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This executive report provides an overall summary of the major elements of the assessment of high-occupancy vehicle (HOV) lane projects located either on freeways or in separate rights-of-way in North America. The report includes a discussion of the purpose of the assessment, an overview of the status of HOV facilities in North America, suggested procedures for evaluating HOV projects, detailed information on selected HOV case studies, proposed future HOV projects, and areas for further research.

This report summarizes information contained in the four major reports that have been prepared as part of the three-year assessment. Those reports are: *A Description of High-Occupancy Vehicle Facilities in North America*; *Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities*; *High-Occupancy Vehicle Project Case Studies: History and Institutional Arrangements*; and *High-Occupancy Vehicle Project Case Studies: Historical Trends and Project Experiences.*

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An Assessment of High-Occupancy Vehicle Facilities in North America: Executive Report

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Technical Report 925-5F
Technical Study 2-11-89/1-925
An Assessment of Freeway High-Occupancy Vehicle Projects

Sponsored By
Texas Department of Transportation

In Cooperation With
Federal Transit Administration,
United States Department of Transportation

Texas Transportation Institute
The Texas A&M University System
College Station, Texas

August 1992

This study was financed in part through a grant from the Federal Transit Administration, United States Department of Transportation, under the Urban Mass Transportation Act of 1964, as amended.

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

LENGTH

Symbol	When You Know	Multiply By	To Find	Symbol
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha

MASS (weight)

Symbol	When You Know	Multiply By	To Find	Symbol
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg

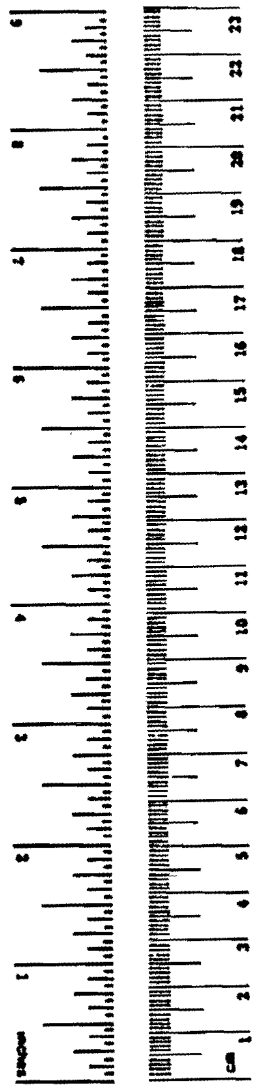
VOLUME

Symbol	When You Know	Multiply By	To Find	Symbol
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



APPROXIMATE CONVERSIONS TO SI UNITS

LENGTH

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

AREA

Symbol	When You Know	Multiply By	To Find	Symbol
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectores (10 000 m^2)	2.53	acres	ac

MASS (weight)

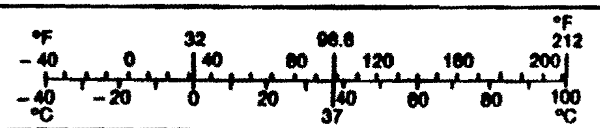
Symbol	When You Know	Multiply By	To Find	Symbol
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T

VOLUME

Symbol	When You Know	Multiply By	To Find	Symbol
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
m^3	metres cubed	1.308	cubic yards	yd^3

TEMPERATURE (exact)

Symbol	When You Know	Multiply By	To Find	Symbol
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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

* SI is the symbol for the International System of Measurements

Abstract

This executive report provides an overall summary of the major elements of the assessment of high-occupancy vehicle (HOV) lane projects located either on freeways or in separate rights-of-way in North America. The report includes a discussion of the purpose of the assessment, an overview of the status of HOV facilities in North America, suggested procedures for evaluating HOV projects, detailed information on selected HOV case studies, proposed future HOV projects, and areas for further research.

This report summarizes information contained in the four major reports that have been prepared as part of the three-year assessment. Those reports are: *A Description of High-Occupancy Vehicle Facilities in North America*; *Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities*; *High-Occupancy Vehicle Project Case Studies: History and Institutional Arrangements*; and *High-Occupancy Vehicle Project Case Studies: Historical Trends and Project Experiences*.

Implementation Statement

This report was funded by the Federal Transit Administration (FTA) through the Texas Department of Transportation (TxDOT). It represents the final report of a three-year assessment of high-occupancy vehicle lane projects located either on freeways or in separate rights-of-way in North America. High-occupancy vehicle (HOV) facilities represent one approach being used in many metropolitan areas to respond to increasing traffic congestion, declining mobility levels, air quality and environmental concerns, and limited resources. HOV facilities, which can offer priority treatments to buses, vanpools, and carpools, focus on increasing the person-movement—rather than vehicle-movement—efficiency of a roadway or travel corridor.

The three-year research study was undertaken to provide an assessment of HOV lanes on freeways and in separate rights-of-way in North America. The assessment included an examination of the design treatments, operating scenarios, enforcement techniques, utilization levels, and general experiences with the different HOV facilities. Further, a more detailed analysis of selected HOV project case studies was conducted to examine the institutional arrangements associated with the development and operation of the projects, historical trends in use, and the impacts of the facilities. A suggested approach and procedure for evaluating freeway HOV lanes was also developed to provide a national model for areas interested in conducting before-and-after evaluations and ongoing monitoring activities. The results of all these activities, which are summarized in this report, should be of benefit to transportation professionals and others interested in ensuring that HOV projects are planned, designed, implemented, and operated to maximize the potential benefits from the use of these facilities.

Disclaimer

Acknowledgements

A number of individuals assisted with the various activities conducted as part of the three-year assessment of high-occupancy vehicle facilities in North America. First, A national peer group—comprised of representatives from federal, state, and local agencies; university research institutes; and consulting firms—assisted with the review of the suggested procedures for evaluating freeway HOV projects. The national peer group consisted of the following individuals:

Dr. Donald Capelle, Parsons Brinckerhoff Quade & Douglas
Mr. Edward Collins, Texas Department of Transportation
Mr. Donald Emerson, Federal Transit Administration
Mr. Les Jacobson, Washington State Department of Transportation
Dr. Dolf May, University of California, Berkeley
Mr. Allen Pint, Minnesota Department of Transportation
Mr. Jim Robinson, Federal Highway Administration
Mr. Morris Rothenberg, JHK & Associates

Second, the HOV project case study history and institutional arrangements were prepared by individuals with knowledge of the different case study facilities. The following individuals or organizations completed the history and institutional arrangements for the different HOV project case studies.

Mr. Richard Kabat, Texas Transportation Institute — Houston, Texas
Mr. Charles Fuhs — Orange County, California
Kilareski and Mason, P.E. — Pittsburgh, Pennsylvania
Dr. G. Scott Rutherford — Seattle, Washington
JHK & Associates — Washington, D.C./Northern Virginia

Third, a number of individuals assisted with providing detailed information on the utilization trends and impacts of the different HOV project case studies. The following individuals were especially helpful in that part of the assessment.

Mr. Allen Pint and Mr. John Gable, Minnesota Department of Transportation
Mr. Tom Fox, Pennsylvania Department of Transportation
Mr. Joe El-Harake, California Department of Transportation
Mr. Jon Williams, Metropolitan Washington Council of Governments
Ms. Carole Valentine, Virginia Department of Transportation
Mr. Les Jacobson, Washington State Department of Transportation

Finally, many members of the Texas Transportation Institute staff assisted in the different activities associated with the assessment. Dennis L. Christiansen, Russell H. Henk, and James W. Hanks, Jr. co-authored other reports prepared for the study. Robert Stokes, Robert Wright, Wanda Hinshaw, Michael Ringrose, Richard Luedke, Patrick Beck, June Housman, Nicole Beasley, and Sheila Fields provided assistance on various support activities.

The assistance of all these individuals is both acknowledged and appreciated.

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I.

Introduction

The Texas Transportation Institute (TTI), a part of The Texas A&M University System, has completed a three-year assessment of high-occupancy vehicle (HOV) lane projects located either on freeways or in separate rights-of-way in North America. The research study was funded by the Federal Transit Administration (FTA) through the Texas Department of Transportation (TxDOT). Several activities were conducted as part of the assessment and a series of reports was prepared documenting the results of those efforts. This executive report provides a summary of the major components of the study. It addresses a number of topics, including the purpose of the assessment, the status of HOV facilities in North America, suggested procedures for evaluating HOV projects, case study examples, proposed HOV facilities, and issues in need of further research.

Purpose of the Assessment

Increasing traffic congestion, declining mobility levels, and air quality and environmental concerns represent major issues facing many metropolitan areas today. Limited financial resources and right-of-way availability further complicate the situation in numerous areas. Realizing that there is no single solution, transportation professionals and decision makers have been pursuing a variety of techniques and approaches to address those problems. High-occupancy vehicle facilities represent one viable technique being used in many areas to respond to these concerns.

High-occupancy vehicle facilities, which offer priority treatments to buses, vanpools, and carpools, focus on increasing the person-movement—rather than vehicle-movement—efficiency of a roadway or travel corridor. Currently in North America, approximately 49 HOV lanes are in operation on freeways or separate rights-of-way in 22 metropolitan areas. Many more HOV projects are in the planning, design, and construction stages. In response to local problems and needs, a variety of design treatments and operating strategies are used for HOV facilities, resulting in variations in the utilization levels and experiences among the different projects.

The three-year research study was undertaken to provide an assessment of HOV lanes on freeways and in separate rights-of-way in North America. The assessment provides an examination of the design treatments, operating scenarios, enforcement techniques, utilization levels, and general experiences with the different HOV facilities. A more detailed analysis of selected HOV project case studies was conducted to examine the institutional arrangements associated with the development and operation of the projects, and the historical trends in their use. Further, a suggested approach and procedure for evaluating freeway HOV lanes was developed to provide a national model for areas interested in conducting before-and-after evaluations and monitoring activities.

Activities Conducted and Reports Prepared

A number of activities were conducted to accomplish the objectives of the assessment. The results of those activities are documented in four reports prepared as part of the research study. This fifth and final executive report provides an overall summary of the major elements from all the activities performed. Although the major findings are highlighted in this document, the individual reports should be consulted for more detailed information.

The first activity conducted as part of the assessment was a survey of all operating HOV projects on freeways or in separate rights-of-way in North America. The results of the survey include descriptions, maps, and design cross-sections of the different facilities. Further, information was provided on the operating characteristics, utilization levels, enforcement techniques, violation rates, and costs for each project. The results of the survey are documented in the report *A Description of High-Occupancy Vehicle Facilities in North America.*[1] Information on the different HOV projects was further updated in 1992. The most recent information is included in this report.

The second activity conducted as part of the assessment was the development of a suggested approach and procedure for evaluating freeway HOV projects. This was accomplished through a review of past and current practices associated with conducting before-and-after evaluations of HOV facilities. Based on this review and the input from a national peer group, appropriate objectives for HOV projects and the corresponding measures of effectiveness, measurement techniques, and data collection methodologies were identified. The procedures, which are documented in the report

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[1]K.F. Turnbull and J.W. Hanks, Jr. *A Description of High-Occupancy Vehicle Facilities in North America.* U.S. Department of Transportation, Washington, D.C., July 1992.

Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities,[2] provide a national model for application with all types of freeway HOV projects. Use of the suggested procedures should enhance project-specific before-and-after studies and provide a comparable and compatible data base for HOV projects.

The final element of the assessment focused on a more detailed examination of selected HOV facilities at six case study sites. High-occupancy vehicle facilities in Houston, Texas; Minneapolis-St. Paul, Minnesota; Orange County, California; Pittsburgh, Pennsylvania; Seattle, Washington; and Washington, D.C./Northern Virginia represent the selected case study projects. The HOV case studies provide an examination of the history, institutional arrangements, operating characteristics, utilization levels, trends, and impacts of HOV projects in different parts of the country.

The history and institutional arrangements associated with the development of HOV facilities at the case study sites were examined first. That analysis included an examination of the reasons behind the development of the projects, the background and history of the facilities, relevant issues, and the roles and responsibilities of the different agencies and organizations involved in the planning and implementation process. The individual case studies and a discussion of the common elements among the projects are documented in the report *High-Occupancy Vehicle Project Case Studies: History and Institutional Arrangements.*[3] The operating characteristics, utilization levels, trends, and impacts associated with HOV projects in the case study sites were also examined. The results of that analysis are provided in the report *High-Occupancy Vehicle Project Case Studies: Historical Trends and Current Experiences.*[4]

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[2]K.F. Turnbull, R.H. Henk, and D.L. Christiansen. *Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities.* U.S. Department of Transportation, Washington, D.C., February 1991.

[3]K.F. Turnbull. *High-Occupancy Vehicle Project Case Studies: History and Institutional Arrangements.* Texas Transportation Institute, College Station, Texas, December 1990.

[4]K.F. Turnbull. *High-Occupancy Vehicle Project Case Studies: Historical Trends and Current Experience.* Texas Transportation Institute, College Station, Texas, August 1992.

Organization of this Report

This report is organized into five chapters. The next chapter provides an overview of HOV facilities in North America located on freeways or in separate rights-of-way. That is followed by a summary of the suggested procedures for conducting before-and-after evaluations of HOV facilities. Chapter IV provides an overview of the key elements associated with the institutional arrangements and utilization trends related to the HOV projects in the six case study sites. A brief discussion of future directions and issues in presented in Chapter V. Finally, this executive report concludes with a summary of the major elements accomplished as a part of the three-year assessment and the identification of areas for further research.

II.

Overview of HOV Facilities in North America

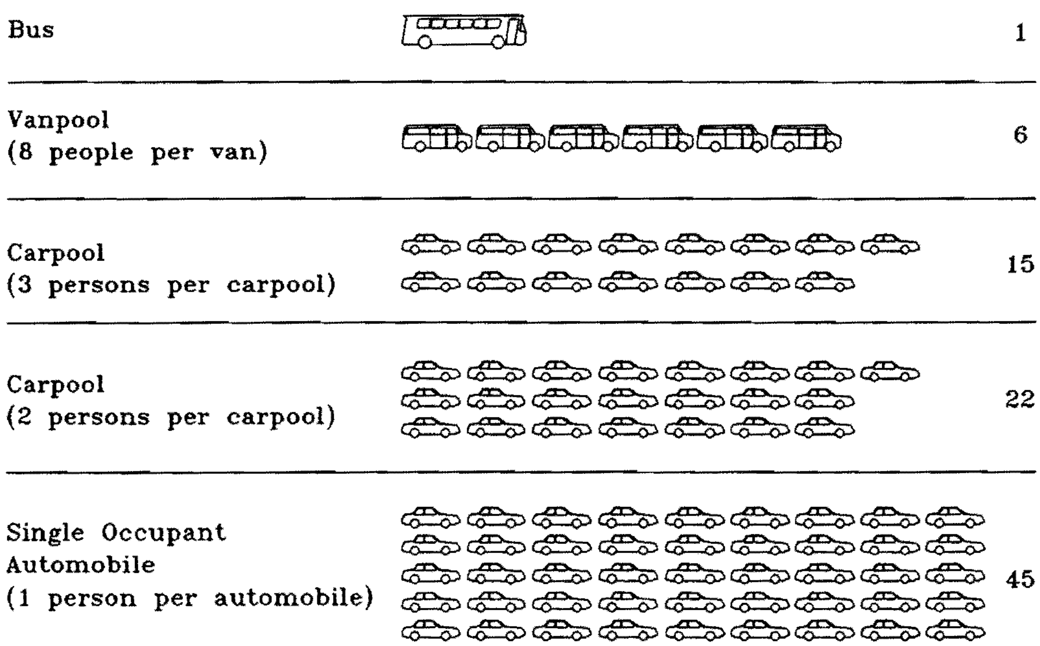
This chapter provides an overview of HOV facilities in operation on freeways or in separate rights-of-way in North America. A discussion of the HOV concept is presented first to provide an understanding of the purpose and objective of those facilities. That is followed by a description of the different types of HOV lanes in use on freeways and in separate rights-of-way. A summary of the status of HOV projects in North America is provided next, including recent statistics on utilization levels. Finally, this chapter concludes with a discussion of the type and orientation of bus services operated in conjunction with the different HOV lanes.

The HOV Concept

The priority measures for high-occupancy vehicles implemented throughout North America, while often differing in design and operation, have similar purposes. In general, HOV facilities are intended to help maximize the person-carrying capacity of the roadway. This is done by altering the design and/or the operation of the facility in order to provide priority treatment for high-occupancy vehicles. The definition of an HOV can include buses, vanpools, and carpools. By encouraging greater use of these modes, HOV projects increase the number of people, rather than the number of vehicles, being carried on a freeway or roadway. As illustrated in Figure 1, buses, vanpools, and carpools can accommodate more persons in fewer vehicles than automobiles with only one person.

A primary concept behind these priority facilities is to provide HOVs with both travel time savings and more predictable travel times. These two benefits serve as incentives for individuals to choose a higher-occupancy mode. This, in turn, can increase the person-movement capacity of the roadway by carrying more people in fewer vehicles. In some areas, additional incentives, such as reduced parking charges or preferential parking for carpools and vanpools, have been used to further encourage individuals to change their commuting habits. The success and acceptance of HOV projects can be influenced by these supporting facilities, services, and programs. Thus, HOV facilities often involve a variety of elements aimed at encouraging commuters to use buses, vanpools, and carpools.

Figure 1. Number of Vehicles Needed to Carry 45 People



The intent of HOV facilities is not to force individuals into making changes against their will. Rather, the objective is to provide a cost-effective travel alternative that a significant volume of commuters will find attractive enough to change from driving alone to using a higher occupancy mode. The HOV lanes and other supporting elements help provide the incentives and benefits to encourage this mode change.

Many HOV projects have focused on meeting one or more of three common objectives. Those objectives are: to increase the average number of persons per vehicle; to preserve the person-movement capacity of the roadway; and to enhance bus operations. A more detailed description of each objective is provided next.

Increase the Average Number of Persons per Vehicle — The travel time savings and travel time reliability offered to high-occupancy vehicles provide incentives for single-occupant automobile drivers to change from driving alone to using a bus, vanpool, or carpool. Thus, a major objective of HOV projects is to move people rather than vehicles. This, in turn, increases the average number of people per vehicle on the roadway or travel corridor.

Preserve the Person-Movement Capacity of the Roadway — Opportunities to expand the vehicular capacity of freeways are limited in many areas. HOV lanes, when implemented in appropriate corridors and operated properly, can help ensure future capacity is available to serve anticipated growth in person travel. An HOV lane, which can move two to five times as many persons as a general-purpose lane, may effectively double the capacity of the roadway to move people. In addition, the vehicle occupancy levels required to use an HOV lane can be raised as needed in response to congestion on the facility. This helps ensure that the HOV lane continues to offer the high speeds and reliable trip times that are essential to HOV facility success.

Enhance Bus Transit Operations — HOV lanes offer a number of advantages to transit operators. Travel times, schedule adherence, and vehicle and labor productivity all can improve. HOV lanes may offer a safer operating environment for buses. All of these factors help in attracting new bus riders and in enhancing the operations of the service.

High-occupancy vehicle facilities have most commonly been used in roadway corridors that are either at, or near, capacity, and where the physical and/or financial feasibility of expanding the roadway is limited. When properly planned and implemented, HOV facilities can offer a number of advantages. However, HOV facilities are not appropriate in all situations, nor does their implementation eliminate the need to also pursue other complementary strategies. The potential use of HOV facilities should be examined thoroughly before any such improvements are made. Some of the advantages of high-occupancy vehicle projects that should be considered in the planning process include the following.

Costs — While actual implementation costs depend on the type of facility and the site, when compared to other fixed-guideway transit alternatives or the addition of multiple general- purpose lanes, HOV priority treatments often represent the low end of the cost scale. This is especially true when the HOV treatment is developed within existing freeway rights-of-way.

Implementation Time — HOV facilities can be planned and implemented within reasonably short time periods. While the exact timing depends on the type of facility and site, major HOV lanes have been planned designed and constructed within a three- to eight-year time period.

Staged Implementation — HOV facilities allow for the staging of construction, and can often be opened for use as the individual segments of the overall project are completed.

Lower Risk — Compared to other fixed transit improvements, HOV facilities may represent a lower risk option. Should the HOV lane not be sufficiently utilized, it may be converted to other uses, such as mixed-flow operation or emergency shoulders.

