NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP Report 414

HOV Systems Manual

Transportation Research Board
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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Report 414

HOV Systems Manual

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Subject Areas

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state and local governmental agencies, universities, and industry; its relationship to the National Research Council is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the National Research Council and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the National Research Council and the Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

Note: The Transportation Research Board, the National Research Council, the Federal Highway Administration, the American Association of State Highway and Transportation Officials, and the individual states participating in the National Cooperative Highway Research Program do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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NOTICE

The project that is the subject of this report was a part of the National Cooperative Highway Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and, while they have been accepted as appropriate by the technical committee, they are not necessarily those of the Transportation Research Board, the National Research Council, the American Association of State Highway and Transportation Officials, or the Federal Highway Administration, U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical committee according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

To save time and money in disseminating the research findings, the report is essentially the original text as submitted by the research agency. This report has not been edited by TRB.

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FOREWORD

By Staff
Transportation Research Board

This report is a comprehensive and detailed HOV (High-Occupancy Vehicle) Systems Manual that incorporates current guidelines and practices. The contents of this Manual are, therefore, of immediate interest to both highway and transit professionals in planning, designing, implementing, operating, marketing, and enforcing HOV systems. The Manual is also useful to those charged with achieving air-quality and congestion-management goals as well as policy makers.

The Texas Transportation Institute (TTI) at Texas A&M University in College Station, Texas, was awarded NCHRP Project 3-53, "Development of a HOV Systems Manual," to evaluate existing formal and informal specifications and procedures for various aspects of HOV systems, to identify alternatives and discuss their applicability, and to prepare a manual that would promote consistency and effectiveness in future applications and emphasize coordinated development of all elements of the HOV system. TTI was assisted in this effort by Parsons Brinkerhoff Quade and Douglas, Inc. (PB), in Orange, California, and Pacific Rim Resources, Inc. (PRR), in Seattle, Washington.

The early chapters (1 through 4) in the manual include an introduction to HOV facilities and address policy considerations and HOV facility planning. Chapters 5 and 6 describe the operation and enforcement of HOV facilities on freeways and separate rights-of-way and the design of these facilities. Separate chapters (7 and 8) discuss the same subjects for arterial street HOV facilities. Subsequent chapters (9 through 13) detail transit and support services and facilities, supporting programs and policies, implementing HOV facilities, public involvement and marketing programs, and monitoring and evaluating HOV facilities. This manual is a companion report to *NCHRP Report 413*, "Development of an HOV Systems Manual," also prepared as a part of NCHRP Project 3-53 by TTI, PB, and PRR. *NCHRP Report 413* documents many gaps and weaknesses in the current guidelines and practices. These gaps and weaknesses are noted in each pertinent chapter of this manual.

NCHRP Report 413 presents an implementation plan for transferring the completed HOV Systems Manual into practice. It also suggests that, as the gaps and weaknesses are filled by future research, those research results should be presented in the same format as this manual and be published on three-holed paper for insertion in the manual. The *NCHRP Report 413* further recommends the manual be completely reviewed every 5 years to determine major update needs and notes that a group well suited for implementing this review process and for presenting future research needs to the NCHRP is the TRB Division A Committee A3A06, High-Occupancy Vehicle Systems.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

The HOV Systems Manual was prepared under NCHRP Project 3-53 by the Texas Transportation Institute (TTI), a part of the Texas A&M University System, Parsons Brinckerhoff Quade and Douglas, Inc., and Pacific Rim Resources, Inc. The Texas A&M Research Foundation was the contractor for this study. In addition to the authors, the following individuals contributed to the development of this Manual. Ms. Pam Rowe, TTI, was responsible for word processing, chapter layout, and Manual design. Ms. Bonnie Duke, Mr. Pat Beck, Mr. Ivan Lorenz, Mr. Stephen Farnsworth, Ms. Laura Higgins, and Mr. Todd Carlson, TTI, assisted with the graphics, word processing, and proofreading. Ms. Mary Halliburton, Parsons Brinckerhoff Quade and Douglas, provided ongoing support during the study. Mr. Lloyd Crowther, NCHRP staff, and members of the Project 3-53 Panel provided overall guidance and direction throughout the research study and the development of the Manual. The assistance of all these individuals is both recognized and greatly appreciated.

