Central Puget Sound

FREEWAY NETWORK

USAGE AND PERFORMANCE

1999 Update, Volume 2: Trends

Washington State
Department of Transportation

Washington State
Transportation Center

Draft Research Report
Research Project T1803, Task 19
FLOW Evaluation

Central Puget Sound

FREEWAY NETWORK USAGE AND PERFORMANCE

1999 Update, Volume 2: Trends

by

Mark E. Hallenbeck
Director

John M. Ishimaru
Senior Research Engineer

Jennifer Nee
Research Engineer

Washington State Transportation Center (TRAC)
University of Washington, Box 354802
University District Building
1107 NE 45th Street, Suite 535
Seattle, Washington 98105-4631

Washington State Department of Transportation
Technical Monitor , David P. McCormick
Regional Traffic Engineer

Prepared for

Washington State Transportation Commission
Department of Transportation

and in cooperation with

U.S. Department of Transportation
Federal Highway Administration

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
WA-RD 493.2		

4. TITLE AND SUBTITLE	5. REPORT DATE
Central Puget Sound Freeway Network Usage and Performance, 1999 Update, Volume 2: Trends	September 2000
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT NO.
Mark E. Hallenbeck, John M. Ishimaru, and Jennifer Nee	
9. PERFORMING ORGANIZATION NAME AND ADDRESS	10. WORK UNIT NO.
Washington State Transportation Center (TRAC) University of Washington, Box 354802 University District Building; 1107 NE 45th Street, Suite 535 Seattle, Washington 98105-4631	11. CONTRACT OR GRANT NO. Agreement T1803, Task 19
12. SPONSORING AGENCY NAME AND ADDRESS	13. TYPE OF REPORT AND PERIOD COVERED
Washington State Department of Transportation Transportation Building, MS 7370 Olympia, Washington 98504-7370 Project Manager Gary Ray, 360-705-7975	Research report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

16. ABSTRACT

This two-volume *summary* report presents an overview of the level of traveler usage (e.g., how many vehicles use the freeways) and travel performance (e.g., how fast they are traveling, where and how often congestion occurs) on the principal urban freeways in the central Puget Sound area. Volume 1 focuses on descriptive snapshots of 1999 freeway usage and performance, while Volume 2 provides a comparative analysis, looking at trends and variations in the usage and performance of the highway network as a function of different background conditions at selected locations. Data presented in this report were collected by the Washington State Department of Transportation's (WSDOT's) freeway surveillance system.

The project that led to this report is intended to meet two separate purposes: 1) to enhance WSDOT's ability to monitor and improve its traffic management efforts on Seattle-area highways, and 2) to provide useful information to the public and decision makers about the status of the freeway system's operational performance. This report is primarily intended to meet the second of these objectives. However, the software developed for this project and many of the graphics presented in this report are directly applicable to the first objective.

This report is one of three products resulting from this WSDOT project. In addition to this report, this project produced a set of software tools to assist in freeway data analysis, as well as a technical report describing the evaluation approach, process, and analytical tool set that were developed to analyze freeway usage and performance in the central Puget Sound region. The freeways studied in this project are managed by WSDOT using its FLOW system, a coordinated network of traffic monitoring, measuring, information dissemination, and control devices that operates on urban state and Interstate highways in the central Puget Sound region.

17. KEY WORDS	18. DISTRIBUTION STATEMENT
Archived Data User Services (ADUS), congestion monitoring, freeway performance	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
None	None		

Disclaimer

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Washington State Transportation Commission, Department of Transportation, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

List of Contents

ACKNOWLEDGMENTS vi

GLOSSARY vii

SECTION 1. INTRODUCTION 1

Purpose of This Report 1

What Is in This Report 1

Geographic Scope 1

Interpreting Results 1

About This Project 2

SECTION 2. VARIATIONS IN SYSTEM PERFORMANCE 3

How Freeway Performance Comparisons Were Measured 3

Where Freeway Performance Comparisons Were Measured 3

Results: Weekday vs. Weekend Daily Averages and 24-Hour Volume Profiles 3

Results: GP vs. HOV 24-Hour Weekday Volume Profiles 11

Results: Facility Performance Changes from 1997 to 1999 14

List of Tables and Figures

Tables

2.1 Average Weekday and Weekend Daily Vehicle Volumes at Selected Freeway Locations 4

2.2 Changes in General Purpose Freeway Lane Volumes, 1997-1999 15

Figures

1.1 Instrumented Freeway Segments on Central Puget Sound Freeways 2

2.1 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-5 at University St, General Purpose Lanes 6

2.2 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-5 at University St, General Purpose Lanes 6

2.3 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-5 at University St, HOV Lanes 6

2.4 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-405 at NE 14th St, General Purpose Lanes 7

2.5 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-405 at NE 14th St, General Purpose Lanes 7

2.6 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-405 at NE 14th St, HOV Lanes 7

2.7 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-405 at NE 14th St, HOV Lanes 7

2.8 1999 Weekday vs. Weekend Estimated Volume Profile, Eastbound SR 520 at 76th Ave NE, General Purpose Lanes 8

2.9 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound SR 520 at 76th Ave NE, General Purpose Lanes 8

2.10 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound SR 520 at 84th Ave NE, HOV Lanes 8

2.11 1999 Weekday vs. Weekend Estimated Volume Profile, Eastbound I-90 at Shorewood Dr, General Purpose Lanes 9

2.12 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound I-90 at Shorewood Dr, General Purpose Lanes 9

2.13 1999 Weekday vs. Weekend Estimated Volume Profile, I-90 at Shorewood Dr, Reversible HOV Lanes 9

2.14 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound SR 167 at South 23rd St, General Purpose Lanes 10

2.15 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound SR 167 at South 23rd St, General Purpose Lanes 10

2.16 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound SR 167 at South 23rd St, HOV Lanes 10

2.17 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound SR 167 at South 23rd St, HOV Lanes 10

2.18 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Southbound I-5 at University St 12

2.19 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Northbound I-405 at NE 14th St 12

2.20 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Southbound I-405 at NE 14th St 12

2.21 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Westbound SR 520 at 76th Ave NE 12

2.22 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Eastbound I-90 at Shorewood Dr 13

2.23 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Westbound I-90 at Shorewood Dr 13

2.24 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Northbound SR 167 at S 23rd St 13

2.25 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Southbound SR 167 at S 23rd St 13

2.26 Example Congestion Frequency Comparison, Northbound I-5 at Dearborn 14

2.27 1997-1999 Congestion Frequency Comparison, Northbound I-5 at Dearborn .. 17

2.28 1997-1999 Volume Trends, Northbound I-5 at Boeing Field 18

2.29 1997-1999 Congestion Frequency Comparison, Northbound I-5 at Northgate .. 19

2.30 1997-1999 Volume Trends, Northbound I-5 at Northgate 20

2.31 1997-1999 Congestion Frequency Comparison and Volume Trends, Northbound I-5 South of the Swamp Creek Interchange 21

2.32 1997-1999 Congestion Frequency Comparison, Southbound I-5 at NE 155th St 22

2.33 1997-1999 Congestion Frequency Comparison, Southbound I-5 North of the Ship Canal 23

2.34 1997-1999 Volume Trends, Southbound I-5 at NE 63rd St 24

2.35 1997-1999 Congestion Frequency Comparison, ?? I-405 [south end] 27

2.36 1997-1999 Congestion Frequency Comparison, Northbound I-405 North of Downtown Bellevue 28

2.37 1997-1999 Congestion Frequency Comparison, Southbound I-405 North of Downtown Bellevue 29

2.38 1997-1999 Volume Trends, Southbound I-405 at Totem Lake 30

2.39 1997-1999 Congestion Frequency Comparison, Southbound I-405 at Totem Lake 31

2.40 1997-1999 Congestion Frequency Comparison, Northbound I-405 at NE 170th St 32

2.41 1997-1999 Volume Trends, Westbound SR 520 at the Floating Bridge 34

2.42 1997-1999 Volume Trends, Eastbound SR 520 at the Floating Bridge 35

2.43 1997-1999 Congestion Frequency Comparison, Westbound SR 520 at NE 72nd 36

2.44 1997-1999 Congestion Frequency Comparison and Volume Trends, Eastbound SR 520 at the Viaduct 37

2.45 1997-1999 Congestion Frequency Comparison and Volume Trends, Westbound I-90 at 169th St 39

2.46 1997-1999 Congestion Frequency Comparison, Westbound I-90 at Island Crest Way 40

2.47 1997-1999 Congestion Frequency Comparison, Eastbound I-90 at Island Crest Way 41

2.48 1997-1999 Volume Trends, Westbound and Eastbound I-90 at Island Crest Way 42

Acknowledgments

A prerequisite for the type of analysis documented in this report is the availability of detailed traffic data and professional guidance from a variety of sources. This project was fortunate to have had the cooperation of numerous state and local agencies and their staff, who responded in a timely and professional manner to requests for data, as well as to follow-up questions. They also provided this project with valuable feedback regarding preliminary analytical results and offered important technical advice. This report would not have been possible without their enthusiastic support; we extend our sincere thanks to them all.

This project was made possible with the support and encouragement of the WSDOT Research Office and its director Martin Pietz, WSDOT's Northwest Region Traffic Systems group and Northwest Region's Regional Traffic Engineer Dave McCormick, and former WSDOT Northwest Region Assistant Regional Administrator Les Jacobson. The project researchers also wish to acknowledge the ongoing technical guidance of WSDOT Northwest Region staff, with particular thanks to Mark Morse.

This research effort was fortunate to have access to a multi-year traffic database for the central Puget Sound freeway network, which was the foundation for most of the results presented in this report. Valuable technical support for the use of this database and the associated Compact disc Data Retrieval (CDR) software was provided by WSDOT Northwest Region's Christian Cheney, Lanping Xu, Greg Leege, Michael Forbis, CDR's original programmer Alan Shen, and the Traffic Systems Management Center (TSMC). Additional assistance with traffic operations data was provided by Morgan Balogh, Paul Neel, and Mark Leth of WSDOT. Dan Dailey of the University of Washington provided technical assistance for selected performance measure algorithms used in this analysis.

Transit ridership data were provided by representatives of regional transit agencies, including Community Transit; King County Department of Transportation (Metro Transit); and Pierce Transit. Vehicle occupancy data were provided by William Brown and Eldon Jacobson of the WSDOT HOV Lane Evaluation project. Data collection assistance was also provided by Nicholas Roach and Joel Pfundt of the Puget Sound Regional Council. WSDOT's Web site provided useful background information, as well as important input to the travel time estimation process via its State Route Viewer freeway image database.

Valuable suggestions were also received during presentations of preliminary project results to regional and state groups. Comments were provided by members of the Washington State Transportation Commission, as well as staff of the WSDOT Research Office, WSDOT Northwest Region Traffic and Freeway Operations group, WSDOT Office of Urban Mobility, WSDOT Transportation Data Office, WSDOT Advanced Technology Branch, Community Transit, Metro Transit, Pierce Transit, and the Puget Sound Regional Council.

The project researchers also wish to recognize the significant contributions made by the Washington State Transportation Center's technical staff. These include Duane Wright, who developed the project's analysis software tools and provided extensive computer graphics support; Stephanie MacLachlan, who contributed to the initial scoping and methodology design phase of this project; Mary Marrah, who was responsible for graphic design; and Amy O'Brien, who edited the text and supervised final document design, report layout, and integration. This report would not have been possible without their participation.

Glossary

GP Lanes General purpose freeway lanes. GP freeway lanes can be used by any vehicle regardless of the vehicle type or the number of occupants in the vehicle.

HOV Lanes High occupancy vehicle freeway lanes. HOV freeway lanes can be used by a) any vehicle with at least 2 occupants, including the driver (3 occupants minimum on the westbound SR 520 HOV lane west of 108th Ave NE), b) motorcycles, and c) transit vehicles.

Lane Occupancy The percentage of time that a roadway sensor detects the presence of a vehicle at a particular freeway location. This value can be used to estimate different levels of traffic congestion. In the central Puget Sound area, electronic sensors embedded in individual freeway lanes are commonly used to collect these data.

Peak Hour Volume The highest number of vehicles that pass a particular freeway location in a one- hour period during the AM hours (midnight to noon) or during the PM hours (noon to midnight).

Peak Period Volume The total number of vehicles that pass a particular freeway location per peak period. In this report, unless otherwise noted the AM peak period is defined as 6:00 AM to 9:00 AM, and the PM peak period is 3:00 PM to 7:00 PM.

Person Volume The estimated total number of persons passing a particular freeway location over a given time period (daily, peak period, or peak hour). Also referred to as person throughput. In this report, person volume is computed by using a combination of vehicle volume data (estimated number of vehicles) and vehicle occupancy data (estimated number of travelers per vehicle, based on data from transit agencies and field observations).

Reversible Lanes Freeway lanes that operate in only one direction during part of the day, and the opposite direction during the rest of the day. Vehicle occupancy requirements on reversible lanes (e.g., HOVs only) vary with location and time of day. In the central Puget Sound area, there are reversible lanes on I-5 between the Seattle central business district and Northgate, and on I-90 between Seattle and the east side of Mercer Island.

Vehicle Volume The estimated total number of vehicles passing a particular freeway location over a given time period (daily, peak period, or peak hour). In the central Puget Sound area, electronic sensors embedded in individual freeway lanes are commonly used to collect these data.

Vplph Also known as Vehicles Per Lane Per Hour, vplph is the estimated vehicle volume at a particular freeway location, adjusted for the number of lanes at that site and the time period of the measurement. For example, if vehicle volume has been collected at each of three lanes at a particular location for 5 minutes, vplph is determined by adding together the 5-minute vehicle counts for the three lanes, dividing that sum by the number of lanes (three), then multiplying the result by 12 to get an equivalent hourly volume (12 times 5 minutes = 1 hour); this produces a per-lane, per-hour equivalent volume. Vplph allows measurements of vehicle volume from different locations with different numbers of lanes to be more directly compared to one another.

Section 1. Introduction

Purpose of This Report

The report, which encompasses two volumes, presents an overview of the level of usage and performance on the principal urban freeways in the central Puget Sound area during 1999. The freeways included in this report are managed by the Washington State Department of Transportation (WSDOT) through operation of its FLOW system, a coordinated network of traffic monitoring, measuring, information dissemination, and control devices that operates on urban state and interstate highways in the central Puget Sound region. This report is a product of a WSDOT-sponsored project whose purpose is twofold: (1) to enhance the Department's ability to monitor and thus improve the effects of its traffic management efforts on Seattle-area highways, and (2) to provide useful information to the public and other decision makers about the status of traffic performance in the region. This report is one of a planned series of periodic evaluations of the central Puget Sound urban highway network and the WSDOT FLOW system.

What Is in This Report

This report summarizes general measures of **facility usage** (e.g., how many vehicles are transported on the freeway network) and **facility performance** (e.g., how fast they are traveling, where and how often congestion occurs). These measures are meant to be succinct, yet provide sufficient detail to convey a sense of the complexity of highway performance variations as a function of location, time, and other conditions. In addition, this analysis is designed to be repeatable, i.e., the report's contents can be updated periodically with a consistent set of measures, so that trends can be monitored over time.

Volume 2 of this report is a comparative analysis, looking at trends and variations in the usage and performance of the highway network as a function of different background conditions at selected locations. Volume 2 expands on the discussion that was formerly included in section 5 (System Performance III: Performance Variations) of the March 1999 edition of this report; it analyzes usage and performance trends from 1997 to 1999, weekday versus weekend performance differences, and general purpose (GP) versus HOV freeway usage.

Volume 1 of this report provides a comprehensive overview of the freeway system's performance in 1999. It discusses overall use of the freeways and the locations and frequency of congestion in the region. Volume 2 focuses on the changes that have occurred in congestion and usage from 1997 to 1999, as well as the variations between weekdays and weekends or GP and HOV lanes.

Geographic Scope

This report summarizes 1999 central Puget Sound area freeway usage and performance on I-5, I-405, SR 520, SR 167, and I-90, in an area approximately bounded by Puget Sound to the west, Redmond and Issaquah to the east, Sea-Tac and Auburn to the south, and Everett to the north. The results reflect the combined effects of all WSDOT traffic management efforts in the region. This is a "state of the system" report, and as such, it does not evaluate the individual contributions of specific traffic management system components, although the effects of some components may be apparent in these aggregate results.

This analysis covers sections of freeway for which 1999 data were available (Figure 1.1).

Interpreting Results

Several considerations should be kept in mind when interpreting the results in this report. First, this is a summary report intended to provide an overview of the freeway system's usage and performance based on information collected at selected locations. Generalizing to other locations in the freeway network requires caution, as performance can vary significantly even among closely spaced sites. (Note, though, that the data analysis procedures used for this project were designed to be general, and can be

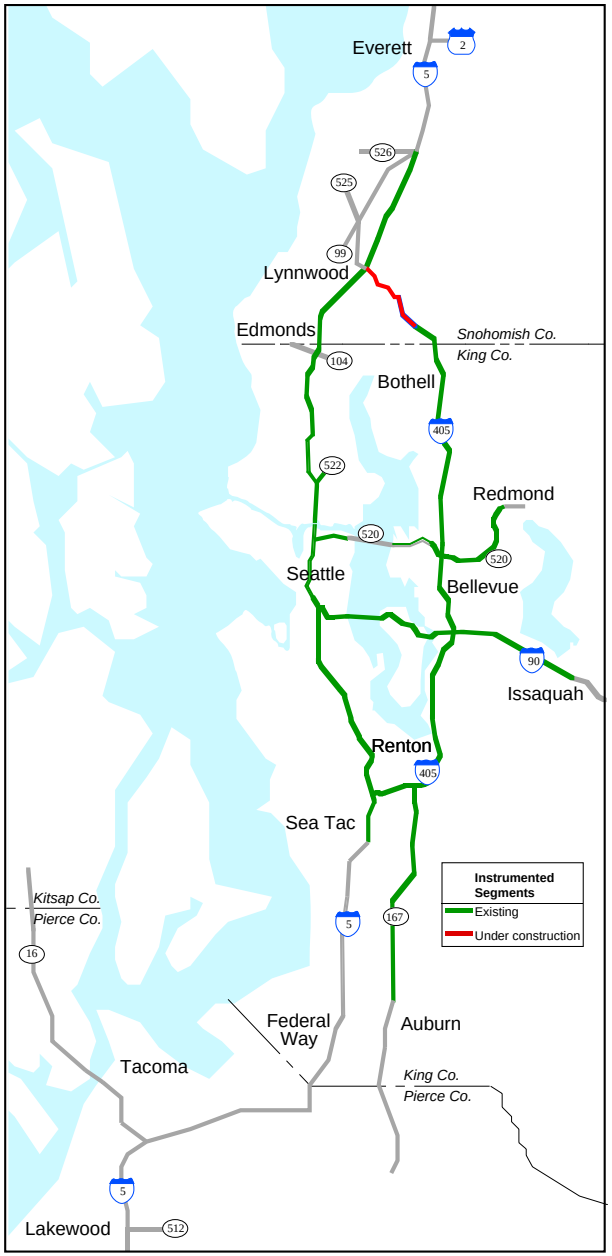

Figure 1.1. Instrumented Freeway Segments on Central Puget Sound Freeways

employed at locations other than those included in this report, provided that the appropriate data have been collected.)

Second, the analysis in this report is dependent on the availability and quality of traffic data for central Puget Sound freeways. Although the regional traffic data used for this report were generally detailed and comprehensive, data for some locations and time periods were occasionally unavailable or of variable quality because the measurement process was affected by construction activity, lack of sensor installations, or equipment problems. The analysis methods used for this report were designed to compensate for extended segments of unavailable or incomplete data as much as was practicable; nevertheless, some of the results are considered tentative because of the nature of the input data upon which they are based.

Third, the measures reported in this document are usually average values based on many days of traffic data; they do not represent a particular day of traffic performance but rather a "typical" day of representative performance. In addition, measures such as speed, congestion, and travel time values are estimates based on approximate formulas; such measures are best treated as relative, rather than absolute, values, and used in a comparative way. Further information about data quality issues and the constraints and caveats of the analysis in this report are provided in the FLOW Evaluation Design Technical Report.

About This Project

This report is a product of a WSDOT-sponsored project, FLOW Evaluation Framework Design. The overall objectives of this project are to 1) develop a methodology, framework, and detailed procedures for conducting an ongoing series of evaluations of the performance and effects of the FLOW traffic management system now in operation on Puget Sound area freeways; 2) create tools for performing those evaluations; and 3) use the developed framework to supplement earlier evaluation data with updated analyses about the state of the freeway system in the central Puget Sound region. This report reflects the results of work on the first two objectives and addresses the third objective.

Section 2. Variations in System Performance

The freeway performance measures described in Volume 1 vary with conditions such as time of day, lane type, direction of travel, location, or year. One of the benefits of the analytical tools used in the FLOW evaluation process is their usefulness in exploring the nature of those linkages. This volume looks in more detail at the variations in freeway performance as a function of these various factors, beginning with a discussion of freeway performance differences as a function of the day of the week (weekday vs. weekend) and facility type (general purpose lanes vs. HOV lanes) at selected locations. This is followed by a discussion of changes in traffic usage and performance trends over the last two years on the major freeway corridors in the region.

How Freeway Performance Comparisons Were Measured

Two types of freeway performance comparisons were made. First, **site-specific** freeway performance at selected locations was measured under different conditions. The following site-specific comparisons were made:

a. The **average daily vehicle volume** was estimated as a function of the day of the week (specifically, weekday or weekend). The average daily vehicle volume performance measure for weekdays was first discussed in Volume 1, Section 2 of this report.

b. The **24-hour vehicle volume profile** graph was estimated as a function of 1) the day of the week (weekday or weekend) and 2) the lane type (general purpose or HOV). The 24-hour weekday vehicle volume profile was first discussed in Volume 1, Section 4 of this report. Each graph provides a profile of the fluctuations in volume at a given site in a given direction of travel on an average weekday or weekend in 1999. The volumes are adjusted to a per-lane basis to enable more direct comparisons between sites with different numbers of lanes; they are also scaled to a per-hour basis.