Multi-Agency Funding — HOV facilities are often eligible for funding from a variety of sources. Federal highway and transit funds can be used for HOV projects, and state and local transportation funds have often been used.

Multiple User Groups — Most HOV facilities are used by not only transit vehicles but also by carpools and vanpools. Thus, multiple user groups have access to the facility, providing a wider base of support. Also, carpools are served at low marginal costs and can offer an effective means of serving suburban travel patterns that are sometimes difficult to serve with conventional transit.

Operating Speeds — Bus services on HOV lanes are usually express or limited-express. As a result, the line-haul speeds are usually high, with many operating at or above 50 miles per hour.

Flexibility — Buses, carpools, and vanpools can use the existing street system for the collection and distribution portions of the trip. This can provide a good deal of flexibility in service orientation, especially in matching service needs to changing demands. Park-and-ride lots and other support facilities need not always be located directly adjacent to the HOV lane, allowing for the ability to utilize less expensive land remote from the facility.

Time Adjustable Operation — Some priority facilities operate only in the peak periods and are used for other purposes at other times. In addition, the occupancy requirements on the facility may be different during different times of the day. This provides for the ability to increase the person carrying capacity of the facility in the future without needing to expand the vehicular capacity.

Even with these numerous potential advantages, it should be recognized that HOV facilities are not appropriate in all situations, and they represent only one of a number of potential transit and highway improvements. High-occupancy vehicle facilities, like other transit and highway alternatives, should be examined thoroughly during the planning stage to ensure that the planned improvements represent an effective and efficient alternative.

Types of HOV Facilities

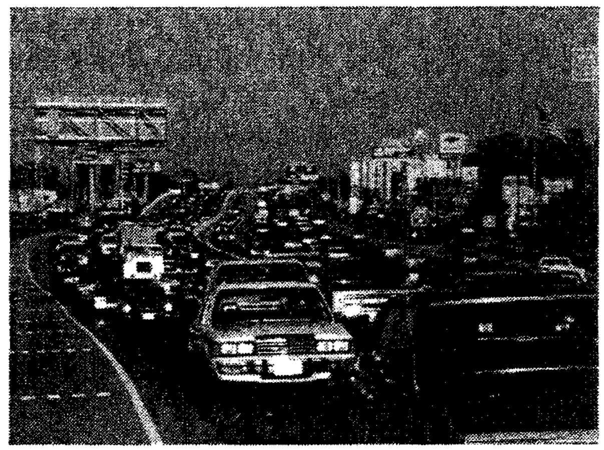
The assessment focused on HOV facilities operated either on freeways or separate rights-of-way. Other HOV priority treatments, such as arterial street HOV lanes and HOV bypass lanes at metered freeway entrance ramps, were beyond the scope of this study. High-occupancy vehicle facilities on freeways or separate rights-of-way are generally classified into the four categories described below and illustrated in Figure 2.

Exclusive HOV Facility, Separate Right-of-Way — This type of HOV facility is a roadway or lane(s) developed in a separate right-of-way and designated for the exclusive use by high-occupancy vehicles. Most existing facilities of this type are designed for, and utilized by, buses only. Most are two-lane, two-direction facilities. Examples of this type of HOV treatment are the South and East Busways in Pittsburgh and the transitway system in Ottawa, Ontario Canada.

Exclusive HOV Facility, Freeway Right-of-Way — This type of HOV facility is a lane(s) constructed within the freeway right-of-way that is physically separated from the general purpose freeway lanes and used exclusively by HOVs for all, or a portion of, the day. Most exclusive HOV facilities are physically separated from the general purpose freeway lanes through the use of concrete barriers. However, a few exclusive facilities are separated from the general purpose lanes by a wide painted buffer. Exclusive HOV facilities in freeway rights-of-way are usually open to all types of HOVs—buses, vanpools, and carpools. Examples of exclusive barrier-separated HOV facilities include the Houston HOV lanes and the Shirley Highway HOV lanes in the Washington, D.C./Northern Virginia area. The I-84 HOV lanes in Hartford provide an example of the use of a 15-foot painted buffer to separate the exclusive HOV and general-purpose traffic lanes.

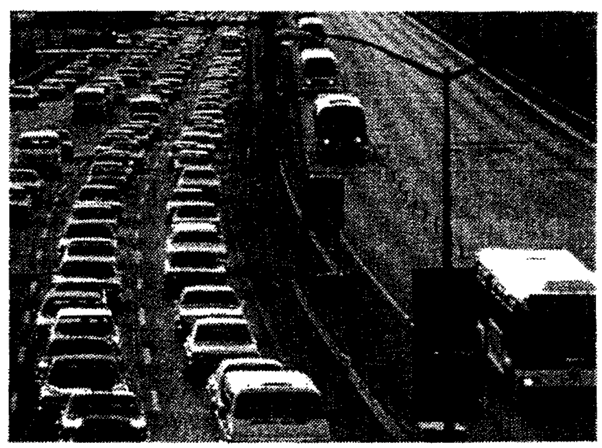
Concurrent Flow Lane — Concurrent flow HOV lanes are defined as a freeway lane in the same direction of travel, not physically separated from the general-purpose traffic lanes, designated for the exclusive use by HOVs for all or a portion of the day. Concurrent flow lanes are usually, although not always, located on the inside lane or shoulder. Paint striping is a common means used to delineate these lanes. HOV facilities of this type are usually open to buses, vanpools, and carpools. Examples of concurrent flow lanes are SR 520, I-5, and I-405 in Seattle, Route 55 in Orange County, California, and Route 101 in San Jose, California.

Exclusive HOV Facility on Separate Right-of-Way, Ottawa Transitway, Canada



Exclusive HOV Facility in Freeway Right-of-Way, Katy Freeway, Houston, Texas

Concurrent Flow Lane, I-5, Seattle, Washington



Contraflow Lane, Gowanus Expressway, New York City

Figure 2. Examples of HOV Facilities

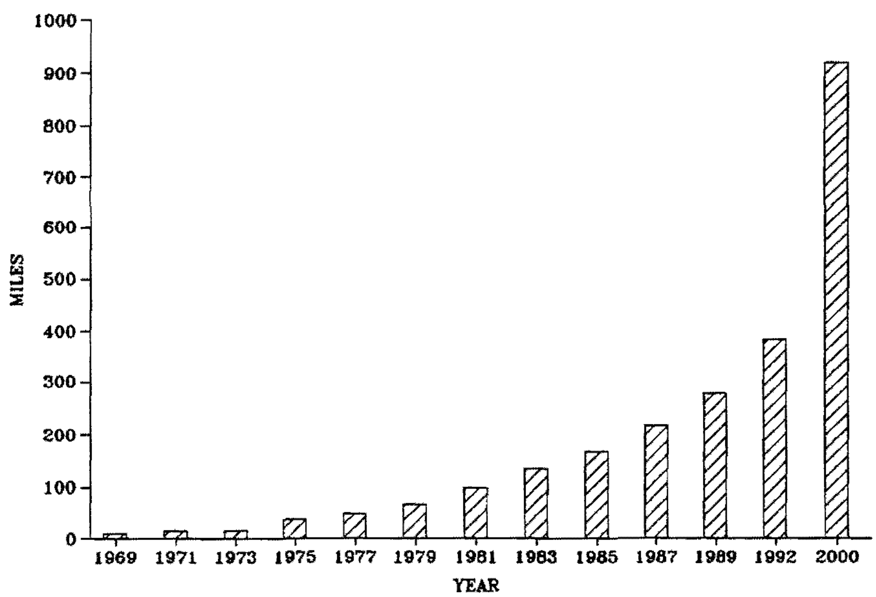
Contraflow Lane — This type of HOV facility is a freeway lane in the off-peak direction of travel, typically the innermost lane, designated for exclusive use by HOVs traveling in the peak direction. The lane is separated from the off-peak direction general-purpose travel lanes by some type of changeable treatment, such as plastic posts or pylons that can be inserted into holes drilled in the pavement. Contraflow lanes are usually operated during the peak periods only, and some operate only during the morning peak period and then revert back to normal use in non-peak periods. Several examples of this type of facility are located in the New York City area, including the eastbound approach to the Lincoln Tunnel, and portions of the Long Island and Gowanus Expressways. In the Dallas area, the East R.L. Thornton (I-30 East) contraflow lane represents the first application of the moveable concrete barrier technology with an HOV facility.

Status of HOV Projects in North America

Currently in North America, some 49 HOV projects are in operation on freeways or in separate rights-of-way in 22 metropolitan areas. Those areas are indicated on the map in Figure 3. The existing projects encompass approximately 378 centerline miles of HOV lanes. As illustrated in Figure 4, this represents a steady growth since the opening of the exclusive bus lane demonstration project on the Shirley Highway (I-395) in the Washington D.C. metropolitan area in 1969. Extensions to existing projects and new facilities are being planned, designed, and implemented in many areas. If the projects under construction and those programmed for implementation are built, approximately 540 additional miles of HOV lanes will be in operation by the year 2000. Areas with new projects underway are identified in Figure 3 as well. Completion of these projects will result in a total of approximately miles of HOV lanes in operation by the turn of the century.

Tables 1, 2, and 3 provide a summary of the general characteristics associated with the different HOV lanes and current use levels of those lanes. These tables provide an indication of the variety of operating scenarios associated with the different facilities and the experience with their use.

Figure 3. HOV Facilities in North America



Note: Data shown are for continously operating HOV lanes located either on freeways or in separate rights-of-way. Mileage is not shown for HOV lanes that have been discontinued. Miles for the year 2000 represent projects expected to open by that date. Projects in the planning stage are not included.

Figure 4. Growth in the Total Miles of Operating HOV Lanes

Table 1. General Characteristics of Operating HOV Facilities

facility	number of lanes	length (miles)	year implemented	hours of operation	separation from general purpose lanes	daily set-up required?[1]
Exclusive Lanes, Separate R.O.W.						
Minneapolis-St. Paul, Minnesota U of M Intercampus Busway[2]	1 (each direction)	1.8	1992	24 hours	separate R.O.W.	no
Ottawa, Ontario, Canada Ottawa Transitway	1 (each direction)	15.4	1982-1989	24 hours	separate R.O.W.	no
Pittsburgh, Pennsylvania South PatWay	1 (each direction)	4.1	1977	24 hours	separate R.O.W.[3]	no
East PatWay	1 (each direction)	6.2	1983	24 hours	separate R.O.W.	no
Exclusive Lanes, Freeway R.O.W.						
Hartford, Connecticut I-84[4]	1 (each direction)	10.0	1989	24 hours	15'-17' painted buffer	no
Houston, Texas I-45N (North)[5]	1 (reversible)	13.5	1979-1990[6]	5:45 am - 8:45 am 3:30 pm - 7:00 pm	concrete barriers	yes
I-45S (Gulf)[7]	1 (reversible)	6.5	1988	4:00 am - 1:00 pm 2:00 pm - 10:00 pm	concrete barriers	yes
I-10W (Katy)	1 (reversible)	13	1984-1990	4:00 am - 1:00 pm 2:00 pm - 10:00 pm	concrete barriers	yes
US 290 (Northwest)	1[8] (reversible)	13.5	1988	4:00 am - 1:00 pm 2:00 pm - 10:00 pm	concrete barriers	yes
Los Angeles Area I-10 (San Bernardino Freeway)	1 (each direction)	12	1973 & 1989	24 hours	barriers and striping[9]	no
Minneapolis, Minnesota I-394[10]	2 (reversible)	3.4	interim 1985 permanent 1991	6:00 am - 10:00 am 2:00 pm - 8:00 pm	concrete barriers	yes
Norfolk, Virginia I-64	2 (reversible)	8	1992	5:00 am - 8:30 am 3:00 pm - 6:00 pm	concrete barriers	yes
Pittsburgh, Pennsylvania I-279	2[11] (reversible)	4.1	1989	5:00 am - noon 2:00 pm - 8:00 pm	concrete barriers	yes

Table 1. General Characteristics of Operating HOV Facilities (continued)

facility	number of lanes	length (miles)	year implemented	hours of operation	separation from general purpose lanes	daily set up required?[1]
San Diego, California						
I-15	2 (reversible)	8.0	1988	6:00 am - 9:00 am 3:00 pm - 6:30 pm	concrete barriers	yes
Washington, D.C./Northern Virginia						
I-395 (Shirley)	2 (reversible)	11	1969-1975	6:00 am - 9:00 am 3:30 pm - 6:00 pm	concrete barriers	yes
I-66	2 (peak direction)	9.6	1982	6:30 am - 9:00 am 4:00 pm - 6:30 pm	both freeway lanes used[12]	no
Concurrent Flow Lanes						
Denver, Colorado						
US 36 (Boulder Turnpike)	1 (eastbound only)	4.1	1986-1988	6:00 am - 9:00 am	striping	no
Honolulu, Hawaii						
Moanaloa Freeway	1 (eastbound only)	2.5	1978	6:00 am - 8:00 am	striping	no
H-1	1 (each direction)	8	1987	6:00 am - 8:00 am 3:30 pm - 6:00 pm	striping	no
Los Angeles Area						
SR 55	1 (each direction)	11	1985	24 hours	striping	no
I-405	1 (each direction)	24	1989-1990	24 hours	striping	no
SR 91 (Los Angeles Co.)	1 (eastbound only)	8	1985	24 hours	striping	no
SR 91 (Riverside Co.)	1 (each direction)	8	-	-	-	-
SR 57	1 (each direction)	10	1992	24 hours	striping	no
I-5	1 (each direction)	10	1992	24 hours	striping	no
Miami, Florida						
I-95	1 (each direction)	11.4	1976-1990	7:00 am - 9:00 am 4:00 pm - 6:00 pm	striping	no
SR 112	1 (each direction)	1.2	1991	7:00 am - 9:00 am 4:00 pm - 6:00 pm	striping	no
Minneapolis, Minnesota						
I-394	1 (each direction)	7.6	1991	6:00 am - 9:00 am 3:00 pm - 6:00 pm	striping	no
New Jersey/New York City						
I-95 (George Washington Bridge)	1 (eastbound only)	1.0	1986	7:00 am - 9:00 am	striping	no

Table 1. General Characteristics of Operating HOV Facilities (continued)

facility	number of lanes	length (miles)	year implemented	hours of operation	separation from general purpose lanes	daily set up required?[1]
Norfolk, Virginia						
SR 44	1 (each direction)	3.3	1992	5:00 am - 8:30 am 3:00 pm - 6:00 pm	striping	no
I-564	1 (eastbound only)	2	1992	3:00 pm - 6:00 pm	striping	no
Orlando, Florida						
I-4	1 (each direction)	30.0	1980	7:00 am - 9:00 am 4:00 pm - 6:00 pm	striping	no
Phoenix, Arizona						
I-10	1 (each direction)	17.0	1987-1990	24 hours	4' painted buffer	no
San Francisco Bay Area						
I-280[13]	1 (each direction)	1.6	1975	24 hours	striping	no
I-80 (Bay Bridge)	4 (westbound only)	2.3	1970	5:00 am - 10:00 am 3:00 pm - 6:00 pm	pylons	no
US 101 (Marin Co.)[14]	1 (each direction)	7.0	1974, 1986-1987	6:30 am - 8:30 am 4:30 pm - 7:00 pm	striping	no
Montague Expressway[15]	1 (peak direction)	5.0	1982, 1984, 1988	6:00 am - 9:00 am 3:00 pm - 7:00 pm	striping	no
US 101 (Santa Clara Co.)	1 (each direction)	12 SB; 11 NB	1986 & 1988	5:00 am - 9:00 am 3:00 pm - 7:00 pm	striping	no
San Tomas Expressway[16]	1 (peak direction)	6.5	1982 & 1984	6:00 am - 9:00 am 3:00 pm - 7:00 pm	striping	no
SR 237[17]	1 (peak direction)	4	1984	5:00 am - 9:00 am 3:00 pm - 7:00 pm	striping	yes
Seattle, Washington						
I-90[18]	1 (westbound only)	4.6	1989	24 hours	striping	no
SR 520[19]	1 (westbound only)	2.3	1973	24 hours	striping	no
I-5 North	1 (each direction)	6.2 NB; 7.7 SB	1983	24 hours	striping	no
I-405 Renton to I-90	1 (each direction)	5.7 NB; 5.3 SB	1986	24 hours	striping	no
I-405 Tukwila	1 (each direction)	5.9	1990	24 hours	striping	no
I-5 South	1 (each direction)	5.6 NB; 5.4 SB	1991	24 hours	striping	no
Vancouver, B.C., Canada						
H-99	1 (each direction)	4 SB; 1 NB	1980	24 hours	striping	no
Washington, D.C./Northern Virginia						
I-95	1 (each direction)	6.8	1985-1986	6:00 am - 9:00 am 3:30 pm - 6:00 pm	striping	no

Table 1. General Characteristics of Operating HOV Facilities (continued)

facility	number of lanes	length (miles)	year implemented	hours of operation	separation from general purpose lanes	daily set up required?[1]
Contraflow Lanes						
Dallas, Texas						
I-30E (East R.L. Thornton Fwy.)	1 (each direction)	5.2 WB 3.3 EB	1991	6:00 am - 9:00 am 4:00 pm - 7:00 pm	moveable concrete barrier	yes
Montreal, Quebec, Canada						
Champlain Bridge	1 (each direction)	4.3	1978	6:30 - 9:30 am 3:30 - 7:00 pm	cones	yes
New Jersey/New York City						
SR 495 (Lincoln Tunnel)	1 (inbound only)	2.8	1970	6:30 am - 10:00 am[20]	drop-in cones	yes
Long Island Expressway	1 (inbound only)	4	1971	7:00 am - 10:00 am	drop-in cones	yes
Gowanus Expressway	1 (inbound only)	2	1980	7:00 am - 9:30 am	drop-in cones	yes

[1]Daily set-up refers to any manual or electronic operation needed to open or close the facility.
[2]Approximately one-half of the University of Minnesota Intercampus Busway was opened in 1992. The remaining half will be opened in the summer of 1993.
[3]A portion of the South PatWay includes a shared right-of-way with a light rail transit line.
[4]The I-84 HOV lane is listed as an exclusive HOV facility. It is separated from the mixed traffic lanes by a 15-17 foot painted buffer.
[5]The final 5.6 mile segment of the I-45 North HOV lane is scheduled to open in two phases; 2.9 miles in 1994 and 2.7 miles in 1997.
[6]Between 1979 and 1984 a contraflow lane was operated on I-45N. The current exclusive facility was opened in 1985.
[7]An additional nine miles of the Gulf Transitway are scheduled to open in three phases by 1993.
[8]Approximately two miles of two-lane, two-direction HOV lanes are in operation on the Northwest Transitway at the connection to the Northwest Transit Center.
[9]The San Bernardino Freeway Busway includes five miles of barrier separated lanes and seven miles with a 13 foot painted buffer.
[10]The I-394 HOV facility includes a combination of reversible barrier separated HOV lanes and concurrent flow diamond lanes.
[11]The two-lane I-279 HOV facility splits into two short, one-lane segments at the southern end. One serves Three Rivers Stadium and the other serves downtown.
[12]I-66 is a four-lane freeway, with two lanes in each direction. During the morning and afternoon peak periods, the lanes in the peak direction are restricted to HOVs.
[13]The I-280 HOV lanes have not been in operation since the October 1989 earthquake in the San Francisco Bay Area.
[14]The HOV lanes on US 101 in Marin County include two segments, three miles and four miles in length, separated by approximately one mile of mixed traffic lanes.
[15]The HOV lanes on the Montague Expressway operate only in the peak direction. The Montague Expressway is a signalized expressway.
[16]The San Tomas Expressway HOV lanes operate only in the peak direction. The San Tomas Expressway is a signalized expressway.
[17]The SR 237 HOV lanes operate only in the peak direction. The section of SR 237 where the HOV lanes are located is a signalized expressway.
[18]The I-90 HOV lane included in this survey is an interim facility.
[19]The SR 520 HOV lane is located on the outside shoulder and operates only in the westbound direction.
[20]The exact closing time for the SR 495 contraflow lane varies. It may be closed earlier or later than 10:00 a.m., depending the demand level.