CHAPTER 1—GUIDE TO THE HOV SYSTEMS MANUAL

Page

I. WELCOME TO THE HOV SYSTEMS MANUAL

This manual provides a comprehensive guide to developing policies, planning, designing, implementing, marketing, operating, enforcing, and evaluating HOV facilities. The HOV Systems Manual is a practical and easy to use reference for transportation professionals at all levels and with a variety of backgrounds. It can also be used by policy makers to review the key elements associated with various aspects of HOV projects. This chapter provides a quick guide to the topics covered in the individual chapters and the format used throughout the manual.

- **Chapters at a Glance—Finding What You Need**. This section provides a quick guide to the major topics covered in each of the chapters in the manual.
- **Chapter Format**. A common format is followed in the individual chapters to allow users to easily find topics of interest. This section highlights the major elements covered in each chapter.

II. CHAPTERS AT A GLANCE—FINDING WHAT YOU NEED

The manual is divided into the following 13 chapters. The titles of each chapter and the major topics covered are highlighted.

Chapter 1—Guide to the HOV Systems Manual
This chapter provides a quick guide for users of the HOV Systems Manual. The content and format of the remaining chapters are described.

Chapter 2—Introduction to HOV Facilities
Metropolitan areas today are facing a variety of issues associated with the surface transportation systems. This chapter provides a summary of current issues, followed by a discussion of the HOV concept, the role HOV facilities can play in addressing some of these concerns, and the current status of HOV projects in North America. The different types of HOV facilities in use on freeways, in separate rights-of-way, and on arterial streets are highlighted. Key elements of successful projects are also summarized.

Chapter 3—Policy Considerations with HOV Facilities
Policies relating to HOV facilities may be adopted at the federal, state, regional, and local levels. These policy guidelines, which can enhance the development and operation of HOV facilities, are discussed in Chapter 3. The role of HOV facilities in the overall transportation system is described first. The evolution of HOV policies in North America are summarized, and examples of policies currently in use are highlighted. Policy considerations that may influence the development and operation of HOV facilities are also identified. These include items such as air quality and environmental legislation, congestion management initiatives, trip reduction programs, and other federal, state, and local efforts. Potential funding sources for HOV facilities are

identified. The process of developing HOV policies are highlighted, including the groups involved and the key elements that should be considered.

Chapter 4—Planning HOV Facilities
A variety of tools and techniques are available to help plan HOV facilities. This chapter provides a comprehensive overview of the steps involved in planning HOV facilities on freeways, in separate rights-of-way, and on arterial streets. Approaches appropriate for regional, corridor, and facility level planning are presented. Available tools and techniques for demand estimation are summarized along with approaches for assessing the potential environmental impacts of HOV facilities.

Chapter 5—Operation and Enforcement of HOV Facilities on Freeways and in Separate Rights-of-Way
The safe and efficient operation and enforcement of HOV facilities located on freeways and in separate rights-of-way is critical to the success of these projects. Topics addressed in this chapter include the development of an operation and enforcement plan, HOV operational alternatives, access options, vehicle eligibility and vehicle-occupancy requirements, transit operations, hours of operation, enforcement, incident management, and special operational consideration. This last section includes a discussion of converting a general-purpose lane to an HOV lane, priority pricing on HOV facilities, Intelligent Transportation Systems (ITS) and HOV projects, truck use of HOV lanes, converting an HOV lane to a transit fixed-guideway facility, and slow moving vehicles.

Chapter 6—Design of HOV Facilities on Freeways and in Separate Rights-of-Way
Ensuring that HOV facilities on freeways and in separate rights-of-way are designed in a safe and efficient manner is key to successful projects. Chapter 6 presents the design elements associated with HOV facilities on freeways and in separate rights-of-way. It includes information on the design process, the groups that are usually included in this process, vehicle design criteria, and the design features of barrier separated, concurrent flow, and contraflow HOV lanes, as well as different types of access treatments. Examples of cross-sections, signing and pavement markings, and other design elements are presented.

Chapter 7—Operation and Enforcement of Arterial Street HOV Facilities
The operation and enforcement of HOV facilities on arterial streets is important to the success of projects. This chapter describes the various approaches that can be used with arterial street HOV facilities, the advantages and disadvantages of different techniques, and the issues that may need to be considered with arterial street applications. It also outlines possible institutional issues associated with arterial street HOV facilities.

