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16.ABSTRACT

This study was designed with two principal objectives in mind: (1) to identify factors that contribute to reduced peak-period mobility in four of Houston's urban activity centers: the central business district, Greenway Plaza, Uptown/Galleria and the Texas Medical Center; and (2) to suggest possible congestion management strategies that would be applicable in each of the study areas. Each activity center has its own unique transportation characteristics, therefore the research included the examination of street designs, total number of employees, availability of public and private transportation, and pedestrian conditions. Analysis of these and other variables revealed numerous conditions that contribute to varying levels of congestion during the peak-period, including turning lane queue space, pedestrian signal systems, the spacing between passenger shelters, and configuration of street corridors. This research concludes with an examination of diverse congestion management strategies designed to reduce dependence on the single occupant vehicle as the primary source of work related trips, but also increase mobility through low cost, or no cost improvements. A strategy is recommended which encourages the use of TDM alternatives, while not asking the commuter to completely relinquish the automobile. Further, the magnitude of BTU consumption and energy savings which may result from implementation of this strategy is reported.

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SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER

IDENTIFICATION OF FACTORS CONTRIBUTING TO REDUCED PEAK PERIOD MOBILITY IN SELECTED URBAN ACTIVITY CENTERS IN HOUSTON, TEXAS

by

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ABSTRACT

This study was designed with two principal objectives in mind: (1) to identify factors that contribute to reduced peak-period mobility in four of Houston's urban activity centers: the central business district, Greenway Plaza, Uptown/Galleria, and the Texas Medical Center; and (2) develop a strategy that will encourage commuters to commit to alternative travel options. Each activity center has its own unique transportation characteristics, therefore the research included the examination of street designs, total numbers of employees, availability of public and private transportation, and pedestrian conditions. Analysis of these and other variables revealed numerous conditions that contribute to varying levels of congestion during the peak-period, including turning lane queue space, pedestrian signal systems, the spacing between passenger shelters, and configuration of street corridors. This research concludes with an examination of diverse congestion management strategies designed to reduce dependence on the single occupant vehicle as the primary source of work related trips, but also increase mobility through low cost, or no cost improvements. A strategy is recommended which encourages the use of TDM alternatives, while not asking the commuter to completely relinguish the automobile. Further, the magnitude of BTU consumption and energy savings which may result from implementation of this strategy is reported.

Executive Summary

Introduction

The objectives of this study are to examine four of Houston's major urban activity centers (the central business district, the Uptown/Galleria, the Texas Medical Center, and the Greenway Plaza) to identify factors that contribute to reduced peak period mobility as well as suggest innovative and voluntary congestion management tools. Several components were considered crucial to the successful completion of this project: the identification of the different elements of peak-period traffic congestion for each center, the recognition of the available public and private transportation systems, analyzation of existing congestion management strategies, and the redefinition of traditional transportation demand management strategies and their applicability to the study areas. Achievement of these objectives requires a methodology that involves the intense examination of predetermined variables that traditionally contribute to varying levels of traffic congestion. These variables include street design, number of employees in a particular study area, pedestrian conditions, the availability of public and/or private transportation systems, and existing commuting patterns.

The activity centers have congestion issues that are unique to their individual areas. The findings of each study area are as follows:

Greenway Plaza. The minor and major arterials traversing this area have sufficient capacity to accommodate traffic destined for the numerous office buildings in Greenway Plaza and for those commuters who use this thoroughfare in route to another area of the city. The levels of service on these roadways are categorized as free flowing (LOS "A" and LOS "B"). Additional findings include:

- The traffic signals at the intersection of Edloe and Richmond do not have a controlled left turn from Edloe traveling east or west onto Richmond.
- The numerous police officers directing traffic in the evening peak hours contribute to the improved mobility along Richmond while simultaneously providing additional safety for pedestrians and motorists.
- Access to Greenway Plaza by Houston Metro is provided by several routes (local, express and park & ride) with increased headways during the peak periods.

Uptown/Galleria. It was predetermined, due to high traffic volumes, that the study team would focus on the intersection of Westheimer and Post Oak. Few congestion problems were observed at this location. The periodic posting of HPD officers during the evening peak period greatly enhanced the mobility into and through the region. However,

three particular elements were identified that contribute to decreased peak period mobility near the Westheimer and Post Oak intersection:

- The brevity of pedestrian signal systems at crosswalks;
- Private transportation boarding and alighting procedures; and,
- The median design along Westheimer.

Texas Medical Center. The study of the Texas Medical Center's peak period mobility was primarily focused on a corridor along Bertner Street where historically pedestrian safety and mobility have been of major concern. The findings in this study area indicate the following:

- The posted speed limits were not enforced;
- There was poor visibility of the pedestrian crossings;
- Pedestrians were observed crossing the street at points other than marked cross-walks; and
- There were three bus stops in a 0.2 mile section of Bertner Street.

Central Business District. The study team observed few consistent or unreasonable incidences of congestion within the area this study defines as the CBD. Pedestrian activities occur relatively smoothly along downtown streets. The availability of the underground tunnel system contributes very positively to the surface movements. A reduction of mobility exists in those highway corridors and intersections adjacent to the CBD. Upon entering the downtown area, motorists can expect to experience constant traffic flows facilitated by progressive and synchronized, as well as "flow sensitive" signal systems on most east-west and north-south streets.

Recommendations

In addition to the primary findings within each center as delineated above, activity centers would benefit from increased emphasis of traditional congestion management strategies. A decrease in vehicle miles traveled and/or increase in commuters' average passenger occupancy would not only remove some vehicles from the roadways, currently, but also provide a foundation to better accommodate projected future growth in activity center employment. Transportation officials recognize that it is unrealistic to expect commuters to completely abandon their automobiles on a daily basis. Thus this study recommends the development of an Energy and Air Quality Model (E•AQ), which will encourage commuters to commit to alternative travel options, such as those discussed below, only one or two days each work week. The energy savings that will be realized if two to five percent of the commuters in each of the above study areas commit to this E•AQ

Model, will exceed 489 million BTUs daily.

Congestion management strategies that have been successfully implemented throughout other urban centers in this country have thus far not been enthusiastically embraced in Houston. However, the following is an example of the creative transportation options of telecommuting programs, alternative work schedules, and structured parking management that should improve peak period mobility, especially when used in conjunction with the E•AQ Model.

- Telecommuting: The concept of telecommuting is not new. However, employees telecommuting one or two days per week would significantly reduce the number of vehicles destined for any area. The limited number of telecommuting days would continue to provide employees with a sense of "belonging" to their individual office culture. The particular logistics of equipment, liability, and responsibility should be evaluated by each employer. As Intelligent Transportation Systems (ITS) technologies become more prevalent in our society and the workplace, it is anticipated that transportation congestion management will become an ancillary benefit to cost savings associated with reduced overhead, land use practices, and corporate competitiveness.

- Alternate work schedules: Alternate work schedules such as flex time, staggered hours and compressed work weeks will reduce the number of vehicles at any one time by distributing them to times other than the morning and evening peak periods. These measures will require the unyielding support of upper management to institute policies that will allow a smooth transition for all employees and customers. Individual organizations should conduct an in-depth examination of the costs and benefits, as well as the ease of transition, of each program before implementation.

- Parking Management: There currently exists an abundance of parking in Houston's urban core. If stronger parking management were instituted in the form of area transportation associations or districts, this would further encourage employees to find alternative ways of commuting to work. Further, recently established transportation management associations in the Houston are working to increase the coordination of travel between diverse organizations within these activity centers.

With the abundance of parking in and around the urban activity centers, motorists have no incentives to leave their vehicles at home. Employer sponsored incentives and

disincentives could be coordinated with area planning organizations to regulate the availablity of excess parking facilities as follows:

- Incentives: As the Texas Natural Resource Conservation Commission (TNRCC), Houston Galveston Area Council, and other transportation officials increase the emphasis on voluntary trip reduction, public transit subsidies will probably become more prominent. Houston METRO currently has programs that allow companies to sell monthly bus passes to their employees at discount rates. Continued aggressive marketing campaigns by the transit authority in conjunction with other employer sponsored incentive programs will increase the viability of public transportation as a transportation demand management (TDM) alternative.

- Disincentives: Disincentives focus on measures used to increase the financial burden of motorists using the single occupant vehicle as a primary means of accomplishing work related trips. Increased parking fees, and direct/indirect user fees are some of the disincentives being studied as possible measures to reduce the attractiveness of the automobile.

Many of the above mentioned programs will undoubtedly be influenced by the rapid development of ITS technology. Not only will the transportation community take advantage of new development, but will devise new applications for existing technology. ITS' applicability to the congestion challenges in Houston will likely be the subject of future transportation studies.

Due to the employment categories and the abundant parking facilities found in Greenway Plaza, the TDM recommendations for this urban activity center do not vary from the general recommendations. A modification of traffic and pedestrian signal systems in the Uptown/Galleria will provide a greater atmosphere of safety for all pedestrians. Revising the private transportation boarding and departing procedures would relegate these time consuming maneuvers to any number of available parking facilities located off the major arterials, removing these vehicles as an interruption to traffic flow. Redesigning the street medians along Westheimer would allow additional queuing space for vehicles desiring to make uncontrolled left turns.

Within the TMC the physical construction of Bertner Street makes it difficult to accommodate the mixed traffic of buses and automobiles. While the construction of additional vehicle lanes is not viewed as a "cure all" for congestion problems, it is recommended that Bertner be expanded from three to four lanes. The installation of traffic controls at the intersection of Bertner and Moursund instead of a three-way stop would also

add additional controls to the area. Due to the nature of employment in the TMC, increased employer sponsored car/vanpools, public transit incentives, and continued parking facility management would help continue the peak period mobility currently enjoyed by commuters through this, and other corridors in the TMC. Mobility within the CBD would benefit from all current traditional TDM measures. Increased employer sponsored programs would also have a positive effect on the highway systems that lead to the CBD.

The challenge facing transportation professionals, and environmentalist alike, is how to persuade the business community and local and/or state politicians to acknowledge the urgency of adequate transportation planning. The support needed to fund and establish successful TDM programs must not be underestimated by those individuals and corporations with immeasurable influence in this community.

PROBLEM STATEMENT

Several dense employment areas are located throughout the Houston Metropolitan region. These major activity centers (MACs) provide a wide range of employment opportunities, from retail to medical offices, and have their own unique transportation characteristics partially depending on their accessibility to Houston's roadway networks. This case study will detail the transportation related challenges facing four of Houston's better known urban MACs, the central business district (CBD), Greenway Plaza, Uptown/Galleria, and the Texas Medical Center (TMC). Each of these MACs are situated adjacent to major highways and arterial roadways which, during the Monday through Friday peak periods (defined roughly as 6a.m. to 9a.m. and 3:30p.m. to 6:30p.m.), experience varying levels of congestion and reduced mobility. The costs associated with congestion and the need for congestion management, or TDM have proven to be immense.

A significant cause of peak period congestion is the large number of commuters who still depend on the single occupant vehicle (SOV) as their primary source of transportation for work related trips. The negative impacts of the SOV on air quality are a damaging side effect of this peak period congestion. Thus, exploring ways in which the private business community can encourage reduced dependence on the SOV is not only necessary, but mandatory as required by the federal Clean Air Act Amendments (CAAA) of 1990. Programs such as carpools, vanpool matching and limited transit subsidies are presently offered by some employers, but the anticipated growth in peak period congestion is evidence that many existing congestion management programs are inadequate. In addition, various powerful incentives for the SOV still exist in the study areas, and will be discussed to ascertain their impacts on work related trips.

STUDY OBJECTIVES

Local transportation planners and analysts have examined these urban MACs in detail for several years to determine trends in congestion and congestion management. This study will make a significant contribution to existing congestion management knowledge by identifying individual causes of reduced peak period mobility in the four study areas, and analyzing potential voluntary solutions considering the withdrawal of mandatory programs by the new Texas legislature. The objectives for this study were chosen to ensure originality of research and are as follows:

- Identify various components of reduced peak period traffic mobility in the study areas;

- Identify public and private transportation services within the major activity centers;
- Analyze innovative strategies applicable to:
  1) the reduction of congestion,
  2) a diminished dependence on the SOV as a principal means of commuting in the peak periods; and,
- Summarize findings and submit recommendations; discuss traditional TDM strategies and their applicability to the case study regions.

METHODOLOGY

The methodology used to accomplish this study provided the research team a solid framework from which to analyze individual factors leading to congestion, and integrated those factors into a cohesive package whereby solutions could be identified. This research will consist of several tasks, some of which will be accomplished concurrently:

Task I. Conduct state-of the-art literature review. Review previous studies on peak period mobility management nationwide and in Houston. Examine congestion management strategies that have proven successful in other urban centers across the country and determine their possible success in Houston.

Task II. Create Houston activity center database. Compile database of information on the four major activity centers that includes employee data, street design, public and private transportation, traffic signal systems and the issue of pedestrian safety. Determine the factor(s) that contribute most to a reduction in peak period mobility.

Task III. Identify those factors which contribute to reduced peak period mobility in each activity center. Identify potentially successful congestion management strategies which could be implemented in the study areas.

Task IV. Prepare the final report.

BACKGROUND

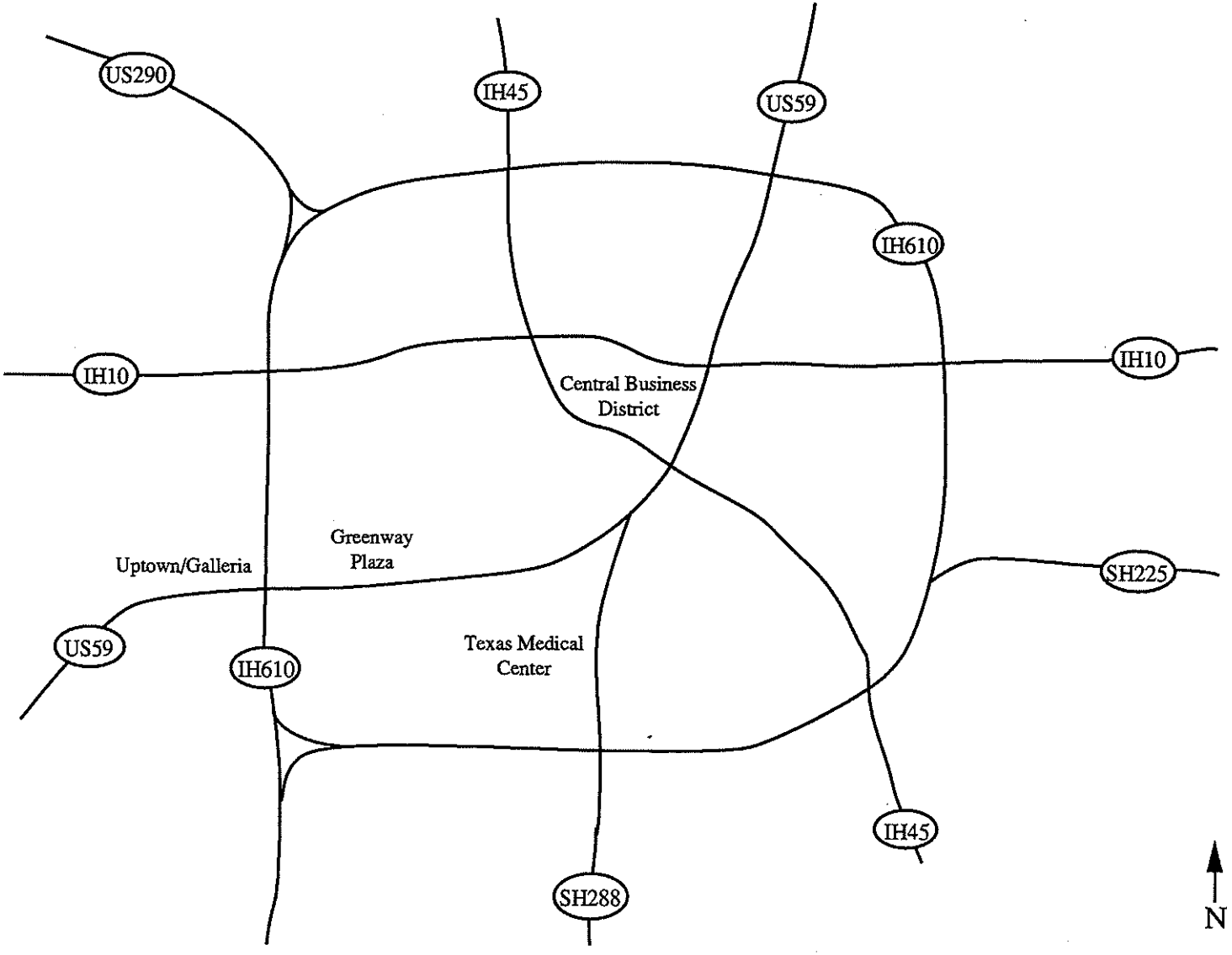
The Houston metropolitan area, with a population in excess of 1.6 million, is characterized by multiple employment areas and a large suburban housing market that is dispersed throughout the region. Travel to the major employment areas is a primary cause of traffic congestion during the morning and afternoon peak periods. The management of traffic congestion is among the highest priorities for the Houston-Galveston region and similar areas across the country with unacceptable levels of air pollution. This case study will examine existing conditions and possible TDM tools that may benefit four of Houston's urban activity centers: the central business district (CBD), the Texas Medical Center (TMC), Greenway Plaza, and the Uptown/Galleria. Figure 1 shows the location of the study areas within the Houston metropolitan area.