Table 2. Vehicles Allowed to Use HOV Facilities

facility	transit buses	school buses	private buses	vanpools	carpools	taxis	police	emergency	other vehicles[1]	carpool occupancy[2]
Exclusive Lanes, Separate R.O.W.										
Minneapolis-St. Paul, Minnesota										
U of M Intercampus Busway	●								bicycles	
Ottawa, Ontario, Canada										
Ottawa Transitway	●		●				●	●		
Pittsburgh, Pennsylvania										
South PatWay	●						●	●	light rail vehicles[3]	
East PatWay	●						●	●		
Exclusive Lanes, Freeway R.O.W.										
Hartford, Connecticut										
I-84	●	●	●	●	●	●	●	●		3+
Houston, Texas										
I-45N (North)	●	●	●	●	●	●	●	●		2+
I-45S (Gulf)	●	●	●	●	●	●	●	●		2+
I-10W (Katy)	●	●	●	●	●	●	●	●		2+/3+[4]
US 290 (Northwest)	●	●	●	●	●	●	●	●		2+
Los Angeles Area										
I-10 (San Bernardino Freeway)	●	●	●	●	●	●	●	●		3+
Minneapolis, Minnesota										
I-394	●	●	●	●	●	●	●	●		2+
Norfolk, Virginia										
I-64	●	●	●	●	●	●	●	●	utility vehicles[5]	2+
Pittsburgh, Pennsylvania										
I-279	●	●	●	●	●	●	●	●	highway dept. cars	2+[6]
San Diego, California										
I-15	●	●	●	●	●	●	●	●		2+
Washington, D.C./Northern Virginia										
I-395 (Shirley)	●	●	●	●	●	●	●	●		3+
I-66	●	●	●	●	●	●	●	●	Dulles Airport traffic[7]	3+

Table 2. Vehicles Allowed to Use HOV Facilities (continued)

facility	transit buses	school buses	private buses	vanpools	carpools	taxis	police	emergency	other vehicles[1]	carpool occupancy[2]
Concurrent Flow Lanes										
Denver, Colorado										
US 36 (Boulder Turnpike)	•									
Honolulu, Hawaii										
Moanaloa Freeway	•	•	•	•	•	•	•	•		2+
H-1	•	•	•	•	•	•	•	•		2+
Los Angeles Area										
SR 55	•		•	•	•	•	•	•		2+
I-405	•		•	•	•	•	•	•		2+
SR 91 (Los Angeles Co.)	•		•	•	•	•	•	•		2+
SR 91 (Riverside Co.)	•		•	•	•	•	•	•		2+
SR 57	•		•	•	•	•	•	•		2+
I-5	•		•	•	•	•	•	•		2+
Miami, Florida										
I-95	•	•	•	•	•	•	•	•		2+
SR 112	•	•	•	•	•	•	•	•		2+
Minneapolis, Minnesota										
I-394	•	•	•	•	•	•	•	•		2+
New Jersey/New York City										
I-95 (George Washington Bridge)	•	•	•	•	•	•	•	•	any 3+ vehicle	3+
Norfolk, Virginia										
SR 44	•	•	•	•	•	•	•	•	utility vehicles[5]	2+
I-564	•	•	•	•	•	•	•	•	utility vehicles[5]	2+
Orlando, Florida										
I-4	•	•	•	•	•	•	•	•		2+
Phoenix, Arizona										
I-10	•	•	•	•	•					2+
San Francisco Bay Area										
I-280	•	•	•	•	•	•	•	•		3+
I-80 (Bay Bridge)	•	•	•	•	•	•	•	•		3+
US 101 (Marin Co.)	•	•	•	•	•	•	•			2+[8]
Montague Expressway	•	•	•	•	•	•	•	•		2+
US 101 (Santa Clara Co.)	•	•	•	•	•	•	•	•		2+
San Tomas Expressway	•	•	•	•	•	•	•	•		2+
SR 237	•	•	•	•	•	•	•	•		2+

Table 2. Vehicles Allowed to Use HOV Facilities (continued)

facility	transit buses	school buses	private buses	vanpools	carpools	taxis	police	emergency	other vehicles[1]	carpool occupancy[2]
Seattle, Washington										
I-90	•	•	•	•	•	•	•	•		3+
SR 520	•	•	•	•	•	•	•	•		3+
I-5 North	•	•	•	•	•	•	•	•		2+[9]
I-405 Renton to I-90	•	•	•	•	•	•	•	•		2+
I-405 Tukwila	•	•	•	•	•	•	•	•		2+
I-5 South	•	•	•	•	•	•	•	•		3+
Vancouver, B.C., Canada										
H-99	•	•	•				•	•		
Washington, D.C./Northern Virginia										
I-95	•	•	•	•	•	•	•	•		3+
Contraflow Lanes										
Dallas, Texas										
I-30E (East R.L. Thornton Fwy.)	•	•	•	•		•				2+
Montreal, Quebec, Canada										
Champlain Bridge	•									
New Jersey/New York City										
SR 495 (Lincoln Tunnel)	•		•							
Long Island Expressway	•	•	•	•		•		•		
Gowanus Expressway	•	•	•	•		•		•		

[1]The ISTEA allows motorcycles on HOV facilities unless local officials are able to demonstrate that the presence of motorcycles on the facility would create a safety hazard.
[2]Unless noted, taxis must meet the occupancy requirements to use the HOV facility, while police, emergency vehicles and motorcycles do not.
[3]A portion of the South PatWay includes a shared right-of-way with a light rail transit line.
[4]The occupancy requirement on the Katy Transitway is 3+ during the morning peak period from 6:45 am to 8:15 am. A 2+ occupancy requirement is used during other times.
[5]When responding to emergencies, utility company vehicles are permitted to use some Virginia HOV lanes.
[6]The occupancy requirement on the I-279 HOV lanes was lowered from 3+ to 2+ in September 1992 as part of a demonstration project.
[7]I-66 traffic to and from Dulles Airport is not subject to the HOV restrictions.
[8]Prior to September 1989, the vehicle occupancy requirement on US 101 was 3+. At that time, the restriction was changed to 2+ for a demonstration project.
[9]The occupancy requirement on the I-5 North HOV lanes was lowered from 3+ to 2+ in August 1991 as part of a demonstration project.

Table 3. Morning Peak-Direction Utilization of HOV Facilities

facility	number of directional lanes		peak hour HOV facility				peak hour non-HOV		peak period HOV facility				peak period non-HOV		peak period length (hours)
			bus		van & carpool				bus		van & carpool				
	HOV	freeway	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	
Exclusive Lanes, Separate R.O.W.															
Minneapolis-St. Paul, Minnesota															
U of M Intercampus Busway	1	0	30	1,350	-	-	-	-	-	-	-	-	-	-	-
Ottawa, Ontario, Canada															
Ottawa Transitway	1	0	180	11,000	-	-	-	-	495	29,000	-	-	-	-	3
Pittsburgh, Pennsylvania															
South PatWay	1	0	51	2,098	-	-	-	-	83	3,682	-	-	-	-	2
East PatWay	1	0	103	5,892	-	-	-	-	145	9,065	-	-	-	-	2
Exclusive Lanes, Freeway R.O.W.															
Hartford, Connecticut															
I-84	1	4	20	940	119	604	-	-	35	1,050	259	1,367	-	-	3
Houston, Texas															
I-45N (North)	1	4	66	2,770	994	2,311	6,348	6,966	145	5,340	1,912	4,478	19,427	20,983	3.5
I-45S (Gulf)	1	4	30	1,030	683	1,491	3,918	4,564	61	1,960	1,061	2,314	12,843	14,744	3.5
I-10W (Katy)	1	3	72	2,720	785	2,095	5,122	6,187	142	4,415	2,458	5,647	16,424	18,786	3.5
US 290 (Northwest)	1	3	23	940	1,396	3,772	5,130	5,307	39	1,580	2,188	4,537	17,576	19,678	3.5
Los Angeles Area															
I-10 (San Bernardino Freeway)	1	4	71	2,750	1,374	4,352	8,375	9,548	132	5,110	2,516	8,075	16,515	19,295	2
Minneapolis, Minnesota															
I-394	2	2	53	1,532	1,138	2,344	4,640	4,918	83	1,990	2,076	4,106	12,824	13,593	3
Norfolk, Virginia															
I-64	2	3	-	-	930	2,130	5,400	6,426	-	-	2,480	5,680	15,200	18,088	3
Pittsburgh, Pennsylvania															
I-279	1	2	23	1,050	845	1,527	4,361	5,001	-	-	-	-	-	-	-
San Diego, California															
I-15	2	4	14	350	1,259	2,686	2,818	-	23	575	2,782	5,961	28,690	-	3
Washington, D.C./Northern Virginia[1]															
I-395 (Shirley)	2	4	200	7,130	2,573	11,276	8,678	10,103	435	15,415	5,112	21,941	24,525	29,076	3
I-66	2	0	6	146	512	2,124	-	-	41	846	869	3,514	-	-	2.5

Table 3. Morning Peak-Direction Utilization of HOV Facilities (continued)

facility	number of directional lanes		peak hour HOV facility				peak hour non-HOV		peak period HOV facility				peak period non-HOV		peak period length (hours)
			bus		van & carpool				bus		van & carpool				
	HOV	freeway	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	
Concurrent Flow Lanes															
Denver, Colorado															
US 36 (Boulder Turnpike)	1	2	28	1,000	-	-	-	-	55	1,900	-	-	-	-	3
Honolulu, Hawaii															
Moanaloa Freeway	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
H-1	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-
Los Angeles Area															
SR 55	1	3	3	50	1,295	2,687	5,284	5,665	5	70	2,371	4,977	10,009	10,691	2
I-405	1	4	4	120	1,625	3,705	8,322	9,154	7	160	3,173	7,171	16,384	18,002	2
SR 91 (Los Angeles Co.)	1	4	0	0	1,294	3,112	10,478	11,212	3	120	2,153	5,186	20,360	21,785	2
SR 91 (Riverside Co.)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SR 57	1	4	0	0	1,100	2,400	-	-	-	-	-	-	-	-	-
I-5	1	5	0	0	500	1,200	-	-	-	-	-	-	-	-	-
Miami, Florida															
I-95	1	3-4	15	610	-	-	-	-	-	-	-	-	-	-	-
SR 112	1	3	1	10	-	-	-	-	-	-	-	-	-	-	-
Minneapolis, Minnesota															
I-394	1	2	49	1,415	1,051	2,165	2,167	2,297	-	-	-	-	-	-	-
New Jersey/New York City															
I-95 (George Washington Bridge)[2]	1	5	36	1,800	253	919	7,100	9,798	70	3,500	429	1,499	12,700	17,018	2
Norfolk, Virginia															
SR 44	1	4	-	-	800	1,520	5,300	6,410	-	-	2,070	3,930	13,980	16,910	3
I-564	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
Orlando, Florida															
I-4	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Phoenix, Arizona															
I-10	1	3	-	-	-	-	1,332	-	-	-	-	-	-	-	-
San Francisco Bay Area															
I-280	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
I-80 (Bay Bridge)	4	5	101	3,535	2,325	8,273	-	-	252	8,820	5,553	20,012	-	-	5
US 101 (Marin Co.)	1	3	57	1,995	678	1,490	4,952	6,274	96	3,360	1,284	2,840	11,888	14,645	2.5
Montague Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
US 101 (Santa Clara Co.)	1	3	3	105	376	803	4,921	5,433	4	140	831	3,108	13,280	-	3
San Tomas Expressway	1	2	-	-	-	-	-	-	-	-	-	-	-	-	3
SR 237	1	2	18	630	754	1,720	3,204	3,222	36	1,260	2,010	4,605	8,920	8,963	3

Table 3. Morning Peak-Direction Utilization of HOV Facilities (continued)

facility	number of directional lanes		peak hour HOV facility				peak hour non-HOV		peak period HOV facility				peak period non-HOV		peak period length (hours)
			bus		van & carpool				bus		van & carpool				
	HOV	freeway	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	veh.	pass.	
Seattle, Washington															
I-90	1	3	34	1,250	200	660	6,070	6,798	89	2,890	270	607	13,547	15,053	3
SR 520	1	2	56	3,140	210	498	2,766	3,043	92	3,690	393	1,191	6,252	6,877	2
I-5 North	1	4	64	2,605	1,169	3,039	7,691	9,476	146	5,810	2,622	6,429	20,721	25,350	3
I-405 Renton to I-90	1	2	20	600	1,200	3,960	1,960	1,999	-	-	-	-	-	-	-
I-405 Tukwila	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
I-5 South	1	4	28	1,176	400	1,320	6,337	-	-	-	1,050	3,465	22,805	-	4
Vancouver, B.C., Canada															
H-99	1	2	27	1,080	-	-	-	-	45	1,800	-	-	-	-	2
Washington, D.C./Northern Virginia															
I-95	1	3	40	1,300	1,062	5,127	3,217	3,666	83	2,778	1,996	9,966	9,488	10,741	3
Contraflow Lanes															
Dallas, Texas															
I-30E (East R.L. Thornton Fwy.)	1	4	55	1,500	1,300	2,800	7,000	7,600	110	2,900	2,500	5,200	20,000	22,000	3
Montreal, Quebec, Canada															
Champlain Bridge	1	3	91	5,300	-	-	-	-	208	10,049	-	-	-	-	3
New Jersey/New York City															
SR 495 (Lincoln Tunnel)	1	3	725	34,685	-	-	4,475	7,380	1,640	65,600	-	-	17,435	29,120	4
Long Island Expressway	1	3	165	7,838	214	394	-	-	366	17,385	428	761	-	-	3
Gowanus Expressway	1	4	202	8,686	173	899	3,794	7,569	409	14,724	399	1,907	10,720	20,818	2.5

[1]Legal vehicles only. Does not include violators.
[2]No updated information provided. Data are from the 1988 ITE report, *The Effectiveness of High-Occupancy Vehicle Facilities*, Table 6.

Based on the information provided in Tables 1, 2, and 3, the following observations have been made about the major characteristics of the different HOV lane projects in North America.

Types of HOV Lanes — Concurrent flow HOV lanes represent the most common application of the HOV technique. Currently, 30 concurrent flow HOV lanes are in operation in North America. Exclusive HOV lanes in freeway rights-of-way, which include 12 projects, represent the second most common application. Finally, four contraflow HOV lanes and three exclusive HOV facilities in separate rights-of-way are currently in operation.

Hours of Operation — The operating hours of HOV facilities can be characterized by three different scenarios: 24-hour operation; morning and afternoon/evening operation; and peak-period only operation. No one specific operating scenario necessarily equates to a certain type of facility. However, the exclusive facilities on separate rights-of-way in Pittsburgh and Ottawa operate on a 24-hour basis, and three of the four contraflow lanes operate only in the inbound direction in the morning peak period. The other contraflow lane, on the East R.L. Thornton Freeway in Dallas, operates in both the morning and afternoon peak periods. Operating hours for the exclusive and concurrent flow lanes vary. In two urban areas, Seattle and Los Angeles/Orange County, the HOV lanes are operated on a 24-hour basis. In other areas, the HOV lanes open in the morning and operate inbound until midday. After a period for reversing the operation, during which the lanes are usually closed for an hour, the facility is open in the outbound direction until the evening. Operation during only the peak periods is characteristic of most of the concurrent flow lanes, except those in Seattle and Los Angeles/Orange County. The exact time these facilities operate with HOV restriction varies. Most operate from approximately 6 a.m. to 9 a.m. in the morning and 3 p.m. to 6 or 7 p.m. in the evening.

Vehicles Allowed to Use the HOV Lanes — The types of vehicles allowed to use the different HOV facilities are fairly similar. The Ottawa transitway system, the two Pittsburgh busways, the US 36 bus lane in Denver, the HOV lanes on Highway 99 in Vancouver, British Columbia, and the contraflow lane on Route 495 approaching the Lincoln Tunnel in the New York City area are open to buses only. The contraflow HOV lanes on the Long Island and Gowanus Expressways allow buses and vanpools. The remainder of the facilities are open to buses, vanpools, and carpools. Most facilities also allow use by taxis meeting the occupancy requirements, and allow police and emergency vehicles to use the lanes without meeting the occupancy requirements.

Vehicle Occupancy Requirements — The carpool occupancy requirements for existing HOV facilities vary between 2+ and 3+ persons per vehicle. No facilities currently use a 4+ requirement, although for many years the Shirley Highway HOV lanes had that designation. Sixteen HOV lanes utilize a 3+ requirement, while 16 also have a 2+ requirement. Some areas with multiple HOV facilities, such as Santa Clara County, use the same occupancy requirements on all HOV lanes. Other areas, such as Seattle and Los Angeles, have different requirements on different facilities. The Katy Transitway in Houston is the only HOV facility with variable occupancy requirements. A 2+ requirement is utilized during all operating periods except during the morning and afternoon peak hours, when a 3+ requirement is in effect. A variable occupancy requirement, which would utilize a 3+ occupancy level in the afternoon peak hour in the outbound direction, is currently being considered for the I-5 North HOV lane in Seattle.

Bus Services Operated with HOV Lanes

The orientation and the number of buses utilizing the different HOV lanes varies. Some, such as the Ottawa transitway system and the Pittsburgh busways, are bus-only facilities. Others, such as Route 55 in Orange County, serve primarily carpools. The majority of HOV projects fall in between the two extremes, with buses comprising an important component of the overall mix of vehicles. Figures 5 and 6 provide an indication of both the total number of passengers and the number of buses using different HOV lanes during the morning peak hour.

The orientation of bus services and the bus operating strategies also vary between the different HOV projects. The exclusive bus-only facilities in Ottawa and Pittsburgh are oriented specifically toward providing a high level of bus service. In both areas, service is provided by buses operating exclusively on the facility, similar to traditional rapid transit lines, and by buses that access the facility after collection in the local neighborhoods. These operating scenarios, which are described more fully below, indicate the flexibility in the service orientation and service level offered by exclusive HOV lanes on separate rights-of-way.

Dedicated Routes — These are routes which operate only on the busway or transitway. Routes of this nature provide service similar to an LRT or heavy rail line, with passengers walking to the stations, using connecting bus routes, or being dropped-off at stations. The East Busway All Stops (EBA) route provides an example of this type of service. This route operates exclusively on the East Busway in Pittsburgh, with four-minute headways in the peak hours.