Chapter 8—Design of Arterial Street HOV Facilities
Ensuring that arterial street HOV facilities are designed in a safe and efficient manner is key to successful projects. Chapter 8 discusses the design elements associated with HOV facilities on arterial streets. It includes information on steps in the design process, the groups that are usually included in this process, vehicle design criteria, and design

features of various types of arterial street HOV facilities. Examples of cross-sections, signing and pavement markings, and other design elements are presented.

Chapter 9—Transit and Support Services and Facilities
Transit and support services and facilities are critical components of many successful HOV projects. This chapter presents the various transit service strategies and supporting fixed facilities that may be used with different types of HOV projects. These include transit stations, park-and-ride facilities, park-and-pool lots, and other supporting elements. It also describes integrating HOV and rail transit services and joint development strategies with HOV facilities.

Chapter 10—Supporting Program and Policies
The development of an HOV facility does not automatically guarantee that it will be used. A number of supporting programs and policies have been identified as important to the successful operation of an HOV project. This chapter discusses other supporting programs and policies that may contribute to the overall success of HOV facilities. These include regional rideshare programs, guaranteed ride home services, parking management and parking pricing, employer-based programs, growth controls, land use policies, and zoning ordinances.

Chapter 11—Implementation Considerations with HOV Facilities
Ensuring that HOV facilities are implemented in a safe and efficient manner is critical not only to the success of the project, but also to the operation of the roadway or corridor. A number of factors may contribute to help ensure that projects are implemented to minimize traffic disruption during construction, and to maximize the operating effectiveness of the HOV lane and the overall facility. This chapter discusses techniques and approaches to meet these objectives. Involving the appropriate groups, developing an implementation plan, project phasing and sequencing, project bidding and contracting, managing traffic during construction, operator training, pre-operational testing, and other considerations are presented.

Chapter 12—Public Involvement and Marketing Programs
Public involvement, market research, and promotional and informational campaigns are all critical components in planning, designing, implementing, and operating successful HOV facilities. This chapter provides a comprehensive summary of the various elements to be considered in developing, implementing, and evaluating public involvement and marketing programs with HOV facilities. Topics covered include public participation, market research, using in-house and consultant resources, marketing campaigns, funding marketing efforts, and evaluating marketing programs. Case study examples of successful and innovative public involvement techniques and marketing programs are also highlighted.

Chapter 13—Monitoring and Evaluating HOV Facilities
The development and implementation of an ongoing program to monitor and evaluate HOV facilities is important to measure progress toward meeting the goals and objectives

of a project. Monitoring programs also provide needed information for making operational changes, for planning other facilities, and for comparing the experience with various facilities on a national basis. This chapter highlights these and other benefits of a comprehensive evaluation program and describes the elements to be included. The processes for conducting an ongoing monitoring and evaluation program are presented and data collection techniques are discussed. Case study examples of evaluation programs with HOV facilities are also included.

Appendix A—Glossary of Terms
A number of terms are frequently associated with planning, designing, funding, implementing, marketing, operating, enforcing, and evaluating HOV facilities. This glossary presents and defines those terms used in the manual, as well as those practitioners are likely to encounter. A listing of glossaries on related topics is provided at the end of the appendix should the reader wish to consult additional sources.

Appendix B—Glossary of Agencies, Organizations and Legislation
A number of agencies, organizations, and federal legislation are commonly associated with different elements of the surface transportation system, including HOV facilities. A listing of these groups and legislation is provided as a separate appendix to accommodate easier updating to reflect new legislation or changes in organizations and agencies.

Appendix C—Characteristics of Selected HOV Facilities and Proposed Projects in Separate Rights-of-Way and on Freeways
A listing of existing HOV facilities in North America in separate rights-of-way and on freeways is provided in this Appendix. Information is presented on the number of HOV lanes, the project length, the HOV operating period, the vehicle eligibility requirement, and the vehicle-occupancy requirement. The Appendix also contains a list of HOV projects in the planning, design, and construction process.

III. CHAPTER FORMAT

The individual chapters follow a common format. This section highlights the elements included in the individual chapters.

Table of Contents
A table of contents is provided at the start of each chapter allowing users to easily find topics of interest.

Introduction
Following the table of contents, an introduction highlights the major topics covered in the chapter.