Kenneth Orski defines congestion management as, "...doing whatever is necessary to contain traffic within the limits of public tolerance..." (Orski, 1990). In another of his publications, Orski states that mass transit alone cannot solve the congestion problem in suburb-to-suburb and suburb-to-CBD commuting (Orski, 1988). However, congestion, and the resultant pollution caused by auto emissions, can be significantly reduced by offering alternatives to SOV travel. Among those alternatives are TDM strategies, which can be successfully implemented using current transportation facilities, without a major financial investment by the public and private sectors. TDM alternatives/strategies are "demand side" in nature defined as encouraging the commuter to reduce the demand for more and or expanded transportation facilities.

Author Carolyn Flynn examined TDM strategies in ten cities across the country and found the results varied due to the extent of support provided by local and regional governing bodies (Flynn, 1989). The categories of TDM alternatives are person trip reduction, vehicle trip reduction, and peak period modification. (Southern California Association of Governments, 1989). TDM also requires the cooperation of developers, landowners, employers, and different levels of government to modify travel behavior (Ferguson, 1990). To facilitate the modification of travel behavior in the Houston-Galveston area, all employers with more than 100 employees will be encouraged to implement a program which could include: 1) organization and implementation of some form of carpool/vanpool service, 2) offering public transportation incentives (bus passes, schedules, and financial subsidies), or 3) reducing available parking and/or increasing parking fees.

Research into the integration of TDM with intelligent transportation systems (ITS), formerly known as intelligent vehicle highway systems (IVHS), is currently

Figure 1
Selected Urban Activity Centers in
Houston, Tx.



underway throughout the country. Texas Transportation Institute (TTI), located on the campus of Texas A & M University in College Station, Texas, is in the forefront of ITS technologies. As the clearing house for ITS America (a non-profit educational and scientific association designed to plan, develop, and promote ITS strategies in the US), TTI's research has expanded the traditional concept of technology applications in transportation systems to include more than just telecommuting. New technologies are being used to provide: 1) pre-trip and enroute information to commuters; 2) transit alternatives; and 3) incentives to increase the use of HOV facilities (Turnbull, 1995).

However, telecommuting is still one of the most widely recognized forms of ITS, and several studies have been completed, or are in progress, to determine its full applicability to congestion management. Srikanth Sampath, et.al., conducted research on the effect of telecommuting in the reduction of cold starts, thereby reducing the levels of auto emissions into the ozone. Sampath reports that the long range benefits associated with telecommuting are best realized when telecommuting is used one to two days per week (Sampath, 1991). Telecommuting has been so successful in various pilot programs throughout California, that the Southern California Association of Governments has published reports to be used as guidelines for companies interested in initiating a telecommuting program (Southern California Association of Government, 1988). These congestion management strategies will be assessed and recommended, as appropriate, for the major activity centers under study, based on research findings.

STUDY VARIABLES

With a focus on congestion management, several categories of variables were examined to determine their relationship to travel behavior, congestion, and the ultimate management of traffic. These variables include employment, pedestrian safety, street design, public/private transportation, and traffic signal systems.

Employment

University of Houston's Center for Public Policy addressed the need to accurately define employment in their January 1989 *Employment Profiles of Houston's Major Activity Centers*. The definition used for employment in this present study will remain consistent with U of H's Center for Public Policy and will be defined as:

> Employment is the total paid jobs resident at a given location. This means that a person who holds more than one job will be counted more than once. It also means that volunteers will not be counted. Jobs will be identified with their specific physical location, or in some instances, the site at which an employee is regularly based for reporting, rather than with an employer headquarters location.

The employment data were collected by U of H's Center for Public Policy, the City of Houston, and the South Main Center Association and are listed in Table 1. These data also show the discrepancies involved with collecting employment figures. Different organizations may use different methodologies, and/or different boundaries, in securing data, as well as gathering data in varying years, thus occasionally leading to seemingly inconsistent numbers.

Since Houston's economy has a strong refining and petrochemical industry base, these, along with other manufacturing jobs, are not located in the CBD. The region's manufacturing industries rely on its water transportation systems, and are primarily located in Galveston Bay, Texas City, and along the ship channel (from Baytown to the Port of Houston).

Figure 2 shows the various employment occupations found in the study areas. The predominate occupation category in the combined study areas is *Office*. The CBD has the largest concentration of office occupations, as was expected.

By examining employment and traffic count data in each of the study areas, conclusions were drawn about the types of occupations and the transportation corridors (highways and major/minor arterials) most likely used during the peak periods. This information was valuable in determining the TDM strategies that would yield the highest degree of success and support from employers, employees, and local governmental agencies.

Table 1

Activity Centers Employment Data
(1990 Census Tracts)

	City of Houston (Dept of Planning)*	UH-Center for Public Policy **	South Main Center Assoc. ***
Central Business District (121.00)	137,530	137,012	N/A
Greenway Plaza (407.01)	32,524	41,184	N/A
Texas Medical Center (316.01/316.02)	1,798/60,397 Total=62,195	836/43,144 Total=43,980	3,717/47,397 Total=51,114
Uptown/Galleria (419.01/420.03)	19,878/29,715 Total=49,593	19,638/31,323 Total=50,961	N/A

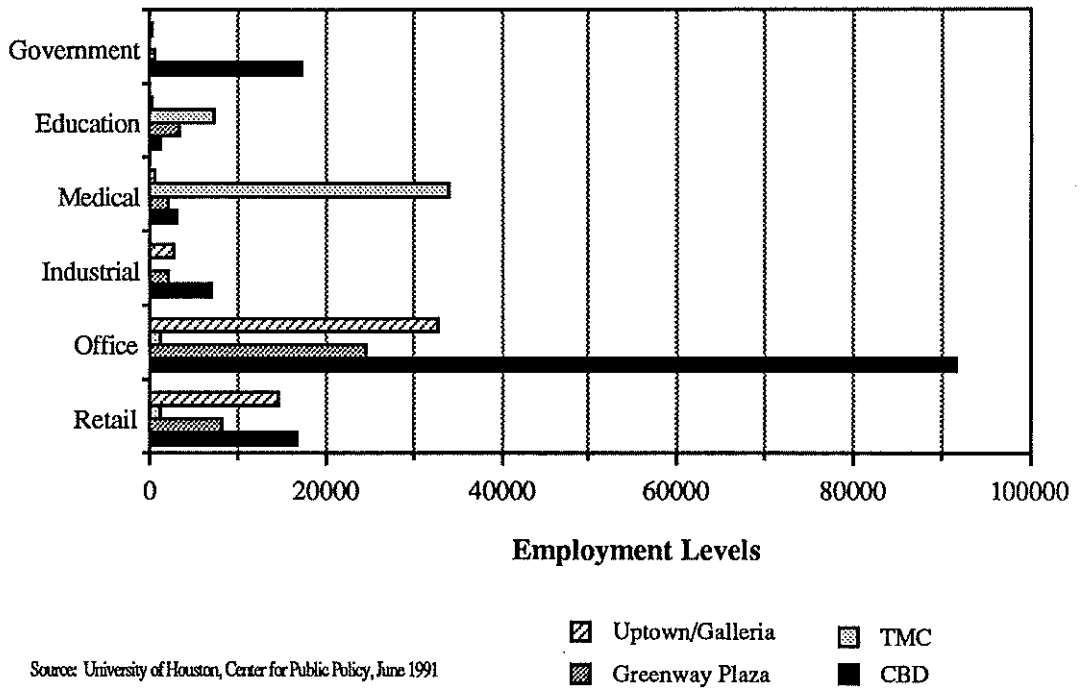
* Source: Houston Galveston Area Council, May 1992

** Source: Dun & Bradstreet, Kerr Real Estate Resource Center, Harris County Appraisal District, 1988 and 1989

*** Source: South Main Center Association (projected 1992)

Figure 2

Employment Categories of Major Urban Activity Centers
(Texas Medical Center, CBD, Greenway Plaza, Uptown/Galleria) in
Houston, Texas



Source: University of Houston, Center for Public Policy, June 1991

Pedestrian Safety

In many United States and European cities, walking and bicycling are considered reasonable transportation alternatives to the private automobile. However, in cities where travel is dominated by the automobile, facilities for walking are not planned or only given secondary consideration. Pedestrian travel will not only aid in the reduction of pollutants, but facilities for walking can serve as a feeder to car/vanpools, and public transportation systems in some limited service areas. The concept of walking as a feeder system can be successfully applied in each of this project's study areas, but pedestrian safety is a factor that could limit its potential for success. This relates not only to potential conflicts with vehicular travel, but the fear of being exposed to personal crime. Pedestrian safety in and around activity centers should receive high consideration when developing new intermodal facilities. Pedestrian environments can be improved by the following methods:

- Improved lighting near street corners, passenger shelters, parking facilities, and

entrance ways;

- Providing crosswalks with reflective stripping;
- Increasing timing of crosswalk signal systems at intersections;
- Increasing visibility of police officers near dense walking areas;
- Organizing media campaign to increase pedestrian awareness and provide personal safety tips.

Street Design

With the nationwide completion of the interstate highway system, many transportation experts feel that new major highway construction projects in this country will be few. The highway systems in Houston were designed to accommodate thousands of motorists daily with many of the major/minor arterials operating near or at their design capacity. This report will not advocate roadway construction as a means to relieve congestion, but will instead examine current roadway designs to determine variables that are contributors to reduced mobility. These roadway designs include median breaks, storage lanes, limited access along certain streets, and prohibited turning movements.

Reasonable home-to-work travel times are generally achievable, since access to the study areas (CBD, Uptown/Galleria, Greenway Plaza, and TMC) can be accomplished by the many highways in the region. Further, travel times between activity centers, by the existing arterials, may be important as potential strategies for reducing congestion and improving peak period mobility are examined. In 1991 the Houston-Galveston Area Council (H-GAC) conducted a survey of travel times between major activity centers throughout the H-GAC 13 county region (Table 2). Unfortunately, the Greenway Plaza activity center was not included in the H-GAC data. However, the travel times between the remainder of the activity centers, that are the focus of this report, are listed. The data reveal that travel between the activity centers can generally be accomplished in less than 20 minutes during peak travel times. This information can be especially useful to any individual or group desiring the formation of a shuttle service, van/carpool, or potentially an inner loop rail system as a basis of scheduling and attracting passengers.

Travel times in excess of 90 minutes were not uncommon during the 1980's for work-related trips throughout the Houston-Galveston area. However, the 1990 census indicates that this trend appears to be reversing, which may be due to the completion of several highway construction projects (including the expansion of the Southwest Freeway and South Loop 610). Travel times experienced by Houston commuters are found in Table 3. Roughly 75% of the employees in the CBD and TMC described their travel time

as less than 30 minutes. Almost 86% of Greenway Plaza employees also traveled less than 30 minutes to work, and nearly 80% of the employees in the Uptown/Galleria spent less than 30 minutes per commute.

The street design factors that contribute to internal congestion vary within each activity center. These factors include median designs at intersections and arterials that have volumes beyond design capacity. With the increase in multimodal transportation systems, the question arises if the existing transportation infrastructure is adequate.

Table 2

Travel Time Between Major Activity Centers in Houston, TX

(Time Shown Is In Minutes)

From \ To		CBD Main @McKinney	Texas Medical Center Main @ University	Uptown/Galleria Westheimer @ Post Oak	Greenway Plaza
CBD Main @McKinney	off Peak		11	15	
	a.m. Peak		9	18	
	p.m. Peak		10	16	
Texas Medical Center Main @ University	off Peak	11		14	
	a.m. Peak	8		15	
	p.m. Peak	10		19	
Uptown/Galleria Westheimer @ Post Oak	off Peak	15	15		
	a.m. Peak	16	17		
	p.m. Peak	19	17		
Greenway Plaza					

Source: Houston-Galveston Area Council, 1991

Note: Greenway Plaza is not reported

Table 3
Travel Time to Work-Major Activity Centers,
Houston, TX, 1990

	Central Business District (CT 121.00)	Texas Medical Central (CT 316.01/316.02)	Greenway Plaza (CT 407.01)	Uptown/ Galleria (CT 419.01/4220.03)
0-14 Minutes	44.05%	39.64%	40.00%	36.39%
15-29 Minutes	30.22%	34.71%	45.96%	43.39%
30-44 Minutes	14.79%	15.10%	8.21%	11.67%
45-59 Minutes	.80%	2.44%	2.80%	4.17%
60 + Minutes	6.59%	5.29%	1.65%	2.39%
Work at Home	3.53%	2.80%	1.35%	1.96%

Source: 1990 U.S. Census

Public and Private Transportation

Successful employee trip reduction plans will undoubtedly include public and private transportation components to reduce congestion and improve air quality. The Metropolitan Transit Authority of Harris County (Houston METRO) operates an extensive network of public transit routes and services. In addition to the regular local, limited, and crosstown service routes, many commuters utilize the express routes, Park & Ride facilities, and Corporate Ride Sponsor programs. Private transportation systems include those car/vanpools operated by non-profit organizations and private companies for a profit. Patrons of Vanpool Services Inc. (VPSI) and other ridesharers may meet at one of the existing Park & Ride facilities or make other private arrangements to commute

to the destinations within Loop 610. Also, many hotels operate a shuttle system as an added benefit for their guests, thus providing transportation to local retail centers, airports, and other attractions within the city. Transportation professionals indicate the transit mode splits for the Houston area have remained stable for the last several years. While a similar statistic is unavailable for vanpool use, transit planners expect riders by van are increasing in the metropolitan area.