Figure 5. Morning Peak–Hour HOV Lane Passengers

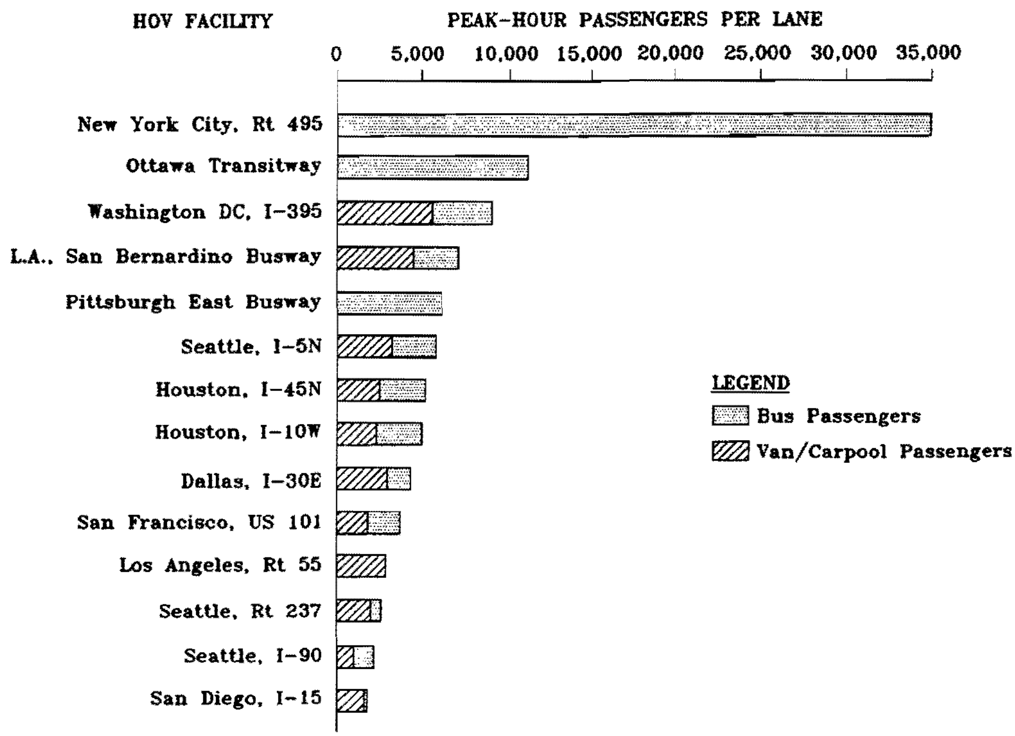
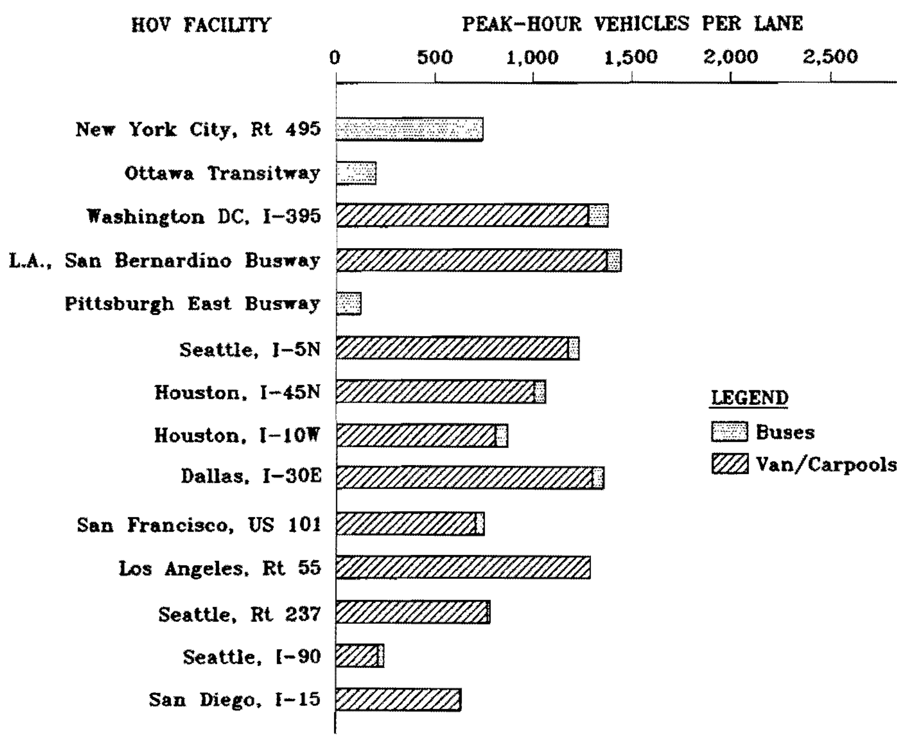


Figure 6. Morning Peak–Hour HOV Lane Vehicles



Neighborhood Oriented Service — The second type of bus service found with the bus-only facilities in Ottawa and Pittsburgh is the local neighborhood route. These routes offer local service in neighborhood areas and then access the HOV lane for the trip to the downtown area.

Bus service on most of the exclusive HOV facilities located within freeway rights-of-way is primarily express service. In most cases, the express service originates at park-and-ride lots, although some routes may provide limited local collection in neighborhood areas. In some cases, such as the Houston HOV lanes, direct access ramps are provided from some park-and-ride lots to the HOV facility. In other cases, buses access the HOV lane from the local streets and freeway. As shown in Figure 5, the actual level of bus service differs greatly between facilities. The highest levels of bus service are found on the Shirley Highway HOV lanes in Washington, D.C./Northern Virginia, the San Bernardino Freeway Busway in Los Angeles, and the I-45 North HOV lane in Houston.

Bus service on the concurrent flow HOV facilities is also oriented primarily to express service, although local service is provided in some areas. In most instances, buses access the HOV facility from either park-and-ride lots or after limited local collection. In a few cases, such as the Seattle facilities with HOV lanes located on the outside freeway lanes, bus stops may be provided along the HOV lane. Some of the concurrent flow HOV lanes, such as those on U.S. 36 (Boulder Turnpike) in Denver and H-99 in Vancouver, British Columbia, are open to buses only, allowing buses to bypass traffic queues that form due to congestion. Other concurrent flow HOV lanes, such as those in Los Angeles, Orange County, San Jose, Orlando, Miami, and Phoenix are oriented primarily to carpools, with little bus service provided.

The three contraflow HOV facilities located in the New York City area are oriented primarily to buses. Only buses are allowed on the Route 495 facility, while buses and vanpools are allowed on the Long Island and Gowanus Expressway facilities. In all three cases, the HOV lanes allow buses to bypass the traffic queues formed at major congestion points.

The implementation of many HOV lanes has had significant impacts on bus operations within the travel corridors. Increased operating speeds, decreased travel times, and improved on-time performance and schedule reliability have been experienced in many areas. These improvements in turn have resulted in increased ridership levels. For example, the opening of the East Busway in Pittsburgh reduced travel times for some trips to the downtown area by 20 minutes and reduced overall travel times by 15 to 23 percent (*1*). The Houston HOV lanes improved bus operating speeds and reduced scheduled travel times on some routes by almost half (*2*).

These improvements have been successful in attracting new bus riders to the system. In Pittsburgh, for example, approximately 11 percent of the riders on the East Busway All Stops (EBA) route and 7 percent of the riders on routes diverted to the East Busway were new riders who previously drove alone (*1*). The Houston HOV lanes have also resulted in an increase in choice bus riders or those individuals who previously drive alone. For example, between 35 and 45 percent of riders in buses using the four HOV lanes in Houston in 1989 indicated that they had previously driven alone (2).

III.

Suggested Procedures for Evaluating Operating HOV Facilities

Evaluating the impact of HOV facilities has been a topic of interest and discussion among transportation professionals in recent years. Potential evaluation criteria, appropriate effectiveness measures, evaluation methodologies, and data collection activities have been a major focus of sessions at recent Transportation Research Board Annual Meetings and national HOV conferences, as well as numerous reports. While there is general agreement among transportation professionals that HOV facilities should be evaluated, no consensus appears to exist regarding the most appropriate measures to use, the performance thresholds projects should meet to be considered effective, or the data collection techniques that should be used. Realizing this, a major activity of the assessment focused on examining the state-of-the-art practices associated with conducting before-and-after evaluations of HOV projects and the development of suggested procedures for evaluating freeway HOV projects.

This chapter provides a summary of the benefits of conducting before-and-after evaluations, a review of the experience to date with HOV project evaluations, and the objectives, evaluation measures, measurement techniques, and data collection methodologies incorporated into the suggested approach and procedures. The approach and procedures are intended to serve as a national model for application with all types of freeway HOV projects. Use of the procedures should enhance project specific before-and-after evaluations and provide a comparable data base for HOV projects.

Benefits of Conducting Before-and-After Evaluations

Multiple benefits can be realized from conducting before-and-after studies of HOV projects. Evaluations provide the ability to determine if the goals and objectives of the project have been achieved. In addition, the information obtained from the evaluation process has numerous secondary benefits. This section provides a brief summary of the reasons for conducting HOV project evaluations, and their resulting benefits.

A main reason for conducting before-and-after evaluations of HOV projects is to identify the benefits accrued from the project and to determine how well the goals and objectives identified for the facility are being met. Evaluations provide an opportunity to ascertain the degree to which the desired results are, in fact, occurring. Further, before-and-after studies provide an official data base for the project. This can help ensure that all groups are utilizing the same data and can help to clarify any possible disagreements over the impact of the project.

The results of before-and-after studies are also important in future planning efforts within the metropolitan area. The information generated can be used to calibrate planning and simulation models for future use and can be used to assist in the decision-making process in other corridors. Planning and simulation models are often used in the analysis of alternatives. Calibrating those models with before-and-after study results so that they more accurately reflect actual experience provides a valuable check on the modeling process and improves the future capabilities of the models. In addition, the results from the evaluation and the experience gained from the project can enhance the decision-making process on future projects.

The information collected as part of the evaluation process has value for operating decisions relating to the HOV facility. Information on usage, violation rates, and accidents are critical for ensuring the efficient and safe operation of the facility. Monitoring these and other aspects of the HOV lane as part of the evaluation process can identify problems that may need to be addressed. For example, changes in operating hours, vehicle occupancy requirements, bus service levels, and access/egress points may be necessary. Thus, the data provided from before-and-after studies, especially longitudinal data on the use of the facility, serves a critical operations function. This information can also be used to evaluate the marketing and public information programs associated with the facility and identify if additional marketing is needed.

Evaluations may also be needed to meet federal or state requirements. A variety of funding sources have been used to implement HOV projects. Different funding sources and programs may require before-and-after evaluations. Even when not a requirement, evaluations of HOV projects can be useful to help justify future funding for similar facilities.

Lastly, by providing information on different projects throughout the country, the results of evaluation studies can assist in establishing an ongoing national data base on HOV facilities. Building a common body of knowledge on the use and effectiveness of HOV facilities is needed to continue to keep pace with the issues facing transportation professionals and decision makers in urban areas. A common national data base on

HOV facilities can assist in ensuring that all areas are kept informed of the latest developments in the field.

It is also important to note that the results of HOV project evaluations are of interest to a variety of groups. These include transportation professionals and technical staff, decision makers, special interest groups, the general public, and federal agencies. In general, these groups can be divided into two categories; those with a technical orientation and those with a more general focus. Given the diverse nature of these two groups, it may be appropriate to use different formats and approaches to present the results of the evaluation process. As with any report, the scope, content, and level of detail should be appropriate for the audience being addressed.

Finally, it is important to ensure that the results of the evaluation are not biased intentionally or unintentionally. Thus, it is suggested that evaluations be conducted by neutral, unbiased, third parties. While it is critical that the sponsoring agencies, both transit and highway, are actively involved in conducting the study, there is much to be gained by maintaining an outside perspective during the evaluation.

Summary of Experience

Since the initial application of HOV facilities in the early 1970s, there has been a steady stream of reports and studies on the subject. Generally, those documents can be divided into three categories. First, there are reports on planning and evaluation procedures or methods for all types of transportation facilities, including HOV lanes. Then there are general reports on the use of HOV facilities, travel demand management (TDM) strategies, transportation systems management (TSM) techniques, and transit. Finally, there are studies that address specific HOV projects. The analysis conducted in the assessment focused mainly on HOV project-specific reports.

While the focus of the assessment was on before-and-after evaluations, it is important to note that the evaluation of an HOV alternative is often conducted as part of a detailed corridor planning study. As such, it may represent one of a number of alternatives under consideration. The results of such an analysis often form the basis for the before-and-after evaluation study if the HOV option is selected as the recommended alternative.

The state-of-the-art review examined a limited number of evaluations conducted on specific HOV projects. Evaluation reports from Washington, D.C./Northern Virginia, Los Angeles, Houston, Seattle, Minneapolis, Orange County, Santa Clara County, and New Jersey were examined.

Although this may not include all evaluation studies conducted of freeway HOV facilities, it does represent a sample of the types of studies, level of detail, and approaches that have been utilized with different projects. The following conclusions relating to the status of HOV project evaluation were drawn from this review.

- Formal evaluations of HOV facilities have been more extensive and comprehensive with major facilities and those with significant federal funding. Most of the HOV projects reviewed represented significant investments in major facilities. Many of these, although not all, also included federal funding for not only the facility, but at least a portion of the evaluation and data collection activities. The limited number of evaluations on other facilities appears to be due in part to the nature of these facilities, many of which were implemented as TSM activities, and the limited availability of funding for data collection and evaluation efforts.

- While formal evaluations have often been conducted during the initial demonstration stages of some projects, such as the Shirley Highway HOV lanes and the San Bernardino Freeway Busway, ongoing monitoring and evaluation efforts are less common. In this regard, the ongoing data collection and evaluation process used on the Houston HOV lanes represents the most extensive and comprehensive effort currently being conducted.

- Many HOV facilities have been implemented without clearly defining the goals and objectives of the project. This lack of a clear understanding of the purpose and goal of a project makes evaluating the effectiveness difficult, since there is no way of knowing if the goal has been reached. Compounding this problem in some cases is the use of objectives that cannot be measured.

- Many evaluations have been conducted using very general evaluation criteria. These measures may be as simple as a statement that the HOV lane should reduce travel times for bus and automobile commuters, without identifying the level of time savings that should occur. Thus, no benchmark or specific threshold is identified against which the project can be measured. If the HOV facility leads to any improvement in the general evaluation measure, the project is likely to be considered successful.

- There does not appear to be a consensus among transportation professionals on which criteria or measures should be used to evaluate HOV facilities. A variety of measures have been used with different facilities. While common elements exist, many different approaches are currently being used. Further, a consensus does not appear to exist on what levels of improvement or change are of sufficient magnitude to conclude that a project has been effective. These appear to be greatly influenced by the type of facility and local conditions and perceptions.

- Some evaluation studies focus just on the HOV lane, without considering the full range of impacts on other elements of the transportation system, such as the effect on non-users in the general purpose lanes and the operation of the total freeway facility. Thus, the full range of impacts are not always considered. It appears that there is agreement that these impacts need to be evaluated, but due to financial limitations, they are not always examined as extensively as might be desired.

- It appears that statistically valid study designs have often not been used with before-and-after studies. As a result, conclusions drawn from data may not be statistically meaningful. In addition, to maximize resources, some areas may try to organize data collection activities to serve more than one purpose. This may reduce the overall effectiveness of the data collection effort and may not provide the information needed to evaluate the HOV facility.

- Many evaluations are based on somewhat limited data that may preclude statistical analysis of the significance of any changes. In many cases, "before" data is very scarce or nonexistent. This, combined with limited samples of "after" data and little ongoing data collection, often makes meaningful comparisons difficult.

- The evaluation methodology, definition of terms, and data collection methods are often different, making comparisons between projects difficult. A close examination of the data collection methods and definition of terms utilized in the preceding evaluations identified a number of differences. For example, the definition of the length of the peak-period is often different.

- There does not appear to be a consensus among studies on the appropriate way to deal with "outside" changes that may impact the results of the HOV project. These could include such things as the rapid escalation in gasoline prices, or other changes that may impact travel in the area. To monitor these overall changes, some areas monitor and evaluate at least one freeway that does not have an HOV lane to provide a "control" facility for comparison purposes. The Houston evaluation process, which monitors not only the four freeways and HOV lanes but also two control freeways that do not currently have HOV lanes, provides one of the better approaches for identifying potential outside influences.

Obviously, not all evaluations of HOV projects suffered from all of these problems. Examples exist of good evaluation studies. However, the review indicated that improvement could be made with even the best studies, and that all projects could benefit from more standardized procedures for evaluating operating HOV facilities. In addition, to better understand the role HOV projects can play in helping to relieve congestion in metropolitan areas and to advance the state-of-the-art use of evaluation procedures, comparability of data between different projects is highly desirable. Based on the results of this review and input from the national peer group, the procedures outlined in the next section were developed.

Suggested Approach for Evaluating Operating HOV Projects

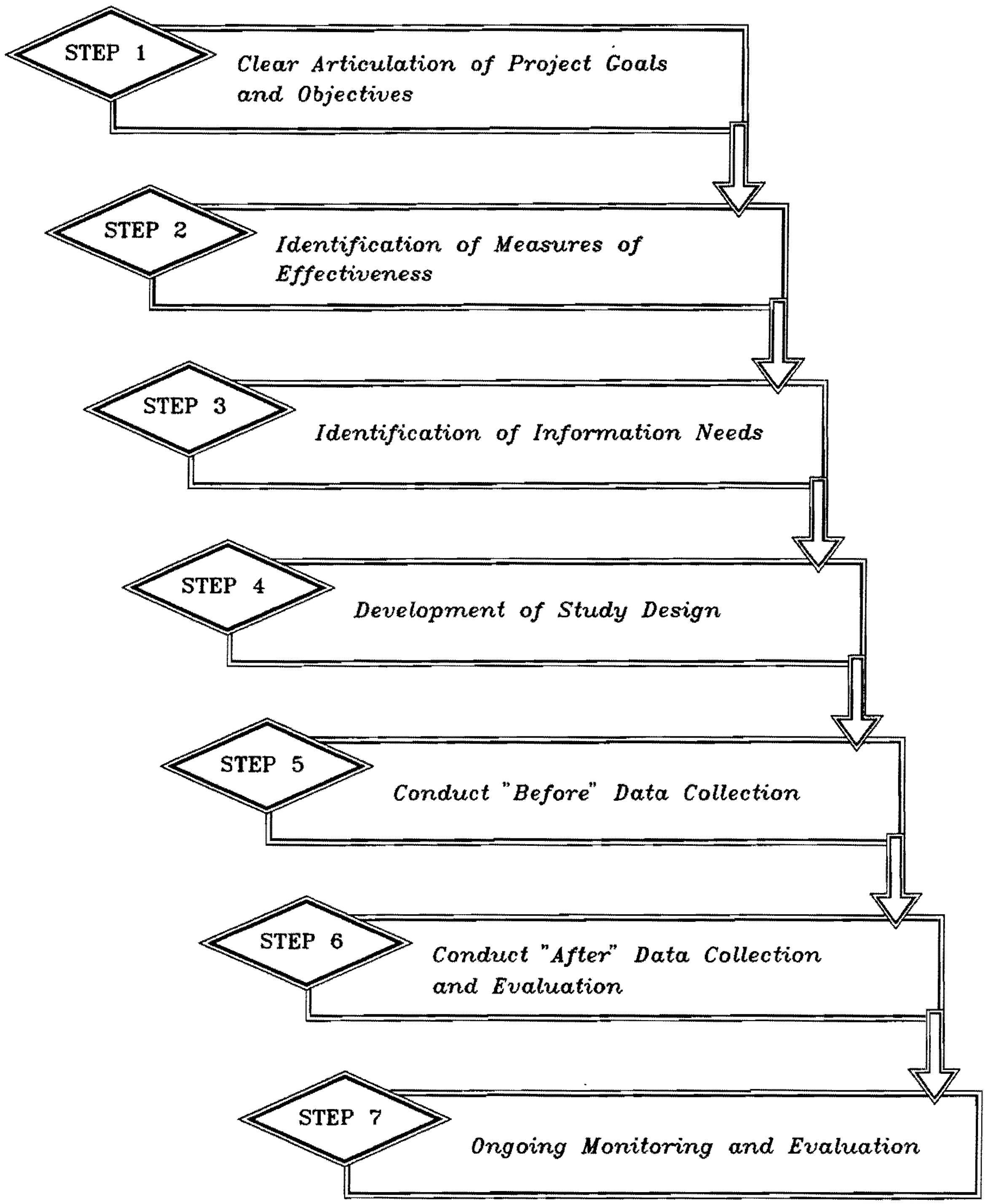
Approach

The development of a before-and-after evaluation program and ongoing monitoring and evaluation process for freeway HOV facilities should include the major activities that would normally be undertaken as part of any evaluation program. The major steps in this process are outlined in this section and shown in Figure 7. To ensure that a comprehensive, well-designed evaluation program is pursued, consideration should be given to each of these steps.

Clear Articulation of Project Goals and Objectives — The goals and objectives the HOV project are intended to accomplish should be clearly defined as the first step in developing the evaluation. This is critical, as the remainder of the evaluation program will be designed to obtain and evaluate information that will largely be used to determine if these objectives have been met. The development of measurable objectives is not an easy task, but time spent on this effort will help ensure a focused evaluation.

For purposes of discussion, the term objective will be used to indicate the goal or purpose the HOV facility is designed to meet. The project objectives should be stated clearly and concisely, so that each represents a well-defined and measurable statement. For example, does the desired increase in person-movement efficiency relate to the peak hour, to the peak period, or to all times of the day? A commonly used approach in developing measurable objective statements is to ensure that the statement includes the desired end result, the action that will be taken to achieve this result, and the time frame within which the result will occur.

Figure 7. Steps in Developing a Before-and-After Evaluation



Identification of Measures of Effectiveness — For each objective, the appropriate measure (or measures) of effectiveness should be identified, along with the desired threshold level of change that will be used to determine if the facility has met the objective. It is important that this activity focus on identifying the measures that most accurately relate to the objectives, and that meaningful threshold levels be established. These measures and thresholds should relate to the key elements identified in the objective statements.

Identification of Information Needs — This step identifies the information needed for the evaluation process. The data needed to determine if the objectives have been realized must be identified for each measure of effectiveness. The appropriate methods to obtain and evaluate the information must also be identified. It is important to ensure that the same procedures and definitions are used throughout the evaluation to ensure comparability.

