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**THE IMPACTS OF CARPOOL UTILIZATION  
ON THE KATY FREEWAY TRANSITWAY  
42-MONTH "AFTER" EVALUATION**

by

H. Gene Hawkins, Jr.  
Assistant Research Engineer

and

Dennis L. Christiansen  
Research Engineer

Research Report 484-11

**An Evaluation of the Impact of Permitting Carpools to Use  
the Katy Transitway**

Research Study Number 2-10-85-484

Sponsored by

Metropolitan Transit Authority of Harris County

and

State Department of Highways and Public Transportation

in cooperation with the

U.S. Department of Transportation

Federal Highway Administration

Texas Transportation Institute

The Texas A&M University System

College Station, Texas 77843

September 1989

# METRIC (SI\*) CONVERSION FACTORS

## APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

<b>AREA</b>				
in <sup>2</sup>	square inches	645.2	millimetres squared	mm <sup>2</sup>
ft <sup>2</sup>	square feet	0.0929	metres squared	m <sup>2</sup>
yd <sup>2</sup>	square yards	0.836	metres squared	m <sup>2</sup>
mi <sup>2</sup>	square miles	2.59	kilometres squared	km <sup>2</sup>
ac	acres	0.395	hectares	ha

<b>MASS (weight)</b>				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

<b>VOLUME</b>				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft <sup>3</sup>	cubic feet	0.0328	metres cubed	m <sup>3</sup>
yd <sup>3</sup>	cubic yards	0.0765	metres cubed	m <sup>3</sup>

NOTE: Volumes greater than 1000 L shall be shown in m<sup>3</sup>.

## TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C
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## APPROXIMATE CONVERSIONS TO SI UNITS

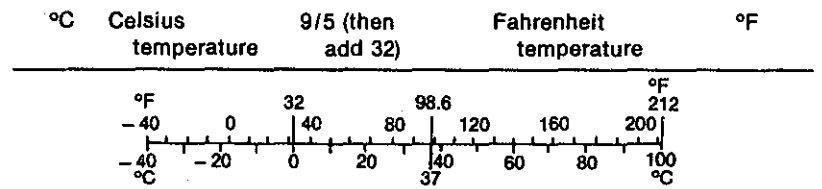
Symbol	When You Know	Multiply By	To Find	Symbol
<b>LENGTH</b>				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi

<b>AREA</b>				
mm <sup>2</sup>	millimetres squared	0.0016	square inches	in <sup>2</sup>
m <sup>2</sup>	metres squared	10.764	square feet	ft <sup>2</sup>
km <sup>2</sup>	kilometres squared	0.39	square miles	mi <sup>2</sup>
ha	hectares (10 000 m <sup>2</sup> )	2.53	acres	ac

<b>MASS (weight)</b>				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

<b>VOLUME</b>				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m <sup>3</sup>	metres cubed	35.315	cubic feet	ft <sup>3</sup>
m <sup>3</sup>	metres cubed	1.308	cubic yards	yd <sup>3</sup>

## TEMPERATURE (exact)



These factors conform to the requirement of FHWA Order 5190.1A.

\* SI is the symbol for the International System of Measurements

THE UNIVERSITY OF CHICAGO  
DIVISION OF THE PHYSICAL SCIENCES  
DEPARTMENT OF CHEMISTRY  
5708 SOUTH CAMPUS DRIVE  
CHICAGO, ILLINOIS 60637

## ABSTRACT

A major commitment has been made in the Houston area to develop physically separated transitways in the medians of freeways. The lanes are reserved for high-occupancy vehicles. Phase 1 of the first completed transitway opened on the Katy Freeway (I-10) in October 1984. Initially, only buses and authorized vanpools were permitted on the transitway. To increase potential utilization of this facility, authorized 4+ carpools began using the transitway on a test basis in April 1985. In November 1985, 3+ carpools were authorized to use the transitway. In August 1986, the authorization requirements were dropped and the transitway was opened to 2+ carpools.

This research study, funded jointly by the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation, was initiated in order to conduct a comprehensive analysis of the effects of permitting carpools to utilize the transitway. This report documents data collected in October 1988, 3.5 years after carpool utilization of the transitway began. This report compares the 1988 data to similar data collected before carpool utilization was permitted (March 1985) and after carpool utilization was permitted (April 1986, October 1987). These comparisons address numerous concerns and provide an indication of the effectiveness of allowing carpools on the transitway.

**Key Words:** High-Occupancy Vehicle Lanes, Transitways, Busways, Carpools, HOV Facilities, Authorized Vehicle Lanes.



## **IMPLEMENTATION STATEMENT**

Since there is relatively little experience with operating exclusive, reversible, high-occupancy vehicle lanes, many of the operating procedures and approaches to be used in Houston will be developed through experience. A key operating issue involves the type of vehicles that will be allowed to utilize the special lanes.

This study was specifically undertaken to assist the Metropolitan Transit Authority of Harris County and the Texas State Department of Highways and Public Transportation in the implementation and operation of transitways. This study, through analyses and comparison of both "before" and "after" data, assesses the impacts of permitting carpools to utilize the special high-occupancy vehicle lanes.

## **DISCLAIMER**

The contents of this report reflect the views of the authors who are responsible for the opinions, findings and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas State Department of Highways and Public Transportation, the Federal Highway Administration, or the Metropolitan Transit Authority of Harris County. This report does not constitute a standard, specification, or regulation.





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## SUMMARY

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The Katy Transitway was opened to authorized buses and vanpools in October 1984. To increase transitway vehicular utilization, authorized 4+ carpools were allowed onto the facility in April 1985; in September 1985, authorized 3+ carpools were allowed to use the transitway. In August 1986, authorization requirements were eliminated, and 2+ vehicles were permitted to use the transitway. In October 1988, the occupancy requirement was raised to 3+ between 6:45 - 8:15 a.m., while remaining at 2+ during all other times.

This report evaluates the impacts of allowing carpools to use the transitway. Data in the report cover the period from April 1985 through October 1988. Another Texas Transportation report (Research Report 1146-1) evaluates the transitway for the period after the occupancy requirement was raised.

### Trends in Transitway Utilization

In September 1988, over 9,300 persons used the Katy Transitway during the a.m. peak period; 69% of these persons were moved in carpools. Of those carpoolers, approximately 7% have been attracted from either buses or vans that use the transitway. Carpools comprise approximately 96% of the vehicles using the transitway.

In September 1988, 1,531 vehicles used the transitway during the peak hour. This value is very close to the capacity of the transitway, which is estimated to be approximately 1,500 vehicles per hour. Allowing carpools to use the lane has increased the frequency of transitway vehicle breakdowns; over 95% of the disabled vehicles on the transitway are carpools.



## Criteria for Judging the Success of the Carpool Experiment

Prior to allowing carpools onto the transitway, both the State Department of Highways and Public Transportation and the Metropolitan Transit Authority of Harris County agreed upon a set of criteria to use in evaluating the success of the carpool experiment. Each criterion is addressed in this report. Table 6 in the report presents the criteria and the basis for their evaluation. Each criterion can be rated as "highly successful," "successful," "unsuccessful," or "highly unsuccessful." In the overall evaluation, the individual criterion are weighted, and a numerical value is assigned; "highly successful" is considered to be a 4, with "highly unsuccessful" considered to be a 1. Thus, a 2.5 would represent a neutral evaluation, midway between "unsuccessful" and "successful."

Data have been collected in April 1986, April 1987, October 1987, and October 1988 that permit analysis, based on the criteria shown in Table 6, of the success of the carpool experiment. As carpool volumes have increased on the transitway, the success of the experiment has also increased. In April 1986 the experiment was rated a 2.63 (between "successful" and "unsuccessful"); in April 1987, and October 1987 the experiment was rated 3.2, and 3.3, respectively (between "successful" and "highly successful"). In October 1988, the experiment was rated a 2.9 (just below successful). The data for these four analyses are summarized in Table S-1. More detailed data for the October 1988 analysis are shown in Table S-2.

The 42-month evaluation shows that the past success of the carpool experiment has increased the transitway travel times, thereby reducing the success of the facility. The travel time increase is a result of vehicular volumes approaching or exceeding the capacity of the transitway, reducing the travel speeds and trip reliability.

Table S-1. Overall Evaluation of Katy Transitway Carpool Experiment,  
April 1986, April 1987, October 1987, and October 1988

Criterion	Relative Weighting	Conclusion Pertaining to Experiment			
		April 1986	April 1987	October 1987	October 1988
1. Change in Person Movement on the transitway Directly Attributable to Carpooling	25%	2.5	4	4	4
2. Non-User Perception of Katy Transitway Utilization	30%	1	2	3	3
3. Change in Travel Time on the Transitway	20%	4	4	3	1
4. Change in Delay to Mixed-Flow Traffic	15%	4	4	4	4
5. Increase in Frequency of Transitway Breakdowns	5%	3	1	1	1
6. Increase in Authorization and Enforcement Costs	5%	3	3	3	3
Total	100%	2.63	3.20	3.30	2.90

Scoring:  
 1 - Highly Unsuccessful  
 2 - Unsuccessful  
 3 - Successful  
 4 - Highly Successful

Table S-2. Overall Evaluation of Katy Transitway Carpool Experiment,  
42 Months After Carpools Were Allowed onto the Transitway

Criterion	Relative Weighting	Conclusion Pertaining to Experiment	Relevant Data
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	"Highly Successful"	Carpools move 68-70% of total peak period person movement
2. Non-User Perception of Katy Transitway Utilization	30%	"Successful"	Just over 50% of non-users feel the transitway is sufficiently utilized.
3. Change in Travel Time on the Transitway	20%	"Highly Unsuccessful"	Average transitway speeds have decreased by 7 mph.
4. Change in Delay to Mixed-Flow Traffic	15%	"Highly Successful"	Mixed flow speeds have increased slightly.
5. Increase in Frequency of Transitway Breakdowns	5%	"Highly Unsuccessful"	Approximately 95% of transitway vehicle breakdowns are carpools. Approximately 5 breakdowns occur per week.
6. Increase in Authorization and Enforcement Costs	5%	"Successful"	Marginal increase in costs due to carpools has not been substantial.
Total	100%	Between "Successful" and "Highly Successful"	



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## SECTION 1 INTRODUCTION

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In an effort to improve the people moving capacity of major freeway corridors, a number of high-occupancy vehicle (HOV) facilities have been implemented in the Houston area in recent years. These facilities attempt to move more people through congested corridors by offering travel time savings and trip reliability to vehicles with high occupancies. This is achieved by constructing a barrier separated, reversible HOV lane, known as a transitway, in the freeway median. Only vehicles with the required number of occupants are permitted to use the transitway.

In October 1984, the first 4.7 miles (Phase 1) of the Katy Freeway I-10 Transitway became operational. The implementation of the Katy Transitway was a joint effort of the Metropolitan Transit Authority of Harris County (Metro) and the Texas State Department of Highways and Public Transportation (SDHPT). Since its opening, the Katy Transitway has been expanded to 11.5 miles and has been found to carry the equivalent of two to three general purpose freeway lanes of people during the peak hour. A map of the Katy Transitway is shown in Figure 1.

When the transitway began operation, only buses and vanpools which had been authorized by Metro and SDHPT were allowed access to the transitway. However, in order to address a perception that the transitway was underutilized, it was opened to carpool use in April 1985. While allowing carpools onto the priority lane represented a means to increase the transitway vehicular volume, the following concerns were associated with such an action.

- 1) Carpools might simply attract riders away from buses or vans, thereby moving the same number of people in a greater number of vehicles.

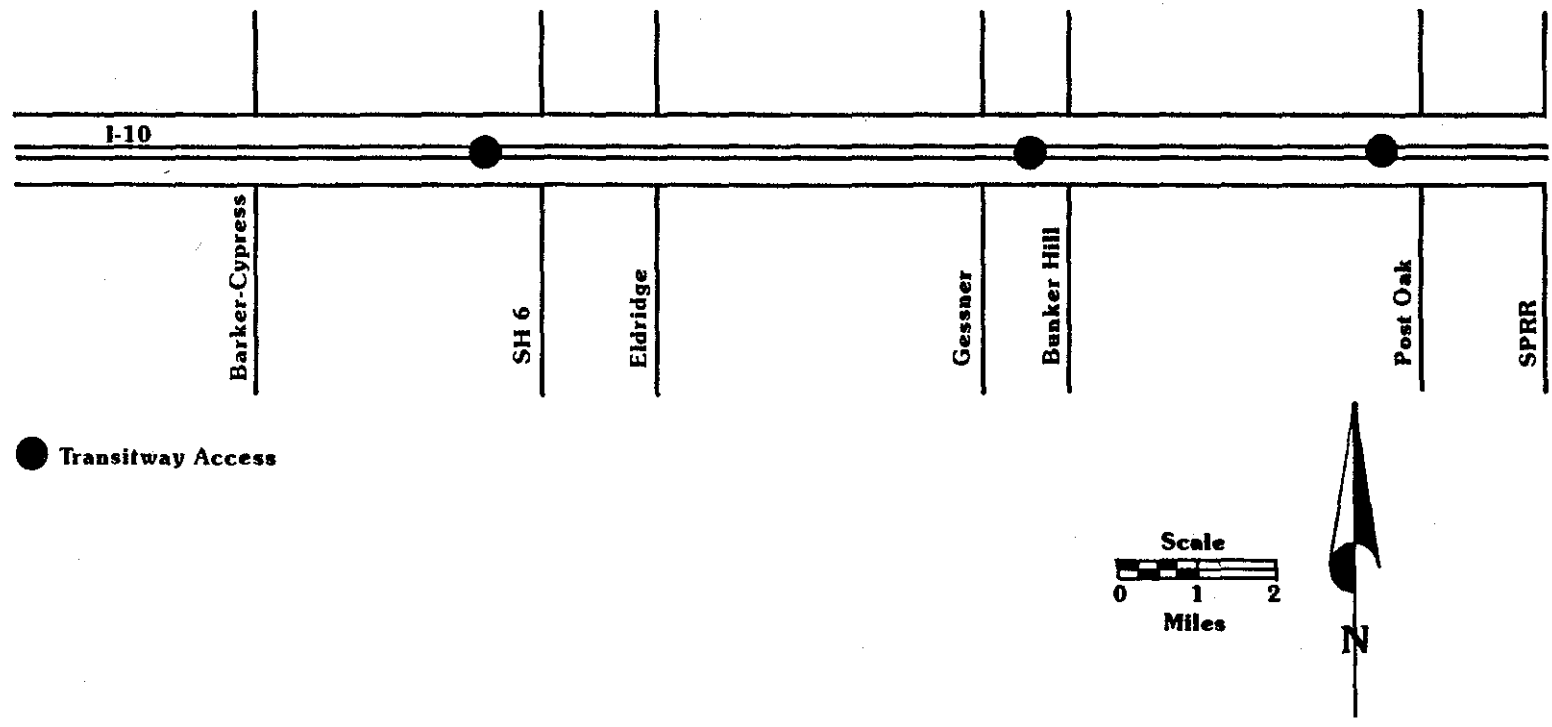


Figure 1. Katy Transitway Corridor

- 2) Introduction of carpools might cause transitway capacity to be exceeded, thereby adversely impacting the level-of-service that is so important to transitway operation.
- 3) If carpool volumes were restricted sufficiently to assure a high level-of-service on the transitway, the increase in vehicles using the facility might not be great enough to change the perception that the transitway is underutilized.
- 4) Increased carpool volumes might result in an increase in vehicle breakdowns, thereby reducing the travel time reliability attribute of the transitways.
- 5) Other safety related concerns might develop.

Since the Katy Freeway Transitway was the first of several transitways being developed in Houston, and the first to permit carpool use, Metro and SDHPT sponsored a Texas Transportation Institute (TTI) research effort to assess the impacts of allowing carpools to use the transitway.

To undertake this assessment, major data collection efforts have been conducted on several occasions. Data were first collected in March 1985 before carpools used the transitway. Data were also collected in April through July 1986, approximately one year after carpools were allowed onto the transitway, in October 1987, 2.5 years after carpools began using the transitway, and in October 1988, 3.5 years after carpools began using the transitway. In this report, the collected information is combined and evaluated to assess the impact of carpools on the operation of the transitway and freeway, 3.5 years after carpools were first allowed onto the transitway.

This study addresses the period through October 15, 1988. The impacts of the change to 3+ during portions of the morning peak are not addressed in this study. Other TTI research (Research Report 1146-1) addresses the impacts of the 3+ restriction.

### **Types of Data Collected**

TTI has conducted periodic volume counts on the Katy Freeway at Bunker Hill since June 1983, and at Eldridge since September 1985. These manual counts classify vehicles according to type and occupancy and are the source of all vehicular volumes used in this report. TTI has also conducted travel time studies on both the freeway and transitway, from the transitway's western terminus to the Southern Pacific Railroad underpass near Washington Avenue. These are used to compare speeds and travel times along the corridor.