Traffic Signal Systems

Houston is one of many cities in this country experimenting with new computerized traffic signal systems. As a forerunner to future applications of intelligent transportation highway systems (ITS), the computerized system monitors traffic flow and allows for the timing of traffic signals to be adjusted during peak and non-peak hours. The traffic signal systems in the CBD are on a timed cycle, as are some other corridors throughout the city during the peak hours. Many of Houston's downtown intersections do not permit left turns, thereby adding increased mobility for through traffic movements. The advantages to a timed signal system are many, the most significant of which is the increased mobility of traffic through highly traveled areas, allowing motorists to maintain a constant rate of speed, usually 23 to 27 miles per hour during certain hours of the work day. Even when two corridors that are on a timed system intersect, the delays observed are generally minimal.

GREENWAY PLAZA

Constructed in the mid-1950's, Greenway Plaza is one of three Houston activity centers located within Loop 610. For the purposes of this study, Greenway Plaza is defined by 1990 census tract 407.01, and is bounded by Westheimer and Alabama to the north, the Southern Pacific railroad to the west, Kirby and Buffalo Speedway on the east, and US59 (Southwest Freeway) forms the southern most border, for a total of 852 acres (Figure 3). Greenway Plaza was designed to house state-of-the-art office complexes, the Summit arena (which supports sporting and entertainment events), and single and multi-family residential neighborhoods.

An explosion in the construction of office buildings occurred during the early 1980's, and by 1986 there were over 12.1 million square feet of office space, an increase of 4.4 million over 1980 office space levels (Rice, 1987). Nearly 60% of the employment in Greenway Plaza is categorized by office occupations (University of Houston, 1991).

The internal circulation within the Greenway Plaza is facilitated by major arterials and freeways that allow ease of egress and ingress. East-west movement is primarily along Westheimer, Alabama and Richmond; while Kirby, Buffalo Speedway, and Edloe provide north-south access. The traffic volumes through Greenway Plaza are not only limited to the transportation activities destined to the activity center itself, but also include commuters who use Westheimer, Richmond, and Alabama as an alternative to the Southwest Freeway. Public transit routes are located predominantly along Richmond, with only a few routes operating on the remaining streets.

Variables

Data from H-GAC, neighborhood associations, and other sources were used to create the following profile for the Greenway Plaza:

Employment. In addition to *Office* the next major occupation category is *Retail*, with a 19.8% share of the total occupations found in the region. *Industrial, Medical, Education,* and *Government* make up the remainder of land uses comprising less than 10 percent each. Figure 4 shows the various employment categories found in the Greenway Plaza. A majority of the employment is located along Richmond, from Timmons to Buffalo Speedway, which includes the Greenway Plaza office complexes and the Summit Sports Arena.

Figure 3
Map of Greenway Plaza, Houston, Tx
(Census Tract 407.01)

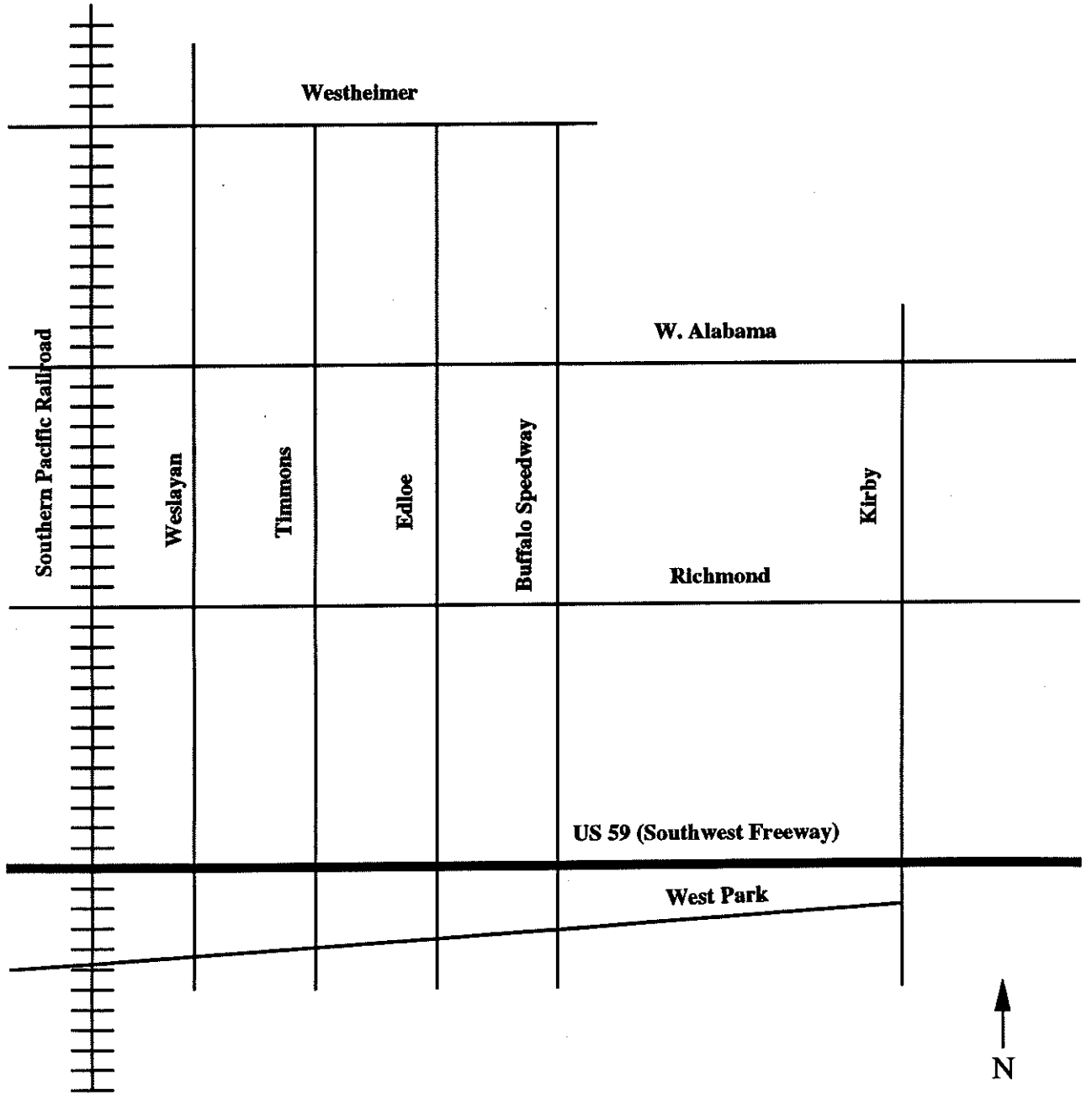
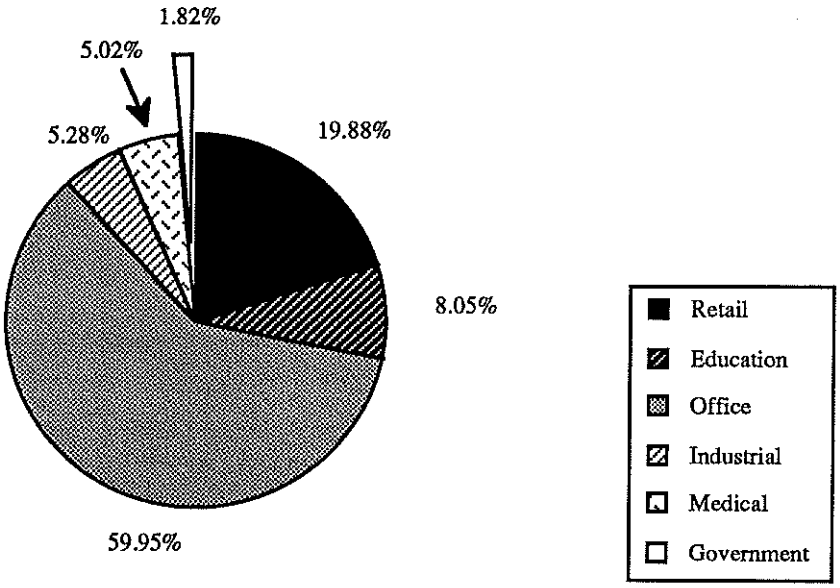


Figure 4

Employment Categories, Greenway Plaza, Houston, Tx.



Source: U of H, Ctr for Public Policy, 1991

Public and Private Transportation. Houston Metro operates nine routes along Richmond which include local, express, and park and ride services. Most recent estimates of transit's share of commuters to the Greenway Plaza denote slightly less than 3 percent arrive by bus. There are several passenger shelters on the northern and southern sides of Richmond to provide seating and refuge from inclement weather for transit patrons. Greenway Plaza is also home to a transit center which serves as a transfer facility for the Houston Metro system. The boardings and alightings for Greenway Plaza are presented in Table 4. Over 2,050 individual trips are made to and from the Greenway area during morning and afternoon rush hours.

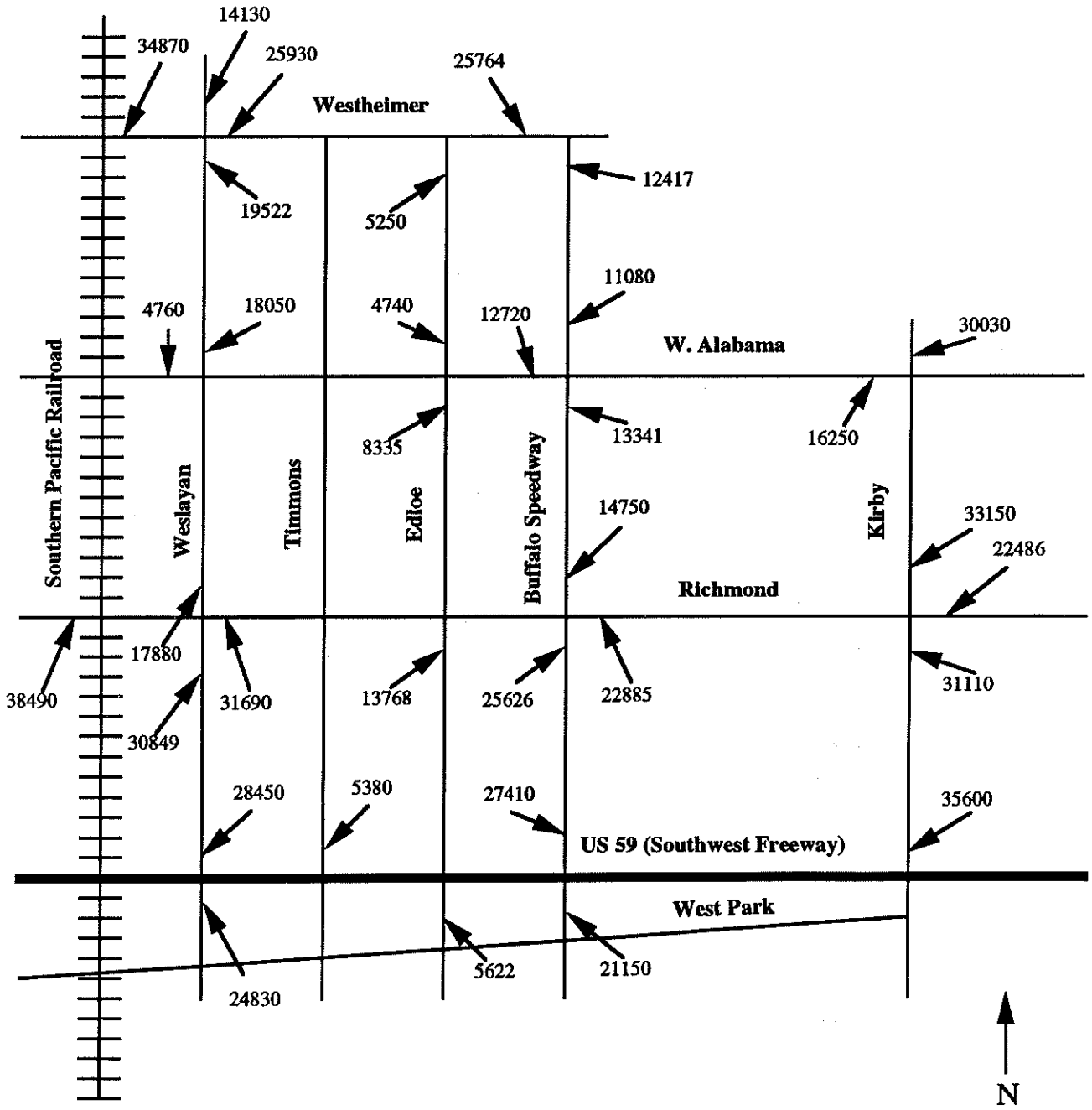
Table 4
Boarding and Alighting Data, Houston Metropolitan Transit Authority, Greenway Plaza, Houston, TX

Boardings		Alightings	
Local		Local	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
173	606	762	298
Park & Ride		Park & Ride	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
*	106	106	*
Total Boardings		Total Alightings	
885		1166	

* Park & Ride is primarily a peak oriented service. Therefore ridership is reported for one direction only.
Source: 1990 Houston Metro Origin and Destination Study

Street Design. The design of major arterials does not appear to be a source of congestion for this area. The traffic volumes for Greenway Plaza are found in Figure 5. Richmond and Westheimer provide east-west access to the CBD from the areas outside Loop 610. Therefore some of the traffic volumes are a result of motorists with destinations other than Greenway Plaza. Westheimer and Richmond are also frequently used as alternate routes to the Southwest Freeway providing access to the CBD and the Uptown/Galleria areas. To prevent extremely high volumes of traffic and "bunching", Houston police officers are stationed at various points along Timmons, Richmond, Buffalo Speedway, and at the access road to the Southwest Freeway. Field observation showed 11 officers supplying traffic control assistance during the evening peak hours from 4:00p.m. to 5:30p.m., Monday through Friday. The officers not only provide traffic control assistance but also act as a crime deterrent due to their high visibility.

Figure 5
Traffic Counts-Greenway Plaza
(Census Tract 407.01)



Traffic Signal Systems. The only potentially dangerous intersection, with regards to traffic signal systems, is the intersection of Richmond and Edloe, where the left turn from Edloe turning west on Richmond is an uncontrolled turn. During this time more than one vehicle each cycle completes the turn after their light has turned red and the green time for cross traffic is underway. In the afternoon peak hours this movement does not offer many difficulties. However, during the morning peak this intersection has a history of causing delays. When there are events at the Summit, severe delays can also be expected at this and other intersections within this MAC.

Pedestrian Safety. The main arterials in Greenway Plaza are well lit by numerous street lights and the sidewalks provide sufficient separation from vehicular traffic. The crosswalks are well designated and the pedestrian traffic signal systems provide adequate time for pedestrians to safely traverse the many intersections in the area. Commuters who use public transportation should find the pedestrian conditions acceptable due to the short distance from passenger shelters to the office buildings, the numerous police officers providing visible crime deterrent, and adequate lighting.

Findings -Greenway Plaza

The peak period traffic levels of service for Greenway Plaza ranged from LOS *B* to LOS *A*. The minor and major arterials have sufficient capacity to accommodate traffic destined for the numerous office buildings in Greenway Plaza, and for those commuters who use this thoroughfare to access other destinations in the Houston metro area. Additional findings include:

- The traffic signal system at the intersection of Edloe and Richmond does not have a controlled left turn from Edloe traveling east or west to Richmond.
- The numerous police officers directing traffic in the evening peak hours contribute to the improved mobility along Richmond while simultaneously providing additional safety for pedestrians and motorists.
- Access to Greenway Plaza by Houston Metro is provided by several routes (local, express and park & ride) with increased headways during the peak periods.

