procedure was also conducted in order to check the robustness of the conclusions. In this approach, the three cities (San Antonio, Houston, and Lubbock) where freeway construction was complete were pooled and analyzed together. In order to make the data comparable across cities, only two years of data were retained for Houston. The coefficients and indices construction is in Appendix 2. The differences in cities were accounted for by including appropriate city dummies.

Table 25 suggests that residential elevated properties show a greater increase in land values in comparison to at-grade, depressed, and double-decked freeway sections. For

commercial properties, at-grade parcels show the greatest appreciation followed by elevated parcels, then depressed and double-decked properties.

The combined city analysis supports the results shown in previous tables. In general, the various approaches lead to the same conclusions: elevated residential properties show the greatest appreciation over the base year. Residential depressed land values exhibited the least appreciation.

Table 25. Combined City Regression Approach: Before Construction and After Construction Land Value Index Summary (1)

	Residential	Commercial	Industrial	Institution	Vacant
At-Grade	32	107	*	109	-2
Elevated	63 (31)	37 (-70)	-33	30	53 (55)
Depressed	26 (-6)	22 (-85)	*	*	*
Double-Decked	8 (-24)	6 (-101)	-12 (-35)	152	-37

(Difference From At-Grade)

(1) 1994 index values minus base year value of 100.

** Data not available in "before" construction period or freeway grade not applicable.*

For commercial land, at-grade parcels showed the greatest increase, followed by property adjacent to elevated sections. Previous research confirms that commercial properties benefit from the greater visibility afforded by at-grade and elevated locations.

A survey conducted as a part of this research (reported in 1327-1) found that many residents generally prefer depressed freeways to elevated freeways, especially residents in Houston and Dallas. However, more than 25% of respondents in Houston, San Antonio, and Lubbock indicated *no preference* between freeway grades. Survey results are shown in Table 26.

Table 26. Adjacent Resident Preference for Freeway Type

	Houston	Dallas	San Antonio	Lubbock	Overall
Depressed	58%	58%	17%	26%	32%
Elevated	13%	15%	29%	21%	23%
No Preference	26%	16%	41%	32%	33%
Not Sure	3%	11%	13%	21%	12%

The land value analysis in this report shows that residential land adjacent to elevated freeways experienced greater after-construction increases than residential land at other grades. Other previous research has shown that the positive residential land value response may be partially attributed to increased accessibility. The land value findings suggest that other variables are off-setting the general negative reaction to elevated freeways.

SUMMARY OF FINDINGS

The literature regarding land value impacts was largely developed between the 1950s and early 1980s. Some clear patterns emerged from these early studies that set the direction for this research and structured the analysis. The concepts under analysis include the following:

- A "life cycle" effect is present in which property values decrease during construction and rebound to pre-construction values in roughly five years after operation begins. Depending on the land use and the local economy, values may continue to rise. Cities with strong land use controls were expected to have more favorable land value responses and fewer decreases in land value.

- Freeway grade has a consistent impact on land value, with the depressed sections having the highest land value for residential, and at-grade having the highest value for commercial properties; the least valuable property for all land uses is elevated. The rationale is that the less visible the freeway and the less noise, emissions, and other negative effects are experienced, the higher the value to residential owners. Commercial uses prefer the high visibility available at-grade.

- It is known that land use influences value. Generally, commercial land use commands the highest value regardless of elevation. The land value response of residential properties has been found to be related to the level of accessibility to the freeway. If the freeway is constructed in such a manner as to require circuitous routing or otherwise hinder access by adjacent residents, residential values will have a negative reaction. If access is considered good by residential dwellers, the property value may respond favorably to proximity to the freeway.

The findings are based on a mean value analysis and an index model based on regression analysis of data drawn from freeway sections in four cities. The analysis of freeway

segments in Texas supports the trends reported in previous literature but offers additional insight. Certain freeway sections followed the expected pattern, in some cases; however, other sections were identified which did not conform to expectations.

