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16. Abstract

This report presents an evaluation of the operation of the North Freeway (I-45N) Transitway in Houston, Texas for calendar year 1987. This represents an evaluation of the third year of transitway operation. Two previous reports have documented experiences during the first two years of transitway operation. This research report provides an analysis of trend data related to: 1) operation of the transitway; 2) operation of the freeway mainlanes; 3) combined transitway and freeway mainlane data; and 4) data relating to transit usage and operations. In comparing A.M. peak-direction data from December 1984 with combined freeway mainlane and transitway data representative of December 1987: 1) peak-hour person movement has increased by 30%; 2) A.M. peak-hour vehicle occupancy has decreased by 4%; 3) peak-period bus passenger trips have increased by 83%; and 4) vehicles parked in corridor park-and-ride lots have increased by 23%. A peak-hour measure of effectiveness frequently associated with high-occupancy vehicle projects is passenger-miles/hour (the multiple of peak-hour passengers times miles per hour). This measure of effectiveness (expressed in 1000's) has increased from 72 in December 1984, to a value of 87 passenger-miles/hour/lane in December 1987, an increase of 21%.

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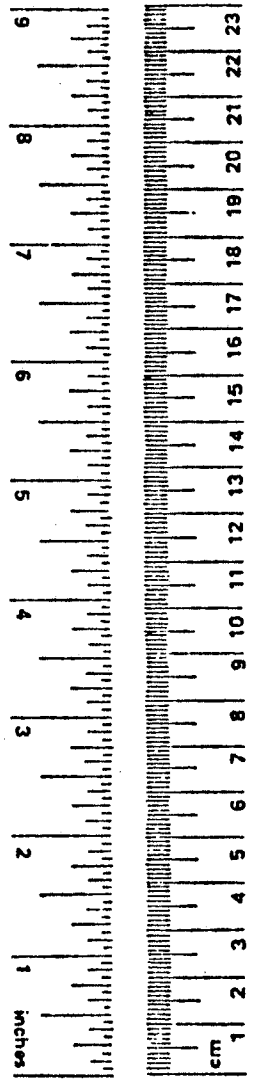
Form DOT F 1700.7 (8-69)

METRIC CONVERSION FACTORS

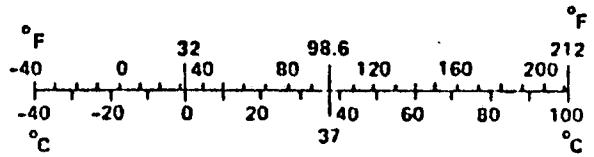
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.

THE NORTH FREEWAY TRANSITWAY
EVALUATION OF OPERATIONS DURING 1987
THE THIRD YEAR OF OPERATIONS

by

Robert W. Stokes
Associate Research Planner

Dennis L. Christiansen
Research Engineer

and

Stephen E. Ranft
Research Associate

Research Report 339-13

Improving Urban Mobility Through Application
of High-Occupancy Vehicle Priority Treatments
Research Study 2-10-84-339

Sponsored by
Texas 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

August 1988

ABSTRACT

This report presents an evaluation of the operation of the North Freeway (I-45N) Transitway in Houston, Texas for calendar year 1987. This represents an evaluation of the third year of transitway operation. Two previous reports have documented experiences during the first two years of transitway operation. This research report provides an analysis of trend data related to: 1) operation of the transitway; 2) operation of the freeway mainlanes; 3) combined transitway and freeway mainlane data; and 4) data relating to transit usage and operations. In comparing A.M. peak-direction data from December 1984 with combined freeway mainlane and transitway data representative of December 1987: 1) peak-hour person movement has increased by 30%; 2) A.M. peak-hour vehicle occupancy has decreased by 4%; 3) peak-period bus passenger trips have increased by 83%; and 4) vehicles parked in corridor park-and-ride lots have increased by 23%. A peak-hour measure of effectiveness frequently associated with high-occupancy vehicle projects is passenger-miles/hour (the multiple of peak-hour passengers times miles per hour). This measure of effectiveness (expressed in 1000's) has increased from 72 in December 1984, to a value of 87 passenger-miles/hour/lane in December 1987, an increase of 21%.

Key Words: High-Occupancy Vehicle Lanes, Transitways, Busways, HOV Facilities, Authorized Vehicle Lanes, Priority Treatment for High-Occupancy Vehicles, Contraflow Lane, Park-and-Ride

SUMMARY

This report presents an evaluation of the operation of the North Freeway (I-45N) Transitway in Houston, Texas for calendar year 1987. This summary section of the research report provides an overview of trend data related to: 1) operation of the transitway; 2) operation of the freeway mainlanes; 3) combined transitway and freeway mainlane data; and 4) data relating to transit usage and operations.

HOUSTON TRANSITWAY SYSTEM

The Houston Metropolitan area is developing approximately 70 miles of transitways within the rights-of-way of five radial freeways. The 71-mile system is being implemented at a total cost of approximately $500 million, and is being funded using state and federal highway dollars as well as federal and local transit monies. As of the end of 1987, 11.5 miles of transitway were operating on the Katy Freeway (I-10W), and 9.1 miles were in operation on the North Freeway (I-45N).

The first of the Houston transitways opened on the Katy Freeway (I-10W) in October 1984. The North Freeway (I-45N) Transitway opened in November 1984, replacing a temporary contraflow lane that had operated on the freeway since 1979. The Gulf Freeway (I-45S) Transitway became operational in May 1988.

The typical Houston transitway is located in the freeway median, is one-lane reversible, is approximately 20 feet wide, and is separated from mixed-flow traffic by concrete median barriers. Adequate space is provided for emergencies and breakdowns within the transitway cross-section. Access points are limited and controlled. Each transitway, however, differs slightly in terms of design, construction and operational features. The transitway on the North Freeway is currently open on weekdays for use by high-occupancy vehicles (HOVs) for 3 to 3.5 hours per peak period (A.M. and P.M.).

I-45 NORTH TRANSITWAY

The I-45N Transitway opened for operation in November 1984. This barrier-separated facility replaced a contraflow lane (CFL) that had operated in the corridor since 1979. The transitway was constructed as part of an overall freeway improvement project that is being implemented in four phases. The capital cost of the project from N. Shepherd to downtown was approximately $60 million, or $6.3 million per mile.

The priority lane is open for use by authorized buses and vanpools. The transitway operates in the southbound direction (toward downtown) from 5:45 to 8:45 A.M., and operates northbound from 3:30 to 7:00 P.M. Daily operations and enforcement are the responsibility of the Metropolitan Transit Authority of Harris County (METRO); the annual operations and enforcement cost is approximately $300,000.

Five park-and-ride lots currently serve the I-45N corridor. These five lots have a combined capacity of over 7000 vehicles. With the exception of the Woodlands Lot, which was developed by The Woodlands Corporation with a mixture of public and private funds, all the park-and-ride lots in the corridor are owned and operated by METRO.

SUMMARY OF TRANSITWAY AND MAINLANE DATA

Transitway Data

The transitway is currently carrying nearly 15,000 passenger trips per day. In terms of total daily volume, buses transport approximately 75% of transitway users in 44% of the vehicles and vanpools carry 25% of the persons in 56% of the vehicles. Since 1984, the most substantial increases in transitway volumes have occurred during the A.M. period (Table S-1). Transitway volumes in the P.M. operating period have generally decreased since 1984. The decreases observed during the P.M. period, however, have been offset by increases in utilization during the A.M. periods and an overall increase in vehicle occupancy rates. As a result, daily person movement on the transitway has increased by 12% since 1984 (Table S-1).

Table S-1. Summary of Selected Transitway Data

Data[a]	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change
Person Volume, Daily	13,150	14,722	+12%
A.M. Peak Hour	3,370	3,928	+17%
A.M. Peak Period	5,480	7,238	+32%
P.M. Peak Hour	4,575	3,765	-18%
P.M. Peak Period	7,670	7,484	-2%
Vehicle Volume, Daily	685	697	+2%
A.M. Peak Hour	190	189	-1%
A.M. Peak Period	290	329	+13%
P.M. Peak Hour	225	157	-30%
P.M. Peak Period	395	368	-7%
Vehicle Occupancy, (persons/vehicle)			
A.M. Peak Hour	17.7	20.8	+18%
Transitway Violation Rate	less than 1%	less than 1%	---

[a]Data collected at Little York Road.

The transitway accident rate for the period from 1986 through 1987 was 0.56 accidents per million vehicle miles. This is approximately 35% of the accident rate for the freeway mainlanes during that same time period. No accidents were recorded on the transitway during 1987.

Mainlane Data

Table S-2 presents a summary of selected freeway mainlane data. As shown in Table S-2, average mainlane vehicle occupancies and vehicle volumes have shown substantial increases, and person throughput on the mainlanes has increased over 1984 levels.

The increases in A.M. peak-hour travel speeds shown in Table S-2 are probably due in large part to the expansion of the freeway cross section from 3 lanes to 4 lanes in the vicinity of Little York Road. The freeway cross-

section is also being expanded to 4 lanes in the outbound (P.M.) direction. When this freeway widening is completed, P.M. speeds should improve considerably. The relatively slow current travel speed shown in Table S-2 for the P.M. peak-hour is probably due to these on-going construction activities.

Table S-2. Summary of Selected Freeway Mainlane Data

Data[a]	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change
Person Volume			
A.M. Peak Hour	4,450	6,240	+40%
A.M. Peak Period	10,560	15,950	+51%
P.M. Peak Hour	4,900	6,220	+27%
P.M. Peak Period	13,755	17,025	+24%
Vehicle Volume			
A.M. Peak Hour	4,060	5,550	+37%
A.M. Peak Period	9,450	14,240	+51%
P.M. Peak Hour	4,210	5,200	+24%
P.M. Peak Period	12,055	14,820	+23%
Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.10	1.12	+1.8%
P.M. Peak Hour	1.17	1.20	+2.6%
Travel Speed (mph)			
A.M. Peak Hour	31	42	+36%
P.M. Peak Hour	31	23	-26%
Accident Rate (accidents/MVM)	2.43	1.58	-35%

[a]Data collected at Little York Road.

The mainlane accident rate has decreased since the transitway opened. However, a number of mainlane improvements were implemented as part of the freeway/transitway improvement project, and the recent decline in the mainlane accident rate may be attributable to these improvements.

Combined Mainlane and Transitway Data

Relative to 1984 conditions, current A.M. peak-hour person volumes show substantial increases (Table S-3). There has been a decline in the combined freeway mainlane and transitway vehicle occupancy rates but these have been off-set by sizeable increases in vehicle and person volumes. Even with this recent decline in vehicle occupancy rate, vehicle occupancy in the North Freeway corridor is considerably higher than on other Houston Freeways (see Table S-5).

Table S-3. Combined Freeway Mainlane and Transitway Data

Combined Mainlane and Transitway Characteristic	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change
Person Volume			
A.M. Peak Hour	7,820	10,170	+30%
P.M. Peak Hour	9,475	9,985	+5%
Vehicle Volume			
A.M. Peak Hour	4,250	5,740	+35%
P.M. Peak Hour	4,435	5,355	+21%
Average Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.84	1.77	-4%
P.M. Peak Hour	2.14	1.87	-13%
Transitway Travel Time Savings (minutes)			
A.M. Peak Hour	---	8	---
P.M. Peak Hour	---	9	---

BUS TRANSIT DATA

Table S-4 presents of summary of bus transit data for the North Transitway. Since the transitway opened, passenger volumes have shown substantial increases. Increases in passenger volumes have been more pronounced than the increases in vehicle trips, as evidenced by the increases

Table S-4. Summary of Bus Transit Data

Data	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change
Bus Passengers			
A.M. Peak Hour	1,570	2,865	+83%
P.M. Peak Hour	2,790	3,025	+8%
Bus Vehicle trips			
A.M. Peak Hour	40	72	+80%
P.M. Peak Hour	80	77	-4%
Average Bus Occupancy (persons/bus)			
A.M. Peak Hour	38.3	39.8	+ 4%
P.M. Peak Hour	34.9	39.3	+13%
Vehicles parked at Park-and-Ride Lots	3,738	4,590	+23%

in average bus occupancy levels. Park-and-Ride lot utilization has also shown substantial increases in recent years.

COMPARISON OF FREEWAYS WITH/WITHOUT TRANSITWAYS

The data presented in Tables S-1 through S-4 indicate that substantial improvements in travel conditions have occurred since the North Transitway opened. In an attempt to determine how much of that change is the result of providing transitways, data from the North and Katy Freeways were compared with similar data from other Houston freeways that do not have transitways (Table S-5). While substantial changes have occurred on the North and Katy Freeways since the opening of the transitways, this is not the case with freeways that do not have transitways. It appears that provision of transitway lanes is responsible for most of the changes that have occurred in the North and Katy corridors.

Table S-5. Comparison of Measures of Effectiveness for Houston Freeways With and Without Transitways

Measures of Effectiveness	"Representative" 1984 Value	"Representative" 12/87 Value	% Change
Average A.M. Peak-Hour Vehicle Occupancy			
Katy Freeway (with/transitway)	1.26	1.53	+21%
North Freeway (with/transitway)	1.84	1.77	-4%
Freeways without Transitway[a]	1.29	1.25	-3%
Peak-Period Bus Passengers			
Katy Freeway (with/transitway)	900	2,485	+176%
North Freeway (with/transitway)	3,175	5,546	+75%
Freeways without Transitway[a]	1,188	1,111	-6%
Cars Parked at Park-and-Ride Lots			
Katy Freeway (with/transitway)	575	1,368	+138%
North Freeway (with/transitway)	3,738	4,590	+23%
Freeways without Transitway[a]	2,722	3,033	+11%
Facility Per Lane Efficiency[b]			
Katy Freeway (with/transitway)	36	86	+139%
North Freeway (with/transitway)	72	87	+21%
Freeways without Transitway[a]	59	42	-29%

[a]Combined data for Northwest (US 290), Southwest (US 59S) and Gulf (I-45S) Freeways.
[b]A.M. Peak-Hour, peak-direction passenger-miles per hour per lane.

A.M. PEAK-HOUR MEASURE OF LANE EFFICIENCY

In assessing the efficiency of a traffic lane, a measure that is commonly used is passenger-miles per hour per lane (peak-hour person volume times average vehicle speed). This takes into account both the magnitude of persons transported as well as the speeds at which they are moved.

As shown in Table S-6, the efficiency of the North Transitway lane is nearly 4 times that of a general purpose freeway mainlane. Since the transitway was implemented, the overall per lane efficiency on the North Freeway has increased by 21%.

Table S-6. A.M. Peak Hour Per Lane Efficiency[a] (passenger-miles per hour), North Freeway and Transitway

Roadway	"Representative" 12/84 Value (1000's)	"Representative" 12/87 Value (1000's)	% Change
North Freeway Mainlanes	39	58	+48%
North Transitway Lane	--	216	---
Combined North Freeway Mainlanes and Transitway[b]	72	87	+21%

[a]A.M. peak-hour, peak-direction lane efficiency equals person volume per lane multiplied by average operating speed.

[b]This is the multiple of total peak-hour passengers (freeway plus transitway) multiplied by the weighted average speed and divided by number of lanes.

IMPLEMENTATION STATEMENT

This study was sponsored by the Texas State Department of Highways and Public Transportation as part of a research effort entitled "Improving Urban Mobility Through Application of High Occupancy Vehicle Priority Treatments". An objective of this research is to perform comprehensive before-and-after evaluations of the five freeway transitways being implemented in Houston, Texas. An intent of these evaluations is to develop guidelines for planning, designing and operating transitways on urban freeways in Texas. The first of the Houston transitways opened on the Katy Freeway (I-10W) in October 1984. The North Freeway (I-45N) Transitway opened in November 1984 and replaced a contraflow lane that had operated in the corridor since 1979. The Gulf Freeway (I-45S) Transitway became operational in May 1988. This third year report presents a summary of operations on the North Transitway and North Freeway. The report focuses primarily on data collected during calendar year 1987.

DISCLAIMER

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

I. INTRODUCTION

HOUSTON TRANSITWAY SYSTEM

The Houston Metropolitan area is developing approximately 70 miles of transitways within the rights-of-way of five radial freeways (Figure 1). The 70-mile system is being implemented at a total cost of approximately $500 million, and is being funded using state and federal highway dollars as well as federal and local transit monies. As of the end of 1987, 11.5 miles of transitway were operating on the Katy (I-10W) Freeway, and 9.1 miles were in operation on the North (I-45N) Freeway.

The first of the Houston transitways opened on the Katy Freeway (I-10W) in October 1984. The North Freeway (I-45N) Transitway opened in November 1984, replacing a temporary contraflow lane that had operated on the freeway since 1979. The Gulf Freeway (I-45S) Transitway became operational in May 1988.

The typical Houston transitway is located in the freeway median, is one-lane reversible, is approximately 20 feet wide, and is separated from mixed-flow traffic by concrete median barriers. Adequate space is provided for emergencies and breakdowns within the transitway cross-section. Access points are limited and controlled. Each transitway, however, differs slightly in terms of design, construction and operational features. The transitway on the North Freeway is currently open on weekdays for use by high-occupancy vehicles (HOVs) for 3 to 3.5 hours per peak period (A.M. and P.M.). The transitways on the Katy and Gulf Freeways are open from 4:00 A.M. to 1:00 P.M. in the inbound direction, and from 2:00 P.M. to 10:00 P.M. in the outbound direction.

Based on experience gained from the operation of the I-45N Contraflow Lane (CFL), which preceded the I-45N Transitway, only vehicles authorized by the Metropolitan Transit Authority (METRO) and the State Department of Highways and Public Transportation (SDHPT) are allowed to use the North Transitway. The authorization process involves several considerations, including driver instruction, vehicle inspection, certain insurance

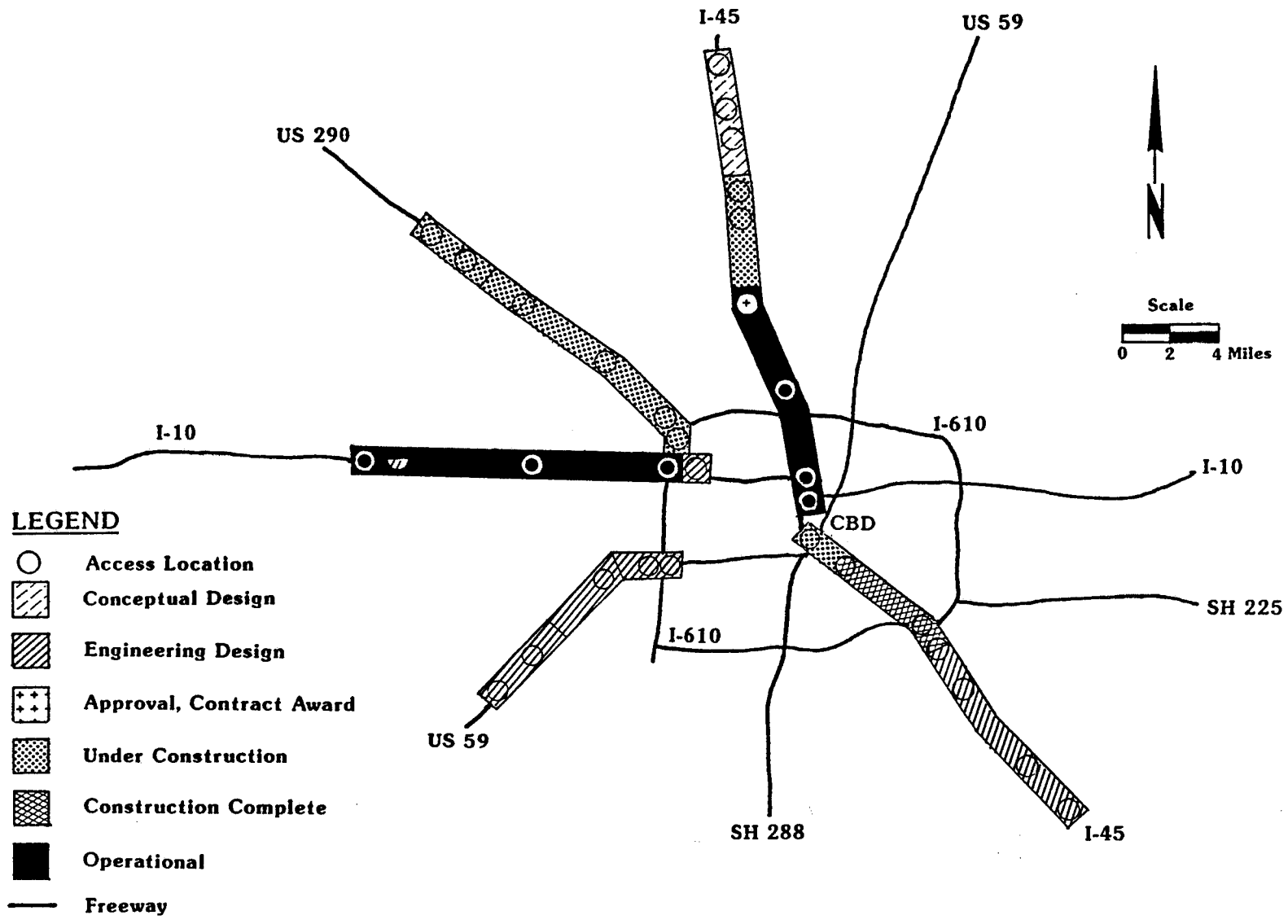


Figure 1. Status of Houston Transitway System (December 1987)

requirements, and a minimum number of registered riders. In addition to providing a level of operational control, the authorization process is considered desirable in that it requires some driver training. At the present time, only authorized buses and vanpools are allowed access to the North Transitway.

STUDY OBJECTIVES

The overall objective of this research effort ("Improving Urban Mobility Through Application of High-Occupancy Vehicle Priority Treatments") is to perform a comprehensive before-and-after evaluation of the five freeway transitways being implemented in Houston, Texas. The intent of these evaluations is to develop guidelines for planning, designing and operating transitways on urban freeways in Texas. This report presents a summary of third year (CY 1987) operations on the North Transitway and North Freeway. Two previous research reports (1, 2) analyzed the first two years of transitway operations.

DATA COLLECTION PROGRAM

In order to perform the comprehensive before-and-after evaluation of the transitways being implemented in Houston, pertinent data have been collected on a regular basis since June 1983. The data collection program has been designed to provide a longitudinal sampling of data before, during, and after implementation of most of Houston's transitways. Unfortunately, the data collection program was not initiated prior to implementation of the I-45N CFL. As a result, the "before data" (i.e., before 1983) are not as comprehensive as the "after data" (i.e., since 1983).

The general types of data being collected include: 1) Peak and off-peak direction travel times; 2) Peak direction traffic volumes and vehicle occupancies; and 3) Park-and-ride lot demand. Data for the North Freeway are collected at Little York Road (See Figure 3). This location is between an exit and an entrance ramp and, as a result, data from this site may understate absolute freeway mainlane volumes. The data should, however, accurately reflect traffic trends. It should also be noted that in May 1987,

the freeway cross-section at Little York was increased from 3 lanes to 4 lanes per direction. This site was selected for purposes of safety and visibility during data collection.

ORGANIZATION OF THE REPORT

In addition to this introductory section, the report consists of the following six major sections.

II. Study Corridor. This section of the report provides an overview of the North Freeway (I-45N) Study Corridor. Section II of the report provides a brief historical sketch of the North Transitway and its support facilities, presents capital and operating cost summaries, and outlines additional improvements that are being considered for the corridor.

III. Transitway Data. Section III of the report summarizes traffic and operations data for the North Transitway for CY 1987. Data summaries are provided for person and vehicle volumes, vehicle occupancies, and transitway lane violations, vehicle breakdown and accident rates. Issues relating to the effectiveness of the transitway and its travel demand impacts are also discussed.

IV. Mainlane Data. Section IV summarizes traffic and operations data for the North Freeway mainlanes for CY 1987. The data summaries in this section of the report include mainlane person and vehicle volumes, vehicle occupancies, mainlane travel times, mainlane accident rates, and mainlane measures of effectiveness.

V. Combined Transitway and Mainlane Data. This section combines the data presented in Sections III and IV and presents a summary of total travel on the North Freeway.

VI. Transit Data. Data related to transit use and operations are presented in this section of the report. The data summaries include ridership characteristics, bus passenger and vehicle trips, bus occupancies, and utilization of the park-and-ride facilities in the study corridor.

VII. Conclusions. The final section of the report presents the conclusions drawn from the analyses. These conclusions are presented in terms of the effects of the transitway on total freeway capacity and operations. A number of transitway-related issues that may need to be addressed in the future are also presented.

Readers who are primarily interested in a statistical overview of the study are referred to the Summary at the front of the report and the brief summaries presented at the conclusions of Sections III, IV, V, and VI.

II. STUDY CORRIDOR

OVERVIEW

The I-45 North Freeway is a major north-south highway serving travel demands in north Houston and Harris County and central Montgomery County (Figure 2). Extensive residential and commercial development and population growth have led to increasing levels of traffic congestion throughout the corridor. Average daily traffic volume on I-45N in 1987 was 160,000 vehicles in an 8-lane section near I-610. Peak direction freeway speeds averaged less than 30 MPH during both the morning and afternoon peak hours. The North Freeway has been one of Houston's more congested freeways for many years.

I-45 NORTH TRANSITWAY

Project Description

In 1979, the Texas State Department of Highways and Public Transportation (SDHPT) and the Metropolitan Transit Authority of Harris County (METRO) jointly developed a 9.6 mile contraflow lane (CFL) on the I-45 North Freeway between downtown Houston and North Shepherd Drive (Figure 3). This project was an interim measure designed to relieve some of the corridor congestion by providing additional peak-direction capacity. This peak-direction capacity was obtained without extensive roadway construction by "borrowing" a lane from the off-peak direction roadway and dedicating it to authorized high-occupancy vehicles (buses and vanpools) traveling in the peak direction. Utilization of the CFL increased from 2900 daily passengers in September 1979 to more than 16,500 daily passengers (its highest utilization rate) in September 1983 (1). Because of the high occupancy rates of the vehicles utilizing the contraflow lane, the lane was serving more person trips during a typical peak hour of operation than two adjacent freeway lanes, and at a much higher level of service. In March 1981, the SDHPT and METRO implemented a 3.3 mile concurrent flow lane (CCFL) in the inbound median shoulder of the freeway, thus extending the priority operation in the morning to West Road (Figure 3).