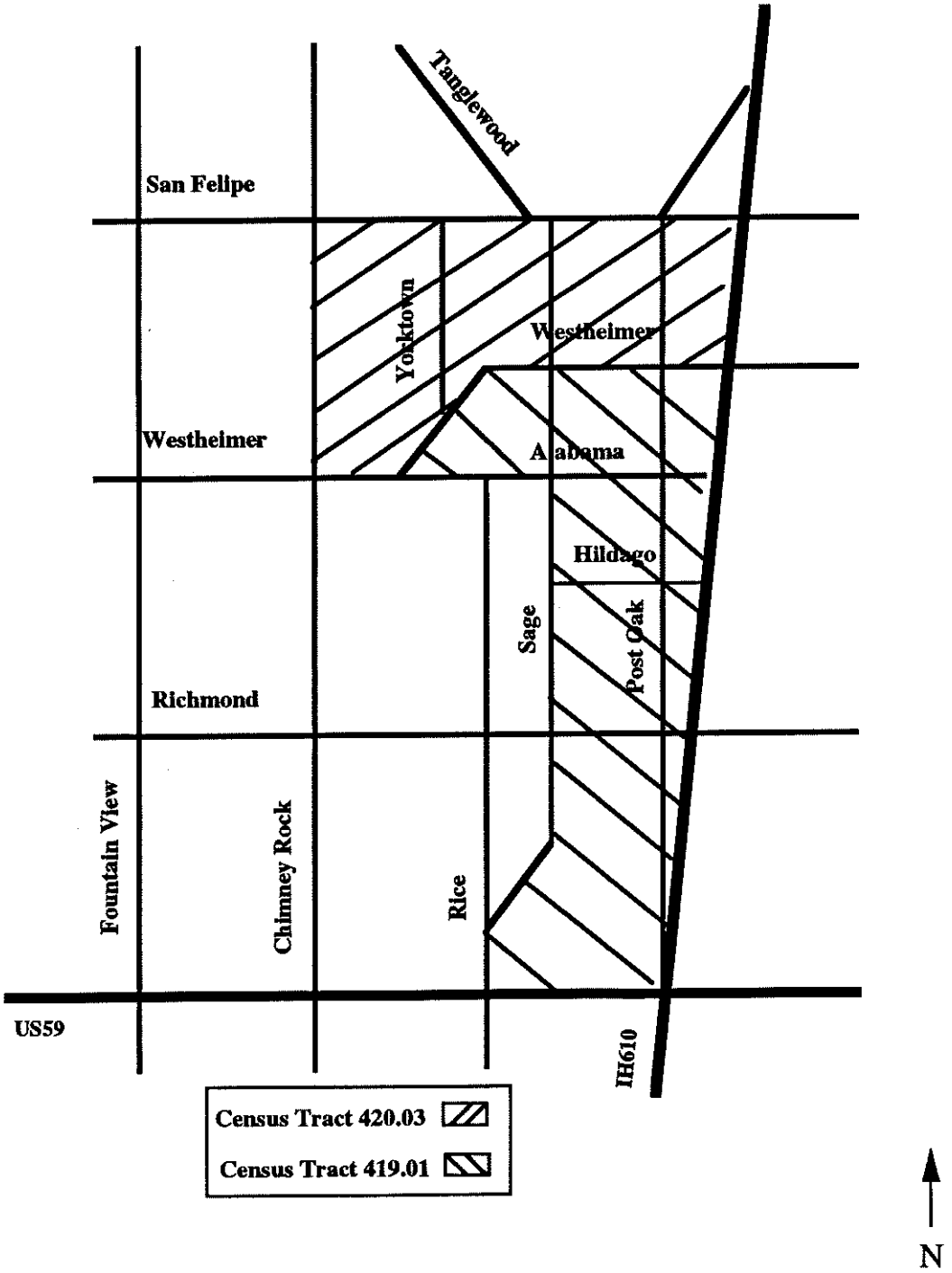
UPTOWN/GALLERIA

Located roughly six miles west of Houston's CBD, the Uptown/Galleria is a showcase of modern shopping and office facilities, and historically has been known by many names (formerly referred to as City Post Oak, or Galleria /Post Oak). Therefore it is no surprise that its physical boundaries have varied depending on who is defining them. For the purposes of this study, Uptown/Galleria will be defined by census tracts 419.01 and 420.03, which is a combined area of 976 acres (Figure 6). Initial construction in the area began in the late 1960s as a mixed land use region to include professional and medical offices, restaurants, retail, entertainment, and recreation facilities with The Galleria Mall being the focal point and hub of economic activity (Hines, 1976).

The geographic location of Uptown/Galleria has the transportation advantage of its proximity to Loop 610 and US59 south (to the east and south respectively). Additionally, the major arterials, Richmond, Westheimer, Alabama, and Post Oak provide commuters and shoppers several routes throughout the region. Institute of Transportation Engineers (ITE) Technical Committee 6A-29 describes how regional retail centers flourished during the massive highway buildup that occurred during the 1950's to the 1970's, relying on its patrons' use of personal automobiles as the primary means of transportation. These retail centers did not encourage the use of public transit because their facilities were set far from the street by large parking areas that were not designed to accommodate the excessive weight of public transit vehicles (ITE Journal, 1986).

The congestion problems associated with the Uptown/Galleria are similar to those of Greenway Plaza in that the internal circulation is complicated by those commuters traveling through the activity center. Westheimer, Alabama, and Richmond are used as an alternative to the Southwest Freeway (as in Greenway Plaza), thereby creating traffic levels that exceed design capacities at several intersections. Author Marshall Hardy suggests that improved phasing between signalized intersections would increase the level of service of arterials in and around shopping malls (Hardy, 1991).

Figure 6
Map of the Galleria/Uptown Activity Center, Houston, Tx
(Census Tracts 420.03 & 419.01)



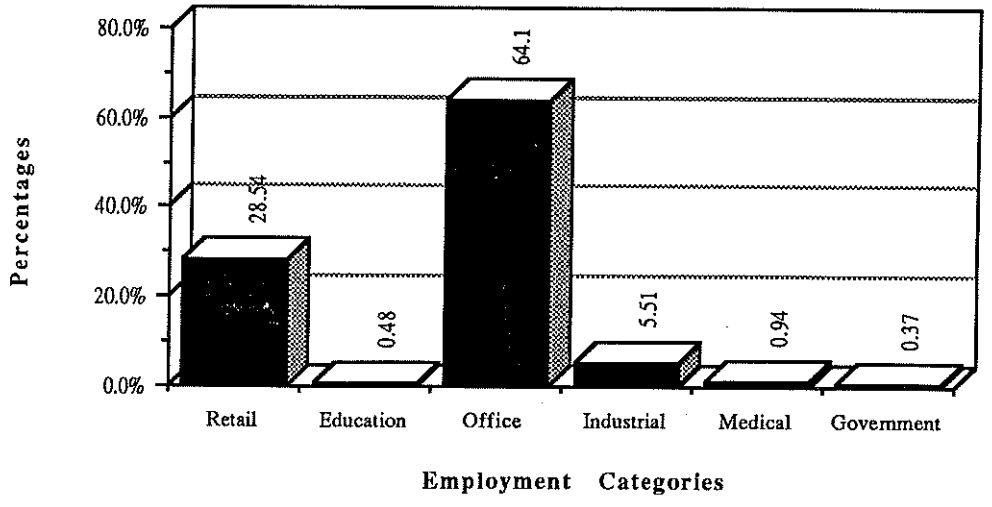
Variables

The data collected for this study area was provided by Uptown/Galleria neighborhood association and the City of Houston's Planning Department. Rather than examine the entire study area, this research will focus on the intersection that provides the most challenges in terms of peak period congestion, that being the intersection of Westheimer and Post Oak.

Employment. The Houston-Galveston Area Council's 1988 employment figures for census tracts 419.01 and 420.03 total over 49,000 employees. Figure 7 shows the various categories of employment found in the Uptown/Galleria with a predominance of office and retail occupations. The challenges associated with these occupations include varying work hours that extend beyond the normal Monday through Friday, 8a.m. to 5p.m.

Figure 7

Employment Categories, Uptown/Galleria, Houston, Tx.



Source: U of H Ctr for Public Policy, 1991

Public and Private Transportation. It is estimated that public transit's share of commuters to this activity center is three percent. The boarding and alighting data are found in Table 5. There are several hotels in the area that provide private transportation services, primarily by passenger vans, for their guests with destinations within the Uptown/Galleria MAC and throughout Houston. However, it has been observed that the boarding and alightings of these vans in the Uptown/Galleria area does not occur in parking facilities or other off street locations, but rather directly on Westheimer, thereby leading to unnecessary delays for motorists waiting for the boarding/departing of passengers.

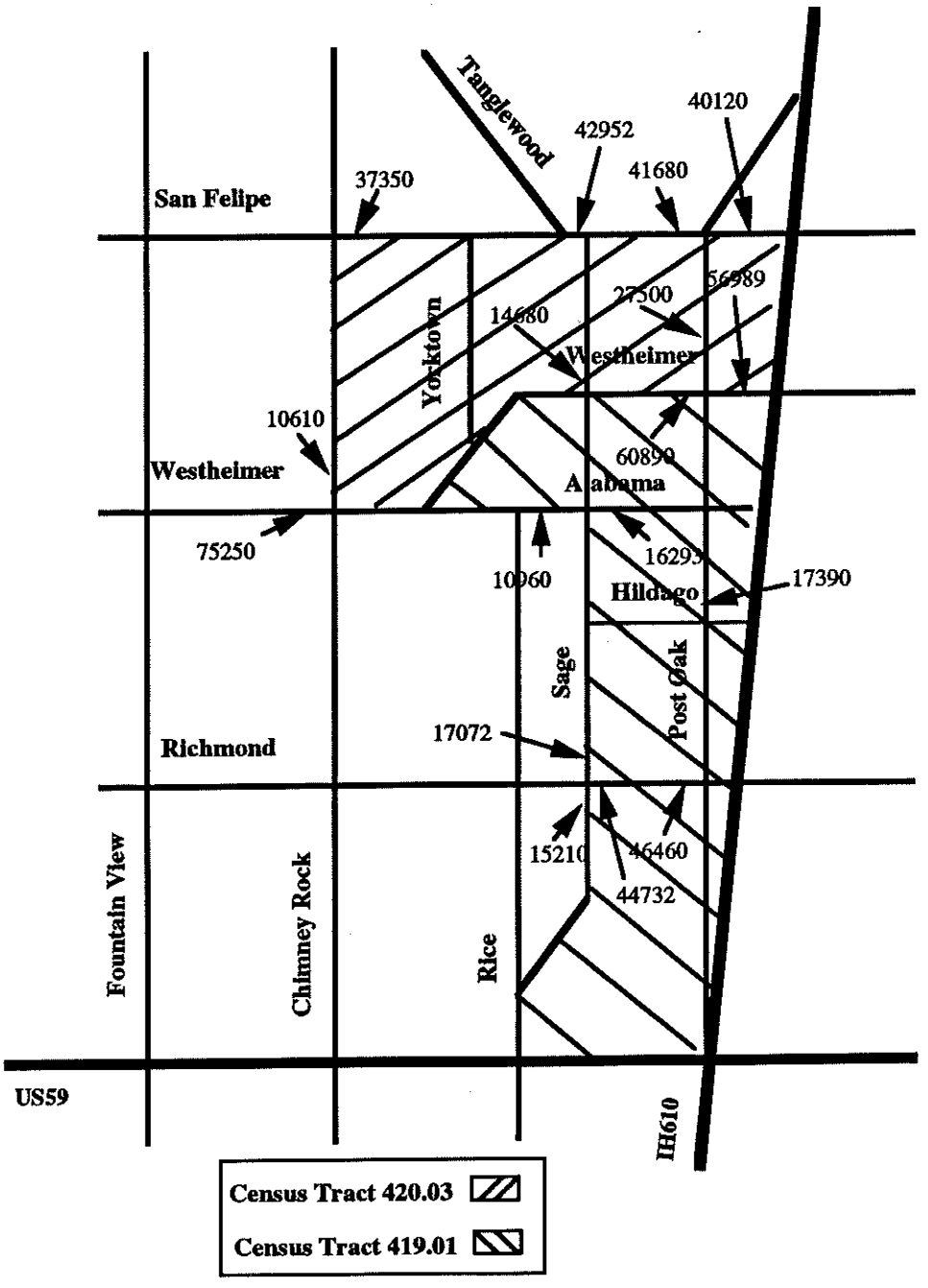
Street Design. The street design allows thousands of commuters ease of access to and through the MAC with traffic counts shown in Figure 8. As previously stated, the intersection of Westheimer and Post Oak was predetermined to contain the most vehicle congestion in the area (based on traffic counts along Westheimer and Post Oak), and, as a result, would be the focus of this study area. The physical design of Westheimer consists of four lanes westbound and three lanes eastbound, including turning lanes. Post Oak consists of two lanes north and south, also including turning lanes.

Table 5
Boarding and Alighting Data, Houston Metropolitan Transit Authority, Uptown/Galleria, Houston, TX

Boardings		Alightings	
Local		Local	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
254	1628	1401	627
Park & Ride		Park & Ride	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
*	47	30	*
Total Boardings		Total Alightings	
1929		2075	

* Park & Ride is primarily a peak oriented service. Therefore ridership is reported for one direction only.
Source: 1990 Houston Metro Origin and Destination Study

Figure 8
Traffic Counts-The Galleria/Uptown
Activity Center, Houston, Tx
(Census Tracts 420.03 & 419.01)



During the evening peak hours it is not uncommon to find one or two Houston police officers assisting in the congestion reduction by directing traffic. This additional visibility by the police department has resulted in a decrease in the number of peak period traffic accidents by deterring motorists from ignoring the controlled intersection and exceeding the posted speed limits. However, the design of the medians, east and west of Post Oak, does not allow enough queuing space for cars desiring to enter the Galleria Mall from Westheimer.

Traffic Signal Systems. The traffic signals operate on a timed system to facilitate the ease of vehicle traffic through the region along Westheimer. Eastbound traffic on Westheimer is prohibited from making left turns onto Post Oak during the evening peak hours, thereby streamlining traffic through the intersection. No unusual problems were observed. As previously noted, Houston police officers are periodically stationed in the study intersection, as well as the intersection of Westheimer and Loop 610 during evening peak hours.

Pedestrian Safety. The pedestrians crossing Post Oak south of Westheimer will experience a satisfactory safety atmosphere. However, the crossing of Westheimer, east and west of Post Oak, presents hazardous safety conditions. The pedestrian crosswalk signal does not permit pedestrians to safely cross all seven lanes of traffic before the flashing "*DON'T WALK* "sign appears. It was observed that many pedestrians had to increase their rate of walking (several were forced to run) before the oncoming traffic entered the crosswalk.

Findings-Uptown Galleria

The study team observed few congestion problems in the Uptown/Galleria area, specifically the intersection of Westheimer and Post Oak. The periodic posting of Houston police officers during the evening peak period greatly enhanced overall mobility throughout the region. However, three particular factors, if improved, can significantly enhance the mobility of the Westheimer and Post Oak intersection:

- Increase the cycle of pedestrian signal systems;
- Limit on-street private transportation boarding and alighting; and,
- Increase median queue capacity along Westheimer.