Life Cycle Effect: One area that matches trends noted in previous research is the "Life Cycle Effect." This phenomenon was examined by nature of the Houston section that has been operational for seven years and the San Antonio I-10 / I-35 section openings which were staggered over a two to ten year period. These two cities represent values during the more mature operational stages. The Lubbock I-27 has been operational for 4 years and is still in the period of adjustment after construction. Dallas' North Central Expressway is under construction as this report is being written and, thus, will reflect values during such a stage. Findings are as described below:

- Based on the mean value analysis, the mature freeways in Houston and San Antonio show values that are generally higher than pre-construction values (in constant $). Such was the case for all land uses in Houston and commercial, residential, and institutional uses in San Antonio. Exceptions are in the depressed section, and industrial and vacant land uses for San Antonio.
- Lubbock's I-27 adjacent values, which have not yet reached the fifth operation year following construction, have not returned to pre-construction year levels. The mean value analysis shows that properties of all land uses and all freeway grades decreased in value over the study period. However, the observed values must be viewed from the perspective that total aggregate market value decreased for the county as a whole during the study period. Thus, the drop in value does not appear to be fully attributable to the development of the freeway. Lubbock has strong land use controls and has set mandates for redevelopment of property along this corridor, which may explain the smallest decrease in value (12.51% for commercial uses) when compared with pre-construction levels. All other land uses decreased more than 40%. The zoning requirements for commercial property establish distance and design standards that encourage more attractive and upscale commercial property than what existed prior to freeway construction.

By Freeway Grade: There are three methods by which the findings from the freeway grade assessment can be viewed: by percentage change, by mean value per square meter, and by regression land value indices. As anticipated, based on previous literature, the percentage change data show parcels adjacent to at-grade and depressed freeways experience greater percentage increases or smaller percentage decreases before and after construction than elevated parcels. An aggregate of Houston, San Antonio, and Lubbock values shows an 18.13% increase in at-grade and a 4.6% increase in depressed sections, but a decrease of 8.47% in elevated values.

While these general trends hold in the aggregate, parcels may exhibit variances, as described below:

- Properties next to elevated sections do not always exhibit deflated values compared to other grades. Parcels adjacent to elevated properties sometimes have higher values than properties next to at-grade or depressed sections. In the San Antonio urban area, the percentage change in the elevated section experienced a 3% increase in value compared to a 9% decrease in the depressed section. This type of observation is supported by the regression land value index in Lubbock which shows the elevated residential values as slightly higher than at-grade and much higher than in depressed sections.
- While depressed properties sometimes showed the highest mean value per square meter, as in suburban San Antonio and Houston, other areas show a different pattern. For instance, in Lubbock and urban San Antonio, elevated property has the highest value.

- The regression indices for Houston indicate the residential values were the same at the elevated and at-grade freeway levels. Lubbock exhibited its highest index for residential elevated, followed by residential at-grade and depressed.
- San Antonio had the only double-decked sections in the study. The percentage change data showed that values adjacent to the two level structures increased 4%, less than the at-grade (15%), but slightly more than elevated (3%) and much more than depressed (-9%).

By Land Use: The mean values per square meter are consistent with findings from previous studies in that commercial, institutional, and industrial uses tend to have the higher values compared to other land uses, regardless of grade. Such is the case for mean values in all cities. Another finding is the high value of vacant property in Dallas that accounts for more than 25% of the parcels along the North Central Expressway. Most of this property is zoned for commercial development which would conform to the previous findings of commercial property as a preferred land use adjacent to freeways. Vacant parcels also show strong value per square meter in Houston and San Antonio.

RECOMMENDATIONS

This study set out to determine how variations in freeway grade influence land value. A related issue was the influence of land use on that process. Many previous decisions regarding freeway construction have been made based on prior research and conventional wisdom that a community would be best served if the freeway was depressed or at-grade. The data from this study essentially concur with that point and lead to the following recommendations.

- TxDOT should continue to construct freeways at-grade and depressed as the preferred conditions where terrain, cost, and other conditions allow. However, this research contains evidence that elevated parcels have strong land values, in some cases. Thus, freeway grade as an independent variable does not necessarily negatively impact land value. Indeed, some residential and commercial property values were noted to have faired well next to elevated configurations. TxDOT should seek to verify those variables that mitigate the potential negative land value effect of elevated structures.

- Since negative influence was mitigated on some elevated property values in this research, TxDOT should conduct additional studies to determine the nature and magnitude of these mitigating variables. Other research has noted that land value is influenced by land use policy, accessibility to the freeway, life cycle, and any number of additional variables. Since freeway grade works with other variables to predict land value response, what are these additional variables, what specifically is the contribution of freeway grade, and how are the freeway and variables working in tandem to impact land values? Issues should be included such as whether the majority of the right-of-way was available at the start of the project, as opposed to a large number of "takes" being required. In Houston, a large amount of the right-of-way had been reserved, and in San Antonio, the footprint of the existing freeway formed the primary path. The

additional acquisitions were minimized in both cases. If this is a valid rationale, the land next to the Dallas North Central Expressway should rebound well when construction has been completed.