Groups Involved

The next section discusses the agencies and groups commonly involved in the specific activity or topic addressed in the chapter. For example, the agencies that typically participate in planning various types of HOV facilities are described in Chapter 4, while those involved in operating HOV facilities on freeways and in separate rights-of-way are discussed in Chapter 5. The roles and responsibilities of the various agencies and groups are highlighted in a table and described briefly in the text.

Specific Elements and Case Studies

The elements, issues, and activities related to the specific topic comprise the major portion of each chapter. Case study examples and information on specific projects are provided.

Further Research

Each chapter concludes with a discussion of areas where further research is needed. These research needs were identified through the survey conducted in the first phase of the project and through the analysis conducted in developing each chapter.

References and Additional Information

The references used are provided at the end of each chapter. A listing of additional sources of information on topics covered in the chapter is also provided.

Cross-References

Cross-references to material contained in other sections are provided as appropriate throughout the manual. In some instances, information discussed extensively in one chapter is briefly highlighted in another. In these cases, a reference to the more detailed description is provided.

Updated Information

A three-ring binder is used for this manual to allow for easy updating and modification. Please contact NCHRP of the Transportation Research Board for information on new and updated sections.

CHAPTER 2—INTRODUCTION TO HOV FACILITIES

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LIST OF FIGURES

I. INTRODUCTION

This chapter provides an overview of the major surface transportation issues in metropolitan areas today, and the role HOV facilities can play in addressing some of these concerns. A summary of current issues is presented first, followed by a discussion of the HOV concept and the current status of HOV projects in North America. The different types of HOV facilities in use on freeways, in separate rights-of-way, and on arterial streets are highlighted. Key elements of successful projects are also summarized. The chapter is divided into four sections covering the following topics.

- **Transportation Issues in Metropolitan Areas**. This section describes the major surface transportation issues facing many metropolitan areas today. Current concerns relating to traffic congestion, air quality, the environment, mobility, and limited financial resources are discussed. The various approaches that may be considered to address these issues are highlighted including alternatives to building additional capacity.

- **Concept, Background, and Effectiveness of HOV Facilities**. This section provides an overview of the concept, purpose, and effectiveness of HOV facilities. The travel time savings and travel time reliability provided by HOV facilities should encourage greater use of buses, carpools, and vanpools. The people moving capacity—rather than the vehicle moving capacity—of HOV facilities is highlighted. The growth in the number of HOV projects is discussed and the effectiveness of selected HOV projects is summarized.

- **Types of HOV Facilities**. This section provides an introduction to the various types of HOV facilities. A general description is provided of HOV facilities on freeways, in separate rights-of-way, and on arterial streets. In addition, the use of various supporting facilities, services, programs, and policies is described, along with a comprehensive HOV systems approach.

- **Key Elements of Successful HOV Facilities**. This section summarizes the key elements of successful HOV projects. The need for interagency coordination, public involvement, logical HOV segments, education and marketing programs, and supporting facilities, services, policies, and programs is discussed. The importance of a comprehensive systems approach, that includes all HOV-related facilities, services, and policies, is highlighted. A realistic assessment of the impact of HOV projects is provided, and the fact that HOV facilities are not appropriate in many instances is noted.

II. CURRENT TRANSPORTATION ISSUES IN METROPOLITAN AREAS

Many metropolitan areas are facing significant issues related to different aspects of the surface transportation system. Concerns about increasing levels of traffic congestion, declining mobility, and increasing air quality and environmental problems have been voiced on many fronts. Complicating the situation, most metropolitan areas are facing these issues in a time of limited resources, both in terms of available funding for the expansion of highway and transit systems, and land for new construction. The following issues represent a few of the more serious concerns associated with the surface transportation system in many metropolitan areas today.

Traffic Congestion. Most metropolitan areas are continuing to experience significant growth in population and employment levels. These increases translate into additional demands on the transportation system. More people mean additional vehicles on the roadway system and more goods needing to be transported. At the same time, the transportation system has not been expanded in many metropolitan areas, resulting in increased levels of traffic congestion in major travel corridors. The cost of congestion has been estimated—based only on the costs associated with fuel consumption and delay—at some $44 billion annually for the 50 largest urban areas in the country (1).