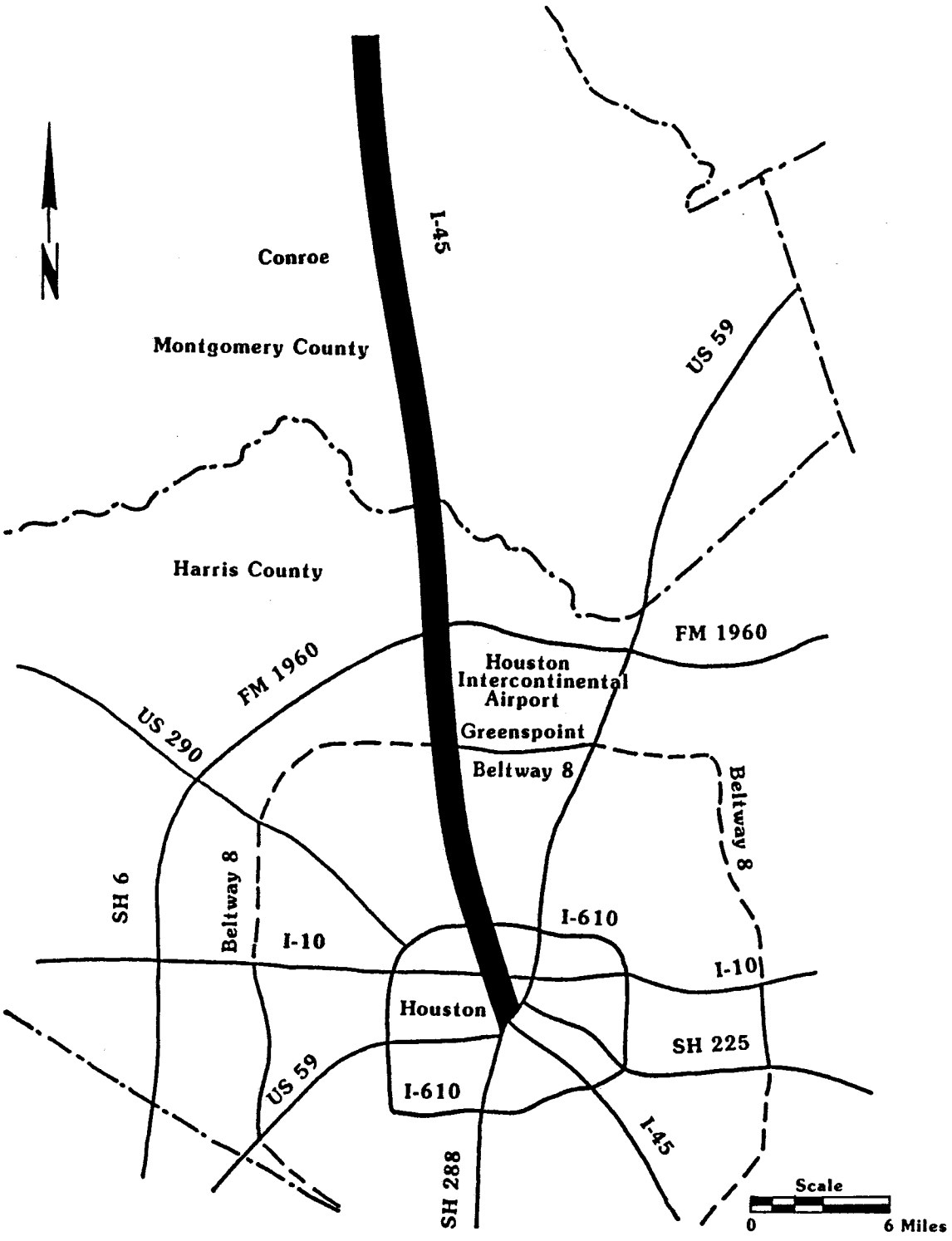


Figure 2. I-45 North Freeway Corridor

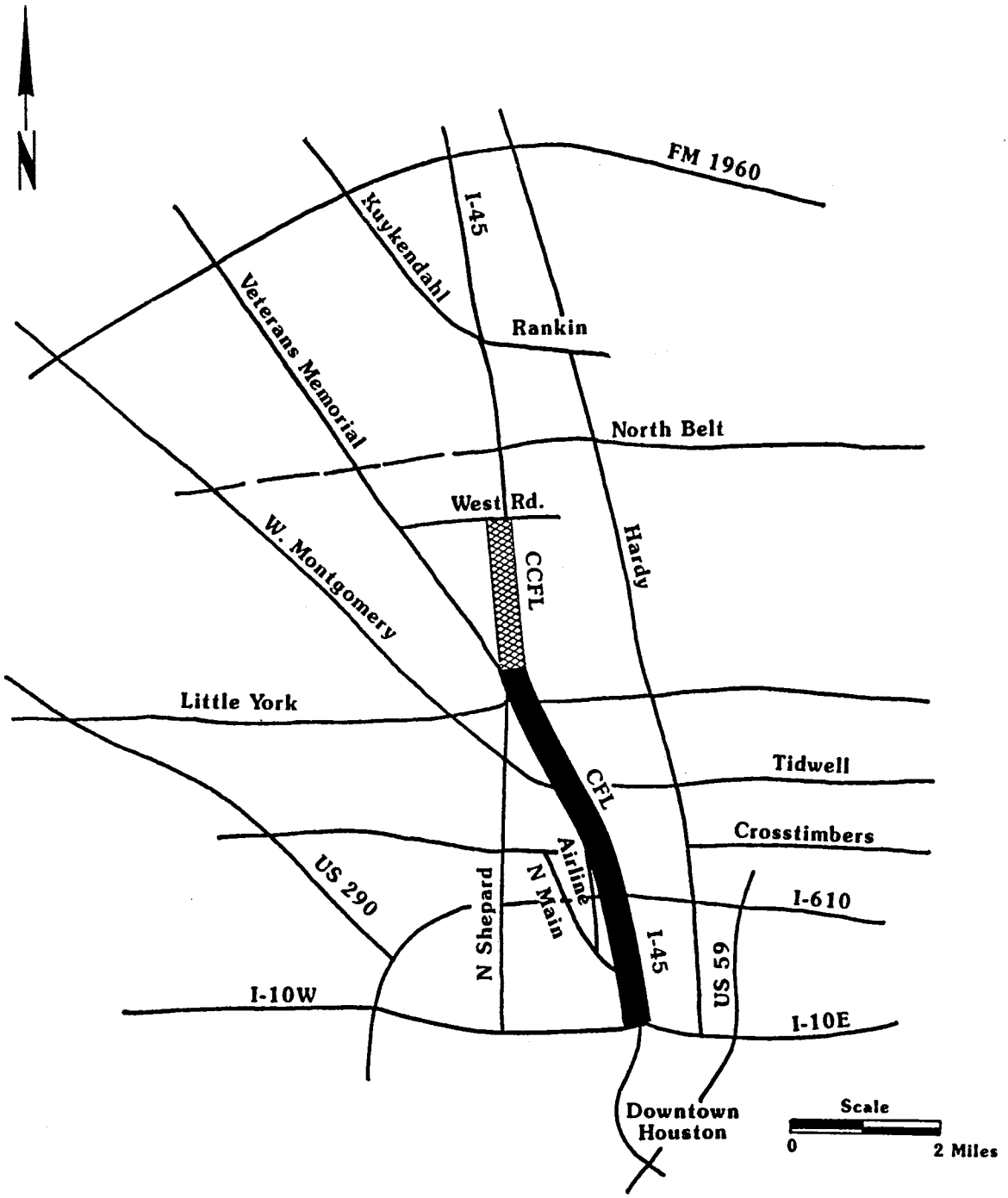


Figure 3. Limits of Pre-Transitway HOV Priority Treatments on the I-45 N Freeway

The contraflow project was considered an interim solution to the need in the corridor for additional capacity. Increases in traffic demands in the off-peak direction precluded the continued operation of the CFL beyond the mid 1980's, without increasing off-peak direction congestion to unacceptable levels (3). Although the continuation of the contraflow project was no longer desirable, it was neither economically nor physically feasible to provide enough additional freeway lanes to satisfy even existing peak-period travel demand, much less serve projected demand levels. The need for a transitway was clear. Moreover, the construction of a transitway within a relatively short time frame was critical in order to preserve the express transit benefits and the resulting transit ridership levels that were derived from the contraflow lane operation.

In 1982, the SDHPT and METRO agreed to develop a transitway in the median of the I-45 North Freeway as part of a corridor improvement project. This project included widening bridges, resurfacing the freeway, providing more efficient and safer lighting and drainage, as well as increasing the freeway capacity along a 9 mile segment of the freeway from the North Loop (I-610) to the North Belt (Beltway 8).

The I-45 North Freeway Transitway and Freeway Improvement Project is being implemented in four phases (Figure 4). Phase I construction extended from downtown Houston to North Shepherd Drive, essentially replacing the contraflow lane with a 16 foot wide, barrier-separated, reversible HOV lane in the freeway median (this narrow transitway width existed only until freeway construction was completed). Phase IA involved the relocation of signing and lighting in order to clear the freeway median for the reversible lane. Phase IB provided for the reconstruction of the median to place the priority lane within the freeway median so that it could be protected from the freeway mainlanes by concrete median barriers. Phase I construction was completed, contraflow operations ceased, and barrier-separated transitway operations began in November 1984. Phase II construction, which began in March 1985, included freeway widening, shoulder replacement, construction of u-turn lanes, and widening of the transitway to its final width. The limits of this project were from North Shepherd to near downtown (Quitman Street). The project was completed in May 1987. The Phase III construction, which

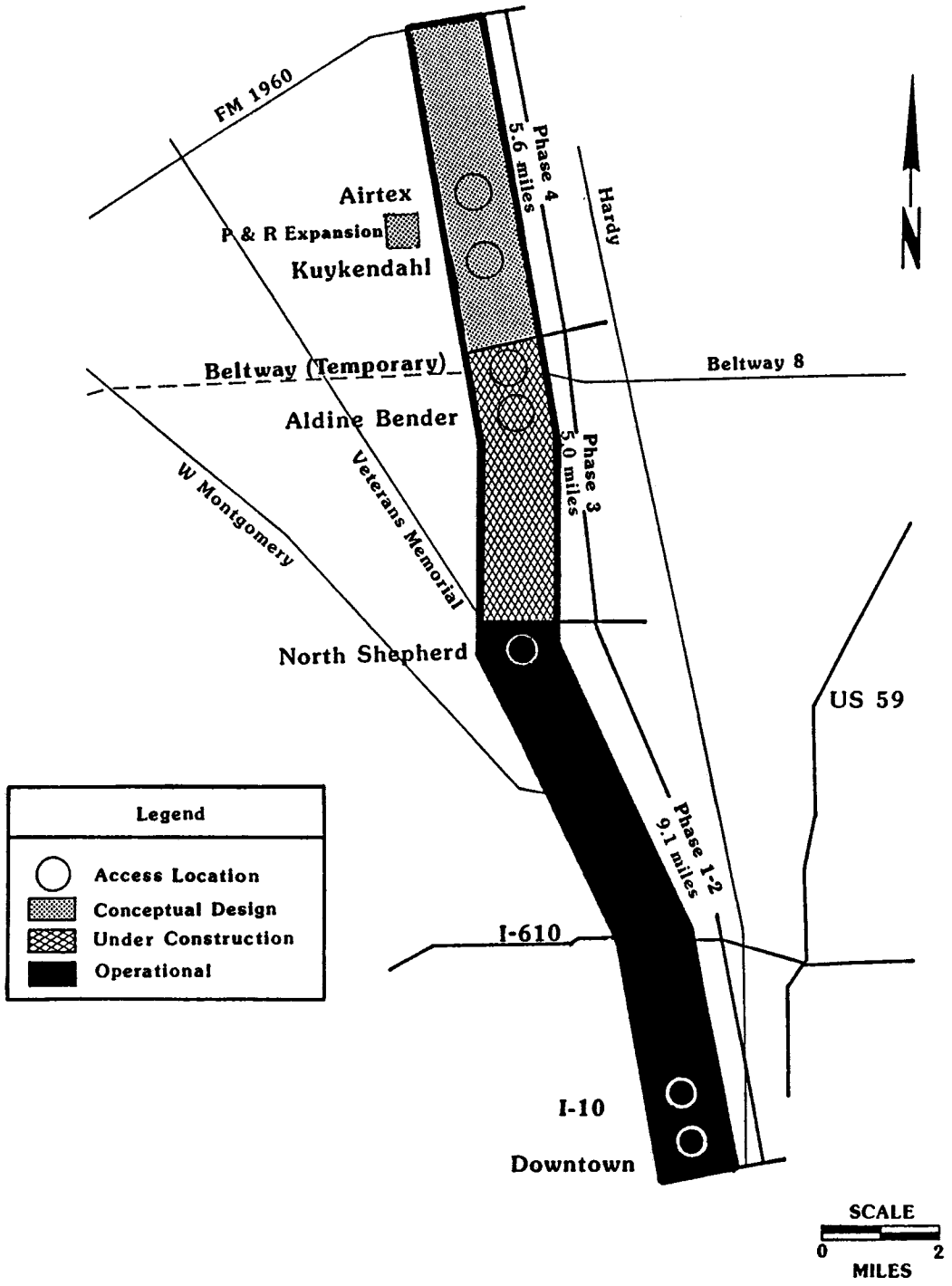


Figure 4. I-45 North Freeway Construction Phases

will extend the transitway from North Shepherd to Beltway 8, began in April 1986. The project, which also includes freeway rehabilitation and widening, replacement of bridge structures, intersection improvements, and transitway construction (including an elevated transitway interchange), is scheduled for completion in October 1989. The transitway is expected to become operational in this section in a temporary configuration in October 1988. The Phase IV segment is undergoing conceptual design and is scheduled to become operational by 1993.

Capital and Operating Costs

In order to expedite the construction of the project's first two phases, METRO agreed to fund both the transitway- and freeway-related costs for Phases I and II, and SDHPT agreed to fund and construct Phase III. Phase IV is to be jointly funded, with SDHPT supervising the construction. The total expected costs for each phase of the transitway and freeway construction are shown in Table 1.

Table 1. I-45 North Freeway Construction Costs

Project Phase	Total Costs	Cost/Mile
Phase I:		
Interim Transitway - North Shepherd to Downtown Actual Costs	$13.0 M	$1.35 M
Phase II:		
Transitway and Freeway Widening - North Shepherd to Downtown Actual Costs	$46.7 M	$ 4.9 M
Phase III:		
Transitway and Freeway Widening - Beltway 8 to North Shepherd Engineer's Estimate	$74.0 M	$16.4 M
Phase IV:		
Beltway 8 to FM 1960 Preliminary Estimate	$57.7 M	$10.3 M

Source: Houston METRO.

METRO is responsible for day-to-day operations of both the North and Katy Transitways. The cost of operating both these facilities is estimated by METRO to be $50,000 per month ($25,000 per facility). This includes costs for both operational and enforcement staffs as well as vehicle maintenance.

Park-and-Ride Facilities

The locations of the five park-and-ride lots currently serving the I-45N corridor are shown in Figure 5. These five lots have a combined capacity of over 7000 vehicles. With the exception of the Woodlands Lot, which was developed by The Woodlands Corporation with a mixture of public and private funds (2), all the park-and-ride lots in the corridor are owned and operated by METRO. Utilization of these lots is discussed in detail in Section VI.

Future Improvements

Plans have been developed to extend the transitway from its current terminus at N. Shepherd to FM 1960, a distance of 10.1 miles (Figure 4). This extension will be completed in two phases as part of a general freeway improvement project.

Two intermediate access points will be constructed as the transitway is extended to the north. An elevated fly-over (wish-bone) connection will be provided at Aldine-Bender, and a direct access ramp will be constructed at the Kuykendahl Park-and-Ride Lot.

The extension of the transitway to FM 1960 and the related freeway mainlane improvements are estimated to cost $132 million (see Table 1). These improvements are scheduled to be completed by 1993.

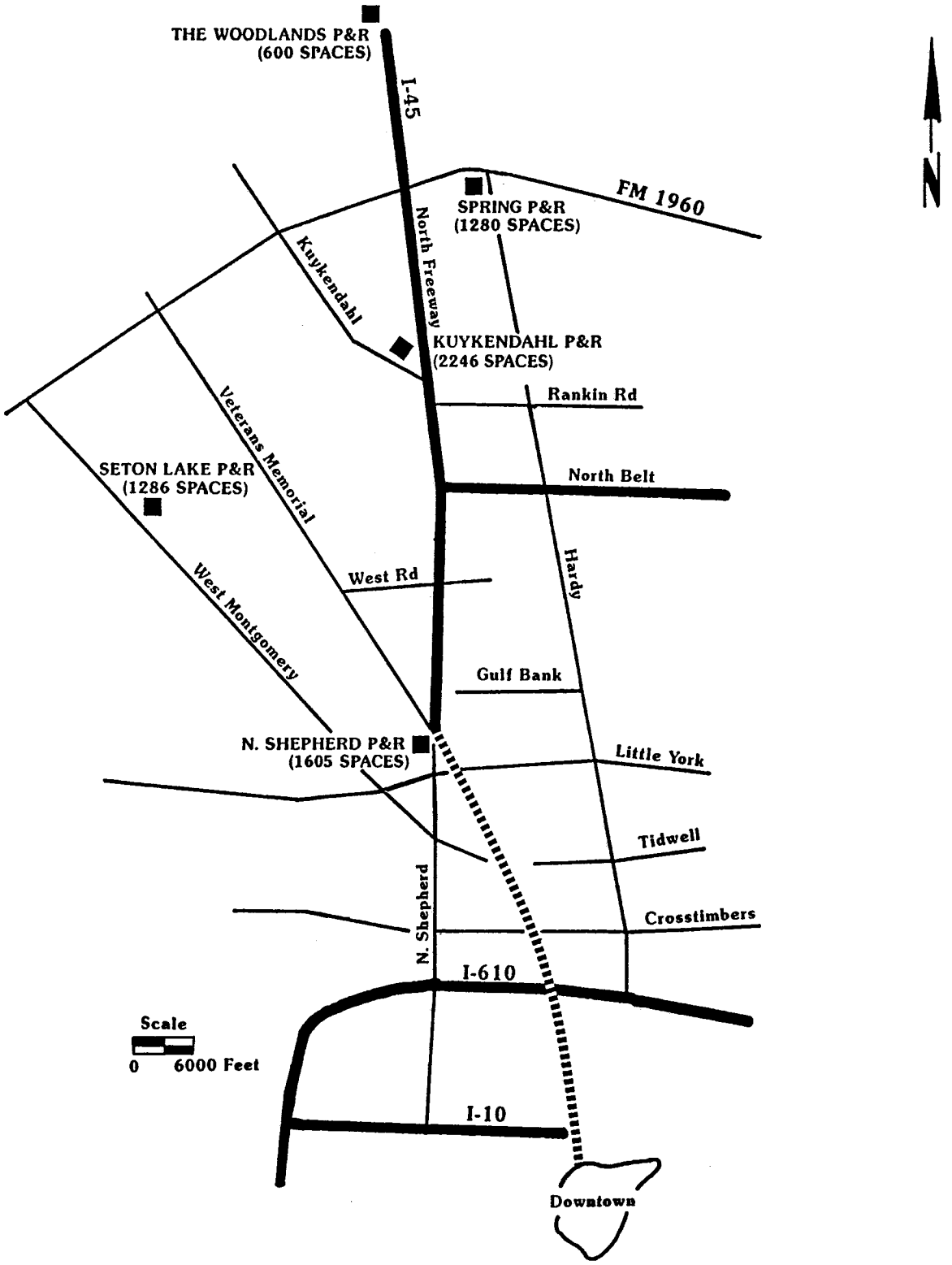


Figure 5. I-45 North Freeway Corridor Park-and-Ride Lots

III. TRANSITWAY DATA

TRANSITWAY PERSON VOLUMES

Daily Person Movement

Trends in daily person movement on the North Transitway are shown in Figure 6. Daily person volume includes the A.M. and the P.M. operating hours. In September 1987, the transitway operating schedule was extended 15 minutes in the morning and 30 minutes in the afternoon, as shown below.

- Before September 1, 1987

  A.M. Hours of Operation = 6:00 - 8:45 A.M.
  P.M. Hours of Operation = 3:45 - 6:45 P.M.

- After September 1, 1987

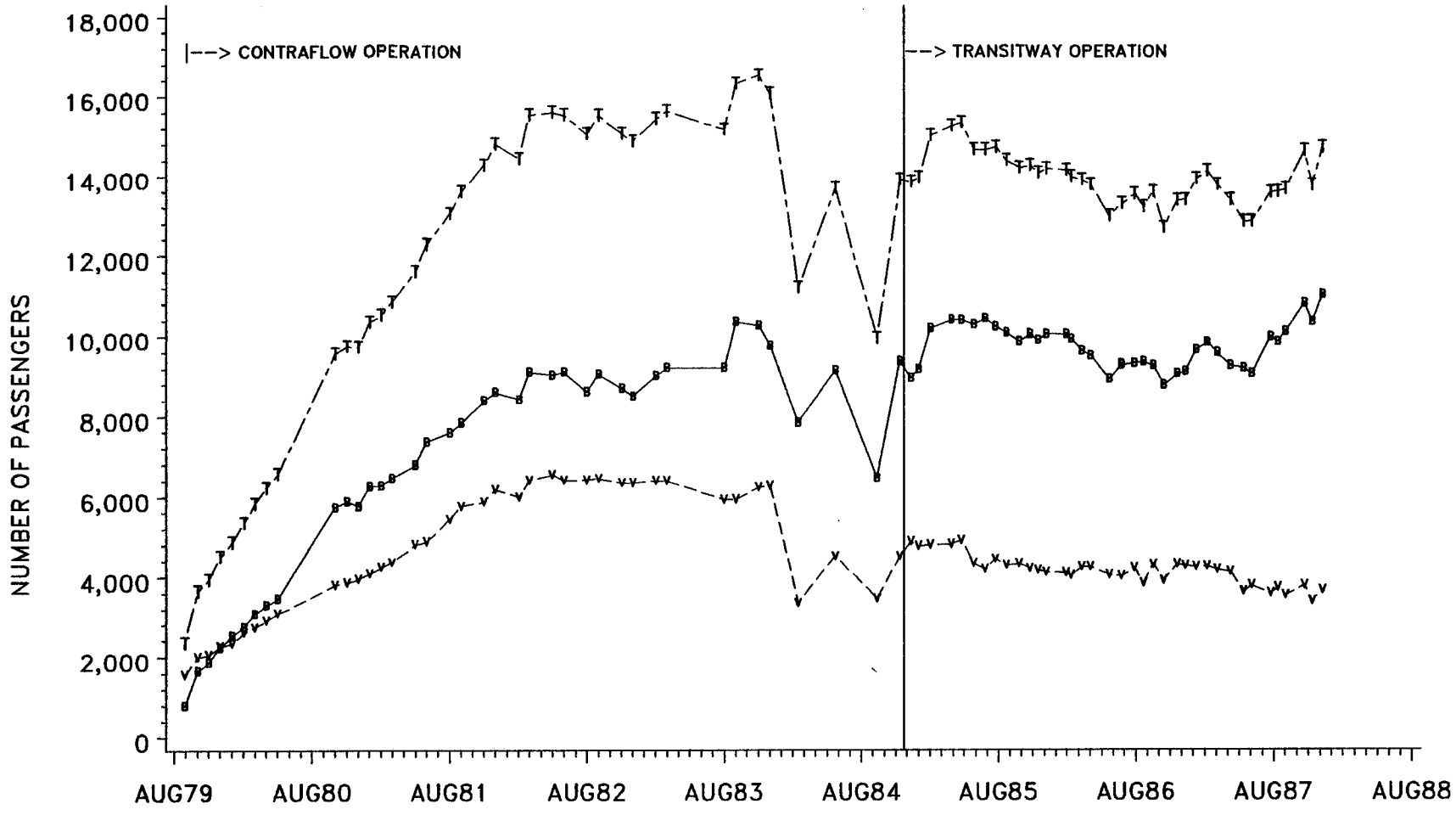
  A.M. Hours of Operation = 5:45 - 8:45 A.M.
  P.M. Hours of Operation = 3:30 - 7:00 P.M.

Daily person movement on the North Transitway in December 1987 was approximately 14,700 persons (Table 2). Buses served 75% of this demand, and vanpools served 25%. Between December 1986 and December 1987, daily person movement increased by 10%. Annual increases in daily person movements for the period 1984-86 have been on the order of 4% to 6%.

Table 2. Changes in North Transitway Person Movement, December 1984-December 1987

Time Period	Person Volume[a] (12/87)	Percent Change		
		12/84-12/87	12/85-12/87	12/86-12/87
A.M. Peak Hour	3928	-5.2%	-3.2%	-2.1%
A.M. Peak Period	7238	+8.5%	+0.5%	+9.0%
P.M. Peak Hour	3765	-12.2%	+0.8%	+7.3%
P.M. Peak Period	7484	+4.1%	+7.0%	+10.5%
Daily Total	14722	+6.2%	+3.7%	+9.7%

[a]Measured at Little York Road (See Figure 3).



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M. AND 3:30 TO 7:00 P.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PASSENGERS
B = BUS PASSENGERS
V = VANPOOLERS

Figure 6. Trends in North Transitway Daily Person Movement

A.M. Person Movement

Figures 7 and 8 show trends in A.M. peak hour and A.M. peak period person movement on the North Transitway. In December 1987, over 3900 persons were moved on the transitway during the A.M. peak hour (Table 2). This represents a 2% decrease from December 1986, and a 3% to 5% decrease from 1984 and 1985. During the A.M. peak hour in December 1987, 73% of the person movement was accommodated by buses, and 27% by vanpools.

In December 1987, 7200 persons were moved on the transitway during the A.M. peak period. This represents a 9% increase from December 1986. A comparable increase (8.5%) was observed for the period from December 1984 to December 1987. For the period December 1985 to December 1987, the increase was only 0.5%. In December 1987, 77% of the A.M. peak period person demand was served by buses, and 23% was served by vanpools.

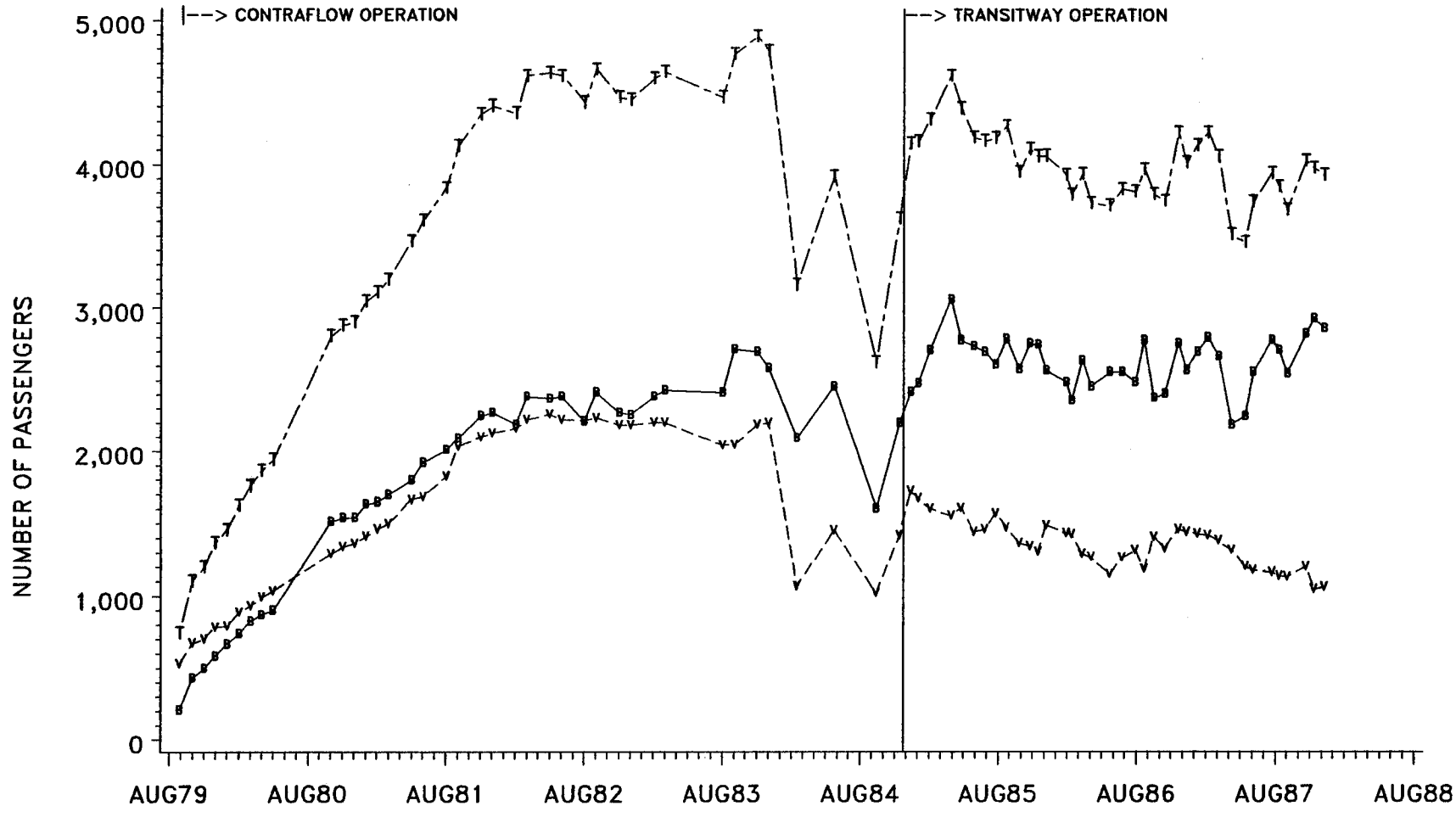
P.M. Person Movement

Figures 9 and 10 summarize trends in P.M. peak hour and P.M. peak period person movement on the North Transitway. In December 1987, 3800 persons were moved on the transitway during the P.M. peak hour (Table 2). This represents a 7% increase from December 1986, and a 12% decrease from December 1984. During the P.M. peak hour, 80% of the person demand was served by buses, and 20% was served by vanpools.

During the P.M. peak period in December 1987, 7500 persons utilized the transitway. This represents an 11% increase over the previous year. The December 1987 person volumes were 4% to 7% higher than those observed during December 1984 and December 1985. Approximately 74% of the December 1987 P.M. peak period person demand was served by buses, and 26% was served by vanpools.