- TxDOT should consider city economy as an indicator of land value response adjacent to a freeway. It is known that city economic conditions and a series of other variables play a role in property values. To what degree was not the focus of this study. The question of background economic condition of the region could be investigated in greater detail. In the two cities (Houston and San Antonio) where adjacent values were the strongest regardless of grade, the aggregate market values in the cities rose. In the two cities where adjacent values were down (Lubbock and Dallas), aggregate market values were down as well.

- Next, does the character of the adjacent community serve to strengthen the properties adjacent to the freeway and offset potential negative effects? The Memorial residential communities in Houston represent some of the more affluent in that city and border much of the residential that is adjacent to the freeway. Likewise, the expensive property in downtown San Antonio may exert some influence on values next to I-35 and I-10.

- TxDOT may utilize findings from this process as a base of comparison in projecting the land value response of potential new freeways utilizing the methodology in Appendix 4.

- Additional research with a more extensive data base could be conducted to further verify the "life cycle effect" in Texas. Another point of consideration for TxDOT is what can be done to mitigate the life cycle effect. Tremendous efforts are already underway to maintain as accessible an environment for businesses, residents, and others as possible during construction phasing.

Schedules are developed to minimize disruptions; driveways are maintained to allow entrance and egress. Overall community mobility goals have long accepted short-term construction interruptions as part of the price of progress. Still, additional methods to relieve the impact of construction may be beneficial.

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APPENDIX 1

Survey of Statewide TxDOT District Engineers for Freeway Sections for Inclusion in the Study

Recent Construction

Estimate the number of **recently constructed** (within the past 10 years) elevated and depressed freeway sections in your District [City].

☐ Number of elevated sections.

☐ Number of depressed sections.

Note: Please list only sections that would be viable for study, that is, sections that involve at least two over/underpasses, or are at least 1/4 mile long.

Give the location and check the descriptive characteristics for each section.

Section Location (Hwy/Frwy Name or Number)*	Elevated	Depressed	Downtown	Suburban	Residential	Commercial	Age of Facility <5yrs	Age of Facility 6- 10yrs	Facility Length (Miles)	Land Use Map Available	Aerial Map Available

*Please attach map with section identified.

Under Construction

Estimate the number of elevated and depressed freeway sections in your District [City] that are currently **under construction**.

☐ Number of elevated sections.

☐ Number of depressed sections.

Note: **Please list only sections that would be viable for study, that is, sections that involve at least two over/underpasses, or are at least 1/4 mile long.**

Give the location and check the descriptive characteristics for each section.

Section Location (Hwy/Frwy Name or Number)*	Elevated	Depressed	Downtown	Suburban	Residential	Commercial	Construction Start Date	Facility Length (Miles)	Land Use Map Available	Aerial Map Available

*Please attach map with section identified.

Planned Construction

Estimate the number of **planned** elevated and depressed freeway sections in your District [City].

☐ Number of elevated sections.

☐ Number of depressed sections.

Note: Please list only sections that would be viable for study, that is, sections that involve at least two over/underpasses, or are at least 1/4 mile long.

Give the location and check the descriptive characteristics for each section.

Section Location (Hwy/Frwy Name or Number)*	Elevated	Depressed	Downtown	Suburban	Residential	Commercial	Construction Start Date	Facility Length (Miles)	Land Use Map Available	Aerial Map Available

*Please attach map with section identified.

APPENDIX 2
Land Value Index Calculation

Houston Land Value Indices

Dependant variable: Logsqft with individual dummies — Rsquare=.9787

Land values are adjusted to 1994 values using Houston CPI values.

Note: These indices have 1982 as the base year purely for comparison purposes. The coefficients are described in the program output.

Sheet 1: Contains the indices as well as the graphs by land use category.
Sheet 2: Contains the graphs by grade level.