Land Uses and Development Patterns. The growth in population and employment has resulted in changes in land uses and development patterns in most metropolitan areas. The growth in both residential and business development in most areas continues to be in suburban and exurban locations. As a result, suburb-to-suburb commuting has replaced travel to and from the central business district (CBD) as the major commute pattern in many areas. These changes in development patterns have placed additional demands on the transportation facilities serving suburban areas.

Air Quality. The emissions generated from motor vehicles represent a major source of air pollution. Motor vehicles in the United States have been estimated to account for some 32 percent of the nation's emission of carbon dioxide (2). As a result, air quality is a significant concern in many urban areas. Currently, 96 metropolitan areas violate the Environmental Protection Agency's (EPA's) ozone standard, and 51 violate the carbon monoxide standard. Classified by the EPA as non-attainment areas, the Clean Air Act Amendments of 1990 require these areas to meet specific requirements by established dates or face potential sanctions (3).

Environment. In addition to declining air quality, issues relating to water quality, noise, habitat, endangered species, and disruption of neighborhoods are concerns in many areas. Many areas are taking steps to mitigate possible concerns related to the impact of the transportation system on these elements.

Declining Mobility. Increases in traffic congestion have resulted in declining levels of mobility in many areas. Trips that were made relatively quickly and easily a few years ago, now take much longer. Declining levels of mobility may negatively impact the economic vitality and the quality of life in metropolitan areas. Residents, visitors, and businesses may all be affected by declining mobility.

Limited Resources. Transportation issues represent just some of the many problems in metropolitan areas. Transportation projects must compete for limited resources with other demands such as education, police and fire protection, and social services. Fiscal constraints are serious concerns in most areas, with limited funding available from federal, state, and local sources.

Realizing that there is no single solution, transportation professionals and decision makers have been pursuing a variety of techniques and approaches to address these problems. HOV facilities represent one viable technique being used in many areas to respond to these concerns. Many other strategies are also appropriate for consideration. The challenge to transportation professionals and decision makers is to match the best approach to the specific issues and opportunities in an area. The following techniques and improvements are being considered and implemented in metropolitan areas throughout the country.

New Roadways. The traditional approach to addressing traffic congestion and transportation capacity concerns has been to build new freeways and roadways. The Interstate system represents the most visible and most significant addition to the transportation system over the last 30 years, but new roadways have also been constructed in metropolitan areas throughout the country. The addition of new freeways and roadways is not a realistic alternative in many urban areas today due to lack of right-of-way, environmental concerns, and limited resources.

Adding Lanes to Existing Freeways and Roadways. Adding lanes to existing facilities has also been a traditional approach to dealing with increasing demands. Widening freeways or roadways, or in some cases, double decking freeways, provides additional capacity to accommodate more vehicles. Available right-of-way, funding, environmental issues, and legislative constraints represent limiting factors to this approach. Also, adding lanes to one facility will result in more vehicles not only on that facility but also on other parts of the system, which may create the potential for further congestion and capacity problems.

Public Transportation Systems. Adding new or expanding existing transit systems represents another approach being used in some areas. Commuter rail, heavy rail, light rail transit (LRT), express bus services, and other approaches all represent viable alternatives for some situations and areas.

Transportation Systems Management (TSM). Transportation Systems Management (TSM) is a term used to denote lower cost alternatives that can be implemented relatively quickly to improve the operation of the transportation system. Examples of TSM techniques include optimizing and coordinating signal timing, providing priority for transit vehicles at traffic signals, ramp metering, and other operational strategies. Some HOV facilities are considered TSM improvements. These tend to be queue jump treatments or other projects that can be implemented relatively quickly and do not involve significant capital expenditures.

Travel Demand Management (TDM). Travel Demand Management (TDM) strategies focus on reducing the demand on transportation facilities, moving travel into less congested times of the day, and removing trips from the roadway system altogether. Examples of TDM techniques include ridesharing services, guaranteed ride home programs, parking management, and parking pricing. Alternative work strategies, such as staggered work hours, flexible work hours, compressed work weeks, and telecommuting are also considered TDM strategies.

Toll Facilities. Toll roads, bridges, and tunnels are a further option for addressing transportation needs. These types of facilities have been used more extensively in some areas than in others. Toll facilities continue to be an option in some areas today, including states and metropolitan areas that have not traditionally considered them. Tolling provides a mechanism to help finance new facilities, but the issues identified previously with new roadways must still be addressed.