The accident data for the Katy Freeway mainlanes are obtained from the Department of Public Safety, and selected data dealing with transitway operations (vehicles breakdowns, violations, etc.) are obtained from Metro.

### **Previous Research Reports**

A number of TTI research reports have addressed carpool utilization of the Katy Freeway (1-11). This report is the eleventh research report prepared as part of this study. No attempt is made in this report to include all the relevant material presented in the previous reports. Some pertinent data from previous reports are used in this report to draw conclusions concerning the impacts of allowing carpools onto the transitway.

### **Organization of This Report**

Following this introductory section, Section 2 describes trends in utilization on the Katy Transitway. Section 3 restates the criteria to be used in evaluating the "success" of the transitway carpool experiment. Each criterion is addressed individually in Sections 4 through 9. Conclusions are presented in Section 10.

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## SECTION 2

# KATY TRANSITWAY UTILIZATION

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The Katy Freeway Transitway began initial operation on October 29, 1984. Since that time, the Katy Transitway has experienced several modifications in its geometrics and operations. Significant modifications include those which affected the transitway length, the types of vehicles permitted to use the transitway, and the hours of operation. Table 1 provides an overview of the historical development of the transitway.

### Background on Katy Transitway Carpool Utilization

Only authorized buses and vanpools were allowed to use the facility during the first 5 months of operation (October 1984 through March 1985). During this period, the public developed a perception that the transitway was underutilized. In order to address this perception, Metro and SDHPT made a decision to allow carpools to use the transitway on a trial basis and, thereby, increase the volume of vehicles on the facility. Carpool operation began on April 1, 1985 and was initially restricted to authorized automobiles carrying four or more persons. In order to become authorized, carpools had to have:

- 1) Certified drivers;
- 2) A valid Texas vehicle inspection sticker no more than 6 months old;
- 3) The minimum state insurance coverage;
- 4) Some familiarity with the transitway geometrics before actually driving in the facility; and
- 5) Passed a visual inspection of the vehicle by Metro.

An authorized carpool was not permitted on the transitway if it had fewer than four persons on any given day, regardless of an individual's reasons for not being in the carpool. This carpool definition was structured to ensure maximum passenger occupancy for the



vehicles travelling on the Katy Transitway. Also contributing to the 4+ occupancy decision was a concern that a 3+ carpool designation could possibly generate vehicular volumes beyond the capacity of the transitway, creating unacceptable operating conditions.

Table 1. Katy Transitway Milestone Dates

Date	Operational Length	Vehicles and Occupancy Requirements to Use Transitway	Operating Hours
10/29/84	Transitway opened, Post Oak to Gessner (4.7 miles).	Authorized buses and 8+ vanpools.	5:45 a.m. - 9:30 a.m. 3:30 p.m. - 7:00 p.m.
4/1/85	Same	Authorized buses, VP, and 4+ CP. 4+ for author. and use.	Same
5/2/85	Gessner to West Belt opened (total length- 6.4 miles).	Same	Same
7/29/85	Same	CP-3+ for use, 4+ for authorization.	Same
11/4/85 <sup>1</sup>	Same	CP-3+ for use and authorization.	Same
8/11/86	Same	All buses, VP, and 2+ CP. No authorization requirements.	5:45 a.m. - 11:00 a.m. 2:00 p.m. - 7:00 p.m.
6/29/87	West Belt to S.H. 6 opened (total length- 11.5 miles).	Same	5:45 a.m. - 11:00 a.m. 2:00 p.m. - 8:00 p.m.
7/25/88	Same	Same	4:00 a.m. - 1:00 p.m. 2:00 p.m. - 10:00 p.m.
10/17/88	Same	All buses, VP, and 2+ CP. 3+ CP only from 6:45 a.m. to 8:15 a.m.	Same

Notes:

1 - Official date of 3+ authorization. Actual 3+ authorization began in 9/85.

Access locations:

- Post Oak - flyover ramp (used from 10/29/84 to present).
- Gessner - intermediate slip ramp (used from 10/29/84 to present).
- West Belt - terminal slip ramp (used from 5/2/85 to 6/29/87).
- Addicks Park and Ride - elevated "T" ramp (used from 6/29/87 to present).
- S.H. 6 - terminal slip ramp (used from 6/29/87 to present).

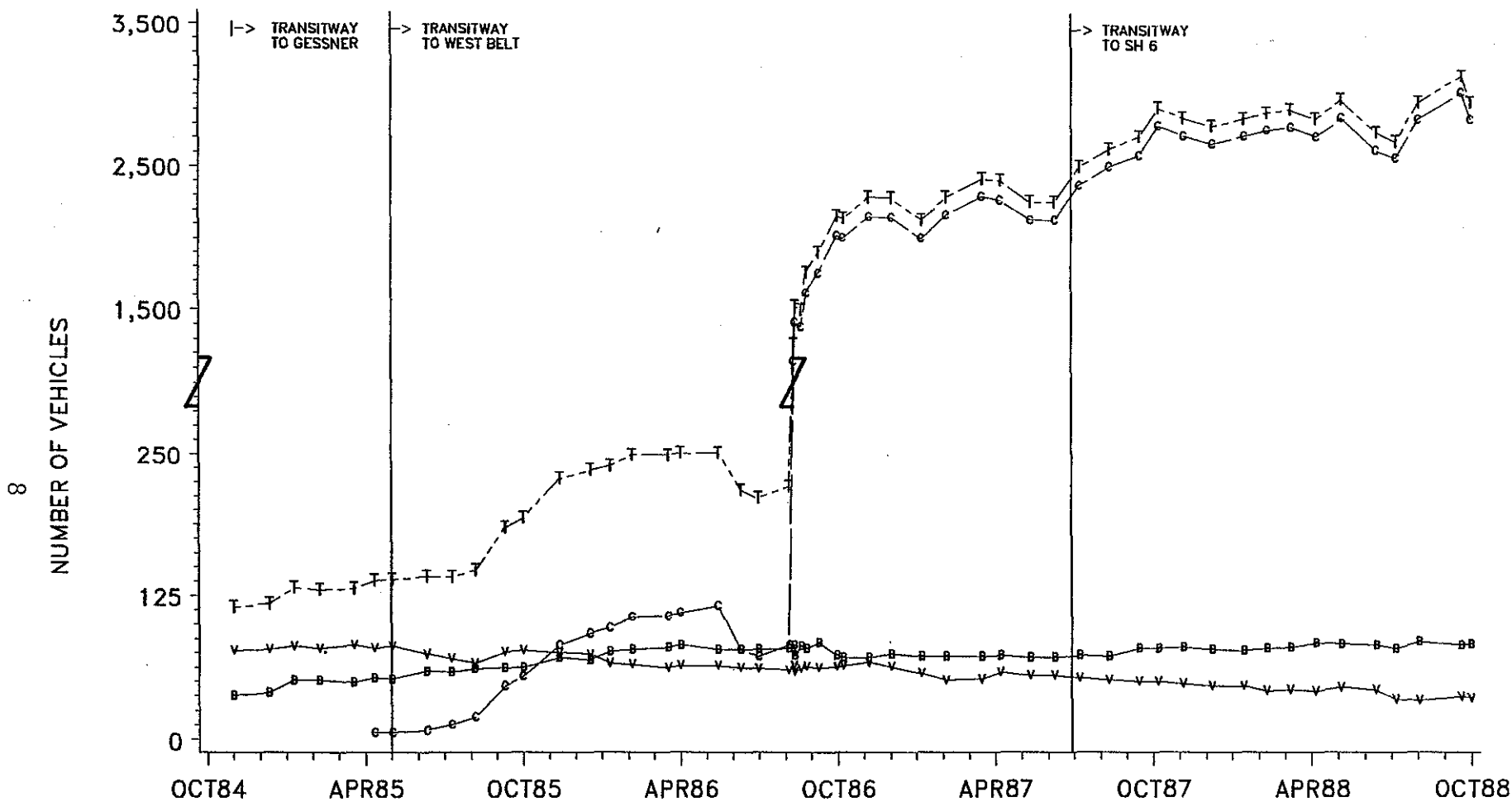
Approximately 30 carpools were authorized to use the transitway in April 1985. However, of these 30 carpools, an average of only 5 carpools actually used the lane during a typical peak period. By July 1985, the number of carpools observed using the transitway had doubled, but absolute demand levels remained extremely low. Consequently, effective July 29, 1985, carpools were permitted to enter the transitway with a minimum of three passengers, although four or more registered passengers were still required to obtain authorization. Less than a month after carpool occupancy requirements were reduced, only nine more carpool trips were being made on the transitway each day. As a result, a decision was made to reduce the minimum authorization requirement from four persons to three persons. Officially, the authorization of 3+ carpools was not to commence until November 4, 1985. However, as early as September, 1985, 3+ carpools had begun to be authorized by Metro and were allowed to travel on the Katy Transitway.

The change allowing 2+ carpools to use the transitway was implemented due to a perception that the transitway was underutilized with 3+ carpools. Beginning August 11, 1986, all carpools with 2 or more occupants were permitted to use the transitway, and all authorization procedures were eliminated. As a result of this change, there was an immediate increase in transitway carpool volumes. These carpool volumes continued to increase and, by October 1988, the transitway was experiencing a reduction in the inbound level-of-service. Therefore, on October 17, 1988 the occupancy requirement for carpools was raised to 3+ between 6:45 a.m. and 8:15 a.m., but remained at 2+ during all other times. This change in occupancy requirement occurred after the data for the 42-month evaluation had been collected. As a result, the 3+ restriction is not specifically addressed in this report, but has been evaluated in other TTI reports (Research Report 1146-1).

### **Trends in Katy Transitway Utilization**

Trends in average peak-period transitway utilization are shown in Figures 2 through 5. In October 1988, on a daily basis prior to the morning 3+ restriction, buses represented 3 percent of vehicles using the transitway and moved 26 percent of the people; vanpools were 1 percent of vehicles and moved 3 percent of people; carpools were 96 percent of the vehicles and moved 71 percent of the people. Carpools have become the dominant mode of transitway person movement since 2+ vehicles were allowed to use the transitway.

KATY FREEWAY (IH 10W) TRANSITWAY  
A.M. PEAK PERIOD TRANSITWAY VEHICLE UTILIZATION

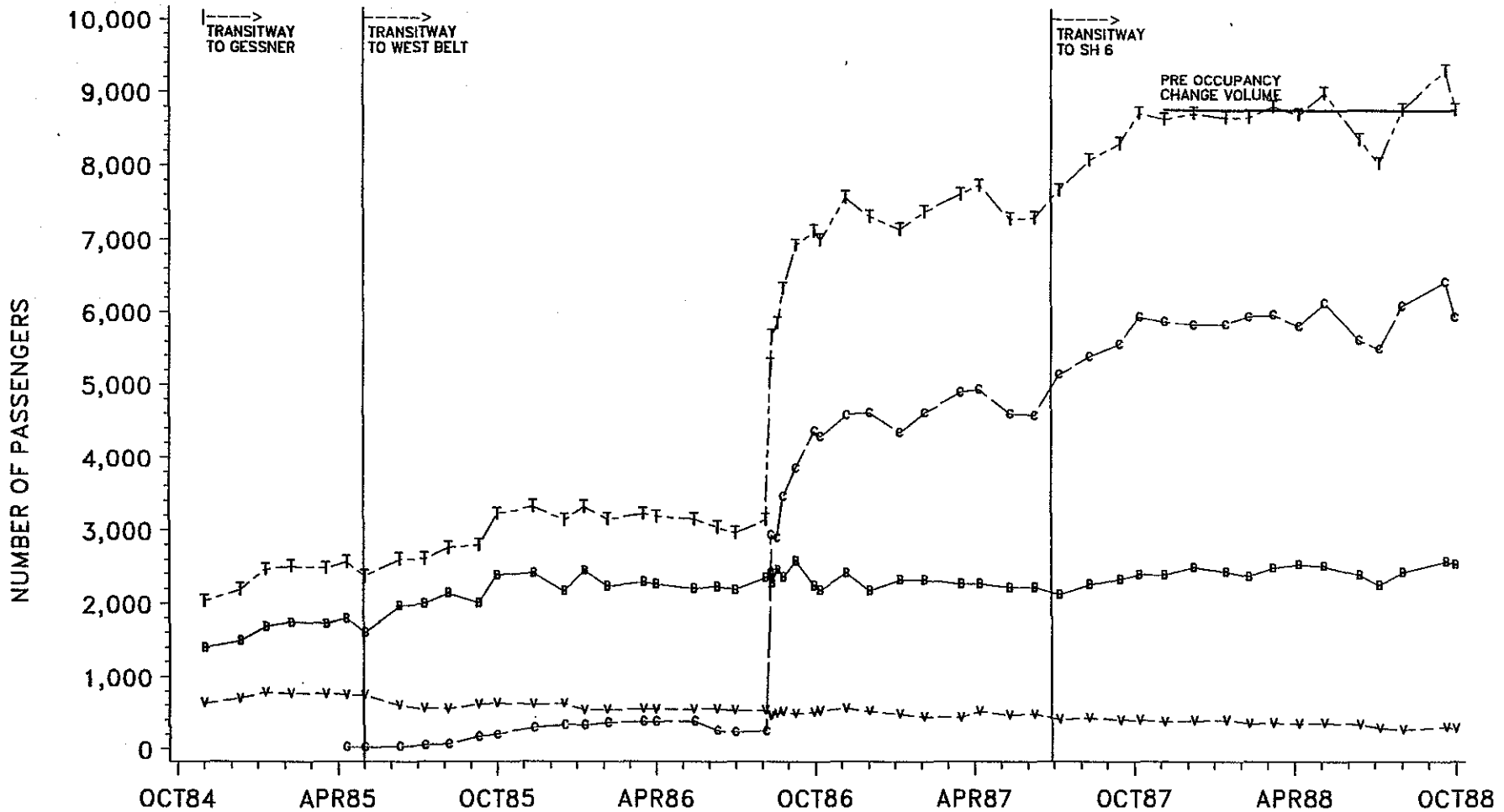


KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
 3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988  
 PEAK PERIOD IS 6:00 - 9:30 A.M.  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV VEHICLES  
 B = TOTAL BUSES  
 V = TOTAL VANPOOLS  
 C = TOTAL CARPOOLS

Figure 2. A.M. Peak Period Transitway Vehicle Utilization

KATY FREEWAY (IH 10W) TRANSITWAY  
A.M. PEAK PERIOD TRANSITWAY PERSON MOVEMENT

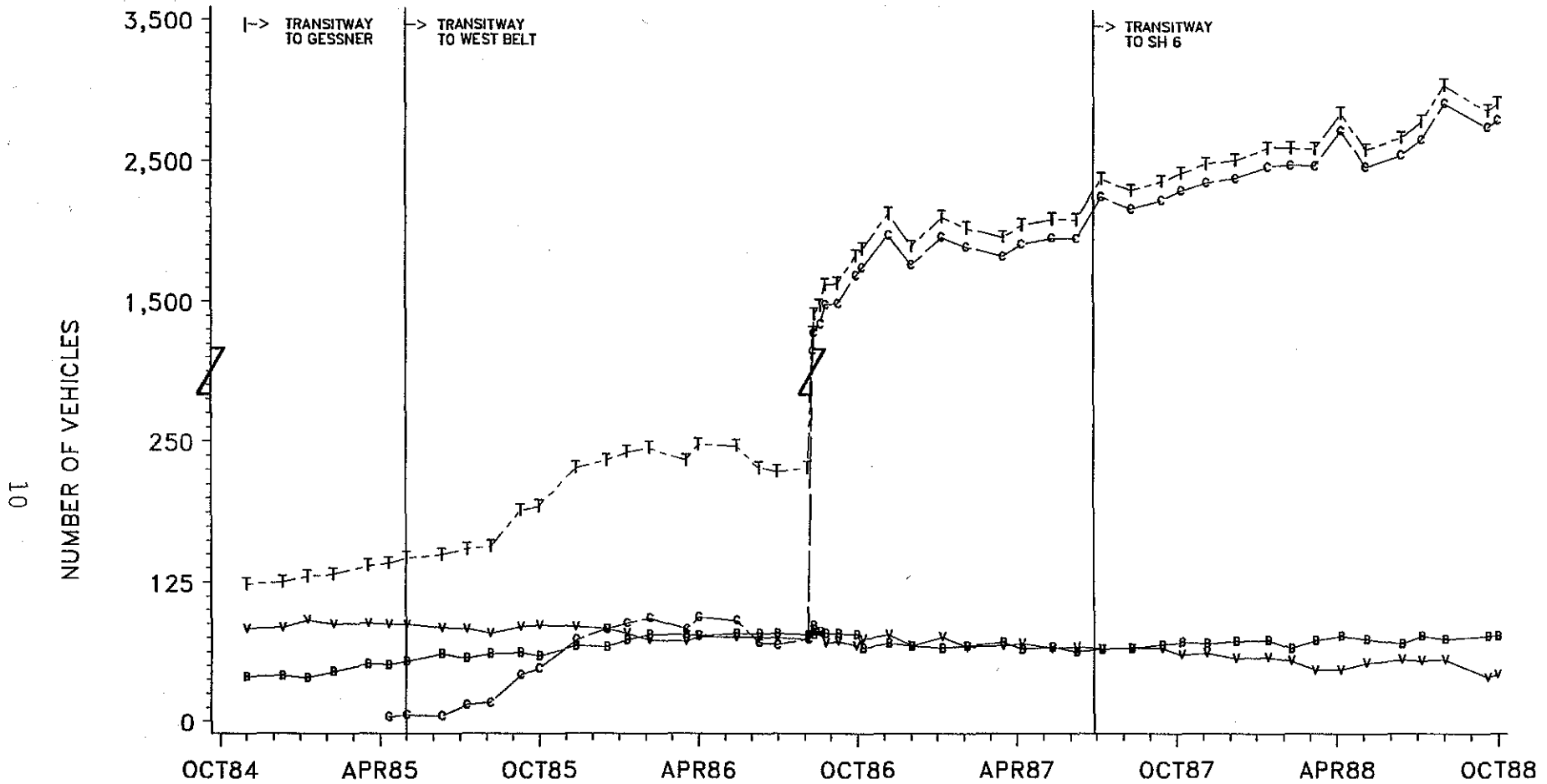


KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
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 3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988  
 PEAK PERIOD IS 6:00 - 9:30 A.M.  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV PASSENGERS  
 B = TOTAL BUS PASSENGERS  
 V = TOTAL VANPOOLERS  
 C = TOTAL CARPOOLERS