Variable	Estimate	Diff between est at "t" and "t+i"	Convert differences to a percentage	index	Year
intre1	0.3287	0	0%	100	1982
intre2	1.9432	1.6145	161%	261	1986
intre3	1.6304	-0.3128	-31%	230	1993
intre4	1.7254	0.095	9%	239	1994
intrd1	0.6959	0	0%	100	
intrd2	2.1969	1.501	150%	250	
intrd3	1.7794	-0.4175	-42%	208	
intrd4	1.8488	0.0694	7%	215	
intra1	0.1954	0	0%	100	
intra2	1.8336	1.6382	164%	264	
intra3	1.4592	-0.3744	-37%	227	
intra4	1.5748	0.1156	12%	239	Year
intce1	0.4676	0	0%	100	1982
intce2	2.1391	1.6715	167%	267	1986
intce3	1.8717	-0.2674	-27%	240	1993
intce4	1.8428	-0.0289	-3%	237	1994
intcd1	1.8481	0	0%	100	
intcd2	3.2047	1.3566	136%	236	
intcd3	2.4766	-0.7281	-73%	163	
intcd4	2.7639	0.2873	29%	192	
intca1	0.1541	0	0%	100	
intca2	1.7919	1.6378	164%	264	
intca3	1.4283	-0.3636	-36%	228	
intca4	1.5543	0.126	13%	241	Year
intida1	0.2226	0	0%	100	1982
intida2	1.8	1.5774	158%	258	1986
intida3	1.5815	-0.2185	-22%	236	1993
intina1	0.2935	0	0%	100	1982
intina3	1.4952	1.2017	120%	220	1992
intina4	1.7378	0.2426	24%	244	1994
intve1	0.3863	0	0%	100	1982
intve2	1.8809	1.4946	149%	249	1986
intve3	1.7795	-0.1014	-10%	239	1993
intve4	1.8534	0.0739	7%	246	1994
intva1	0.1771	0	0%	100	1982
intva2	1.9615	1.7844	178%	278	1986
intva3	1.7301	-0.2314	-23%	255	1993

San Antonio Land Value Index Urban and Suburban Combined

Land values are adjusted to 1994 values
For the index, however, 1983 is used as a base purely for comparison purposes.
Model with account number dummies used here Rsquare=.9230

Variable	Coefficient	Diff. in coeff. value time 't' and 't+i'	percent	index
intra1	0.6086	0	0.00%	100
intra2	0.6039	-0.0047	-0.47%	99.53
intca1	1.2304	0	0.00%	100
intca2	1.6578	0.4274	42.74%	142.75
intre1	0.5621	0	0.00%	100
intre2	0.9016	0.3395	33.95%	133.95
intce1	0.6605	0	0.00%	100
intce2	0.8154	0.1549	15.49%	115.49
intide1	1.0987	0	0.00%	100
intide2	0.8782	-0.2205	-22.05%	77.95
intine1	2.0579	0	0.00%	100
intine2	2.3524	0.2945	29.45%	129.45
intve1	1.0464	0	0.00%	100
intve2	1.097	0.0506	5.06%	105.06
intrd1	3.8056	0	0.00%	100
intrd2	3.6411	-0.1645	-16.45%	83.55
intcd1	1.4638	0	0.00%	100
intcd2	1.7228	0.259	25.90%	125.9
intrdd1	2.2735	0	0.00%	100
intrdd2	2.3379	0.0644	6.44%	106.44
intcdd1	1.673	0	0.00%	100
intcdd2	1.8024	0.1294	12.94%	112.94
intiddd1	0.8293	0	0.00%	100
intiddd2	0.5639	-0.2654	-26.54%	73.46
intindd1	0.3368	0	0.00%	100
intindd2	2.079	1.7422	174.22%	274.22
intvdd1	1.3632	0	0.00%	100
intvdd2	0.6464	-0.7168	-71.68%	28.32
intina2	1.8645	0	0.00%	100
intva2	0.6299	0	0.00%	100
intvd2	2.0104	0	0.00%	100

Dallas Land Value Indices

Dependant variable: Logsqft Rsquare=.9790
Model with all individual dummies used because F-test exceeds critical value.
Land values are adjusted to 1994 values using Dallas CPI values.
Note: These indices have 1985 as the base year purely for comparison purposes. The coefficients are described in the program output.
Sheet 1: Contains the indices as well as the graphs by land use category.
Sheet 2: Contains the graphs by grade level.