The basic information needed includes vehicle and occupancy counts, travel time and speed information, safety and accident data, violation and enforcement data, and information on the perception of users, non-users, and the general public. Most of this information is desirable for the HOV facility, adjacent freeway lanes, and a control freeway. The control freeway corridor, which represents a corridor without an HOV or other fixed-guideway transit facility, allows for the monitoring of trends and possible confounding variables that may influence travel in the metropolitan area.

Development of Study Design — The previous three activities should all be brought together in the development of a study design. The study design should include a listing of the objectives, measures of effectiveness, thresholds, the statistical study design, and data collection needs, locations, and procedures. Funding and staffing resources can then be matched to the scope of this effort. The study design should identify the procedures for the data collection activities, the schedule, the roles and responsibilities of the different agencies, and the methods for compiling and analyzing the data.

Conduct "Before" Data Collection — In this step, data is collected prior to the implementation of the HOV project. This step is critical. If no "before" data are collected, it is very difficult to determine the impact of the HOV facility. Recreating "before" data it is very difficult at best. The timing and duration of the "before" data collection activities is important. Ideally, the data collection should take place well before any construction activities that may impact traffic conditions have started. This helps ensure that a true picture of the "before" conditions is recorded. Similarly, the duration of the "before" data collection should be long enough to provide accurate trend data; a single data point is unlikely to accurately reflect before conditions.

Conduct "After" Data Collection and Evaluation — In this step, the "after" data are collected. Usually a number of different evaluation time frames are identified, such as after six months, after one year, after two years, and on an ongoing basis. This long-term perspective is important, since many of the significant impacts of successful HOV projects appear to occur two to four years after implementation. The before-and-after data are then evaluated based on the procedures identified in the study design, and the project effectiveness is assessed. To ensure comparability of data, it is important that the same procedures, techniques, and definitions be used in both the before-and-after data collection and ongoing monitoring activities. The results of such evaluation efforts provide the opportunity to not only evaluate the effectiveness of the facility, but also to identify potential issues associated with the operation of the facility. These problems can then be addressed to ensure the optimum operation of the facility.

Ongoing Monitoring and Evaluation — After the initial evaluation, an ongoing monitoring and evaluation process should be maintained. It is realized that different areas will have different resources available for this ongoing process. Thus, the program should be designed to ensure that the key information is collected and analyzed within the resources available.

Following this general approach will result in the development and implementation of a meaningful evaluation process for examining the impact of the HOV facility. While some elements of this approach may vary in different areas, the basic procedures are appropriate for consideration in evaluating freeway HOV facilities.

Objectives, Measures of Effectiveness, Thresholds, and Data Needs

Information from the literature review, experience with evaluation programs, and input from the national peer group were all used to develop suggested objectives, measures of effectiveness, thresholds, and data needs for conducting before-and-after evaluations of HOV projects.

The objectives presented here represent general statements that reflect the reasons most commonly cited for developing HOV facilities. These objectives should be defined in more detail and expanded as necessary so that each represents a measurable statement appropriate to the specific

HOV project. Once the objectives have been clearly defined, the next step is to identify the appropriate measures of effectiveness (MOEs) that correspond to each objective. These measures should focus on the key elements of the objectives, so that the information needed to determine if the objective has been achieved can be obtained.

Commonly used measures of effectiveness associated with each of the objectives were examined to identify those that appear to represent key elements to be measured. The MOEs that can assist in determining the impact of the HOV facility are included in the following listing. Each of the general objectives is presented, along with possible corresponding measures of effectiveness, threshold guidelines, and data needs. The threshold ranges presented are intended to serve as very general guidelines. It is realized that the appropriate thresholds will vary for individual projects depending on local conditions.

Objective: The HOV facility should improve the capability of a congested freeway corridor to move more people by increasing the number of persons per vehicle.

Measures of Effectiveness: In general, the increase in the peak-hour, peak-direction person volume resulting from the HOV facility should at least be greater than the percentage increase in directional lanes added to the roadway. In effect this will be accomplished by increasing the average vehicle occupancy (persons per vehicle) on the roadway. A significant portion of the increase in average vehicle occupancy should be the result of creating *new* carpoolers and *new* bus riders, rather than just diverting buses, carpools, and vanpools from the adjacent freeway lanes or parallel routes to the HOV facility. The attraction of a significant volume of new bus and carpool users is critical to the effectiveness of HOV facilities. Simply moving existing rideshare patrons from the general-purpose lanes or parallel routes will not impact the person-movement capability of the total corridor.

The following are some specific MOEs that may be appropriate for use with this objective. For each of the MOEs, it may be appropriate to identify a specific criterion for anticipated change in the peak hour, peak period, and the daily total.

- Actual and percent increase in the person-movement on the total freeway facility (general-purpose lanes plus HOV facility).
- Actual and percent increase in the average vehicle occupancy rate for the total freeway facility (general-purpose lanes plus HOV facility).

- Actual and percent increase in carpools and vanpools for the total freeway facility (general-purpose lanes plus HOV facility).
- Actual and percent increase in bus riders for the total freeway facility (general-purpose lanes plus HOV facility).

General Threshold Ranges: Based on experience, possible threshold ranges for these MOEs could include at least a 10 percent increase in the peak-hour, peak-direction average vehicle occupancy, an increase in person volumes greater than the increase in directional lanes added to the roadway due to HOV lane implementation, at least a 20 percent increase in carpoolers, and depending on the amount of new transit service provided, a 10 to 20 percent increase in bus riders.

Data Needs: Primary data needs include before-and-after vehicle and vehicle occupancy counts on the HOV lane(s), adjacent freeway, and control freeway. Secondary data needs include before-and-after vehicle and occupancy counts on parallel roadways, and surveys of users of the HOV facility (bus riders, carpoolers, and vanpoolers) and non-users (individuals in the general-purpose lanes).

Objective: The HOV facility should increase the operating efficiency of bus service in the freeway corridor.

Measure of Effectiveness: By increasing bus operating speeds and improving service reliability, HOV facilities can increase the vehicle operating efficiency of bus service in the freeway corridor. The following measures of effectiveness can be used with this objective.

- Improvement in vehicle productivity, measured by operating cost per vehicle-mile, operating cost per passenger, operating cost per passenger-mile.
- Improved bus schedule adherence, measured by on-time performance.
- Improved bus safety, measured by a reduction in vehicle accident rates.

General Threshold Ranges: As discussed previously, the impact HOV facilities have had on bus service productivity, schedule adherence, and safety has been examined on a limited scale. Some information is available from the Shirley Highway HOV lanes, the San Bernardino Freeway Busway, and the Houston HOV lanes. Experience from these areas indicate that improvements of 5 to 20 percent in vehicle productivity can be realized with the implementation of HOV facilities, resulting in similar reductions in operating cost per vehicle-mile, operating cost per passenger, and operating cost per passenger-mile. On-time schedule adherence can be expected to improve significantly. Experience from a number of areas indicated that the average schedule adherence for buses operating on HOV lanes improves to 95 percent or better compared to the situation before the HOV lane was implemented. The state-of-the-art review did not identify any information on bus accidents. However, depending on the design of the facility, a reduction in the bus accident rate could be anticipated.

Data Needs: Data needed for these measures of effectiveness include before-and-after bus service levels; vehicle productivity; on-time performance; number and severity of bus accidents; vehicle operating costs; and changes in labor, fuel, and other costs. On-time performance is usually measured by the number of vehicles arriving at their destination at the scheduled time. On-time performance may be defined differently by different transit systems, but a range from arriving on schedule to five minutes behind schedule is often used. It is suggested that the actual arrival times of buses be monitored before-and-after implementation of the HOV facility, as this provides the most accurate picture of changes in on-time performance. In addition, the perception of bus users to changes in bus on-time performance can be measured through the use of on-board ridership surveys.

Objective: The HOV facility should provide travel time savings and a more reliable trip time to high-occupancy vehicles utilizing the HOV facility.

Measure of Effectiveness: During the peak-periods, the travel time on the HOV facility should be less than the travel time on the adjacent freeway lanes in the peak-direction of travel. The reliability of the travel time in the HOV lane should also improve from that experienced in the general-purpose lanes in the pre-HOV lane period.

General Threshold Ranges: A general guide that has been used in some areas is that the travel time savings for users of the HOV facility should be approximately one minute per mile for the length of the HOV facility. This guideline further suggests that a minimum total travel time savings of at least five to seven minutes should be realized during the peak hour. The travel time reliability of vehicles using the HOV facility should improve from the pre-HOV conditions. Both the Shirley Highway HOV lanes and the Houston HOV lanes have shown significant improvements in travel time reliability.

Data Needs: Travel time runs of vehicles in the general-purpose lanes should be conducted before the HOV project is implemented. Travel time runs of vehicles in both the HOV lane(s) and the general-purpose freeway lanes should be conducted on an ongoing basis after the HOV facility is open. The travel time runs can also be used to measure the travel time reliability.

Objective: The HOV facility should have favorable impacts on air quality and energy consumption.

Measures of Effectiveness: For the total demand being served by the facility, the HOV lane(s) should have more favorable impacts on air quality and energy consumption than would either no improvement at all or the addition of a general purpose lane. The measures most commonly used with this objective are based on calculations or simulation models that use information generated from other objectives. The following MOEs are commonly used with this objective.

- Reductions in emissions.
- Reductions in total fuel consumption.
- Reductions in the growth of vehicle-miles of travel (VMT) and vehicle-hours of travel (VHT).

General Threshold Ranges: The HOV lane(s) should have a more positive impact on air quality and energy consumption than would either no improvement or the addition of mixed traffic lanes. More specific levels can be set for individual projects based on the results of the demand estimation process.

Data Needs: Estimations based on vehicle and occupancy counts, travel time runs, and responses to surveys are used to measure changes in these MOEs. Many simulation models require a good deal of data. Direct monitoring of air quality impacts along the corridor may be appropriate in some cases.

Objective: The HOV facility should increase the per lane efficiency of the total freeway facility.

Measures of Effectiveness: This objective can be measured by a comparison of the peak-hour per lane efficiency of the freeway lanes prior to implementation of the HOV project and combined peak-hour per lane efficiency of the freeway lanes and HOV facility after implementation. The "before" measure can be calculated by taking the person volume on the freeway multiplied by the average freeway operating speed. The "after" measure can be calculated by taking person volume on the freeway multiplied by the average freeway operating speed combined with the person volume on the HOV facility and multiplied by the average HOV lane operating speed.

General Threshold Ranges: A 5- to 20-percent increase in the peak-hour per lane efficiency of the total facility could be expected from an HOV project.

Data Needs: The information obtained from the freeway and HOV lane(s) vehicle and occupancy counts and travel time runs taken before and after implementation of the HOV facility are used to calculate the per lane efficiency.

Objective: The HOV facility should not unduly impact the operation of the freeway general-purpose lanes.

Measure of Effectiveness: The capacity and operating speeds of the adjacent freeway general-purpose lanes should not be degraded due to the implementation of the HOV facility. This can be measured by a comparison of the level-of-service on the general-purpose lanes before and after implementation of the HOV project. As presented next, it is suggested that safety be addressed in a separate objective.

Threshold Ranges: The level-of-service in the general-purpose lanes should not decline due to the implementation of the HOV project.

Data Needs: The information obtained from the freeway and HOV lane vehicle and occupancy counts and travel time runs taken before and after implementation of the HOV facility are used to calculate the level-of-service.

Objective: The HOV facility should be safe and should not unduly impact the safety of the freeway general-purpose lanes.

Measure of Effectiveness: Appropriate MOEs include a before-and-after comparison of the following items.

- Number and severity of accidents for HOV and freeway lanes.
- Accident rate per million vehicle-miles or million passenger-miles of travel for the HOV and freeway lanes.

General Threshold Ranges: It is suggested that the accident rates should not increase with the implementation of the HOV facility and that the accident rates should be lower on the HOV facility than the freeway general-purpose lanes. However, if implementation of the HOV facility has resulted in the narrowing of the general-purpose lanes or shoulder, or the removal of a shoulder, this may not be a realistic threshold. Thus, it is suggested that this MOE and possible threshold ranges be carefully examined for each project. Given the experience with some of the evaluations of HOV facilities in California, it appears important to monitor not only the freeway lanes and HOV facility, but also a control freeway to determine any overall changes in accident rates in the area. Maintaining the same analysis procedure throughout the evaluation is another lesson from the California experience.

Data Needs: Accident statistics on the freeway general-purpose lanes should be collected for a representative period of time before the HOV facility is opened. Statistics on the accident rates for both the HOV lane and the general-purpose lanes should then be collected for a representative period of time after the HOV facility is open. Information collected should include the number, type, and severity of the accidents. Continued, ongoing monitoring should also be conducted.

Objective: The HOV facility should have public support.

Measure of Effectiveness: Opinion surveys or other techniques should show support for the HOV facility among users, non-users, the general public, and policy makers; a general perception should exist that the facility is adequately utilized. Since these are two different elements, it is suggested that one MOE focus on the perception of utilization of the HOV facility and another MOE focus on the perception of whether it is a good transportation improvement. The violation rates, or the percentage of vehicles using the HOV facility that do not meet the minimum occupancy requirement, can also be used as a MOE for this objective.

General Threshold Ranges: It may be difficult to establish a desired threshold level for this objective. However, a desired level of public acceptance, user acceptance, and non-user acceptance can be identified and measured through the use of surveys. As a general guideline it is suggested that a majority of users and non-users should feel the HOV facility is a good transportation improvement. The perception of the utilization of the facility may be slightly lower, especially for non-users. In addition, performance measures and thresholds could be established related to the number of calls and letters received concerning the facility. Suggested threshold levels for violation rates are less than 10 percent for exclusive and contraflow lanes and less than 20 percent for concurrent flow lanes. It is realized that the violation rates relate somewhat to capacity and public support issues, enforcement design, and the level of enforcement.

Data Needs: Data needed to evaluate this objective can be obtained from surveys of users, non-users, focus groups, and the general public; monitoring of calls and letters; newspaper articles; other public reactions relating to the facility; violation rates; and enforcement levels. Much of this information can be gathered through ongoing marketing and public information programs, which usually have monitoring and evaluation elements. Many of the case studies support the importance of marketing and public information programs to educate both the public and policy makers on the purpose and use of HOV projects.

Objective: The HOV facility should be a cost-effective transportation improvement.

Measure of Effectiveness: The measure most commonly used with this objective is the benefit-cost ratio.

General Threshold Ranges: A number of different elements such as travel time savings, operating cost savings, and savings in the cost of congestion can be included as benefits to calculate the benefit-cost ratio of an HOV facility. It is suggested that a basic guideline is that, if an HOV facility has a benefit-cost ratio of greater than 1.0 based only on the value of travel time savings by persons using the facility, then the project can be considered cost-effective. It is realized that this is an extremely conservative approach, since the HOV facility should also generate other benefits. However, it provides a relatively easy to understand measure and is based on obtainable information. Some groups have suggested that only the time saved by new HOV users should be used in calculating the benefit-cost ratio.

Data Needs: In order to develop a benefit-cost ratio, the total cost (capital and operating) of the project is needed along with a costing of the benefits. As discussed above, it is suggested that the travel time savings to persons using the facility be used as a primary benefit.

The various suggested objectives, measures of effectiveness, and data needs for evaluating freeway HOV lane projects that were discussed above are summarized in Tables 4 and 5.

Table 4. Suggested Objectives and Measures of Effectiveness

objective	measures of effectiveness
• The HOV facility should improve the capability of a congested freeway corridor to move more people by increasing the number of persons per vehicle.	• Actual and percent increase in the person-movement efficiency • Actual and percent increase in average vehicle occupancy rate • Actual and percent increase in carpools and vanpools • Actual and percent increase in bus riders
• The HOV facility should increase the operating efficiency of bus service in the freeway corridor.	• Improvement in vehicle productivity (operating cost per vehicle-mile, operating cost per passenger, operating cost per passenger-mile) • Improved bus schedule adherence (on-time performance) • Improved bus safety (accident rates)
• The HOV facility should provide travel time savings and a more reliable trip time to HOVs utilizing the facility.	• Peak-period, peak-direction travel time in the HOV lane(s) should be less than the adjacent general-purpose freeway lanes • Increase in travel time reliability for vehicles using the HOV lane(s)
• The HOV facility should have favorable impacts on air quality and energy consumption.	• Reduction in emissions • Reduction in total fuel consumption • Reduction the growth of vehicle-miles of travel (VMT) and vehicle-hours of travel (VHT)
• The HOV facility should increase the per-lane efficiency of the total freeway corridor.	• Improvement in the peak-hour per-lane efficiency of the total facility
• The HOV facility should not unduly impact the operation of the freeway general-purpose lanes.	• The level of service in the freeway general-purpose lanes should not decline
• The HOV facility should be safe and should not unduly impact the safety of the freeway general-purpose lanes.	• Number and severity of accidents for HOV and general-purpose lanes • Accident rate per million vehicle-miles of travel • Accident rate per million passenger-miles of travel
• The HOV facility should have public support.	• Support for the facility among users, non-users, general public, and policy makers • Violation rates (percent of vehicles not meeting the occupancy requirement)
• The HOV facility should be a cost-effective transportation improvement.	• Benefit-cost ratio

Table 5. Suggested Data Collection Efforts

objective	data collection efforts							corresponding measures of effectiveness (MOEs)[3]
	vehicle and occupancy counts		travel time runs		surveys[1]			
	freeway[2]	HOV lane	freeway[2]	HOV lane	freeway	HOV lane	other	
Increase vehicle occupancy	●	●			○	○	○[4]	Actual and percent increase in peak-hour, peak-direction person volume; increase in average vehicle occupancy; and modal shift
Bus operating efficiency			●	●			●[5]	Improved vehicle productivity; improved bus schedule adherence; and improved bus safety
Travel time savings			●	●	○	○	○[6]	Amount of travel time saving by HOV users; reliability of trip time for HOV users
Energy and air quality	●	●	●	●	○	○	○[7]	Reduction in vehicle emissions; reduction in energy consumption
Per-lane efficiency	●	●	●	●				Increase in peak-hour per-lane efficiency of total freeway facility
Freeway operations	●		●		○			Maintain or improve level of service on general-purpose freeway lanes
Safety	○	○					●[8]	Number and severity of accidents; accident rate per million vehicle-miles of travel and million passenger-miles of travel
Public support		○			●	●	○[9]	Percent of users, non-users, and general public who approve of HOV facility; violation rates
Cost effectiveness	○	●	●	●				Benefit-cost ratio

● Indicates the top-priority data collection efforts needed to evaluate the objectives.
○ Indicates data collection efforts which should ideally be conducted, but are not absolutely necessary to evaluate the objectives.

[1]Involves periodic surveys of HOV users (bus riders, carpoolers, and vanpoolers), non-HOV users in the general-purpose lanes, and, in some cases, the general public.
[2]It is strongly suggested that these data be collected for the control freeway as well as the freeway adjacent to the HOV lanes.
[3]The table lists some, but not necessarily all, of the potential MOEs associated with the objectives.
[4]Occupancy data collection on a control freeway, at park-and-ride lots, and on parallel arterial routes to identify any changes in corridor throughput.
[5]Before-and-after data on bus service levels; vehicle productivity; schedule adherence; accident patterns; vehicle operating costs; and labor, fuel, and other costs.
[6]Monitoring bus on-time performance and schedule adherence before and after implementation of the HOV facility.
[7]Monitoring air quality levels along the corridor and use of simulation models to estimate energy impacts.
[8]Monitoring freeway accident statistics before and after implementation of the HOV facility, as well as collecting accident data on the HOV lanes.
[9]Identifying violation rates for the HOV lane (i.e., those vehicles not meeting the minimum occupancy requirement). Monitor complaints, media, and policy actions.

Data Collection

A set of suggested procedures and techniques for conducting each of the data collection activities needed to support the before-and-after evaluation was also outlined as part of this element of the assessment. The specific data collection activities covered included vehicle and occupancy counts, travel time runs, user and non-user surveys, safety and accident information, and violation rates. The report, *Suggested Procedures for Evaluating the Effectiveness of Freeway HOV Facilities,* should be consulted for a full description of the suggested data collection procedures and techniques.