Intelligent Transportation Systems (ITS). Intelligent Transportation Systems (ITS) include a variety of advanced technologies that are being applied to improve the efficiency of the overall transportation system. ITS technologies focus on elements such as monitoring freeways and roadways, providing pre-trip and in-vehicle information, enhancing vehicle diagnostics, and improving other safety and information systems.

Congestion Pricing. Congestion pricing strategies focus on charging for use of the transportation system based on some combination of miles of travel, time of day, and congestion levels. Although congestion pricing has never been implemented in the United States, there is currently a good deal of interest in the concept. Studies of various approaches are underway throughout the country, and possible demonstration programs are being evaluated.

III. CONCEPT, BACKGROUND, AND EFFECTIVENESS OF HOV FACILITIES

Although differing in design and operation, the priority measures for high-occupancy vehicles implemented throughout North America all share a similar purpose. In general, HOV facilities are intended to help maximize the person-carrying capacity of the roadway. This objective is accomplished 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 2-1, buses, vanpools, and carpools can accommodate more persons in fewer vehicles than automobiles with only one person.

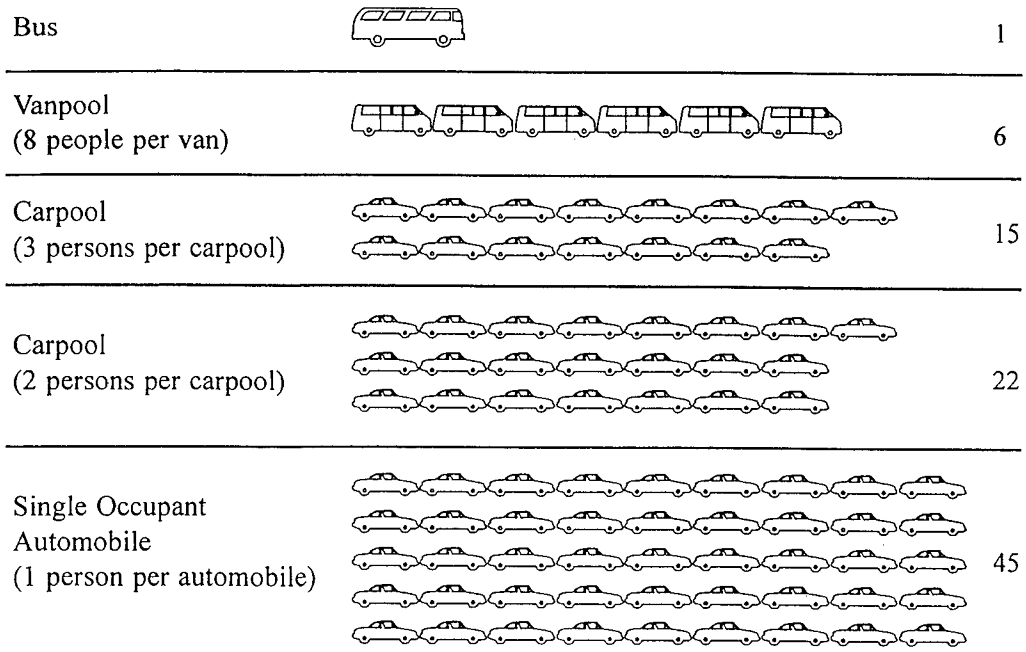


Figure 2-1. Number of Vehicles Needed to Carry 45 People

A. Concept

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 over driving alone. The person-movement capacity of the roadway is increased 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. Since the success and acceptance of HOV facilities can be influenced by these supporting facilities, services, and programs, many projects involve a variety of elements aimed at encouraging commuters to use buses, vanpools, and carpools.

The intent of HOV facilities is not to force individuals to make 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 to increase the average number of people per vehicle on the roadway or travel corridor.

Preserve the Person-Movement Capacity of the Roadway. As noted previously, opportunities to expand the 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 these roadways 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 to help ensure that the HOV lane continues to offer the high speeds and reliable trip times that are essential for success.

Enhance Bus Transit Operations. HOV lanes offer a number of advantages to transit operators. Travel times, schedule adherence, and vehicle and labor productivity may all 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 pursue other complementary strategies. The potential use of HOV facilities should be examined thoroughly before any such improvements are made. Chapter 4 describes the basic elements that should be considered in the planning process.