Variable	Estimate	Diff between est at "t" and "t+i"	Convert differences to a percentage	index
intra1	2.5263	0	0.00%	100
intra2	2.3313	-0.195	-19.50%	80.5
intce2	2.0426	0	0.00%	100
intcd1	3.6919	0	0.00%	100
intcd2	3.0372	-0.6547	-65.47%	34.53
intca1	2.5851	0	0.00%	100
intca2	1.8793	-0.7058	-70.58%	29.42
intida1	2.9419	0	0.00%	100
intida2	1.7208	-1.2211	-122.10%	-22.1
intvd1	3.5801	0	0.00%	100
intvd2	2.4347	-1.1454	-114.50%	-14.5
intva1	2.3517	0	0.00%	100
intva2	2.4369	0.0852	8.52%	108.5
intve2	1.0022	0	0.00%	100
intrd1	-0.3314	0	0.00%	100
intrd2	-1.0541	-0.7227	-72.30%	27.7
intidd1	1.3433	0	0.00%	100
intidd2	1.7981	0.4548	-45.50%	54.5

Lubbock Land Value Indices

Lubbock Land Value Index Key

Intre: Residential Elevated
Intra: Residential At-grade
Intcd: Commercial Depressed
Intve: Vacant Elevated
Intrd: Residential Depressed
Intce: Commercial Elevated
Intca: Commercial At-grade
Intva: Vacant At-grade

Variable	Estimate	Diff between est at "t" and "t+i"	Convert differences to a percentage	index
intre1	-0.5948	0	0%	100
intre2	-0.7807	-0.1859	-19%	81
intrd1	-0.3697	0	0%	100
intrd2	-1.842	-1.4723	-147%	-47
intra1	-0.3383	0	0%	100
intra2	-0.5845	-0.2462	-25%	75
intce1	0.0095	0	0%	100
intce2	-0.1336	-0.1431	-14%	86
intcd1	-0.2667	0	0%	100
intcd2	-0.2189	0.0478	5%	95
intca1	0.597727	0	0%	100
intca2	0.4832	-0.114527	-12%	88
intide1	-0.3559	0	0%	100
intide2	-0.7359	-0.38	-38%	62
intina1	-0.7869	0	0%	100
intina2	-1.1787	-0.3918	-39%	61
intva1	-1.5032	0	0%	100
intva2	-2.0292	-0.526	-53%	47
intind2	-1.609	0	0	100

Combined City Index

Using full model with city dummies Rsquare=.583
In the case of Houston only, 1982 and 1994 data were retained in order to be comparable to other cities

Variable	Coefficienct	Diff. in coeff. value at time 't' and 't+i'	Convert diff. to %	ndex
intra1	0.2914	0	0.00%	100
intra2	0.616	0.3246	32.46%	132.46
intca1	0.2806	0	0.00%	100
intca2	1.3452	1.0646	106.46%	206.46
intina1	0.0046	0	0.00%	100
intina2	1.0911	1.0865	108.65%	208.65
intva1	-0.4369	0	0.00%	100
intva2	-0.4537	-0.0168	-1.68%	98.32
intida1	-0.3919	0	0.00%	100
intre1	0.0834	0	0.00%	100
intre2	0.7168	0.6334	63.34%	163.34
intce1	0.6305	0	0.00%	100
intce2	1.0002	0.3697	36.97%	136.97
intide1	0.7719	0	0.00%	100
intide2	0.4389	-0.333	-33.30%	66.7
intine1	2.0579	0	0.00%	100
intine2	2.3525	0.2946	29.46%	129.5
intve1	0.3858	0	0.00%	100
intve2	0.9183	0.5325	53.25%	153.3
intrd1	0.1349	0	0.00%	100
intrd2	0.3901	0.2552	25.52%	125.5
intcd1	0.5944	0	0.00%	100
intcd2	0.8141	0.2197	21.97%	121.9
intidd2	1.7668	0	0.00%	100
intind2	-0.5758	0	0.00%	100
intvd2	2.0104	0	0.00%	100
intrdd1	1.1182	0	0.00%	100
intrdd2	1.1939	0.0757	7.57%	107.6
intcdd1	1.4464	0	0.00%	100
intcdd2	1.5036	0.0572	5.72%	105.7
intiddd1	0.9294	0	0.00%	100
intiddd2	0.8146	-0.1148	-11.48%	88.5
intindd1	0.5577	0	0.00%	100
intindd2	2.079	1.5213	152.13%	252.1
intvdd1	1.5006	0	0.00%	100
intvdd2	1.1332	-0.3674	-36.74%	63.3

APPENDIX 3

Record of Accounts Collected By City

Appendix 3

Record of Accounts Collected by City

Houston 1982

	Residential	Commercial	Industrial	Institutional	Vacant	Totals
At-Grade	45	8	1	1	1	56
Elevated	29	26	0	0	2	57
Depressed	111	7	0	0	0	118
Totals	185	41	1	1	3	231

Houston 1994

	Residential	Commercial	Industrial	Institutional	Vacant	Totals
At-Grade	48	10	0	1	0	59
Elevated	29	29	0	0	2	60
Depressed	116	7	0	0	0	123
Totals	193	46	0	1	2	242