Figure 3. A.M. Peak Period Transitway Person Movement

KATY FREEWAY (IH 10W) TRANSITWAY  
P.M. PEAK PERIOD TRANSITWAY VEHICLE UTILIZATION

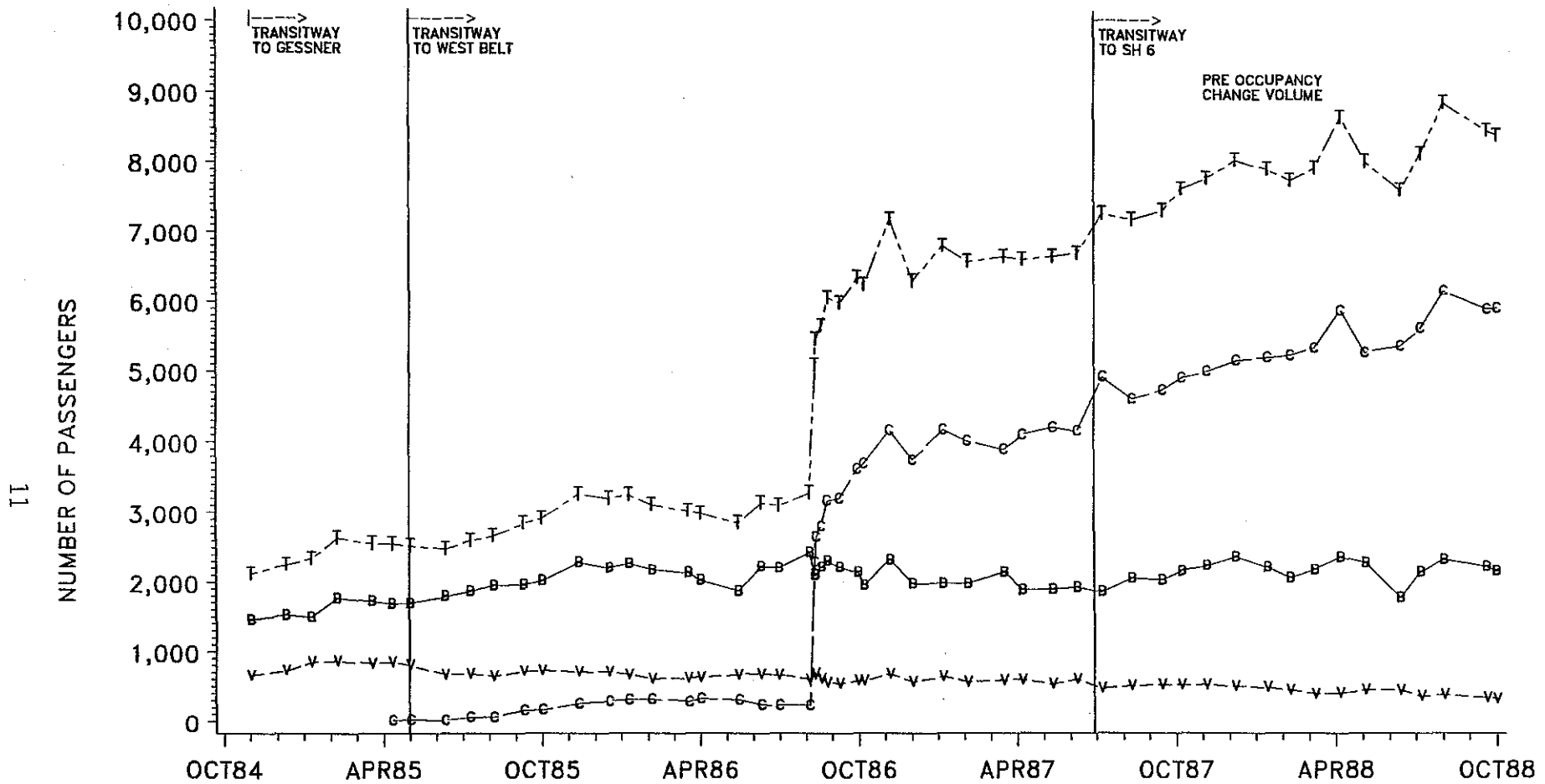


KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
 PEAK PERIOD IS 3:30 - 7:00 P.M.  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV VEHICLES  
 B = TOTAL BUSES  
 V = TOTAL VANPOOLS  
 C = TOTAL CARPOOLS

Figure 4. P.M. Peak Period Transitway Vehicle Utilization

### KATY FREEWAY (IH 10W) TRANSITWAY P.M. PEAK PERIOD TRANSITWAY PERSON MOVEMENT



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
 PEAK PERIOD IS 3:30 - 7:00 P.M.  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL HOV PASSENGERS  
 B = TOTAL BUS PASSENGERS  
 V = TOTAL VANPOOLERS  
 C = TOTAL CARPOOLERS

Figure 5. P.M. Peak Period Transitway Person Movement

Data pertaining to daily transitway utilization are summarized in Table 2. Since carpools were initially allowed onto the transitway, bus passenger volumes have increased by 40 percent, and vanpool person volumes have decreased by 61 percent. The vanpool decline appears to be more a function of the downturn in the Houston economy than it is the introduction of carpools; this conclusion is supported subsequently where the previous mode is documented for transitway carpools.

Table 2. Trends in Daily Utilization of the Katy Transitway

Transitway Vehicle Type	Volume					Percent Change	
	11/84 <sup>1</sup>	3/85 <sup>2</sup>	4/86 <sup>3</sup>	10/87 <sup>4</sup>	10/88	3/85 to 10/88	10/87 to 10/88
Buses							
Vehicles	78	100	160	156	166	+66%	+6%
Passengers	2,860	3,450	4,302	4,685	4,830	+40%	+3%
Vanpools							
Vehicles	160	170	140	112	79	54%	-29%
Passengers	1,304	1,596	1,180	942	623	61%	-34%
Carpools							
Vehicles	0	0	204	5,466	6,227	---	+14%
Passengers	0	0	706	11,716	13,042	---	+11%
Total							
Vehicles	238	270	504	5,734	6,472	2297%	+13%
Passengers	4,164	5,046	6,188	17,343	18,495	+267%	+7%

<sup>1</sup>First full month of transitway operation.

<sup>2</sup>Month before carpools were allowed onto the transitway.

<sup>3</sup>Data from 12-month evaluation report (Research Report 484-3).

<sup>4</sup>Data from 30-month evaluation report (Research Report 484-3).

Source: Texas Transportation Institute Counts.

An overall assessment of trend data in the Katy corridor is shown in Table 3. This table compares conditions in the corridor prior to implementation of the transitway (1984) with conditions in the corridor during 1987 and 1988. The transitway has been successful in increasing total person throughput and average vehicle occupancy.

Table 3. Comparison of Travel Conditions in the Katy Freeway Corridor  
Prior to Transitway Implementation and in 1987 and 1988, A.M. Peak Period, Peak Direction

Type of Data	"Representative Value"		
	1984 <sup>1</sup>	1987 <sup>2</sup>	1988 <sup>3</sup>
<u>Transitway Data</u>			
Person-Movement			
Peak Hour (7-8 a.m.)	----	4,252	4,569
Peak Period (6-9:30 a.m.)	----	8,369	9,341
Total Daily	----	16,737	9,950
Vehicle Volumes			
Peak Hour	----	1,364	1,531
Peak Period	----	2,719	3,146
Accident Rate (Accidents/MVM)	----	0.96	1.06
Vehicle Breakdowns (VMT/Breakdown)	----	29,000	37,570
Violation Rate	----	1%	1%
<u>Combined Freeway and Transitway Data</u>			
Total Person Movement			
Peak Hour	5,100	9,183	8,566
Peak Period	15,655	23,442	25,102
Peak-Hour Vehicle Occupancy	1.26	2.55	1.60
Peak-Period Vehicle Occupancy	1.23	1.38	1.40
Peak-Period Carpool Volumes	1,570	3,300	3,541
Total Peak-Period Vehicle Volume	12,750	16,941	17,985
<u>Freeway Data</u>			
Peak-Period Freeway Vehicle Volume	12,750	14,222	14,839
Peak-Period Freeway Person Volume	15,655	15,073	15,761
Peak-Period Freeway Occupancy	1.23	1.06	1.06
Peak-Period Operating Speed in mph (W. Belt to Wirt)	27	27	22
Accident Rate (Accidents/MVM)	1.34	1.34	1.22
<u>Transit Data</u>			
Vehicles Parked in Park-and-Ride Lots	575	1,250	1,530
Peak-Period Bus Trips	32	90	82
Peak-Period Bus Passengers	900	2,400	2,585

<sup>1</sup>Represents typical pre-transitway conditions.

<sup>2</sup>Represents typical transitway conditions during 2+ carpool operation.

<sup>3</sup>Represents typical transitway conditions prior to morning 3+ carpool restriction, September 1988.

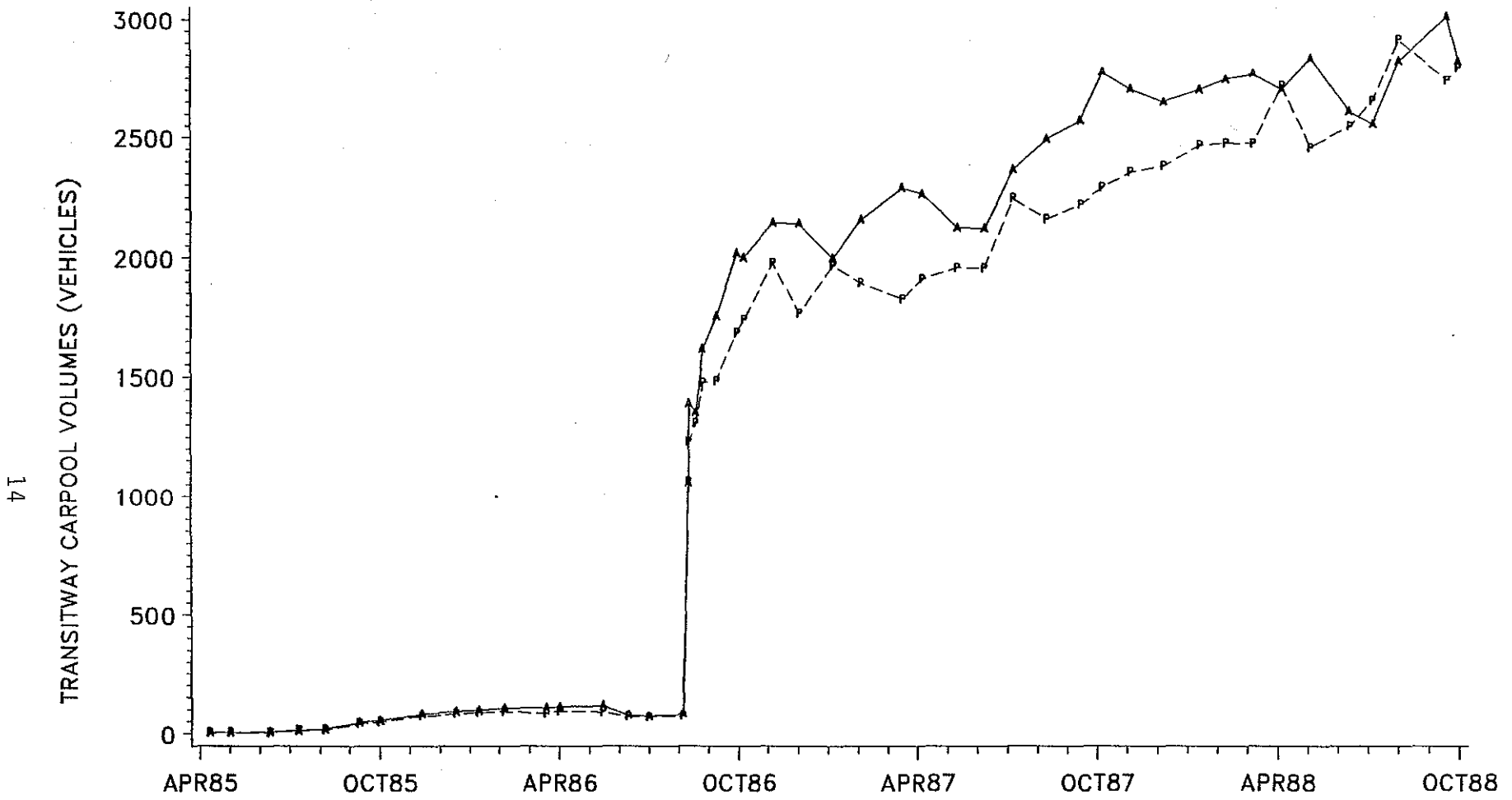
Source: Texas Transportation Institute data collection.

### Carpool Data, Katy Transitway and Selected Other HOV Projects

Trends in carpool utilization are shown in Figures 6 and 7. Morning carpool demand has been higher than the afternoon demand. This may be due to the fact that many of the carpools using the transitway are transporting children to school; thus, their afternoon travel may not coincide with the peak commuter period.