IV.

HOV Project Case Studies

In order to obtain a more comprehensive understanding of the variety of factors associated with the planning, implementation, operation, and evaluation of HOV facilities, several HOV project case studies were conducted. Six case study sites were selected to provide a mix of old and new projects, HOV design treatments, and geographic coverage. High-occupancy vehicle facilities in Houston, Texas; Minneapolis-St. Paul, Minnesota; Orange County, California; Pittsburgh, Pennsylvania; Seattle, Washington; and Washington, D.C./Northern Virginia were included in the case studies. The history and institutional arrangements associated with the HOV projects were examined, along with a more detailed analysis of the operating characteristics, utilization rates, and impacts of the facilities. The results from the case study analyses are briefly summarized in this chapter. The history and institutional arrangements are presented first, followed by an overview of the operating experience with each facility.

History and Institutional Arrangements

The assessment of the history and institutional arrangements associated with HOV projects in the six case study sites identified a number of common elements. While these were not present in all case studies to the same degree, the elements occurred often enough to represent common features that appear to be significant in the development of HOV projects. Major similarities among the projects are outlined below. The first elements identify common characteristics that resulted in the decision to implement the HOV facilities, while the later elements relate to similarities during the development of the actual projects. Table 6 provides a summary of the major characteristics common to multiple HOV case study projects.

Table 6. Common Characteristics in the Development of the Case Study HOV Projects

features common to multiple projects	case study sites					
	Houston	Minneapolis	Orange County	Pittsburgh	Seattle	Washington, D.C.
Decision Making Process						
Intense congestion in corridor	•	•	•	•	•	•
No agreed-upon fixed-guideway transit plan	•	•	•		•	•[1]
Planned or scheduled highway improvement	•	•	•	•	•	•
Project champion within implementing agency	•	•	•			
Legislative or policy direction		•	•			•
Implementation Process						
Lead agency in implementation	•[2]	•	•	•	•	•
Interagency cooperation	•	•	•	•	•	•
Joint funding	•	•	•	•	•	•
Support of federal agencies, including funding	•	•	•	•	•	•
Flexibility and adaptability	•	•	•	•	•	•

[1]In 1968, the Washington Metropolitan Transit Authority adopted a plan that included a Metrorail line along a portion of the I-66 corridor.
[2]The development of the Houston transitway system is best characterized as a multi-agency effort requiring multi-agency decisions.

Common Characteristics in the Decision-Making Process

Corridor and Areawide Characteristics — All of the case study sites are located in major metropolitan areas in the United States. In terms of population, all fall within the top 20 most populated metropolitan areas in the country. Further, the HOV projects in each case study site are all located in major travel corridors. In all cases, the metropolitan areas and the specific corridors were experiencing significant growth in travel demand at the time the HOV projects began to be considered. In addition, travel demands were projected to increase in all corridors.

The need for major transportation improvements of some sort had been identified in all the corridors, and in many cases, the examination of alternatives and the development of detailed plans had been initiated. HOV facilities became one of the alternatives examined to address the anticipated travel demand, and ultimately emerged as a major element of the final recommendation. Thus, in all of the case studies, an awareness of the need to address increasing traffic congestion problems in a major travel corridor had developed.

Lack of a Fixed-Guideway Transit Plan for the Corridor — Another similarity among the case sites was the lack of an agreed upon or approved long-range fixed-guideway transit plan for the corridor. An approved fixed-guideway transit plan did not exist for most of the case study corridors at the time consideration of an HOV alternative was initiated. In many instances there was disagreement among different agencies over the role transit should play in the corridor and the technology that should be used. In some cases there had been an ongoing debate over this issue.

In addition, in some instances, such as in Seattle, Houston, and Minneapolis, the lack of consensus over the role of transit and the technology to be used applied not just to the corridor, but to the metropolitan area as a whole. In these cases, the debate, which continues today, relates to the implementation of a rail transit component as one element of the overall public transportation system. Thus, in most of the case study sites, no decision had been made on the development of a fixed-guideway transit system in the corridor where the HOV facility was ultimately developed.

Planned or Scheduled Highway Improvements — Some type of highway improvements were either planned or scheduled in most of the corridors where the HOV projects were eventually built. These ranged from major new freeways, such as I-394 in Minneapolis, I-66 in Northern Virginia, and I-90 in Seattle, to pavement rehabilitation projects such as Katy (I-10W) in Houston and Route 55 in Orange County. Thus, consideration of the HOV project was often initiated as one approach to increasing the person-movement efficiency of the roadway facility.

Once the decision had been made to include the HOV element, coordinating the planning, design, and construction of both the freeway and HOV elements were initiated to maximize available resources and minimize disruptions to the traveling public. Thus, HOV projects in many of the case study sites were considered and implemented as part of larger highway improvements. These ranged from new freeway facilities to pavement rehabilitation projects. This coordination helped maximize available resources and minimize the impacts of implementation on the traveling public.

Project Champion or Champions — One individual, or a small group of individuals, was identified in most of the case studies as being instrumental in the development, promotion, and support of the HOV project. These were individuals, usually within the state transportation department or local transit agency, that had the authority and position to influence the outcome of the process. The support of these individuals was often noted as a major reason for the development of the HOV projects in many of the case study areas. These individuals reflected a willingness to try new and innovative approaches to dealing with growing traffic congestion problems and were willing to move the projects forward. As many of the projects represented the first uses of the different types of HOV facilities in the country, some risk was associated with their implementation. Thus, individuals in positions of authority in highway and transit agencies supported the HOV project concept and promoted it through the project development and implementation process.

Legislative Direction and Policy Support — The consideration of HOV facilities was supported in many of the case study sites by legislative or policy directives. This took the form of policy directives from the federal level on the I-66 facility in Northern Virginia and the state level on I-394 in Minneapolis. These legislative or policy directives assisted in ensuring that HOV facilities were one of the alternatives considered in the planning process and supported the implementation of the ultimate recommendation. The involvement of Congress and federal agencies in the many aspects of planning, designing, and operating the HOV facilities in the Washington, D.C. area represents a unique feature not found in the other case study sites. Thus, legislative or agency policies and directives played an important role in the decision-making process in some of the HOV case study projects.

Common Characteristics in the Implementation Process

Lead Agency — In general, the agency responsible for making the decision to proceed with the development of the HOV project also had the overall responsibility for implementing the project. In all cases, the state department of transportation or the state highway department was responsible for construction of the actual facility. However, transit agencies were also actively involved in different aspects of many of the case study HOV projects.

The Houston transitways can best be described as multi-agency projects requiring multi-agency decisions. The Houston Office of Public Transportation, the predecessor agency to the Metropolitan Transit Authority of Harris County (METRO) was the lead agency in the initial contraflow demonstration project. However, on this and subsequent HOV projects, extensive agreements between METRO and the Texas Department of Transportation were used to identify the roles, responsibilities, and financial participation of the two agencies.

Most of the case study projects utilized some type of project management team or coordinating group. In many cases other agencies also participated in funding some elements of the projects. Thus, one agency, usually the state department of transportation, had overall responsibility for implementing the HOV project. However, transit and other agencies were often involved in some aspects of planning, designing, and in a limited number of cases, financing the projects.

Interagency Cooperation — All of the HOV projects in the case study sites involved some degree of interagency cooperation. The exact nature and level of this involvement varied substantially between projects. Some type of interagency coordination structure, such as a project management team, was used with many of the HOV projects. These coordinating groups were identified as an important component to ensuring that all groups were adequately involved in the implementation process.

This coordination was noted as especially important due to the unique nature of the HOV projects and the need to involve highway, transit, enforcement, and other groups in the process. In most cases, these committees were actively involved in many aspects of the planning, design, implementation, and operation of the facilities. These groups usually involved all the relevant agencies and groups associated with the projects. In a number of the case study sites, the metropolitan planning organization (MPO) was actively involved in the process and openly supportive of the HOV project. Thus, interagency cooperation, including the use of multi-agency project management groups, played an important part in the coordinated implementation of most of the case study HOV projects.

Joint Funding — A variety of funding sources were used for many of the HOV projects in the case study sites. Different combinations of funds from the Federal Highway Administration, Federal Transit Administration, and state and local highway and transit agencies were often used. In addition, many areas such as Houston and Minneapolis, used a variety of funding approaches and institutional arrangements to develop the HOV projects. Thus, multiple funding sources and innovative financing approaches were utilized with some of the case study HOV projects.

Support of Federal Agencies — The Federal Highway Administration and the Federal Transit Administration were supportive of the HOV projects in the case study sites. This involvement included providing funding for initial demonstration programs, construction of the HOV lanes and supporting elements, and research and evaluation programs, participating in project management teams, providing technical assistance, and providing policy guidance. Thus, support from FHWA and FTA was evident, although in different degrees, in the development of some of the case study HOV facilities.

Flexibility and Adaptability — All the case studies seem to indicate that flexibility and the ability to adapt to change were important elements in both the development and ongoing operation of the HOV facilities. Almost every project has experienced some change in the operating requirements of the HOV facility. These changes have been the result of experience and policy directives. In either case, the need to maintain flexibility in responding to changing travel demands and policies appears to be an important element of the HOV projects in the case study sites.

Utilization Levels and Trends

A more detailed examination was conducted of the operating experience and impact of the case study HOV projects. This included a review of the historical utilization trends and an analysis of the HOV projects based on the evaluation measures described in Chapter III. Although at least some general information on the vehicle volumes, person movement, and operating characteristics was available for all the HOV project case studies, the data needed to examine many of the evaluation measures was not available for all projects. Thus, this part of the analysis focused on providing a sample of the range of experience with the different HOV projects based on available information.

A brief overview of the operating characteristics and the historical trends in vehicle- and person-volumes is presented next for each of the case study HOV projects. A one page summary is provided on each project that includes a short description of the physical features and operating characteristics of the HOV facility. A separate page with a map and a figure showing the historical trends in vehicle and person volumes is also provided. As can be noted from the figures, the availability of data among the different projects varies greatly. In some cases, such as the Katy HOV lanes and the I-394 HOV facility, good longitudinal data is available as a result of an ongoing data collection program. The number of data points are much more limited with many of the other HOV projects. The report, *High-Occupancy Vehicle Project Case Studies: Historical Trends and Project Experiences*, should be consulted for the more detailed examination of the different projects by the evaluation measures described previously.

Katy Freeway (I-10 West) — Houston, Texas

The Katy Freeway HOV lane is located on I-10 West in Houston, Texas. The location of this facility, which serves as the major travel corridor on the west side of the city, is shown in Figure 8. The 13-mile HOV lane was opened in stages between 1984 and 1990. It is a one-lane, barrier-separated, reversible HOV lane located in the freeway median. Three park-and-ride lots and three park-and-pool lots are located in the corridor. Access and egress is provided by both slip ramps and direct access ramps. The Katy Freeway HOV lane is one of four operational HOV lanes in the Houston area and is part of a planned 96-mile HOV network.

The HOV lane is open in the inbound direction from 4:00 a.m. to 1:00 p.m. It is then closed from 1:00–2:00 p.m. to reverse the flow of HOV traffic. The lane reopens at 2:00 p.m. and operates in the outbound direction until 10:00 p.m. The vehicle occupancy requirement on the facility has changed a number of times over the life of the project. Only buses and authorized vanpools were allowed to use the facility when it opened in 1984. Due to low utilization, it was opened to authorized carpools with four or more persons in April 1985. The occupancy requirement was lowered to 3+ in December 1985, and in August 1986 it was changed to 2+ and the authorization requirement was dropped.

The 2+ occupancy requirement remained in effect until the fall of 1988. In response to the high volumes occurring in the morning peak hour, and the corresponding decline in travel speeds and travel time reliability, a 3+ vehicle occupancy requirement from 6:45–8:15 a.m. was reinstated in October 1988. The 3+ hours were slightly revised to 6:45–8:00 a.m. in May 1990, and in the fall of 1991, the 3+ requirement was applied to the afternoon peak hour from 5:00–6:00 p.m.

The historical trends in vehicle volumes and person movement during the morning peak hour are shown in Figure 9. The figure illustrates the change in utilization levels over an eight-year period. The vehicle volumes grew steadily after the lane was opened to 2+ carpools, reaching a high of almost 1,500 peak-hour vehicles in 1986. The vehicle and person volumes dropped initially after implementation of the 3+ occupancy requirement, but have been increasing since that time. As of December 1991, approximately 840 vehicles and 4,000 persons were using the HOV lane during the morning peak hour. In the peak period (6:00–9:30 a.m.) approximately 2,350 vehicles and 8,760 persons were using the lane (*2*).

Figure 8. Katy Freeway HOV Lane,
Houston, Texas

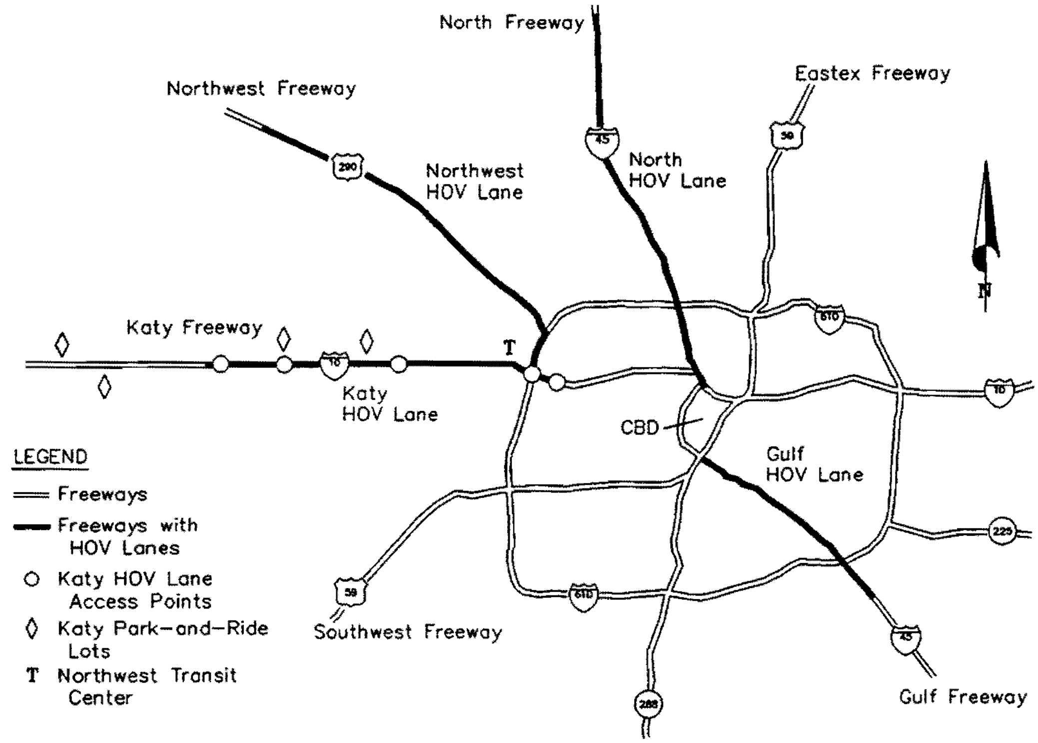
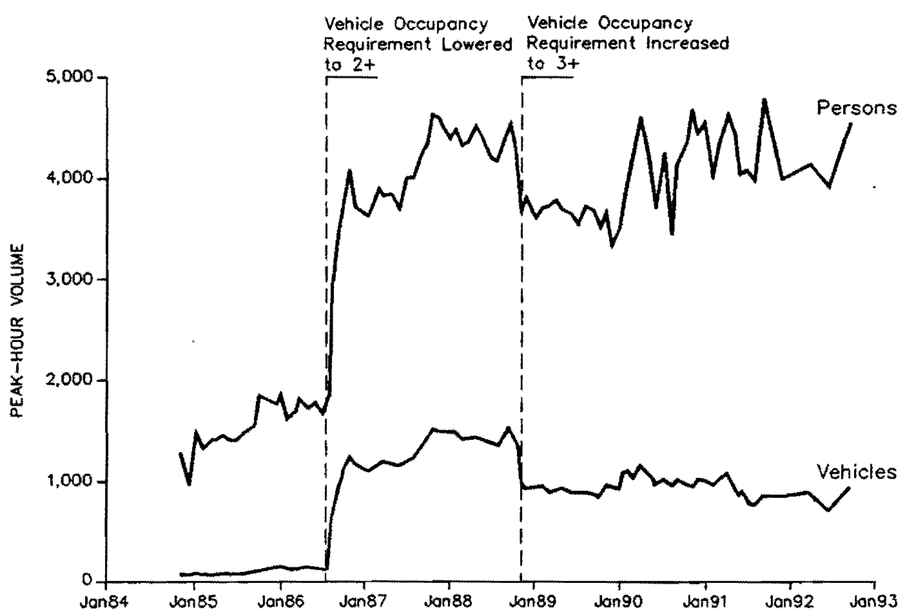


Figure 9. Katy Freeway HOV Lane,
A.M. Peak-Hour Utilization



I-394 — Minneapolis, Minnesota

The I-394 freeway and HOV lanes are located on the western side of the Minneapolis-St. Paul metropolitan area. As shown in Figure 10, the facility extends 11 miles from downtown Minneapolis to the city of Wayzata. I-394, which represents the final segment of the interstate system to be completed in the area, was constructed on the alignment of an existing arterial, US 12. Completed in the fall of 1992, the final freeway and HOV design includes two general-purpose traffic lanes in each direction and two different HOV treatments. East of Highway 100, a three-mile, two-lane, barrier-separated, reversible HOV facility is located in the median of the freeway. Those HOV lanes provide direct access into the downtown parking garages built as part of the overall project. West of Highway 100, eight miles of concurrent flow HOV lanes are in operation.

An interim HOV lane was used during construction of the I-394 facility. The interim facility was marketed as the "Sane Lane," and was implemented to help manage traffic during construction and to introduce the HOV concept in the area. The interim HOV lane was approximately three miles long, and was located in the median of US 12. Opened in November 1985, the interim HOV lane operated in the inbound direction during the morning peak period (6:00–9:00 a.m.) and in the outbound direction in the afternoon (2:00–7:00 p.m.). The operating hours changed slightly during the interim period in response to construction needs. A 2+ vehicle occupancy requirement has been in effect over the life of the project, and buses, vanpools, and carpools are allowed to use the facility.

Figure 11 illustrates the morning peak-hour vehicle and person volumes for the I-394 HOV lanes. The interim HOV lane was in operation for approximately five years. During this time, an average of some 500 vehicles carrying 1,400 persons used the facility during the morning peak hour (*3*). In the fall of 1992, approximately 1,100 vehicles carrying 3,580 persons were using the peak-direction concurrent flow HOV lane west of Highway 100 during the morning peak hour (*4*).