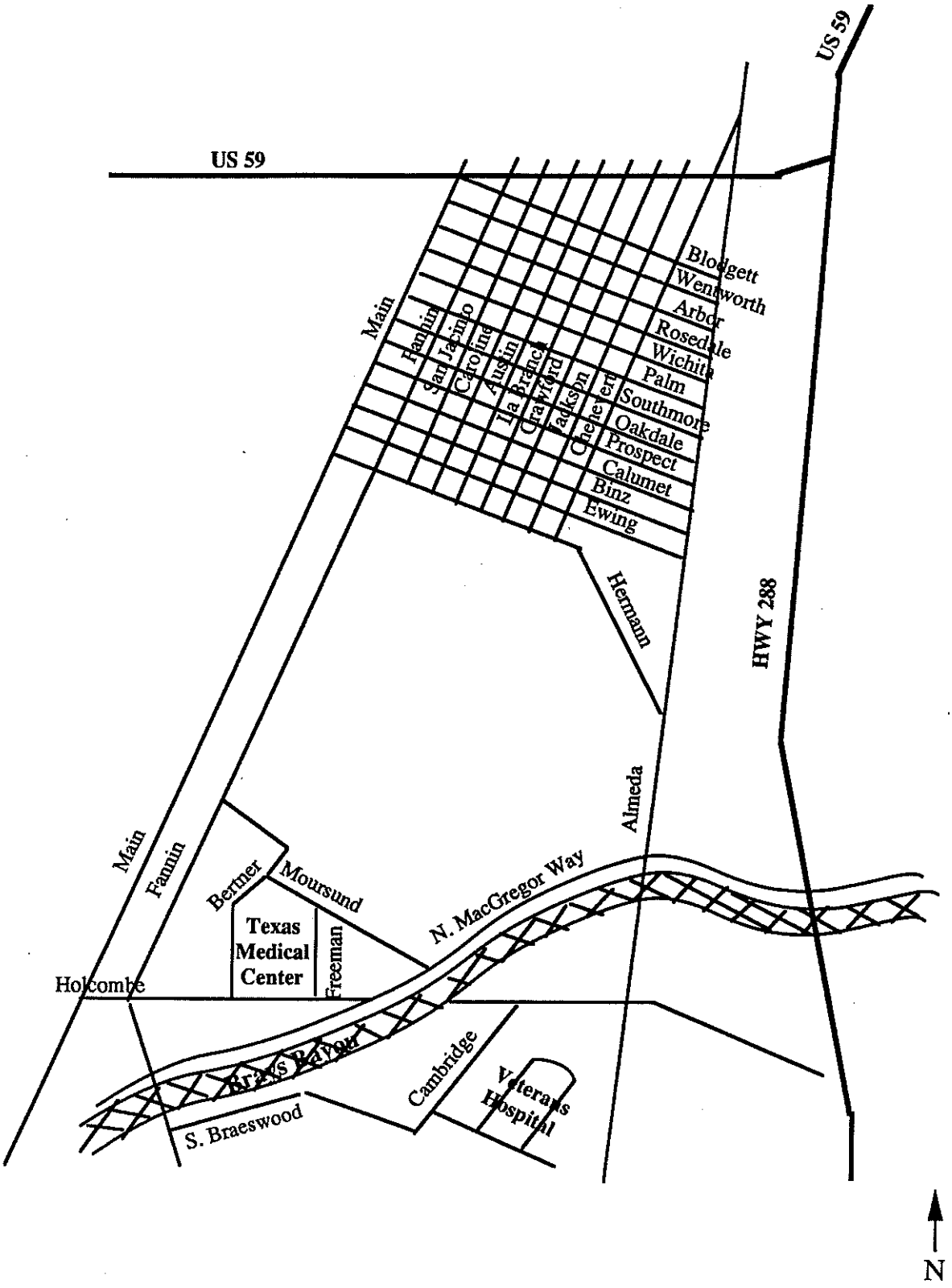
TEXAS MEDICAL CENTER

The TMC was built in Houston in the mid-1940s with only the Baylor College of Medicine and the University of Texas MD Anderson Cancer Center. Today, the TMC is the largest single employer in Houston with a direct economic impact of $3.5 billion, and an indirect economic impact that equals $8 billion (Greater Houston Convention and Visitors Bureau, 1992). As with the other activity centers examined in this report, the TMC area can be defined narrowly or broadly. The narrow definition would include the hospitals and other medical facilities only. The broad definition encompasses not only the hospitals/medical facilities but also the numerous offices and auxiliary businesses on several adjacent streets. This study will concentrate on the core of the TMC, which consists of census tracts 316.01 and 316.02, with a combined acreage of 1,102 acres.

Unlike the CBD or other Houston activity centers, TMC is not dependent on the energy industry, or office and retail occupations for its survival. Instead the TMC's economic strength is the health care profession (and its related industries), and educational facilities (SMCA, 1990). The TMC provides care to over two million patients annually at their several medical facilities (Greater Houston Convention and Visitors Bureau, 1992).

A similar research format was used here as in the previous MAC's of this case study where the examination of the internal circulation revealed a particular corridor or intersection with a history of congestion problems. A map of the Texas Medical Center is found in Figure 9.

Figure 9
Texas Medical Center, Houston, TX

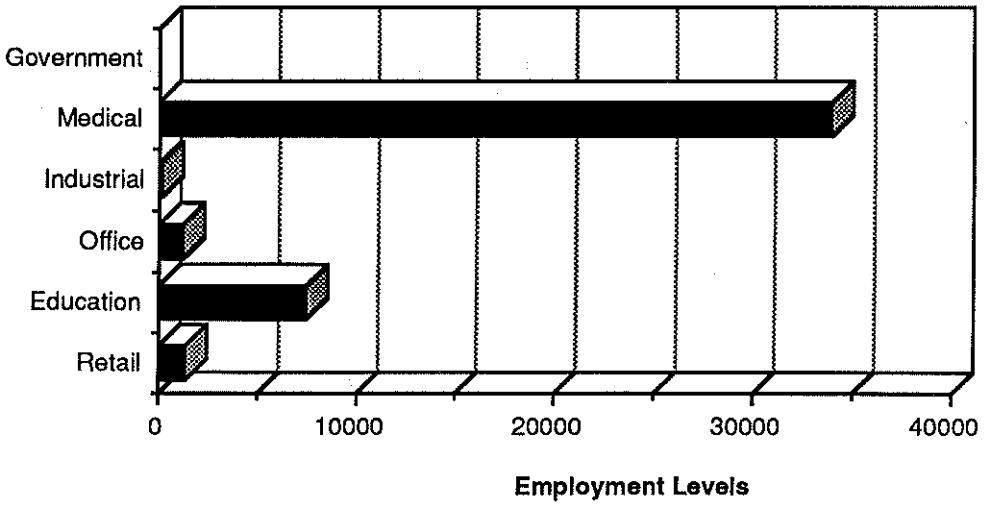


Variables

Information was gathered not only from the City of Houston but from the South Main Center Association as well. This study identified relatively few traffic obstacles leading to congestion. However, the existing traffic problems identified in the TMC area are primarily confined to an area east of Fannin, on Bertner Street, which exist largely due to the configuration of the street itself (two southbound lanes, and one northbound lane).

Employment. The Houston-Galveston Area Council provided 1988 employment for census tracts 316.01/.02 as being over 62,000. Figure 10 shows a representation of the employment categories as of 1992. Over 67 percent of those employed in the TMC are in medical occupations. The educational facilities located within the study area comprise 17.4 percent of the total employee population. The remaining 14 percent consists of those persons in retail, office and industrial occupations.

Figure 10
Texas Medical Center Employment Categories



Source: U of H Center for Public Policy, June 1991

Public and Private Transportation. Access to the TMC is provided by over 10 Houston Metro routes offering local, park and ride, and express services. The boarding and alighting data are provided in Table 6. The frequency of the peak headways for these various routes provide access to public transportation with minimal delays. Due to the limited available parking in the TMC, public transportation is a necessary alternative to the SOV during the morning and afternoon shifts. However, the night shift does not have the same opportunity and access to public transportation because of the limited number of routes operating after 9p.m. Nevertheless, the share of transit rides to the TMC is roughly 9 percent, the second highest of all employment centers in Houston metropolitan region.

Street Design. The traffic counts for the TMC are shown in Figure 11, and reflect the high volumes of traffic on TMC's arterials. The physical design of most arterials throughout the TMC appears adequate to satisfactorily accommodate peak period demand. However, the exception is found on Bertner Street, between Holcombe and Moursund, which is not sufficient to accommodate the traffic of this MAC. Bertner Street is a three lane arterial (two lanes northbound, one lane southbound) that does not allow ample mobility during peak periods (Figure 12).

Table 6
Boarding and Alighting Data, Houston Metropolitan Transit Authority, Texas Medical Center, Houston, TX

Boardings		Alightings	
Local		Local	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
726	2505	3526	702
Park & Ride		Park & Ride	
a.m. peak	p.m. peak	a.m. peak	p.m. peak
*	112	112	*
Total Boardings		Total Alightings	
3513		4340	

* Park & Ride is primarily a peak oriented service. Therefore ridership is reported for one direction only.
Source: 1990 Houston Metro Origin and Destination Study

Figure 11
Traffic Counts-Texas Medical Center Houston, Tx

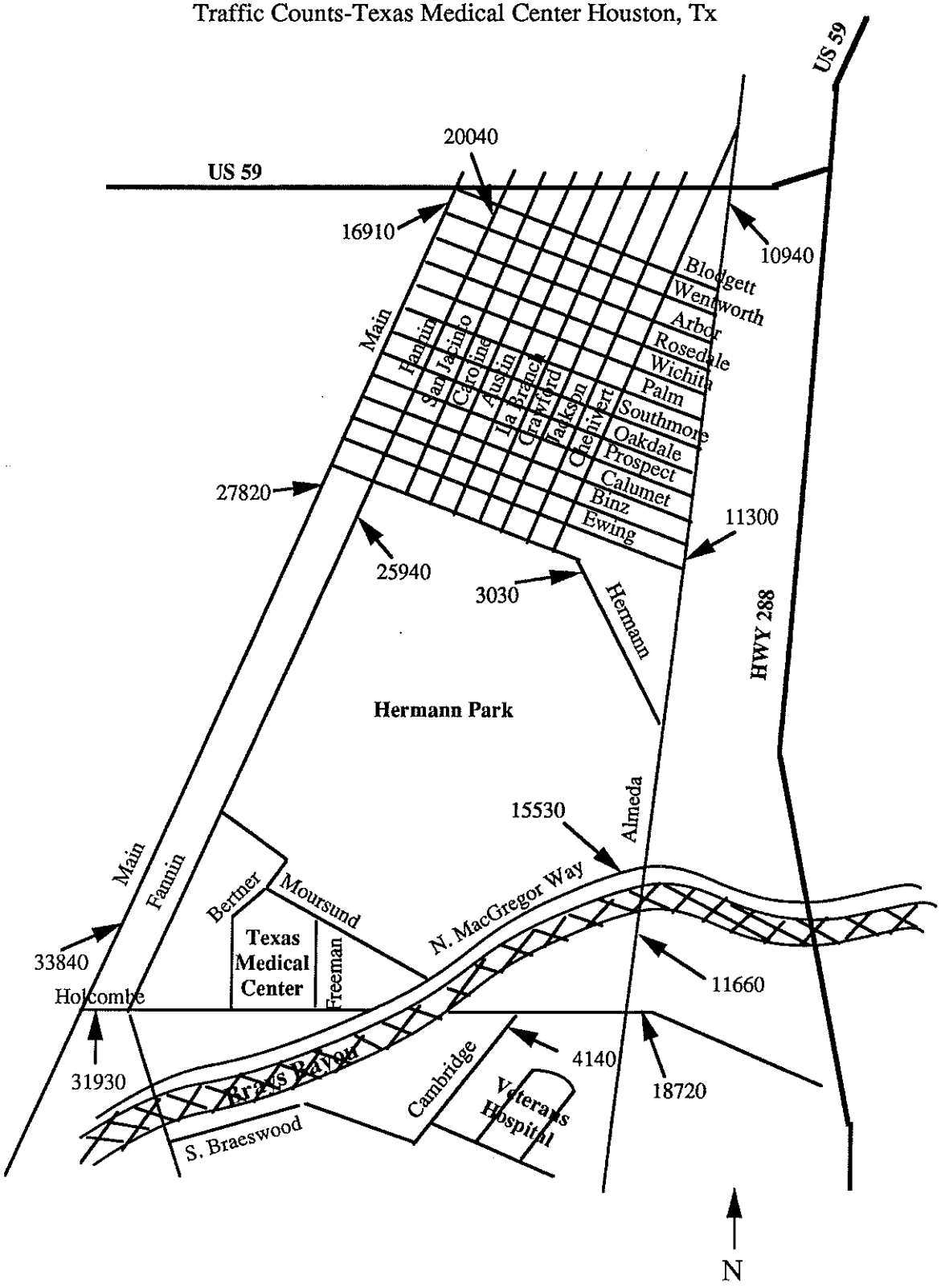
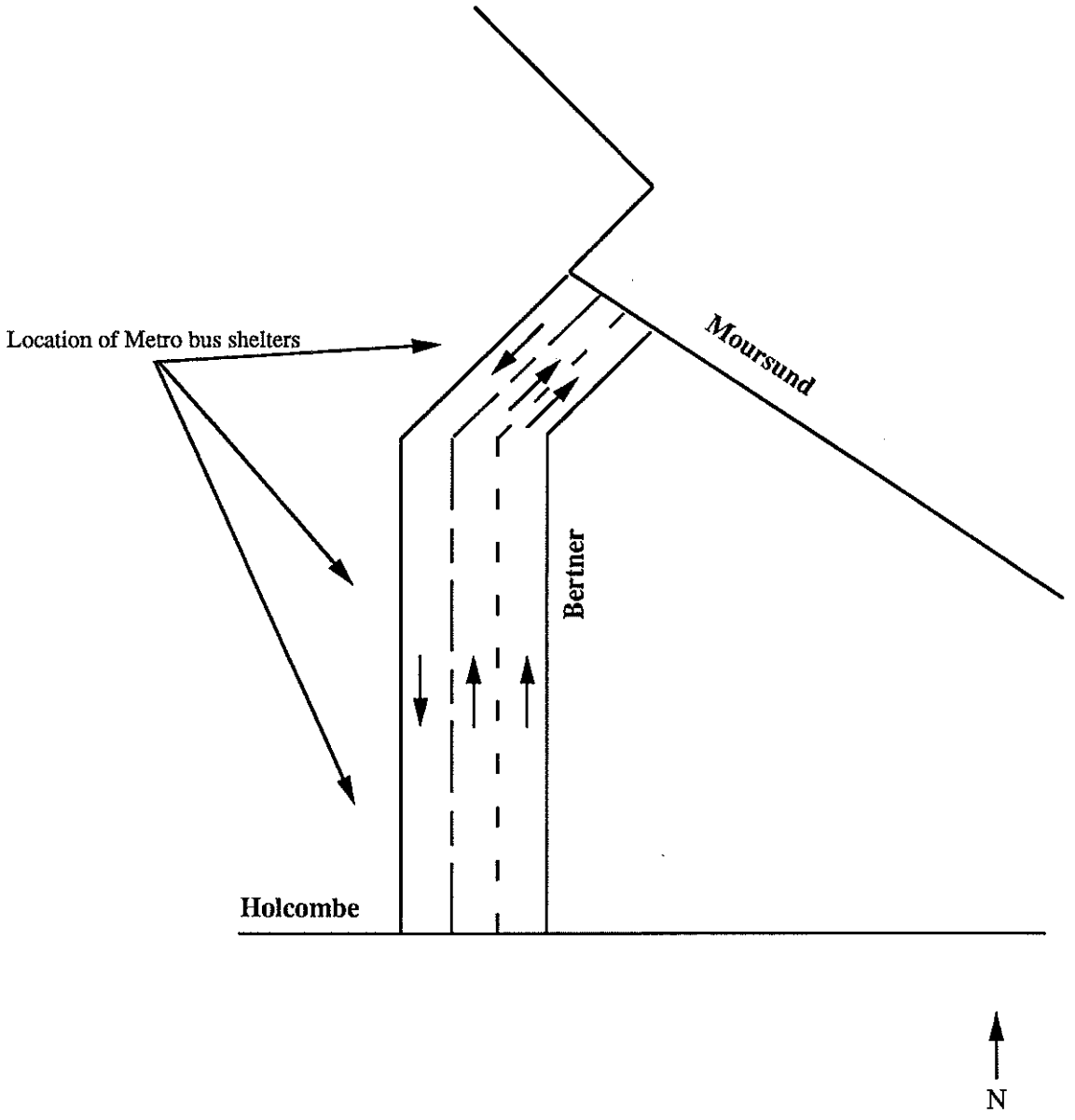


Figure 12
Bertner Street Corridor, Texas Medical Center,
Houston, TX



There are three passenger shelters for bus patrons along this 0.2 mile section of Bertner. The obstacles to mobility occur when the buses are proceeding southbound and are stopped at one of the shelters thereby prohibiting the following traffic from passing. Field observations showed impatient motorists passing the temporarily stopped buses by moving into oncoming traffic creating even further hazards and traffic delays. However, police officers were also observed directing traffic and acting as a deterrent to motorists exceeding the posted speed limits. The remainder of the arterials in the TMC have enough capacity to accommodate relatively high volumes of traffic.