KATY FREEWAY (IH 10W) TRANSITWAY  
PEAK PERIOD TRANSITWAY CARPOOL UTILIZATION



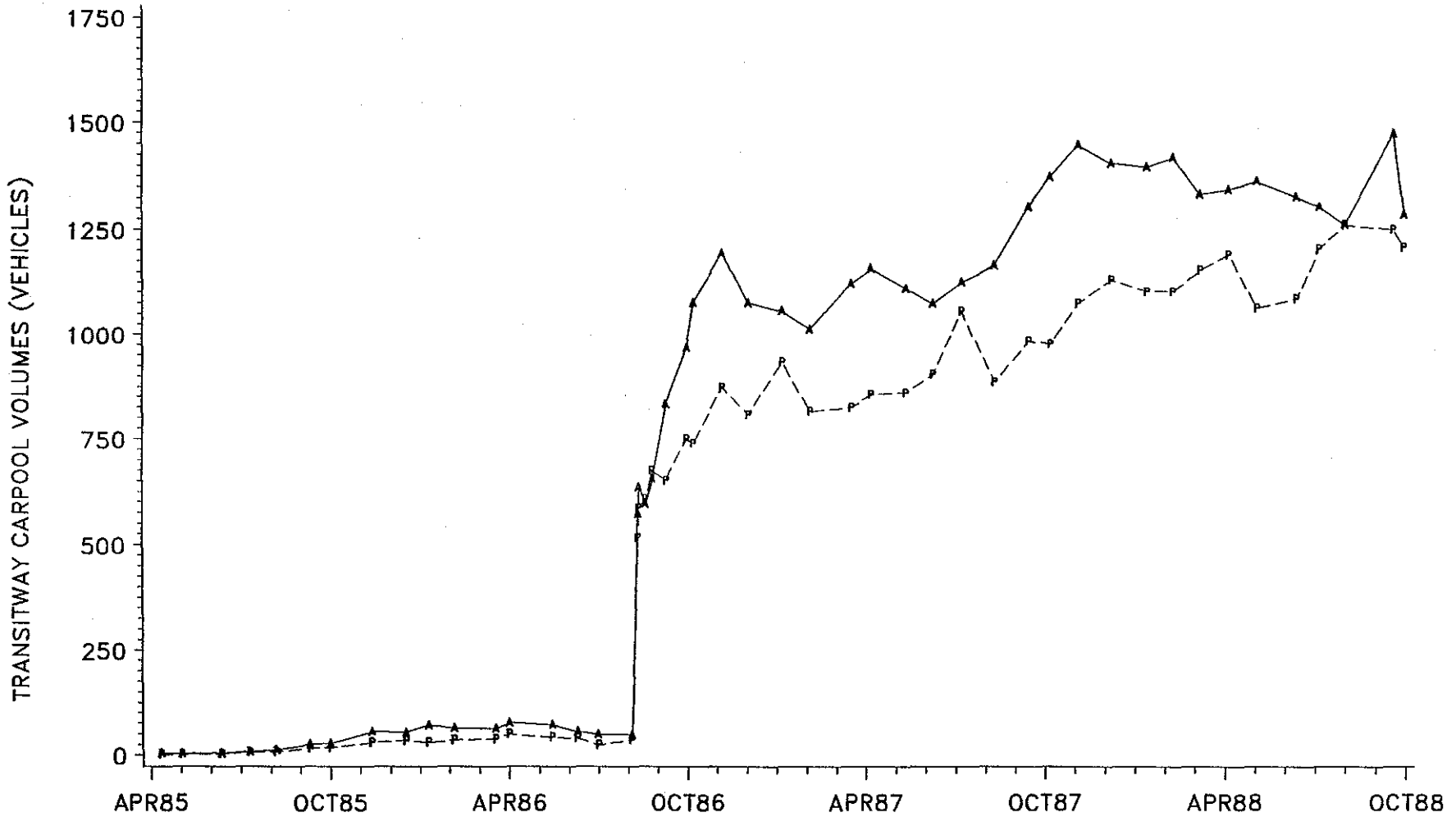
14

AUTHORIZED 4+ CARPOOLS ALLOWED ON TRANSITWAY, APRIL 1, 1985  
 AUTHORIZED 3+ CARPOOLS ALLOWED ON TRANSITWAY, SEPTEMBER, 1985  
 2+ CARPOOLS WITH NO AUTHORIZATION ALLOWED ON TRANSITWAY, AUGUST 1986  
 3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 PEAK PERIOD(S) ARE 6:00-9:30 A.M. & 3:30-7:00 P.M.  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK PERIOD  
 P = P.M. PEAK PERIOD

Figure 6. Peak Period Transitway Carpool Utilization

KATY FREEWAY (IH 10W) TRANSITWAY  
PEAK HOUR TRANSITWAY CARPOOL UTILIZATION



15

AUTHORIZED 4+ CARPOOLS ALLOWED ON TRANSITWAY, APRIL 1, 1985  
 AUTHORIZED 3+ CARPOOLS ALLOWED ON TRANSITWAY, SEPTEMBER, 1985  
 2+ CARPOOLS WITH NO AUTHORIZATION ALLOWED ON TRANSITWAY, AUGUST 1986  
 3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : A = A.M. PEAK HOUR  
 P = P.M. PEAK HOUR

Figure 7. Peak Hour Transitway Carpool Utilization

Since they were permitted to use the transitway, carpools have consistently represented approximately 95 percent of the total transitway vehicular volume and 60 to 70 percent of the total transitway person volume. These trends are illustrated in Figure 8.

### Peak-Hour Carpool Volumes

Table 4 summarizes peak-hour carpool volumes for selected freeway HOV projects in the United States. The Katy Transitway, at approximately 1,300 carpools per peak hour, is presently one of the better used HOV lanes.

Table 4. Carpool Vehicle Volumes on Freeway High-Occupancy Vehicle Lanes

Facility Carpool	Definition	Peak Hour Carpool Volume <sup>1</sup> (vph)
Katy Transitway, Houston	2+	1,292 (a.m.) <sup>2</sup> 1,267 (p.m.) <sup>2</sup>
I-66, Washington, D.C. (2 lanes)	3+	2,980
Shirley (I-395), Washington, D.C. (2 lanes)	4+	2,165
Rte. 91, Los Angeles	2+	1,370
I-95, Miami	2+	1,370
Rte. 55, Orange County	2+	1,250
El Monte, Los Angeles	3+	905
I-4, Orlando	2+	900
I-495, Lincoln Tunnel, N.Y.C.	buses only	740 buses
I-5, Seattle	3+	400
US 101, San Francisco	3+	360
SR 520, Seattle	3+	250

Notes:

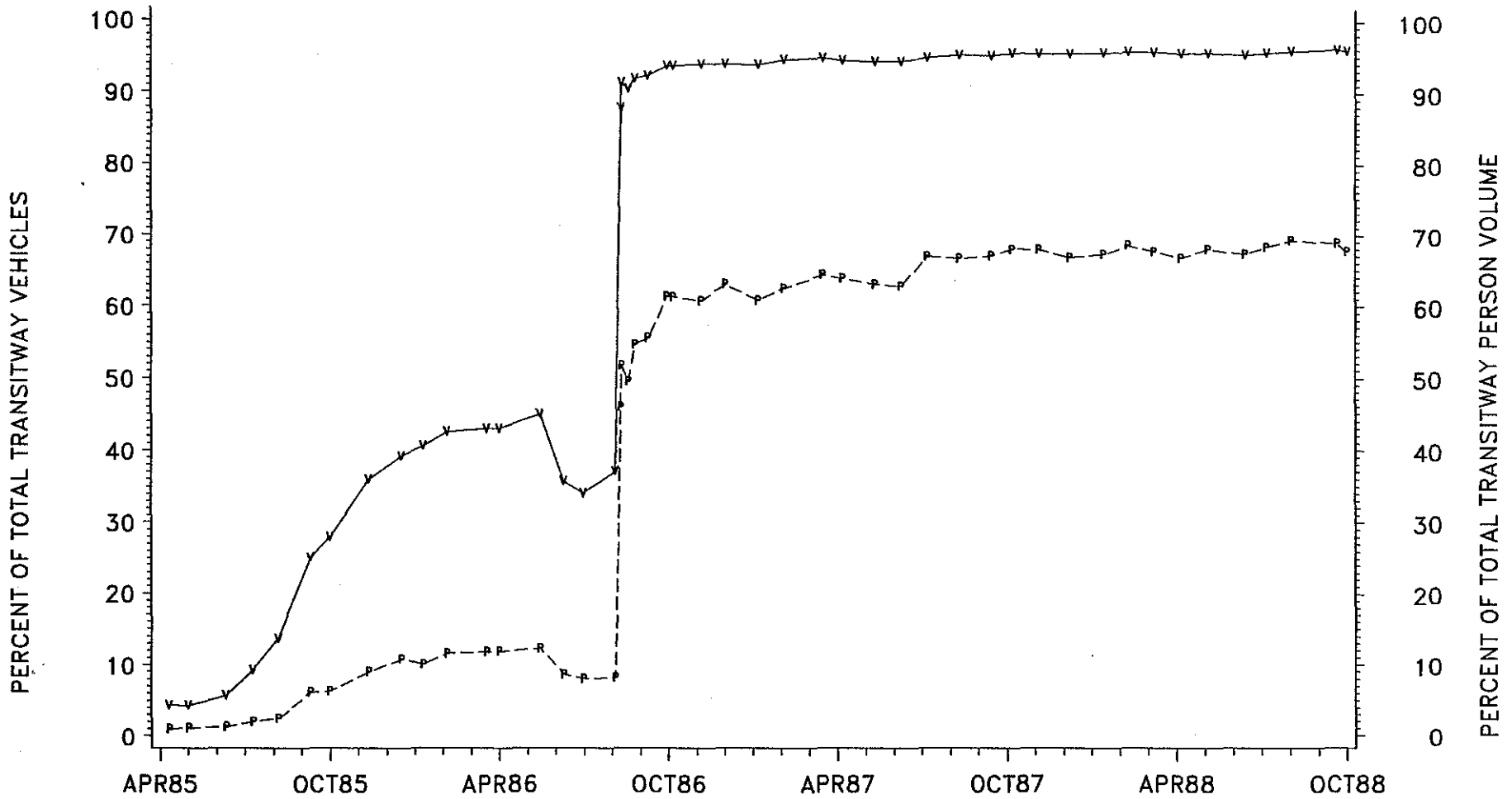
<sup>1</sup> Including autos in HOV lane in violation of HOV occupancy requirements.

<sup>2</sup> 2+ vehicles with no authorization

Sources: TTI Analyses and 1985 ITE Survey of HOV Projects.

The high peak hour volumes on some HOV lanes create the need to determine an appropriate capacity level. A consensus of the agencies involved in operating freeway HOV lanes is that the capacity of these lanes is somewhere in the range of 1,000 to 1,500 vehicles per hour per lane (TTI Research Report 484-3). As evaluated in TTI Research Report 484-6, it appears that 1,500 vehicles per hour is representative of the capacity of the Katy Transitway.

KATY FREEWAY (IH 10W) TRANSITWAY  
 A.M. PEAK PERIOD CARPOOL VOLUMES AS A PERCENT OF TOTAL KATY TRANSITWAY VOLUMES



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
 3+ CARPOOL REQUIREMENT FROM 6:45 TO 8:15 A.M. IMPLEMENTED OCTOBER 17, 1988  
 DATA COLLECTED BETWEEN GESSNER AND POST OAK 6:00 TO 9:30 A.M.  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : V = TOTAL VEHICLES  
 P = TOTAL PERSONS

Figure 8. Transitway Carpools as a Percent of Total Transitway Travel, A.M. Peak Period

By the fall of 1988, transitway volumes were approaching and sometimes exceeding 1,500 vehicles per hour. As a result, the transitway was operating at the capacity boundary, causing travel times and trip reliability to suffer. Therefore, the morning 3+ restriction was implemented, and vehicular demand has been reduced to a level below capacity. The impacts of this change are addressed in other TTI reports (Research Report 1146-1).

### **Increase in Carpooling Due to Transitway Implementation**

Typically, allowing carpools to use an HOV lane increases the total volume of carpools on the freeway. With the introduction of 2+ carpools, this has also occurred on the Katy Freeway.

Extensive carpool data have been collected on the Katy Freeway since 1983. These data are summarized in Figures 9 and 10. It is apparent that, particularly since carpools were allowed onto the transitway, the increase in carpooling has at least been similar to that experienced on the other projects shown in Table 5.

The data in Table 5 indicate that, up to the implementation of the 3+ restriction during portions of the morning period, carpooling on the Katy Freeway in the a.m. peak period has increased 124 percent since the inception of the transitway.

Surveys were conducted in March 1987, October 1987, and November 1988 to determine the origin of carpools. These analyses are summarized in Figure 11. It is apparent that perhaps as much as 55 percent of the carpools using the transitway are "new" carpools (sum of previous mode being either "drove alone" or "did not make trip").

Table 5. Estimated Increases in Carpool Volumes Due to HOV Lane Implementation

Facility	Carpool Volume Before HOV	Carpool Volume After HOV <sup>1</sup>	Percent Change
Katy Transitway, Houston (1983-1988) a.m. peak period (6:00-9:30)	1570	3541 <sup>2</sup>	+ 126%
El Monte, Los Angeles (1976-1985) a.m. peak period	670	2166	+ 323%
Rte. 91, Los Angeles (4 mo. in 1985) p.m. peak hour	1000	1350	+ 35%
Rte. 55, Orange Co. (1984-6) a.m. peak period	1341	1916	+ 43%
p.m. peak period	1925	2473	+ 28%
I-95, Miami (1976-1984) a.m. peak period	2185	2714	+ 24%
Shirley Highway, Washington, D.C. a.m. peak period (1974-1985)	272	3723	+1269%
I-93, Boston (1974-1980) a.m. peak period	315	1224	+ 289%
Banfield Fwy., Portland, Ore. a.m. peak period	106	518	+ 389%
Moanalua Fwy. (1974-1982) a.m. peak period	600	1750	+ 192%

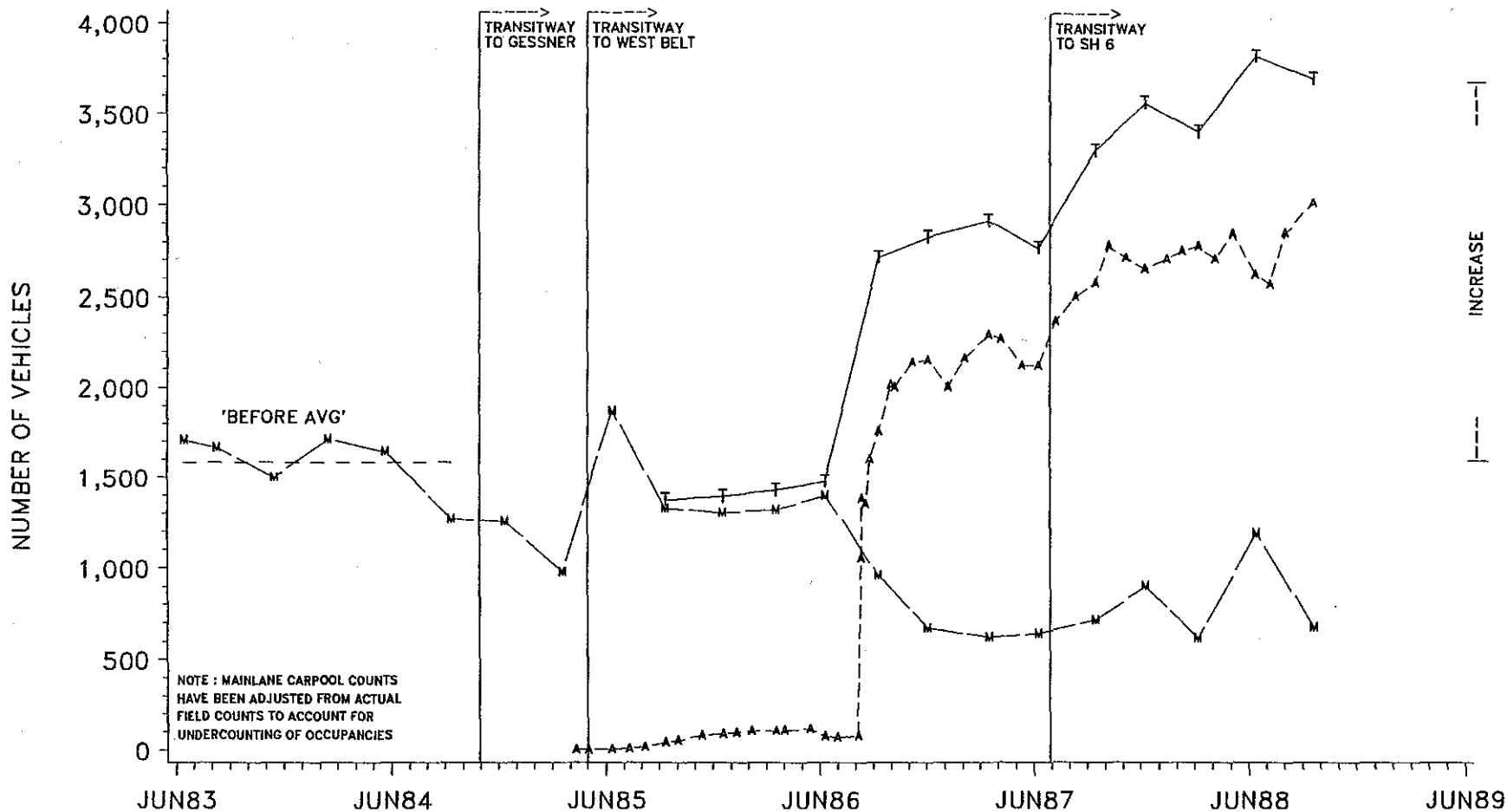
Notes:

<sup>1</sup> Freeway plus HOV lane volume.

<sup>2</sup> 2+ vehicles with no authorization, September 1988

Sources: TTI Analyses, ITE 1985 Survey of Operating HOV Projects, and "Study of Current and Planned High-Occupancy Vehicle Lane Use: Performance and Prospects", by Frank Southworth and Fred Westbrook, 1985.