Second, **facility-wide** traffic volume and congestion trends from 1997 to 1999 were analyzed for major freeway facilities in the region, including I-5, I-405, SR 520, and I-90. This analysis discusses in more detail the changes in freeway usage and performance over time, including external factors that may have contributed to those trends. Freeway performance at locations of particular significance or interest on each facility are highlighted.

Where Freeway Performance Comparisons Were Measured

The weekday/weekend and GP/HOV comparisons in this volume were performed on a core set of four central freeway locations in the Seattle area "rectangle" bounded by I-5, SR 520, I-405, and I-90, and at one location on SR 167. There is one measurement site on each major freeway in the region; while this limited number of sites is not representative of all freeway sections, they provide interesting views of the nature of performance differences at significant locations in the freeway system. The locations are downtown Seattle on I-5 at University Street, downtown Bellevue on I-405 at NE 14th Street, SR 520 just east of the bridge, I-90 at Shorewood Drive (east of Island Crest Way) on Mercer Island, and SR 167 at South 23rd Street just south of the I-405 interchange.

The year-to-year freeway usage and performance trends were analyzed for four of the five major freeway facilities in the central Puget Sound region: I-5, SR 520, I-405, and I-90. Because data collection equipment on SR 167 only began operations in 1999, historical data upon which to base an analysis of year-to-year trends are not yet available. Therefore, trend analyses were not performed on SR 167.

Results: Weekday vs. Weekend Daily Averages and 24-Hour Volume Profiles

Weekday vs. Weekend Average Daily Volumes

Table 2.1 summarizes the estimated average total daily weekday and weekend volumes for general purpose (GP) and HOV lanes at selected freeway sites in the region in 1999. Weekend daily traffic volumes at those sites were significant in comparison to corresponding weekday averages at the same sites; in some cases, the average weekend

Table 2.1. Average Weekday and Weekend Daily Vehicle Volumes at Selected Freeway Locations

East-West Facilities	1999			
	EB GP	WB GP	EB HOV	WB HOV
SR 520 @ 76th/84th Ave NE				
Weekday	52,700	55,500		2,630
Weekend	37,800	38,300		2,040
Weekend, as % of weekday	72%	69%		78%
I-90 @ Shorewood Drive				
Weekday	70,000	70,200	6,010	2,770
Weekend	43,500	49,700	8,400	
Weekend, as % of weekday	62%	71%	140%	

North-South Facilities	1999			
	NB GP	SB GP	NB HOV	SB HOV
I-5 @ University Street				
Weekday	102,500	110,100		7,800
Weekend	82,000	94,200		10,000
Weekend, as % of weekday	80%	86%		128%
I-405 @ NE 4th Street				
Weekday	66,900	61,800	8,540	10,010
Weekend	50,500	47,700	9,260	9,470
Weekend, as % of weekday	75%	77%	108%	95%
SR 167 @ S 23rd St				
Weekday	48,300	54,200	11,210	6,790
Weekend	43,800	42,200	6,950	7,070
Weekend, as % of weekday	91%	78%	62%	104%

GP = General purpose
HOV = High occupancy vehicle
indicates no HOV lane at that location in that direction

Site	Description
SR 520 at 76th/84th Ave NE	East end of the bridge
I-90 at Shorewood Drive	Mercer Island, west of Island Crest Way (weekend HOV volume is 24 hours; weekday is 12 hours)
I-5 at University Street	Downtown Seattle (reversible lanes not included)
I-405 at NE 14th Street	Downtown Bellevue
SR 167 at South 23rd Street	SR 167 near the I-405 interchange

volumes approached or exceeded the corresponding weekday volumes. On general purpose lanes, weekend volumes ranged from approximately 60 percent to 90 percent of average weekday daily volumes among the five sites studied. On HOV lanes at those locations, weekend volumes ranged from approximately 60 percent to 140 percent of average weekday daily volumes. (Note that in the latter case, weekend volume counts were for 24 hours, while corresponding weekday counts were only 12 hours because of differences in I-90 reversible lane operation.)

Weekday vs. Weekend 24-Hour Volume Profiles

Figures 2.1 through 2.17 show 1999 weekday and weekend volume profiles over an average 24-hour period for the sites summarized in Table 2.1. All volumes were converted to per-lane, per-hour values to enable more direct comparisons between sites with different numbers of lanes. Overall, weekend volumes tend to show a gradual increase during the morning, peaking between midday to early afternoon, then dropping the rest of the day. This weekend volume pattern reflects an absence of the typical AM and PM peak period commute "spikes" in volume that one often sees during the weekdays. Midday and early afternoon weekend volumes often approach, but are generally not equal to, weekday volumes, though HOV volumes during those times are often higher than their weekday counterparts at the selected sites.

Downtown Seattle (I-5 at University Street) (Figures 2.1-2.3). Average weekend volumes in the GP lanes in either direction are generally substantially lower than corresponding weekday volumes during the AM peak period, reflecting the absence of the commute traffic on weekends. However, weekend volumes show steady growth as the day goes on before leveling off during the afternoon; in the afternoon and evening, weekend volumes approach the volumes generally seen during the average weekday. During the evening hours, weekend volumes match those on weekday evenings. In the HOV lane (southbound only at this location) average weekend volumes exceed corresponding weekday volumes throughout much of the day, with the exception of the times corresponding to the AM and PM peak periods, when commute trips that are usually part of typical weekday volumes are not present.

Downtown Bellevue (I-405 at NE 14th Street) (Figures 2.4-2.7). As with the I-5 site above, during the time of day corresponding to the AM peak period, weekend volumes in the GP lanes in either direction are noticeably lower than the corresponding weekday volumes. Similarly, weekend volumes rise steadily throughout the AM hours, then level off during the afternoon and begin to drop. During the afternoon hours and into the evening, average weekend volumes generally approach, though not quite match, the weekday volumes. Weekend HOV lane volumes follow a similar overall pattern of steadily increasing volumes that peak during the afternoon, then gradually drop. In the AM peak period, weekend HOV volumes are substantially lower than the corresponding weekday volumes; however, this pattern reverses by mid-morning, and during the middle of the day HOV weekend volumes are noticeably higher than their weekday counterparts. As the time period corresponding to the evening peak approaches, weekend HOV volumes are usually no greater than, and generally lower than, the weekday volumes that usually include commute traffic; the values reverse once again, though, during the evening when weekend volumes are again somewhat higher than weekday volumes.

SR 520 at 76th/84th Ave. NE (Figures 2.8-2.10). The pattern in the GP lanes on SR 520 is similar to those at the other sites, with lower weekend volumes during the peak periods and significant weekend volumes at other times that can approach, though not match, the level of corresponding weekday volumes. Night and early morning weekend volumes can actually be higher than those on weekdays. The HOV lane (westbound only at this location) follows a similar pattern, except with higher midday volumes during the weekend than the weekday.

I-90 at Shorewood Drive (east of Island Crest Way) (Figures 2.11-2.13). This I-90 location very clearly shows the same pattern as the other sites, with very prominent weekday peak period volumes that are absent during the weekends. Midday volumes can be comparable on weekdays and weekends. Note that the HOV lane is a reversible lane at this location, operating westbound in the AM weekday hours, eastbound in the PM weekday hours, and eastbound throughout the weekend.

SR 167 at South 23rd Street (south of I-405 interchange) (Figures 2.14-2.17). This site also exhibits patterns similar to those at the other sites. One variation occurs northbound during the afternoon and evening, when the weekend volumes (both GP and HOV) are comparable to or exceed average weekday volumes.

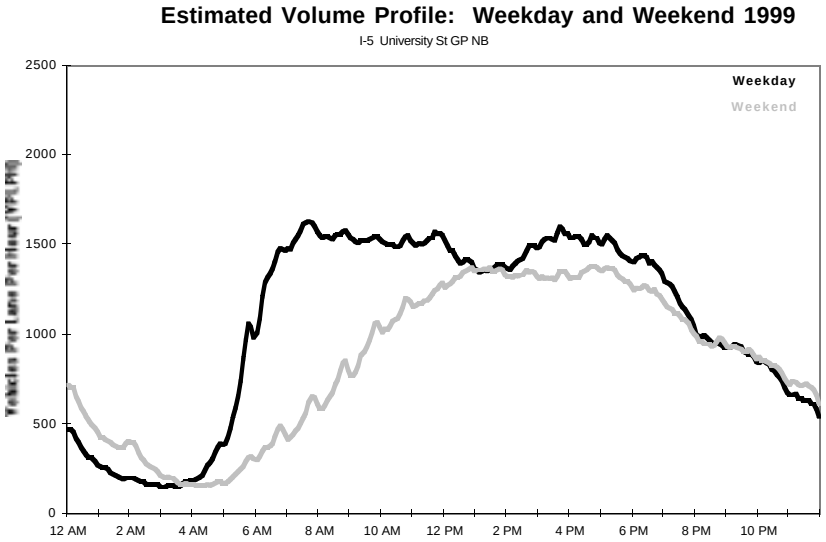

Figure 2.1. 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-5 at University St, General Purpose Lanes

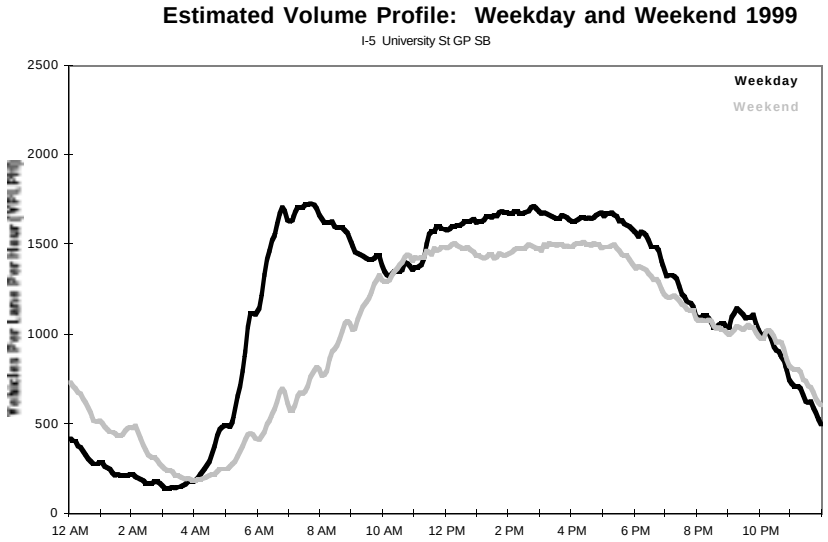

Figure 2.2. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-5 at University St, General Purpose Lanes

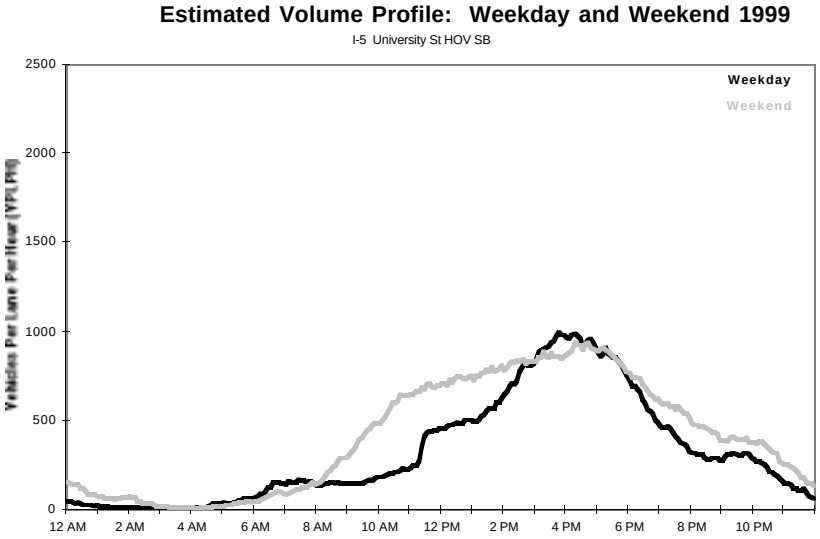

Figure 2.3. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-5 at University St, HOV Lanes

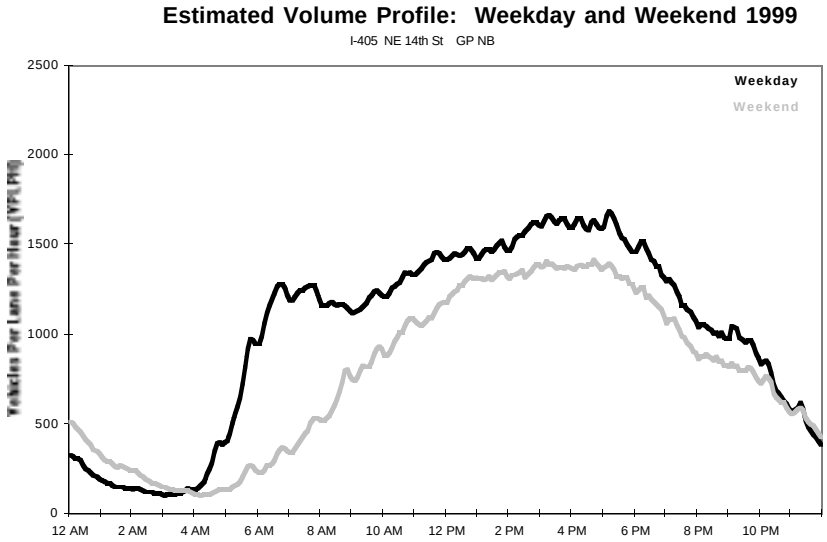

Figure 2.4. 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-405 at NE 14th St, General Purpose Lanes

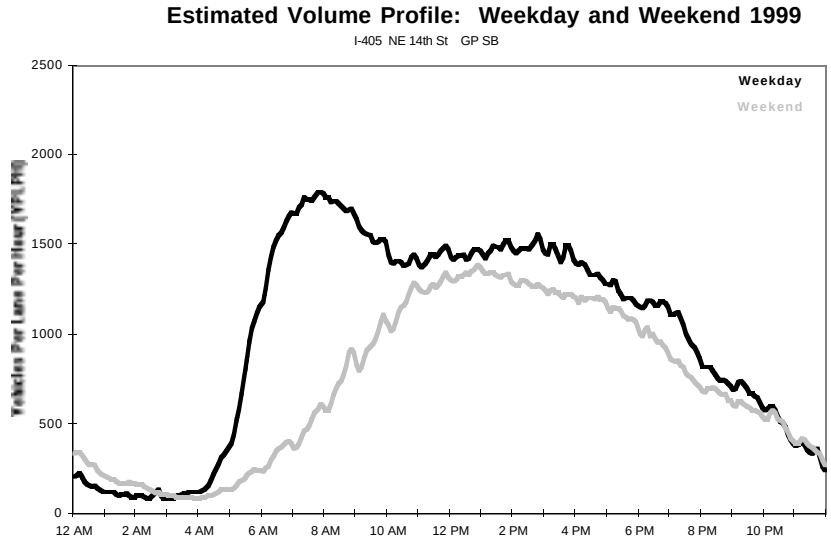

Figure 2.5. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-405 at NE 14th St, General Purpose Lanes

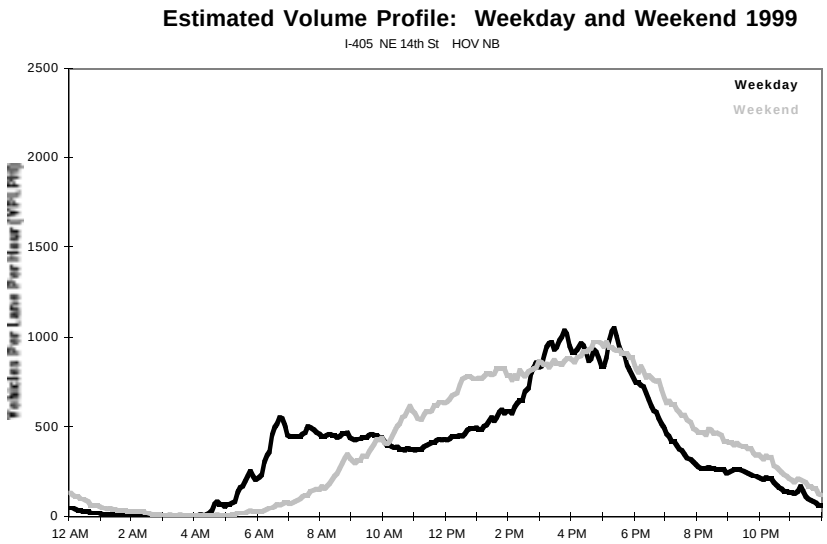

Figure 2.6. 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound I-405 at NE 14th St, HOV Lanes

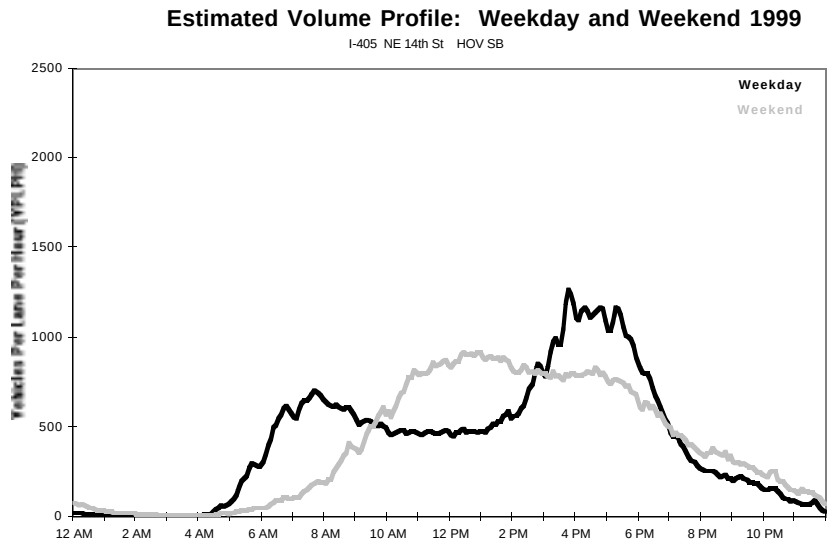

Figure 2.7. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound I-405 at NE 14th St, HOV Lanes

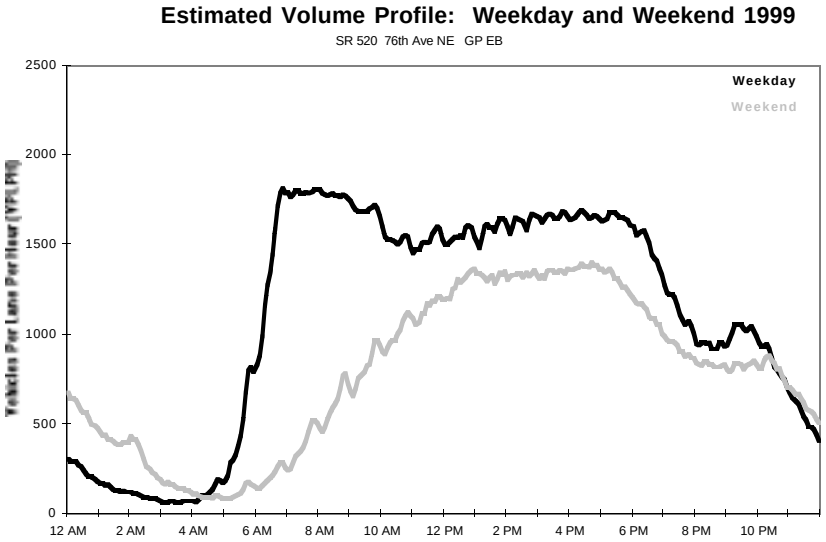

Figure 2.8. 1999 Weekday vs. Weekend Estimated Volume Profile, Eastbound SR 520 at 76th Ave NE, General Purpose Lanes

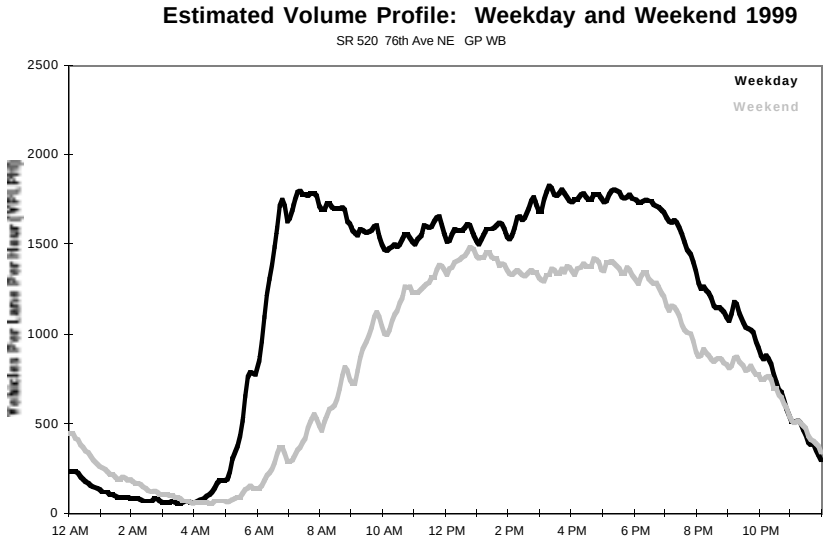

Figure 2.9. 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound SR 520 at 76th Ave NE, General Purpose Lanes