Traffic Signal Systems. There were no observed problems with the traffic signal systems in the TMC. The timing cycles were adequate to allow peak period traffic to flow uninhibited.

Pedestrian Safety. Due to the layout of the TMC, high density core with relatively few parking spaces, pedestrians were not an uncommon sight. There is sufficient lighting in the parking lots and on adjacent streets to provide a sense of personal safety for pedestrians. Unfortunately, many of the pedestrian crossings were not clearly marked, and limited sight distance on some of the arterials could lead to potentially dangerous situations. Underground and overhead passageways provide complete separation from vehicular traffic and unfriendly weather conditions in selected locations. The addition of speed controls would also greatly enhance the safety of pedestrians traveling from parking lots or passenger shelters.

Findings-TMC

The study of the Texas Medical Center's peak period mobility was primarily focused on an identified area where mobility was a major concern. In the TMC this area was Bertner Street. The findings of this research include:

- The posted speed limits were not enforced;
- There was poor visibility of the pedestrian crossings;
- Motorists make illegal passing maneuvers;
- Pedestrians were observed crossing the street at points other than marked cross-walks; and
- There were three bus stops in a 0.2 mile section of Bertner Street.

CENTRAL BUSINESS DISTRICT

Across the country central business districts (CBD) have been their region's economic focal points primarily because of one or more interregional transportation termini (a port, rail head, or highway system intersections) (Smith, 1989). The decentralization of downtown Houston, as in other US. cities, began after World War II as the automobile became affordable and the single family home became the life-long dream for the American family. Greater transportation accessibility, in the form of expanded interstate and state highway systems, has allowed many families to relocate to the suburbs and beyond, while still making a reasonable commute into the CBD's. As more company management personnel relocated to the outer fringes of the cities, employers decided to abandon the CBD and other urban locations and move their operations closer to their employee base. Suburban activity centers developed out of the need to provide employment opportunities near the desirable labor market, and to provide competition for a perceived scarce human resource.

As a major economic hub in southeast Texas and the Houston-Galveston region, Houston's CBD is supported by its proximity to major highways and the Port of Houston (the CBD is bordered by US59, IH45, IH10, and the Buffalo Bayou). Defined by 1990 census tract 121.00, the Houston CBD consists of 976 acres. The predominance of non-manufacturing employment has led to the need for extensive office space, which has tripled in the Houston CBD since 1970 (Smith, 1989). The average amount of added office space from 1970-1979 and 1980-1985 was 1.4 million and 1.9 million square feet, respectively . Houston's position as a regional economic core in the southwest US is further solidified by the number of firms who are headquartered in the CBD, which, in 1987, was over 60% of all headquarters located in the Houston area (Rice Center, 1987). However, in the last few years surrounding counties have established high incentives to lure companies away from Houston's CBD and Harris county. Adding to this decentralization of the Houston economy away from the CBD are several factors including the growth in suburban activity centers, transportation facilities and/or systems, shifts in population and economic stability, and the lack of zoning and other land use constraints (Smith, 1989).

The current transportation facilities provide access to every part of the Houston-Galveston region and consists of an extensive network of highways and arterial roads. With the nearly 50 miles of HOV lanes throughout the city, access to the CBD from suburban park and ride facilities is abundant. However, current reports from the *Houston Chronicle* state that the benefit of time savings from utilizing the HOV lanes is rapidly

diminishing as more Houstonians join carpools and use Metro's express buses. This same article also suggests the short term solution may be to increase the minimum vehicle occupancy from two to three persons (Houston Chronicle, February 20, 1994). Figure 13 shows the traffic counts found within census tract 121.00. Rail has been used successfully in cities across the country in allowing commuters' ease of entry and exit from the CBD without the usual inconveniences associated with automobiles and other forms of public transit. Those cities with rail systems have reported major differences in the economy, congestion management, and land use practices versus non-rail communities (Regional Plan Association, 1991). However, not only is Houston the only major US city without a formal zoning ordinance, it is also the only major city not currently advocating some form of intercity rail system in its long range transportation comprehensive plan.

Employment. The employment data for the CBD can be found in Figure 14. The 1992 estimates of employment in the CBD exceeds 137,000 Houstonians, with a majority being employed in *Office* occupations (66.84%). Of the remaining categories each are less than 12.62% of the total with *Education* being the lowest at less than one percent.

Figure 13

Traffic Counts-Central Business District
Houston, TX
(Census Tract 121.00)

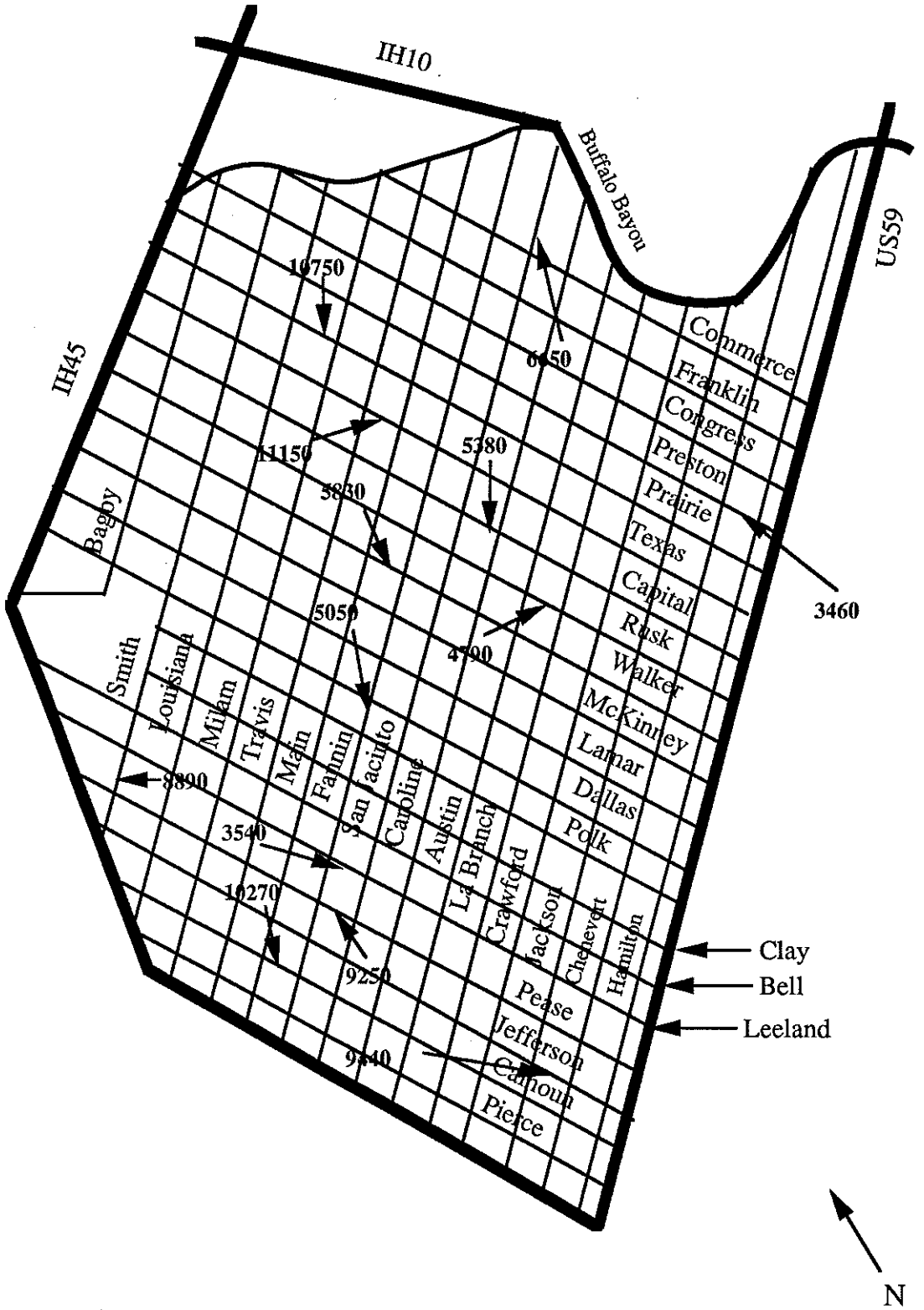
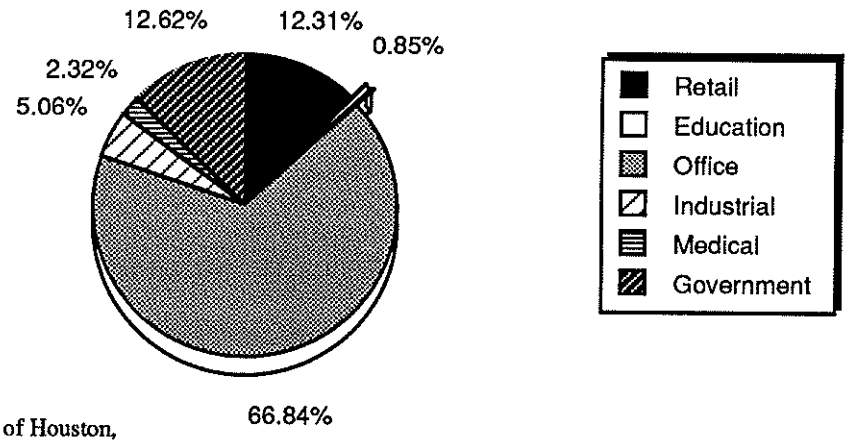


Figure 14
Central Business District-Employment Categories



Source: University of Houston,
Center for Public Policy, June 1991

Public Transportation. Houston Metro's routing system is based on the hub and spoke concept, with the CBD being the center of transportation activity. The CBD attracts the greatest percentage of transit riders of all the employment centers in the Houston area at 30 percent. There are several corridors, particularly Main Street, where access to public transit is available to all parts of the city. Metro's 1990 origin and destination survey indicates that during the morning peak period between 500 to 11295 local/express transit trips are destined for the CBD, and another 400 to 1631 local/express transit trips originate in the CBD.

Street Design. The physical layout of the streets in the CBD are in a north-south and east-west pattern. The alternate streets are one-way providing corridors which allow motorists to navigate the CBD with minimal difficulties. Restrictions on left turns exists on Main Street to further facilitate the movement of automobiles and public transportation.

Traffic Signal System. The traffic signal systems on many streets of the CBD are on a synchronized system during the morning and evening peak hours. No significant problems have been observed in this area.

Pedestrian Safety. All streets in the CBD have sidewalks at least 6 feet wide, providing access to all downtown facilities. Houston's downtown tunnel system contains many restaurants and shops providing ease of access while shielding pedestrians from the natural elements which would normally necessitate the need for a vehicle.

Findings-CBD

The study team observed few incidences of unreasonable reduced peak period mobility. The availability of the underground tunnel system contributes to pedestrian mobility and encourages CBD employees to walk to local restaurants during the lunch hour. Mitigating the congestion on the access points to the CBD seems to be of greater concern. Motorists experience constant traffic flows, facilitated by the timed signal systems, upon entering the downtown area.

SUMMARY

The identification of factors that precipitate reduced transportation mobility is required prior to devising TDM strategies for congestion relief. Many of the factors that contribute to reduced transportation mobility in this case study can be rectified with low-cost, or in some cases no-cost, modifications. The minor and major arterials of **Greenway Plaza** were found to have sufficient capacity to accommodate traffic destined for its numerous office buildings, as well as those commuters passing through. However, factors that contribute to reduced mobility were found to include a traffic signal system, at the intersection of Edloe and Richmond, which does not have a controlled left turn from Edloe traveling east or west to Richmond. The numerous police officers directing traffic in the evening peak hours have contributed to the improved mobility in the area while simultaneously increasing the perception of safety for pedestrians and motorists; accessibility by Houston Metro is provided by several routes (local, express and park & ride) with increased headways during the peak periods.

The study team observed few congestion problems in the **Uptown/Galleria** area. The periodic posting of Houston police officers during the evening peak period greatly enhanced the mobility into and through the region. Mobility is hindered by the brevity of pedestrian signal systems, private transportation boarding and departing procedures, and median design. Several Houston Metro routes operate along Westheimer and Post Oak providing a high transit level of service to the area.

The study of the **Texas Medical Center's** peak period mobility was primarily focused on Bertner Street, between Holcombe and Moursund, an area where mobility and safety were a major concern. It was observed that the posted speed limits were neither enforced nor adhered to, and there existed poor visibility of pedestrian crossings. Additionally, pedestrians were crossing the street at points other than marked cross-walks, and the existence of three bus stops in a 0.2 mile section of Bertner Street contributed to delays as automobiles and buses (some articulated), maneuvered in this congested corridor. It is unclear at this juncture what traffic impacts, if any, will exist upon completion of the construction projects currently underway in the area.

The mobility within the **central business district** does not appear to be a primary concern for commuters. The systematic traffic flow through the CBD, due to the timed signal systems, provides relief from the infamous congestion problems of the neighboring highways, thus allowing the travel through the CBD to be relatively unhindered. A review of transit patterns indicates that the system's largest users of local/express service

for morning peak hours originates and ends in the CBD. Parking facilities are abundant, but prices are higher than in the other activity centers studied. The awareness of motorists near crosswalks, as well as the high visibility of police officers, provide increased physical safety for pedestrians.

Recommendations

This study was designed to determine components of reduced peak period mobility, to identify available public and private transportation services, and to analyze the applicability of various innovative strategies to reduce congestion and the dependence upon the SOV. The location of the MAC's adjacent to highways was considered a plus for the businesses located there because of the relative ease of access for employees and customers in private vehicles. However, this convenience is associated with congestion delays on the highways at entrance and exit points of these MAC's. Numerous TDM strategies have been introduced and successfully implemented in various parts of this country. In Houston the success of TDM strategies will be dependent upon existing transportation infrastructure and innovative ways of applying existing technologies and motivations. The following strategies could successfully be implemented in Houston's urban activity centers if given the needed support from governmental officials and business leaders:

- Telecommuting. The concept of telecommuting is not new. However, greater use of this option (i.e. employees telecommuting one or two days per week) would significantly reduce the number of vehicles destined for any area. The limited number of telecommuting days would continue to provide employees with a sense of "belonging" to their individual office culture. The particular logistics of equipment, liability, and responsibility should be accomplished by each employer. As ITS technologies become more prevalent in our society and the workplace, it is anticipated that transportation demand management will become an ancillary benefit to cost savings associated with reduced overhead, land use practices, and corporate competitiveness.