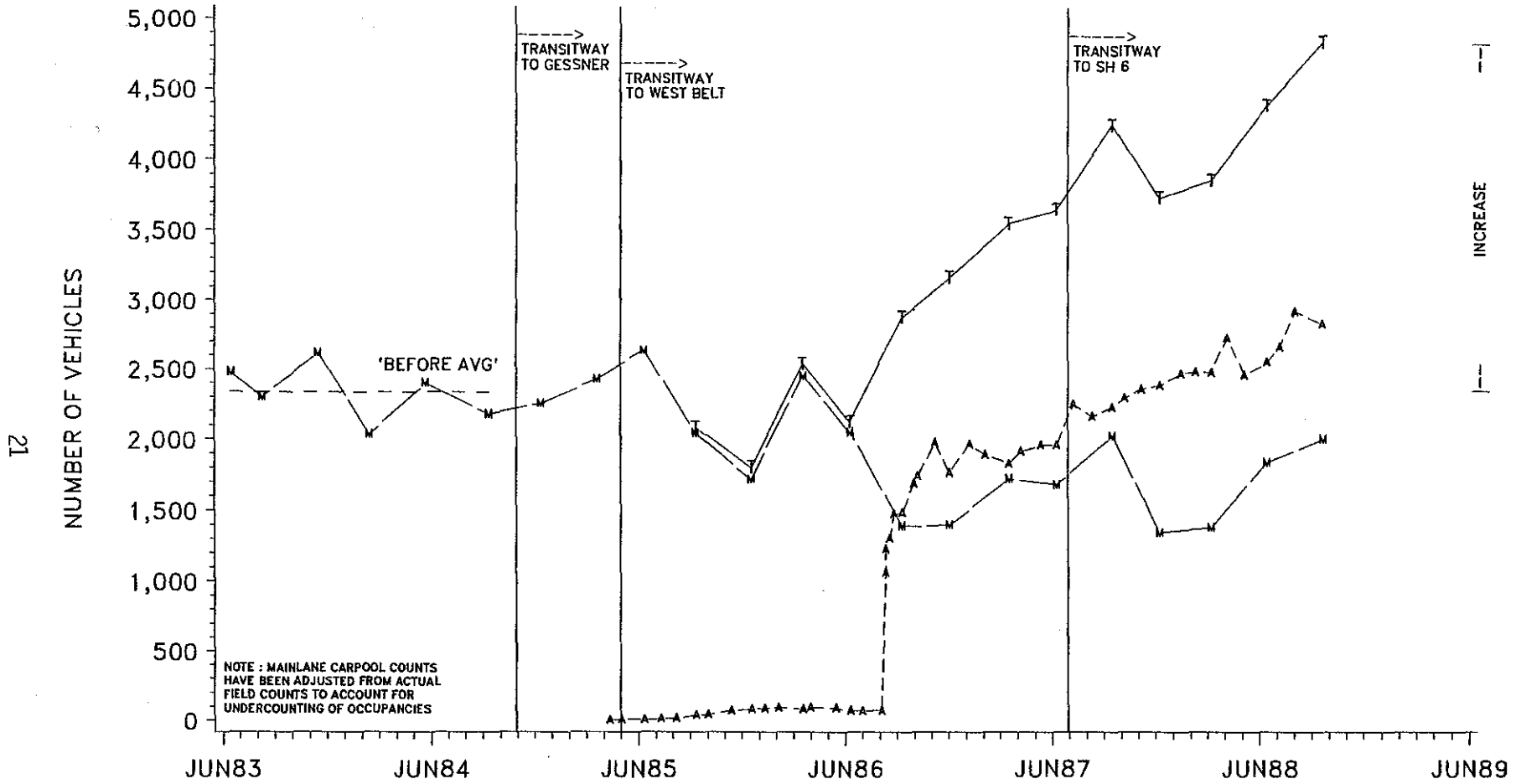
KATY FREEWAY (IH 10W) MAINLANE AND TRANSITWAY  
 A.M. PEAK PERIOD 2+ CARPOOL UTILIZATION  
 DATA COLLECTED EASTBOUND OVER BUNKER HILL



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
 TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
 OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
 TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
 PEAK PERIOD IS 6:00 - 9:30 AM  
 SOURCE : TEXAS TRANSPORTATION INSTITUTE

Figure 9. Increases in Carpooling in the A.M. Peak Period.

KATY FREEWAY (IH 10W) MAINLANE AND TRANSITWAY  
P.M. PEAK PERIOD 2+ CARPOOL UTILIZATION  
DATA COLLECTED WESTBOUND OVER BUNKER HILL



KATY TRANSITWAY PHASE 1, POST OAK TO GESSNER (4.7 MI.), OPENED OCTOBER 29, 1984  
TRANSITWAY EXTENSION FROM GESSNER TO WEST BELT (1.7 MI.) OPENED MAY 2, 1985  
OFF-PEAK, UNAUTHORIZED & 2+ CARPOOL OPERATION BEGAN AUGUST 11, 1986  
TRANSITWAY EXTENSION FROM WEST BELT TO SH 6 (5.0 MI.) OPENED JUNE 29, 1987  
PEAK PERIOD IS 3:30 - 7:00 PM  
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL 2+ CARPOOLS  
A = TOTAL TRANSITWAY 2+ CARPOOLS  
M = TOTAL MAINLANE 2+ CARPOOLS

Figure 10. Increases in Carpooling in the P.M. Peak Period



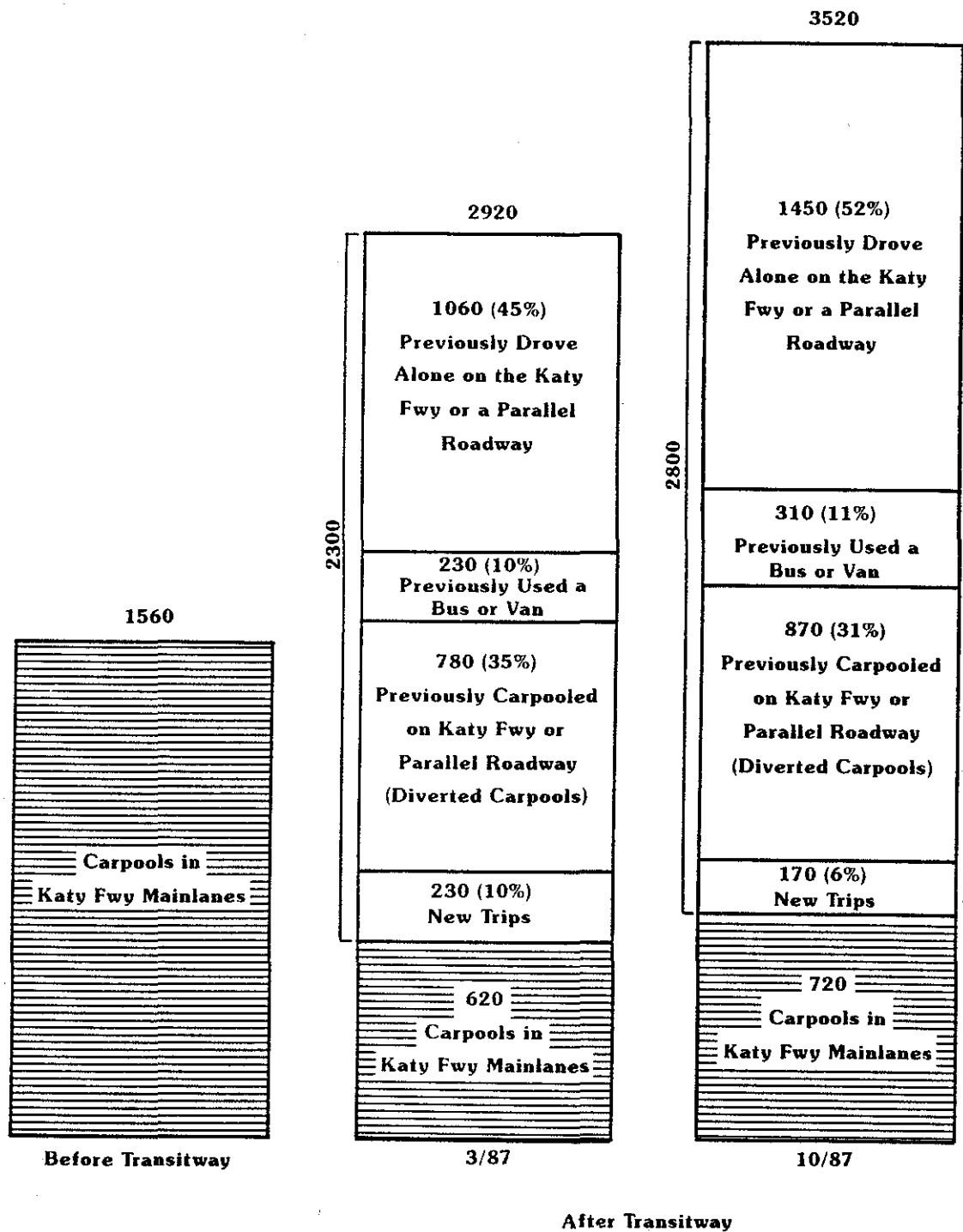


Figure 11. A.M. Peak Period Carpool Volumes (Freeway + Transitway) Before and After Transitway

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## SECTION 3

# CRITERIA FOR EVALUATING THE SUCCESS OF THE TRANSITWAY CARPOOL EXPERIMENT

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Allowing carpools to use the Katy Transitway was initiated as an experiment, which would be evaluated on a regular basis to determine the effectiveness of the experiment. Prior to allowing carpools on the transitway, Metro and SDHPT identified the general criteria that would be used to evaluate the success of the carpool experiment. Those criteria were developed and presented in Research Report 484-1 and are repeated in Table 6.

These criteria, and the performance of the carpool experiment in regards to the criteria, are addressed individually in subsequent sections of this report. Included in this presentation is relevant data from the 12-month "after" evaluation conducted in April 1986, the 30-month "after" evaluation conducted in October 1987, and the 42-month "after" evaluation conducted in October 1988 (prior to implementing the 3+ carpool occupancy requirement from 6:45 a.m. to 8:15 a.m.).

Table 6. Criteria for Judging the Success of the Katy Transitway Carpool Experiment

Proposed Evaluation Factor	Relative Weighting	Resulting Impact
1. Change in person movement on the Katy Transitway directly attributable to carpooling	25	<p><u>Highly Successful:</u> Total transitway person movement increases by at least 20% due to carpooling.</p> <p><u>Successful:</u> Person movement increases by between 5% and 20%.</p> <p><u>Unsuccessful:</u> Person movement essentially unchanged (0% to 5% increase)</p> <p><u>Highly Unsuccessful:</u> Person movement decreases.</p>
2. Non-User Perception of Katy Transitway Utilization	30	<p><u>Highly Successful:</u> At least 70% of non-users respond that transitway is sufficiently utilized.</p> <p><u>Successful:</u> Between 50% and 70% of non-users respond that transitway is sufficiently utilized.</p> <p><u>Unsuccessful:</u> Between 50% and 70% of non-users respond that transitway is not sufficiently utilized.</p> <p><u>Highly Unsuccessful:</u> More than 70% of non-users respond that transitway is not sufficiently utilized.</p>
3. Change in average travel time on the Katy Transitway	20	<p><u>Highly Successful:</u> No change.</p> <p><u>Successful:</u> Average travel speed decreases by no more than 3 mph.</p> <p><u>Unsuccessful:</u> Average travel speed decreases by between 3 mph and 6 mph.</p> <p><u>Highly Unsuccessful:</u> Average travel speed decreases by more than 6 mph.</p>
4. Change in person delay to mixed-flow traffic	15	<p><u>Highly Successful:</u> No change or a decrease in total delay.</p> <p><u>Successful:</u> Delay increases by less than 5%.</p> <p><u>Unsuccessful:</u> Delay increases by 5% to 10%.</p> <p><u>Highly Unsuccessful:</u> Delay increases by more than 10%.</p>
5. Increase in frequency of breakdowns on the Katy Transitway	5	<p><u>Highly Successful:</u> None.</p> <p><u>Successful:</u> Less than 5%.</p> <p><u>Unsuccessful:</u> Increase by between 5% and 15%.</p> <p><u>Highly Unsuccessful:</u> Increases by more than 15%.</p>
6. Increase in authorization and enforcement costs	5	<p>Values developed by Metro. Authorization has been eliminated.</p>

In this table, items 1, 3 and 4 indirectly address change in total corridor delay; item 5 indirectly addresses trip reliability.

## SECTION 4 PERSON MOVEMENT IMPACTS OF CARPOOLING

A desired impact of permitting carpools onto the Katy Transitway is to increase the volume of persons moved on the facility. As shown previously (Table 2), carpools are presently moving the majority of persons on the transitway.

### Carpool Component

The percentage of persons moved on the transitway is shown for each vehicle type in Table 7. As can be seen, the carpool component of total person movement has increased significantly over time, particularly since 2+ carpools were allowed onto the transitway.

Table 7. Person Movement on the Katy Transitway

Time Period	Bus		Vanpool		Carpool		Total
	Volume	%	Volume	%	Volume	%	
A.M. Eastbound							
Peak Hour							
April 1986	980	61%	377	23%	261	16%	1618
April 1987	1025	27%	256	7%	2531	66%	3812
October 1987	1200	28%	195	4%	2965	68%	4360
October 1988	1215	38%	240	4%	2375	63%	3830
Peak Period							
April 1986	2270	71%	548	17%	378	12%	3196
April 1987	2300	30%	534	7%	4960	63%	7794
October 1987	2405	27%	400	5%	5956	68%	8761
October 1988	2540	29%	298	3%	5961	68%	8799
P.M. Westbound							
Peak Hour							
April 1986	670	56%	366	30%	166	14%	1202
April 1987	1065	35%	212	7%	1804	58%	3081
October 1987	1175	34%	185	5%	2083	61%	3443
October 1988	1195	28%	92	2%	2543	70%	3830
Peak Period							
April 1986	2032	68%	632	21%	328	11%	2992
April 1987	1895	29%	596	9%	4113	62%	6604
October 1987	2175	29%	521	7%	4925	64%	7621
October 1988	2180	26%	325	4%	5921	70%	8426

Notes:

April 1986 - authorized 3+ carpools were allowed to use the transitway.  
 April 1987, October 1987, and October 1988 - 2+ carpools with no authorization.  
 Peak Periods - 6:00 to 9:30 a.m. and 3:30 to 7:00 p.m.  
 Peak Hour - peak hour for vehicle volumes

These data could lead to a determination that, in October 1988, allowing carpools onto the transitway increased person movement by 210 percent in the a.m. peak period and by 236 percent in the p.m. peak period. However, such conclusions do not consider the fact that some of the carpools used other transitway modes prior to carpooling (Table 8).

Table 8. Prior Use of the Transitway By Carpoolers

Did You Use the Transitway Before Carpooling	Carpool Survey Date				
	10/85	4/86	4/87	10/87	11/88
Yes, Bus	3%	7.1%	7%	8%	6%
Yes, Van	2%	7.1%	2%	1%	1%
No	95%	85.5%	91%	91%	93%

Table 8 suggests that, since 2+ unauthorized carpools were allowed onto the transitway, approximately 7 percent of carpools were drawn from other transitway modes; these trips do not represent an effective increase in transitway person movement due to carpooling. Therefore, in October 1988, carpooling actually increased a.m. peak period person movement by about 170 percent, and p.m. peak period person movement by about 189 percent. The average increase in people movement on the transitway is assumed to be approximately 180 percent for both a.m. and p.m. peak periods.

### Conclusion Pertaining To Evaluation Criterion

The increase in transitway person movement resulting from carpool utilization is a criterion for evaluating the success of the carpool experiment (Table 6). Table 9 summarizes the application of the data to this criterion. As of October 1988, in terms of this evaluation criterion, the experiment is judged to be "highly successful."

Table 9. Transitway Person Movement Impacts of Carpooling, Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	A.M. Peak Period Carpool Person Volume	Est. % Increase in Transitway Person Movement	Rating of Criterion (see Table 6)
4/86	378	10%	"Successful"
4/87	4960	135%	"Highly Successful"
10/87	5956	150%	"Highly Successful"
10/88	5961	180%	"Highly Successful"

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## SECTION 5

# PERCEPTION OF TRANSITWAY UTILIZATION

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A major purpose for allowing carpools to use the transitway was to make the facility appear better utilized to the general public. Carpooling has significantly increased the volume of vehicles using the transitway. The number of vehicles on the transitway during the peak period was: 138 in March 1985; 256 in April 1986; 2,410 in April 1987; 2,922 in October 1987; and 2,957 in October 1988. The effect of this increased volume on the perception of transitway utilization has been noticeable; it is evident that a relationship does exist between vehicular utilization of the transitway and the perception that the transitway is sufficiently utilized.

The perceptions of transitway utilization are based on TTI surveys of transitway and non transitway users. These surveys were conducted in March 1985, April 1986, October 1987, and November 1988. The November 1988 survey was conducted after the 3+ occupancy restriction was implemented during portions of the morning period. Therefore, the results from this survey do not provide a true indication of the perception of transitway utilization in October 1988, before the change to 3+ took place. As there were no major operational changes between October 1987 and October 1988, the October 1987 survey is assumed to represent the October 1988 conditions and was used for the 42-month evaluation.

As one would expect, there is a difference in the perception of transitway utilization between the transitway users and non users. Table 10 indicates how transitway users perceive transitway utilization.

However, persons operating vehicles in the Katy Freeway general purpose lanes -- persons who may not perceive they are directly benefitting from the transitway -- do not believe the facility to be as well utilized as do the users of the transitway. Nevertheless, as transitway volumes have increased, the perception of the freeway motorists regarding the

utilization of the transitway has changed perceptibly. The majority of the motorists feel the transitway is a good transportation improvement (Table 11).