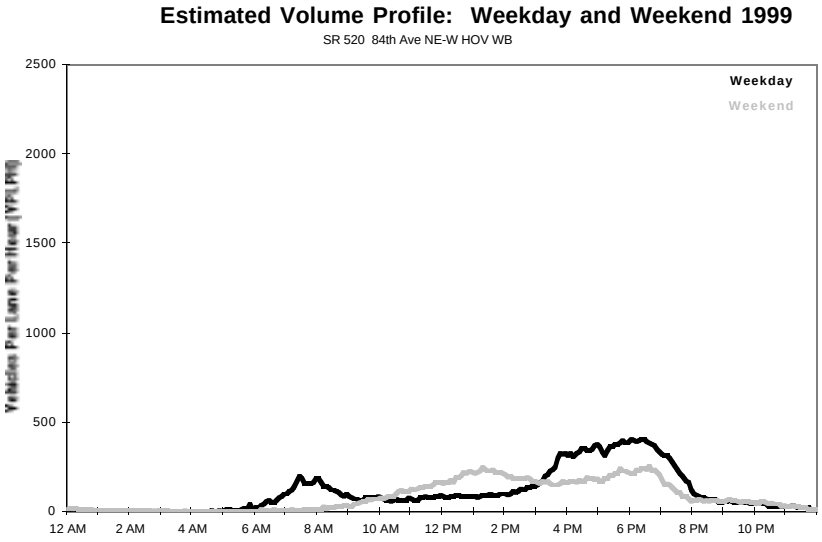

Figure 2.10. 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound SR 520 at 84th Ave NE, HOV Lanes

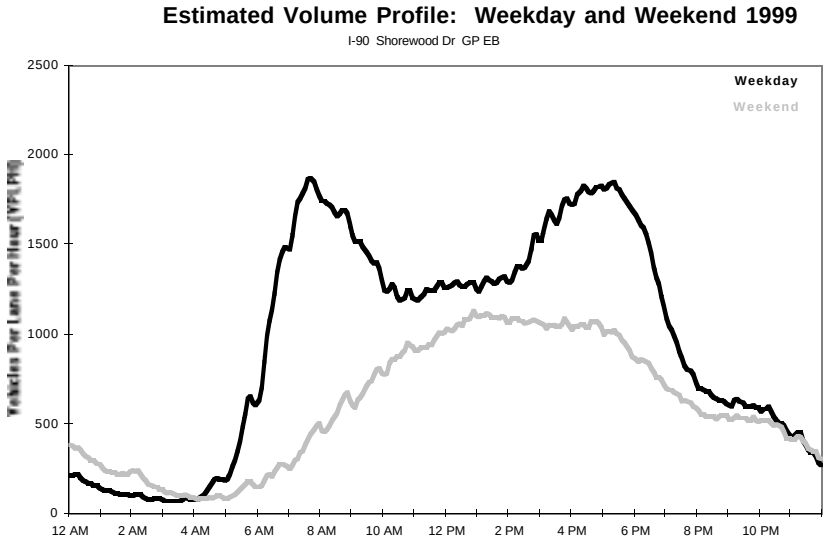

Figure 2.11. 1999 Weekday vs. Weekend Estimated Volume Profile, Eastbound I-90 at Shorewood Dr, General Purpose Lanes

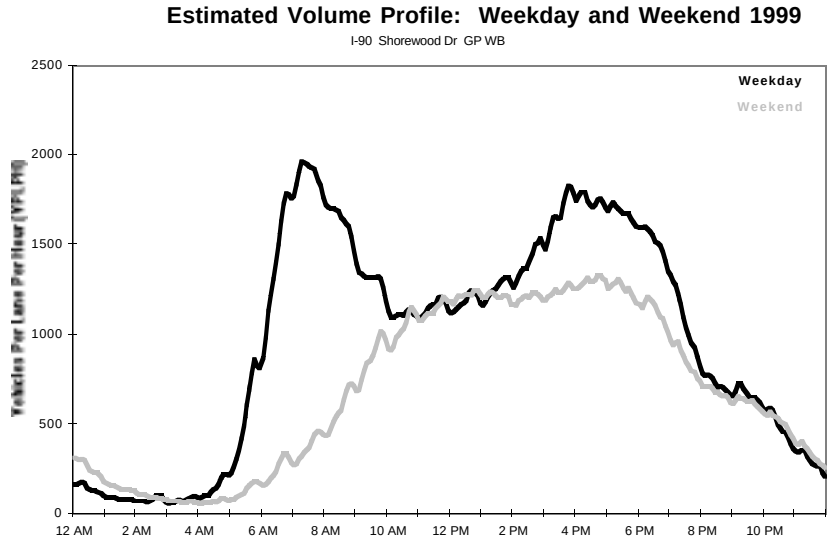

Figure 2.12. 1999 Weekday vs. Weekend Estimated Volume Profile, Westbound I-90 at Shorewood Dr, General Purpose Lanes

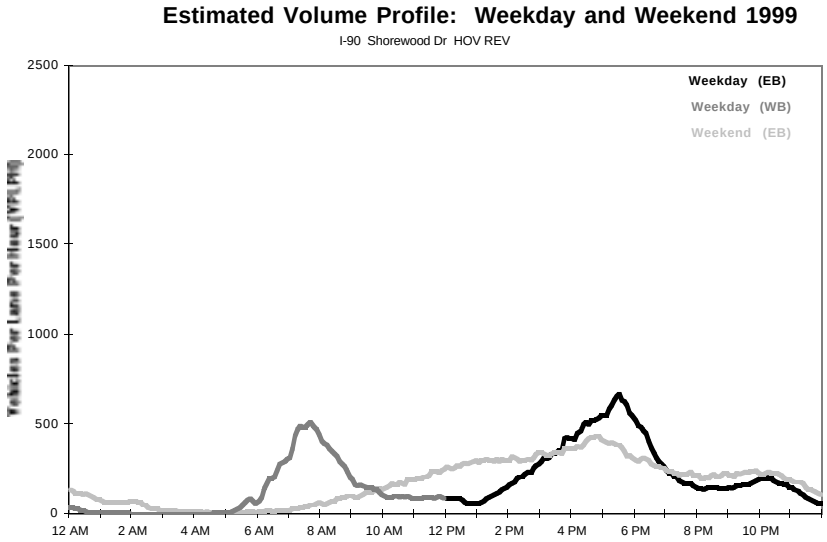

Figure 2.13. 1999 Weekday vs. Weekend Estimated Volume Profile, I-90 at Shorewood Dr, Reversible HOV Lanes

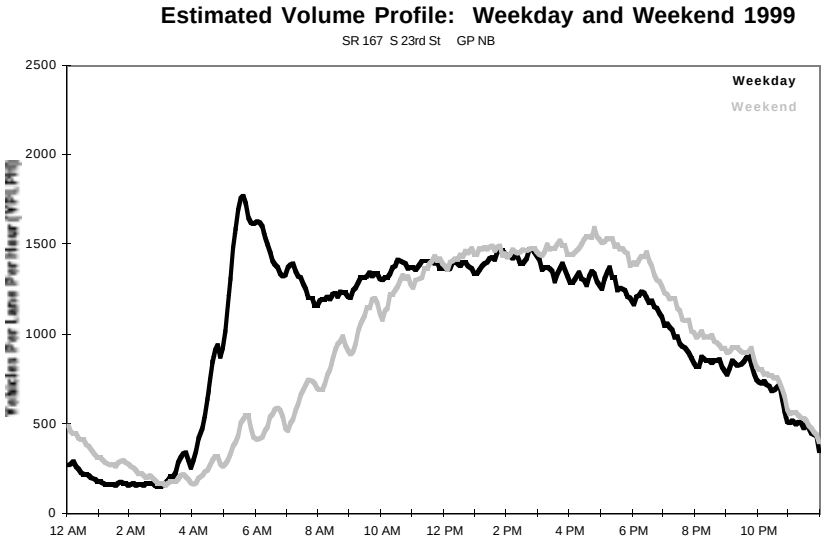

Figure 2.14. 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound SR 167 at South 23rd St, General Purpose Lanes

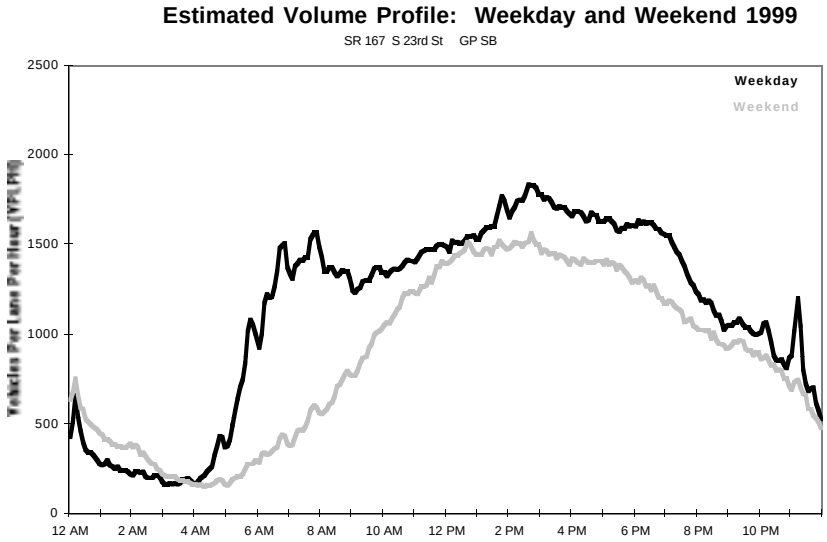

Figure 2.15. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound SR 167 at South 23rd St, General Purpose Lanes

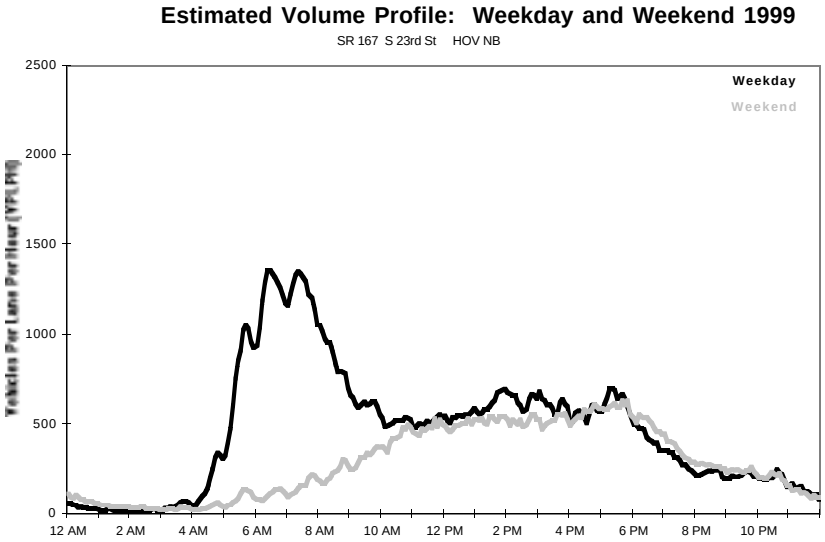

Figure 2.16. 1999 Weekday vs. Weekend Estimated Volume Profile, Northbound SR 167 at South 23rd St, HOV Lanes

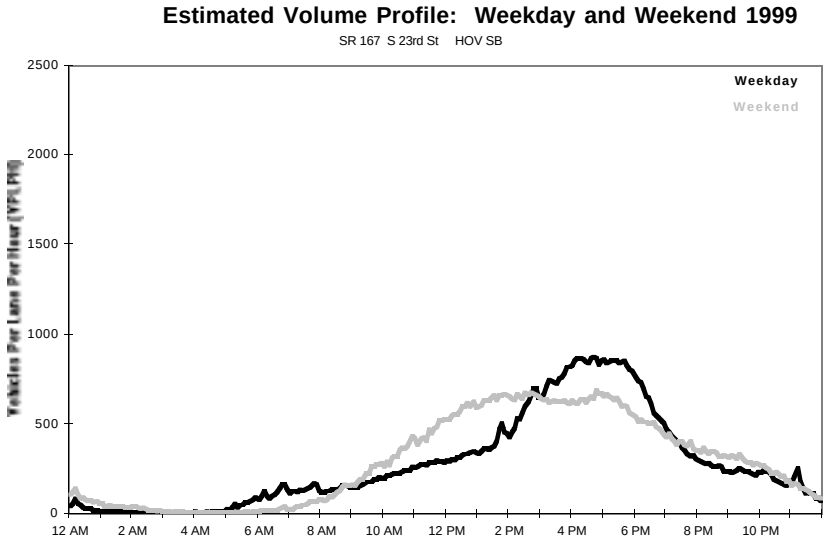

Figure 2.17. 1999 Weekday vs. Weekend Estimated Volume Profile, Southbound SR 167 at South 23rd St, HOV Lanes

Results: GP vs. HOV 24-Hour Weekday Volume Profiles

Figures 2.18 through 2.25 combine the weekday GP and HOV 24-hour volume profiles that were shown separately in Figures 2.1 through 2.17. Overall, while per-lane HOV volumes are usually noticeably lower than corresponding GP volumes, there are locations and periods when HOV volumes are significant in comparison to their GP counterparts. Furthermore, given that the HOV lane network is focused on vehicles with higher person occupancies (e.g., carpools, vanpools, buses), it is useful to compare not just the number of vehicles but the number of people traveling on HOV lanes vs. GP lanes. See Volume 1, Section 5 for a further discussion of person volume comparisons; additional information is also provided in HOV Lane Performance Monitoring: 1998 Annual Report, a WSDOT research report available at the Washington State Transportation Center's Web site <depts.washington.edu/trac>.

Downtown Seattle (I-5 at University Street, southbound only) (Figure 2.18). Per-lane weekday HOV volumes are higher during the afternoon peak period, as vehicles travel through or away from downtown Seattle. During this time, HOV volumes are significant, peaking at about 1,000 vehicles per hour.

Downtown Bellevue (I-405 at NE 14th Street) (Figures 2.19-2.20). Here, also, HOV volumes are higher during the afternoon peak period. This is partly due to the fact that many southbound carpools and buses in the AM hours must move out of the inside HOV lane in preparation to exit the freeway at downtown Bellevue just south of this location. As a result, they are not counted as using the HOV lane at this data collection site. Note that the afternoon peak period southbound HOV volume is close to the GP volume on a per-lane basis.

SR 520 at 76th/84th Ave. NE (westbound only) (Figure 2.21). The HOV volumes are relatively low at this location; among the factors that affect usage are the higher vehicle occupancy requirement (3+ persons per vehicle vs. 2+ persons elsewhere in the region) and the roadway configuration (a converted shoulder). Also, the HOV lane ends shortly after this site at the east approach to the Evergreen Point floating bridge, so one would expect many HOVs to have merged into the GP lanes by this point.

I-90 at Shorewood Drive (east of Island Crest Way) (Figures 2.22-2.23). The HOV volume peaks mirror those in the GP lanes, though at a substantially lower level. Note that the HOV lane is reversible at this location, switching directions at midday.

SR 167 at South 23rd Street (south of I-405 interchange) **(Figures 2.24-2.25).** Northbound HOV volumes in the AM peak period are comparable to those in the GP lanes.

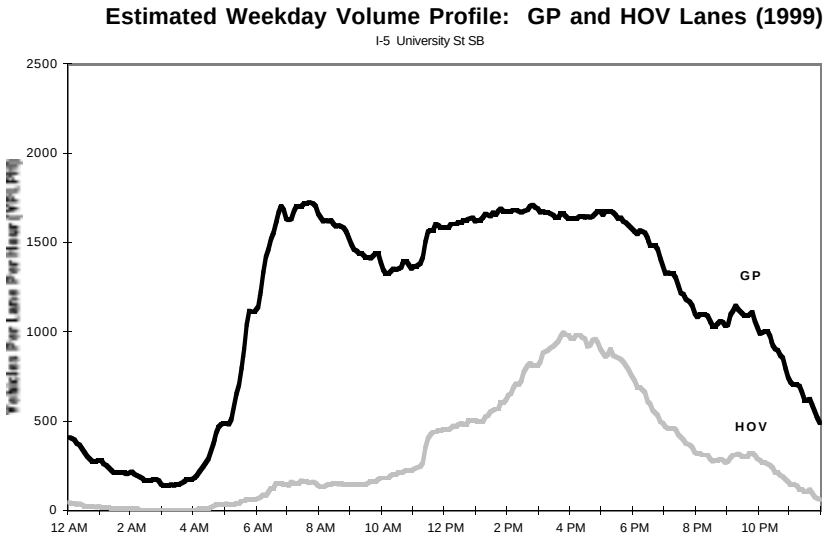

Figure 2.18. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Southbound I-5 at University St.

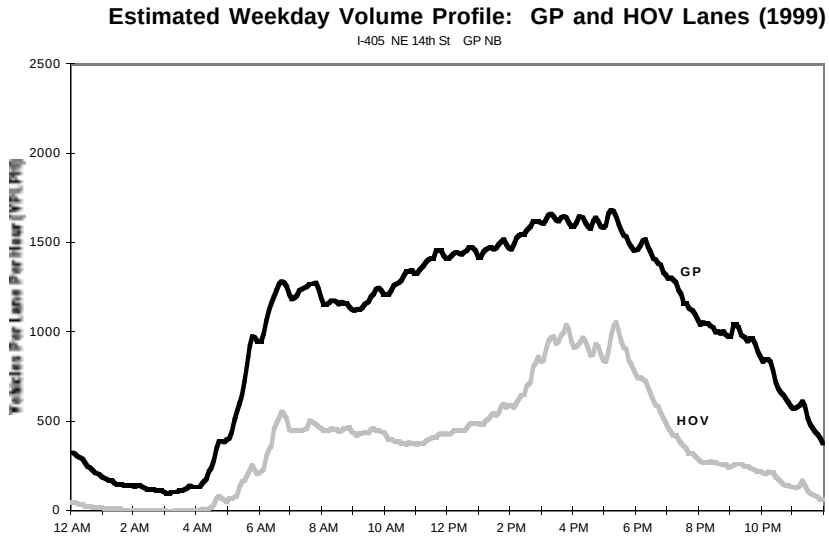

Figure 2.19. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Northbound I-405 at NE 14th St.

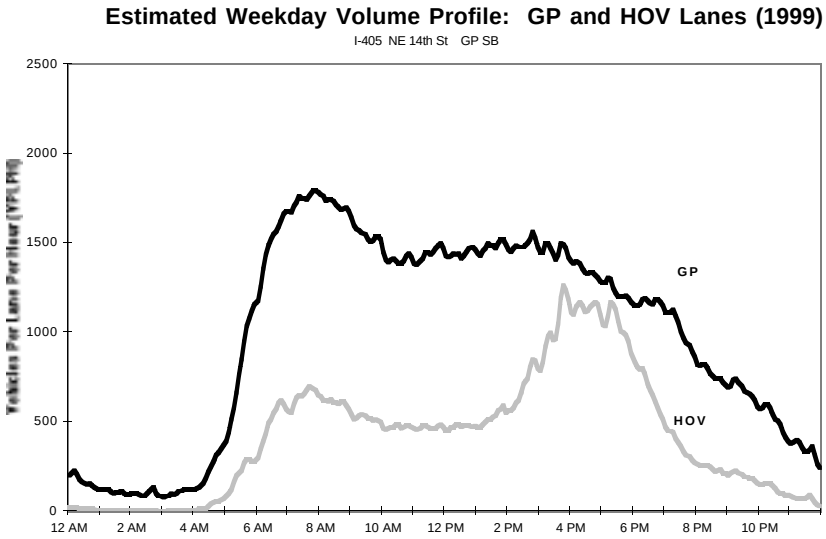

Figure 2.20. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Soutbound I-405 at NE 14th St.