Figure 10. I-394 HOV Lanes,
Minneapolis, Minnesota

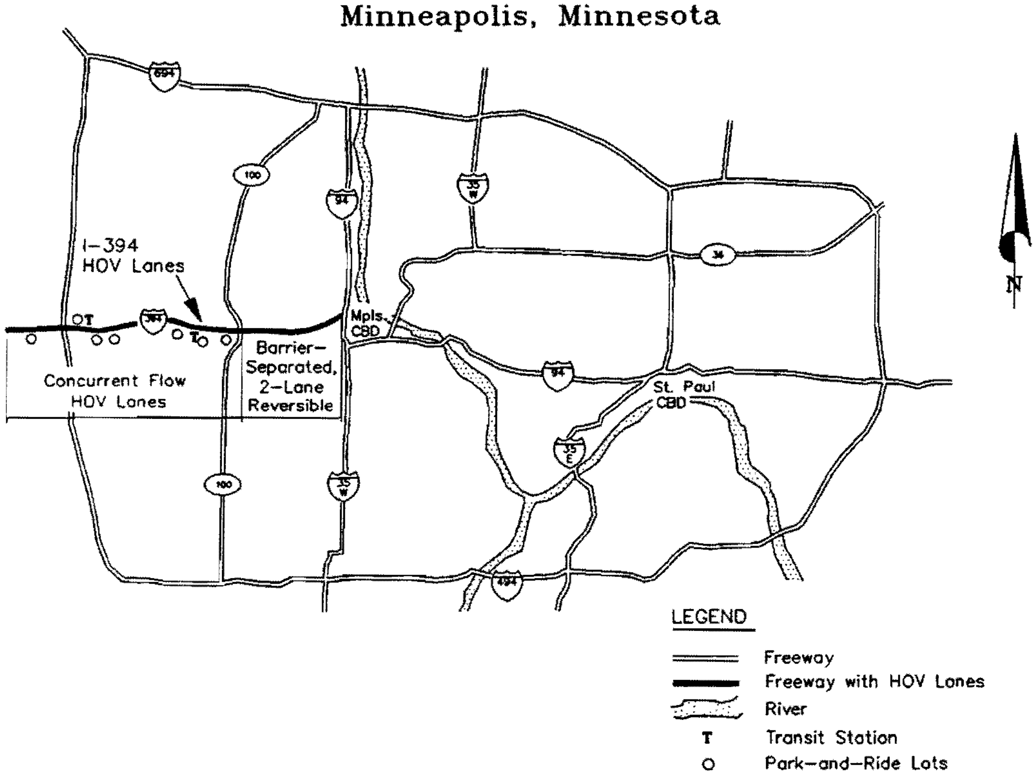
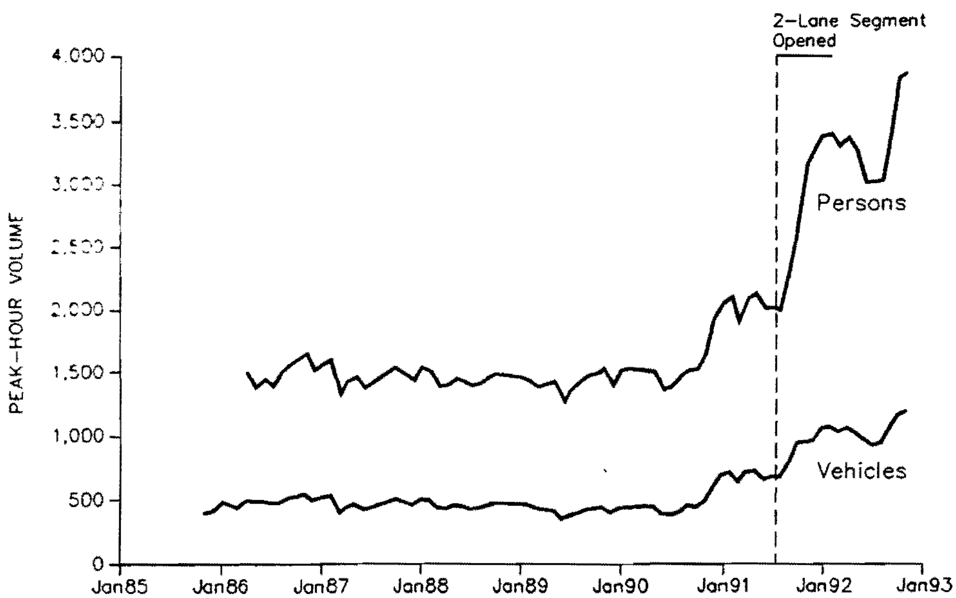


Figure 11. I-394 HOV Lanes,
A.M. Peak-Hour Utilization



Route 55 — Orange County, California

The location of the Route 55 HOV lanes in Southern California is shown in Figure 12. Route 55 (the Newport-Costa Mesa Freeway) serves as a heavily-traveled link between the residential areas in eastern Orange and Riverside Counties and the employment centers in central Orange County. Eleven miles of HOV lanes—or commuter lanes as they are called locally—were opened on Route 55 in 1985.

The Route 55 HOV facility consists of a pair of concurrent flow commuter lanes (one in each direction), and is open to buses, vanpools, and carpools on a 24-hour basis. A 2+ vehicle occupancy requirement is in effect on the Route 55 HOV lanes.

The historical morning peak-hour, peak-direction vehicle volumes and person movement on the Route 55 HOV lanes are shown in Figure 13. The vehicle volumes have been relatively consistent over the eight-year period, averaging between 1,100 and 1,500 vehicles during the morning peak hour in the peak direction. However, morning peak-hour vehicle volumes as high as 1,600 have been recorded on the Route 55 HOV lane. The corresponding person movements have also remained relatively constant over this period, averaging between 2,300 and 3,200 persons during the morning peak hour in the peak direction. Since very little bus service is provided in the Route 55 corridor, the vehicle volumes and person movements for the HOV lanes primarily reflect carpools (*3, 5, 6*).

Figure 12. Route 55 HOV Lanes,
Orange County, California

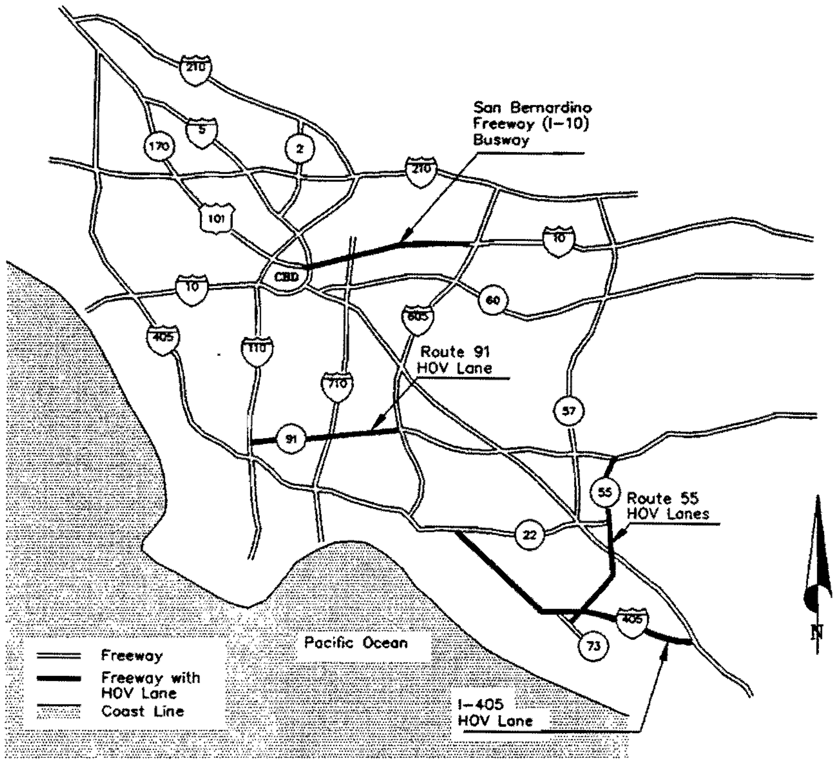
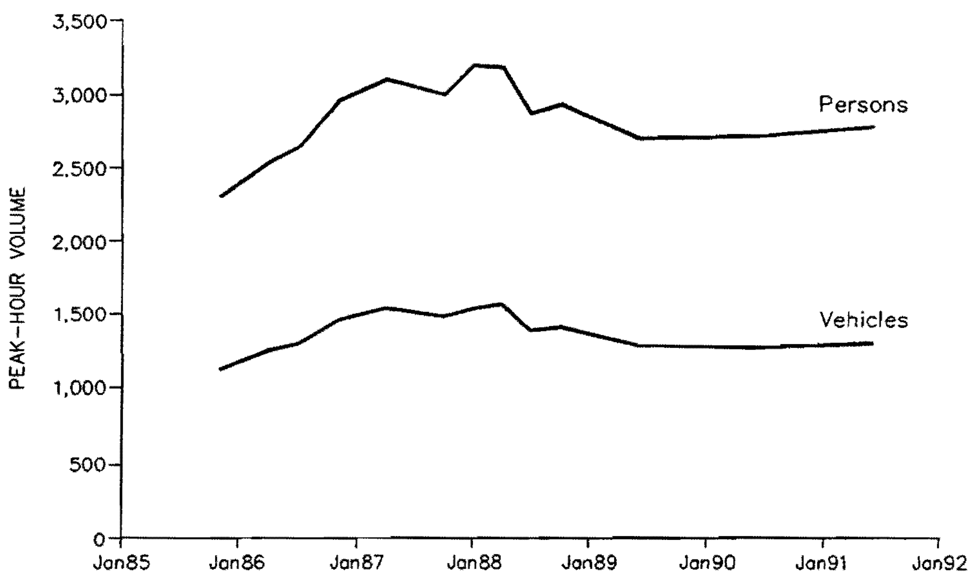


Figure 13. Route 55 HOV Lanes,
A.M. Peak-Hour Utilization



I-279 — Pittsburgh, Pennsylvania

The location of the I-279 HOV lanes in the Pittsburgh area is shown in Figure 14. The project is a four-mile, two-lane, reversible, barrier-separated HOV facility located in the median of I-279. Two short one-lane segments are located at the southern end of the facility, providing access to Three Rivers Stadium via I-579 and the downtown area via I-279. The freeway and HOV lanes were first opened in August of 1989. The HOV lanes were open to buses, vanpools, and 3+ carpools during the first three years of operation. In August 1992, a demonstration project was implemented in which the vehicle occupancy requirement on the HOV facility was lowered to two or more persons per vehicle.

The I-279 HOV lanes operate in the inbound direction from 5:00 a.m. to noon. From noon to 2:00 p.m. the lanes are closed to reverse the flow of HOV traffic. From 2:00–8:00 p.m. the lanes operate in the outbound direction with the HOV restrictions. Finally, from 8:00 p.m. to 3:00 a.m. the lanes operate in the outbound direction with no vehicle occupancy restrictions. This is done in part to accommodate traffic leaving events at Three Rivers Stadium.

Information on the morning peak-hour vehicle and person volumes for the I-279 HOV lanes is shown in Figure 15. With the 3+ occupancy requirement, the morning peak-hour vehicle volumes had increased from approximately 164 vehicles in November 1989 to 345 vehicles in November 1991. The corresponding peak-hour person volumes had increased from some 1,100 persons to 2,200 persons. After the vehicle occupancy requirement was lowered to 2+ for a demonstration project in August 1992, the morning peak-hour volume increased to 868 vehicles and the corresponding person movement rose to 2,600 (*3, 7*).

Figure 14. I-279 HOV Lanes, Pittsburgh, Pennsylvania

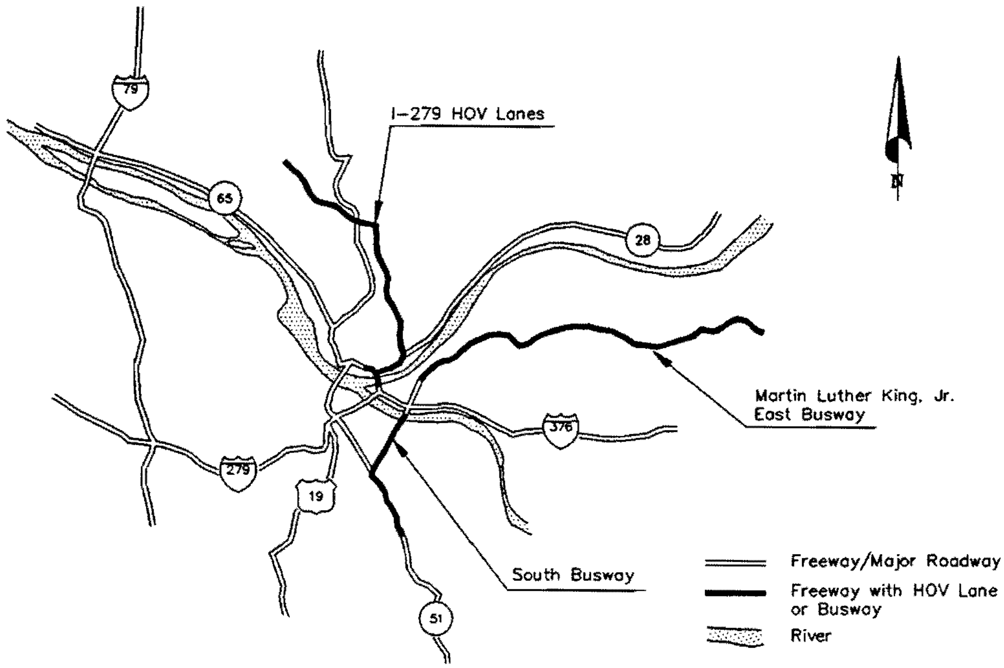
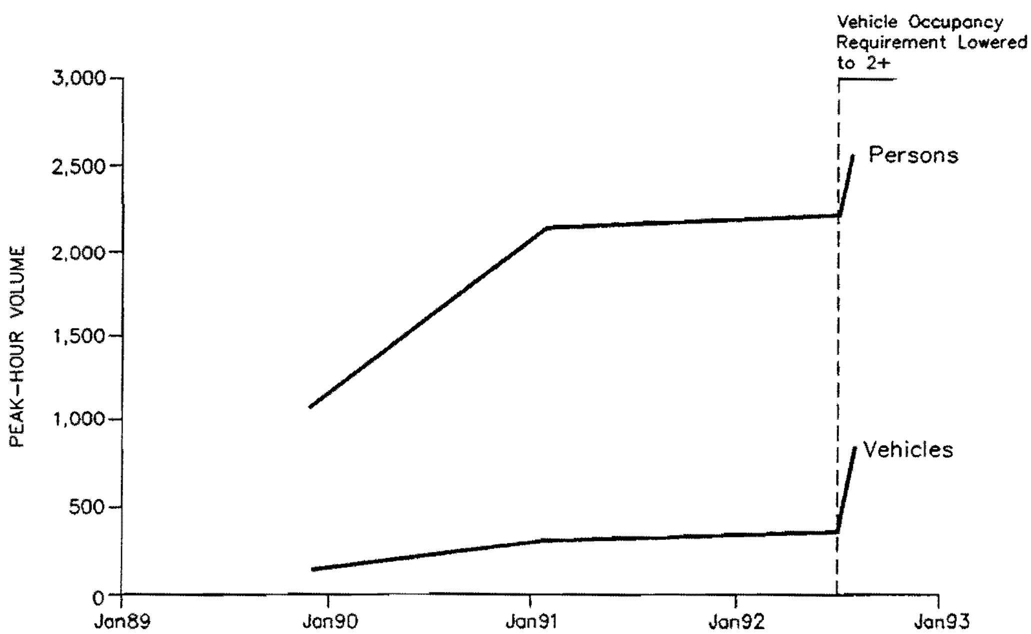


Figure 15. I-279 HOV Lanes, A.M. Peak-Hour Utilization



I-5 North — Seattle, Washington

The location of the I-5 North HOV lanes selected as a case study project is shown in Figure 16. The concurrent flow HOV lanes are located to the north of both downtown Seattle and the University of Washington. The southbound HOV lane is 7.7 miles in length and the northbound HOV lane is 6.2 miles in length. The I-5 North HOV lanes were opened in 1983 and are operated on a 24-hour basis. From 1983 until July 1991, a 3+ vehicle occupancy requirement was in effect. On July 29, 1991, the occupancy requirement was lowered to two or more persons per vehicle as part of a demonstration project.

The historical trends in morning peak-hour, peak-direction vehicle volumes and person movement on the I-5 HOV lanes are shown in Figure 17. An average of about 280 vehicles used the facility during the morning peak hour in the first few weeks following the opening of the facility. That volume had grown to 410 vehicles after the first three months of operation and 460 vehicles after the first 20 months (*8, 9*). Between 1985 and August 1991, an average of 460 to 550 vehicles used the HOV lane during the morning peak hour in the peak travel direction (*8, 9*). After initiation of the demonstration project lowering the vehicle occupancy requirement to 2+, the morning peak-hour, peak-direction volumes averaged between 1,200 and 1,400 vehicles (*10*).

Figure 17 also shows the change in person volumes over the life of the project. Between 1985 and 1991, an average of 3,710 persons used the facility during the morning peak hour in the peak travel direction. Approximately 70 percent, or 2,605 persons, rode buses on the HOV lane, while 30 percent, or 1,105 persons, were in 3+ carpools. After the vehicle occupancy requirement was changed to 2+, the person volumes increased to an average of 5,644 during the morning peak hour in the peak travel direction. Bus ridership remained relatively constant with the reduced occupancy requirement, but the number of persons carried in carpools increased to 3,039—approximately 54 percent of the total morning peak-hour, peak-direction person volume on the facility (*10*).

Figure 16. I-5 North HOV Lanes, Seattle, Washington

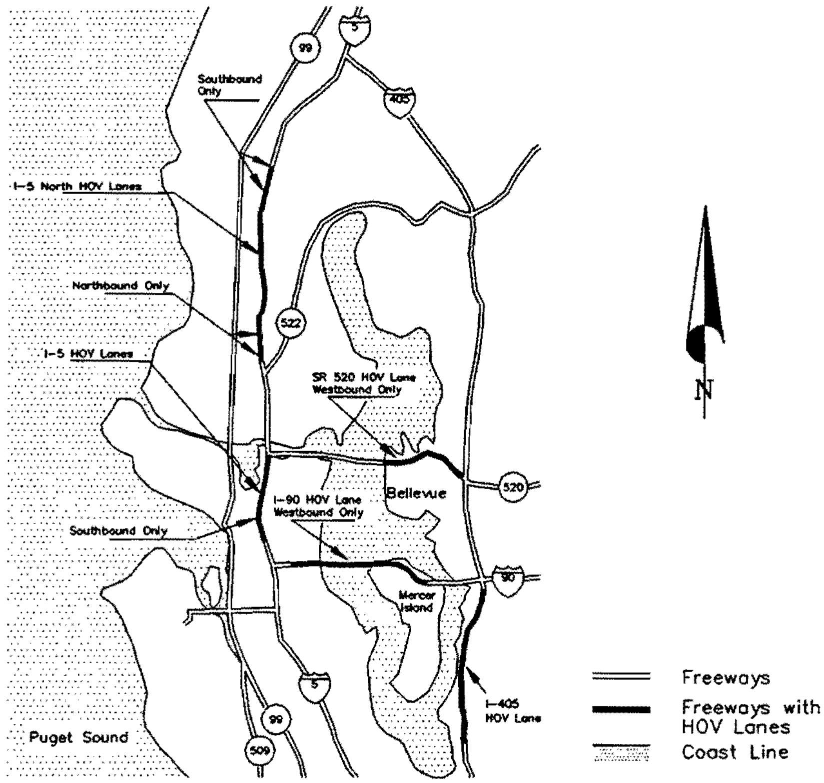
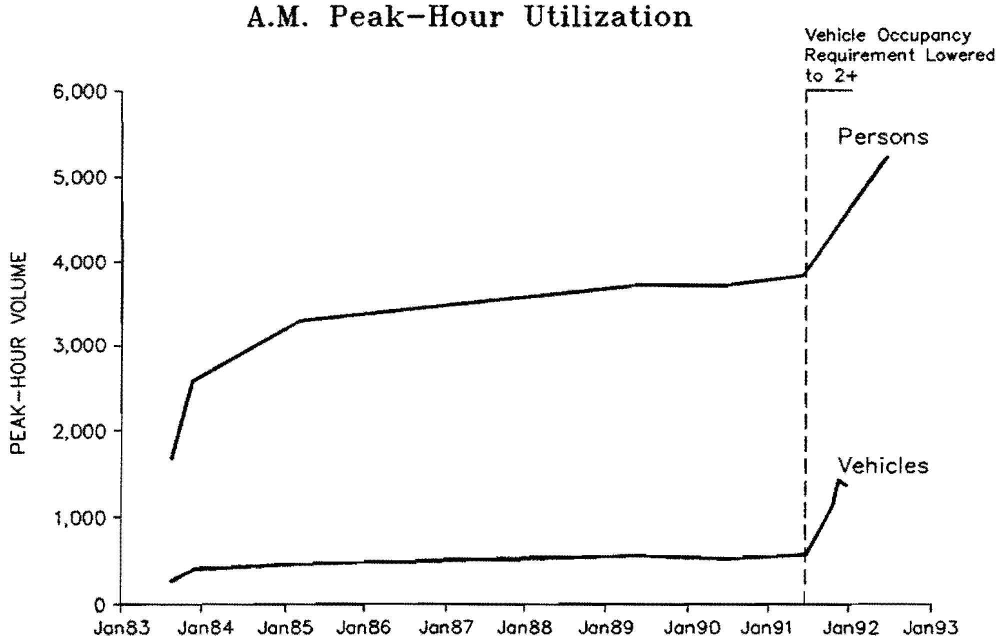


Figure 17. I-5 North HOV Lanes, A.M. Peak-Hour Utilization



Shirley Highway (I-395) — Washington, D.C./Northern Virginia

The opening of the initial five miles of bus-only lanes on the Shirley Highway (I-395) in 1969 represented the first use of an HOV facility on a freeway in the United States. The location of the Shirley Highway HOV lanes is shown in Figure 18. The project, which was opened in several stages between 1969 and 1975, is now approximately 11 miles in length. The two-lane, reversible HOV facility is located in the median of the freeway and is separated from the general-purpose traffic lanes by concrete barriers. Park-and-ride lots and direct access ramps are provided at strategic points along the corridor.