Table 10. Perception of the Utilization of the Katy Transitway By Users of the Transitway

Measure of Effectiveness	Transitway Users								
	Transit			Vanpool		Carpool			
	3/85	4/86	10/87	3/85	4/86	10/85	4/86	4/87	
Is the Transitway Sufficiently Utilized									
Yes	49%	66%	77%	30%	41%	34%	45%	82%	
No	33%	14%	7%	51%	34%	43%	32%	9%	
Not Sure	18%	20%	16%	19%	25%	23%	23%	9%	

Table 11. Perception of the Utilization of the Katy Transitway By Motorists in the General Freeway Lanes

Measure of Effectiveness	Non Transitway Users			
	3/85 <sup>1</sup>	4/86 <sup>2</sup>	4/87 <sup>3</sup>	10/87 <sup>3</sup>
Transitway A.M. Peak Period Vehicle Volume	138	256	2410	2922
Is the transitway sufficiently utilized?				
Yes	3%	3%	36%	44%
No	90%	92%	55%	42%
Not Sure	7%	5%	9%	14%
Is the transitway a good transportation improvement?				
Yes	41%	36%	56%	63%
No	35%	43%	29%	20%
Not Sure	24%	21%	15%	17%

<sup>1</sup>Authorized buses and vanpools (before carpools)

<sup>2</sup>Authorized buses, vanpools and 3+ carpools

<sup>3</sup>2+ vehicles, no authorization

### Conclusion Pertaining to Evaluation Criterion

In the criteria for evaluating the success of the carpool experiment, the non-user perception of transitway utilization was the single most important criterion (Table 6). Table 12 summarizes the application of the perception findings to the criterion. As of October 1988 (based on the results of the October 1987 survey), in terms of this criterion, the experiment is judged to be "successful." The October 1987 survey data was assumed to represent the October 1988 conditions as there were no major operational changes on the transitway during this period.

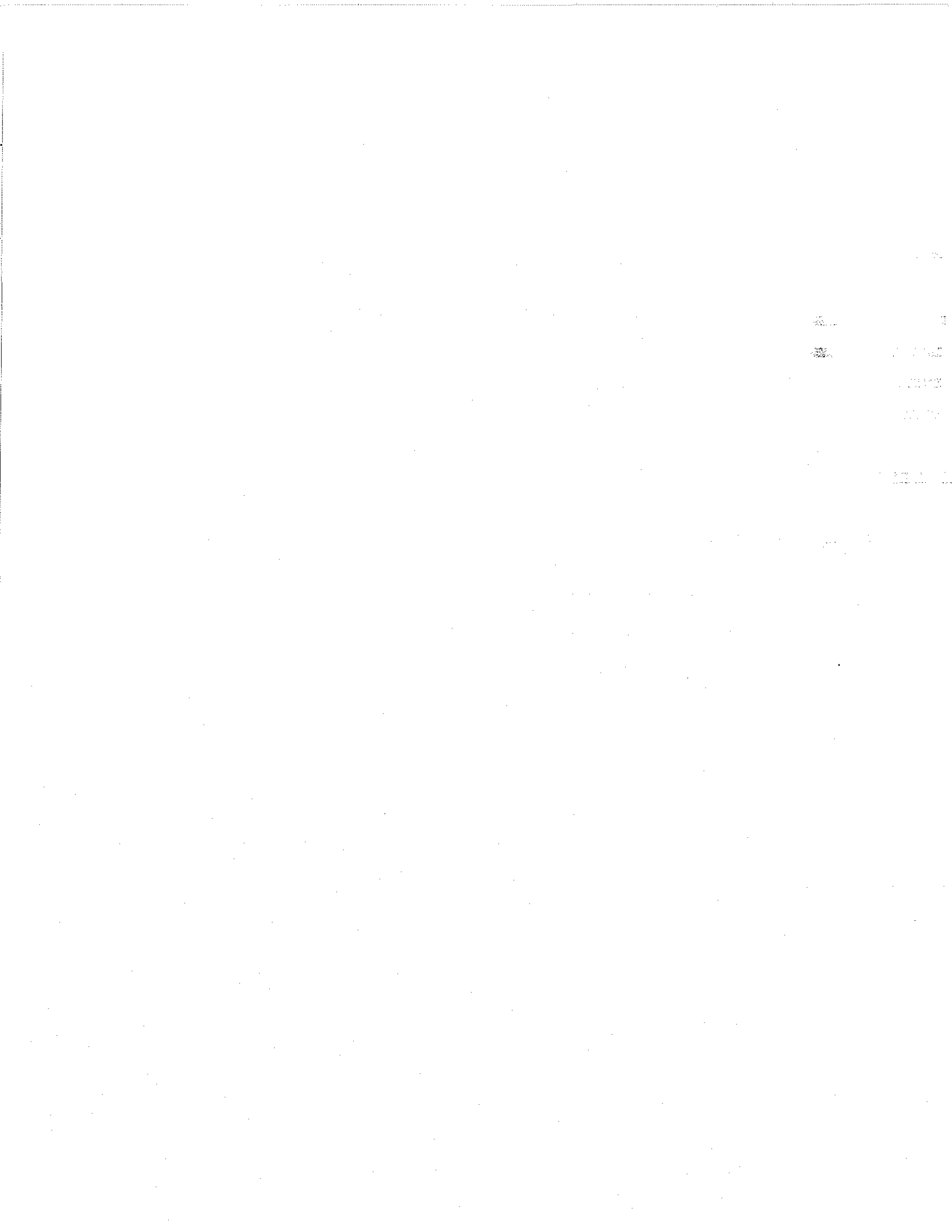
Table 12. Perception of Transitway Utilization, Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	A.M. Peak Period Transitway Vehicle Volume	% of Motorists in General Purpose Lanes Who Feel Transitway Is Sufficiently Utilized <sup>1</sup>	Rating of Criterion (See Table 6)
4/86	256	6%	"Highly Unsuccessful"
4/87	2410	40%	"Unsuccessful"
10/87	2922	51%	"Successful"
10/88	2032	51%	"Successful"

<sup>1</sup>This represents the sum of those saying the transitway is sufficiently utilized plus one-half of those stating they were "not sure". See Table 11 for data breakdown.

<sup>2</sup>The October 1987 survey responses are assumed to represent October 1988 conditions.





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## SECTION 6

# CHANGE IN AVERAGE TRAVEL TIME ON THE TRANSITWAY

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A reduction in transitway speeds resulting from increased volume is one of the concerns associated with permitting carpools to use the transitway. Any decrease in transitway speed would reduce the transitway travel time savings and trip time reliability, in turn, reducing the attractiveness of the transitway.

### Transitway Average Travel Speeds

The average travel speed (space mean speed) was calculated for each bus using the Katy Transitway. Bus speeds were used to estimate the transitway speeds of vanpools and carpools, as bus flow rates during peak periods were high; buses ran at average headways of two minutes.

The average of peak period a.m. and p.m. travel speeds of all buses using the transitway when there were no carpools is compared to the same average speed for 1987 and 1988 when carpools were present (Table 13). The average of the a.m. and p.m. peak period bus speeds in October 1988 was 5 mph less than the 1987 speeds. Figure 12 illustrates the hourly changes in the a.m. travel speeds since carpools began using the transitway. The drop in peak hour speeds occurring in 1988 is evident in this figure and provided part of the impetus for implementing the 3+ restriction between 6:45 and 8:15 a.m.

The drop in average travel speed is the result of vehicular volumes approaching, and sometime exceeding, the transitway capacity and also from delay encountered at the eastern transitway terminus.

# AVERAGE TRANSITWAY A.M. SPEEDS

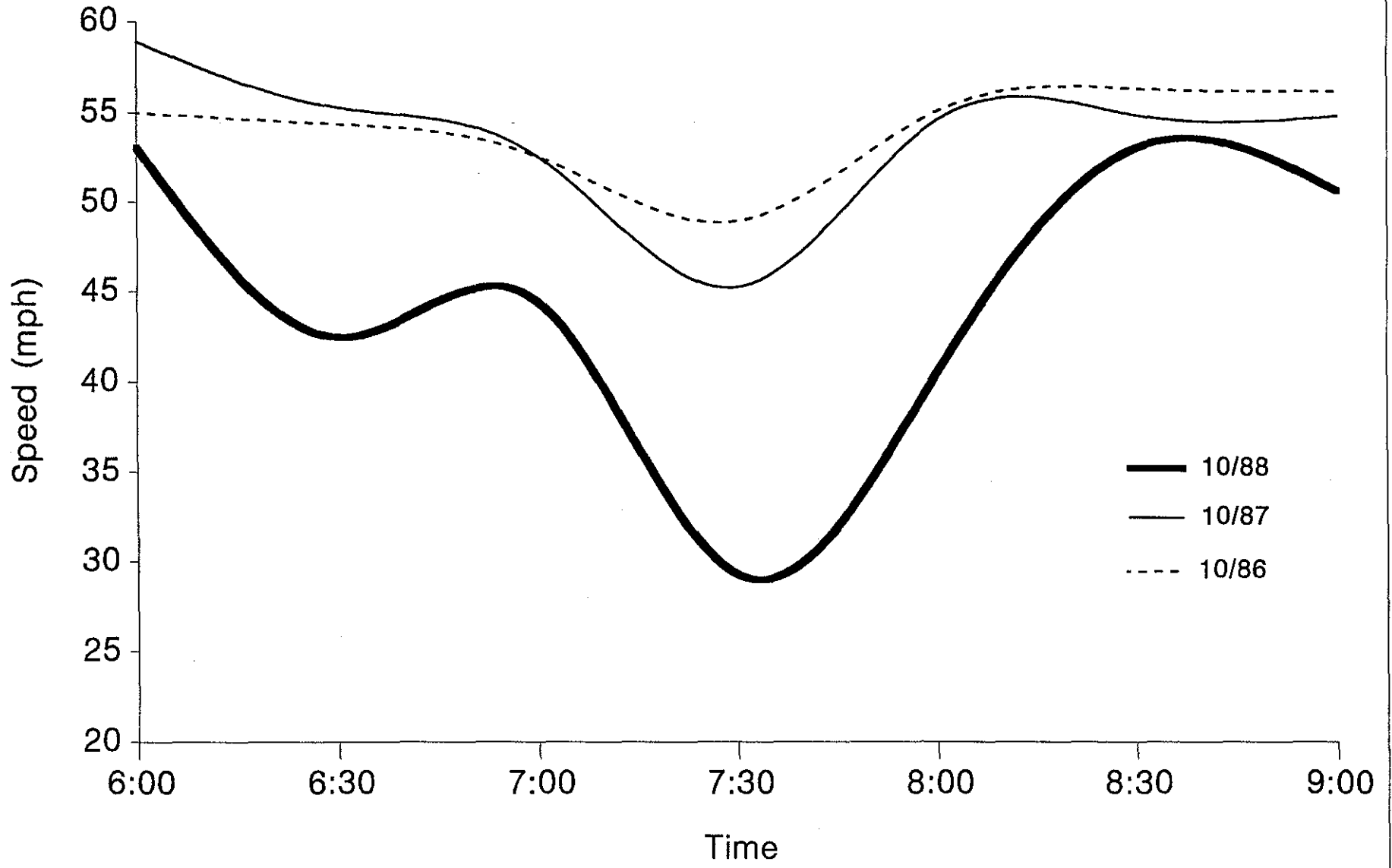


Figure 12. A.M. Average Transitway Running Speeds from Western Terminus to Post Oak Intersection

Table 13. Average Travel Speed (mph) for Vehicles on the Katy Transitway, 1985, 1986, 1987, and 1988

Vehicle Type	Date			
	3/85 <sup>1</sup>	5/86 <sup>2</sup>	11/87 <sup>3</sup>	10/88 <sup>3</sup>
Bus	52	56	52	45
Van	56	57	N/A	N/A
Carpool	--	56	N/A	N/A

Speeds represent average of a.m. and p.m. peak period speeds based on travel time runs between S.H. 6 and the S.P.R.R. (13.3 miles).

<sup>1</sup> Prior to carpool implementation

<sup>2</sup> Authorized 4+ carpools only

<sup>3</sup> 2+ Carpools, no authorization.

Transitway speeds for 4:00, 5:00, and 6:00 p.m. were measured in November 1988.

N/A Speed not available. Bus speeds are assumed to estimate all transitway speeds.

### Conclusion Pertaining to Evaluation Criterion

Possible changes in transitway operating speed are a criterion for evaluating the success of the carpool experiment (Table 6). The 30-month evaluation (Research Report 484-7) found that, in 1987, transitway speeds had decreased slightly, to a speed equal to the base condition (no carpools). Therefore this criterion was considered to be "successful." As shown in Table 14, the October 1988 speeds are 7 mph less than the 1985 speeds. As a result, this criterion is considered to be "highly unsuccessful" for October 1988.

Table 14. Change in Average Bus Travel Speed on the Transitway, Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	Average Transitway Speed (mph)	Rating of Criterion (See Table 6)
3/85	52	Base Condition
5/86	56	"Highly Successful"
11/87	52	"Successful"
10/88	45	"Highly Unsuccessful"

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This ensures transparency and allows for easy verification of the data.

In addition, it is crucial to review the records regularly to identify any discrepancies or errors. This proactive approach helps in maintaining the integrity of the financial data and prevents small mistakes from escalating into larger issues.

### Financial Statement Analysis

The second section provides a detailed analysis of the company's financial performance over the past year. It compares the current year's results with the previous year, highlighting areas of growth and areas that need improvement. Key metrics such as revenue, profit margins, and asset turnover are discussed in detail.

The following table summarizes the key financial indicators for the period:

Indicator	Year 1	Year 2	Change (%)
Total Revenue	1,200,000	1,350,000	+12.5%
Operating Profit	300,000	350,000	+16.7%
Net Profit	200,000	220,000	+10.0%
Current Assets	500,000	550,000	+10.0%
Current Liabilities	250,000	280,000	+12.0%
Equity	750,000	820,000	+9.3%

Overall, the company has shown a strong upward trend in its financial performance. The increase in revenue and profit margins indicates that the business is effectively managing its operations and market demand. However, the rise in current liabilities suggests that the company may need to reassess its short-term debt obligations to maintain a healthy financial position.

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## SECTION 7

### MIXED-FLOW TRAFFIC LANES

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It is conceivable that allowing carpools onto the transitway could have either a positive or a negative impact on speeds and operation in the mixed-flow lanes. If substantial carpool volumes use the transitway, mainlane volumes could be decreased, which might improve operations. Conversely, the existing access/egress locations to the transitway are not necessarily optimal. Large volumes entering or exiting the transitway (particularly at Gessner) could deteriorate the level-of-service on the mainlanes.

#### Speeds

Travel time studies were conducted on the Katy Freeway at 30-minute intervals between the S.H. 6 interchange and the Southern Pacific Railroad (S.P.R.R.) overpass east of the Washington Avenue, a distance of approximately 13 miles. The studies were conducted in October 1988. The results of these travel time studies were compared to similar studies from 1985, 1986, and 1987 using the study sections shown in Table 15.

Table 15. Section Limits for Travel Time Runs on the Katy Transitway

Section Number AM Designation	PM Designation	Limits of Section
1	3	S.H. 6 to Gessner Access Ramps (6.4 mi.)
2	2	Gessner Access Ramps to transitway east terminus at Post Oak (4.7 mi)
3	1	Post Oak to the S.P.R.R. overpass of I-10 (2.2 mi)

### AM Peak Period

Morning (eastbound) floating car travel times were taken over the 13 mile study length on the freeway, and the average speeds for the three study sections were calculated. The results of these travel time runs are shown in Table 16. The travel speeds for each freeway section were then averaged for each time period. The 1988 data, presented in Figure 13 and Table 16, can be directly compared to previous travel speed data.

Table 16. AM Average Speeds on the Eastbound Katy Freeway Mainlanes for 1985, 1986, and 1988

Date Time	Section 1 - AM			Section 2 - AM			Section 3 - AM			Total Length-AM		
	3/85	11/87	10/88	3/85	11/87	10/88	3/85	11/87	10/88	3/85	11/87	10/88
6:00	54	56	61	55	56	59	55	55	59	55	56	60
6:30	32	33	28	39	34	37	36	55	54	36	36	33
7:00	22	24	24	28	26	26	27	55	56	27	28	28
7:30	18	22	17	21	22	21	21	55	57	21	24	20
8:00	32	37	19	26	28	23	32	55	55	32	34	23
8:30	37	48	44	28	31	29	35	57	57	35	40	38
9:00	--	50	59	--	50	36	--	55	59	--	50	48

The travel time profile shown in Figure 13 indicates that travel speeds between 6:00 and 7:30 are similar to 1987 and 1985 speeds and lower than 1986 speeds. However, the average speeds measured in 1986 are very high because of the reduced demands on the freeway during the summer months. Between 7:30 and 8:30, the 1988 freeway travel speeds appear to be slower than the previous study years.

Average travel time and average speeds for freeway and transitway traffic are shown for both two- and three-hour periods in Table 17. These values represents travel times over the entire study length from S.H. 6 to the S.P.R.R.