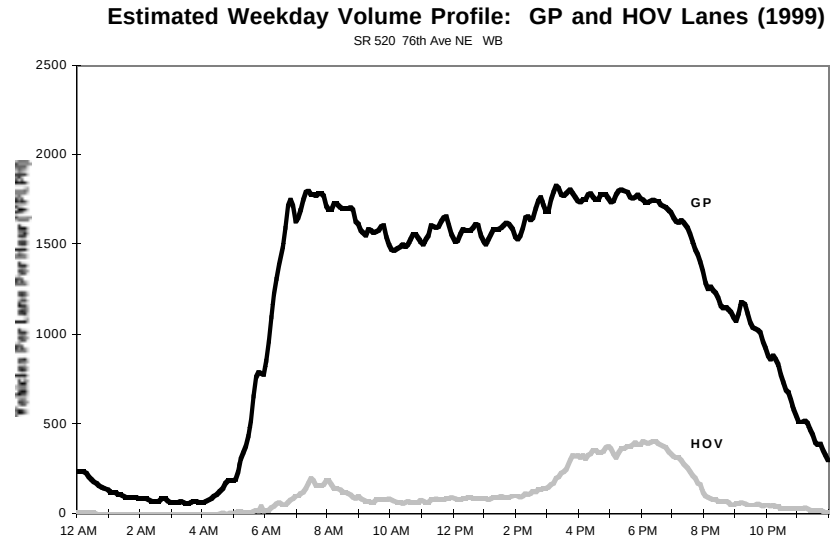

Figure 2.21. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Westbound SR 520 at 76th Ave NE

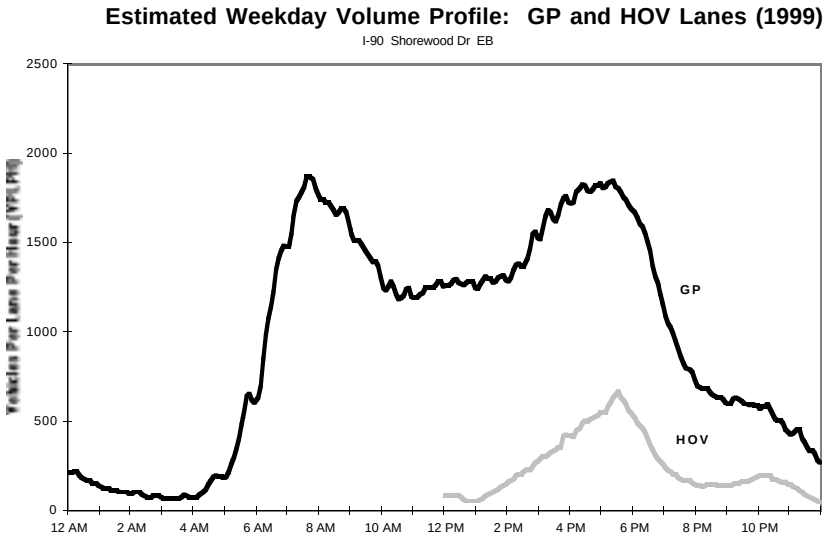

Figure 2.22. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Eastbound I-90 at Shorewood Dr

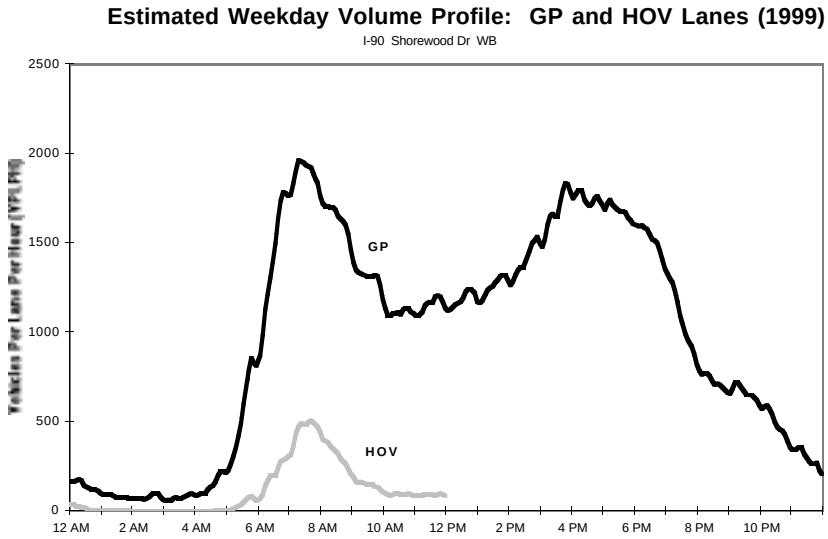

Figure 2.23. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Westbound I-90 at Shorewood Dr

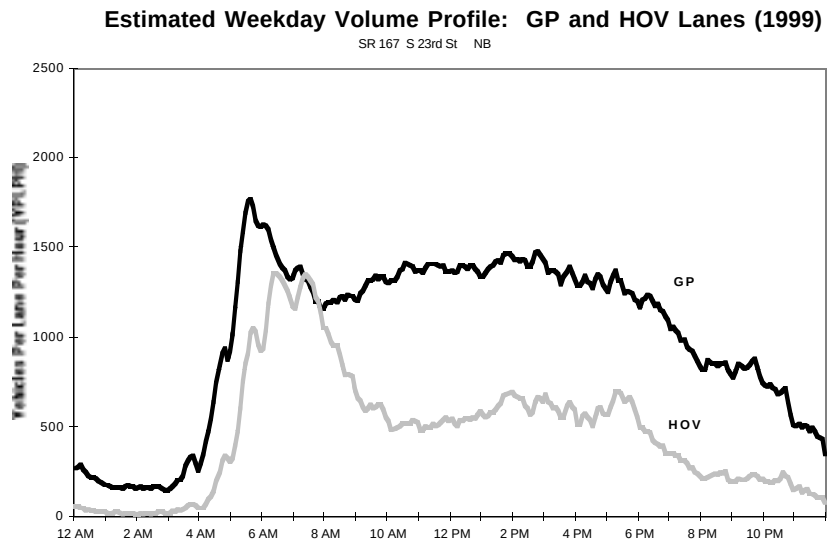

Figure 2.24. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Northbound SR 167 at S 23rd St

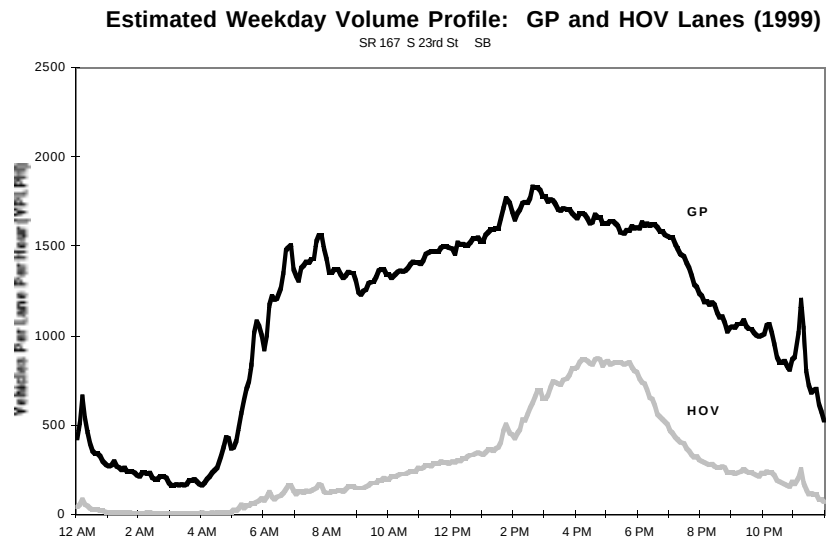

Figure 2.25. 1999 Estimated Weekday Volume Profile, GP and HOV Lanes, Southbound SR 167 at S 23rd St

Results: Facility Performance Changes from 1997 to 1999

The following is a discussion of how freeway usage and performance changed between 1997 and 1999 on the Puget Sound freeway system. (Note that SR 167 is not discussed because data were not available for this freeway in 1997.) The objective of this discussion is to look at freeway usage and performance from a facility perspective, bringing together individual performance measures, analyzing their interrelationships, and providing some insight into the potential factors that can produce changes in freeway performance over time. Because performance changes from location to location along a facility, most of the corridor discussions presented below are sub-divided into two or more geographic areas. This demonstrates that changes that occur on one portion of a freeway may not always occur on other parts of the facility.

Table 2.2 summarizes traffic volume changes that occurred between 1997 and 1999. In general, volumes in the central portions of the metropolitan area changed little in the last two years, while volumes on freeway segments near the outer boundaries of the region increased. However, changes in volume are only part of a discussion about how freeway performance changed in the last two years. In some cases, marginal increases in volume resulted in significant increases in congestion, while in other cases, increased demand had no measurable impact on congestion.

Reading the Graphs

Two primary types of graphs are used to illustrate the changes that have occurred between 1997 and 1999. In the first, the volume per lane per hour, computed as the average condition for all weekdays during the year, is shown for both years. This simple graph aids analysis of how and at what times throughput has changed at specific locations.

The second illustration is a bar graph that shows how frequently a roadway location experiences congestion. Congestion is defined as Level of Service F, or the onset of unstable speeds. These bar charts show the percentage of days during which congestion occurred for each time of day. By overlapping the 1997 (blue) and 1999 (orange) histograms, it is possible to determine whether congestion frequency (the likelihood that a motorist will be caught in congestion at this location) increased or decreased from 1997 to 1999. Where the blue histogram extends beyond the orange histogram, freeway performance has improved since 1997. Where the orange histogram extends beyond the blue, congestion has gotten worse since 1997.

In the example of Northbound I-5 at Dearborn (Figure 2.26), the blue peaks at 8:15 AM and 5:45 PM indicate slight improvement at those times; congestion has changed from occurring 70 percent to 65 percent of the time in the morning and from about 75 percent to about 65 percent of the time in the evening. However, the orange bars for much of the morning indicate that mid-morning congestion has become more prevalent, occurring over 50 percent of the time from 9:00 AM to slightly after noon.

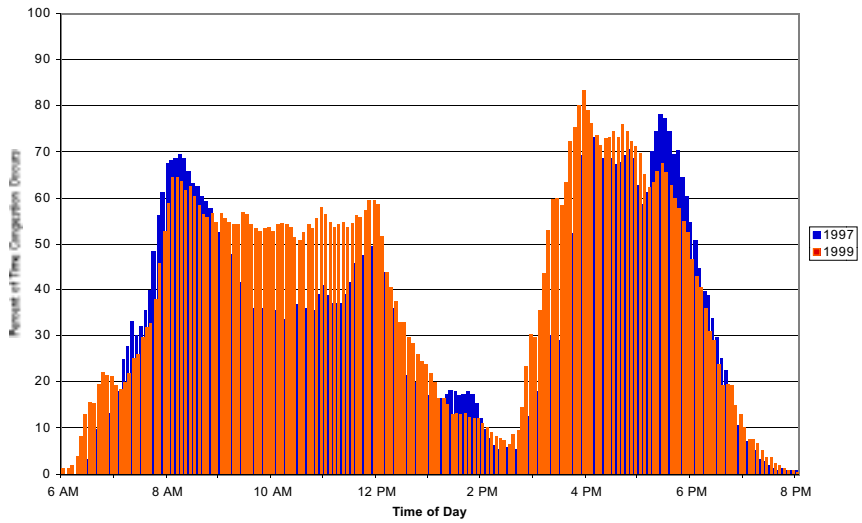

Figure 2.26. Example Congestion Frequency Comparison, Northbound I-5 at Dearborn

Table 2.2. Changes in General Purpose Freeway Lane Volumes, 1997-1999

Location (GP Lanes Only)	**1999 Weekda Daily Volume** (Both Directions Combined)	**Percentage of Change** in Volume	**1999** AM Peak Period[1] Volume (peak direction)	**Percentage of Change** in Volume	**1999** PM Peak Period[2] Volume (peak direction)	**Percentage of Change** in Volume
Interstate 5						
S. Pearl Street	208,500	-1.00%	19,700	-3.90%	25,200	-3.10%
Universit	212,700	-3.60%	19,200	-6.70%	25,800	-6.80%
128th St SW	118,100	4.10%	11,500	15.00%	14,800	9.60%
Interstate 405						
SE 52nd Street	111,400	6%	9,100	-1.10%	13,300	4.70%
NE 14th Street	192,500	8.70%	19,800	8.10%	25,000	-6.70%
NE 85th Street	136,100	-3.30%	15,200	-7.90%	18,500	-7.80%
Damson Road	97,400	2.00%	9200	-1.00%	14,600	6.60%
Interstate 90						
Midspan	130,700	-1.60%	13,900	-4.80%	19,500	-3.00%
Reversible	83,800	0.70%	11,700	-2.70%	14,100	5.20%
161st Ave SE	14,000	8.30%	3,600	5.40%	5,500	0.00%
SR-520						
76th Ave NE	108,300	-2.10%	9,900	-1.00%	14,100	-2.10%

[1] The 3-hour period from 6:00 to 9:00 AM

[2] The 4-hour period from 3:00 to 7:00 PM

I-5

As with most freeways, changes in volume and congestion on I-5 depend on location. Growth in traffic volumes occurred on some, but not all, stretches of the freeway. As with the rest of the Puget Sound, core freeway segments near established major activity centers (e.g., near downtown Seattle) remained at fairly constant traffic volumes, while outlying roadway segments experienced modest growth in traffic volumes. In the core areas, peak period vehicle volumes were not able to increase because the roadway was already running near capacity. Total daily volume in core areas rarely changed by more than 1 percent (either up or down). However, volumes in outlying areas (such as north of Lynnwood) increased by as much as 4 percent over the last two years.

Because volumes are already at or near capacity for much of I-5, marginal changes in volume or an increase in the number of even minor incidents can create measurable changes in congestion levels on this facility.

Because of the construction of the HOV lanes south of downtown Seattle and the reconstruction of the Duwamish River bridge in the mid-1990s, freeway surveillance data were not available on the southern portion of I-5 before late 1998. Similarly, surveillance equipment in the far north end (north of Lynnwood) was installed only as a result of the latest HOV lane construction project. Consequently, changes in travel volumes and congestion levels can only be discussed for I-5 in the area stretching from roughly Boeing Field to Lynnwood. Since south end data were not readily available, the discussion of changes to I-5 performance is divided into northbound and southbound.

Northbound I-5. On northbound I-5, congestion entering downtown from the south increased slightly during the very early morning commute and then again in the late morning. A modest improvement occurred from 7:00 to 8:00 AM. But congestion increased throughout the late morning (10:00 AM to noon). In the afternoon, congestion tended to start earlier in the day but did improve slightly earlier in the evening in 1999 than in 1997. Figure 2.27 illustrates the differences in the frequency of congestion northbound on I-5 at Dearborn. Volume changes at this location show a marginal decline in volume during much of the day (see Figure 2.28).

Northbound congestion also increased measurably during the afternoon commute period from the Ship Canal Bridge to NE 155th (see Figure 2.29). This increase in peak period congestion pushed some of the traffic volume farther into the shoulders of the peak period while slightly lowering average volumes near 5:00 PM (see Figure 2.30). One cause of the changes illustrated in Figure 2.29 was the redesign of the merge of the Express lanes with the main freeway, and the resulting shift in where the resulting merge congestion occurs.

Not all northbound change was for the worse. Some reduction in congestion occurred starting just south of the I-405 (Swamp Creek) Interchange (see Figure 2.31), where volumes increased in the afternoon at the same time congestion declined. This improvement was likely due, in part, to completion of construction projects in the north end, which reduced the congestion spillback in the monitored freeway sections during the late afternoons. Modest decreases in congestion also occurred in the south end of the monitored area, from the Duwamish curve through Boeing field.

Southbound I-5. Southbound I-5 saw three significant congestion increases. First, congestion increased consistently between Lynnwood and downtown Seattle during the late morning commute period. North of Northgate this increase in congestion extended throughout the morning peak period (see Figure 2.32).

At two specific locations (just north of the Ship Canal bridge and just south of Lynnwood) congestion also increased throughout most of the business day (i.e., including midday and the afternoon commute periods) (see Figure 2.33). It is not clear at this time what caused increases in congestion at these locations, as volumes did not change significantly (see Figure 2.34). Other segments of the southbound trip into the city also experienced measurable (but less significant) increases in congestion during the afternoon. The most significant of these were the approach to the express lanes entrance and the Mercer weave in the late morning commute period.

As with northbound traffic, congestion improvements occurred in the far south end (from north of Boeing Field until the Duwamish curve) and north of the I-405 (Swamp Creek) interchange.

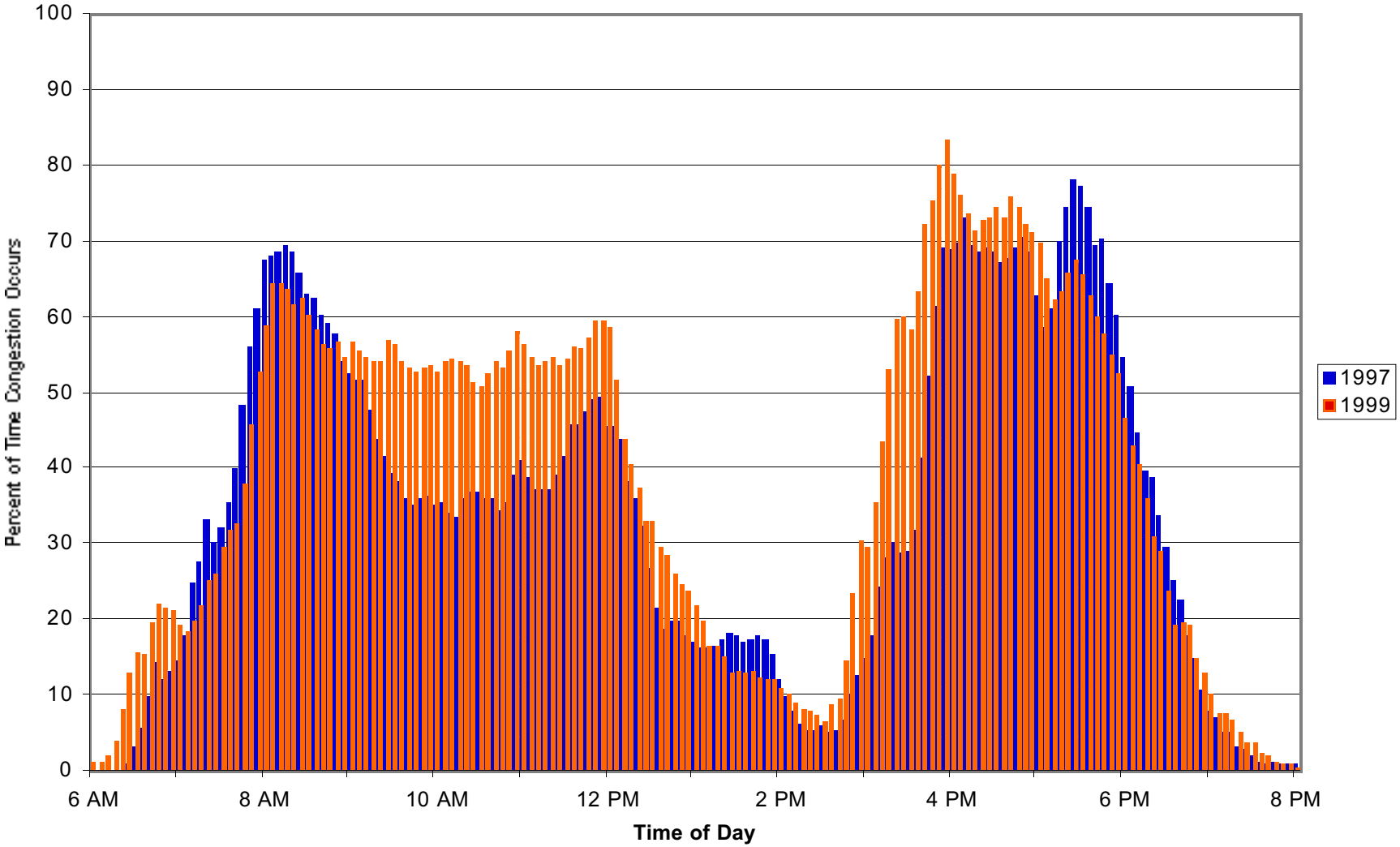

Figure 2.27. 1997-1999 Congestion Frequency Comparison, Northbound I-5 at Dearborn

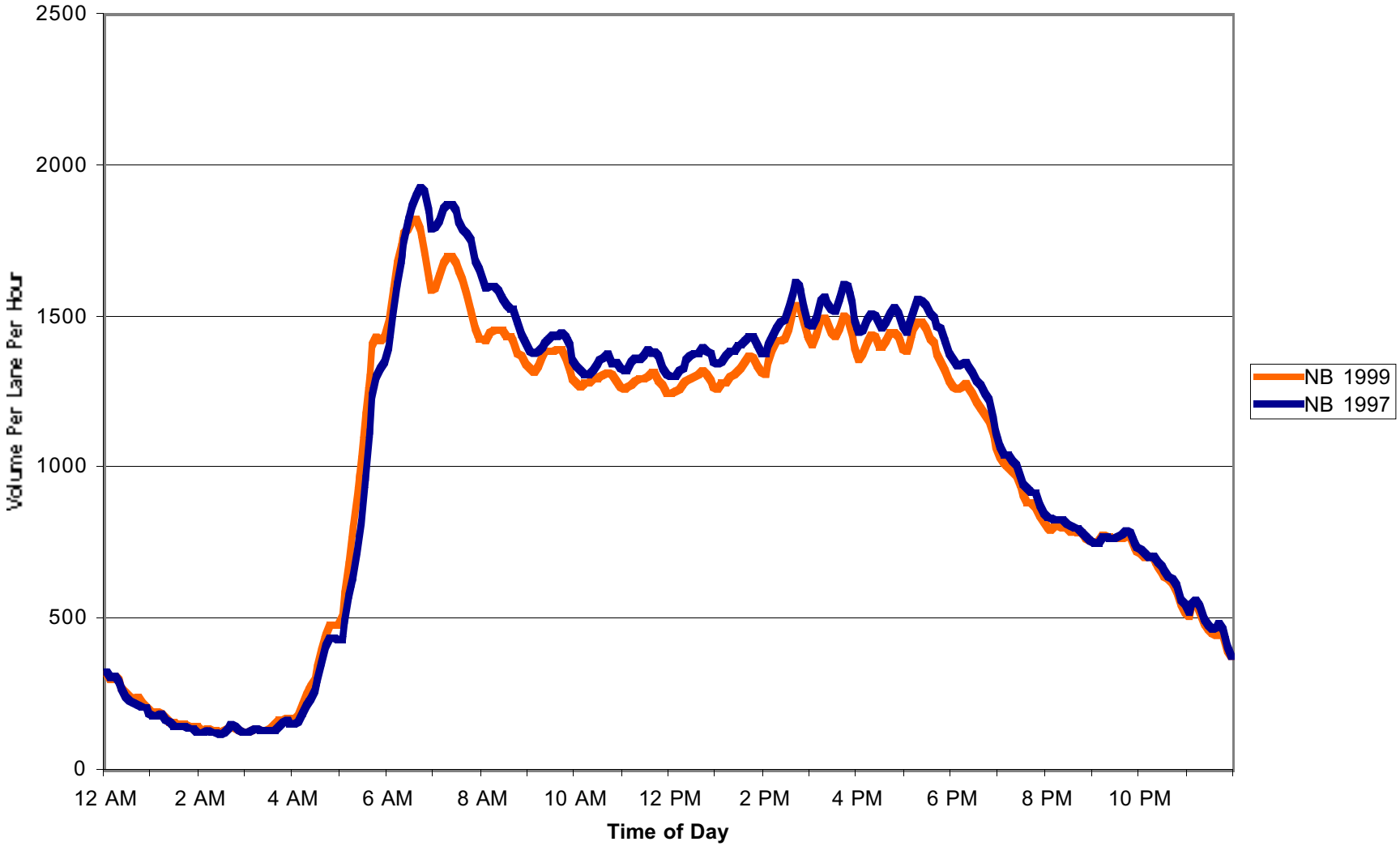

Figure 2.28. 1997-1999 Volume Trends, Northbound I-5 at Boeing Field

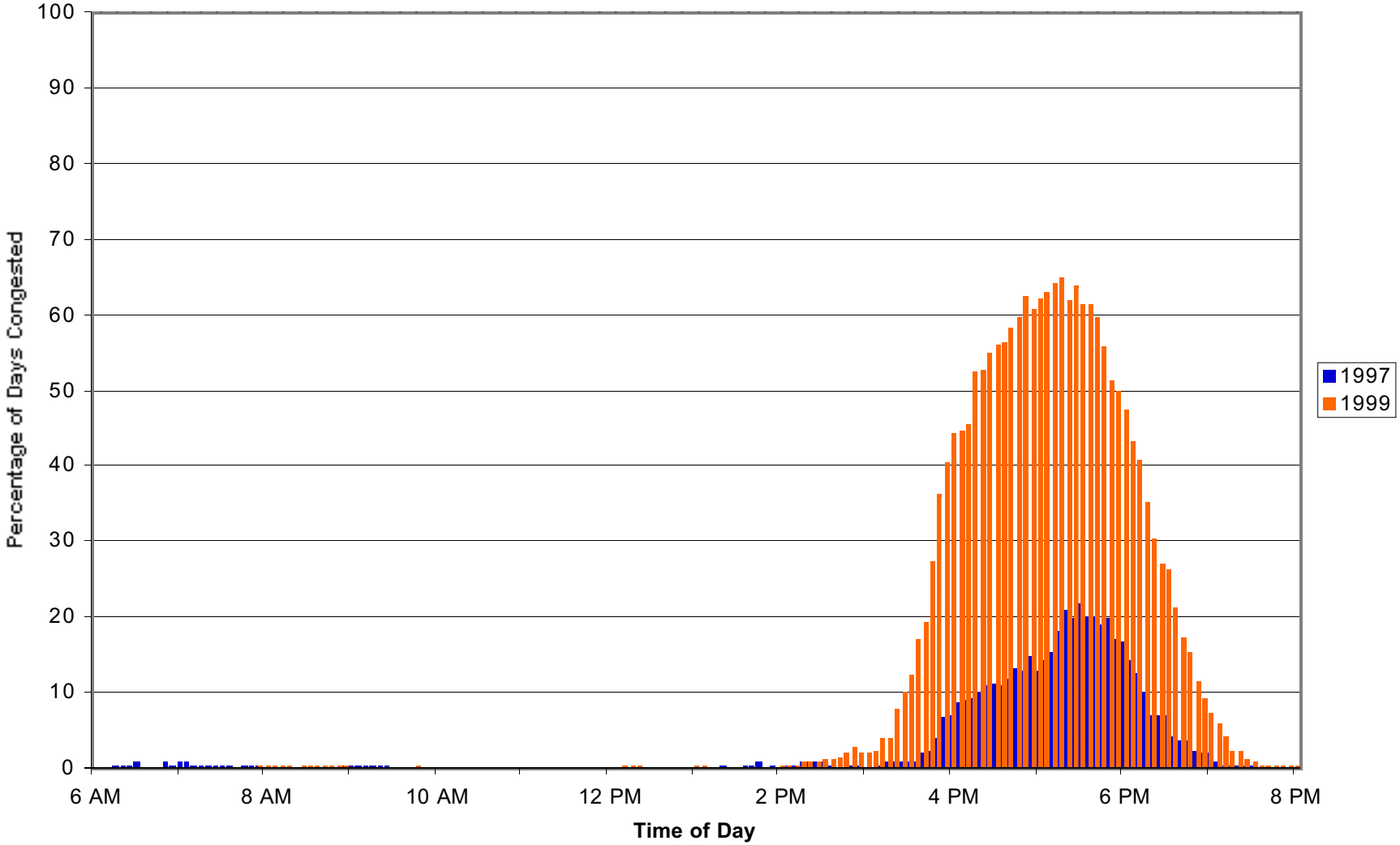

Figure 2.29. 1997-1999 Congestion Frequency Comparison, Northbound I-5 at Northgate