COMPARISON WITH OTHER HOV PROJECTS

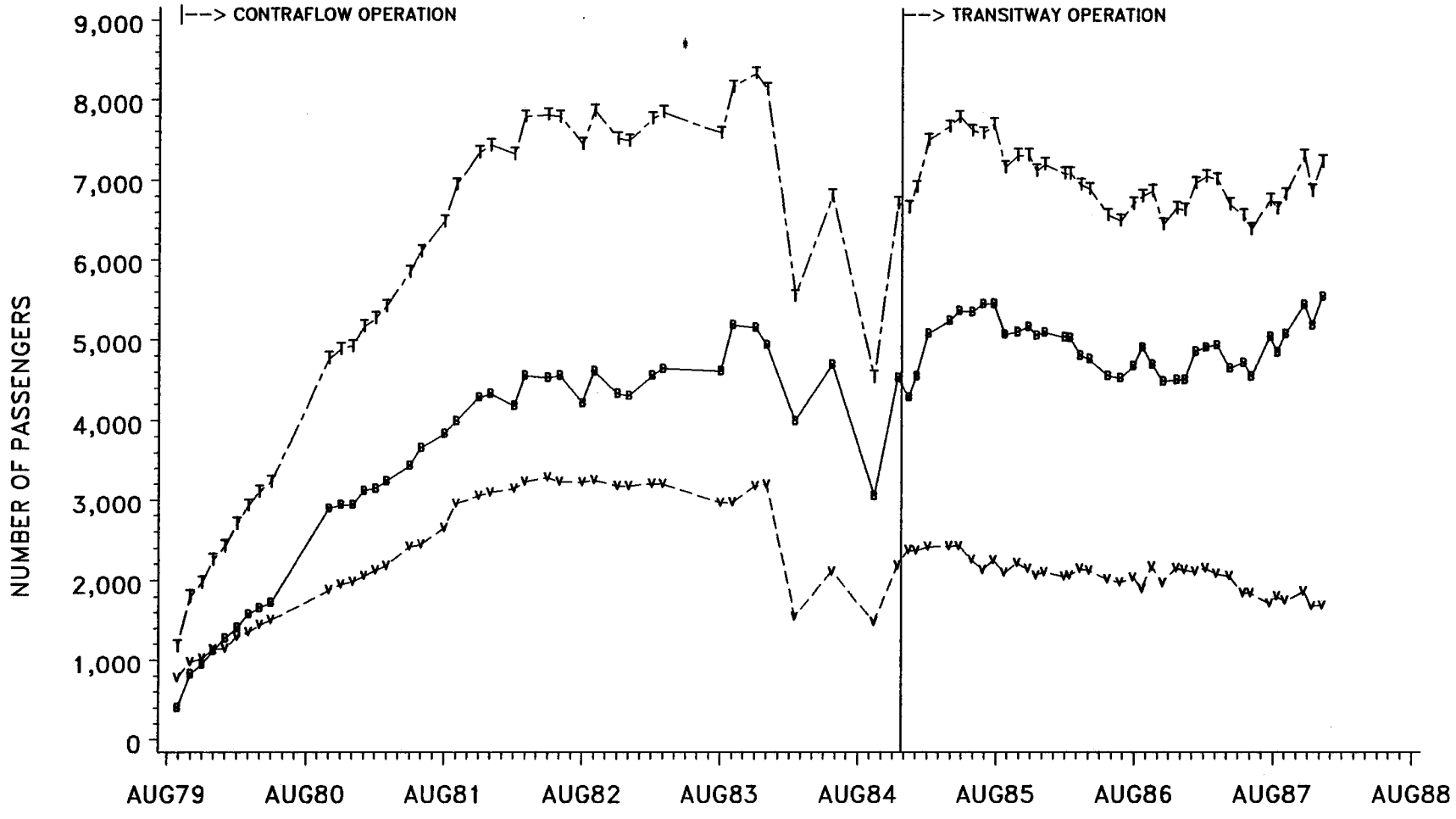
Table 3 presents a comparison of A.M. person movement on selected HOV facilities. An examination of the data in Table 3 shows that (with the



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45•A.M.
DATA BEFORE 6/83 ESTIMATED FROM PEAK PERIOD DATA
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PASSENGERS
B = BUS PASSENGERS
V = VANPOOLERS

Figure 7. Trends in North Transitway A.M. Peak Hour Person Movement

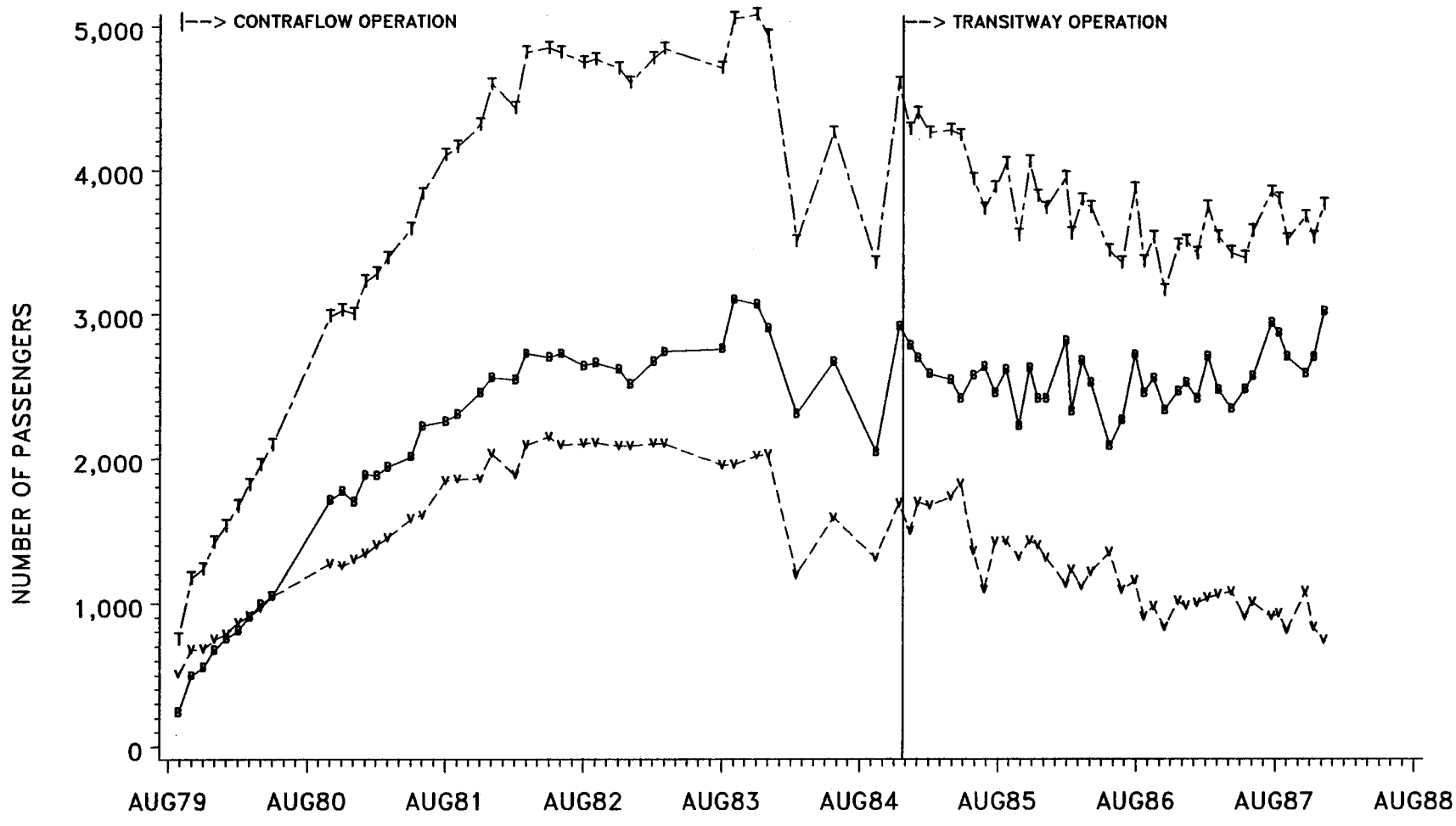


NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PASSENGERS
B = BUS PASSENGERS
V = VANPOOLERS

Figure 8. Trends in North Transitway A.M. Peak Period Person Movement



NORTH TRANSITWAY OPERATES FROM 3:30 TO 7:00 P.M.
DATA BEFORE 6/83 ESTIMATED FROM PEAK PERIOD DATA
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PASSENGERS
B = BUS PASSENGERS
V = VANPOOLERS

Figure 9. Trends in North Transitway P.M. Peak Hour Person Movement

NORTH TRANSITWAY OPERATES FROM 3:30 TO 7:00 P.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PASSENGERS
B = BUS PASSENGERS
V = VANPOOLERS

Figure 10. Trends in North Transitway P.M. Peak Period Person Movement

exception of the Lincoln Tunnel facility) the North Transitway person volumes are comparable to those observed on other "non-carpool" HOV facilities.

Table 3. A.M. Person Movement for Selected HOV Facilities

HOV Facility	Eligible Vehicles	A.M. Person Movement
Lincoln Tunnel, N.J. Rte. 495	Buses	65,600
Shirley Highway, Washington, D.C.	4+ Carpools	27,000
I-66, Washington, D.C.	3+ Carpools	16,800
Rte. 55, Orange County, CA	2+ Carpools	12,400
San Bernardino, Los Angeles	2+ Carpools	12,200
Rte. 91, Los Angeles	3+ Carpools	10,500
Katy, Houston	2+ Carpools	9,100
East Patway, Pittsburgh	Buses	8,600
U.S. 101, San Francisco	3+ Carpools	7,400
NORTH, HOUSTON	Buses and Vans	7,200
Rte. 520, Seattle	3+ Carpools	5,100
South Patway, Pittsburgh	Buses	4,500

Source: (4).

TRANSITWAY VEHICLE VOLUMES

Daily Vehicle Volumes

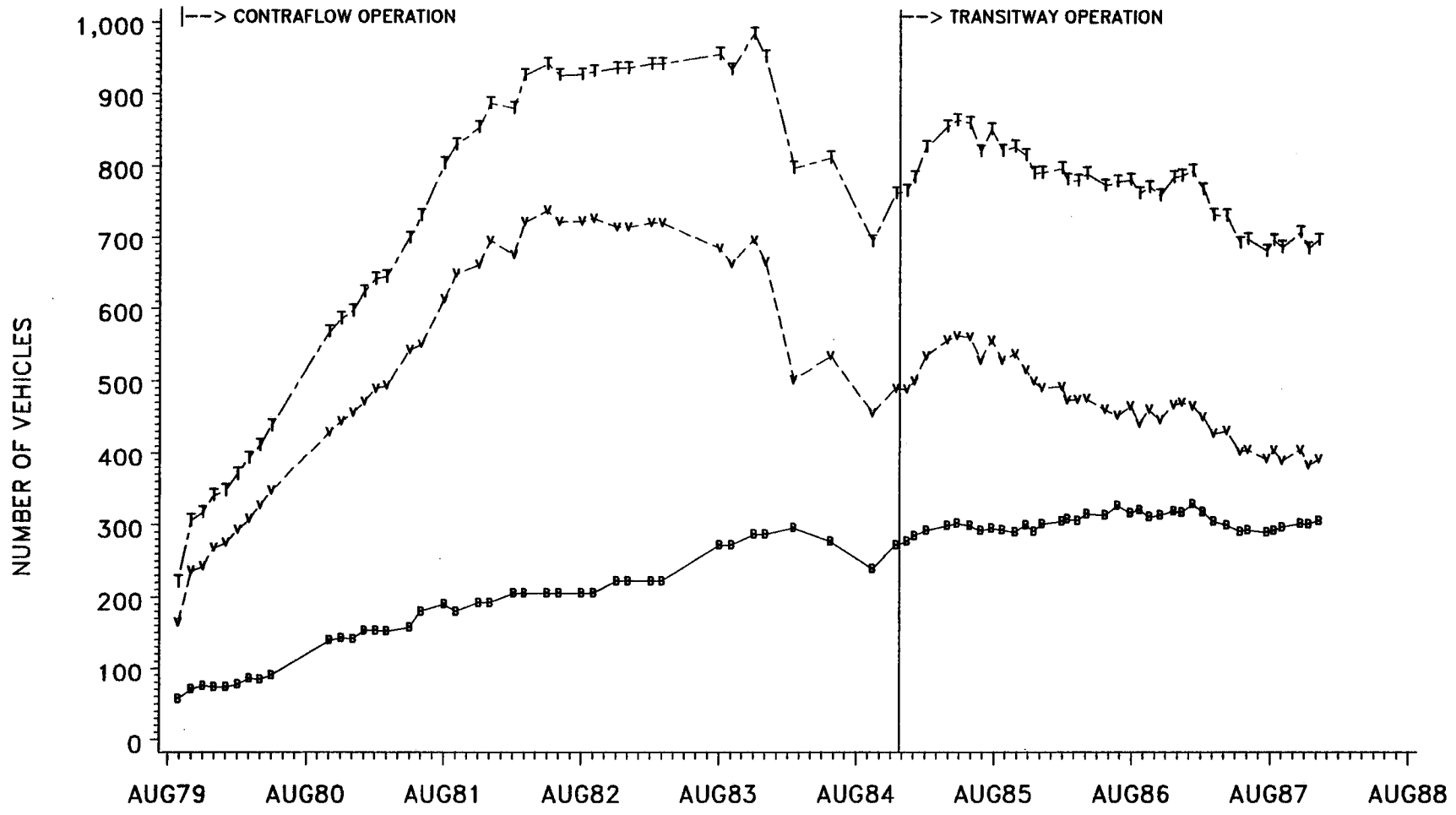
Trends in daily vehicle volumes on the North Transitway are shown in Figure 11. In December 1987, total daily traffic on the transitway was 697 vehicles. Of this total, 306 (44%) were buses, and 391 (56%) were vanpools.

A.M. Vehicle Volumes

Figures 12 and 13 show A.M. peak hour and A.M. peak period vehicle volumes on the North Transitway. In December 1987, 72 buses and 117 vanpools were observed during the A.M. peak hour. In the A.M. peak period, 150 buses and 179 vanpools utilized the transitway.

P.M. Vehicle Volumes

Figures 14 and 15 summarize P.M. peak hour and P.M. peak period transitway vehicle volumes. During the P.M. peak hour in December 1987, 77

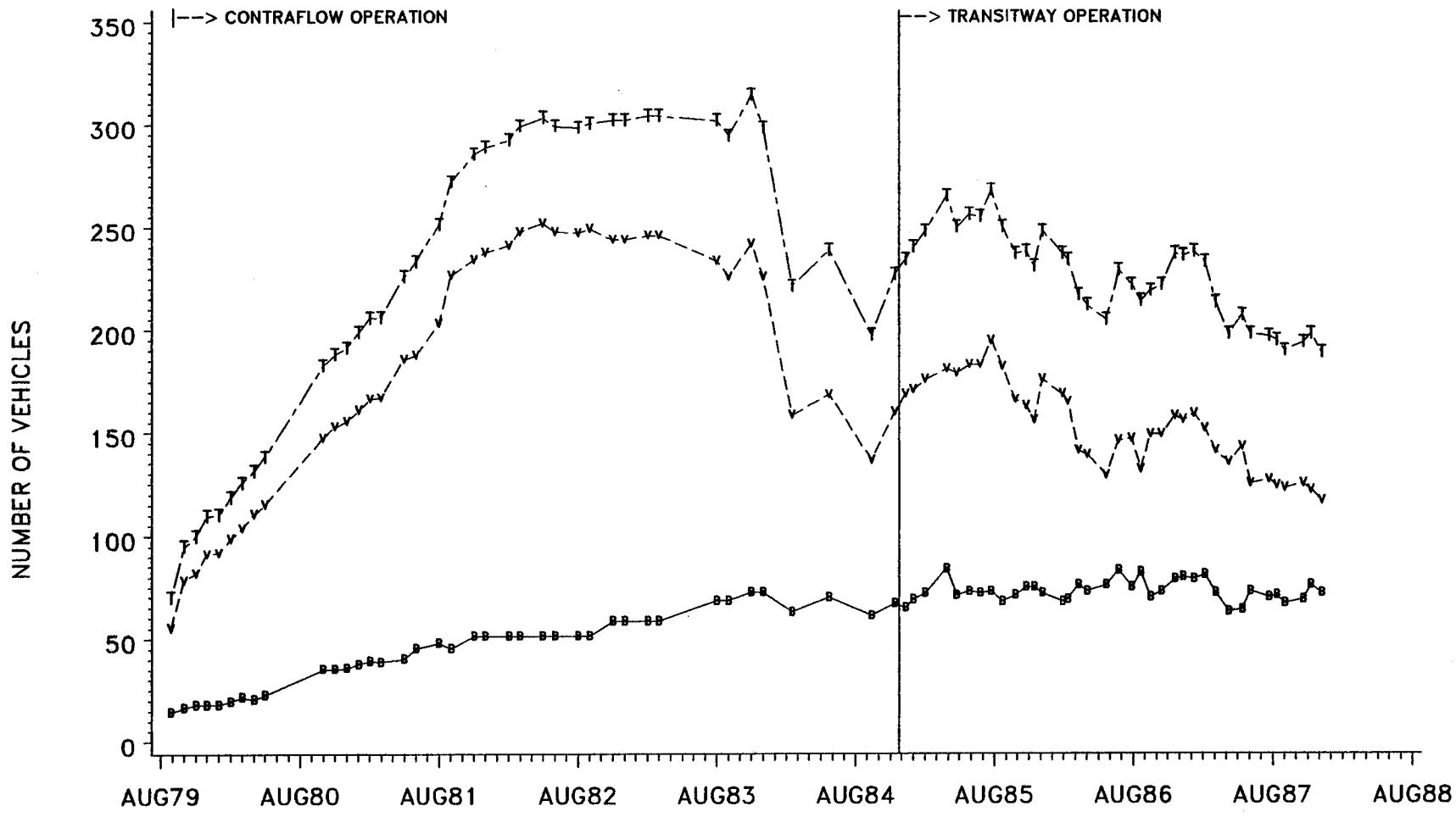


NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M. AND 3:30 TO 7:00 P.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL VEHICLES
B = BUSES
V = VANS

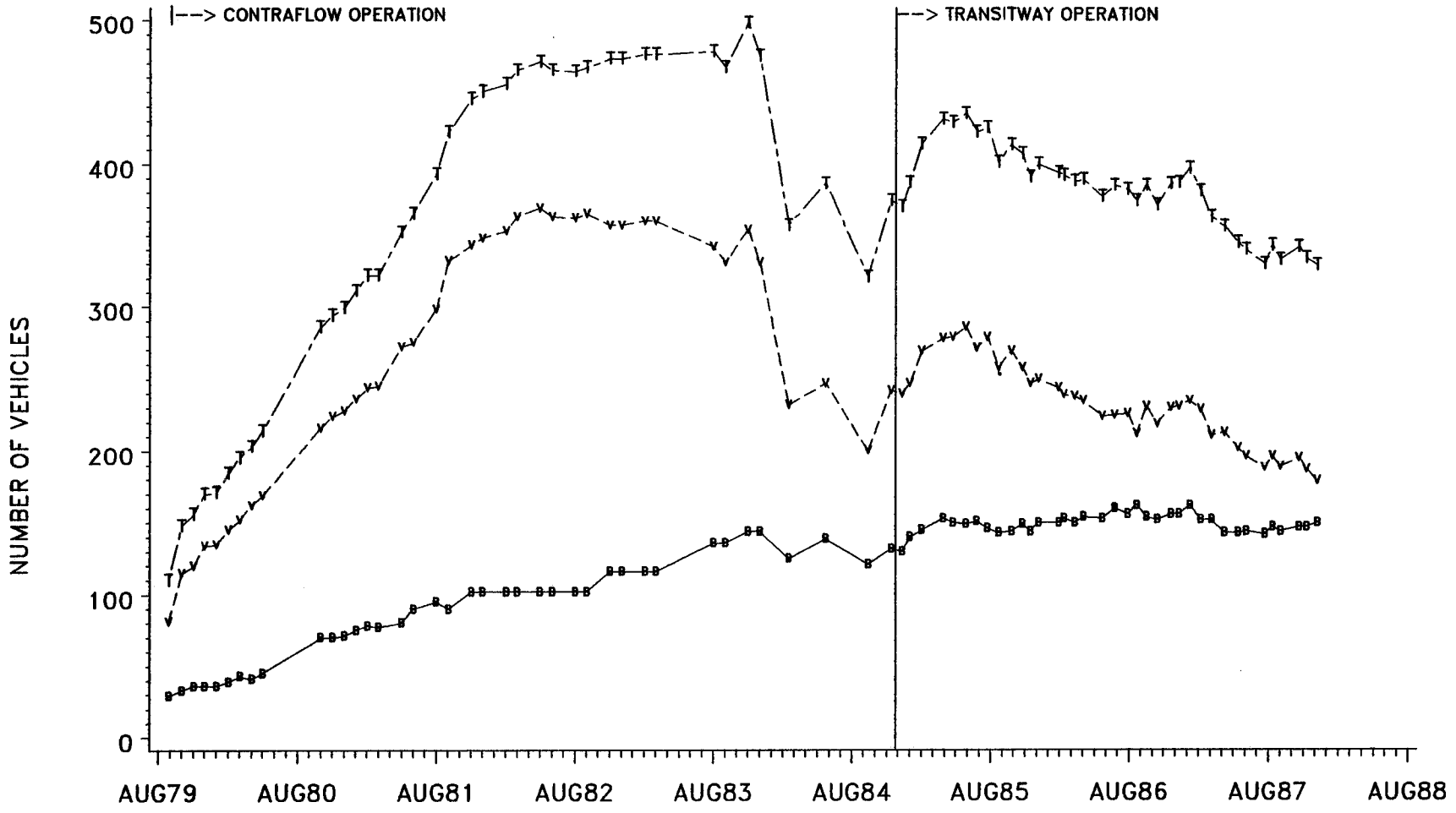
Figure 11. Trends in North Transitway Daily Vehicle Volumes



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M.
DATA BEFORE 6/83 ESTIMATED FROM PEAK PERIOD DATA
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL VEHICLES
B = BUSES
V = VANS

Figure 12. Trends in North Transitway A.M. Peak Hour Vehicle Volumes

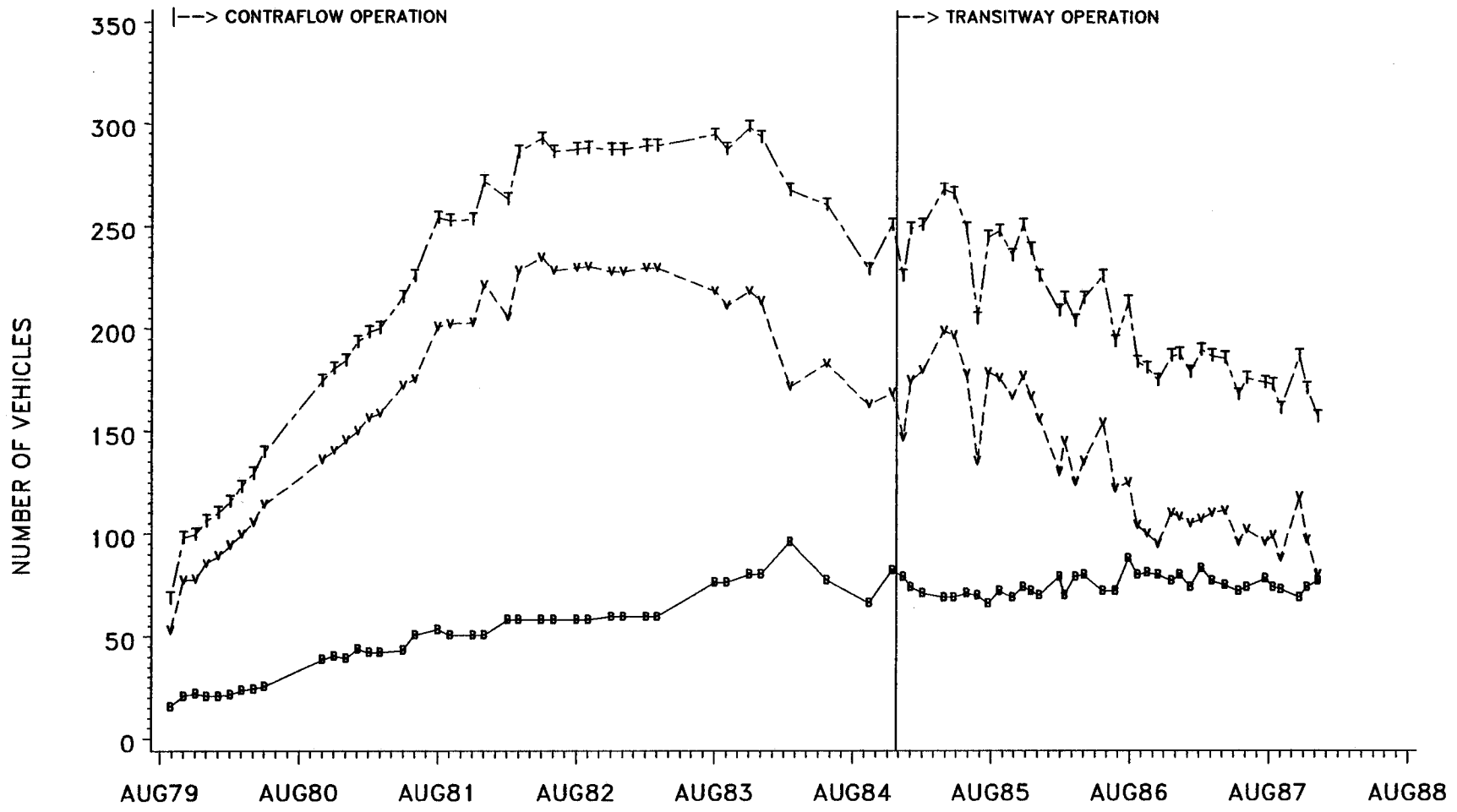


NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL VEHICLES
B = BUSES
V = VANS

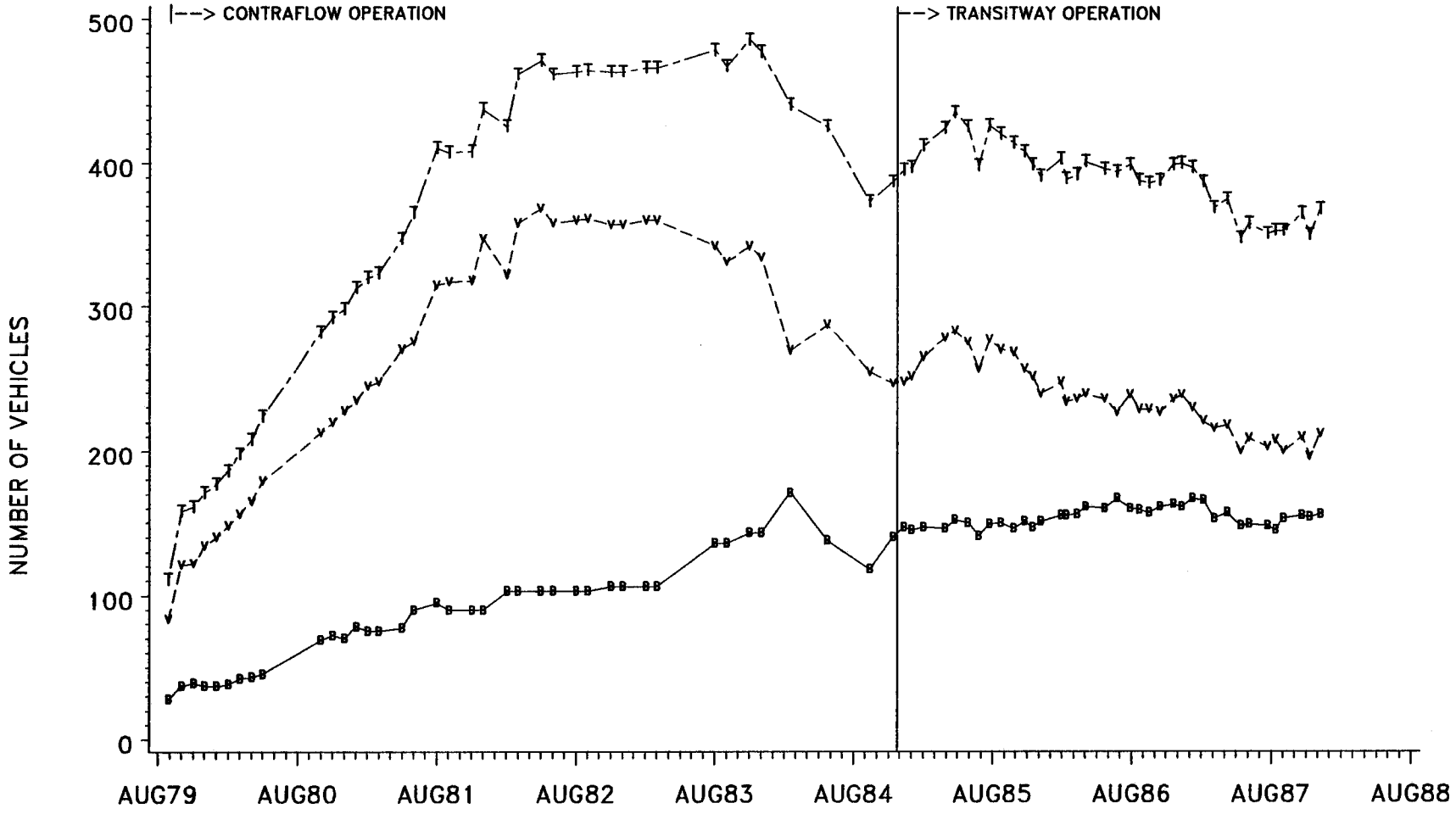
Figure 13. Trends in North Transitway A.M. Peak Period Vehicle Volumes



NORTH TRANSITWAY OPERATES FROM 3:30 TO 7:00 P.M.
DATA BEFORE 6/83 ESTIMATED FROM PEAK PERIOD DATA
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL VEHICLES
B = BUSES
V = VANS

Figure 14. Trends in North Transitway P.M. Peak Hour Vehicle Volumes



NORTH TRANSITWAY OPERATES FROM 3:30 TO 7:00 P.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL VEHICLES
B = BUSES
V = VANS

Figure 15. Trends in North Transitway P.M. Peak Period Vehicle Volumes

buses and 80 vanpools utilized the transitway. During the P.M. peak period, 156 buses and 212 vanpools were observed.

PEAKING CHARACTERISTICS

In the A.M. peak period, transitway vehicle volumes are generally highest between 7:00 and 7:30 (Figure 16). Vanpool traffic is generally highest at about 7:00 A.M. Buses are scheduled more evenly, and volumes are fairly uniform across the peak hour.

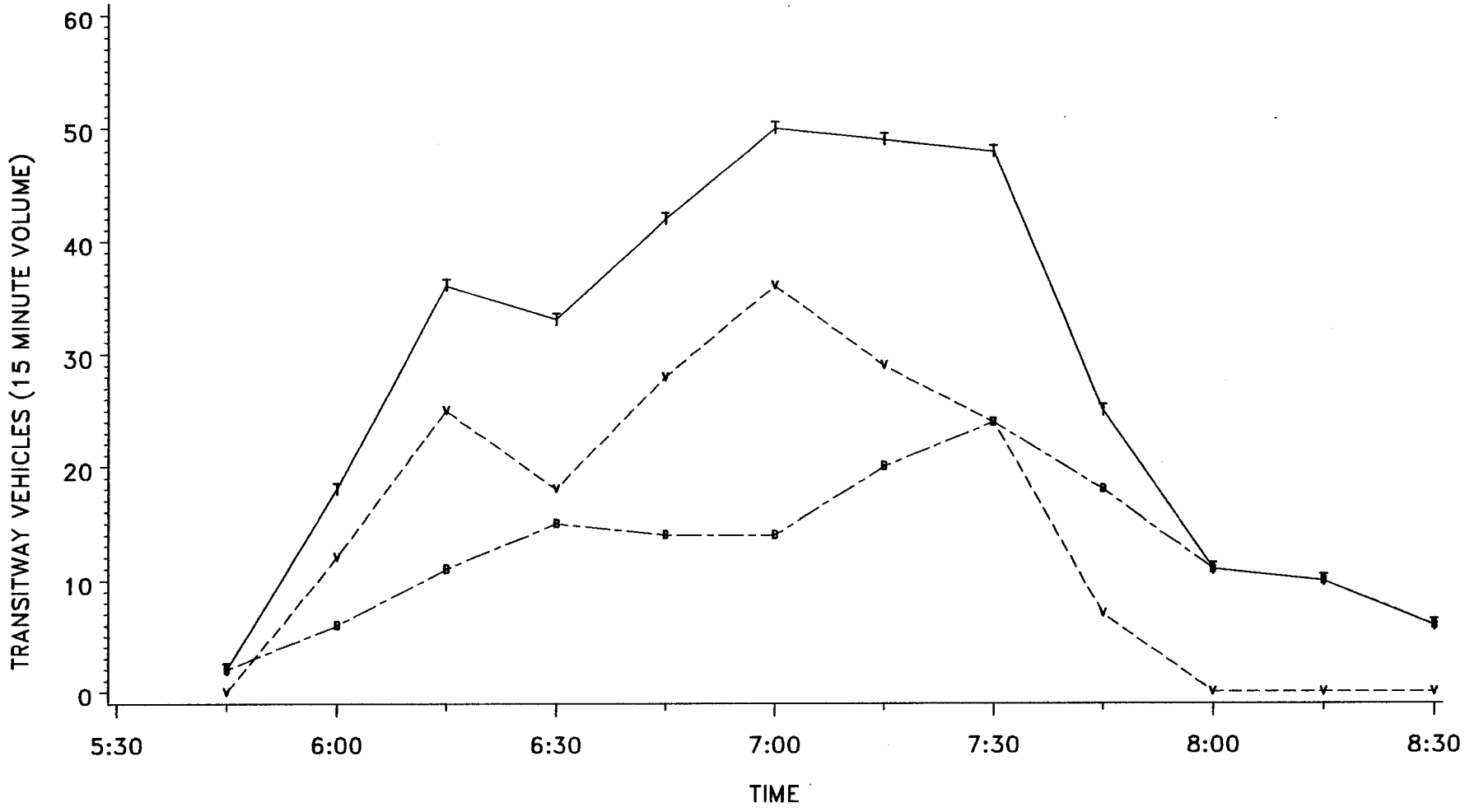
In the P.M. peak period, transitway vehicle volumes are generally highest between 5:00 and 5:30 P.M. (Figure 17). Like the A.M. peak period, vanpool volumes in the afternoon exhibit peaking characteristics that are more pronounced than the bus volumes.