### PM Peak Period

The westbound freeway speeds are presented by section in Table 18 and compared to the 1985, 1986, and 1987 studies in Table 19. The average travel speeds are compared to the 1985, 1986, and 1987 conditions in Figure 14.

# KATY FREEWAY TRAVEL SPEEDS

AM - AVERAGE MAINLANE

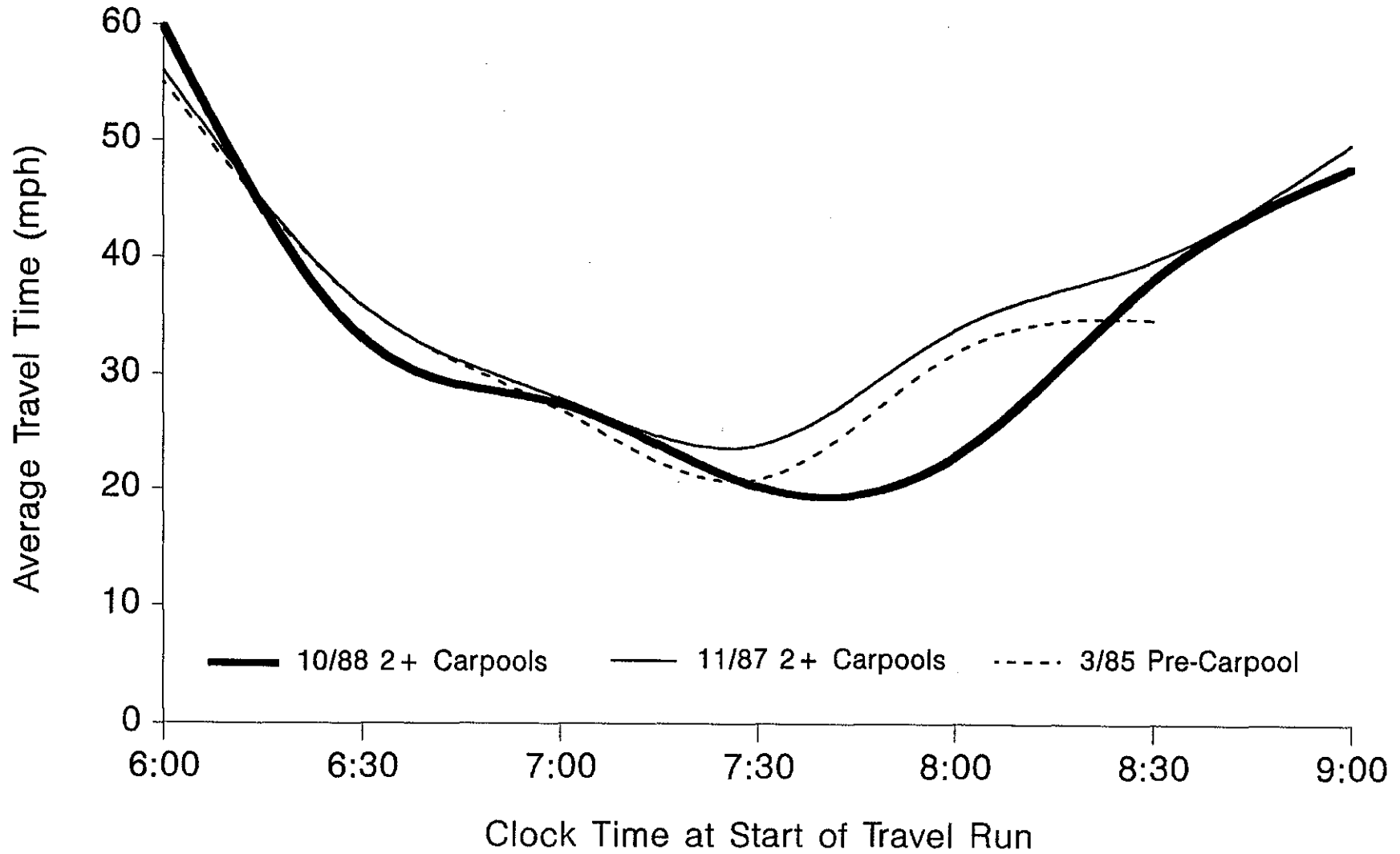


Figure 13. Katy Freeway Average Mainlane Travel Speeds, A.M. Eastbound, S.H. 6 to S.P.R.R.



# KATY FREEWAY TRAVEL SPEEDS

PM - AVERAGE MAINLANE

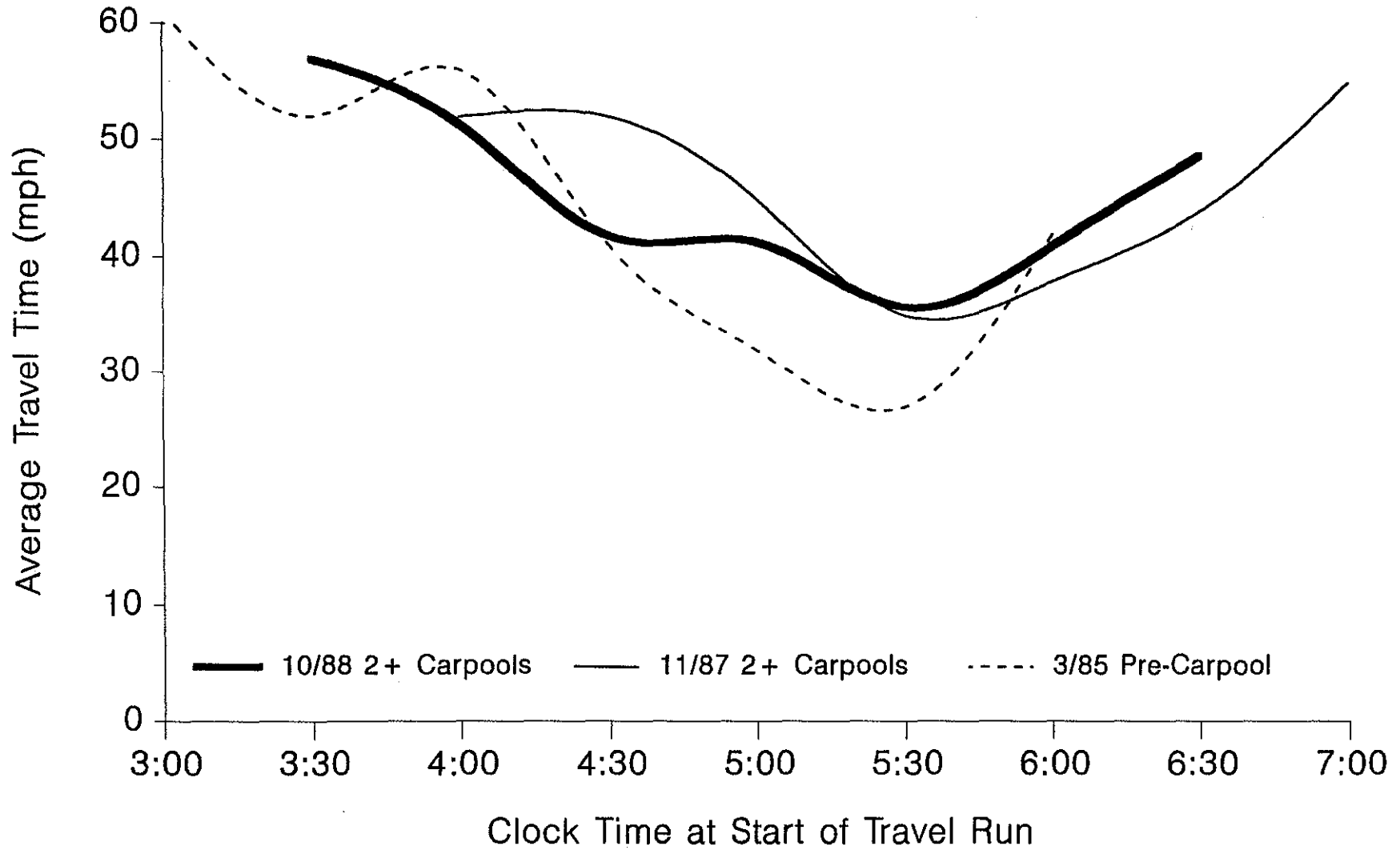


Figure 14. Katy Freeway Average Mainlane Travel Speeds, P.M. Westbound, S.P.R.R. to S.H. 6

Table 17. Eastbound AM Travel Times and Average Speeds, Katy Freeway Mainlanes and Transitway, 1985, 1987, 1988

Time Period	Average Travel Time (minutes)			% Change 85-88
	3/85	11/87	10/88	
3-Hour Period, 6:00-9:00 a.m. Non Transitway Traffic	26.5	22.0	26.9	+ 2
	21.2	16.6	19.0	-10
2-Hour Period, 6:30-8:30 a.m. Non Transitway Traffic	30.6	26.4	31.8	+ 4
	23.5	17.4	20.9	-11

Time Period	Average Speed (MPH)			% Change 85-88
	3/85	11/87	11/88	
3-Hour Period, 6:00-9:00 a.m. Non Transitway Traffic	30	36	30	0
	37	48	42	+14
2-Hour Period, 6:30-8:30 a.m. Non Transitway Traffic	26	30	25	- 4
	34	46	38	+12

Note: Travel times and speeds for freeway and transitway are from S.H. 6 to Southern Pacific RR.

Table 18. PM Average Speeds on the Westbound Katy Freeway Mainlanes for 1985, 1986, and 1988

Average Speed in MPH

Date Time	Section 1 - PM			Section 2 - PM			Section 3 - PM			Total Length - PM		
	3/85	11/87	10/88	3/85	11/87	10/88	3/85	11/87	10/88	3/85	11/87	10/88
3:00	55	--	--	66	--	--	61	--	--	61	--	--
3:30	57	--	55	54	--	55	52	--	59	52	--	57
4:00	55	60	57	60	44	42	56	52	59	56	52	51
4:30	54	56	38	34	46	34	41	55	53	41	52	42
5:00	46	54	54	24	34	30	32	54	52	32	45	41
5:30	49	51	46	19	25	24	27	37	52	27	35	36
6:00	50	55	55	32	31	28	42	32	56	42	38	41
6:30	--	57	55	--	38	38	--	37	59	--	44	49
7:00	--	59	--	--	49	--	--	56	--	--	55	--

Table 19. Westbound PM Travel Times and Average Speeds, Katy Freeway Mainlanes and Transitway, 1985, 1987, and 1988

Time Period	Average Travel Time (minutes)			% Change 85-88
	3/85	11/87	10/88	
3-Hour Period, 4:00-7:00 p.m.				
Non Transitway Traffic	21.3	18.0	18.7	-12
Transitway Traffic	16.3	17.3	17.3	+ 6
2-Hour Period, 5:00-7:00 p.m.				
Non Transitway Traffic	24.7	19.3	19.4	-21
Transitway Traffic	16.6	17.5	18.0	+ 8
Time Period	Average Speed (MPH)			
	3/85	11/87	10/88	
3-Hour Period, 4:00-7:00 p.m.				
Non Transitway Traffic	37	44	43	+16
Transitway Traffic	49	46	46	- 6
2-Hour Period, 5:00-7:00 p.m.				
Non Transitway Traffic	32	41	41	+28
Transitway Traffic	48	45	44	- 8

Note: Travel times and speeds for freeway and transitway are from Southern Pacific RR to S.H. 6

### Freeway Mainlane Volumes

Volume counts were taken in October of 1988 from the loop detectors installed in the mainlanes of I-10 at the Silber overpass and the Gessner overpass. The ADT, a.m. peak period, and p.m. peak period counts for 1985 through 1988 are shown in Table 20. Virtually all 1988 volume counts indicate an increase over 1987 traffic volumes, with some increases near 10 percent. The westbound peak hour and peak period volumes are greatly increased by the closure of the Gessner and West Belt freeway entrance ramps due to construction in the corridor.

These traffic volume increases are another indication that the economy of the Houston area improved between 1987 and 1988. The increased number of people utilizing the Katy Freeway corridor place a greater demand on both the freeway and the transitway and make the determination of transitway impacts on the freeway more difficult.

Table 20. Traffic Volumes, Katy Freeway Mainlanes, 1985 - 1988

Eastbound Direction Location and Time	Date				% Increase 87-88
	3/85	8/86	10/87	10/88 <sup>1</sup>	
Silber Overpass - 4 Lanes					
ADT	90,325	89,507	87,730	92,588	+ 5.5
6:30-9:30 am	20,589	19,445	20,783	21,270	+ 2.3
3:30-6:30 pm	16,406	16,296	16,662	17,722	+ 6.4
Peak Hour	7,295	7,113	7,200	7,425	+ 3.1
Gessner Overpass - 3 Lanes					
ADT	70,069	69,250	64,064	71,647	+11.8
6:30-9:30 am	15,263	15,528	13,448	13,771	+ 2.4
3:30-6:30 pm	13,547	12,717	12,972	14,734	+13.6
Peak Hour	5,526	5,523	5,127	5,444	+ 6.2
Westbound Direction Location and Time	Date				
	3/85	8/86	10/87	10/88	
Silber Overpass - 4 Lanes					
ADT	86,978	87,622	85,690	89,787	+ 4.8
6:30-9:30 am	14,395	13,864	13,973	14,868	+ 6.4
3:30-6:30 pm	17,539	17,692	18,535	18,211	- 1.7
Peak Hour	6,368	6,278	6,426	6,497	+ 1.1
Gessner Overpass - 3 Lanes					
ADT	70,919	69,965	69,147	75,199	+ 8.8
6:30-9:30 am	12,130	11,432	11,375	12,476	+ 9.7
3:30-6:30 pm	14,270	12,835	16,911	17,322	+ 2.4
Peak Hour	4,985	4,933	5,886	6,041	+ 2.6

Peak Hour - Eastbound direction for am period, westbound for pm period  
<sup>1</sup>Volume represents average of Tuesday through Thursday.

### Travel Time Savings

Desirably, the transitway will result in travel time savings for both the transitway users and the freeway users. Transitway users can reduce travel time by utilizing the transitway to avoid congestion delays in the freeway mainlanes. By changing travel mode and using the transitway, the number of vehicles on the freeway mainlanes may be reduced, thereby reducing the travel time on the freeway.

Travel time saved by the transitway traffic is calculated by comparing the freeway mainlane travel time to the transitway travel time at the same time period, and determining the number of vehicles and persons using the transitway during the same time period. The number of vehicles, by type and occupancy rate, were determined from independent surveys taken at the same time as the travel times. In Table 21, the eastbound direction from S.H. 6 to the Gessner access ramp is analyzed. In almost all time periods, the travel time for the transitway traffic is less than the freeway travel time, and the results are positive

savings. In Table 22, for the section from Gessner to the S.P.R.R., the early morning data indicate that the users of the transitway lose time, because of lower speeds and delays at the Post Oak terminus and the route followed to re-enter the I-10 mainlanes. Thus, the travel time savings are negative during the early hours. However, the fact that motorists use the transitway during these periods indicates that the trip time reliability can offset some losses in travel time savings.

Table 21. Eastbound AM Travel Time Savings for Katy Transitway Traffic, S.H. 6 to Gessner Entrance, October, 1988

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
6:00 am	6.3	6.6	-0.3	4	5	165	506	-152
6:30 am	13.8	7.7	6.1	15	11	398	1,295	7,900
7:00 am	15.7	6.7	9.0	4	13	534	1,639	14,751
7:30 am	23.2	13.1	10.1	1	11	285	899	9,080
8:00 am	19.7	7.5	12.2	0	3	156	401	4,892
8:30 am	8.6	6.2	2.4	0	2	98	235	564
3 Hour Total 6:00-9:00			7.4	24	45	1,636	4,975	37,035
2 Hour Total 6:30-8:30			8.6	20	38	1,373	4,234	36,623

The total time saved by transitway users is determined from Tables 21 and 22 and shown in Table 23. During the morning peak period, the total time saved by transitway users was over 50,000 person-minutes (over 800 person-hours). Table 23 also provides similar data for 1985, 1986, and 1987. Table 23 shows that the total travel time saved has continued to increase with time, even though the person volume was fairly consistent between 1987 and 1988.

Similar calculations for the afternoon period are shown in Tables 24, 25 and 26. The data in these tables do not indicate the dramatic improvements shown for the morning period.