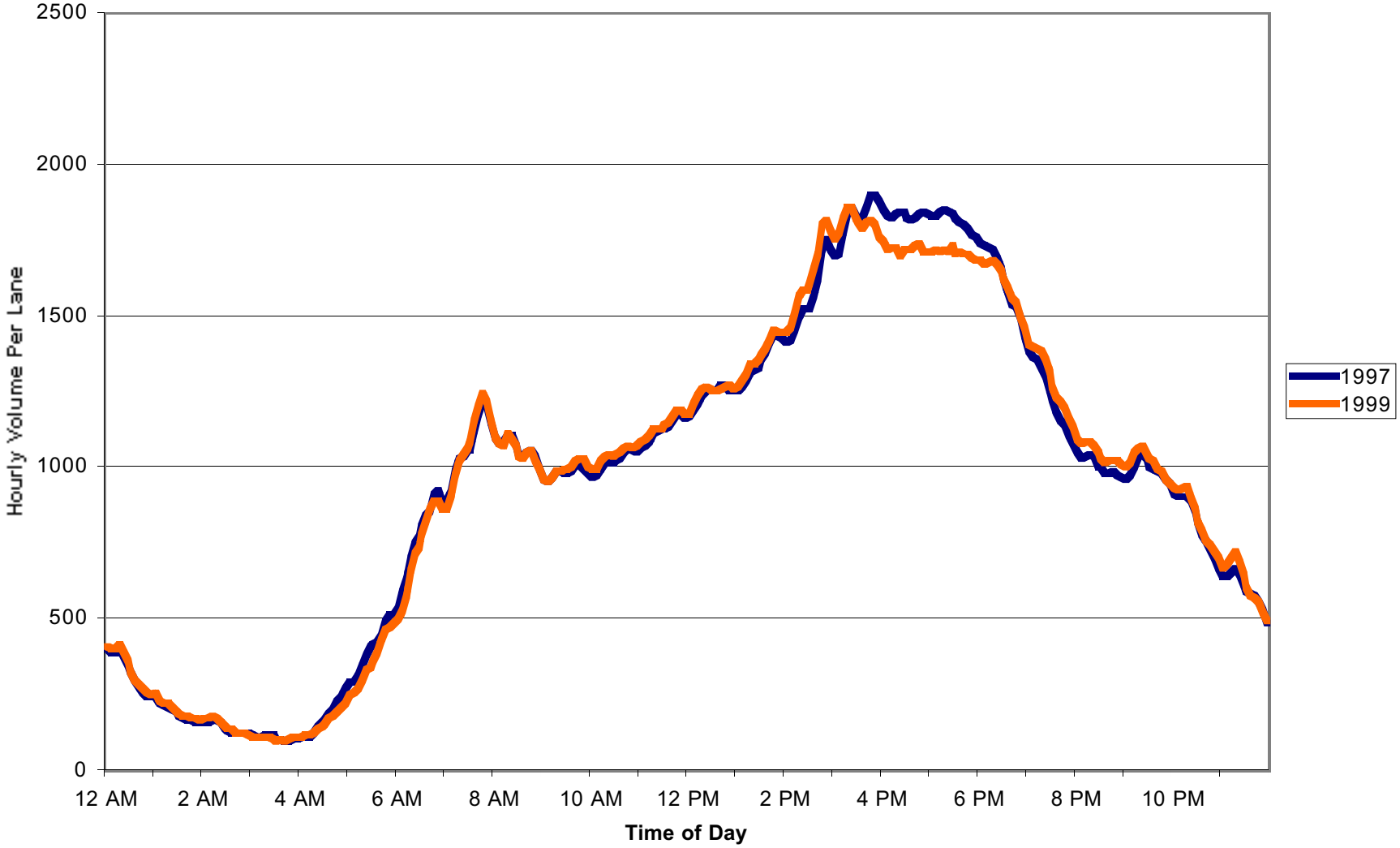

Figure 2.30. 1997-1999 Volume Trends, Northbound I-5 at Northgate

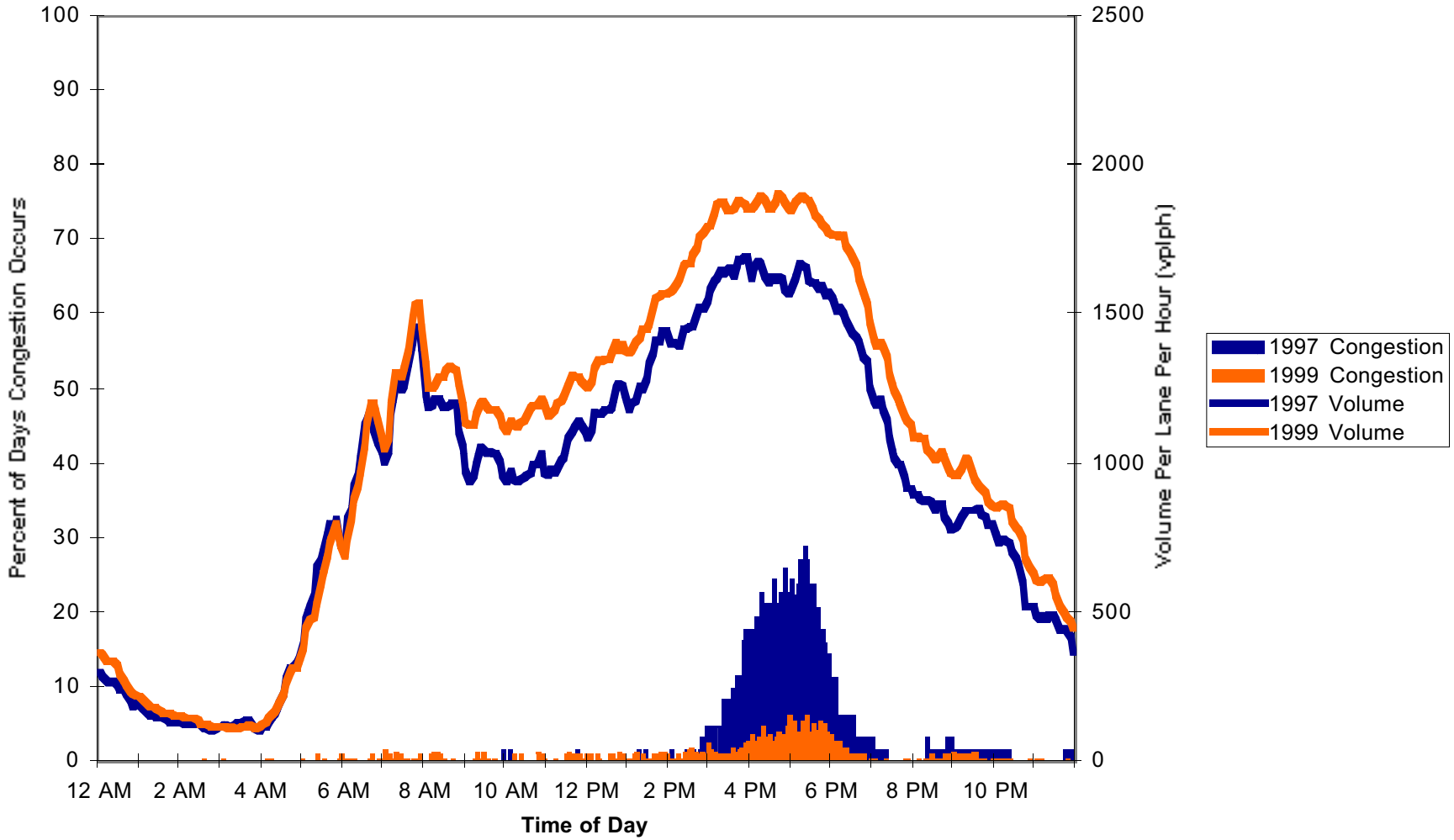

Figure 2.31. 1997-1999 Congestion Frequency Comparison and Volume Trends, Northbound I-5 South of the Swamp Creek Interchange

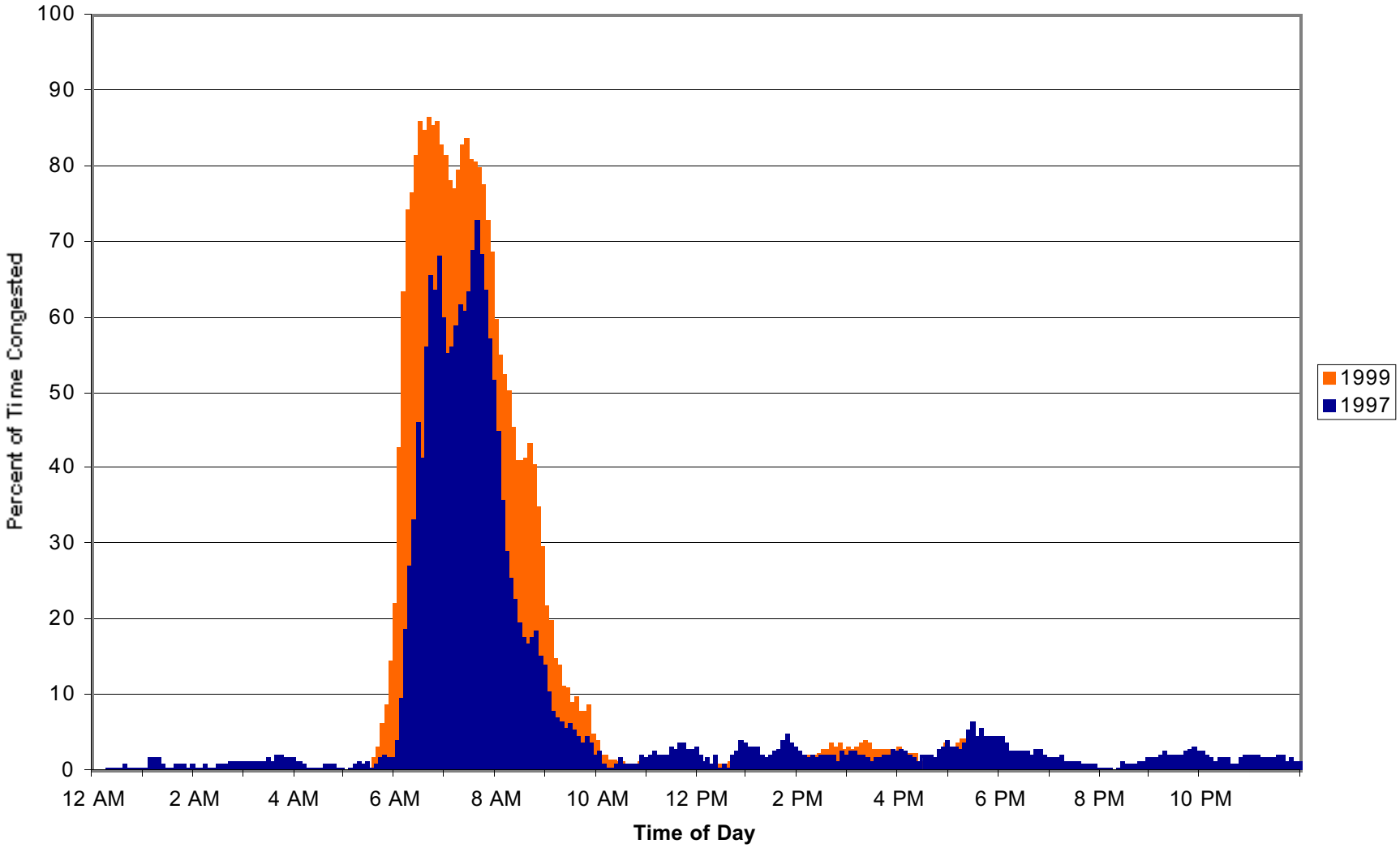

Figure 2.32. 1997-1999 Congestion Frequency Comparison, Southbound I-5 at NE 155th St

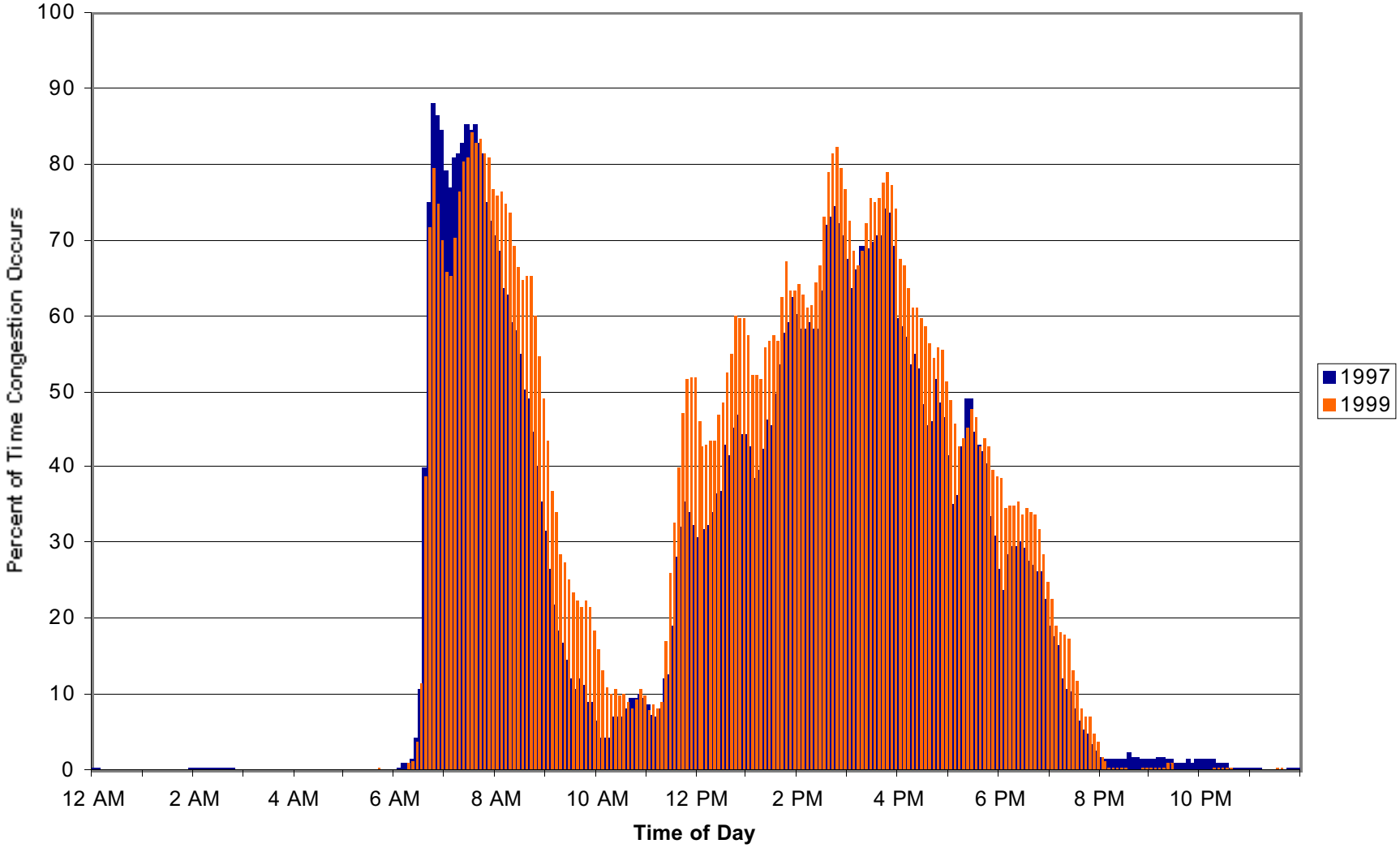

Figure 2.33. 1997-1999 Congestion Frequency Comparison, Southbound I-5 on the Ship Canal Bridge

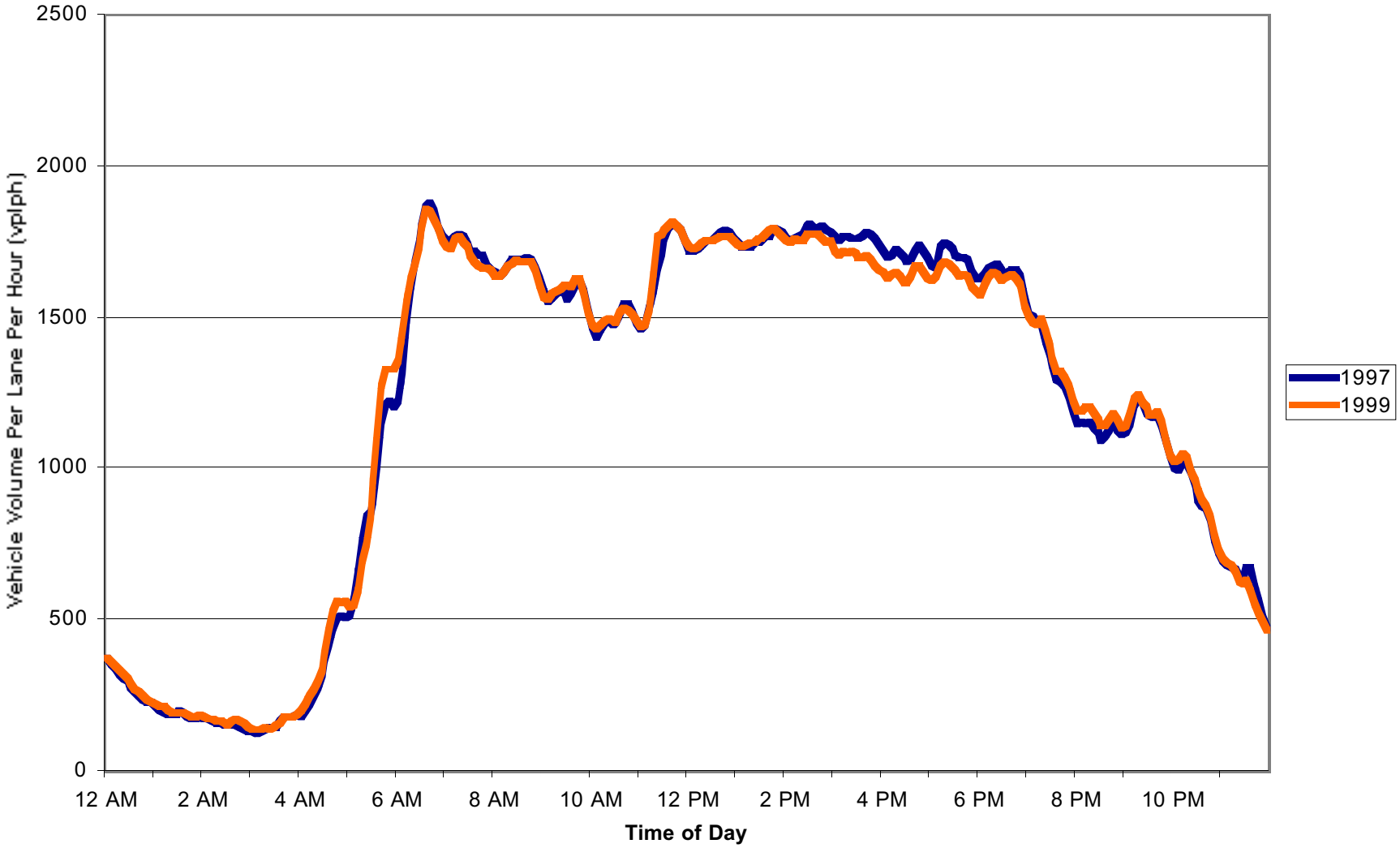

Figure 2.34. 1997-1999 Volume Trends, Southbound I-5 on the Ship Canal Bridge

I-405

In discussing changes in traffic congestion on I-405 from 1997 to 1999, it is important to note that in 1998 the HOV lanes were moved from the outside (right most lane) of the facility to the inside (left most lane). This change removed the conflict that occurred when vehicles entering the freeway first merged with fast moving HOV vehicles and then, while in the HOV lane, merged with the slower general purpose lanes. This double merge slowed the HOV lane and also created unsafe conditions because of the speed differential between HOV vehicles and both merging vehicles and general purpose vehicles.