Lubbock 1983

	Residential	Commercial	Industrial	Institutional	Vacant	Totals
At-Grade	80	2	0	1	2	85
Elevated	30	43	15	0	0	88
Depressed	46	38	0	0	0	84
Totals	156	83	15	1	2	257

Lubbock 1994

	Residential	Commercial	Industrial	Institutional	Vacant	Totals
At-Grade	85	2	0	1	2	90
Elevated	30	50	15	0	0	95
Depressed	46	40	0	1	0	87
Totals	161	92	15	2	2	272

San Antonio Urban 1983

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	32	11	0	0	0	0	43
Elevated	4	11	4	1	3	0	23
Depressed	65	36	0	0	0	0	101
2 Level	18	20	20	3	7	0	68
Totals	119	78	24	4	10	0	235

San Antonio Urban 1994

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	33	11	0	0	0	0	44
Elevated	14	19	8	1	3	0	45
Depressed	64	37	0	0	0	0	101
2 Level	23	31	26	1	14	0	95
Totals	134	98	34	2	17	0	285

San Antonio Suburban 1980

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	0	0	0	0	0	0	0
Elevated	0	0	0	0	0	0	0
Depressed	0	7	0	0	0	0	7
2 Level	0	0	0	0	0	0	0
Totals	0	7	0	0	0	0	7

San Antonio Suburban 1993-1995

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	54	59	0	2	1	0	116
Elevated	0	0	0	0	0	0	0
Depressed	0	12	1	0	1	0	14
2 Level	0	0	0	0	0	0	0
Totals	54	71	1	2	2	0	130

Dallas 1985

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	3	35	2	0	13	0	53
Elevated	0	0	0	0	0	0	0
Depressed	25	26	0	0	8	0	59
2 Level	0	0	0	0	0	0	0
Totals	28	61	2	0	21	0	112

Dallas 1993

	Residential	Commercial	Industrial	Institutional	Vacant	Misc.	Totals
At-Grade	4	59	3	0	30	0	96
Elevated	0	2	0	0	5	0	7
Depressed	40	36	1	0	18	0	95
2 Level	0	0	0	0	0	0	0
Totals	44	97	4	0	53	0	198

APPENDIX 4

Implementation Methodology

APPENDIX 4

IMPLEMENTATION METHODOLOGY

The findings in this report may be used along with the findings from previous literature to assess the potential impact of new construction or a change in freeway grades on adjacent land values. Implementation steps include the collection of base land value data, local economic projections, the analysis of mean values, and a land value index model. These steps are described below.

Collect Base Land Value Data

The principal researcher should collect, where available, annual land value data by land use for up to five years prior to the anticipated start of construction. Compile the profile of land values by land use during this pre-construction period. Trends may be plotted on a graph to facilitate viewing. Land values that have been increasing may respond positively to improved accessibility resulting from freeway construction. Land values that have been in decline may be even more vulnerable during construction. Determine the mean value by proposed grade and by land use, and in accordance with design drawings.

Obtain Local Economic Projections

Short and long term projections for the local economy should be obtained. In this study, when freeway sections were more than five years old and overall county economies improved over pre-construction levels, land values exceeded pre-construction amounts. Also, where county market values declined, properties adjacent to freeways depreciated. Ultimately, if the county economy is projected to decline, additional years will be required for property values to return to pre-construction levels.

Mean Values

The mean analysis and land value index model corroborated previous studies' findings that short-term decreases in value occurred for adjacent properties during and immediately after construction. However, five to ten years after construction, values began to rebound. The mature freeway sections in San Antonio and Houston provide the basis for the level of increases that may be considered. When viewing the minimum increases in these two cities, a 15% increase occurred for properties adjacent to at-grade freeways; elevated properties experienced at least a 3% increase, and depressed properties received at minimum a 48% increase. Such increases can be anticipated in situations where market values are projected to increase.

Land Value Index Model

The Land Value Index Model presented in this study may be used to examine pre-construction and post-construction levels of significance. The land value impacts for properties adjacent to at-grade, elevated, and depressed freeways in other locations in Texas may be evaluated by utilizing the equation presented in the Land Value Index section of this document. The model may yield stronger results when provided several years of pre-construction and several years of post-construction data. Additional details on econometric models, land use models, and mean value analysis may be found in Urban Planning Analysis: Methods and Models, (Krueckeberg and Silvers, 1974) and Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences, (Cohen and Cohen, 1983).