A number of changes have been made in the occupancy requirements and operating hours for the Shirley Highway HOV lanes. Only buses were allowed to use the facility during the first four years of operation. In December 1973, the HOV lanes were opened to vanpools and carpools with four or more persons. In January 1989, a 3+ carpool definition was implemented for the facility. Until 1985, the lanes operated in the inbound direction from 11:00 p.m. to 11:00 a.m. and in the outbound direction from 1:00–8:00 p.m. The lanes were closed for maintenance and reversing the flow of HOV traffic during other hours. As a result of a Congressionally-mandated demonstration project in the spring of 1985, the operating hours of the HOV lanes were changed to 6:00–9:00 a.m. in the inbound direction and 3:30–6:00 p.m. in the outbound direction. The lanes are open to general-purpose traffic during the remainder of the day, except when they are closed to reverse the flow of traffic. Bus service levels and service orientation were changed in 1983 with the opening of the Metrorail Yellow Line, resulting in a slight decline in vehicle and person volumes on the HOV lanes.

The historical morning peak-hour vehicle and person volumes for the Shirley Highway HOV lanes are shown in Figure 19. Approximately 39 peak-hour buses, carrying some 1,920 persons, used the HOV lanes during the first year of the project (*11*). By 1974, that number had increased to 279 buses and 11,340 passengers (*11*). The slight decline resulting from the opening of the Metrorail Yellow Line in 1983 is also illustrated in Figure 19. As of 1991, the morning peak-hour volume for buses, vanpools, and carpools was approximately 2,773 vehicles, carrying some 18,406 persons (*12*).

Figure 18. Shirley Highway HOV Lanes, Washington, D.C./Northern Virginia

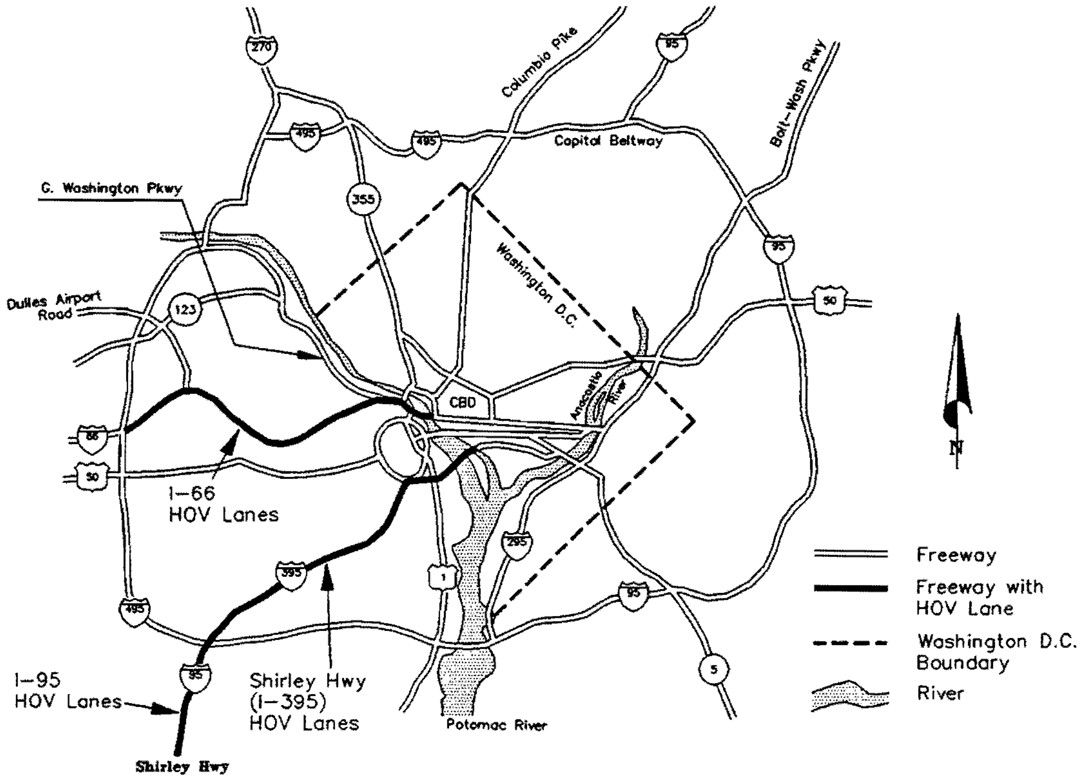
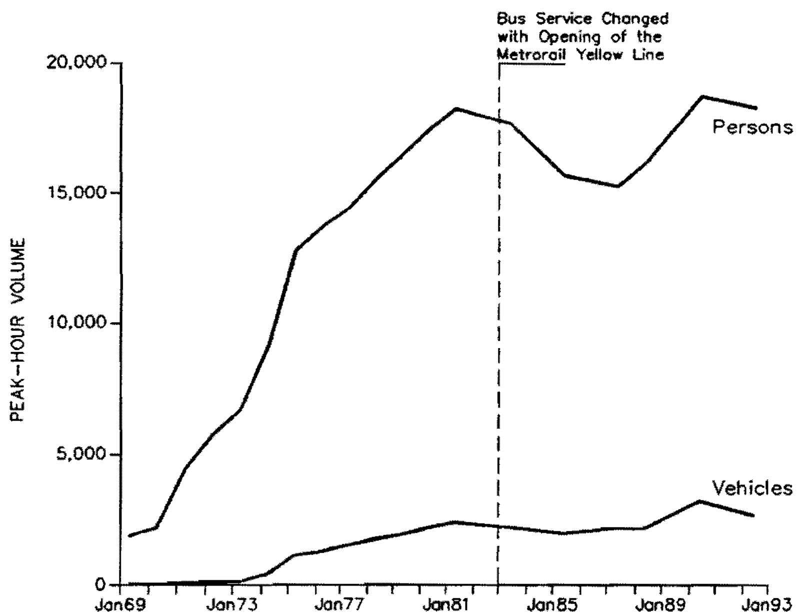


Figure 19. Shirley Highway HOV Lanes, A.M. Peak-Hour Utilization



V.

Future Directions and Issues

The use of HOV facilities continues to increase in metropolitan areas across the country. New projects are being planned and implemented and existing facilities are being extended. In addition, further consideration of HOV projects may be influenced by recent federal legislation. For example, the Clean Air Act Amendments of 1990 and the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 provide legislative support and funding for HOV facilities. Further, in some areas, state and local programs and policies provide additional support for HOV projects.

The federal Clean Air Act Amendments require areas in violation of the EPA ozone and carbon monoxide standards to meet certain criteria by established deadlines. Specifically, some 100 areas failing to meet the federal standards must develop pollution control strategies and congestion management systems to reduce vehicle-miles of travel and increase vehicle occupancies. By encouraging greater use of buses, vanpools, and carpools, HOV facilities have the potential to help meet those requirements.

Sections of the ISTEA further support consideration of HOV projects in appropriate applications. For example, the ISTEA places limitations on expanding the capacity of the interstate highway system in air quality non-attainment areas. New lane-miles are not eligible unless they are for HOV or auxiliary lanes. The Congestion Mitigation and Air Quality Improvement Program of the ISTEA further limits new capacity to HOV facilities, although the lanes may be opened to general-purpose traffic during parts of the day. In addition, the ISTEA provides greater flexibility and discretion in the use of federal funds. State and local governments are given more flexibility in determining the appropriate solutions, whether transit or highway, to transportation problems in their areas.

This chapter presents a summary of HOV projects currently in the planning and design stages and discusses some of the issues associated with HOV facilities where additional research is needed. These are presented to help ensure that future HOV projects are planned, designed, implemented, and operated in a cost-effective and efficient manner.

Proposed HOV Projects and Project Extensions

Table 7 provides a summary of the new HOV projects and project extensions identified through the research conducted as part of this assessment. The table provides a listing of the project, the type of HOV facility, the project length, and the anticipated completion date. The listing is not indented to be all-inclusive; rather it is represents some of the projects that have been identified as reasonably committed with the potential to be in operation by the year 2000. Obviously, the projects included in Table 7 are subject to change.

Implementation of all the projects listed will result in approximately 542 additional miles of HOV lanes by the year 2000. This represents a significant increase from the estimated 378 miles in operation in the fall of 1992. If all the projects listed are completed, approximately 1,000 miles of HOV lanes will be in operation on freeways or in separate rights-of-way in North America by the year 2000.

Table 7. Summary of Proposed HOV Facilities

location, type of project	length (miles)	anticipated completion date
Boston, Massachusetts		
I-90, concurrent flow lanes	1	late 1990s
I-93S, barrier-separated lanes	1.5	late 1990s
I-93N, concurrent flow lane	0.5	late 1990s
Charlotte, North Carolina		
US 73, exclusive reversible lanes	3	1996
Dallas, Texas		
I-635, combination two-direction/exclusive lanes	21	late 1990s
I-35E (Stemmons), reversible-flow lanes	17	mid-to-late 1990s
I-35E, concurrent flow lanes	10	mid-to-late 1990s
US 75 (Central Expressway), reversible-flow lanes	10	mid-to-late 1990s
Denver, Colorado		
I-25, exclusive reversible lanes	12	1994
Ft. Lauderdale, Florida		
I-95, concurrent flow lanes	27	1990, 1991
Hartford, Connecticut		
I-91, concurrent flow lanes	9	late 1992
Houston Texas		
I-45N (North), extension of reversible exclusive lane	6.2	1994, 1997
I-45S (Gulf), extension of reversible exclusive lane	9	1993
US 59S (Southwest), reversible exclusive lane	15.8	1993, 1996
US 59N (Eastex), two-direction exclusive facility	20	mid-to-late 1990s
Los Angeles Area		
I-5, two-direction exclusive lanes	21	early 1990s
I-10 (San Bernardino), extension of concurrent flow lanes	6	mid-to-late 1990s
I-210, concurrent flow lanes	37	mid 1990s
I-110 (Harbor Freeway), exclusive lanes	23	mid 1990s
I-105 (Century Freeway), concurrent flow lanes	18	mid 1990s

Table 7. Summary of Proposed HOV Facilities (continued)

location, type of project	length	anticipated completion date
Los Angeles Area (continued)		
SR 118, concurrent flow lanes	26	mid-to-late 1990s
SR 91 (Orange Co.), concurrent flow lanes	19	1993 (12 mi.), 1996 (6 mi.)
SR 91 (Los Angeles Co.), concurrent flow lanes	13	mid 1990s
I-405, concurrent flow lanes	23	1994 (10 mi.), 1997 (13 mi.)
I-605 (Orange Co.), concurrent flow lanes	2	1993
I-605 (Los Angeles Co.), concurrent flow lanes	8	1993
Miami, Florida		
I-95, exclusive facility, one lane in each direction	1.8	1995
Minneapolis-St. Paul, Minnesota		
U of M Intercampus Busway, extension of exclusive facility	1.2	mid-to-late 1990s
Nashville, Tennessee		
I-65, concurrent flow lanes	8	mid 1993
New Jersey/New York City		
I-80, concurrent flow lanes	11	1995
I-495 (Long Island Expressway), concurrent flow lanes	23	1995-1999
Norfolk, Virginia		
I-64, concurrent flow lanes	2	mid 1993
SR 44, concurrent flow lanes	10	mid 1993
Ottawa, Ontario, Canada		
extension to transitway system, planning additional sections	5	early 1990s
Phoenix, Arizona		
SR Loop 202 (East Papago Freeway)	9	1992
I-10, extensions to concurrent flow lanes	8	1992 (3 mi.), 1995 (5 mi.)
Pittsburgh, Pennsylvania		
Airport Busway	8.1	1997
Sacramento, California		
Route 99, concurrent flow lanes	11	1990 (3 mi.), 1993 (8 mi.)
San Diego, California		
I-5, concurrent flow lanes	21	late 1990s
I-15, concurrent flow lanes	12	late 1990s
San Francisco Bay Area		
I-580, concurrent flow lanes	6.1	1994-1995
I-80, concurrent flow lanes	35.2	1990
I-680, concurrent flow lanes	14.4	mid 1990s
US 101, concurrent flow lanes	15.2	1990
Lawrence Expressway, shoulder lanes	8.0	1990
US 101, extension of concurrent flow lanes	7.7	
US 101, extension of concurrent flow lanes	5.9	
I-280, extension of concurrent flow lanes	9.6	
I-80, concurrent flow lanes	4	
SR 237, concurrent flow lanes	15	mid 1990s
SR 85, concurrent flow lanes	16	1994
Seattle, Washington		
I-90, two-lane reversible exclusive facility	14	1994
I-5, extensions to existing lanes (6 projects)	39	1992-1997
I-405, extensions to concurrent flow lanes (5 projects)	31	1993-2000
SR 167, concurrent flow lanes	13	1996
Vancouver, B.C., Canada		
H-7 (Barnet Highway), concurrent flow lanes	6	1993
Washington, D.C./Northern Virginia		
I-95, extension of exclusive reversible lanes	19	mid 1990s
I-66, concurrent flow lanes	7.7	1993

Issues and Future Research Needs

As the number of HOV facilities continues to grow, the understanding of issues associated with the planning, design, implementation, and operation of HOV projects has also increased dramatically. However, even with this increased understanding, there are still a number of issues where experience is lacking or where there is disagreement over the most appropriate approach. These issues and some of the areas where additional research is needed are discussed in this section.

Support Facilities — Data from the different HOV projects seem to indicate that the presence of park-and-ride lots, transit transfer centers, direct access ramps, and other support facilities enhance the performance of HOV facilities. Park-and-ride lots provide convenient collection areas for both bus riders and carpool and vanpool users. The number and size of park-and-ride facilities varies among the different HOV projects. Parking lots of less than 300 spaces appear to be most common, although a number of exclusive HOV lanes are served by park-and-ride lots with over 1,000 spaces. Although a number of techniques exist, estimating the demand for park-and-ride facilities remains an inexact science.

A more detailed examination of the role supporting facilities play in encouraging HOV use would be a benefit. Further, additional research on developing techniques for estimating the demand for these supporting elements would be of value.

Support Services — Recent experience with HOV projects seems to indicate that the types and levels of support services provided can influence utilization of the facility. Thus, it appears that simply providing an HOV lane is not enough to ensure maximum use. Programs focusing on improved bus service, ridesharing, parking supply and pricing, and travel demand management (TDM) have all been used in different areas to promote and support HOV facilities.

A number of areas are continuing to experiment with a variety of TDM programs, primarily those focusing on providing additional incentives to individuals who use a high-occupancy mode. These include the guaranteed ride home program, preferential parking and/or reduced parking charges for carpools and vanpools, monetary incentives or additional vacation time for using alternative commute modes, providing access to midday shuttle services, and providing on-site services at the work place. The ongoing monitoring and evaluation of these programs should provide additional experience on the most appropriate types of support services to use with HOV facilities.

Operations and Enforcement — The understanding of the major operational and enforcement issues associated with HOV projects has improved significantly in the past few years. The importance of addressing operational and enforcement concerns in the planning and design stage has been identified as an important consideration. Early consideration of these issues is critical to ensuring that the facility operates in the intended manner and can be easily enforced.

Many areas are continuing to examine the use of different enforcement techniques. The use of "HERO" programs in Seattle and other areas appears to be effective in lowering violation rates and providing an educational tool to promote the use of higher-occupancy modes. The use of advanced technologies and advanced traffic management systems may further assist with enforcement activities and improve the overall operation of the HOV facilities.

A number of areas, including Houston, Seattle, Minneapolis, Los Angeles/Orange County, San Diego, and the Washington, D.C. region, are testing the application of a variety of intelligent vehicle highway system (IVHS) technologies with HOV lanes. It appears that the application of IVHS technologies may hold benefits for increasing the use of HOVs, improving the operation of the facilities, enhancing enforcement efforts, and improving the efficiency of the corridors. Additional research is needed to identify appropriate applications, analyze potential benefits, and evaluate operation tests and demonstration programs.

Questions concerning the safety and accident rates associated with both the use of HOV lanes and the impact on the adjacent general-purpose lanes have also been raised. Additional analyses of the safety and accident experience with different HOV facility types, designs, and operating characteristics would be of great benefit in responding to such questions. The results of these analyses would also be of help in refining design guidelines and operating procedures to improve safety considerations.

Additional research on the impact of HOV facilities on bus operations is also needed. The analysis conducted as part of this assessment included a very preliminary examination of some of the benefits realized by transit systems through the implementation of HOV lanes. Factors such as improved travel speeds, decreased travel times, improved on-time performance, and enhanced schedule reliability were briefly reviewed. A more detailed examination is needed, however, to fully determine the impacts on bus service productivity and operating costs.

Evaluating HOV Facilities — As outlined in this report, one of the major activities of this assessment was the development of a suggested approach and procedures for evaluating operating HOV projects. Although evaluating the impact of HOV facilities continues to be a topic of considerable discussion and interest, only a few examples of ongoing comprehensive evaluations exist. The most extensive ongoing evaluation of HOV facilities is being conducted in Houston, Texas. The evaluation of the Houston HOV lanes has been sponsored by the Texas Department of Transportation and conducted by the Texas Transportation Institute. Houston METRO has also supported some elements of the evaluation program. Additional evaluations and the ongoing monitoring of HOV projects around the country—based on the procedures developed in the assessment—would help advance the understanding of the effectiveness of different types of HOV projects.

Design — It appears that many HOV projects continue to be designed as "special case" facilities. Even within the same urban area, HOV facilities have been designed and operated differently. However, it appears that, both within and among metropolitan areas, design practices for HOV projects are becoming more standardized. This is important to help insure that safe and efficient facilities are designed and operated. Recently, the American Association of State Highway and Transportation Officials (AASHTO) published revised guidelines on the design of HOV facilities and park-and-ride lots. In addition, a report on the design features of HOV facilities has been prepared by a technical committee of the Institute of Transportation Engineers (ITE). Finally, states such as Texas and California have developed guidelines for use within the state. All of these documents provide improved guidelines on the design of HOV lanes and supporting facilities. Additional issues associated with the design of HOV facilities still remain, however. Additional research into these issues and identifying alternative designs may be appropriate.

Air Quality Impacts of HOV Facilities — Currently, no comprehensive assessment has been conduced on the impact of HOV facilities on air quality levels and energy consumption. The few analyses that have been conducted have focused primarily on the use of computer models to simulate the potential impacts of alternative transportation improvements. Given the importance placed on HOV projects in both the Clean Air Act Amendments and the Intermodal Surface Transportation Efficiency Act, more research in this area is critical. This research should first focus on the development of appropriate methods and techniques for evaluating the impact of HOV facilities on air quality and energy. Once this has been accomplished, a number of evaluations should be conducted of different HOV projects in North America.

VI.

Conclusion

Given current trends, it appears that mobility, traffic congestion, and air quality issues will continue to be major concerns in metropolitan areas throughout the country. The research conducted as part of this assessment indicates that HOV facilities represent one viable approach to addressing some of these concerns. When implemented in appropriate corridors and operated properly, HOV projects are an effective means of moving people instead of vehicles. The travel time savings and travel time reliability provided by HOV facilities offer incentives that many commuters find attractive enough to change from driving alone to taking the bus, carpooling, or vanpooling.

However, HOV lanes are not appropriate in all situations, and implementing an HOV lane does not preclude the need for making other improvements. Further, supporting facilities and policies are needed to maximize the benefits of HOV projects. Thus, HOV projects should not be viewed as the total solution to the transportation problems facing many metropolitan areas.

High-occupancy vehicle facilities do represent one realistic approach that transportation professionals and policy makers can use to help address current and future transportation problems. When implemented with supporting policies, facilities, programs, advanced technologies, and other innovative and creative approaches, HOV projects offer a promising approach for many areas.

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