TRANSITWAY VEHICLE OCCUPANCIES

Figures 18 and 19 show trends in vehicle occupancy rates for the North Transitway. Average transitway occupancy by vehicle type for December 1987 is summarized in Table 4. In comparison to the first year of transitway operations, average bus occupancy has increased in both the A.M. and P.M. operating periods (Table 5).

Table 4. Average Vehicle Occupancy, North Transitway, December 1987

Time Period and Vehicle Type	Occupancy (persons/vehicle)
Daily, all vehicles	21.12
A.M. Peak Hour, all vehicles	20.78
Buses	39.79
Vanpools	9.09
A.M. Peak Period, all vehicles	22.00
Buses	37.00
Vanpools	9.50
P.M. Peak Hour, all vehicles	23.98
Buses	39.29
Vanpools	9.25
P.M. Peak Period, all vehicles	20.34
Buses	35.26
Vanpools	9.36

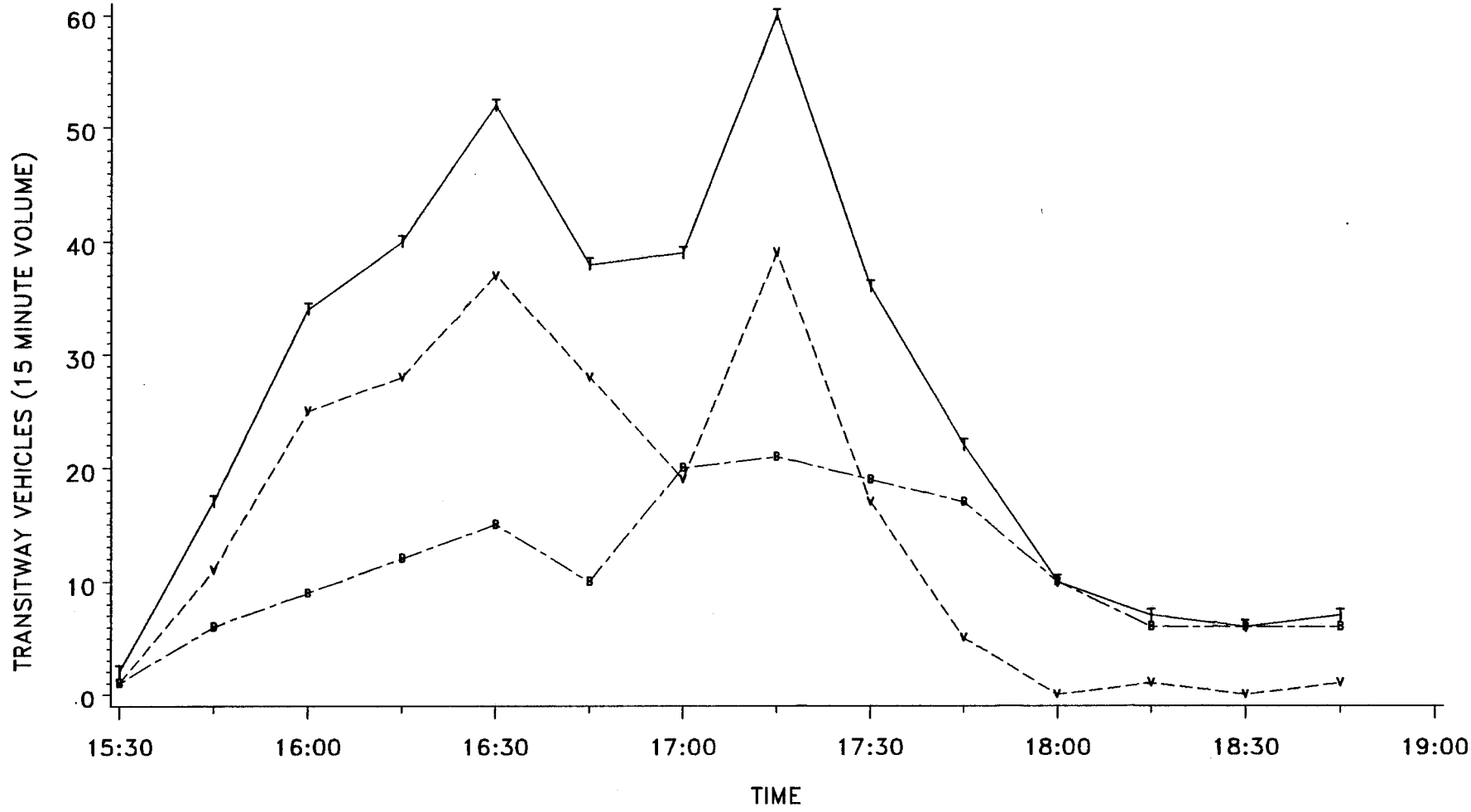


TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL
V = VANPOOLS
B = BUSES

Figure 16. North Transitway Vehicle Distribution, A.M. Peak Period (December, 1987)

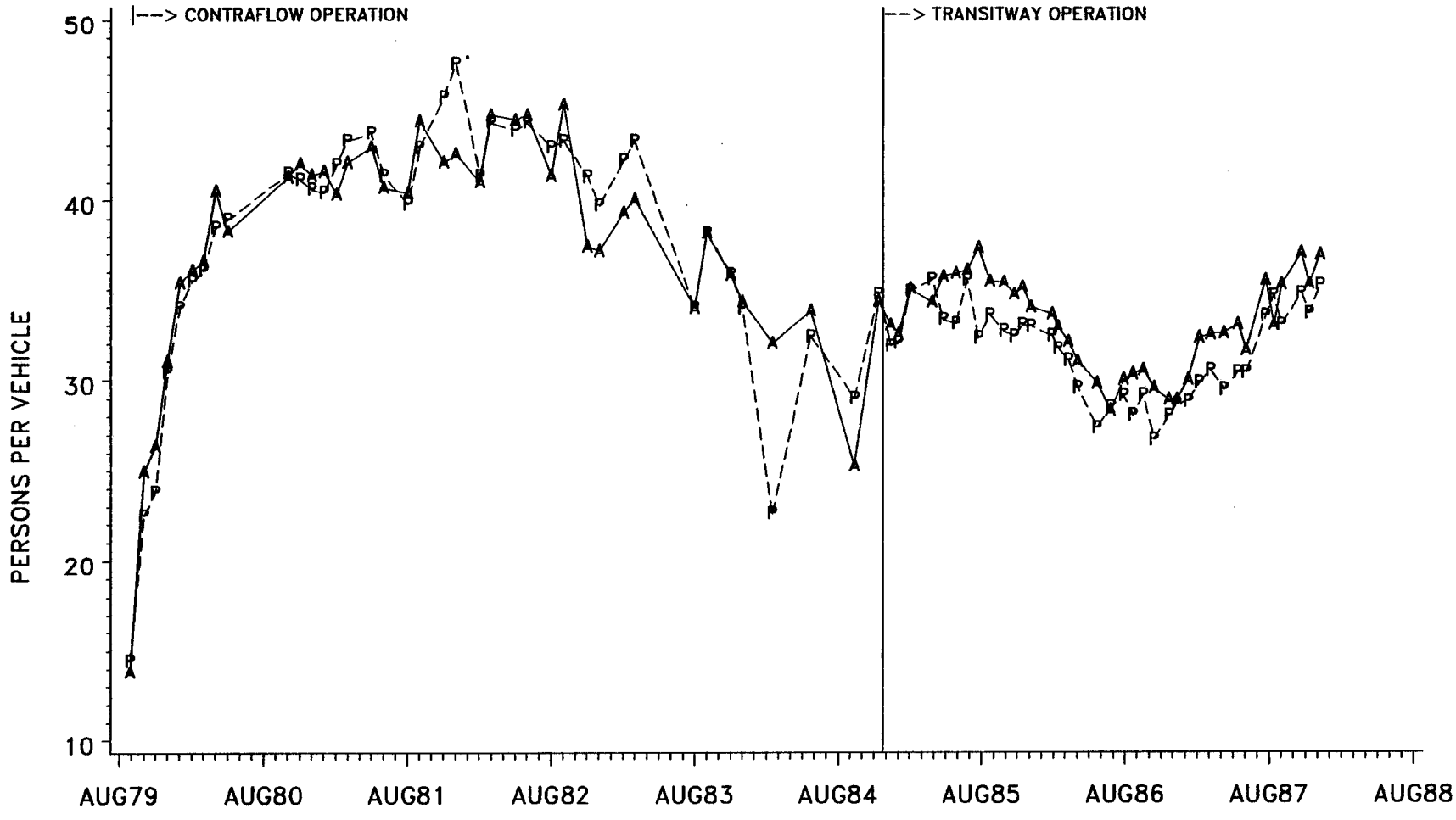


TRANSITWAY OPERATES FROM 3:30 TO 7:00 P.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL
V = VANPOOLS
B = BUSES

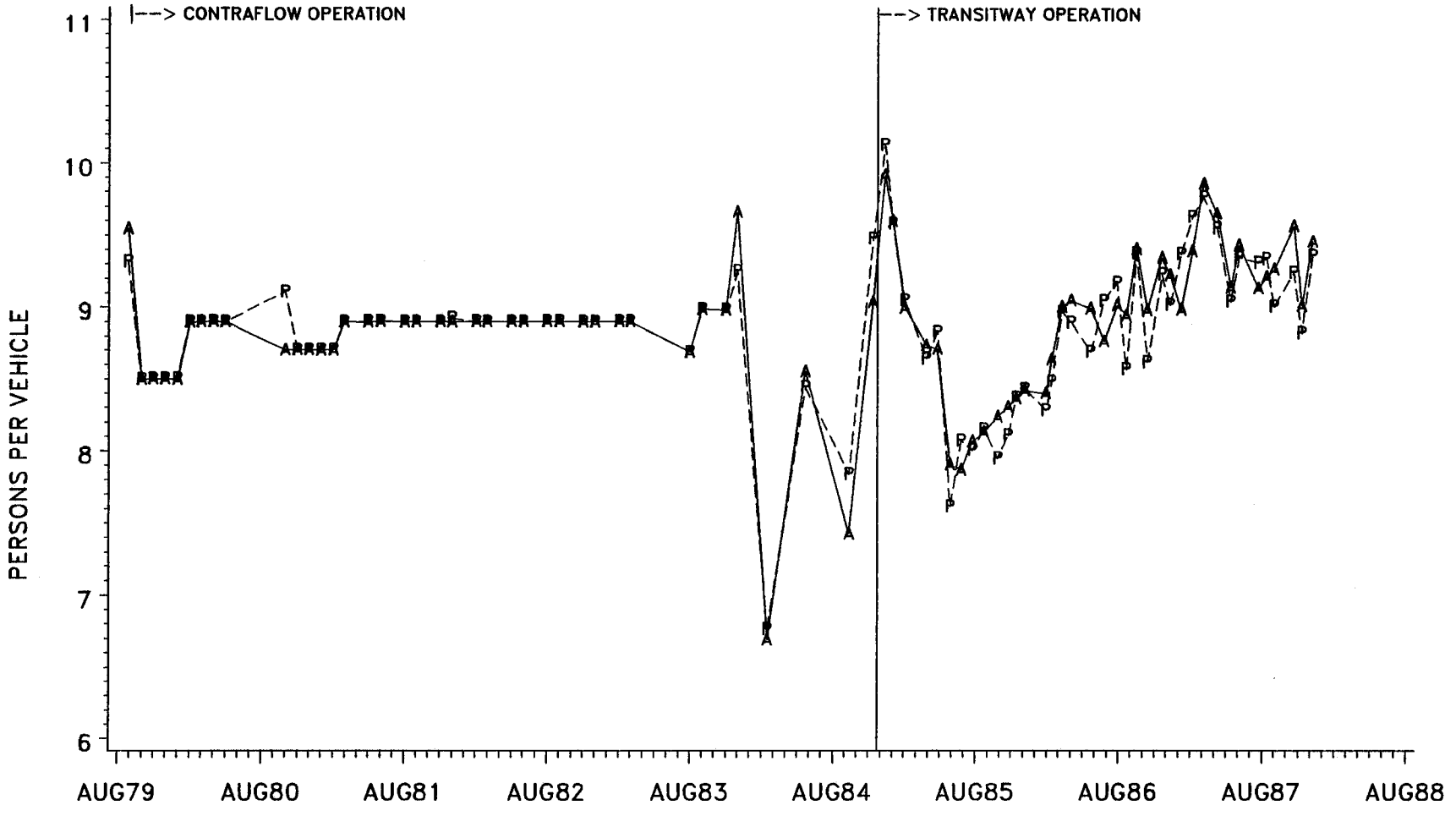
Figure 17. North Transitway Vehicle Distribution, P.M. Peak Period (December, 1987)



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M. & 3:30 TO 7:00 P.M.
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

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

Figure 18. Trends in North Transitway Bus Occupancy Rates



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M. & 3:30 TO 7:00 P.M.
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

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

Figure 19. Trends in North Transitway Vanpool Occupancy Rates

Table 5. Average Bus Occupancy (Persons/Bus) North Freeway Corridor

Time Period	"Representative" 12/84 Value	"Representative" 12/87 Value	Percent Change
A.M. Peak Hour	38.29	39.79	+3.9%
A.M. Peak Period	32.72	37.00	+13.1%
P.M. Peak Hour	34.89	39.29	+12.6%
P.M. Peak Period	33.10	35.26	+6.5%

TRANSITWAY LANE VIOLATION RATES

The design of the transitway provides limited opportunities for access and egress. In addition, the transitway is regularly patrolled by METRO police. The result is an extremely low violation rate.

METRO maintains records of the volume of unauthorized vehicles on the transitway. Since METRO personnel are not always present during all operating hours, this count data may be somewhat low. Monthly trends in the numbers of unauthorized vehicles using the North Transitway during 1987 are shown in Table 6. As shown in Table 6, there was an average of 185 unauthorized vehicles per month on the transitway during 1987. This corresponds to a violation rate of less than 0.1%. Over 90% of these violations occurred during the P.M. operating period.

TRANSITWAY DISABLED VEHICLES

The transitway is an enclosed environment and is operated on a daily basis by METRO. As a result, reliable data are available pertaining to vehicle breakdown rates.

During an average month in 1987, 4.3 vehicles became disabled on the transitway (Table 7). Approximately 40% of the disabled vehicles required towing. A summary of trends in vehicle breakdown data for the North Transitway is shown in Table 8.

Table 6. North Transitway Unauthorized Vehicles (1987)

Month	Number of Unauthorized Vehicles			Monthly Citations Issued
	AM	PM	Total	
January	12	143	155	16
February	26	188	214	39
March	15	249	264	25
April	7	58	65	4
May	4	91	95	3
June	8	147	155	22
July	9	189	198	43
August	6	233	239	55
September	12	97	109	25
October	13	136	149	4
November	28	308	336	NA
December	22	219	241	NA
Total	162	2058	2220	236
Monthly Average	13.5	171.5	185.0	19.7

Table 7. North Transitway Disabled and Towed Vehicles (1987)

Month	Buses		Vanpools		Others		Total	
	Disabled	Towed	Disabled	Towed	Disabled	Towed	Disabled	Towed
January	2	0	4	2	5	3	11	5
February	1	1	2	0	0	0	3	1
March	3	0	0	0	0	0	3	0
April	0	0	2	0	1	0	3	0
May	1	0	2	0	0	0	3	0
June	1	1	0	0	0	0	1	1
July	1	0	3	1	1	1	5	2
August	2	0	3	3	1	1	6	4
September	3	0	2	1	1	1	6	2
October	3	0	1	1	0	0	4	1
November	0	0	1	0	0	0	1	0
December	3	2	3	2	0	0	6	4
Total	20	4	23	10	9	6	52	20
Monthly Average	1.7	0.3	1.9	0.8	0.75	0.5	4.3	1.7

Table 8. Estimated Vehicle Breakdown Rates, North Transitway

Vehicle Group	Time Period		
	12/84-11/85	12/85-11/86	12/86-11/87
No. of Disabled Vehicles, Total[a]	108	86	57
Buses	48	34	22
Vans	24	12	21
Other (unauthorized vehicle)	36	40	14
No. of Towed[b] Vehicles, Total[a]	48	38	23
Buses	16	12	4
Vans	4	1	8
Other	28	25	11
VMT Per Disabled Vehicle, Total[a]	18,460	21,820	30,060
Buses	14,780	22,180	32,945
Vans	53,510	93,560	47,080
Other	NA	NA	NA
VMT Per Towed Vehicle, Total[a]	41,530	49,390	74,500
Buses	44,330	62,840	181,200
Vans	321,090	1,122,690	123,600
Other	NA	NA	NA

[a]Includes unauthorized vehicles.
[b]Towed vehicles are a subset of disabled vehicles.

TRANSITWAY ACCIDENT RATES

Table 9 shows a summary of estimated accident rates for the North Transitway for 1985-1987. During the period 1985-87 there was a total of five accidents involving transitway vehicles. In 1987, there were no accidents involving transitway vehicles. There were, however, approximately ten "security-related" incidents reported for the transitway in 1987. These incidents were situations where the transitway support crew had to escort pedestrians from the transitway facility.

TRANSITWAY LANE MEASURE OF EFFECTIVENESS

In assessing the relative efficiency of a transitway lane, a measure that has frequently been used is the product of peak-hour passengers times

Table 9. Estimated Accident Rates, North Transitway

Time Period	No. of Accidents[a]	Estimated Annual Vehicle Miles of Travel (millions)	Est. Accident Rate (accidents/MVM)
1985	3	1.98	1.51
1986	2	1.87	1.07
1987	0	1.71	0.00
1986 and 1987	2	3.58	0.56
1985 thru 1987	5	5.56	0.90

[a]Transitway vehicles only (Source: Metropolitan Transit Authority).

average operating speed (passenger-miles/hour). For the North Transitway in December 1987, this value (expressed in 1000's) is estimated to be 216 (3930 passengers times 55 mph). As shown in Section IV of this report, this value is nearly 4 times the efficiency of a mixed-flow lane on the North Freeway.

In comparison to other major HOV projects in the nation, the North Transitway is relatively successful in terms of this measure of effectiveness (Table 10).

Table 10. Measure of Effectiveness for Major HOV Projects in the United States

City and Project	Passenger-miles per hour[a] (1000's)
New York City, N.J. Route 495	1040
Washington, D.C., Shirley Highway	480
Los Angeles, San Bernardino Busway	360
Washington, D.C., I-66	330
Houston, Katy Transitway	229
HOUSTON, NORTH TRANSITWAY	216
San Francisco, US 101	210
Los Angeles, Route 55	200
Los Angeles, Route 91	180
Pittsburgh, East Busway	180
Miami, I-95	130
Pittsburgh, South Busway	80

[a]Peak hour passengers times operating speed.
Source: (4).

SUMMARY OF SELECTED TRANSITWAY DATA

A summary of selected data describing the operation of the North Transitway is provided in Table 11. The facility is used by authorized buses and vanpools and currently operates inbound from 5:45 A.M. to 8:45 A.M. and outbound from 3:30 P.M. to 7:00 P.M. Prior to September 1, 1987, the transitway was open from 6:00-8:45 A.M. in the inbound direction, and from 3:45-6:45 P.M. in the outbound direction.

Table 11. Summary of Selected North Transitway Data

Data[a]	Value	% Change 1986-1987
Person Movement, Daily (12/87)	14722	+9.7%
A.M. Peak Hour	3928	-2.1%
A.M. Peak Period	7238	+9.0%
P.M. Peak Hour	3765	+7.3%
P.M. Peak Period	7484	+10.5%
Vehicle Volume, Daily (12/87)	697	-11.5%
A.M. Peak Hour	189	-19.9%
A.M. Peak Period	329	-15.0%
P.M. Peak Hour	157	-16.5%
P.M. Peak Period	368	-8.2%
Transitway Vehicle Occupancy, all vehicles (A.M. Peak Hours)	20.78	+22.2%
Transitway Lane Violation Rate	Less than 1%	0%
Transitway Breakdown Rate (12/84-11/87) (vehicle miles of travel per breakdown)	22,165	+37.8%
Transitway Accident Rate, Accidents/MVM (1986-87)	0.56	NA
Transitway Lane Measure of Peak-Hour Effectiveness (passenger-miles/hour)[b]	216	-1.5%

[a]Site specific data collected at Little York Road.
[b]The multiple of peak-hour passengers times speed.

IV. MAINLANE DATA

MAINLANE TRAFFIC VOLUMES

Daily Mainlane Vehicle Volumes

Trends in average daily traffic on the North Freeway mainlanes for the period 1983-87 are summarized in Table 12. Due to the extensive construction activities in the corridor in recent years, the automatic traffic recorder (ATR) at the permanent traffic count station near Link Road has not been in operation since 1983. As a result, the daily traffic volumes shown in Table 12 have been estimated from ATR data collected at Cypress Creek (just north of FM 1960). These estimates are based on trend analyses and are subject to considerable error. The estimates include frontage traffic. It should also be noted that the freeway cross-section has been expanded in recent years. Table 13 summarizes these improvements.

The data in Table 12 suggest that daily traffic on the freeway has increased nearly 16% since 1983. Since 1984, daily traffic on the freeway has increased by only 4%.

Table 12. Average Daily Traffic, North Freeway Mainlanes (1983-87)

Year	Average Daily Traffic[a]	Annual Change (%)
1983	138,000	-
1984	154,000	+11.6%
1985	162,000	+5.2%
1986	148,000	-8.6%
1987	160,000	+8.1%
(1983-87)	-	+15.9%
(1984-87)	-	+3.9%

[a]Estimated at Link Road (Between I-610N and I-10W). Includes frontage road traffic.
Source: SDHPT.

Table 13. Changes in North Freeway Cross-Section (1984-87)

Freeway Section	Number of Freeway Mainlanes	
	1984	1987
I-10 to N. Main	10	10
N. Main to I-610	8	8
Over I-610	6	6
I-610 to Airline	8	10
Airline to N. Belt	6	8
N. Belt to FM 1960	6	6

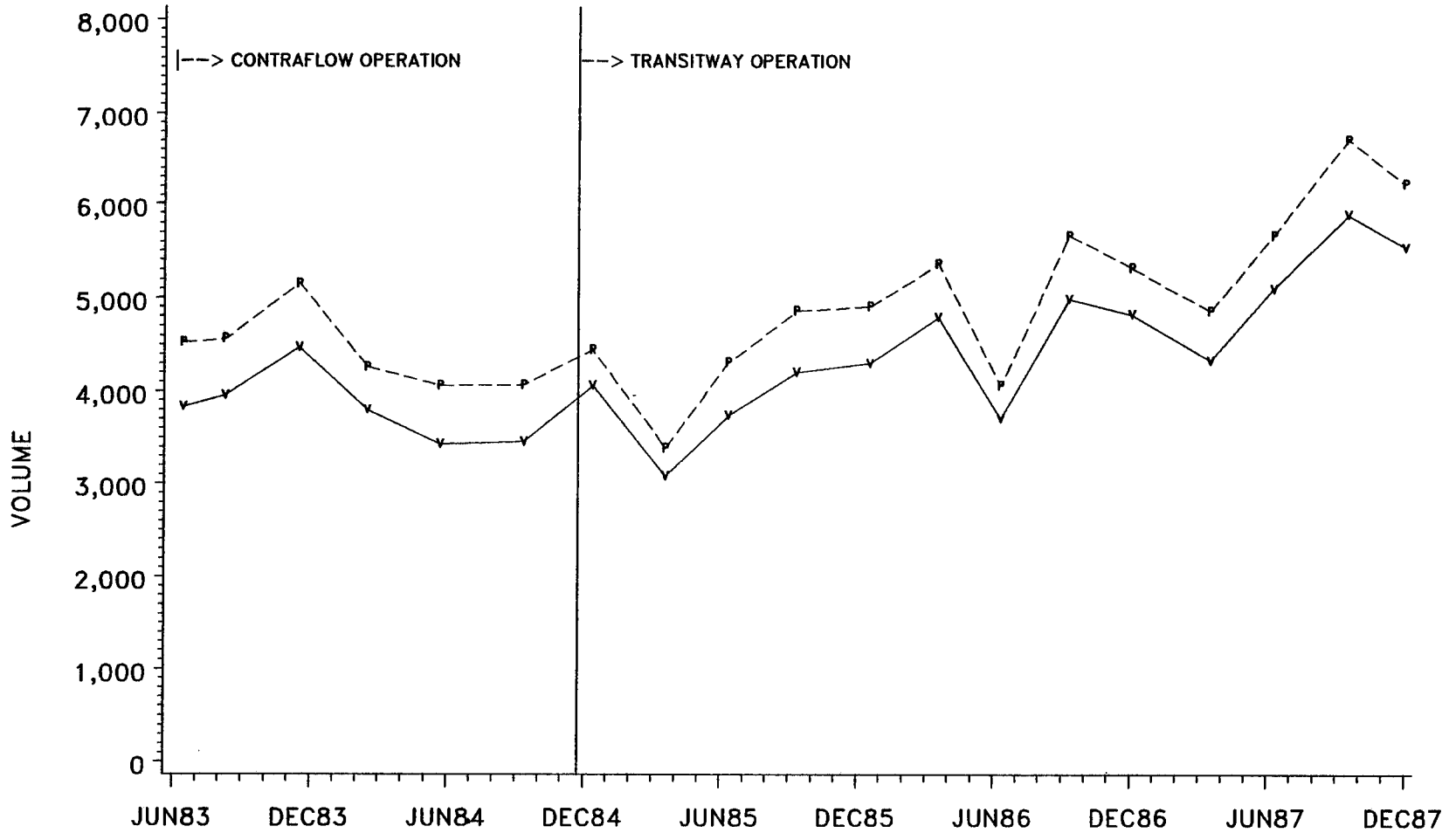
A.M. Mainlane Vehicle and Person Volumes

Trends in A.M. vehicle and person movement on the freeway mainlanes, as measured at Little York Road, are shown in Figures 20 and 21. In December 1987, 6240 persons were moved on the mainlanes in 5550 vehicles during the A.M. peak hour (Table 14). This represents a 15% increase in vehicles and a 17% increase in persons over the 1986 volumes. In the A.M. peak-direction, peak-period, 15950 persons were moved in 14240 vehicles in December 1987; an 18% increase over 1986 conditions.

Table 14. A.M. Peak-Direction (Southbound) Traffic Volumes, North Freeway Mainlanes

Time Period	A.M. Peak-Direction Volume[a]							
	12/84		12/85		12/86		12/87	
	Veh.	Pers.	Veh.	Pers.	Veh.	Pers.	Veh.	Pers.
Peak Hour	4060	4450	4300	4910	4830	5325	5550	6240
Annual Change	-	-	+5.9%	+10.3%	+12.3%	+8.5%	+14.9%	+17.2%
Peak Period	9450	10560	10670	11780	12070	13550	14240	15950
Annual Change	-	-	+12.9%	+11.6%	+13.1%	+15.0%	+18.0%	+17.1%

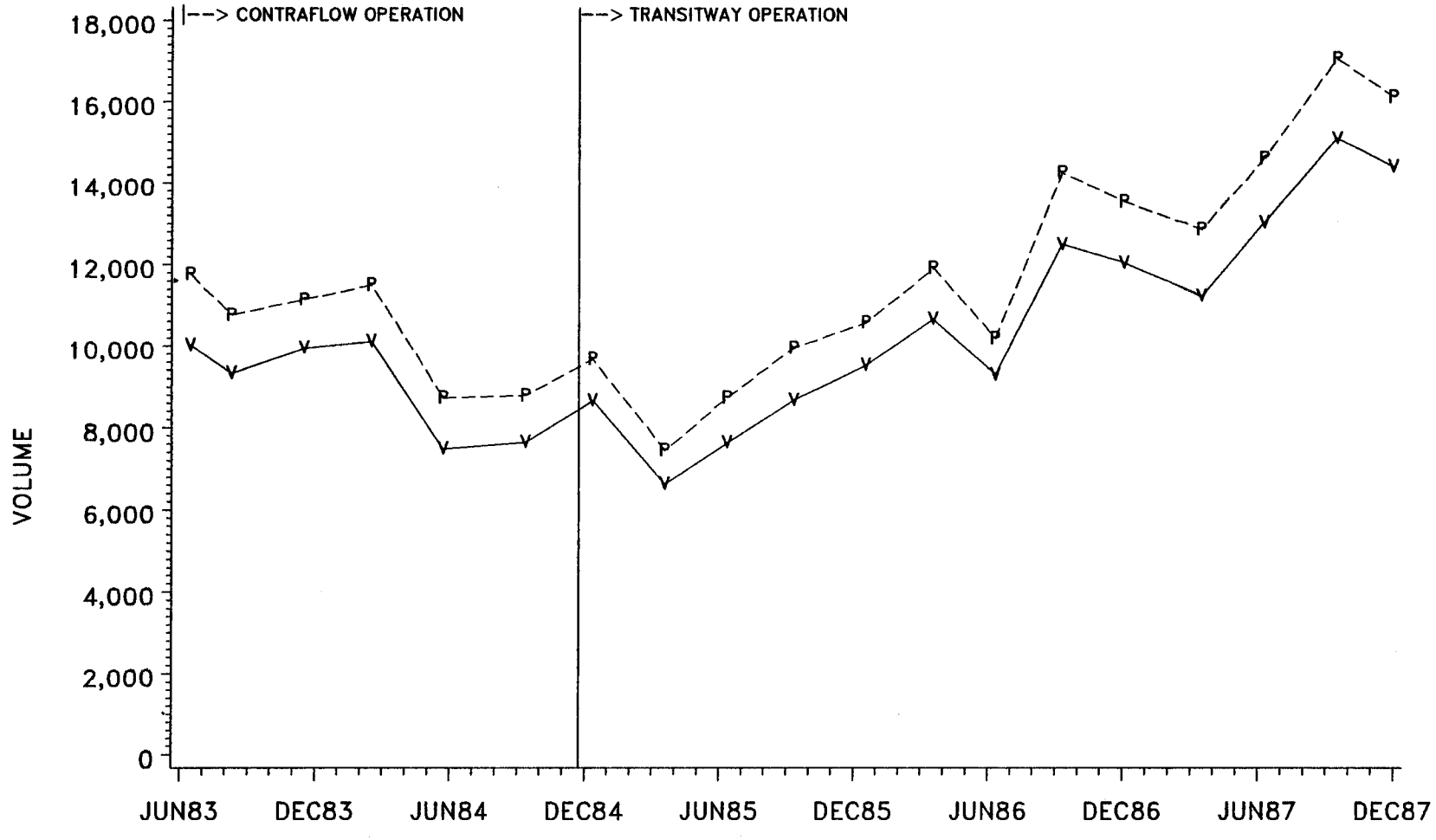
[a]Measured at Little York Road.
Source: TTI Surveys.



DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

Figure 20. Trends in North Freeway Mainlane A.M. Peak Hour Traffic



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 8:45 A.M
DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

Figure 21. Trends in North Freeway Mainlane A.M. Peak Period Traffic

P.M. Mainlane Vehicle and Person Volumes

Figures 22 and 23 depict trends in P.M. vehicle and person movement on the freeway mainlanes at Little York Road. In December 1987, 6220 persons were moved in 5200 vehicles on the freeway mainlanes during the P.M. peak hour (Table 15). This represents a 13% increase in vehicle movement and a 15% increase in person movement over 1986 operations.

Table 15. P.M. Peak-Direction (Northbound) Traffic Volumes, North Freeway Mainlanes

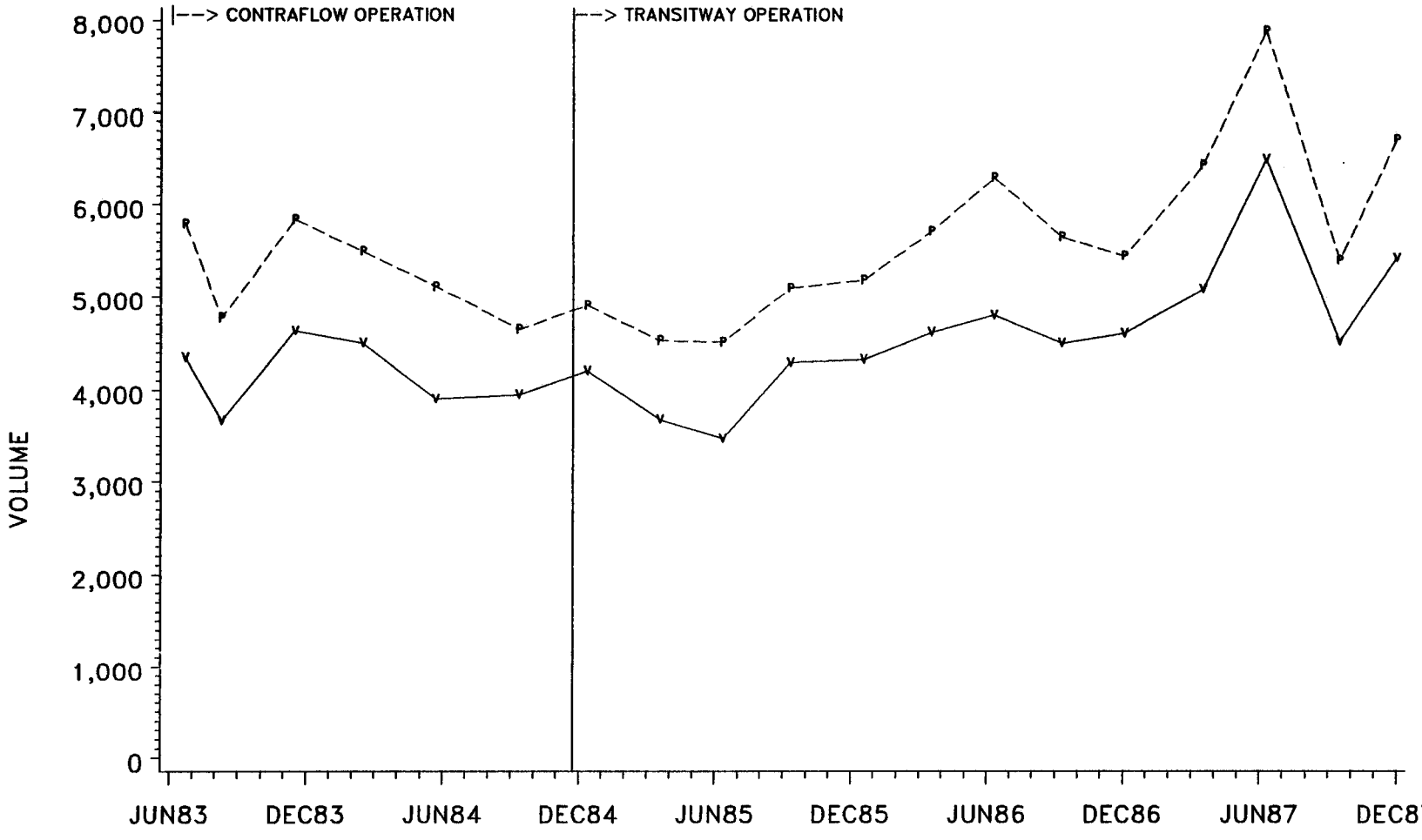
	P.M. Peak-Direction Volume[a]							
	12/84		12/85		12/86		12/87	
Time Period	Veh.	Pers.	Veh.	Pers.	Veh.	Pers.	Veh.	Pers.
Peak Hour	4210	4900	4320	5180	4610	5425	5200	6220
Annual Change	-	-	+2.6%	+5.7%	+6.7%	+4.7%	+12.8%	+14.7%
Peak Period	12055	13755	10755	13000	12845	14740	14820	17025
Annual Change	-	-	-10.8%	-5.5%	+19.4%	+13.4%	+15.4%	+15.5%

[a]Measured at Little York Road.
Source: TTI Surveys.

During the P.M. peak period in December 1987, 17025 persons were moved in 14820 vehicles on the freeway mainlanes; a 16% increase relative to 1986 levels.

MAINLANE VEHICLE OCCUPANCIES

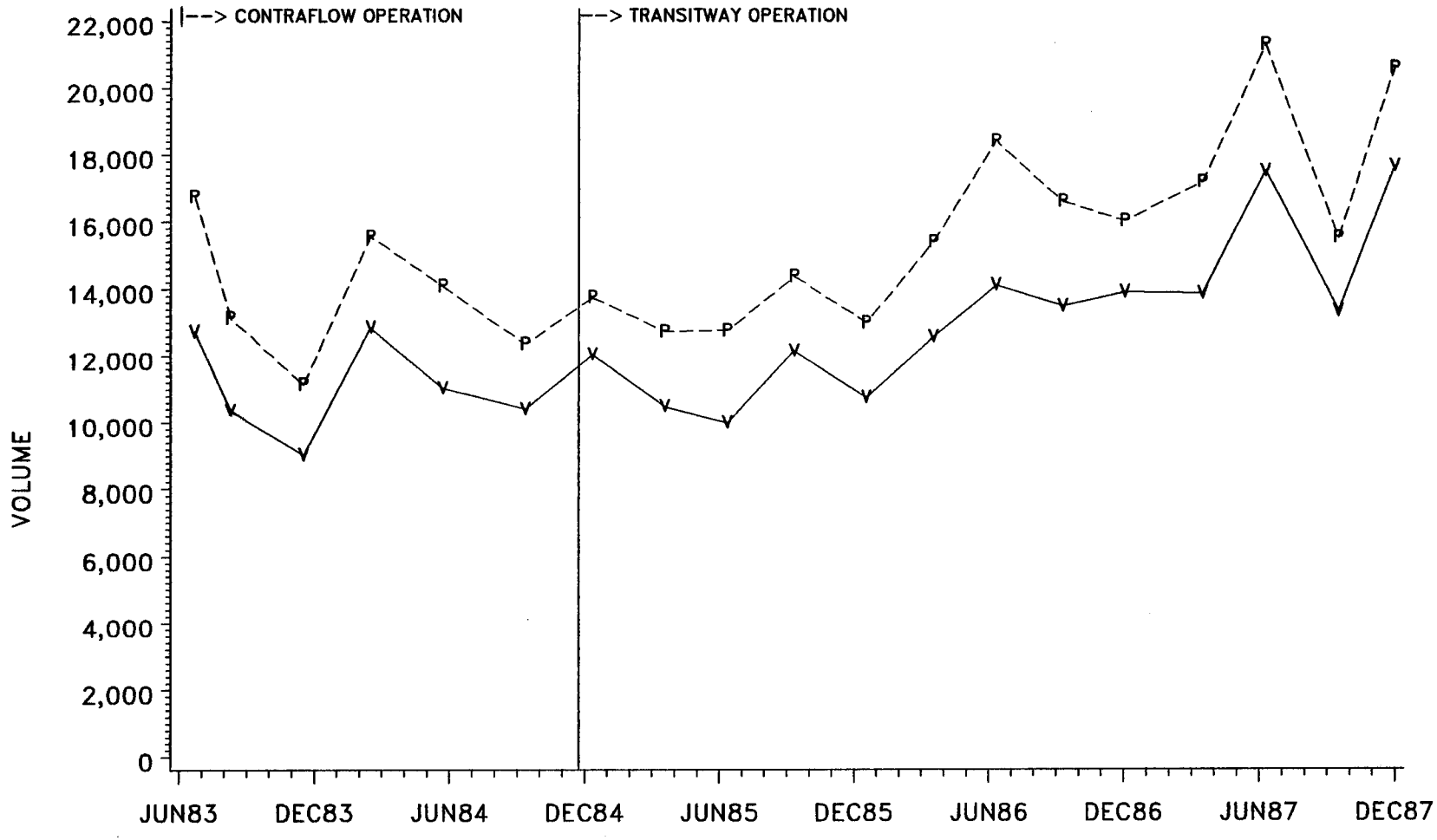
Trends in A.M. and P.M. peak hour and peak period mainlane vehicle occupancies are summarized in Figures 24 and 25. The data suggest that mainlane vehicle occupancies have increased slightly since the transitway opened (Table 16). The most substantial increases have occurred in the P.M. peak hour.



LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

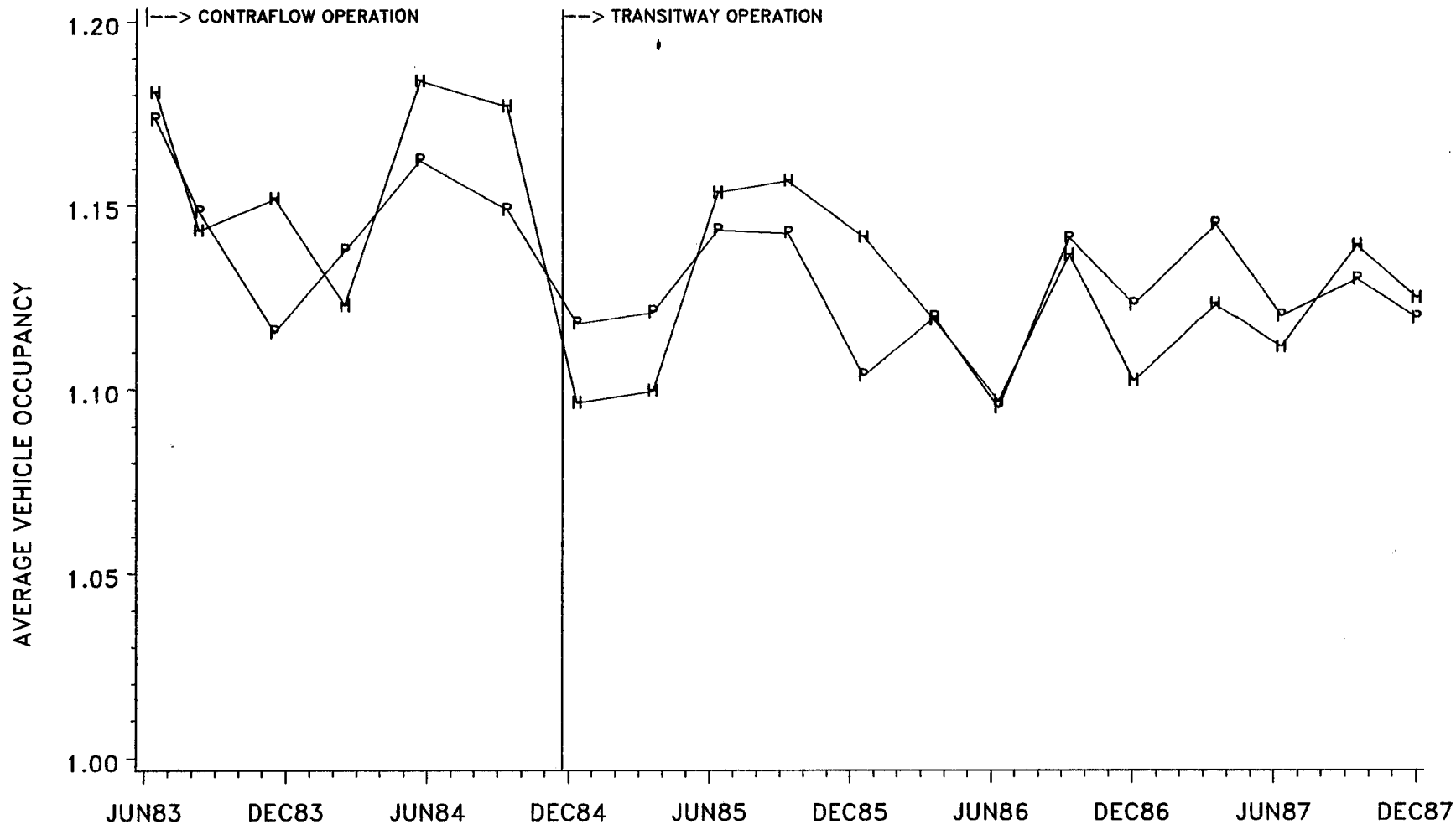
Figure 22. Trends in North Freeway Mainlane P.M. Peak Hour Traffic



P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M
DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : P = MAINLANE PERSONS
V = MAINLANE VEHICLES

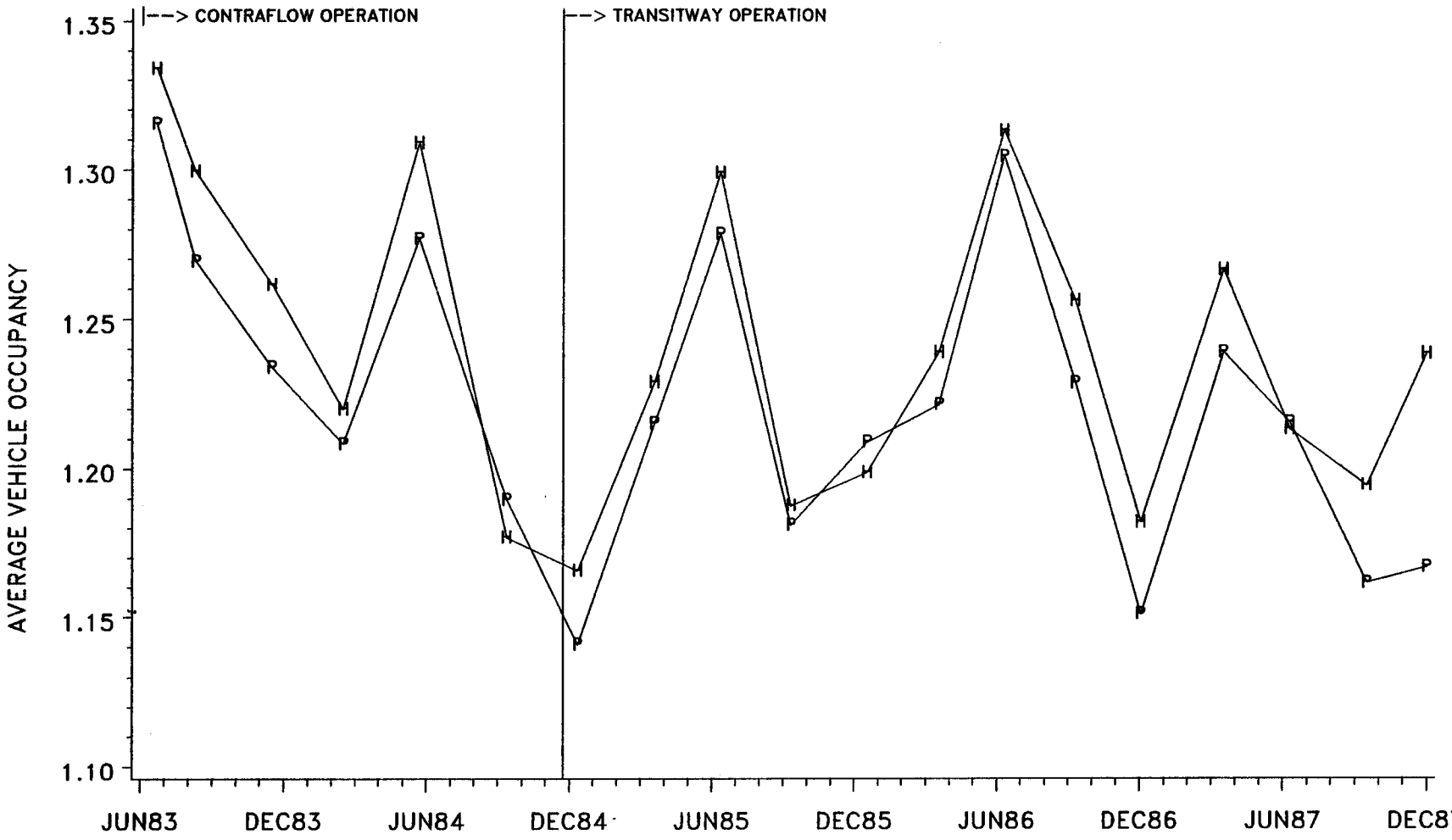
Figure 23. Trends in North Freeway Mainlane P.M. Peak Period Traffic



DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : H = PEAK HOUR OCCUPANCY
P = PEAK PERIOD OCCUPANCY

Figure 24. Trends in North Freeway Mainlane A.M. Peak Hour and Peak Period Vehicle Occupancy



DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : H = PEAK HOUR OCCUPANCY
P = PEAK PERIOD OCCUPANCY

Figure 25. Trends in North Freeway Mainlane P.M. Peak Hour and Peak Period Vehicle Occupancy

Table 16. Average Vehicle Occupancies, North Freeway Mainlanes

Time Period	Average Occupancy[a] (persons/vehicle)		
	12/84	12/87	Percent Change
A.M. Peak Hour	1.10	1.12	+1.8%
A.M. Peak Period	1.12	1.12	-
P.M. Peak Hour	1.17	1.20	+2.6%
P.M. Peak Period	1.14	1.15	+1.0%

[a]Measured at Little York Road.

MAINLANE TRAVEL TIMES/SPEEDS

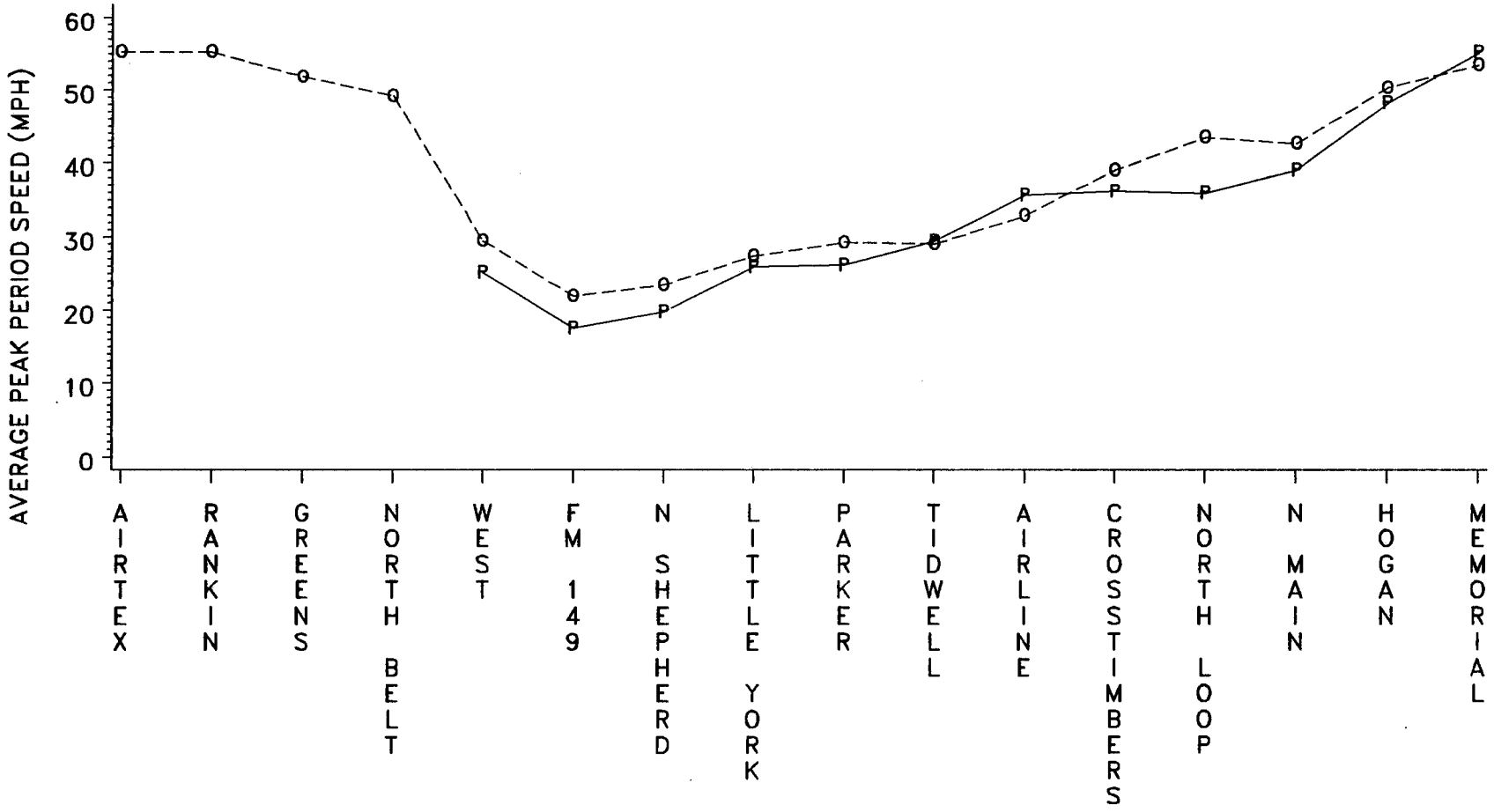
Figures 26 and 27 summarize average A.M. and P.M. peak period mainlane speeds. These travel time/speed data are collected on a quarterly basis. The data shown in Figures 26 and 27 represent data collected since November 1984 that has been averaged to reflect current conditions.

As shown in Table 17, average A.M. peak speeds have increased on the freeway mainlanes since 1984. Average travel speeds in the P.M. periods have decreased since 1984. This decline in P.M. period speeds is due to on-going construction activities in the outbound direction and should improve considerably in the near future.

Table 17. North Freeway Mainlane Average Travel Speeds (N. Shepherd to Hogan)

Time Period	Average Travel Speeds (mph)		
	12/84	12/87	Percent Change
A.M. Peak Hour	31	42	+36%
A.M. Peak Period	35	47	+34%
P.M. Peak Hour	31	23	-26%
P.M. Peak Period	35	30	-14%

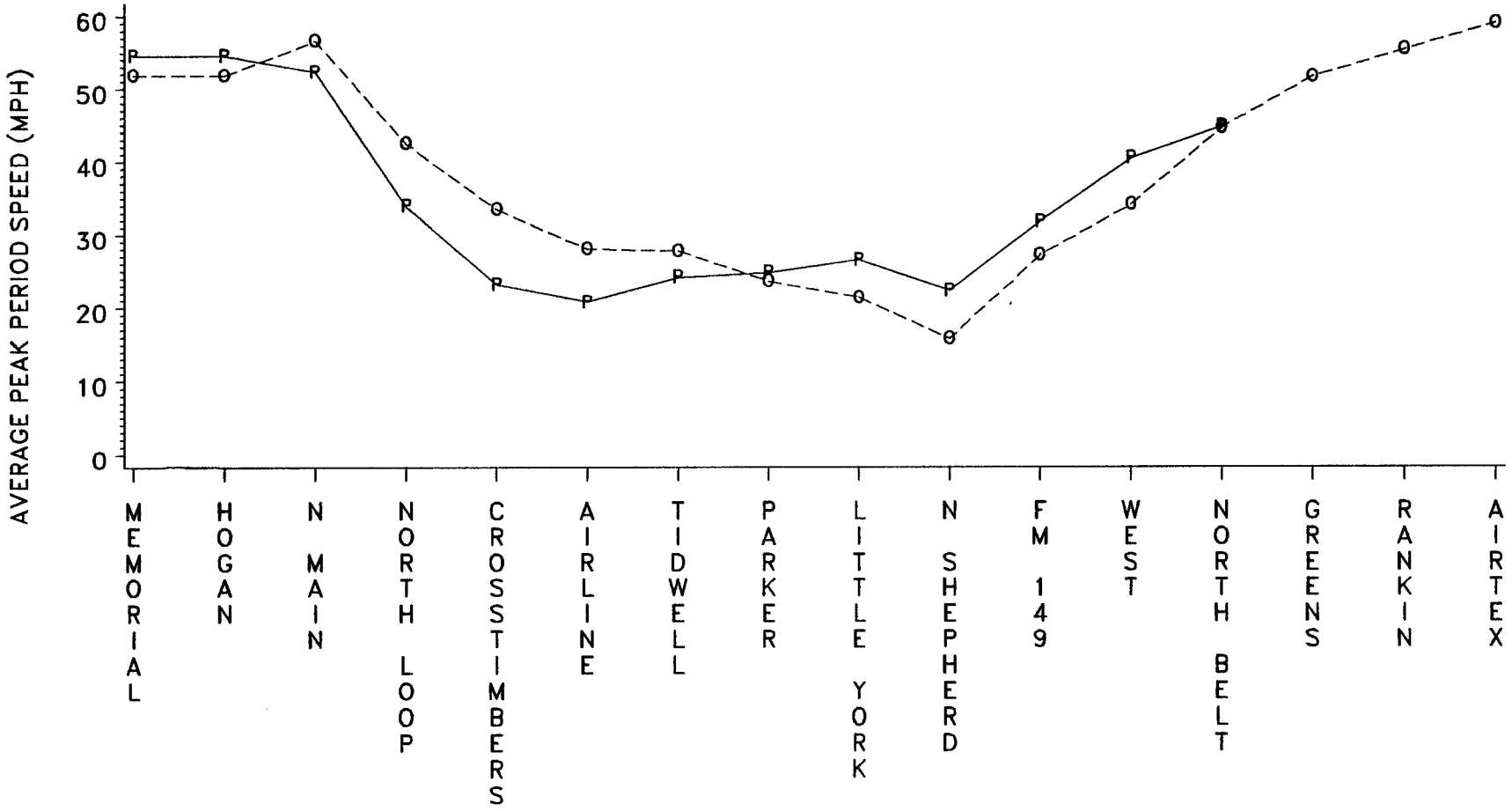
Source: TTI Surveys.



TRANSITWAY OPENED NOVEMBER 23,1984
DATA COLLECTED 6:00 TO 8:45 A.M. JUNE, 1983 TO DECEMBER, 1987
TRANSITWAY OPERATES FROM N. SHEPHERD TO DOWNTOWN (9.62 MI)
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : P = FREEWAY SPEEDS PRIOR TO OPENING TRANSITWAY
O = FREEWAY SPEEDS SINCE TRANSITWAY OPENED

Figure 26. Average A.M. Peak Period, Peak Direction (Southbound) Speeds, North Freeway Mainlanes



TRANSITWAY OPENED NOVEMBER 23,1984
DATA COLLECTED 3:30 TO 7:00 P.M, JUNE, 1983 TO DECEMBER, 1987
TRANSITWAY OPERATES FROM N. SHEPHERD TO DOWNTOWN (9.62 MI)
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : P = FREEWAY SPEEDS PRIOR TO OPENING TRANSITWAY
O = FREEWAY SPEEDS SINCE TRANSITWAY OPENED

Figure 27. Average P.M. Peak Period, Peak Direction (Northbound) Speeds, North Freeway Mainlanes

MAINLANE ACCIDENT RATES

Mainlane accident statistics for the period 1983-1987 are summarized in Table 18. These statistics are for the section of the North Freeway from N. Shepherd to Hogan Street (i.e., the limits of the North Freeway Transitway). As shown in Table 18, the highest mainlane accident rate was observed during the period of transitway construction (January 1984-November 1984). It should be noted, however, that mainlane improvements were also being implemented during this same period.

For the "after transitway" period (November 1984 - November 1987), the mainlane accident rate declined by about 6%, relative to the CFL acccident rate. However, a number of mainlane improvements were implemented at the same time the transitway was constructed. As a result, the decline in mainlane accident rates suggested in Table 18 are probably attributable to several factors. Additionally, in recent years, there has been a general decline in the overall accident rate for freeways in Harris County.