Table 22. Eastbound AM Travel Time Savings for Katy Transitway Traffic, Gessner Entrance to S.P.R.R. October, 1988

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
6:00 am	7.1	8.4	-1.3	3	7	115	391	-508
6:30 am	10.2	11.1	-0.9	14	16	475	1,703	-1,533
7:00 am	13.3	11.3	2.0	14	16	665	2,127	4,254
7:30 am	16.1	14.2	1.9	1	19	589	1,922	3,652
8:00 am	15.0	12.2	2.8	2	15	542	1,540	4,312
8:30 am	12.2	8.8	3.4	1	9	266	706	2,400
3 Hour Total 6:00-9:00			1.5	35	82	2,652	8,389	12,577
2 Hour Total 6:30-8:30			1.5	31	66	2,271	7,292	10,685

Total Time Saved = 37,035 + 12,577 = 49,612 Person Minutes (6:00-9:00 am)  
 Total Time Saved = 36,623 + 10,685 = 47,308 Person Minutes (6:30-8:30 am)

Table 23. Total Travel Time Savings for Eastbound Katy Transitway Traffic, 1985, 1987, and 1988

Time of Day	Time Saved by Transitway (minutes)*			Transitway Person Volume			Travel Time Saved (person-minutes)		
	5/85	11/87	10/88	5/85	11/87	10/88	5/85	11/87	10/88
6:00 a.m.	-1.2	-0.9	-1.7	242	387	391	-299	-361	-660
6:30	4.0	3.1	3.7	532	1,540	1,703	2,123	4,840	6,367
7:00	9.4	4.8	8.9	646	2,346	2,127	6,061	11,157	19,005
7:30	11.4	6.1	6.6	384	2,320	1,922	4,372	14,057	12,732
8:00	7.8	4.8	6.0	426	1,198	1,540	3,329	5,735	9,204
8:30	3.7	2.3	4.2	150	600	706	558	1,400	2,964
3 Hour Total	6.8	4.4	5.9	2,380	8,391	8,389	16,144	36,828	49,612
2 Hour Total	8.0	4.8	6.5	1,988	7,404	7,292	15,885	35,789	47,308

\*Time saved by Transitway (minutes) was calculated, and rounded to tenths, by dividing "person-minutes" by person volume.

3 Hour Total represent period from 6:00 a.m. to 9:00 a.m.  
 2 Hour Total represents period from 6:30 a.m. to 8:30 a.m.

Table 24. Westbound PM Travel Time Savings for Katy Transitway Traffic, S.P.R.R. to Gessner Exit, October, 1988

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
4:00 pm <sup>1</sup>	9.1	9.2	-0.1	13	8	315	1,011	-101
4:30 pm <sub>1</sub>	11.9	9.2	2.7	14	16	453	1,566	4,228
5:00 pm <sup>1</sup>	12.0	12.5	-0.5	7	16	632	1,907	-954
5:30 pm <sub>1</sub>	14.9	15.8	-0.9	4	18	635	1,844	-1,660
6:00 pm <sup>1</sup>	12.7	9.2	3.5	0	7	388	1,023	3,581
6:30 pm	9.9	8.5	1.4	1	7	197	563	788
3 Hour Total 4:00-7:00			0.7	39	72	2,620	7,914	5,883
2 Hour Total 5:00-7:00			0.3	12	48	1,852	5,337	1,755

<sup>1</sup> The 4:00, 5:00, and 6:00 p.m. transitway travel times were measured in November 1988, as October 1988 travel times were not available for these time periods.

Table 25. Westbound PM Travel Time Savings for Katy Transitway Traffic, Gessner Exit to S.H. 6, October, 1988

Time of Day	Average Travel Time		Time Saved by Transitway (minutes)	Transitway Volumes				Travel Time Saved (Person Minutes)
	Non-Transitway (minutes)	Transitway (minutes)		Vans	Buses	Carpools	Persons	
4:00 pm <sup>1</sup>	6.5	6.6	-0.1	7	2	142	406	-41
4:30 pm <sub>1</sub>	7.3	6.5	0.8	11	7	210	751	601
5:00 pm <sup>1</sup>	7.3	6.3	1.0	5	10	280	906	906
5:30 pm <sub>1</sub>	7.4	6.7	0.7	3	13	355	1,174	822
6:00 pm <sup>1</sup>	6.8	6.9	-0.1	0	7	307	820	-82
6:30 pm	6.5	6.1	0.4	0	7	105	355	142
3 Hour Total 4:00-7:00			0.5	26	46	1,399	4,412	2,348
2 Hour Total 5:00-7:00			0.5	8	37	1,047	3,255	1,788

Total Time Saved = 5,883 + 2,348 = 8,231 Person Minutes (4:00-7:00 p.m.)

Total Time Saved = 1,755 + 1,788 = 3,543 Person Minutes (5:00-7:00 p.m.)

<sup>1</sup> The 4:00, 5:00, and 6:00 p.m. transitway travel times were measured in November 1988, as October 1988 travel times were not available for these time periods.

Table 26. Total Travel Time Savings for Westbound Katy Transitway Traffic, 1985, 1987, and 1988

Time of Day	Time Saved by Transitway (minutes)*			Transitway Person Volume			Travel Time Saved (person-minutes)		
	5/85	11/87	10/88	5/85	11/87	10/88	5/85	11/87	10/88 <sup>1</sup>
3:30 pm <sub>1</sub>	-0.9	-0.9	--	278	407	--	-246	-366	--
4:00 pm <sup>1</sup>	-0.1	-0.9	-0.3	412	1,024	1,011	-30	-937	-142
4:30 pm <sub>1</sub>	5.5	-1.8	6.4	654	1,435	1,566	3,576	-2,646	4,829
5:00 pm <sup>1</sup>	10.3	-0.5	-0.1	496	1,632	1,907	5,110	-831	-48
5:30 pm <sub>1</sub>	12.2	3.1	-0.7	364	1,909	1,844	4,436	5,880	-838
6:00 pm <sup>1</sup>	2.0	4.5	4.3	180	898	1,023	366	4,363	3,499
6:30 pm	--	--	2.6	--	--	563	--	--	930
3 Hour Total	5.5	1.0	1.9	2,384	7,380	7,914	13,212	7,044	8,231
2 Hour Total	7.0	2.2	1.1	1,926	4,921	5,337	13,488	10,627	3,543

\*Time saved by Transitway (minutes) was calculated, and rounded to tenths, by dividing "person-minutes" by person volume.

<sup>1</sup> The 4:00, 5:00, and 6:00 p.m. transitway travel times were measured in November 1988, as October 1988 travel times were not available for these time periods.

The change in travel time for freeway users is also a concern. A comparison of freeway mainlane travel times in 1988 was made with similar data for 1985. Tables 27 and 28 use the freeway travel times, the freeway occupancy rate from Table 3 (1.06 persons per vehicle), and the volume count at Gessner (assumed as an average flow rate for the 13 miles) to calculate the vehicle-minutes of travel time saved. Table 27 indicates that there are no clear travel time savings for freeway users during the morning peak, when compared to the 1985 travel times. However, Table 28 indicates a significant travel time savings during the evening peak period. The average of the a.m. and p.m. travel time savings for freeway users is used as the evaluation criterion for this section of the report.

Table 27. Eastbound AM Travel Time Savings for Katy Non Transitway Traffic, S.H. 6 to S.P.R.R., October, 1988

Time of Day	Non Transitway 1985 (minutes)	Non Transitway 1988 (minutes)	Time Saved 1985-1988 (minutes)	Vehicle Volume at Gessner <sup>1</sup> (vehicles)	Total Time Saved (person minutes)
6:00 am	13.8	13.4	0.4	2,621	1,111
6:30 am	21.5	24.0	-2.5	2,700	-7,155
7:00 am	30.2	29.0	1.2	2,290	2,913
7:30 am	38.2	39.3	-1.1	1,897	-2,212
8:00 am	32.7	34.7	-2.0	2,001	-4,242
8:30 am	24.4	20.9	3.5	2,477	9,190
3 Hour Total 6:00-9:00			0.0	13,986	-395
2 Hour Total 6:30-8:30			-1.2	8,888	-10,696

<sup>1</sup>Average of Tuesday through Thursday volume

Table 28. Westbound PM Travel Time Savings for Katy Non Transitway Traffic, S.P.R.R. to S.H. 6, October, 1988

Time of Day	Non Transitway 1985 (minutes)	Non Transitway 1988 (minutes)	Time Saved 1985-1988 (minutes)	Vehicle Volume at Gessner <sup>1</sup> (vehicles)	Total Time Saved (person minutes)
3:30 pm	14.8	14.0	0.8	3,192	2,707
4:00 pm	14.5	15.6	-1.1	3,263	-3,805
4:30 pm	19.6	19.1	0.5	3,197	1,694
5:00 pm	27.2	19.3	7.9	3,007	25,181
5:30 pm	30.3	22.4	7.9	2,736	22,911
6:00 pm	23.2	19.5	3.7	2,817	11,048
6:30 pm	--	16.4	--	--	--
3 Hour Total 3:30-6:30			3.3	18,212	59,737
2 Hour Total 4:30-6:30			5.2	11,757	60,835

<sup>1</sup>Average of Tuesday through Thursday volume

Although previously mentioned, it is important to note that increases in delay to freeway motorists is not solely the result of the transitway. The Houston economy has been improving in the time since the carpool experiment began, particularly during the last evaluation period. As a result, more vehicles are using the freeways and delay is increasing.



**Conclusion Pertaining to Evaluation Criterion**

Changes in freeway speeds and travel times are a criterion for evaluating the success of the carpool experiment (Table 6). Table 29 indicates the results of the evaluation of mixed flow lanes. In terms of this evaluation factor or measure of effectiveness, the carpool experiment is considered "highly successful" in that freeway speeds have actually improved. It is recognized that factors other than the transitway have had a major impact on the fact that freeway speeds have improved.

Table 29. Change in Person Delay to Mixed-Flow Traffic, Criterion for Assessing the Success of the Katy Transitway Carpool Experiment

Date of Evaluation	Total Travel Time Saved (person minutes)		Rating of Criterion (See Table 6) <sup>1</sup>
	a.m.	p.m.	
9/86	19,485	23,102	"Highly Successful"
11/87	55,623	66,245	"Highly Successful"
10/88	-395	59,737	"Highly Successful"

<sup>1</sup>Based on average of a.m. and p.m. Total Travel Time Saved

## SECTION 8

# TRANSITWAY VEHICLE BREAKDOWN DATA

A concern associated with allowing carpools onto the transitway has been that such an action would increase the frequency of vehicle breakdowns; if those breakdowns blocked the lane, the reliability of service on the transitway would be adversely impacted.

Metro operating data have been analyzed for the period from October 29, 1984 through October 17, 1988. These data are summarized in Table 30.

Table 30. Vehicle Breakdown Rates, Katy Transitway

Vehicle Group	10/29/84-10/17/88*	4/1/85-10/17/88**	8/11/86-10/17/88***
No. of Disabled Vehicles, Total	677	673	619
Buses	66	62	26
Vans	12	12	6
Carpools	599	599	587
Disabled Veh per Week	3.32	3.68	5.58
No. Of Towed Vehicles, Total	418	418	402
Buses	20	20	12
Vans	6	6	5
Carpools	392	392	385
Vehicle Miles of Travel (VMT), Total	23,437,200	23,311,687	22,326,339
Buses	986,855	943,333	631,721
Vans	910,517	828,526	489,789
Carpools	21,539,828	21,539,828	21,204,829
VMT Per Disabled Vehicle, Total	34,619	34,638	36,068
VMT Per Disabled Bus	14,952	15,215	24,297
VMT Per Disabled Van	75,876	69,044	81,631
VMT Per Disabled Carpool	35,960	35,960	36,124
VMT Per Towed Vehicle, Total	56,070	55,770	55,538
VMT Per Towed Bus	49,343	47,167	52,643
VMT Per Towed Van	151,753	138,088	97,958
VMT Per Towed Carpool	54,949	54,949	55,077

Note: Towed Vehicles are a subset of disabled vehicles

\* Operating period from inception of the transitway

\*\* Operating period from when carpools allowed onto the transitway

\*\*\* Operating period since unauthorized 2+ carpools allowed onto transitway

Since carpools represent 95 percent of the vehicles on the transitway, allowing carpools to use the transitway has greatly increased the number of vehicle breakdowns that occur. Carpools represent 95 percent of all disabled vehicles on the transitway since the time 2+ carpools began using the facility. The carpool breakdown rate (approximately 1 per 36,000 vehicle-miles of travel) is actually less than that which would exist if only buses used the facility (a breakdown rate of 1 per 24,000 vehicle-miles of travel).

### **Conclusion Pertaining to Evaluation Criterion**

Increase in the frequency of breakdowns on the transitway was an evaluation criterion. The criterion was evaluated as follows: "Highly Successful," no increase; "Successful," less than a 5 percent increase; "Unsuccessful," increase by 5 percent to 15 percent; "Highly Unsuccessful," increase by over 15 percent.

The data suggest that total breakdowns have increased substantially due to carpool utilization of the transitway; this equates to "highly unsuccessful." Even though carpool breakdowns generally do not physically block the lane, their frequency (roughly one per day) does create reliability concerns and requires frequent use of the Metro emergency crews. As a result, the findings for this criterion appear warranted.

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## SECTION 9

# AUTHORIZATION AND ENFORCEMENT COSTS

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Allowing carpools onto the transitway could have increased costs for both enforcement and vehicle authorization. However, in August 1986 authorization was at least temporarily eliminated on the Katy Transitway; as a result, authorization costs also were eliminated and, at this time, are not an issue.

### Increase In Enforcement Costs

The Director of Transportation Programs for Metro was requested to address this issue. Her response is summarized below.

*Currently, Metro does not have permanent enforcement stations on the Katy or North Transitway. The officers assigned to the lanes use a roving patrol or stationary enforcement mode as the situation dictates. Currently, there is a minimum of one officer assigned to each lane which does not represent an increase or decrease in enforcement costs.*

The introduction of carpools on the Katy Transitway has resulted in an increase in traffic violations and vehicle breakdowns; however, operating costs have not been significantly affected at the present time.

### Conclusion Pertaining to Evaluation Criterion

Experience has shown that, at least to date, the transitway can be operated without authorization; thus, authorization costs have been eliminated.

It appears that the marginal impact on enforcement due to transitway carpool utilization has been minimal. In regard to this criterion, the carpool experiment is judged

to be "successful." This is the same conclusion found in the 30-month evaluation report (Research Report 484-7).

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## SECTION 10 CONCLUSIONS

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A summary of the evaluation of the individual criterion for the 42-month evaluation is shown in Table 31. Based on that evaluation, as of October 1988, the Katy carpool experiment is judged to be between "successful" and "highly successful." If numerical values are assigned to the possible outcomes (with "highly successful" = 4; "successful" = 3; "unsuccessful" = 2; and "highly unsuccessful" = 1), the weighted value for the carpool experiment is 2.90. The criteria related to transitway person movement, non-user perception, mixed-flow traffic delay, and enforcement costs were rated as "successful" or "highly successful." The criteria rated as "unsuccessful" or "highly unsuccessful" included transitway travel time and transitway breakdowns.

Since the introduction of carpools, the Katy Transitway has maintained at least a minimal level of success (defined as rating greater than 2.5). Since the introduction of the 2+ occupancy requirement with no authorization procedures, the transitway has maintained a rating near the "successful" level (3.0±). The trends in transitway success are shown in Table 32.

Table 31. Overall Evaluation of Katy Transitway Carpool Experiment,  
42 Months After Carpools Were Allowed onto the Transitway

Criterion	Relative Weighting	Conclusion Pertaining to Experiment	Relevant Data
1. Change in Person Movement on the Transitway Directly Attributable to Carpooling	25%	"Highly Successful"	Carpools move 68-70% of total peak period person movement
2. Non-User Perception of Katy Transitway Utilization	30%	"Successful"	Just over 50% of non-users feel the transitway is sufficiently utilized.
3. Change in Travel Time on the Transitway	20%	"Highly Unsuccessful"	Average transitway speeds have decreased by 7 mph.
4. Change in Delay to Mixed-Flow Traffic	15%	"Highly Successful"	Mixed flow speeds have increased slightly.
5. Increase in Frequency of Transitway Breakdowns	5%	"Highly Unsuccessful"	Approximately 95% of transitway vehicle breakdowns are carpools. Approximately 5 breakdowns occur per week.
6. Increase in Authorization and Enforcement Costs	5%	"Successful"	Marginal increase in costs due to carpools has not been substantial.
Total	100%	Between "Successful" and "Highly Successful"	

Table 32. Overall Evaluation of Katy Transitway Carpool Experiment,  
April 1986, April 1987, October 1987, and October 1988

Criterion	Relative Weighting	Conclusion Pertaining to Experiment			
		April 1986	April 1987	October 1987	October 1988
1. Change in Person Movement on the transitway Directly Attributable to Carpooling	25%	2.5	4	4	4
2. Non-User Perception of Katy Transitway Utilization	30%	1	2	3	3
3. Change in Travel Time on the Transitway	20%	4	4	3	1
4. Change in Delay to Mixed-Flow Traffic	15%	4	4	4	4
5. Increase in Frequency of Transitway Breakdowns	5%	3	1	1	1
6. Increase in Authorization and Enforcement Costs	5%	3	3	3	3
Total	100%	2.63	3.20	3.30	2.90

Scoring:

- 1 - Highly Unsuccessful
- 2 - Unsuccessful
- 3 - Successful
- 4 - Highly Successful

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