- Alternate work schedules. Alternate work schedules such as flex time, staggered hours, and compressed work weeks will reduce the number of vehicles at any one time by their distribution to times other than the morning and evening peak periods. These measures require the unyielding support of upper management to

institute policies that will allow a smooth transition for all employees and customers. Individual organizations considering some form of alternate work schedule should conduct an in-depth evaluation of the costs and benefits, as well as the ease of transition of each program.

- Transit Incentives. As a voluntary trip reduction program begins to take shape for this region public transit subsidies may become more prominent. Houston METRO currently has numerous routes that are scheduled through each urban activity center. Further, Houston Metro has several programs which reduce the base bus fare. Aggressive marketing campaigns by the transit authority in conjunction with employer incentive programs will increase the viability of public transportation as a TDM alternative.

- Miscellaneous Incentives. Employers can consider additional incentives to encourage greater use of multiple occupancy transportation options. For example, the capital costs of vehicles can be borne by an employer, leaving only the van operations and maintenance costs for the users. Other incentives can be provided for ridesharers such as movie or restaurant discounts, priority parking privileges or reduced parking fees. Guaranteed ride home programs provide security that ridesharers can return home in the event of an emergency. The potential financial and promotional incentives are numerous and may go well beyond their value depending upon upper management's support for TDM strategies.

- Transportation Management Organizations (Associations). Transportation Management Organizations (TMOs) are to encourage private and public entities to work cooperatively to improve travel and transportation for a designated geographic area. In addition, these organizations enable private agencies to better pool resources to facilitate implementation of TDM strategies in the specific area. Each of the activity centers studied would benefit from an proactive Transportation Management Organization dedicated to decreasing SOV use. The regional Metropolitan Planning Organization has funded several TMOs, including one for the Uptown/Galleria area.

- Disincentives. Disincentives focus on measures used to increase the financial burden or decrease the convenience associated with using the SOV as the primary means of accomplishing work related trips. Increased parking fees, higher

gasoline prices, and direct or indirect user fees are some of the disincentives being studied across the nation as possible measures to reduce the attractiveness of the SOV. Also, some communities limit the availability of parking spaces or create long walks for those who must park.

- Parking Management. There currently exists an abundance of parking in Houston's MACs. If some form of parking management were instituted, this would further encourage employees to find alternative ways of commuting to work.

Many of the above mentioned programs will undoubtedly be influenced by the rapid development of ITS technologies. Not only will the transportation community experience new development, but will devise new applications for existing technologies. ITS' applicability to the congestion challenges in Houston will certainly be the subject of future transportation studies.

Due to the employment categories and the abundant parking facilities found in **Greenway Plaza,** the TDM recommendations for this MAC include: telecommuting, emphasis on public transit subsidies by employers, parking restrictions, and the increase of employer sponsored car/vanpools. With over sixty percent (60%) of the employees in the **Uptown/Galleria** employed in office occupations, all of the previous delineated TDM strategies could be considered. A modification of traffic and pedestrian signal systems will provide a greater atmosphere of safety for all pedestrians. Revising the private transportation boarding and departing procedures would relegate these time consuming maneuvers to any number of available parking facilities located off the major arterials, removing these vehicles as an interruption to traffic flow. Redesigning the street medians along Westheimer would allow additional queuing space for vehicles desiring to make uncontrolled left turns.

The physical construction of Bertner Street, in the **Texas Medical Center**, makes it difficult to accommodate the mixed traffic of buses and automobiles. While the construction of additional vehicle lanes is not viewed as a "cure all" for congestion problems, it is recommended that Bertner be expanded from three to four lanes. The installation of traffic controls at the intersection of Bertner and Moursund instead of a three-way stop would also add additional controls to the region. Due to the nature of employment in the TMC increased employer sponsored car/vanpools, public transit incentives, and continued parking facility management would enhance the peak period mobility currently enjoyed by commuters through this, and other corridors in the TMC.

Mobility within the central business district would benefit from all of the traditional TDM measures. Increased employer sponsored programs would also have a positive effect on the highway systems that lead to the CBD, where most of the congestion now occurs.

The primary challenge facing transportation professionals, and environmentalist alike, is the persuading of the business community and local and/or state politicians to acknowledge the urgency of adequate transportation planning. The support needed to fund and establish successful TDM programs must not be underestimated by those individuals and corporations with notable influence in this community.

Model of Implementation

Transportation professionals have documented extensively the methods and strategies by which peak period congestion can be reduced. Many of these strategies are recommended, in combination with other actions, in this report. These methods and strategies have had varying degrees of success depending on a cadre of variables, including the culture of the particular locale and commitment of area public officials and business leaders. The commitment of business leaders can be best addressed by public officials under the auspices of regional programs and business development. It is the former area, local transportation culture that will be the focus of this section.

The Houston metropolitan area has an auto dominated culture. In addition, Houstonians drive on average more miles to work and utilize more fuel than the national averages. The average travel time, speed, and miles traveled to work for Houstonians is 25.4 minutes, 35 mph, and 14.5 miles, respectively (1990 United States Journey-to-Work census data). Conversely, the national average for similar characteristics is 19.7 minutes, 32.3 mph, and 10.7 miles (1990 United States Journey-to-Work census data) . In terms of energy consumption, Houstonians expend on average 86,753 BTUs compared to 64,018 BTUs used by the average commuter nationwide, based on 5,983 BTUs utilized per vehicle mile.

Planned improvements in the area's transportation system will continue to favor roadways and encourage use of the auto. Roughly 20 percent of regional funds between 1997 and 2010 will be focused on options that encourage increased vehicle occupancy; while the remaining 80 percent will facilitate the overall traffic movement (Metropolitan Transportation Plan, Houston Galveston Area Council, 1995). Clearly buses and car/vanpools receive this general mobility benefit, however, the net effect will be to encourage more individual and solitary trips. As the next century rapidly approaches, the Houston metroplex and surrounding communities will find themselves at a major

transportation crossroad. Some transportation officials recognize that it is unrealistic to expect commuters to abandon their automobiles on a daily basis; consequently, a blending of mode choice is a more reasonable goal. An Energy and Air Quality Model (E•AQ) would encourage commuters to commit to an alternative travel option one to three days each week and utilize their private automobile the remaining days. Utilizing travel demand strategies need not be seen as an all or nothing phenomenon. Instead, commuters may retain the benefits of the private automobile some days, while still contributing to a reduction in vehicle miles traveled. Even this minimal alteration of individual travel behavior, if adopted by enough commuters, will reduce emmissions and billions of BTUs each day. An E•AQ Model can make the difference. For instance, two percent of peak period commuters in Houston's CBD (2,751) consume 1,193,120,886 BTUs during an average five day work week. If the same 2 percent commuters would adopt the E•AQ model, roughly 238,624,177 BTUs would be saved daily. Five percent of the CBD's commuters (6,877) consume 2,982,802,214 BTUs during a work week, and would also realize an energy savings of 596,560,443 BTUs each day an alternative mode to work is selected. Table 7 shows the energy consumption and daily savings of the 2 and 5 percent travelers of the CBD, TMC, Greenway Plaza, and the Uptown/Galleria. A similar calculation could be applied considering that for every 16.4 miles tailpipe emissions and road dust cause one pound of pollution ("Go Boulder", City of Boulder Alternative Transportation Newsletter, February 1996).

The E•AQ model will have many implications in the transportation environment including mode splits, public transit, and parking. For example, parking fees for personal autos are based on 21 to 23 working days per month (assuming a five day work week). Commuters could realize substantially reduced parking fees because parking for personal autos would only be needed 11 to 19 days per month.

This study focused on the existing conditions of the four activity centers in Houston's metropolitan urban core. Future growth for these urban centers is projected to be steady. Thus, it is imperative that the travel demand be managed. The E•AQ model provides the mechanism by which these centers can experience the predicted growth, while avoiding the normal growing pain of decreased traffic flows. The added benefit of the environmental improvement provides additional incentive for this option.

The support and enthusiasm of the business community for such a proposal is critical to its success. Previous research has shown that TDM strategies that work have a strong advocacy from high level executives and civic leaders. As part of this study E•AQ implementation details could be delineated, but a more participant involved

Table 7
Energy Savings per Activity Centers

Activity Center	1990 Employment	2 % of Employment	1 Day Energy Savings *	5 Day Energy Savings *	5% of Employment	1 Day Energy Savings **	5 Day Energy Savings **
CBD	137,530	2,751	238,624,177	2,193,120,886	6,877	596,560,443	1,982,802,214
Greenway Plaza	32,524	650	56,431,417	282,157,083	1,626	141,078,542	705,392,709
TMC	62,195	1,244	107,912,679	539,563,393	3,110	269,781,697	1,348,908,483
Uptown/ Galleria	49,593	992	86,047,327	430,236,633	2,480	215,118,31[illegible]	1,075,591,581

Note: Average trip length is 14.5 miles; BTUs per vehicle mile equals 5,983. All calculations have been rounded.
* Energy that would be saved if 2 % of the employees in each MAC did not drive alone to work for one work day or five workdays
** Energy that would be saved if 5% of the employees in each MAC did not drive alone to work for one work day or five workdays

process would yield higher results. Therefore, the creation of an advisory council consisting of local business and civic leaders will be imperative for successful implementation of this program. Primary specifics to be delineated include, but are not limited to:

- The logistics of the staggered parking accommodations; although an odd-even arrangement could be designed with relative ease.
- An educational campaign to advise the commuter of the benefits of TDM and the options available.

Adoption and active implementation of the E•AQ Model would posture the Houston community to meet environmental challenges in a manner that more easily meshes with the lifestyles of this area's commuters. Further, the anticipated long-term growth in employment throughuot the region could be better managed given the financial constraints which will limit future roadway expansion. Although this case study focused on four urban centers, the findings readily apply to employment centers in metropolitan areas throughout the nation.

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Bye, Larry, Francis Cooper, and James Lightbody, "Solving the Suburban Mobility Problem: Two Case Studies in the Application of Collaborative Problem Solving Techniques", Transportation Research Record no. 1156, pp. 41 - 46, 1988.

Two transportation planning projects involving the public and private sectors in a collaborative process are reviewed. The Santa Clara County region of California is the site of both projects. Transportation 2000 is a midrange transportation project in Silicon Valley, and the Fremont -South Bay Alternatives Analysis of San Francisco's corridors in the Santa Clara County. A few of the results indicate the public and private sectors have similar visions of regional transportation, and the projects have increased community support for transportation facility development. The authors also list several lessons learned from the projects, to be used in future collaborative ventures.

Cervero, Robert, "Experiences with Time-of Day Transit Pricing in the United States", Transportation Research Record no. 1039, pp. 21 - 30, 1985.

This paper examines time-of day transit pricing in the U.S., to determine the effect of pricing peak and non peak transit users. Since the early 1970's thirty-two transit fare programs were initiated in the U.S., and as of 1983 twenty-two programs were still in existence. These programs were implemented on conventional bus services, rail, and some van programs, with differences between peak and non peak fares ranging from $0.05 to $0.35 (the average was near $0.15). The objective was to increase non peak use of the transit systems. The correlation between agencies with time-of-day pricing and those with flat fares was examined to determine the extent of differences (if any) in ridership, efficiency, fare collection, and consumer reaction to fare pricing. Cervero concludes that insights to time-of-day pricing remains unclear and incomplete. Further research needs to be conducted by a carefully designed and administered demonstration program.

Cervero, Robert, and Gary Black, "Possible Effects of Eliminating Federal Transit Operating Subsidies", Transportation Research Record no. 936, pp. 25 - 36, 1983.

During the early days of the Reagan administration federal subsidies for local transit systems were considered for possible cutbacks. The authors examine the possible effects of such reductions. Their findings suggest the larger transit agencies would only incur small impacts, while the smaller metropolitan transit agencies would find themselves in greater inconveniences. Impacts would be anticipated in the following

policies: environmental and energy, equity, political, and labor.

Chung, Jeong, "Running Out of Road", The Economist, Sep. 14, 1991, Vol. 320, pp. 80 - 81.

This article states that the central business districts (C.B.D.) and roads in Japan have become so congested that the country lacks space to accommodate its ever increasing automobile population. Japan's traffic jams have reached a point that has forced the government to enact new parking laws. In response, the auto industry is marketing devices to reduce congestion, such as double-tier parking machines and driving parks where motorists can escape the unbearable, but unavoidable traffic jams.

Federal Highway Administration, "Edge City and ISTEA - Examining the Transportation Implications of Suburban Development Patterns", Searching for Solutions, A Policy Discussion Series - Number 7, August 13,1992.

This publication summarizes the seminar examining the growth of "edge cities" and their relationship to future travel demand. Edge cities have developed on the outer fringes of the metropolitan areas where there is a dependence on the private auto, due in part to a lack of available public transit. The seminar featured speakers from the public and private sectors in an attempt to forecast the trends and problems associated with edge cities.

Ferguson, Erik, "Transportation Demand Management and Implementation", Journal of the American Planning Association, Autumn 1990, Vol. 56, No. 4, pp. 442 - 457.

Ferguson looks at Transportation Demand Management (T.D.M.) as the art of modifying travel behavior. T.D.M. requires the cooperation of actors, according to Ferguson, which may include developers, landowners, employers, and various levels of government. He suggests that on-site employee transportation coordination, parking management provisions, and alternative work schedule are effective T.D.M. strategies.

Flynn, Carolyn, and Lawrence Jesse Glazer, "Ten Cities' Strategies for Transportation Demand Management", Transportation Research Record no. 1212, pp. 11 - 23, 1989.

This paper examines the Transportation Demand Management (T.D.M.) strategies used in ten cities/counties (California: Irvine, Pleasanton, Los Angeles, Sacramento; Washington: Bellevue, Seattle; Texas: Dallas; Florida: Orlando; Maryland: Montgomery County). Each case study examines the use of transportation management organizations (T.M.O.), region wide rideshare agencies, transportation fees, incentives,

and T.D.M. ordinances. The results varied from city to city, but in each case some type of congestion strategy is in place to serve the particular needs of each individual city/county.

Fravel, Frederick, "Intercity Bus Passenger Profile", Transportation Research Record no. 1012, pp. 50 - 56, 1985.

As part of the Bus Regulatory Reform Act of 1982, national and state surveys of bus passengers were conducted to develop an intercity bus profile. This was necessary to assess the impact of the act on persons over the age of 60, particularly those living in rural and small towns. Some of the demographic characteristics gathered in the survey include age distribution, trip characteristics and purposes, age, and income. Fravel concludes by stating that intercity bus service generally is not meeting the essential trip needs for work, shopping or medical purposes. The intercity bus service is mainly used for recreation and social purposes.

Gur, Yehuda, Marianne Miller Mintz, and Robert Morrison, "Demographic Influences on Household Travel and Fuel Purchase Behavior", Transportation Research Record no. 1155, pp. 46 - 55, 1987.

This paper describes the influences of demographic characteristics on travel and fuel consumption. The data was obtained from the Residential Energy Consumption Survey Household Transportation Panel which contains data of fuel purchase, socioeconomic information, and miles traveled. Approximately 1000 households were studied to determine their personal transportation patterns and habits. The survey revealed: 1)Black and poor households tend to own fewer vehicles and purchase fuel more frequently, and 2) elderly and female households also own fewer vehicles but maintain higher fuel inventories and drive much less intensely than standard households (standard households being described as white households).

Hardy, Marshall, "Avoiding the Stop and Go of Development", American City and County, March 1991, p. 24.