Although the new configuration addressed much of the congestion in the HOV lanes caused by merging, it increased the congestion in general purpose lanes caused by merging vehicles. In some locations this resulted in far better HOV lane performance at the expense of increased general purpose lane congestion. In other cases, where little merge congestion occurred, the switch of the HOV lane to the inside position had little or no impact on facility performance.

The new configuration also made tracking changes in HOV lane use difficult in some locations. Before the lane switch, HOV lane volumes at some locations actually included both HOV vehicles and general purpose vehicles either entering or exiting the freeway. After the switch, entering/exiting vehicles were no longer in the HOV lanes. At the same time, at several locations some HOVs were no longer being counted as HOV lane users because these vehicles were in the process of weaving between the HOV lane and the lane connecting to the exit/entrance ramp. Consequently, to track HOV use over time, users of WSDOT surveillance data must be careful to select HOV lane detector locations located away from ramps.

Also note that changes in freeway performance on I-405 varied considerably from location to location along the entire corridor. These changes were often more dramatic than those on I-5, partly because of the changes in geometric configuration along I-405's length and partly because of differences in facility usage. For clarity, I-405's performance is discussed in three geographic segments, the south end (south of I-90), Bellevue (from I-90 to SR 520), and the north end (north of SR 520).

South End. Confidently determining changes in the performance of I-405 in the south end is difficult because construction activities caused much of the data collection equipment to be out of operation for major portions of 1997. The available data suggest that congestion got marginally worse between 1997 and 1999. Very minor decreases in vehicle throughput occurred during the morning peak period, although minor increases in traffic volume occurred just before the start of the morning peak period (see Figure 2.35). The decreases in AM peak period vehicle throughput appear to be the result of congestion slowdowns rather than the result of a reduction in traffic demand. Outside of the peak periods, however, modest growth in demand occurred on I-405, particularly in the middle of the day.

The limited data available in 1997 make absolute statements difficult, but it appears that congestion on I-405 in the south end worsened over the last two years. Much of this congestion was caused by the SR 167 interchange. Because vehicle volumes attempting to use this interchange far exceed its capacity during many hours of the day, queues form on I-405 approaching the interchange. These ramp queues slow all of I-405. This slowing is partly the result of friction between the two general purpose lanes and partly the result of vehicles slowing in order to "jump" the queue that forms in the right hand lane by using the left hand lane to pass queued vehicles. WSDOT had plans to upgrade this interchange, but those plans were put on hold as a result of passage of Initiative 695 and subsequent reduction in road construction funding.

Bellevue. With the switch of HOV lanes from the outside to the inside, traffic volumes changed significantly, but inconsistently, from location to location near downtown Bellevue. In areas where considerable numbers of vehicles enter and exit the freeway, volumes in the general purpose lanes appear to have increased, while HOV volumes appear to have declined. However, at detectors not located near ramp terminals, general purpose volumes declined during the peak periods and HOV volumes remained fairly constant or increased. The conclusion is that the HOV lane reconfiguration masked I-405 volume trends at this portion of the facility. Most of the measured changes appear to be the result of a redistribution of vehicles across lanes rather than a significant change in vehicle volumes. (That is, some vehicles that were in the HOV lane are now in the general purpose lane that exits the freeway.)

What is clear, however, is the change in congestion, as congestion worsened for general purpose traffic in this area, while the HOV lanes, for the most part, improved. Just north of downtown Bellevue, northbound congestion in 1999 occurred one or more extra day per week for both morning and midday periods in comparison to 1997 (see Figure 2.36). Morning congestion at this location is caused primarily by ramp queues leading to SR 520, where vehicles from I-405 are attempting to go both east and west. Afternoon congestion can be caused either by the SR 520 ramp queues or by congestion farther north on I-405, which can create queues that reach this location. Southbound at this location, congestion increased only in the evening peak period but also occurred roughly one extra day per week in 1999 in comparison to 1997 (see Figure 2.37). This increase in southbound I-405 evening congestion is typical of this section of the corridor. Southbound evening congestion worsened because more vehicles attempt to reach I-90, either to head east toward the growing eastern suburbs or to go west, as motorists attempt to avoid congestion on SR 520 by using the Mercer Island floating bridge.

North End. Unlike the majority of the I-405 corridor, in the north end of the facility (at least through the SR 522 interchange, where data from 1997 end), some additional capacity existed during the shoulders of the peak period. This allowed some growth in peak period volumes. In addition, as in downtown Bellevue, an increase in general purpose vehicle volumes at many locations was partially offset by a reduction in HOV lane volumes due to the change in lane configuration that removed entering/exiting GP vehicles from the HOV lane counts. However, even with this change, most observed volume growth occurred in the shoulders of the peak period and during midday, indicating that the growth was primarily the result of increasing travel demand (see Figure 2.38).

Congestion frequency increased in this section of the freeway by roughly one day per week in the peak direction and peak period throughout most of the corridor (southbound in the morning, northbound in the evening). This is illustrated in Figure 2.39. Most of the congestion growth was in the shoulders of the peak period, rather than during the peak hour. This is primarily because congestion in the peak hour was already almost a daily occurrence and thus could not get substantially more frequent. As demand increased, that congestion spread.

Some improvements in congestion did occur between 1997 and 1999. The largest of these was north of Totem Lake in the evening, as the capacity improvements north of SR 522 moved the bottleneck (and the associated queues) several miles farther north (see Figure 2.40).

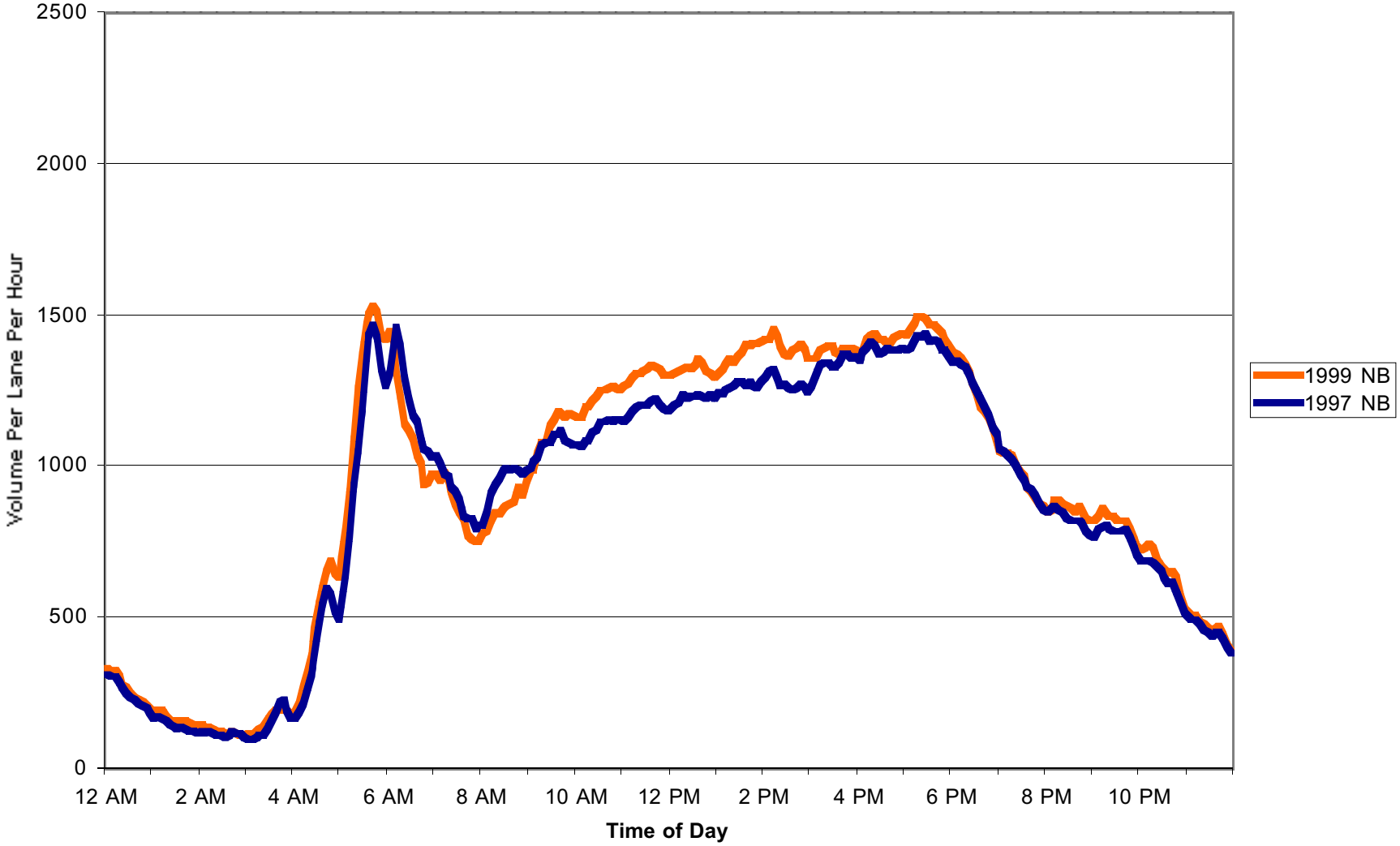

Figure 2.35. 1997-1999 Volume Trends, Northbound I-405 at SR 169 in Renton

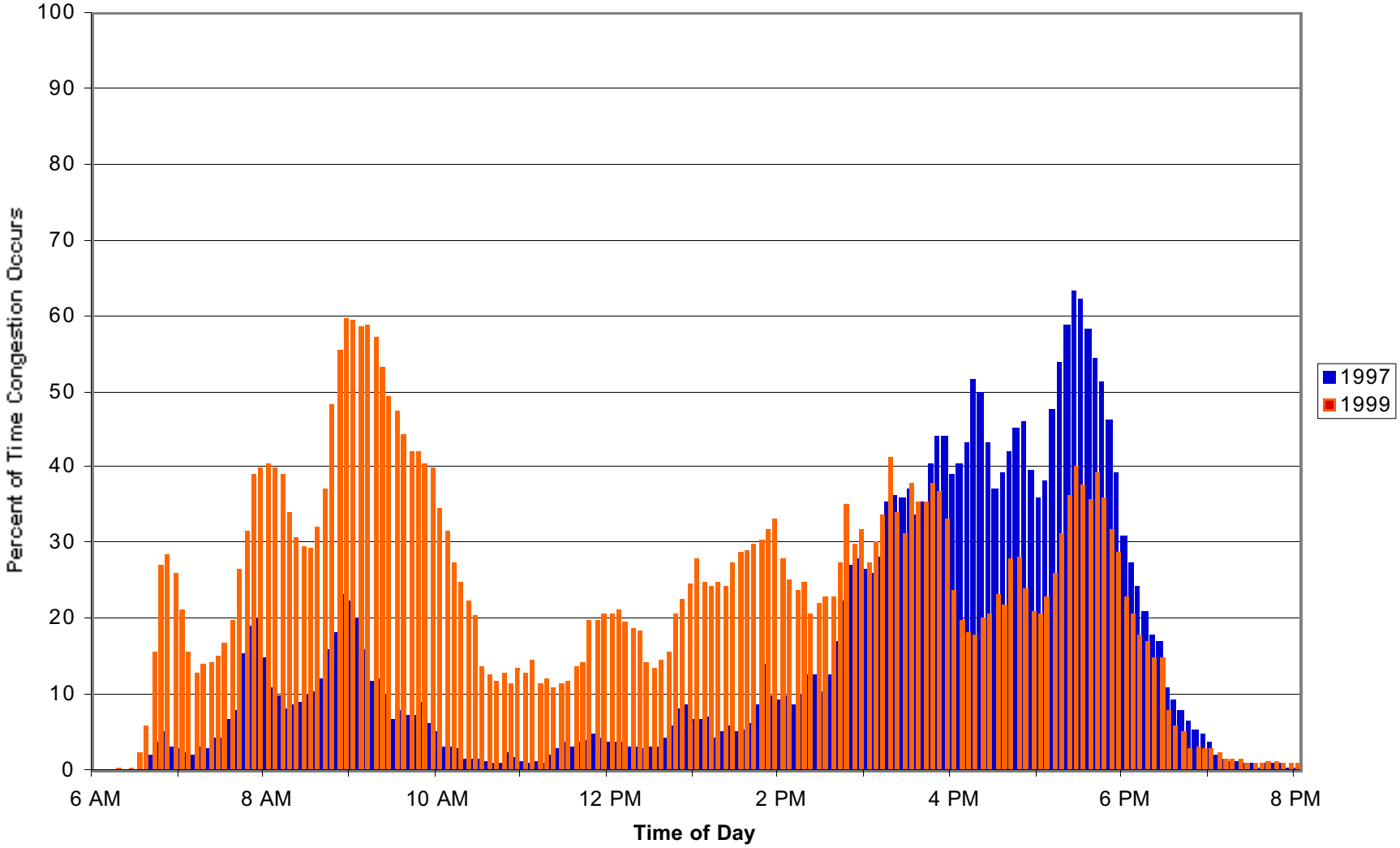

Figure 2.36. 1997-1999 Congestion Frequency Comparison, Northbound I-405 North of Downtown Bellevue

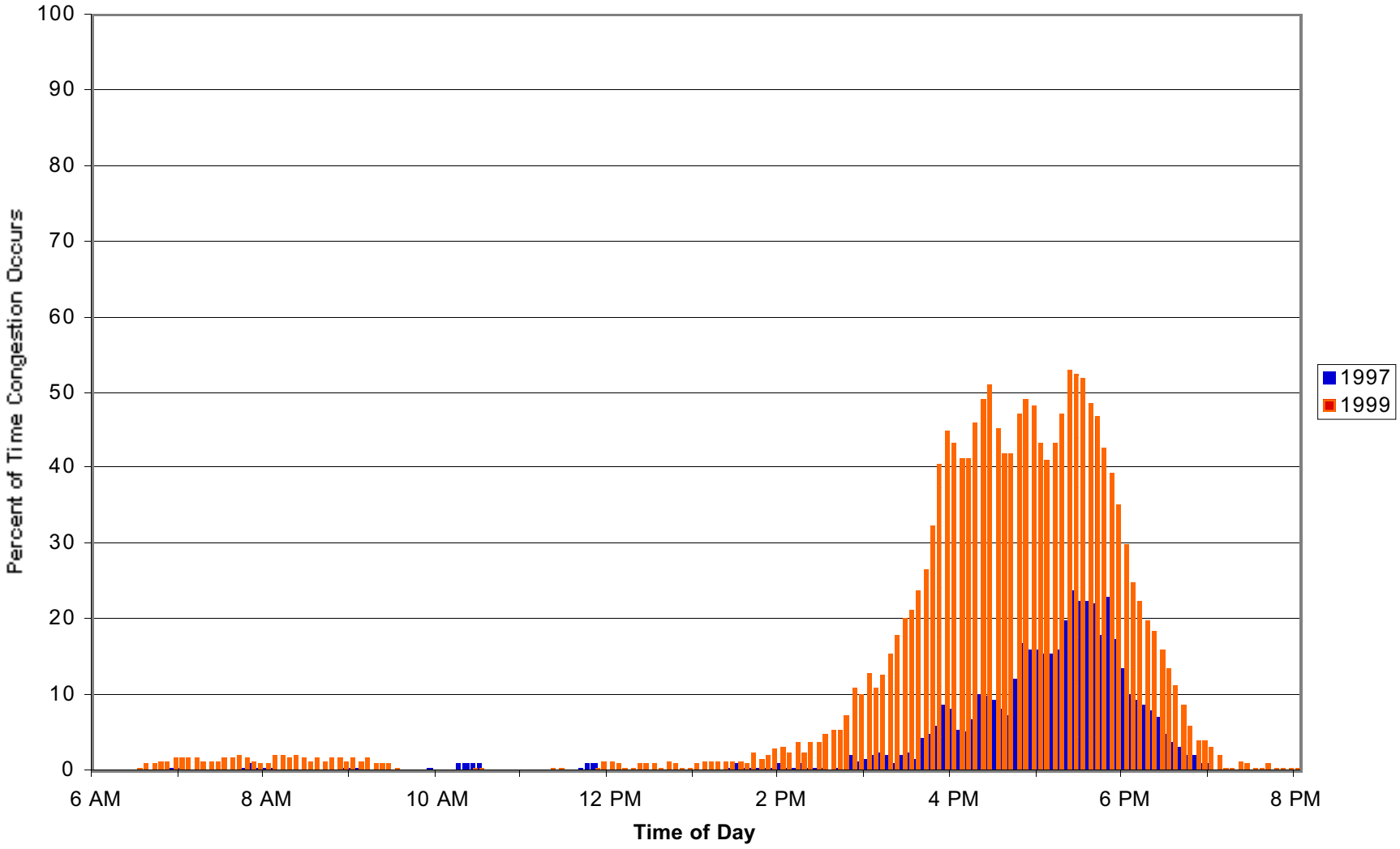

Figure 2.37. 1997-1999 Congestion Frequency Comparison, Southbound I-405 North of Downtown Bellevue