Table 18. North Freeway Mainlane Accident Rates (North Shepherd to Hogan)

Time Period	Total Number Accidents	Accidents Per MVMT	Change in Rate Since Contraflow
Contraflow Operation[a]	929	2.105	-
During Transitway Construction[b]	958	2.432	+15.5%
After Transitway Construction			
1985 (11/84-11/85)	964	1.926	-8.5%
1986 (11/85-11/86)	1303	2.403	+14.2%
1987 (11/86-11/87)	800	1.583	-24.8%
Total (11/84-11/87)	3067	1.987	-5.6%

[a]January 1983-January 1984.
[b]January 1984-November 1984.

MAINLANE MEASURE OF EFFECTIVENESS

In assessing the efficiency of a freeway lane, a measure that has been used is the multiple of peak-hour passengers times average operating speed (passenger-miles per hour per lane). For the North Freeway mainlanes during the A.M. peak hour in December 1987, this value (expressed in 1000's) is estimated to be 58.2 passenger-miles per hour per lane. The efficiency of the freeway lanes has increased considerably since the transitway opened and since the freeway cross section was expanded. The freeway is moving a higher volume of persons in the A.M. peak hour and is doing it at a higher average operating speed.

SUMMARY OF SELECTED MAINLANE DATA

A summary of selected data describing the operation of the North Freeway mainlanes is provided in Table 19.

Table 19. Summary of Selected North Freeway Mainlane Data

Data	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change
Person Volume			
A.M. Peak Hour	4450	6240	+40.2%
P.M. Peak Hour	4900	6220	+26.9%
Vehicle Volumes			
A.M. Peak Hour	4060	5550	+36.7%
P.M. Peak Hour	4210	5200	+23.5%
Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.10	1.12	+1.8%
P.M. Peak Hour	1.14	1.20	+5.3%
Travel Speed (mph)			
A.M. Peak Hour	31	42	+35.5%
P.M. Peak Hour	31	23	-25.8%
Accident Rate (accidents/MVM)	2.432	1.583	-34.9%
A.M. Peak-Hour Lane Efficiency (1000's)	39.4	58.2	+47.7%

V. COMBINED MAINLANE AND TRANSITWAY DATA

PERSON VOLUMES

A.M. Person Movement

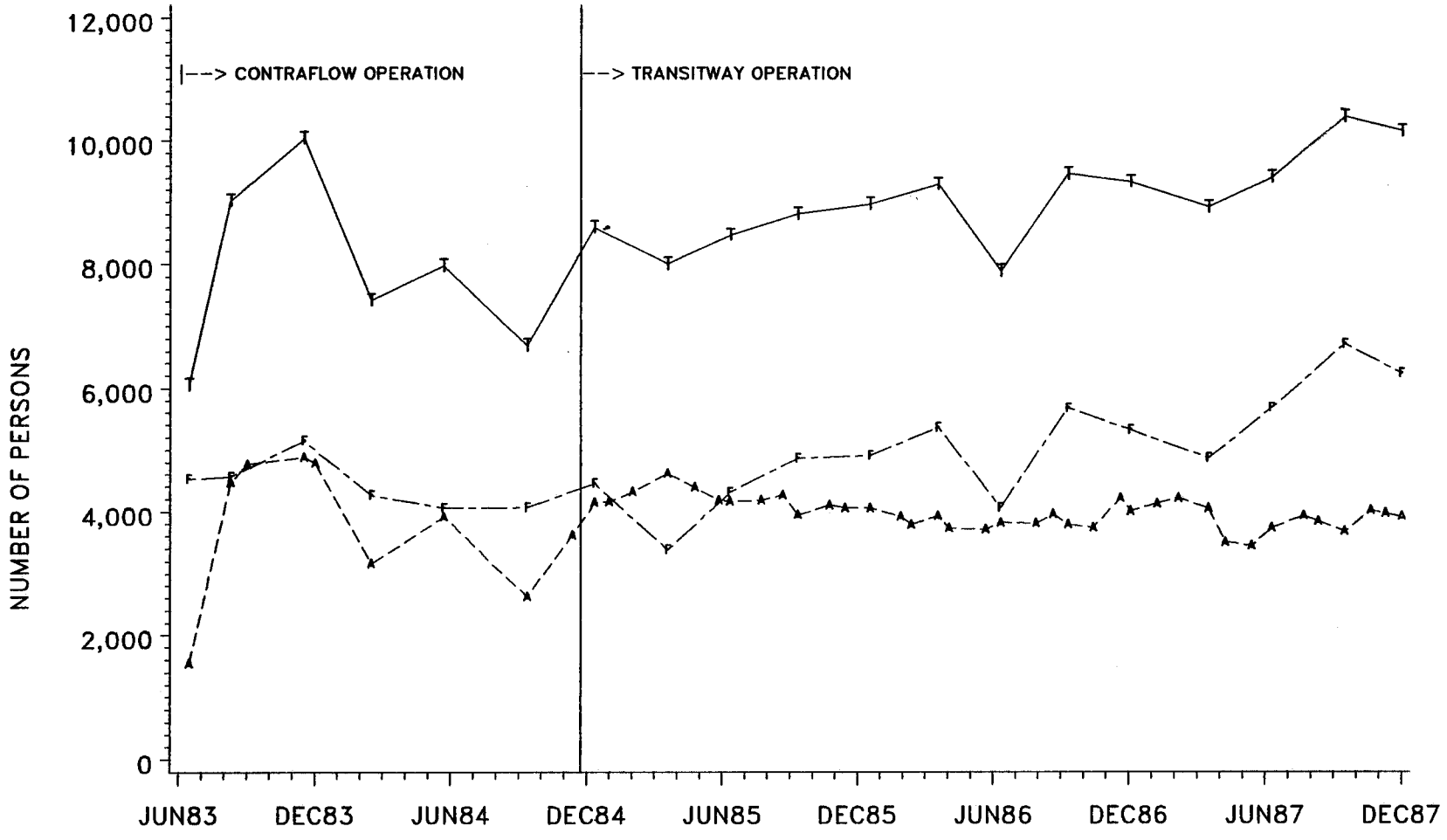
In December 1984, the A.M. peak-hour person volume on the North Freeway mainlanes and the transitway was 7820 persons (Table 20). In December 1987, the total (mainlane and transitway) A.M. peak-hour, peak-direction volume at the Little York count location was 10,170 persons (Table 21). Of this total, 3930, or 39%, was on the transitway (Figure 28). In comparison to the December 1984 volume, A.M. peak-hour person volume has increased by 30%.

In December 1984, the A.M. peak-period person volume on the mainlanes and the transitway was 16,040 persons (Table 20). In December 1987, the combined mainlane and transitway person movement in the A.M. peak-period was 23,190 persons at the Little York count site (Table 21). Of this total 7240, or 31%, was on the transitway (Figure 29). In comparison to the December 1984 volume, A.M. peak-period person volume has increased by 45%.

Table 20. North Freeway Mainlane and Transitway Vehicle and Person Volumes[a], December 1984

	Mainlanes		Transitway		Total		
Time Period	Vehicles	Persons	Vehicle	Persons	Vehicle	Persons	Pers./Veh.
A.M. Peak Hour	4060	4450	190	3370	4250	7820	1.84
A.M. Peak Period	9450	10560	290	5480	9740	16040	1.65
P.M. Peak Hour	4210	4900	225	4575	4435	9475	2.14
P.M. Peak Period	12055	13755	395	7670	12450	21425	1.72

[a]Measured at Little York Road.



DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

Figure 28. Trends in North Freeway Mainlane and Transitway A.M. Peak Hour Person Volumes

Table 21. Volume and Occupancy Data[a], North Freeway Mainlanes and Transitway, December 1987

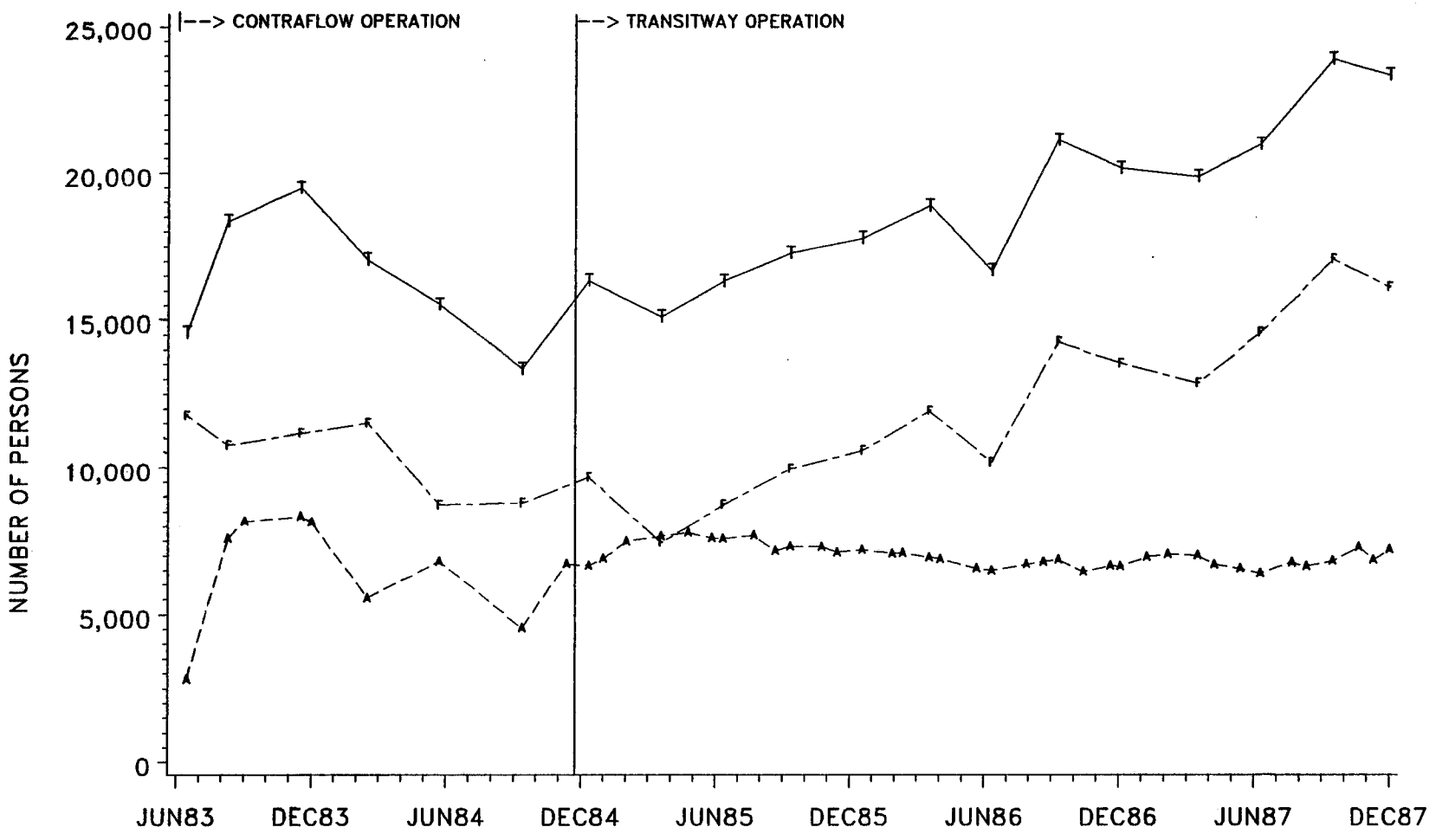
Operating Period	Vehicles		Persons		Persons/Vehicle
	Number	% Total	Number	% Total	
A.M. Peak Hour					
Freeway Mainlanes (4 lanes)	5550	97%	6240	61%	1.12
North Transitway (1 lane)	190	3%	3930	39%	20.68
Total or Average	5740	100%	10170	100%	1.77
A.M. Peak Period					
Freeway Mainlanes (4 lanes)	14240	98%	15950	69%	1.12
North Transitway (1 lane)	330	2%	7240	31%	21.94
Total or Average	14570	100%	23190	100%	1.59
P.M. Peak Hour					
Freeway Mainlanes (4 lanes)	5200	97%	6220	62%	1.20
North Transitway (1 lane)	155	3%	3765	38%	24.29
Total or Average	5355	100%	9985	100%	1.87
P.M. Peak Period					
Freeway Mainlanes (4 lanes)	14820	98%	17025	70%	1.15
North Transitway (1 lane)	370	2%	7485	30%	20.23
Total or Average	15190	100%	24510	100%	1.61

[a]Data collected at Little York Road.

P.M. Person Movement

In December 1984, the P.M. peak-hour person volume on the freeway mainlanes and the transitway was 9475 persons (Table 20). In December 1987, the total P.M. peak-hour, peak-direction, volume at Little York Road was 9985 persons; of that volume, 3765, or 38%, was on the transitway (Figure 30). Relative to the December 1984 volume, P.M. peak-hour person volume has increased by 5.4%.

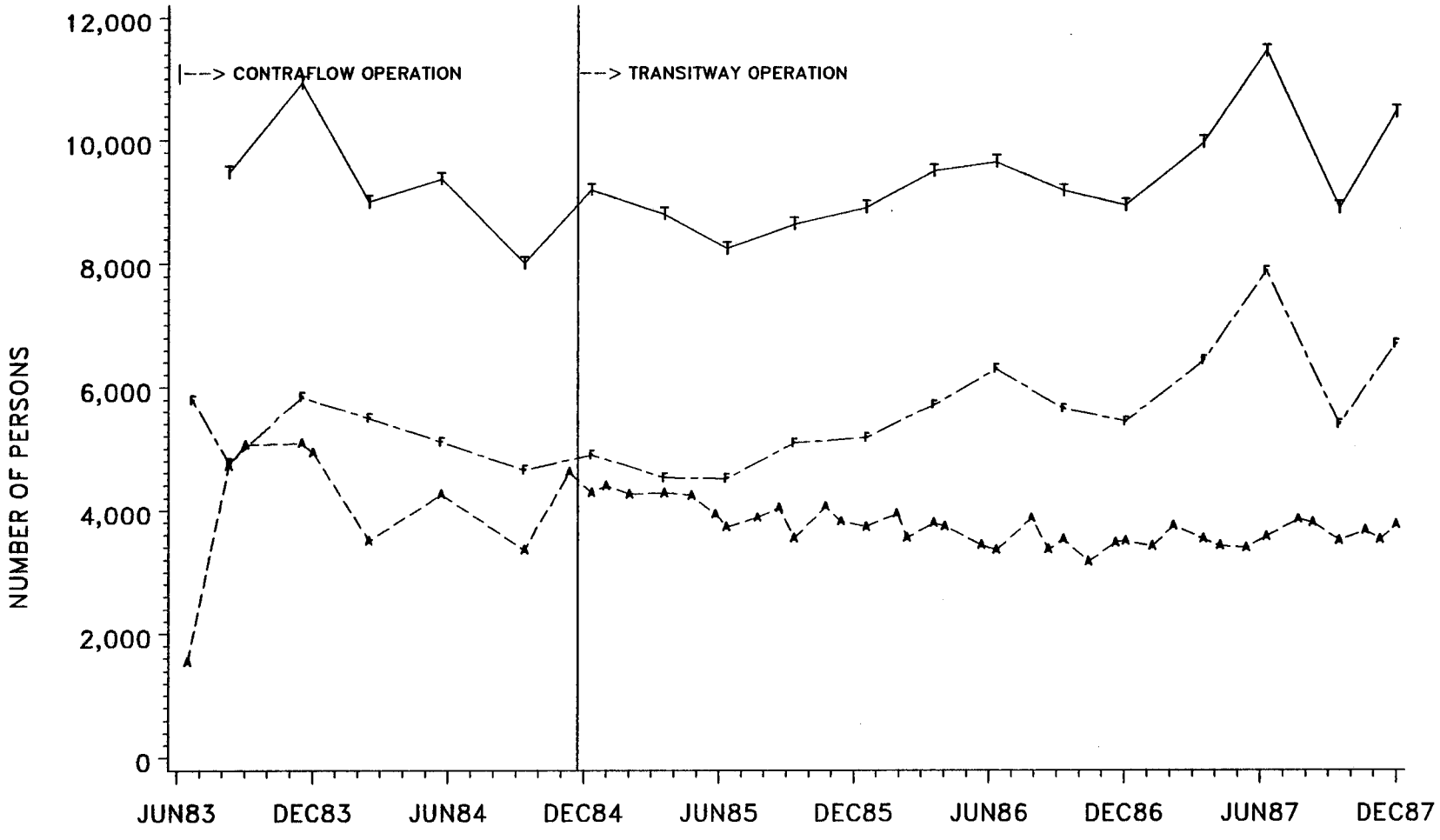
In December 1984, P.M. peak-period person volume on the freeway mainlanes and the transitway was 21425 persons (Table 20). In December 1987, the total peak-period, peak-direction volume at Little York Road was 24510 persons. Of that total volume, 7485 (30%), was on the transitway (Figure 31). Since December 1984, P.M. peak-period person movement has increased by 14%.



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 8:45 A.M
DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

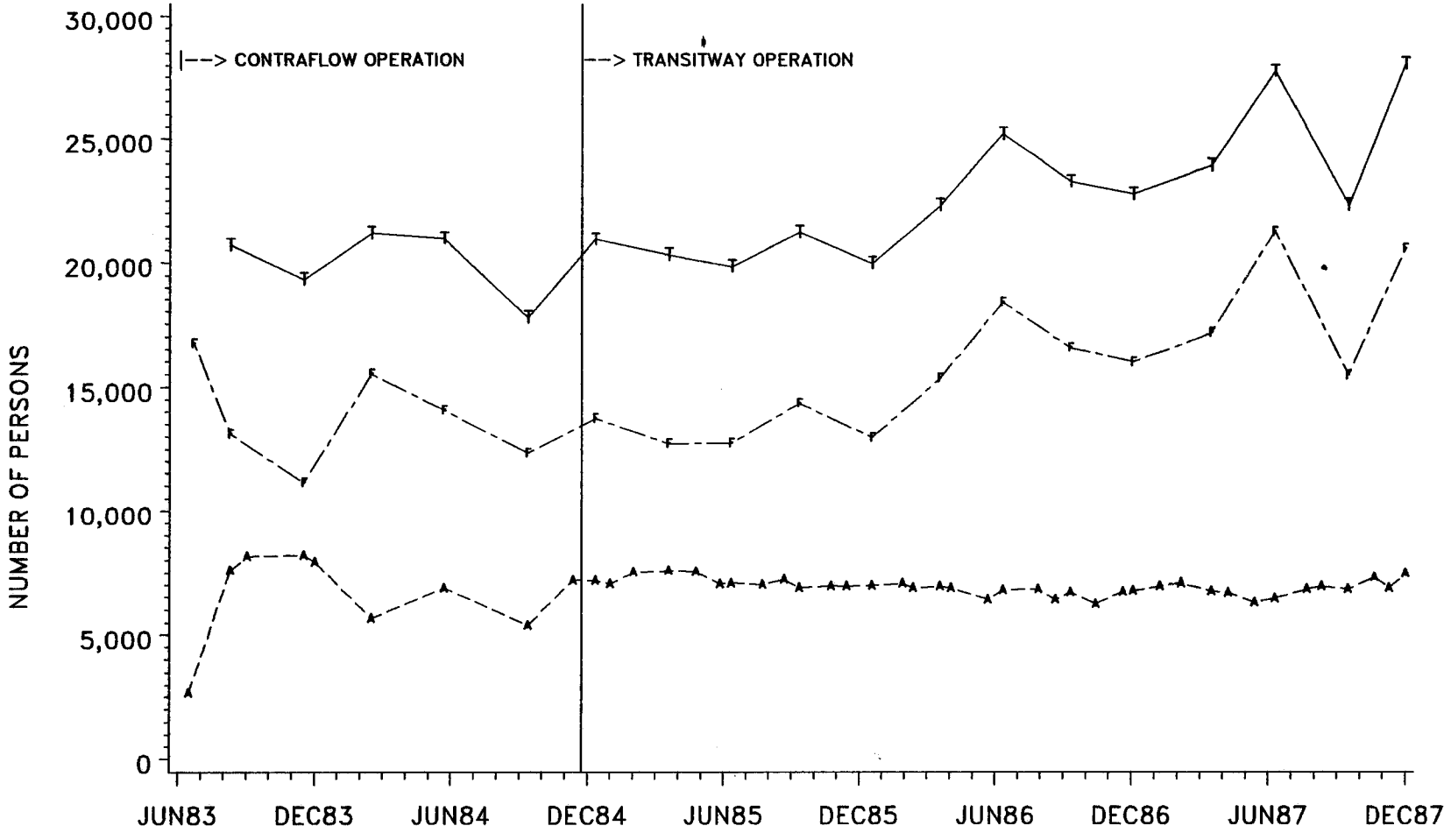
Figure 29. Trends in North Freeway Mainlane and Transitway A.M. Peak Period Person Volumes



DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

Figure 30. Trends in North Freeway Mainlane and Transitway P.M. Peak Hour Person Volumes



P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M
DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL PERSONS
F = MAINLANE PERSONS
A = TRANSITWAY PERSONS

Figure 31. Trends in North Freeway Mainlane and Transitway P.M. Peak Period Person Volumes

VEHICLE VOLUMES

A.M. Vehicle Volumes

Trends in A.M. peak-hour and peak-period vehicle volumes for the North Freeway mainlanes and transitway are shown in Figures 32 and 33. Since the transitway became operational, A.M. peak-hour vehicle volumes have increased from 4250 (Table 20) to 5740 vehicles (Table 21), a 35% increase. Of this total, 97% of the vehicles were operating on the freeway mainlanes. In the A.M. peak period, the 1984 volume was 9,740 vehicles (Table 20). By December 1987, this volume had increased to 14,570 vehicles, a 50% increase over 1984 levels.

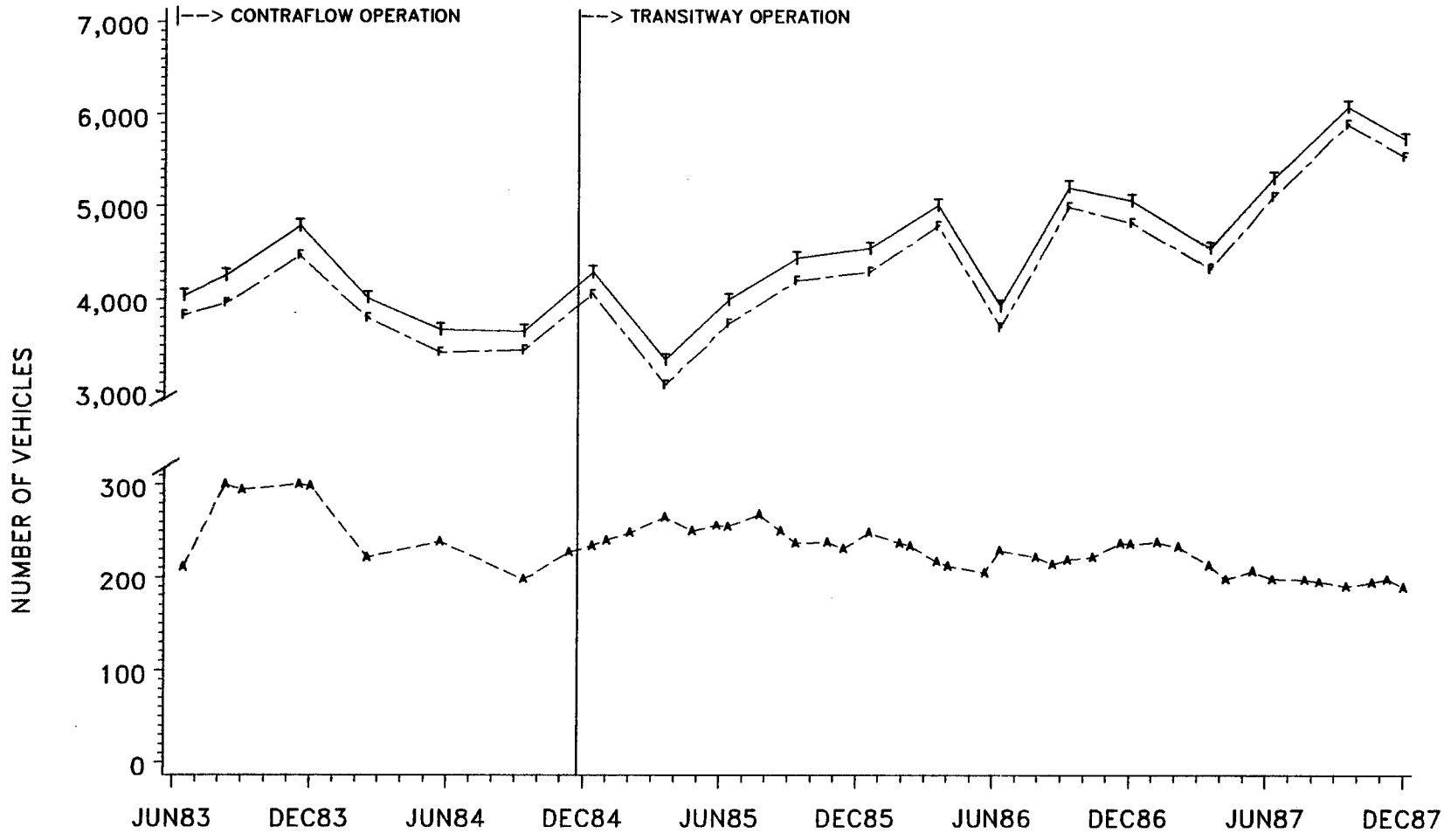
P.M. Vehicle Volumes

Figures 34 and 35 depict P.M. peak-hour and peak-period vehicle volumes for the North Freeway mainlanes and transitway. The P.M. peak-hour volumes have increased by 21%; from a 1984 volume of 4435 vehicles to a December 1987 volume of 5355 vehicles. Approximately 97% (5200) of these vehicles were operating on the freeway mainlanes. In the P.M. peak-period in December 1984, 12,450 vehicles were operating on the freeway mainlanes and the transitway (Table 20). By December 1987, a total of 15,190 vehicles were operating on the freeway mainlanes and the transitway, a 22% increase.