This article addresses a traffic impact study conducted for a local shopping mall. One of the goals of this study was to evaluate present road conditions based on the level of service (LOS). The LOS is defined in terms of seconds of delay for signalized intersections. The study begins with traffic counts taken every 15 minutes to determine the peak traffic hours. Once all data has been assembled, general traffic patterns for the area are studied. Possible solutions suggested: 1) adding a turning lane, 2) installing

traffic signals, 3) widening a thoroughfare, and 4) improving the phasing between existing signalized intersections.

Howard, Mark, "Successfully Establishing a Strategic Planning Process", Transportation Research Record no. 1156, pp. 73 - 80, 1988.

New York's Metropolitan Transit Authority (MTA), has established a strategic planning process, Strategic Planning Initiative (SPI), to respond to changing ridership demand in the context of financial resources, and the threats and opportunities that may arise in the evolving region. The SPI was designed to evaluate the strengths and weaknesses of the services provided by the various agencies under MTA. The future of the SPI suggest that agencies will continue to increase their data collection efforts, detailed corridor studies, and an extension of the of the SPI to address problems as they arise in the future.

Hyman, William A., Ted Miller, and J.Christopher Walker, "Impacts of the Greenhouse Effect on Urban Transportation", Transportation Research Record no. 1240, pp. 45 - 50.

This article examines the greenhouse effect on transportation systems in Miami and Cleveland. The Environmental Protection Agency (EPA) anticipates an increase of five to nine degrees in the Earth's temperature by the year 2080. Increasing heat can affect steel joints in rails, and soften existing asphalt highways. The authors believe the potential global warming will increase the sea level, requiring streets, bridges and drainage to be reconstructed. In Cleveland, the effects of a warmer climate would mean a reduction in snow and ice controls, and maintenance and construction costs. The current implications suggest urban planners should begin examining designing bridge under clearances and drainage systems with a life expectancy of 20 to 100 years.

I.T.E. International Board of Direction, "I.T.E. Develops Plan for Addressing Traffic Congestion", I.T.E. Journal, Nov. 1987, pp.14 - 15.

The I.T.E. International Board of Direction has developed a resource plan to address the problem of traffic congestion. Their solution involves working with the local communities, state governments and elected officials, and focusing on four areas to direct initial actions: career guidance, education and training, public relations, and funding. The I.T.E. institute has increased its effort to assist professionals in solving the traffic congestion problems, and is looking for strong support from its members.

I.T.E. Technical Council Committee 6A-29, "Transit Service to Regional Shopping

Centers", I.T.E. Journal, July 1986, pp.19 - 22.

This report describes how regional shopping centers flourished during the highway construction boon during the 1960's. These shopping centers were designed to maximize the new independence felt by many motorists as automobiles became affordable and new interstate highways were connecting communities. Therefore, these shopping centers were not designed for effective public transportation. Committee 6A-29 was established to address the issue of transit service in and around regional shopping centers located outside of the central business districts (C.B.D.). The committee's findings center on three categories: the transit user, transit operator, and the shopping center owner(s).

I.T.E. Technical Council Committee 6A-37, "The Effectiveness of High Occupancy Vehicle Facilities", I.T.E. Journal, Feb. 1988, pp.17 - 18.

This report was prepared to provide agencies planning new high occupancy vehicle (H.O.V.) facilities with data that can be used in project development, both in separate and freeway rights-of-ways. The surveys found that the presence of park-and-ride lots and other transfer centers enhance the performance of H.O.V. vehicles by providing easier access. In addition, data suggest that H.O.V. lanes had a lower accident rate versus parallel non-H.O.V. lanes. Some of the issues that remain unsolved are the design of streets and highways to accommodate H.O.V. vehicles, and the standards for signing and striping.

I.T.E. Technical Council Committee 6A-40, "Effectiveness of Downtown Transit Transfer Centers", I.T.E. Journal, Sep. 1990, pp. 34 - 38.

Committee 6A-40 identified how well downtown transit transfer centers were utilized and their effectiveness in solving their transportation objectives. The data was obtained by questionnaire and follow up phone calls, and was collected from two viewpoints: the operator and the user. The general conclusion was that downtown transfer centers rated satisfactory, but the facilities did not have an impact on ridership.

Kadesh, Eillen, and Laurie Elder, "Guaranteed Ride Home: Insurance Program for H.O.V. Users", Transportation Research Record no. 1212, pp. 72 - 75, 1989.

This study evaluates the Guaranteed Ride Home Program for H.O.V. users to increase participation in Seattle Metro's transit, carpools, and vanpool services. The ride home program provides free taxi service, for a predetermined number of miles, to ad from work. Two business centers were identified for this program because of their

employment size. The results indicate the commuters viewed the ride home program as a worthwhile service.

Mullin, J.A. III, Earl Washington, Robert Stokes, et al, "Land Use Impacts of the Houston Transit Way System: Third Year Update." Texas Transportation Institute (TTI) in cooperative with DOT and UTMA, February, 1988.

The report provides third year update of research performed under project 2-10-85-1086 between the State Department of Highway, Public Transportation and TTI. This five year research effort examines transportation and land use impacts resulting from implementation of an extensive priority system of busways (transitways) and park and ride facilities in Houston, Texas. Over the duration of this research, four H.O.V. lanes with supporting park and ride facilities will be placed in operation in the I-45 north and I-10 west (Katy freeway) corridors in Houston. The impacts resulting from three of the H.O.V. treatments, I-45N and I-10W are the objects of this research.

Orski, C.K., "Traffic and Transit Futures From the Book Transit, Land Use & Urban Form", University of Texas, Austin, 1988.

This article argues that mass transit alone cannot solve the congestion problem in suburb-to-suburb commuting. Congestion management has the following additional components:

1) cost sharing, requiring developers to share in the cost of transportation improvements
2) private sector involvement in traffic mitigation through transportation management associations
(TMA)
3) regulatory innovations, including private participation in traffic mitigation.

Orski, Kenneth, "The Problem of Traffic Congestion", Vital Speeches, Jan. 1, 1990, Vol. 156, pp. 190 - 192.

This article began by examining the changing nature of traffic congestion. Traffic congestion affects suburbs and central cities alike, while intruding on the lives of an ever increasing population. The author then questions if rail transit or road expansion can offer lasting relief. Orski suggests officials talk less about solving congestion and more about management of the congestion problems. He defines management as "...doing whatever is necessary to contain traffic within the limits of public tolerance...". Three strategies are offered to achieve this objective: 1) incrementally expanding road capacity, 2) reducing the growth of transportation demands, and 3) controlling the intensity and

pace of development.

Powers, John, "George Washington Bridge Bus-Carpool Lane: 1-Year Operational Report", Transportation Research Record no. 1212, pp. 63 - 71, 1989.

Powers examines the reserved bus-carpool lane on the New Jersey routes into the George Washington Bridge. This report reviews operational data of carpool, bus, and violator activities over the first year of operations. The conclusions reveal the dedicated lanes have achieved their intended goals, and exerted a positive effect on the formation of car/vanpools in the region. The presence of Port Authority of New York and New Jersey police have been successful in providing adequate law enforcement.

Pultz, Susan, "Key Considerations for Developing Local Government Transportation System Management Programs", Transportation Research Record no 1212, pp. 24 - 33, 1989.

The author establishes the decision making factors that influence transportation systems management (T.S.M.), program goals, and administrative structures. The factors that need to be evaluated include transportation environment, employer and employee characteristics, and the development environment. It was determined that T.S.M. programs are cost-efficient methods to reduce traffic congestion, but are more successful as a part of a comprehensive region-wide transportation strategy. Regional efforts should include H.O.V. lanes and park and ride facilities, sponsored and supported by local/regional government officials.

Regional Plan Association, "The Renaissance of Rail Transit in America", June 1991.

This report examines the resurgence of rail usage since the end of World War II. The 18 metropolitan areas planning new rail systems are studied for desired and expected benefits. A comparison is made between cities with rail and those without to reveal any major differences in the economy, congestion management, and land use. A history of the rail in Europe is given to evaluate how European communities have developed with rail as a transit option.

Reno, Arlee, William Gellert, and Alex Verzosa, "Evaluation of Springfield Instant Carpooling", Transportation Research Record no. 1212, pp. 53 - 62, 1989.

This study examines the idea of instant carpools to allow commuters to use the H.O.V. lanes in the commute from the Springfield area of Northern Virgina to downtown Washington, D.C. and the Pentagon, using the Shirley Highway. The authors define

instant carpooling as well dressed business-people who ask for rides from strangers. This method of assembling a carpool has provided savings in travel time, and operating costs for public agencies. Also presented are ways to protect the instant carpool, and offer suggestions to other communities for encouraging similar programs in their respective communities.

Rice Center -Joint Center for Urban Mobility Research, "Houston's Major Activity Centers and Worker Travel Behavior", prepared for the Houston-Galveston Area Council, January 1987.

This study examines four of Houston's major activity centers (Downtown/C.B.D., Greenway Plaza, City Post Oak, and the Energy Corridor), and the characteristics of their respective employees. The activity centers are defined in terms of physical size, land use , numbers and types of employees, and total square footage of available office space. The primary characteristics analyzed also included worker travel patterns, and the types of transportation facilities, transit services, and traffic patterns.

Robison, Rita, "Transit Triumph", Civil Engineering, July 1988, pp. 38 - 41.

Robison describes the city of Boston's Southwest Corridor Project. This rail project is unique in its complexity, technology, environmental, public policy, and social benefits. The $743 million, 4.7 mile project was the largest public construction effort in Massachusetts at the time and represents the strongest rejection of highway construction by a community.

Sampath, Srikanth, Somitra Saxena, and Patricia Mokhtarian, "The Effectiveness of Telecommuting as a Transportation Control Measure", submitted to the proceedings of the ASCE Urban Transportation Division national Conference on Transportation Planning and Air Quality, Santa Barbara, California, July 28, 1991.

This report examines telecommuting as a transportation demand measure, and the associated air quality implications. There were studies accomplished to determine the effects of telecommuting and the overall reductions of vehicle cold-starts. Further research was offered to examine telecommuting and the long range benefits associated

network of roads may choose to use public transit, change their schedule, combine trips, or eliminate some trips altogether.

Soloman, Charlene M., "The Traffic Trap", Personnel Journal, Nov.1990, Vol. 69, No. 11, pp. 64 - 71.

In order to reduce traffic congestion, many companies are offering their employees options in their transportation policies. Those options include carpools, vanpools, flexible work schedules, and subsidies for bus service and/or gifts for ridesharing.

Southern California Association of Governments, "Evaluation Report - Telecommuting Pilot Project", August 1988.

This report details the evaluation of the Southern California Association of Government's (SCAG) telecommuting pilot project. This report was intended to provide a guide for other organizations who are exploring the telecommuting option, and assess SCAG's own commitment to its telecommuting program. Comments from telecommuting employees and managers.

Spielberg, Frank, "The Traditional Neighborhood Development: How Will Traffic Engineers Respond?", I.T.E. Journal, Sep. 1989, pp. 17 - 18.

The author describes a symposium held in Seaside, Florida to discuss the concept of traditional neighborhood development (TND) versus the planned unit development (PUD). TND seeks to recapture the appeal of neighborhoods before the current wave of PUD's sprung up in suburbia. Some main objectives include making the neighborhoods pedestrian friendly by increasing the radii of curbs, narrowing the streets, and encouraging on-street parking. These actions will reduce the speed of the traffic flow. However, many of these concepts are in conflict with some state and local codes that facilitate rapid traffic flow, although at the expense of pedestrian safety.

Torluemke, Donald, and David Roseman, "Vanpools: Pricing and Market Penetration", Transportation Research Record no. 1212, pp. 83 - 87, 1989.

Torluemke examines the history of vanpools and strategies used to increase their market share. The article looks at two case studies, the Aerospace Corporation and McDonnell Douglas, to compare and contrast their individual approaches to vanpooling. The company sponsored program (Aerospace) was more successful in penetrating additional markets versus the vendor sponsored (McDonnell) programs.

University of Southern California, "Travel Trends in Non-CBD Activity Centers: An Assessment of Potential Roles for Mass Transit", UMTA-CA-11-0032, Sep. 1992.

This research project assesses the ability of both existing transit operations and potential alternative transit programs in satisfying the evolving travel demand patterns that are investigated with respect to the emerging centers based on identified flows within and between those centers. The feasibility of alternative forms of transit is also assessed.

United States Department of Transportation, "The Implementation of Downtown Auto-Restricted Projects", June 1984.

This report details the demonstration program of Auto Restricted Zones (ARZ), conducted by the UMTA's office of Service and Methods Demonstration (SMD). The findings centered on the following findings: CBD revitalization, implementation problems, and ARZ demonstration cases. Of the six cities originally selected, only two have implemented ARZs under the SMD program. The only city with a successful ARZ in place was the Boston, Ma. project. The findings reveal the ARZ policies are continually adapted through the negotiating process, and planners have problems confronting support types of problems.

Valdez, Roberta, and Judy Wang, "Comparison of Transportation Demand Management Market Research Study Results and Transportation Management Association Development in Three Suburban Activity Centers", Transportation Research Record no. 1212, pp. 1 - 10, 1987.

This paper presents the relationship of transportation demand management (TDM) planning, Transportation management association (TMA) development, and program development in three activity centers in Orange County California. The activity centers were located in different parts of the county (Newport Center: south; South Coast Metro: center; Brea: north) to provide a comprehensive picture of the travel characteristics of the region. The findings revealed similar perceptions to congestion, the role of business, and commute modes. The study shows the effects of TDM programs will be different for each region due to the involvement of local government and the business community.

Wegmann, Frederick, "Cost Effectiveness of Private Employer Ridesharing Programs: An Employer's Assessment", Transportation Research Record no. 1212, pp. 88 - 100,

1989.

The beneficiaries of rideshare programs are the employees, employer and the community. This research investigates the extent of benefits to these various groups. The data was collected through a mail-back survey of businesses with current rideshare programs, and those businesses that have discontinued the program. Responses were received from 160 businesses, but most were unable (or unwilling) to quantify their individual benefits. The benefits recorded included a decrease in absenteeism, tardiness, and in improvement of the corporate image. The data states that 56 percent of the surveyed firms were able to operate the service at a financial break-even point.

Williams, Jon, Paul Marchione, and Abdurahman Mohammed, "Vanpool Operator Survey for the Washington, D.C., Region", Transportation Research Record no. 1285, pp. 109 - 117, 1990.

The number of vanpools in the Washington, D.C. area has increased almost 60 percent from 1982 levels to 1,060 in 1989. This article describes a mail-back survey of vanpool drivers taken during May and June of 1989. The survey methodology is presented along with anticipated goals and results. The design of the 1989 survey was based on the findings of the initial vanpool survey of 1982. The findings reveal that vanpooling is effective in serving long-distance commuter travel. State and local governments desire to increase vanpool growth, and incentive packages are being considered in several areas of Maryland and Virginia. The main concern for vanpoolers in the Washington, D.C. area is the issue of insurance because of owner-operated vans.

Wesemann, Larry, Paulette Duve, and Nick Roach, "Comparison of Travel Behavior Before and After the Opening of HOV Lanes in a Suburban Travel Corridor", Transportation Research Record no. 1212, pp. 41 - 52, 1989.

This article describes the efforts by Orange County Transit District and the California Department of Transportation to accurately collect data to maintain up-to-date travel information. In three corridors video cameras were in place to record the license plates and those commuters were sent mail-back surveys. By using this technique the data base has grown in excess of 6,200 records. The four surveys conducted using the video camera information has not disrupted traffic, provided a focused framework for analysis, and much more cost effective versus the large survey team that would be required to gather the same volume of information.