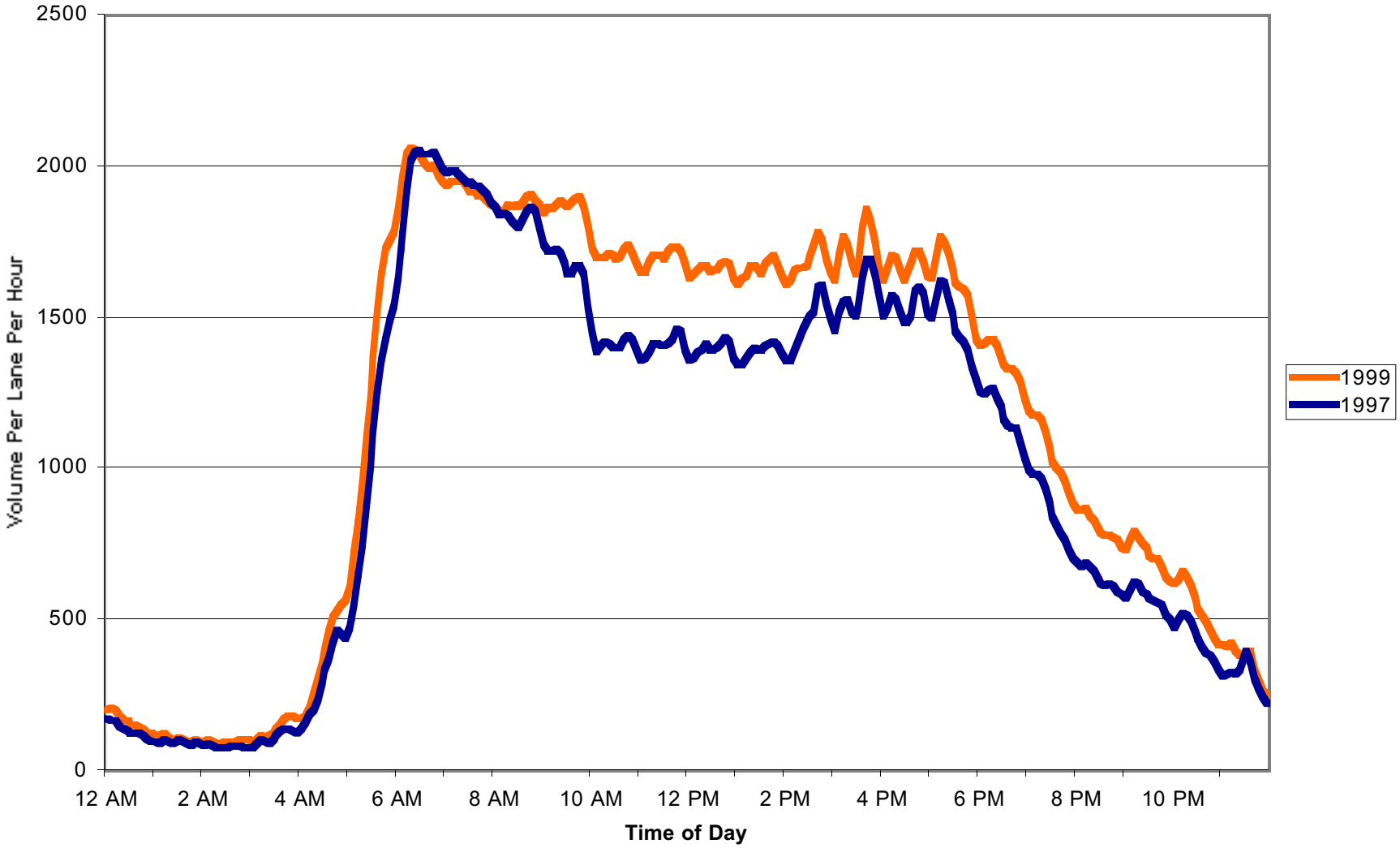

Figure 2.38. 1997-1999 Volume Trends, Southbound I-405 at Totem Lake

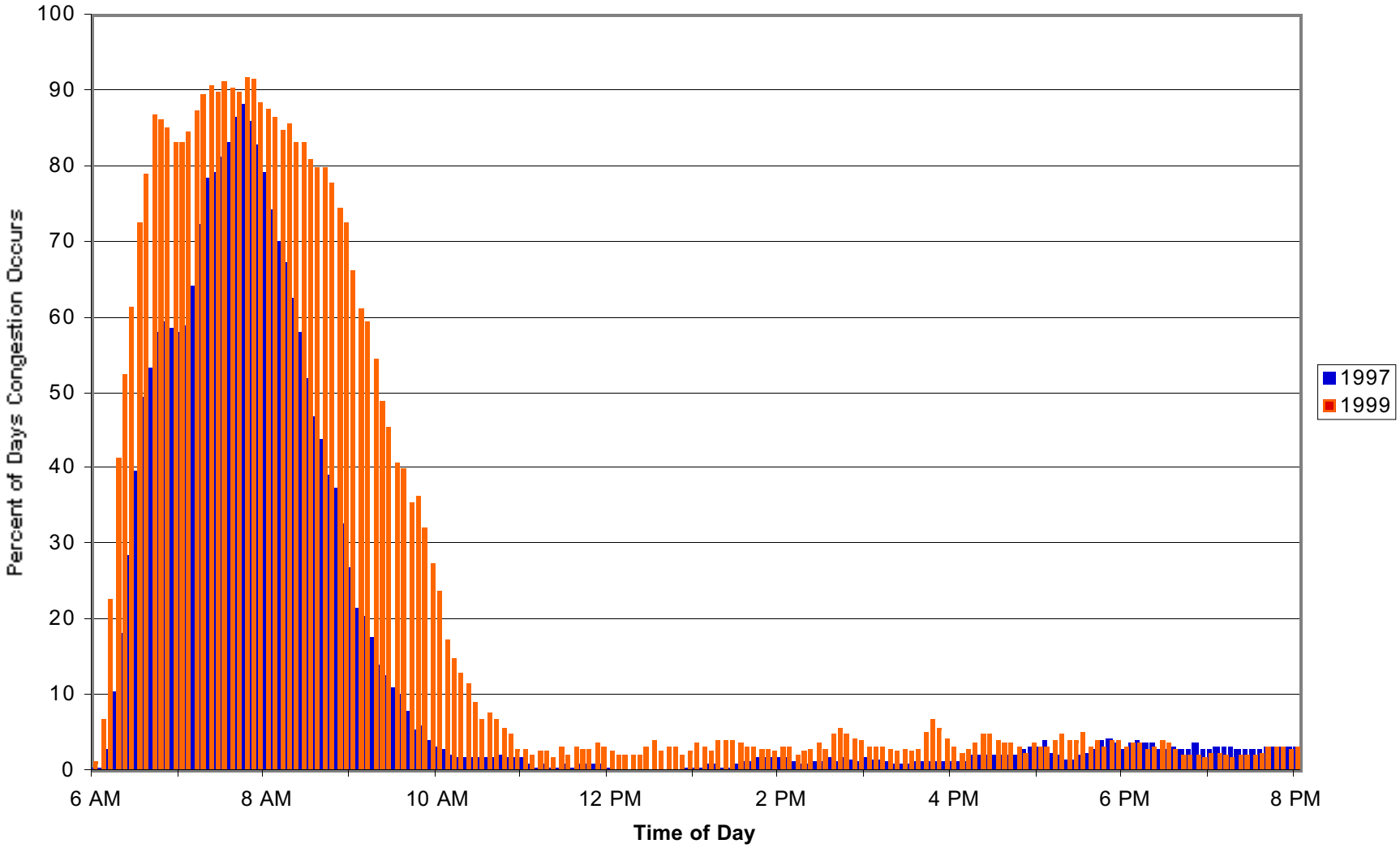

Figure 2.39. 1997-1999 Congestion Frequency Comparison, Southbound I-405 at Totem Lake

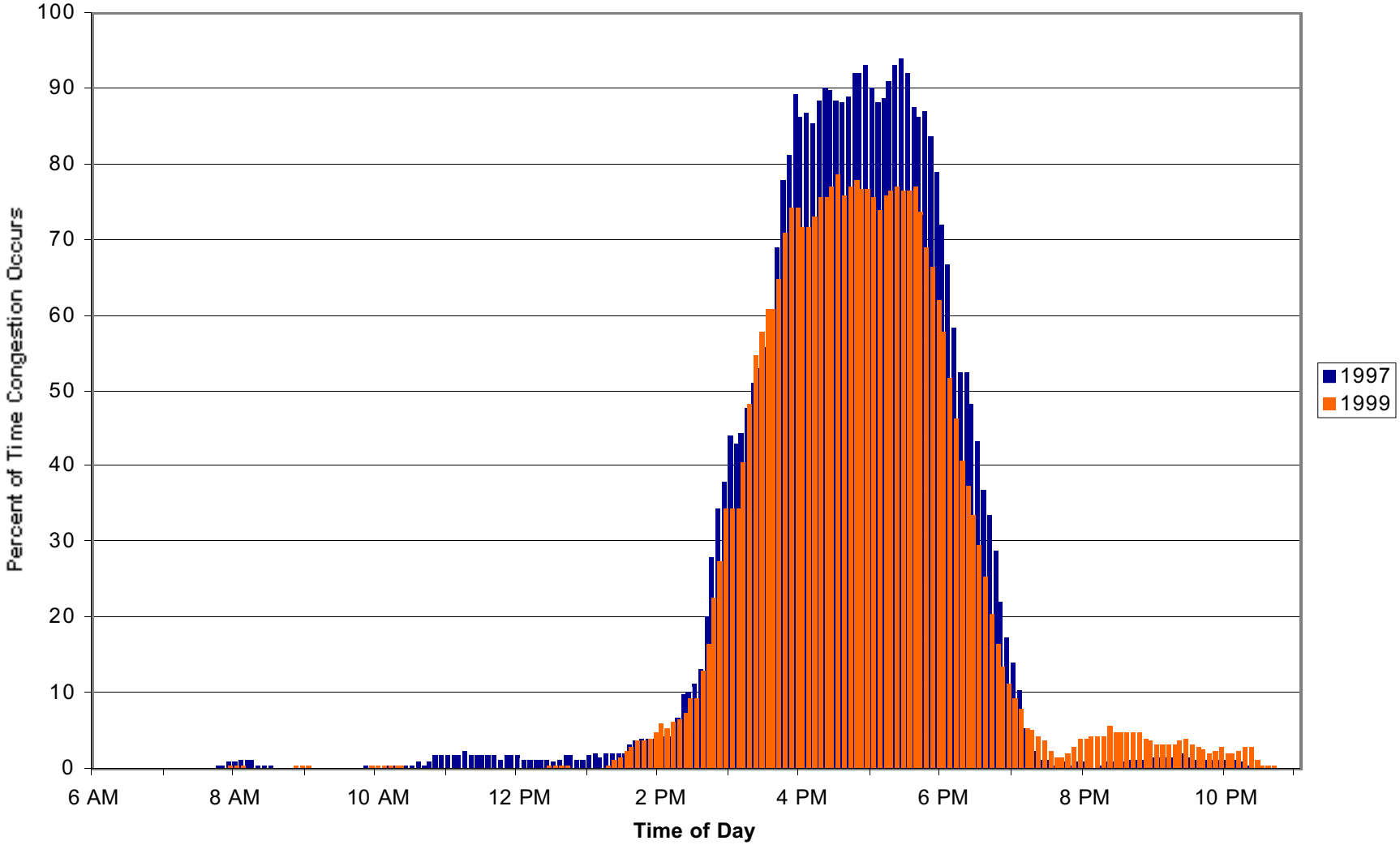

Figure 2.40. 1997-1999 Congestion Frequency Comparison, Northbound I-405 at NE 170th St

SR 520

From 1997 to 1999, traffic volumes on the SR 520 floating bridge have actually declined marginally (Figures 2.41 and 2.42). Floating bridge volumes returned to 1995 levels. These volume reductions were not actually noticeable to motorists using the bridge; however, the traffic congestion improvements that occurred during the morning commute may be large enough to be noticed.

Traffic congestion in the "traditional" directions on the corridor (westbound in the morning and eastbound in the evening) improved during the last two years. However, congestion in the "reverse commute" (eastbound in the morning and westbound in the evening) got measurably worse. For example, Figure 2.43, which illustrates the westbound approach to the floating bridge, shows that congestion improved slightly in the morning from 1997 to 1999 but got worse in the afternoon.

Note that while traffic volumes declined marginally during both AM and PM periods, these declines were caused by different factors and have different relationships to congestion. In the morning, a minor decline in traffic demand, spread evenly throughout the morning, resulted in a measurable decline in the frequency of congestion (free flow conditions occurred as much as one day per week more often in 1999 than in 1997). In the afternoon, demand actually increased, but because the road was already over-saturated with vehicles, that increased demand caused congestion levels to increase. Because congestion was already very high, the number of vehicles that could cross the bridge during the peak period actually declined slightly, while the duration of congestion increased. (That is, in 1999 the back-ups started earlier and ended later, and because the back-ups existed, the peak period volumes were slightly lower.)

Eastbound, traffic approaching the bridge showed little change from 1997. The morning peak widened (started earlier and ended later), with an increase in the frequency of congestion in the late morning. (In 1999 morning congestion took longer to dissipate.) In the evening commute, congestion frequency declined slightly in the shoulders of the peak period (before 3:30 and after 7:30 PM), while increasing slightly during the peak hour (see Figure 2.44).

The most striking feature of the eastbound movement is the impact that operation of meters at the Montlake and Lake Washington Boulevard ramps has on SR 520 performance. Operation of the meters in the afternoon significantly reduces the frequency, intensity, and duration of the afternoon congestion in comparison to the morning congestion (when the meters are not operated). In the morning, these ramp meters are not used, to give more priority to ramp traffic, and the effect is both a significant increase in the delay on the freeway and a sizeable decrease in mainline throughput (note the drop in volume near 7:30 AM at the peak of the morning congestion). In the afternoon, a reduction in throughput and increase in delay is experienced by the motorists who use these ramps.

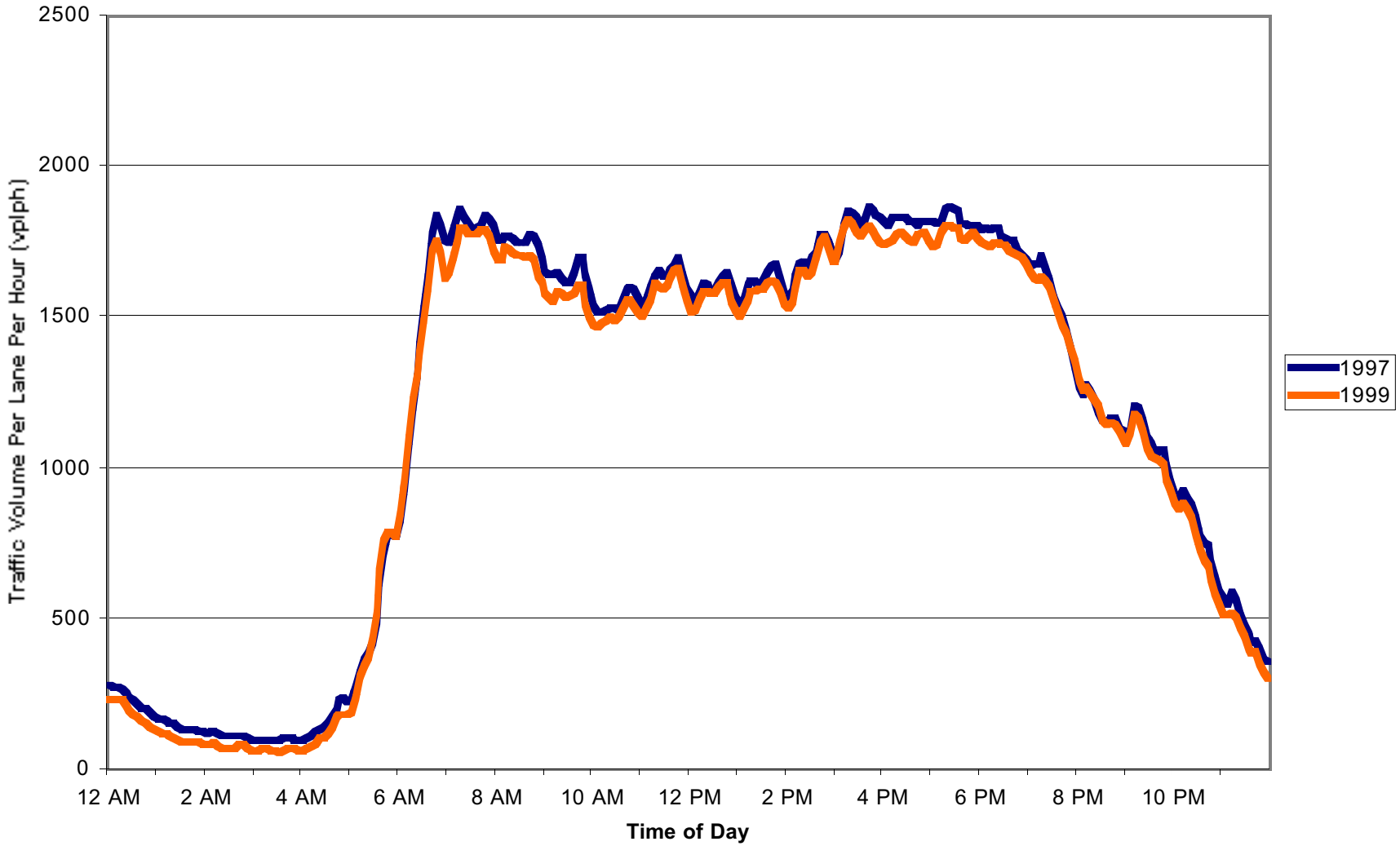

Figure 2.41. 1997-1999 Volume Trends, Westbound SR 520 at the Floating Bridge

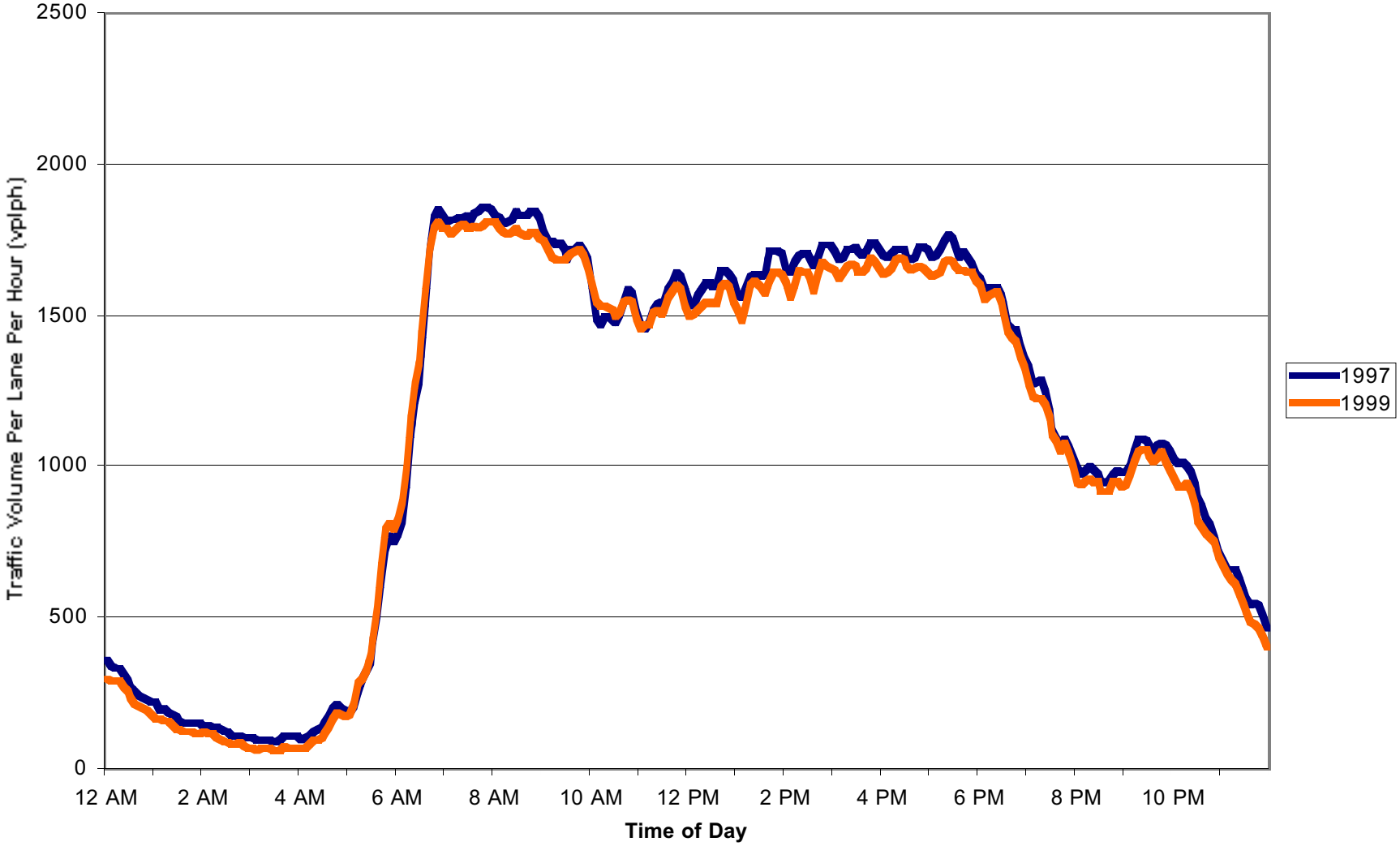

Figure 2.42. 1997-1999 Volume Trends, Eastbound SR 520 at the Floating Bridge

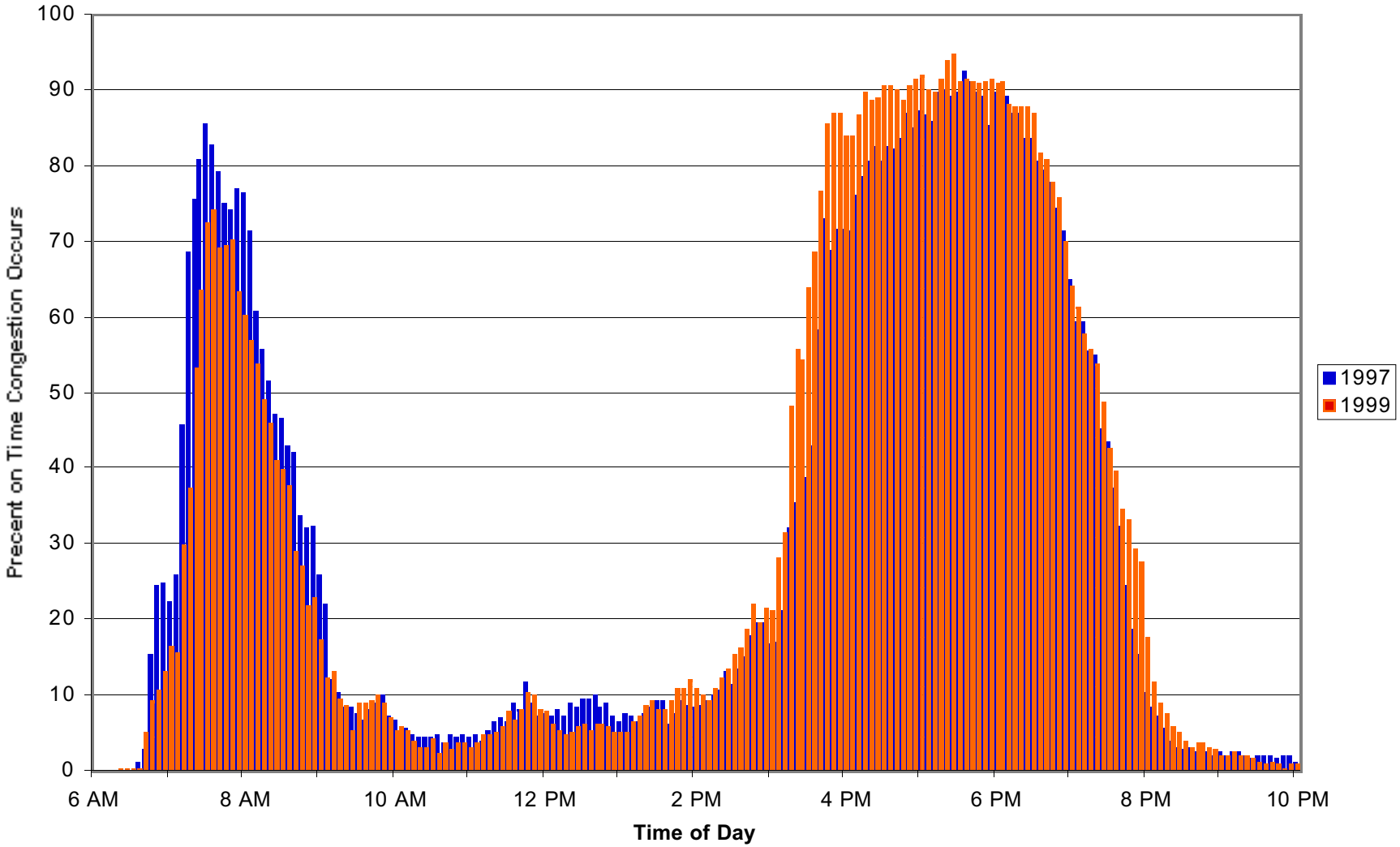

Figure 2.43. 1997-1999 Congestion Frequency Comparison, Westbound SR 520 at NE 72nd (east end of the Floating Bridge)