VEHICLE OCCUPANCIES

A.M. Operations

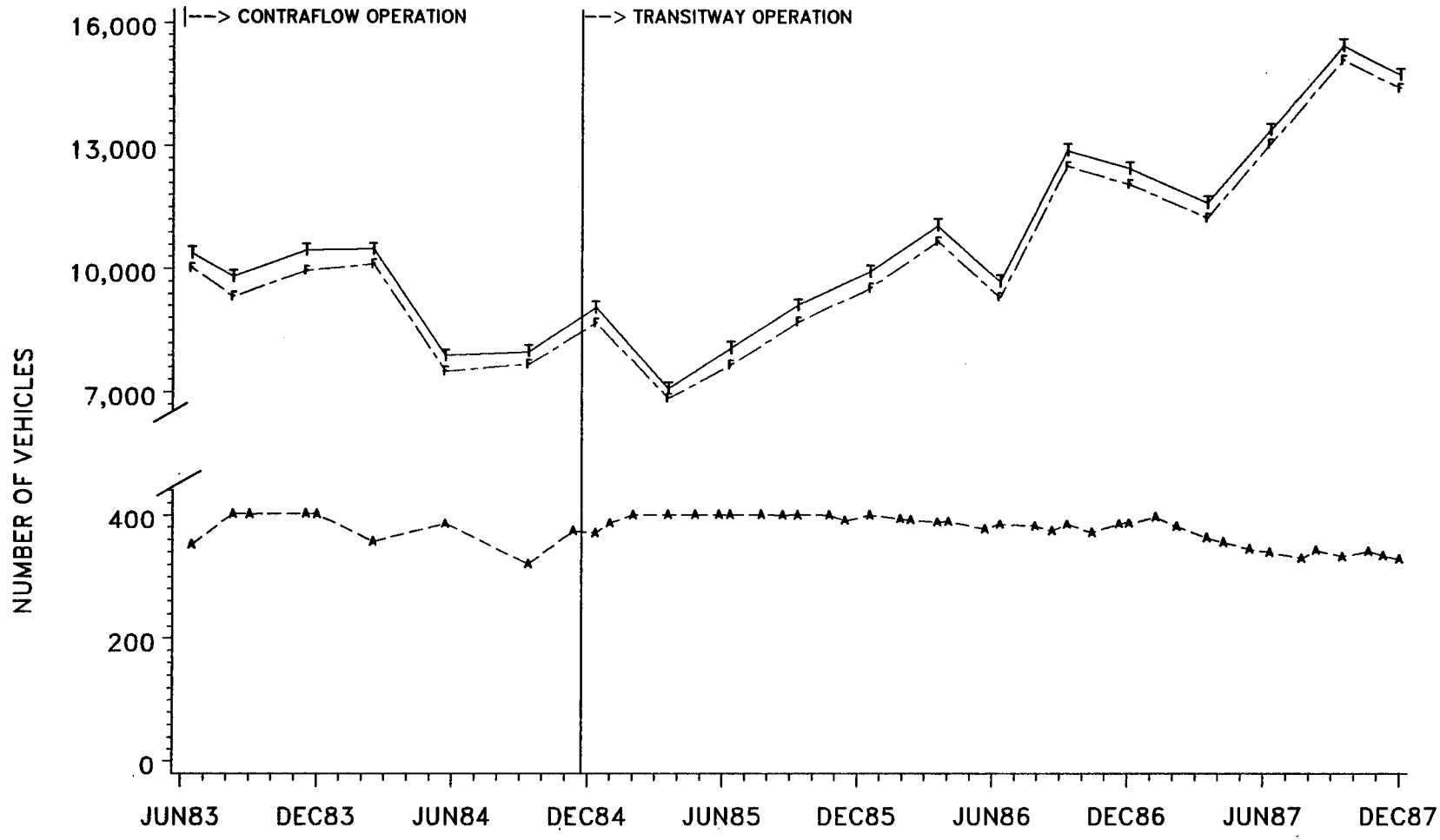
In December 1984, the A.M. peak-hour occupancy for the freeway mainlanes and the transitway was 1.84 persons/vehicle (see Table 20). In December 1987, the combined mainlane and transitway occupancy was 1.77 persons/vehicle, a decrease of 4% (Figure 36). For the A.M. peak-period,



DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL VEHICLES
F = MAINLANE VEHICLES
A = TRANSITWAY VEHICLES

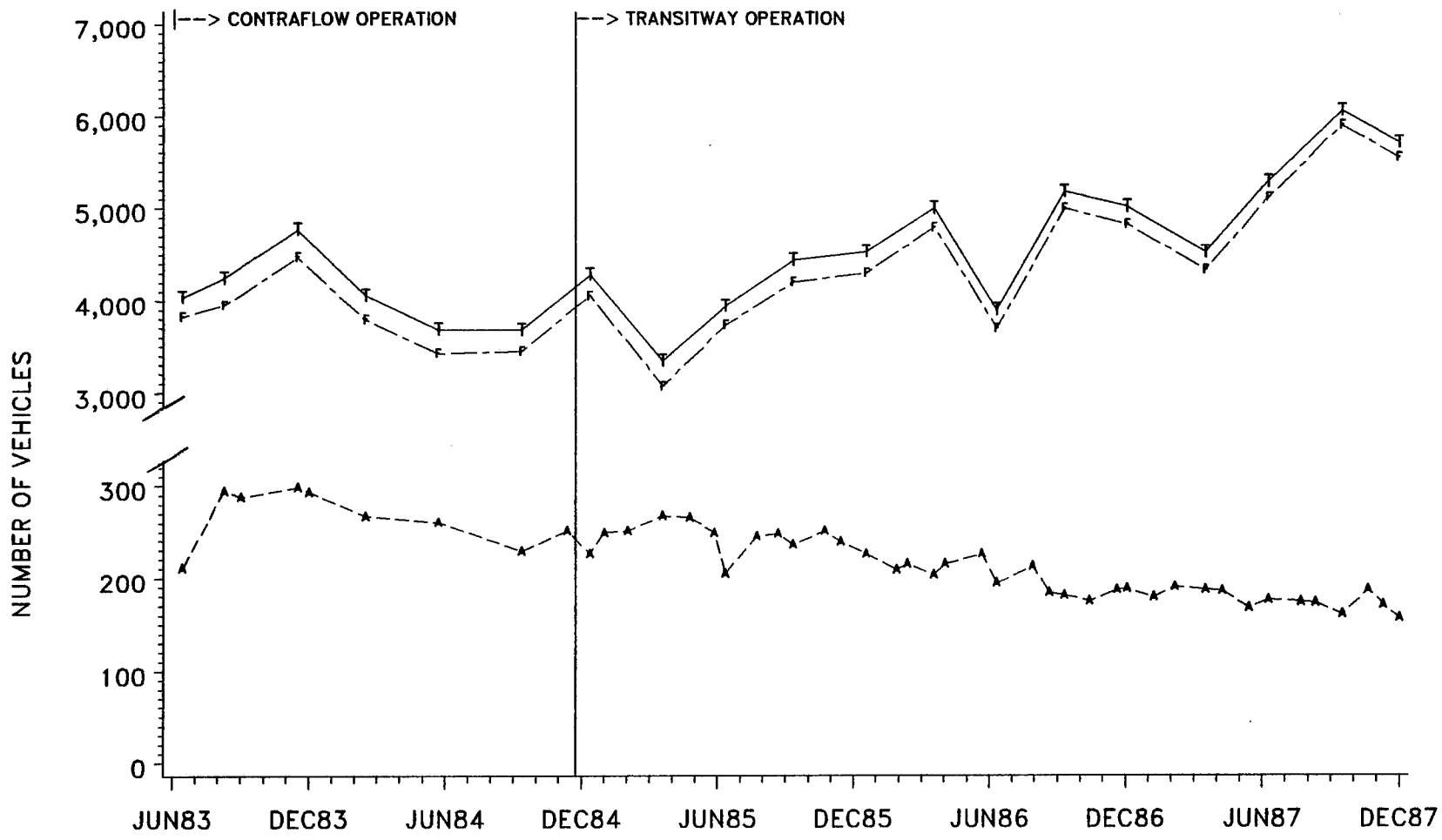
Figure 32. Trends in North Freeway Mainlane and Transitway A.M. Peak Hour Vehicle Volumes



A.M. PEAK PERIOD DEFINED AS FROM 5:45 TO 8:45 A.M
DATA COLLECTED SOUTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL VEHICLES
F = MAINLANE VEHICLES
A = TRANSITWAY VEHICLES

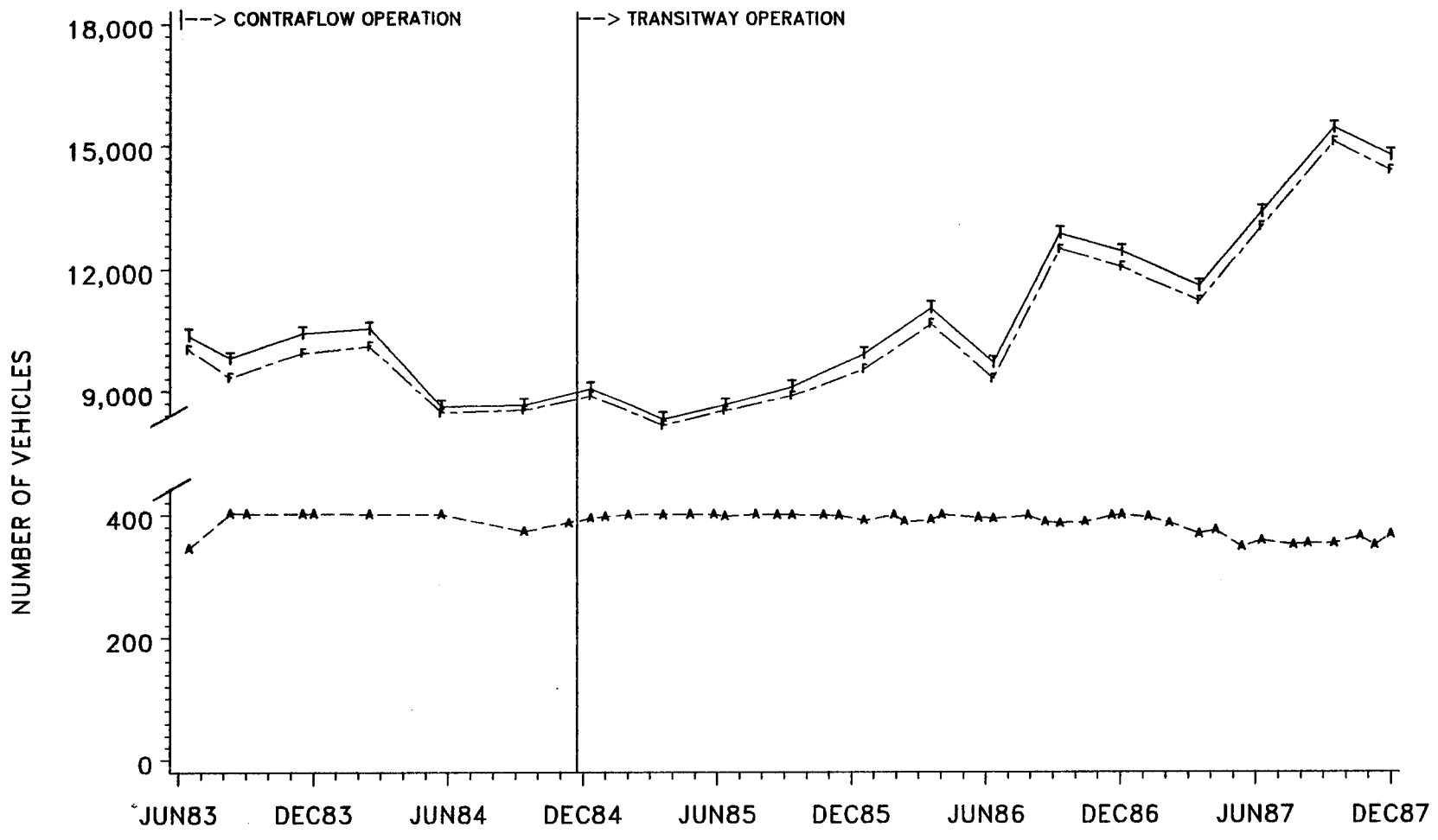
Figure 33. Trends in North Freeway Mainlane and Transitway A.M. Peak Period Vehicle Volumes



DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL VEHICLES
F = MAINLANE VEHICLES
A = TRANSITWAY VEHICLES

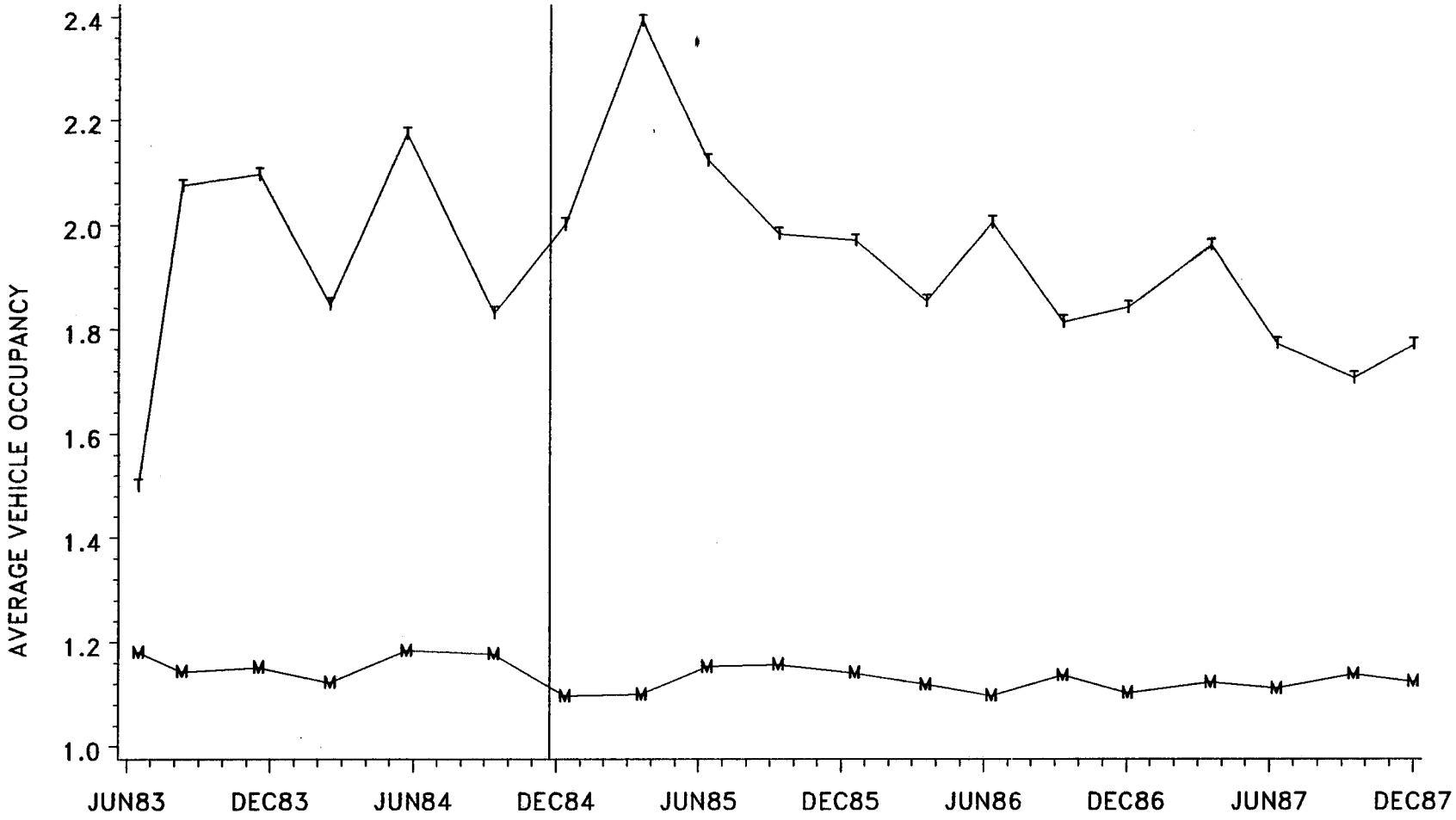
Figure 34. Trends in North Freeway Mainlane and Transitway P.M. Peak Hour Vehicle Volumes



P.M. PEAK PERIOD DEFINED AS FROM 3:30 TO 7:00 P.M
DATA COLLECTED NORTHBOUND AT LITTLE YORK
SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : T = TOTAL VEHICLES
F = MAINLANE VEHICLES
A = TRANSITWAY VEHICLES

Figure 35. Trends in North Freeway Mainlane and Transitway P.M. Peak Period Vehicle Volumes



DATA COLLECTED SOUTHBOUND AT LITTLE YORK

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

Figure 36. Trends in North Freeway Mainlane and Transitway A.M. Peak Hour Vehicle Occupancy

occupancy has also declined by 4%; from 1.65 to 1.59 persons per vehicle (Figure 37).

P.M. Operations

The P.M. peak-hour occupancy for the freeway mainlanes and transitway was 2.14 persons/vehicle in December 1984 (see Table 20). By December 1987, the P.M. peak-hour occupancy for the mainlanes and transitway had decreased to 1.87 persons/vehicle, a 13% decrease (Figure 38). For the P.M. peak-period, total vehicle occupancy has declined from 1.72 persons/vehicle in 1984, to 1.60 persons/vehicle in December 1987 (Figure 39).

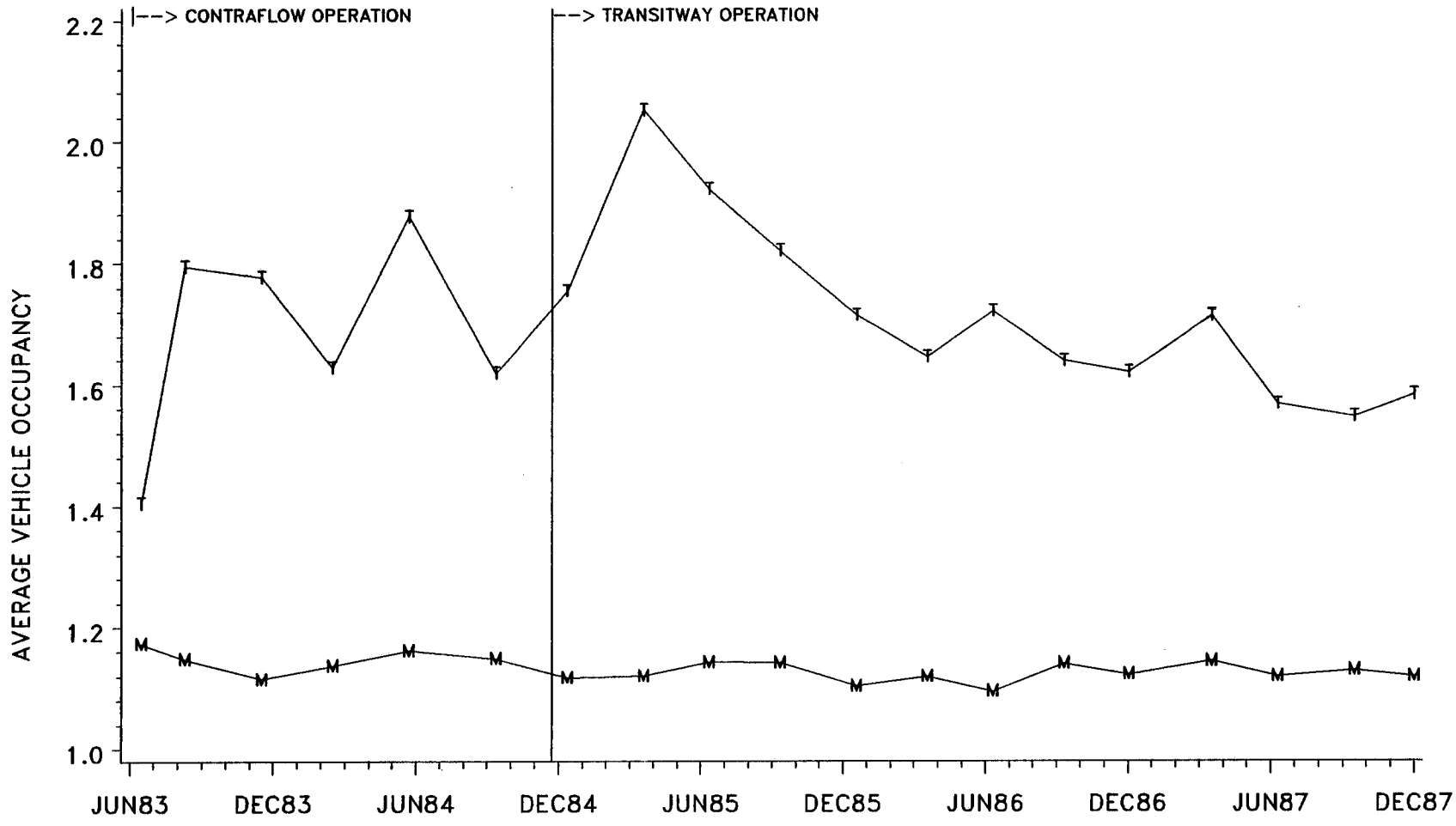
Comparison of Freeways With/Without Transitways

Data from the Houston area show that freeways with transitways have nearly 40% higher average vehicle occupancy than do freeways without transitways (Table 22). Even though vehicle occupancy rates in the North Freeway corridor have declined slightly since 1984, the occupancy rate for the North corridor is still considerably higher than on other Houston freeways (Table 22 and Figure 40).

Table 22. Average A.M. Peak-Hour Occupancies, Houston Freeways With and Without Transitways, December 1987

Freeway[a]	A.M. Peak-Hour, Peak-Direction Average Vehicle Occupancy (persons/vehicle)	
With Transitway, Average	1.65	
North (I-45N)		1.77
Katy (I-10W)		1.53
Without Transitway, Average	1.20	
Gulf (I-45S)		1.25
Southwest (US 59S)		1.20
Northwest (US 290)		1.14

[a]North Freeway data collected at Little York, Katy data collected at Bunker Hill, Gulf data collected at Monroe, Southwest data collected at Westpark, and Northwest data collected at Pinemont.

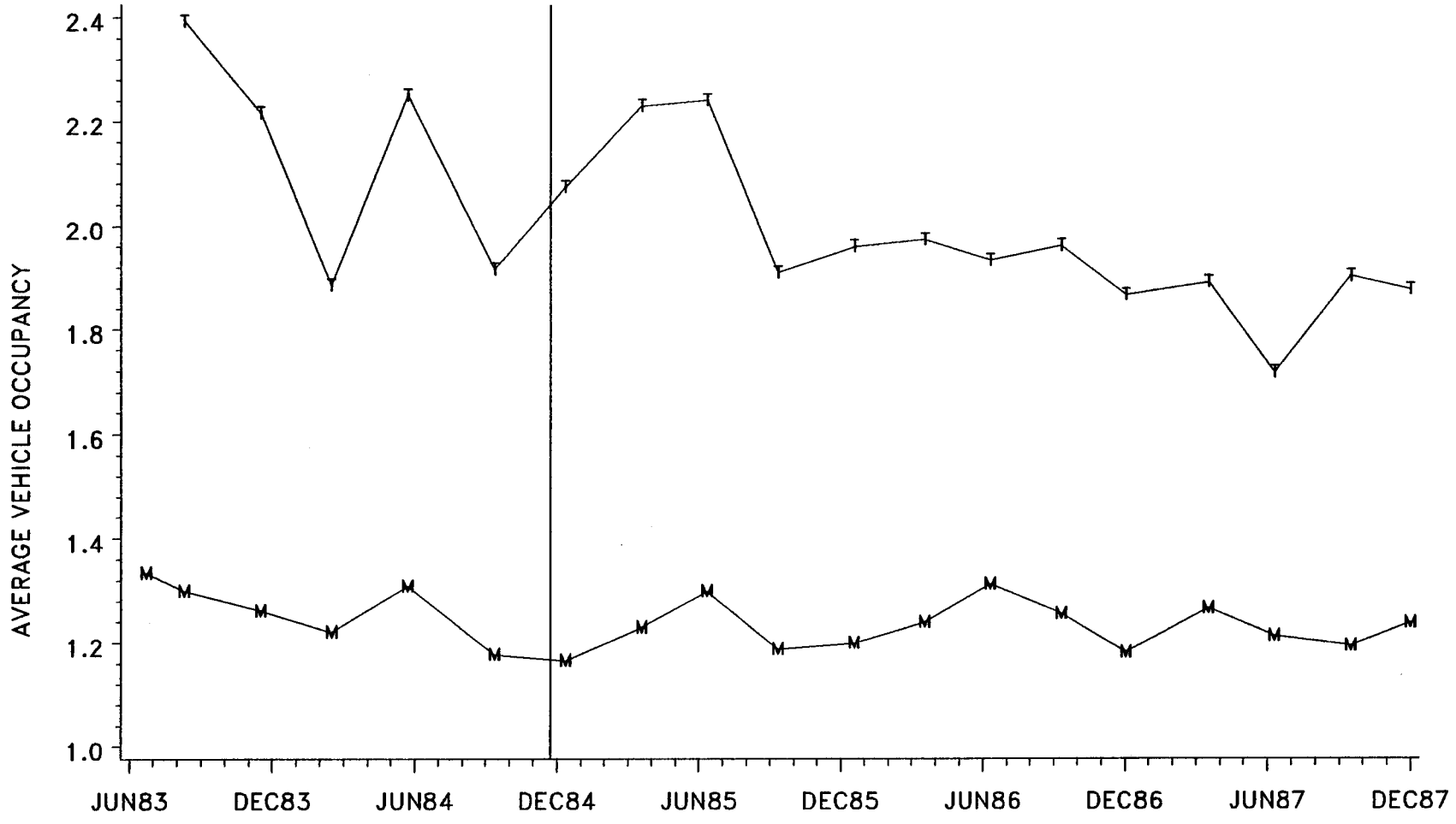


DATA COLLECTED SOUTHBOUND AT LITTLE YORK

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

Figure 37. Trends in North Freeway Mainlane and Transitway A.M. Peak Period Vehicle Occupancy

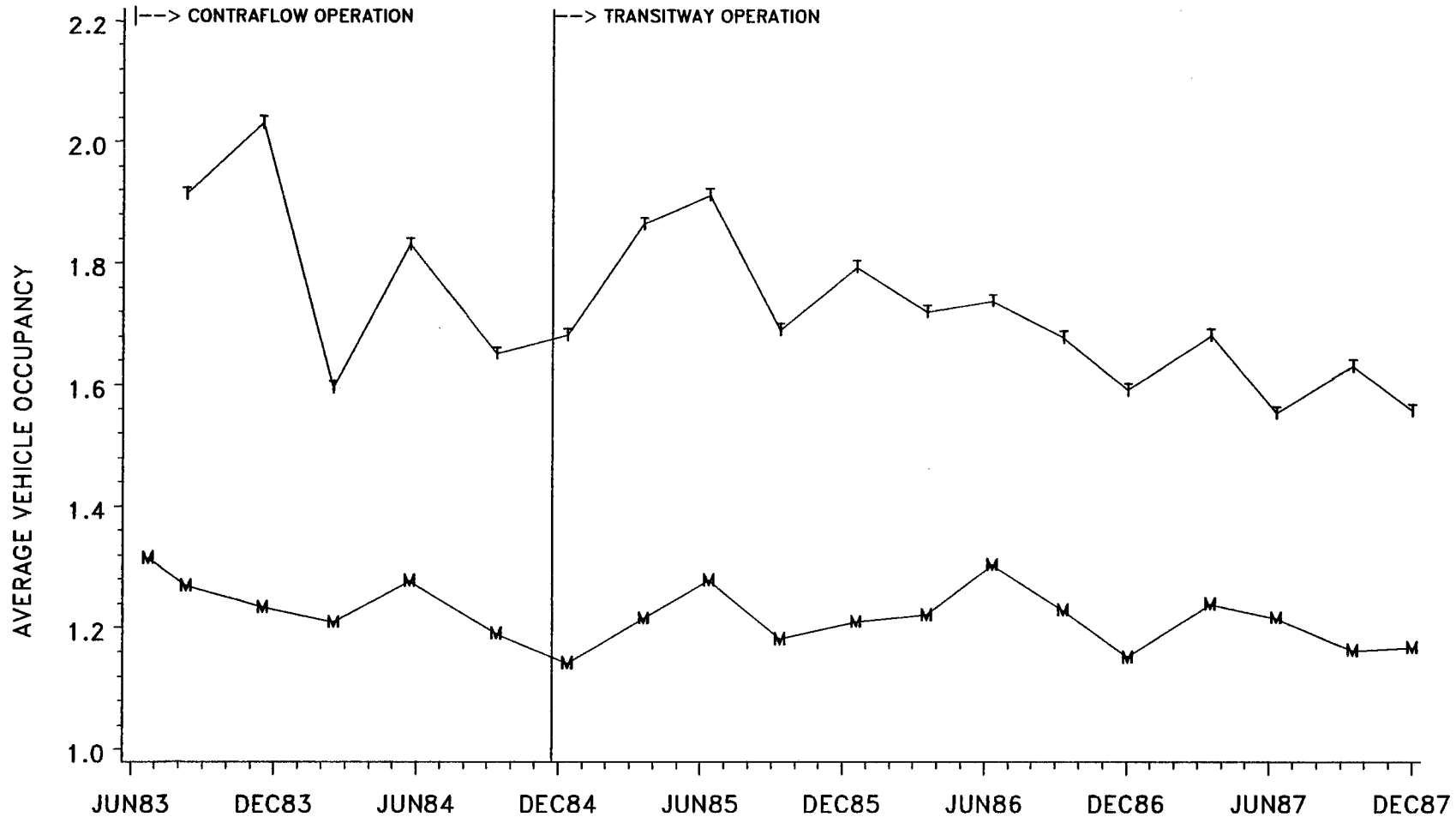


DATA COLLECTED NORTHBOUND AT LITTLE YORK

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

Figure 38. Trends in North Freeway Mainlane and Transitway P.M. Peak Hour Vehicle Occupancy

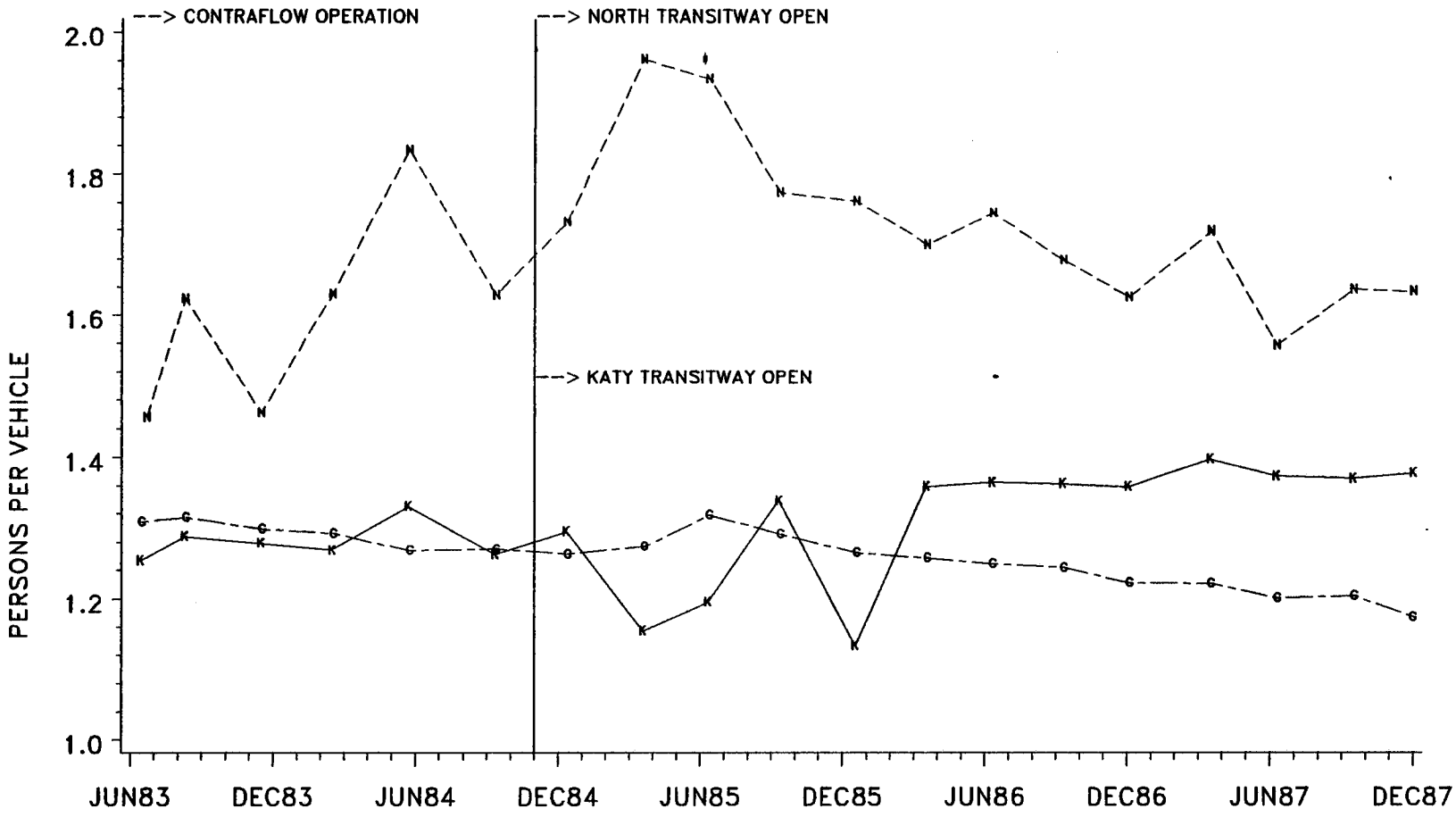


DATA COLLECTED NORTHBOUND AT LITTLE YORK

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : M = MAINLANE OCCUPANCY
T = TOTAL OCCUPANCY
(FREEWAY PLUS TRANSITWAY)

Figure 39. Trends in North Freeway Mainlane and Transitway P.M. Peak Period Vehicle Occupancy



KATY FREEWAY (IH 10W) DATA COLLECTED AT BUNKER HILL
GULF FREEWAY (IH 45S) DATA COLLECTED AT MONROE
NORTH FREEWAY (IH 45N) DATA COLLECTED AT LITTLE YORK

SOURCE : TEXAS TRANSPORTATION INSTITUTE

LEGEND : N = NORTH FREEWAY OCCUPANCY
(FREEWAY PLUS TRANSITWAY)
K = KATY FREEWAY OCCUPANCY
(FREEWAY PLUS TRANSITWAY)
G = GULF FREEWAY OCCUPANCY
(NO TRANSITWAY)

Figure 40. Trends in Daily Vehicle Occupany for Freeways With and Without Transitways

TRAVEL TIME SAVINGS

Travel time savings and travel time reliability have been shown to be essential for a transitway to be successful. Previous TTI research (5) has determined that these lanes must offer a 5 to 10 minute minimum travel time savings in order to encourage switches to ridesharing modes. Travel time saved by transitway users is calculated by comparing the freeway mainlanes to the transitway for the same time period, and then determining the number of vehicles and persons using the transitway during that time period.

Travel time data for the North Freeway have been collected for both the A.M. and the P.M. operating periods on a quarterly basis. It should be realized that these data probably understate actual travel time savings. Data for the North Freeway are collected during non-incident conditions on a Wednesday. Monday and Friday volumes are heavier, and, thus, travel time savings are greater on those days. Also non-incident conditions only exist during about 60% of the peak periods. When incidents occur, travel savings on the transitway can be considerably greater.

A.M. Travel Time Savings

Southbound A.M. travel times for the North Freeway mainlanes and the transitway in December 1987 are shown in Table 23. As shown in Table 23, transitway users realize the greatest time savings between 7:00 and 7:30 A.M. Nearly 9 minutes are saved by using the transitway during this time period. The total travel time savings for transitway users during the morning time period is approximately 740 person-hours.

P.M. Travel Time Savings

Table 24 shows northbound P.M. travel times for the North Freeway mainlanes and the transitway, as observed in December 1987. During the P.M. period, the greatest time savings for transitway users occur between 5:00 and 6:00 P.M. During this time period, transitway users can make the trip from downtown nearly 9 minutes faster than those who use the freeway mainlanes.

Total travel time savings for transitway users during the afternoon time period is approximately 770 person hours.

Table 23. Southbound A.M. Transitway Travel Time Savings, N. Shepherd to Downtown (7.75 miles), December 1987

Time Period	Average Travel Time (Minutes)		Time Saved by Transitway (Minutes)	Transitway Volume			Person Minutes Saved
				Vehicles			
	Mainlanes	Transitway		Buses	Vans	Persons	
5:45-6:30 A.M.	12.6	9.4	3.2	34	55	1690	5408
6:30-7:00 A.M.	15.7	9.4	6.3	28	64	1670	10,521
7:00-7:30 A.M.	18.3	9.4	8.9	44	53	2258	20,096
7:30-8:00 A.M.	15.7	9.4	6.3	28	7	1160	7308
8:00-8:30 A.M.	11.5	9.4	2.1	16	0	460	966
A.M. Total	-	-	-	150	179	7238	44,299

Table 24. Northbound P.M. Transitway Travel Time Savings, Downtown to N. Shepherd (7.75 miles), December 1987

Time Period	Average Travel Time (Minutes)		Time Saved by Transitway (Minutes)	Transitway Volume			Person Minutes Saved
				Vehicles			
	Mainlanes	Transitway		Buses	Vans	Persons	
3:30-4:00 P.M.	11.8	9.4	2.4	15	37	796	1910
4:00-4:30 P.M.	13.7	9.4	4.3	27	65	1447	6222
4:30-5:00 P.M.	16.0	9.4	6.6	30	47	1479	9761
5:00-5:30 P.M.	17.4	9.4	8.0	40	56	2128	17024
5:30-6:00 P.M.	17.9	9.4	8.5	26	5	1103	9376
6:00-6:30 P.M.	14.3	9.4	4.9	12	1	378	1852
6:30-6:45 P.M.	10.5	9.4	1.1	6	1	153	168
P.M. Total	-	-	-	156	212	7484	46,313

TRANSITWAY MODE SPLITS

Previous research (6) has shown that provision of priority treatment on a freeway can essentially double the bus transit mode split. These mode splits are in the range of 15% to 20% at park-and-ride lots in corridors without priority treatment; bus mode splits at park-and-ride lots with priority treatment tend to be in excess of 30%.

Mode split data from 1986 for the I-45 North Transitway are shown in Table 25. This mode split is measured at West Little York Road, which is essentially the last opportunity to enter the transitway. Table 25 shows A.M. work trips to Houston's major activity centers and the percentage of those trips that are on the freeway and on the transitway.

Table 25. Mode Split for A.M. Peak Period Person Trips, I-45 North Freeway at West Little York (1986)

Trip Destination	Peak-Period Person Trips				
	Freeway Mainlanes	Transitway			Total (Freeway Plus Transitway)
		Total	Bus	Van	
Downtown	5580 (50%)	5590 (50%)	4270	1320	11,170
City Post Oak	1620 (89%)	200 (11%)	50	150	1,820
Greenway Plaza	720 (80%)	180 (20%)	90	90	900
Texas Medical Center	540 (71%)	220 (29%)	50	170	760
Other	9540 (95%)	520 (5%)	90	430	10,060
Total	18,000 (72%)	6710 (28%)	4550	2160	24,710

Source: (2).

MEASURE OF EFFICIENCY FOR THE FREEWAY AND TRANSITWAY

In assessing the efficiency of a lane on the North Freeway, a measure that has been used is the multiple of peak-hour passengers times average operating speed (passenger-miles/hour). For the overall facility, this efficiency has to combine the single lane transitway with 4 lanes of freeway traffic. It is computed as shown below.

$$\frac{\text{(Transitway Passengers) (Transitway Speed) + (Freeway Passengers) (Freeway Speed)}}{\text{5 Lanes}}$$

For the combined freeway and transitway in the A.M. peak-hour in December 1987, this value (expressed in 1000's) is estimated to be approximately 87 passenger-miles/hour/lane. Implementation of the transitway greatly increased the per lane efficiency. In December 1984, the per lane efficiency was approximately 72 passenger-miles/hour/lane.

SUMMARY OF COMBINED MAINLANE AND TRANSITWAY DATA

A summary of selected data describing the combined operation of the freeway mainlanes and the transitway is shown in Table 26.

Table 26. Summary of Combined North Freeway Mainlane and Transitway Data

Combined Freeway and Transitway Characteristic	"Representative" 12/84 Value	"Representative" 12/87 Value	% Change (12/84-12/87)
Person Volume			
A.M. Peak Hour	7820	10170	+30%
% in Transitway	43%	39%	-9%
P.M. Peak Hour	9475	9985	+5%
% in Transitway	48%	38%	-21%
Vehicle Volume			
A.M. Peak Hour	4250	5740	+35%
% in Transitway	4.5%	3.3%	-27%
P.M. Peak Hour	4435	5355	+21%
% in Transitway	5.1%	2.9%	-43%
Average Vehicle Occupancy (persons/vehicle)			
A.M. Peak Hour	1.84	1.77	-4%
P.M. Peak Hour	2.14	1.87	-13%
Freeways w/Transitways[a]	----	1.65	-
Freeways w/o Transitways[b]	----	1.20	-
Transitway Travel Time Savings (minutes)			
A.M. Peak Hour	----	8	-
P.M. Peak Hour	----	9	-
Transitway Mode Split[c]			
% Trips to CBD	----	54%	-
% Trips to City Post Oak	----	37%	-
% Trips to Greenway Plaza	----	29%	-
% Trips to Texas Medical Center	----	43%	-
A.M. Peak Hour Lane Efficiency (1000's)[d]	72	87	+21%

[a]The average of occupancies for the North (I-45) and Katy (I-10) Freeways.

[b]The average of occupancies for the Gulf (I-45), Northwest (US 290) and Southwest (US 59 Freeways.

[c]Measured at Little York, approximately 10 miles north of downtown. This is the percentage of the total trips (freeway plus transitway) that are on the transitway. Data are from 1986.

[d]This is the multiple of total peak-hour passengers (freeway plus transitway) multiplied by the weighted average speed and divided by number of lanes.

VI. BUS TRANSIT DATA

BUS PASSENGERS AND BUS TRIPS

When compared to bus ridership trends from December 1984, peak-hour and peak-period ridership on the North Freeway has increased substantially (Table 27 and Figure 41). The increases in bus ridership in the North corridor, as well as in the Katy (I-10W) corridor, have been substantially greater than those observed in corridors without transitways. In fact, bus ridership has actually decreased in recent years in two of Houston's freeway corridors which do not have transitways (Table 28).

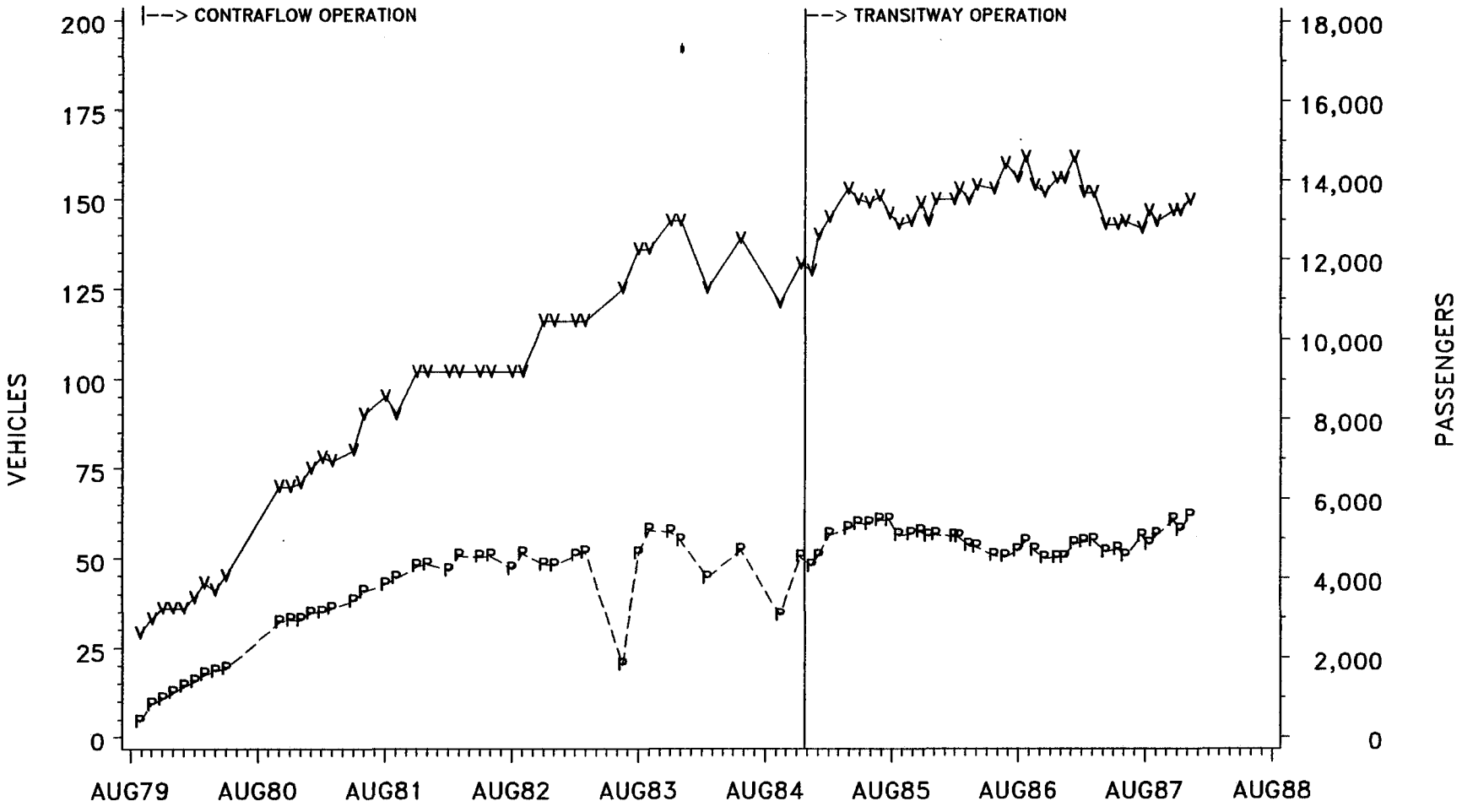
Table 27. Bus Passengers and Bus Trips, December 1984-December 1987

Time Period	12/84		12/87		% Change	
	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Peak Hour						
Passengers	1570	2790	2865	3025	+83%	+8%
Trips	40	80	72	77	+80%	-4%
Peak Period						
Passengers	3175	4800	5546	5500	+75%	+15%
Trips	95	145	150	156	+58%	+8%

Table 28. Change in Peak Period Bus Passengers, Freeway Corridors With and Without Transitways

Corridor	Before	Current (12/87)	% Change
Katy Freeway (w/transitway)	1114 (9/84)[a]	2485	+123%
North Freeway (w/transitway)	2357 (11/83)	5546	+135%
Gulf Freeway (w/o transitway)	1188 (9/84)	1111	-6.5%
Southwest (w/o transitway)	2326 (9/86)	2298	-1.2%

[a]Denotes month/year.
Source: TTI Surveys.



NORTH TRANSITWAY OPERATES FROM 5:45 TO 8:45 A.M.

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : V = BUS VEHICLE VOLUME
P = BUS PASSENGER VOLUME

Figure 41. Trends in North Transitway Bus Trips and Bus Passengers, A.M Peak Period

BUS OCCUPANCY

As was shown in Table 27, increases in bus passengers have been even greater than increases in the number of bus trips. The result has been that bus occupancy on the transitway has increased over the levels observed for 1984 (Table 29).

Table 29. Change in Average Bus Occupancy[a] (persons/bus), North Transitway

Time Period	12/84	12/87	% Change
Peak Hour			
A.M.	38.3	39.8	+4%
P.M.	34.9	39.3	+13%
Peak Period			
A.M.	32.7	37.0	+13%
P.M.	33.1	35.3	+7%

[a]Data collected at Little York Road.

PARK-AND-RIDE UTILIZATION

Houston METRO currently operates 4 park-and-ride lots in the North corridor. In addition to the 4 METRO lots, the Woodlands Corporation, a private corporation, also operates a park-and-ride lot in the corridor. With the exception of the North Shepherd lot (which has experienced a decline in utilization due to the opening of the Seton Lake Lot), substantial increases have occurred in the number of cars parked at the park-and-ride lots in the North corridor (Table 30 and Figure 42). Overall, utilization of the park-and-ride lots in the corridor has increased by nearly 25% over the CFL levels of November 1983.

Table 31 shows a comparison of park-and-ride utilization for freeway corridors with and without transitways. As shown in Table 31 (and Figure 43), park-and-ride utilization is substantially higher in corridors with transitways than in corridors without transitways. While recent growth in park-and-ride use in the North corridor has not been as dramatic as in the

Table 30. Average Daily Utilization of North Freeway Corridor Park-and-Ride Lots

Date	Daily Utilization (Parked Vehicles)					
	N. Shepherd	Kuykendahl	Spring	Seton Lake	Woodlands	Total
Nov. 83	852	1426	875	543	-	3696
Dec. 84	735	1466	887	650	-	3738
Dec. 85	690	1737	961	668	-	4056
Dec. 86	706	1582	877	715	289	4169
Dec. 87	673	1737	968	864	348	4590
Percent Change						
Nov. 83 - Dec. 87	-21.0%	+21.8%	+10.6%	+59.1%	-	+24.2%
Dec. 86- Dec. 87	-4.7%	+9.8%	+10.4%	+20.8%	+20.4%	+10.1%

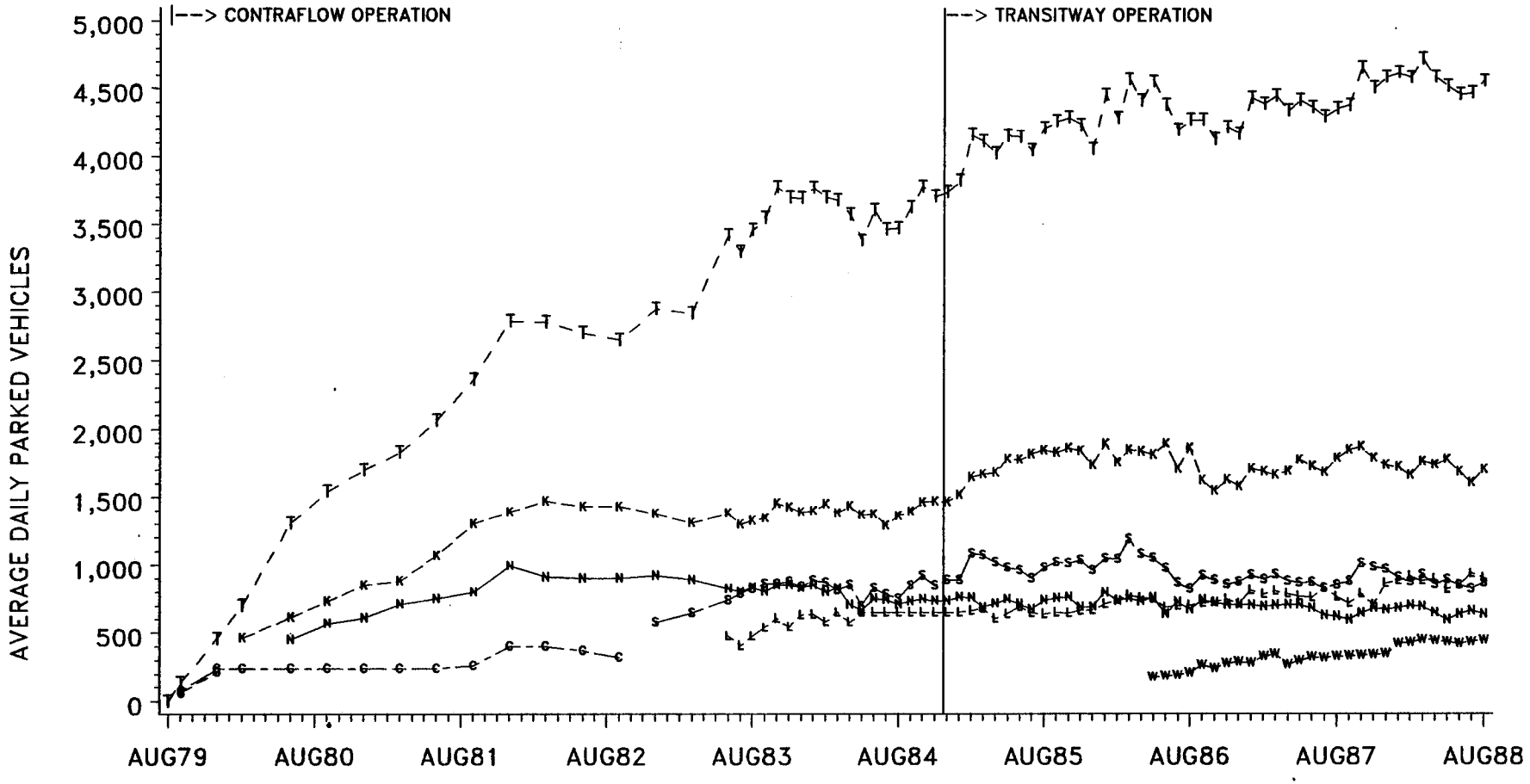
Source: TTI Surveys.

Table 31. Comparison of Vehicles Parked at Park-and-Ride Facilities for Freeway Corridors With and Without Transitways

Corridor	Park-and-Ride Utilization		
	Before	Current (12/87)	% Change
Katy Freeway (with transitway)	575 (12/83)[a]	1368	+138%
North Freeway (with transitway)	3738 (12/84)	4590	+23%
Freeways without Transitways[b]	2722 (9/84)	3033	+11%

[a]Denotes month/year.
[b]Sum of data from Northwest (US 290), Southwest (US 59S), and Gulf (I-45S) Freeways.

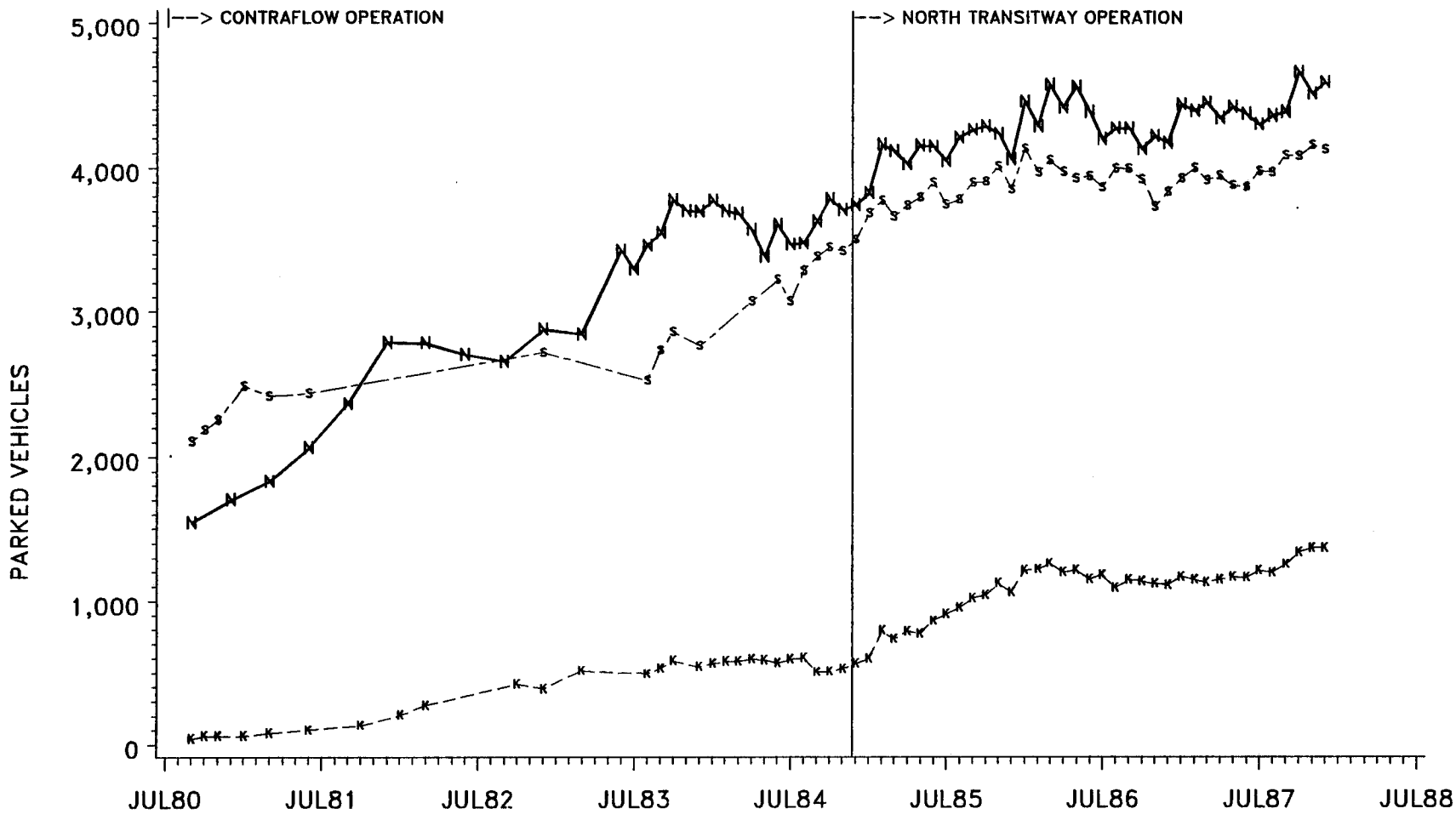
Katy corridor, park-and-ride lot utilization in the North corridor is higher than the park-and-ride use in all the other freeway corridors combined. Additionally, much of the initial dramatic growth in park-and-ride demand in the North corridor occurred during the years of the CFL operation in the corridor. The modest growth rates observed for park-and-ride demand in the North corridor in recent years may be indicative of more long-term, stable growth rates that occur in corridors with transitways.



NORTH CFL FROM DOWNTOWN TO NORTH SHEPHERD (9.6 MI.) OPENED AUGUST, 1979
CONCURRENT FLOW LANE (A.M. ONLY) FROM NORTH SHEPHERD TO WEST RD (3.3 MI.) OPENED MARCH, 1981
NORTH TRANSITWAY FROM DOWNTOWN TO NORTH SHEPHERD (9.6 MI.) OPENED SEPTEMBER, 1984
CURRENT TOTAL CORRIDOR PARKING CAPACITY = 7017 SPACES
CHAMPIONS (C) AND GREENSPOINT (G) LOTS WERE TEMPORARY LOTS
SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

LEGEND : T = TOTAL PARKED VEHICLES
K = KUYKENDAHL LOT (2246 SPACES)
L = SETON LAKE LOT (1286 SPACES)
N = NORTH SHEPHERD LOT (1605 SPACES)
S = SPRING LOT (1280 SPACES)
W = THE WOODLANDS LOT (600 SPACES)

Figure 42. Trends in North Freeway Corridor Park-and-Ride Lot Demand



LEGEND : N = NORTH FREEWAY
K = KATY FREEWAY
S = SUM, NON TRANSITWAY FREEWAYS

SOURCE : TEXAS TRANSPORTATION INSTITUTE & METRO

Figure 43. Trends in Park-and-Ride Demand in Freeway Corridors With and Without Transitways

SUMMARY OF TRANSIT DATA

Implementation of the transitway has resulted in substantial increases in transit use. Table 32 summarizes selected transit data for the North Transitway.

Table 32. Summary of A.M. Bus Transit Impacts of Implementing the North Transitway

Data	12/84	12/87	% Change
Bus Passengers			
A.M. Peak Hour	1570	2865	+83%
A.M. Peak Period	3175	5546	+75%
Bus Vehicle Trips			
A.M. Peak Hour	40	72	+80%
A.M. Peak Period	95	150	+58%
Bus Occupancy (Persons/Bus)			
A.M. Peak Hour	38.3	39.8	+4%
A.M. Peak Period	32.7	37.0	+13%
Vehicles Parked at Park-and-Ride Lots	3738	4590	+23%

VII. CONCLUSIONS

TRANSITWAY IMPACTS

Implementation of the transitway on the I-45N Freeway has produced substantial increases in the person movement capacity of the freeway. The North Transitway, which replaced the temporary CFL operation, has resulted in dramatic improvements in the overall level-of-service provided by the freeway. Specifically, the North Transitway has produced the following improvements in freeway level-of-service.

1. The single transitway lane serves almost 40% of the total volume of persons moved on the roadway during the A.M. peak hour (Table 33).

Table 33. Percent of Total Person Movement on the North Freeway Mainlanes and Transitway, December 1987

Time Period	Percent of Person Movement	
	Freeway Mainlanes	Transitway
A.M. Peak Hour	61%	39%
A.M. Peak Period	69%	31%
P.M. Peak Hour	62%	38%
P.M. Peak Period	70%	30%

2. The transitway project has created increases in the use of transit and ridesharing, thereby increasing total person throughput. In comparison to 1984 conditions, peak-hour bus ridership has increased by over 80%. These increases have not been experienced on freeways without transitways. In comparison to 1984 conditions, A.M. peak-hour person volume on the mainlanes and transitway combined has increased 30%, while P.M. peak-hour person volume has increased 5%. In the A.M. peak-hour, the transitway is serving over 3900 persons. These do not reflect the even larger increases that occurred during contraflow operation.

3. The transitway is serving a respectable modal share. Of the trips on the freeway and transitway during the A.M. peak period in 1986: 50% of downtown trips are on the transitway; 29% of Texas Medical Center trips are

on the transitway; 11% of City Post Oak trips are on the transitway; and 20% of Greenway Plaza trips are on the transitway.

4. The per lane efficiency (passenger-miles per hour) for the transitway is relatively high. Using this measure of effectiveness for the A.M. peak hour, the efficiency of the transitway lane is nearly 4 times greater than the efficiency of a general purpose freeway mainlane. In comparison to 1984 conditions for the A.M. peak hour, the overall per lane efficiency of the roadway (combined freeway and transitway) has increased by 21%.

FREEWAY IMPACTS

Implementation of the transitway has not resulted in a degradation of service or safety on the freeway mainlanes. The accident rate has declined, while freeway mainlane speeds and volumes have increased slightly. This is partly due to freeway improvements.

FUTURE ISSUES

By most measures, the North Transitway has been a successful improvement. It should be recognized that both travel patterns and congestion in the corridor make this an ideal freeway corridor for an HOV facility. However, the following issues will need to be addressed in the future.

1. Transitway Capacity. The capacity of the Katy Transitway, which is open to buses, vanpools, and 2+ carpools, has been estimated to be 1500vph (4, 8). This facility is currently operating near its vehicular capacity, with A.M. peak-hour volumes in excess of 1400 vph. It has been estimated that in order to accommodate design year person volumes, average vehicle occupancy on the Katy Transitway will need to increase by 60% to 100% (4). As a result, a number of strategies are already being considered to reduce peak-hour vehicle demand on the Katy Transitway.

Recent experiences on the Katy Transitway, then, suggest that vehicle occupancy requirements (i.e., whether to allow carpools to use transitways

and, if so, what size carpools) should be given careful consideration in transitway planning.

2. **Transitway Operational Issues.** Operational issues will continue to exist. Transitways must provide relatively high speeds and reliable travel times. In order for transitways to appear utilized, it will probably be necessary to maintain peak-hour volumes of 1000 vph or more (4). Finally, the capability of effectively enforcing the operating rules must be maintained.

3. **Transitways Are Not the Solution to All Urban Congestion Problems.** Transitways can be effective tools to help maintain mobility in certain corridors. Providing transitways, however, does not eliminate the need to pursue a range of other transportation improvements, including: 1) new street and highway construction; 2) improved operation of the street and highway system; 3) demand management strategies; and 4) other mass transportation improvements.

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