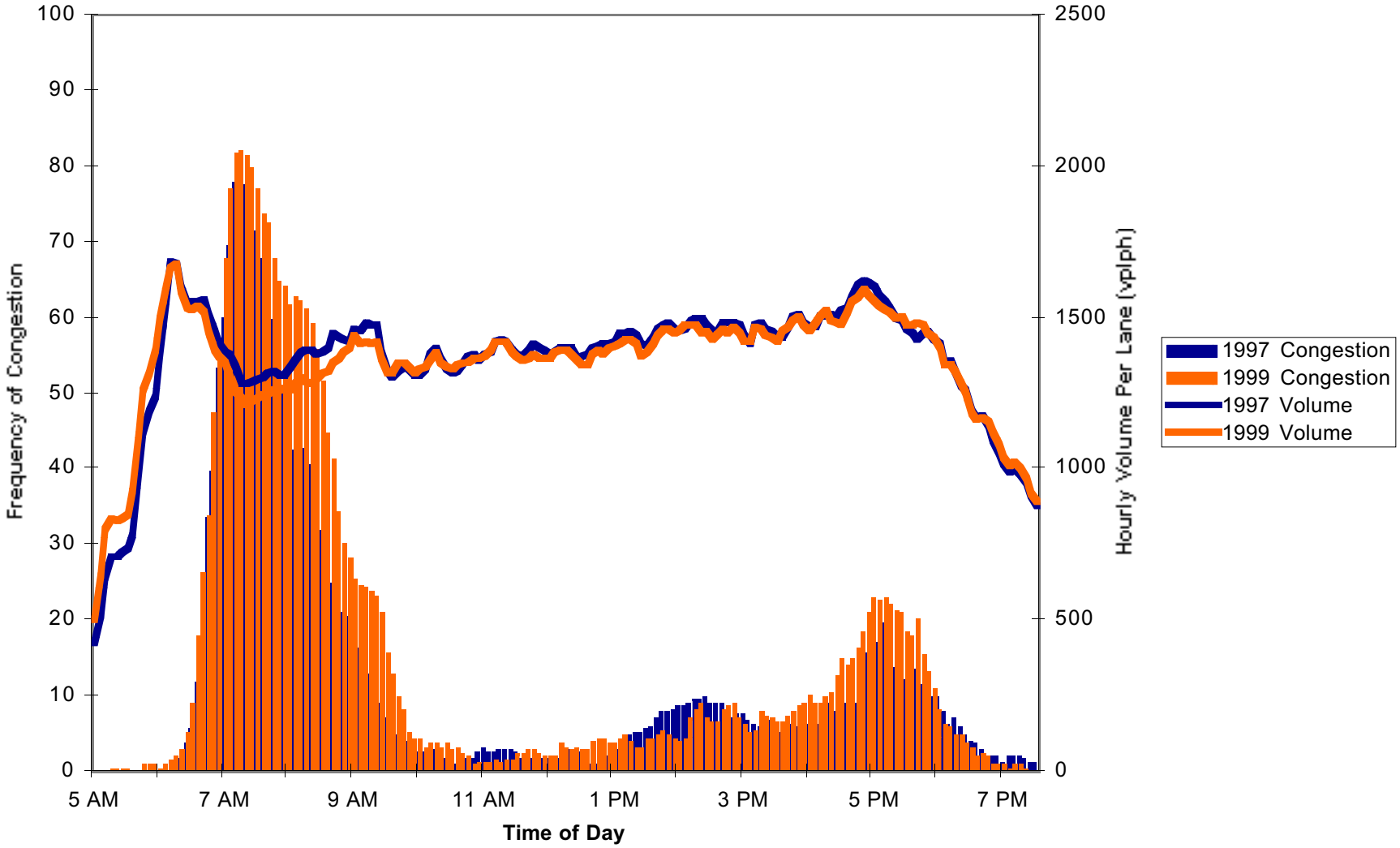

Figure 2.44. 1997-1999 Congestion Frequency Comparison and Volume Trends, Eastbound SR 520 at the Viaduct

I-90

Changes in facility performance on I-90 demonstrate the two most common and expected occurrences in the metropolitan region. The first is that most growth in traffic volumes in the Puget Sound region continues to occur in the suburban areas, not in the established core areas heavily served by alternative modes of transportation. Second is that as a result of growth in both population and employment in the suburban areas, travel patterns are slowly changing, with a growing percentage of trips headed to the suburbs (in this case the east side) rather than to downtown Seattle. I-90 is somewhat unique in that it had freeway surveillance equipment in place well before 1997, and thus these changes can be measured more accurately on I-90 than on the other freeways in the metropolitan area.

The growth in suburban population and employment and the lack of effective alternative transportation modes resulted in traffic volume growth and an increase in congestion on most sections of I-90. Traffic growth and increased congestion were not evenly distributed. In fact, as on SR 520, some of the traditionally congested portions of I-90 experienced modest improvements in traffic conditions.

East of the I-405 Interchange. East of I-405 modest growth in traffic volumes occurred throughout the day. However, despite this growth in traffic, congestion only occurred during the traditional peak periods and peak directions. This is because considerable unused capacity still exists in the off-peak times and directions (see Figure 2.45).

Despite the growth in employment opportunities in Issaquah and other eastern edge cities, this portion of I-90 still has a very significant "tidal flow" traffic pattern, with heavy travel movements to the west in the morning and to the east in the afternoon. During these movements, congestion increased substantially. Between 7:00 and 8:30 AM significant congestion occurred almost twice as often in 1999 as it did in 1997, although this is still only an average of once or twice a week. Eastbound, traffic congestion only existed in the afternoon peak periods and was primarily a result of queue spill-back onto the freeway from exit ramps and the friction between these spillbacks and the freeway traffic continuing farther east.

This portion of I-90 is an excellent example of the need to coordinate freeway capacity with land-use changes and arterial infrastructure improvements.

West of the I-405 Interchange. West of the I-405 interchange, I-90 experienced the same travel pattern changes observed on SR 520. Modest improvements occurred in the traditional commute directions, while congestion on the "reverse commute" (from Seattle to the eastside in the morning and back to Seattle in the afternoon) worsened considerably in the last two years. Figure 2.46 shows the frequency of westbound congestion. It decreased slightly in the morning, the traditional commute, and increased in the afternoon, the "reverse commute." Figure 2.47 shows eastbound congestion, where peak hour congestion in both directions decreased slightly from 1997 to 1999. However, in the morning, while the frequency of congestion at 8:00 AM decreased, the frequency of congestion at 9:15 AM increased. This lengthening of the duration of frequent congestion is typical of facilities on which travel demand is increasing in the shoulders of the peak period.

As with SR 520, the modest improvements in the frequency of congestion in the traditional directions were primarily a result of volumes having dropped marginally during the peak period. Conversely, increases in demand in the "reverse" direction caused congestion to start earlier and end later. These increases resulted in reduced reliability for the "reverse" commute trip, with congestion frequency increasing by as much as 10 percent (one extra day of congestion every two weeks in comparison to 1997).

The modest volume changes on this facility are illustrated in Figure 2.48.

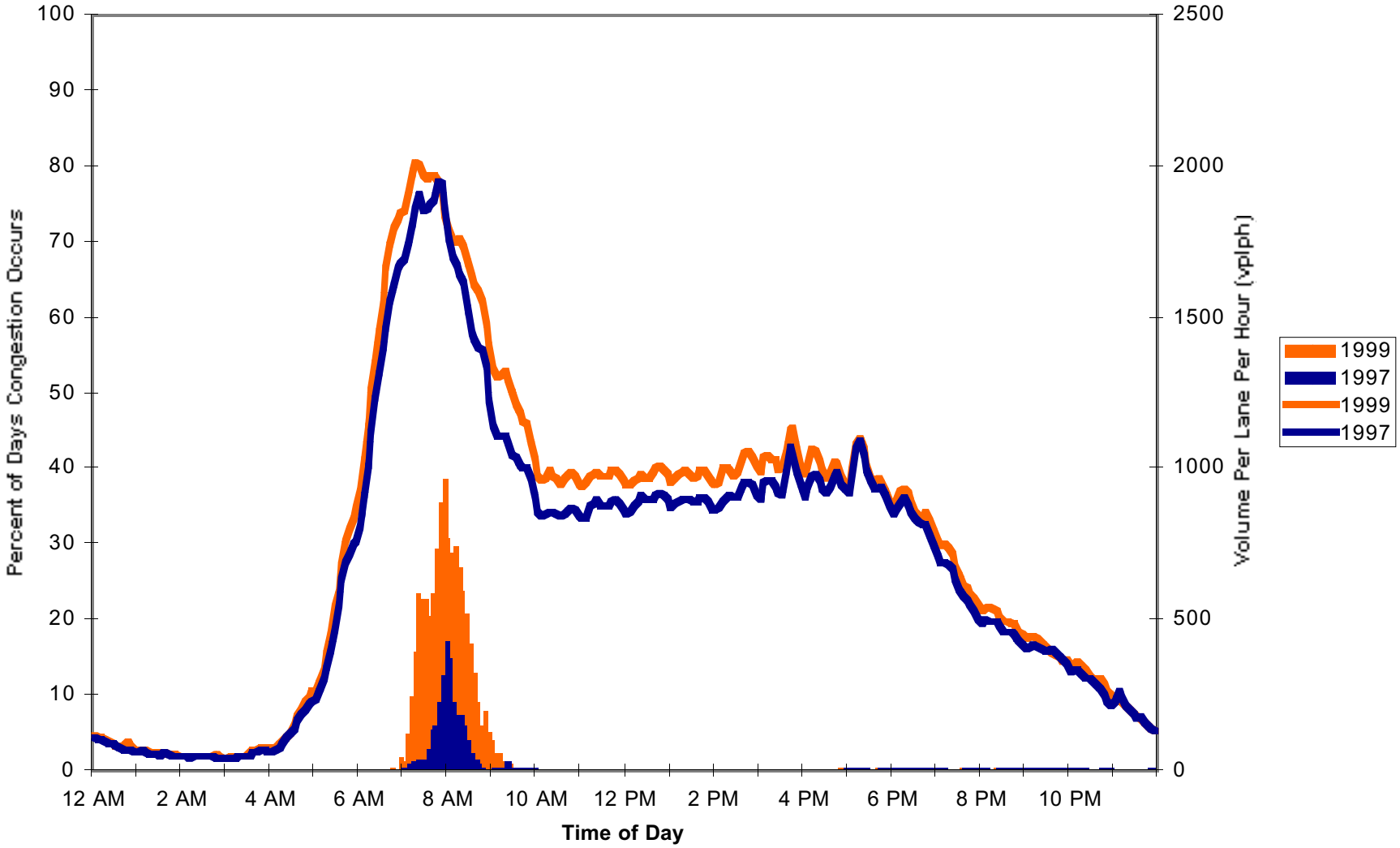

Figure 2.45. 1997-1999 Congestion Frequency Comparison and Volume Trends, Westbound I-90 at 169th St.

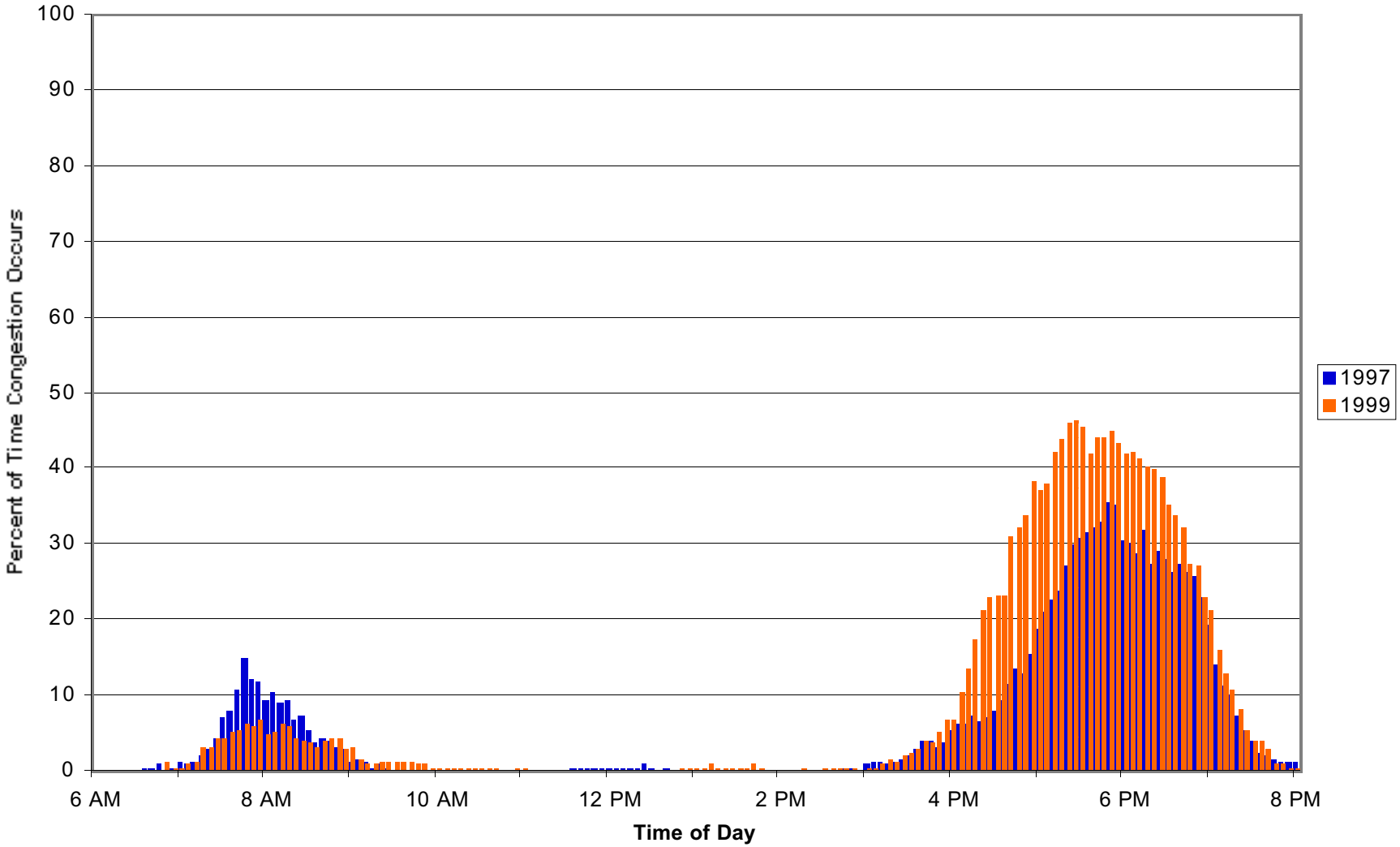

Figure 2.46. 1997-1999 Congestion Frequency Comparison, Westbound I-90 at Island Crest Way

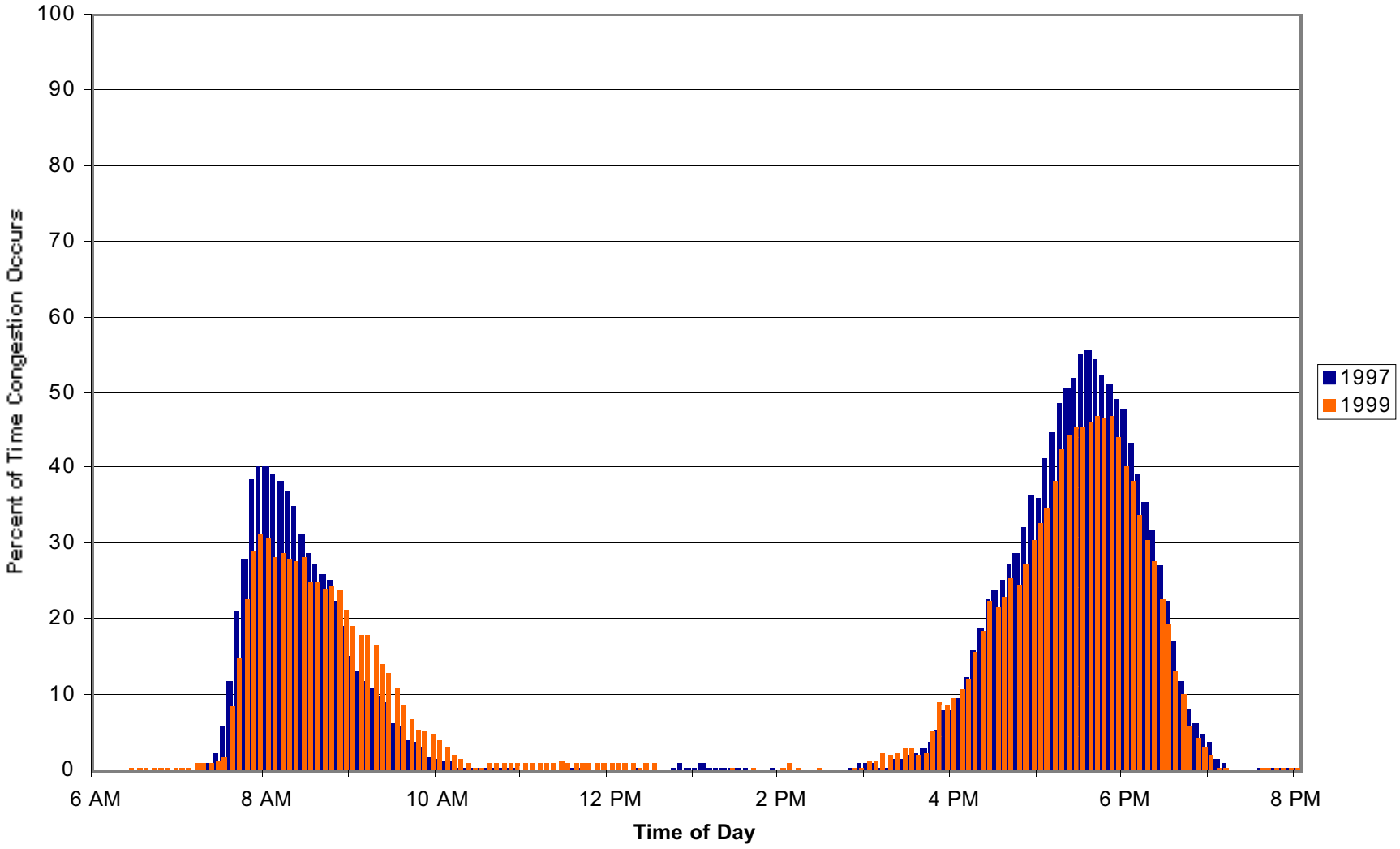

Figure 2.47. 1997-1999 Congestion Frequency Comparison, Eastbound I-90 at Island Crest Way

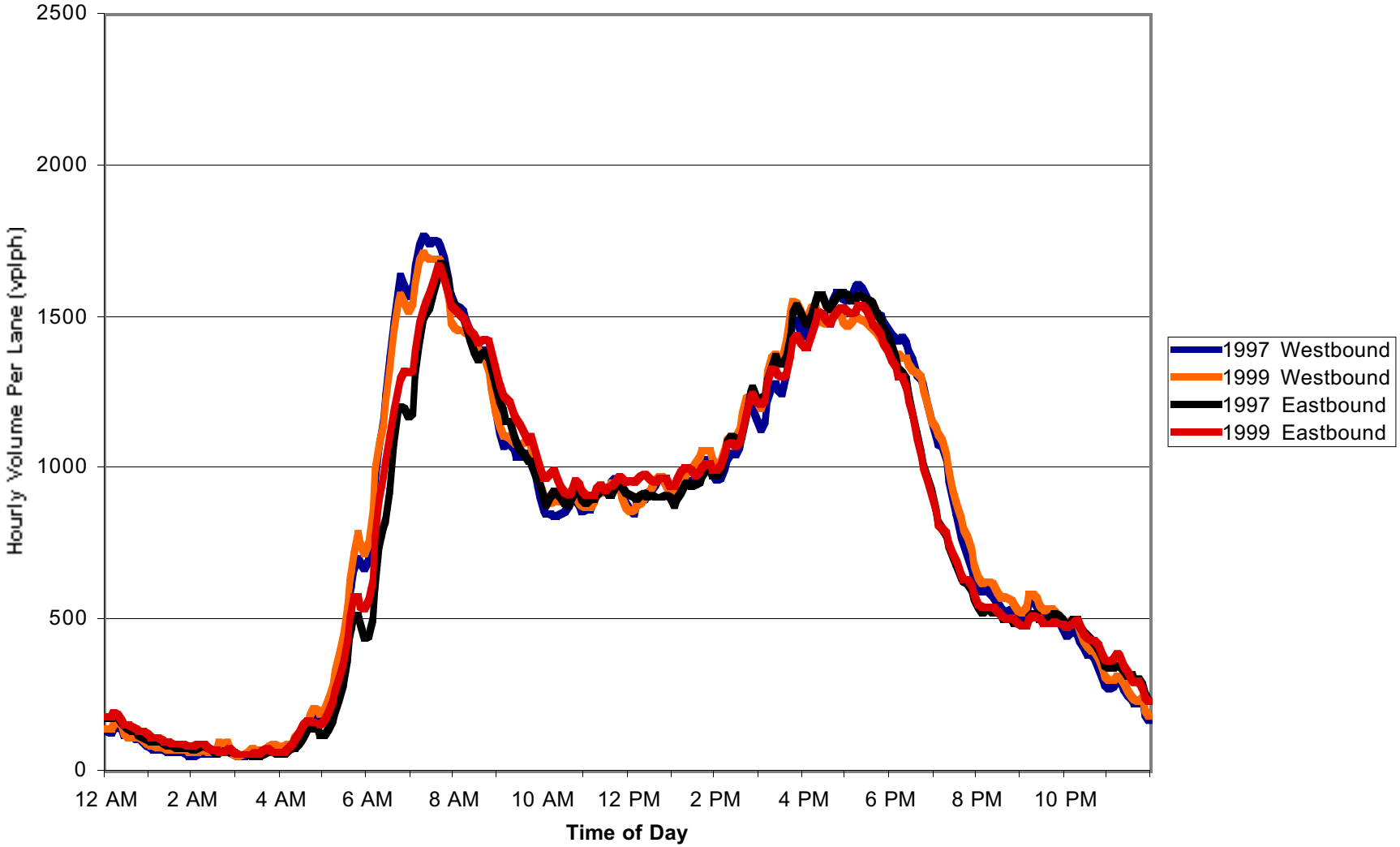

Figure 2.48. 1997-1999 Volume Trends, Westbound and Eastbound I-90 at Island Crest Way