B. Background

The first freeway HOV lane in the United States was opened as a bus-only lane on the Shirley Highway (I-395) in Washington, D.C./Northern Virginia in 1969. The initial 3 kilometer (4.8 mile) reversible bus-only lane was extended and expanded into a 5.6 kilometer (9 mile) two-lane reversible facility in 1973 and opened to carpools with 4 or more occupants (4+) and vanpools. An additional 1.2 kilometers (2 miles) were opened in 1974. In the 1990s, additional extensions were completed along I-95, and the system is now over 12.5 kilometers (20 miles) in length. This facility continues to represent one of the most successful HOV lanes in operation today, carrying some 18,500 people in 2,770 buses, vanpools, and carpools during the morning peak hour.

The Shirley Highway HOV lanes were followed by the development of the contraflow bus lane on SR 495 on the approach to the Lincoln Tunnel in New York City in 1970, the San Bernardino Freeway (I-10) Busway in Los Angeles in 1973, the Long Island Expressway contraflow HOV lane in 1971, and the SR 520 HOV lanes in Seattle in 1973. As illustrated in Figure 2-2, the growth in total kilometers of operating HOV lanes was relatively slow during the early and mid-1970s. The use of HOV lanes became more widespread in the 1980s and 1990s, and additional projects are being planned in many metropolitan areas.

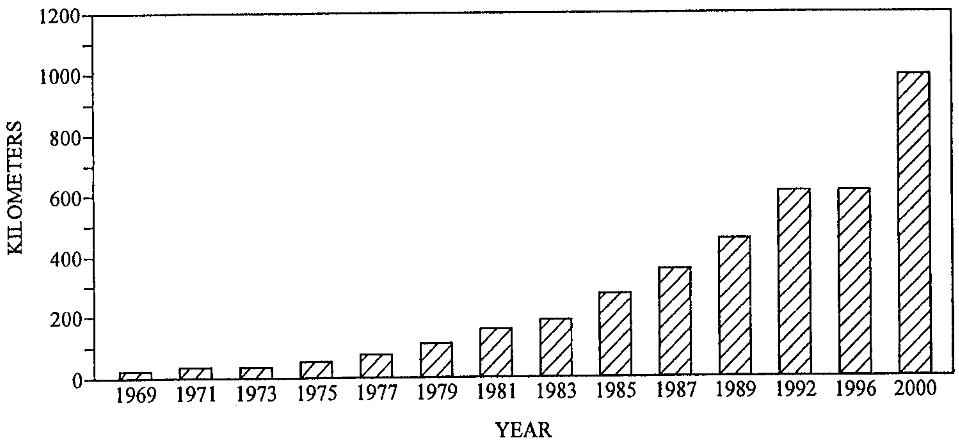
The existing projects on freeways and in separate rights-of-way encompass approximately 612 centerline kilometers (980 centerline miles) of HOV lanes. Extensions to existing projects and new facilities are being planned, designed, and implemented in many areas. If the projects under construction and those programmed for implementation are built, approximately 375 kilometers (600 miles) of additional HOV lanes will be in operation by the year 2000. Metropolitan areas with existing HOV lanes, those with projects under construction, and those in the planning process are shown in Figure 2-3. Appendix C contains a listing of the operating and planned HOV facilities in North America.

Not all of the HOV lanes implemented continue to operate, however. A few projects, such as the Santa Monica diamond lanes and the HOV lanes on the Dulles access road in Northern Virginia were discontinued. These projects could be considered successful from a purely technical standpoint in that they operated as planned but were viewed as unsuccessful by the public and policy makers. Both projects suffered from the "empty lane syndrome;" that is, there were not enough buses, vanpools, and carpools to make the lane look well used. Further, both projects represent cases where lanes open to general-purpose traffic were converted to HOV lanes, rather than cases where HOV lanes resulted from the addition of new HOV lanes.

On the other hand, there have been a number of successful examples of converting an existing general-purpose lane to an HOV lane. These include the contraflow HOV lane on the Long Island Expressway and on Route 495 on the approach to the Lincoln Tunnel, and the concurrent flow HOV lanes on I-90 in Seattle, SR 85 in Santa Clara County, and I-80 in Morris County, New Jersey. All of these examples support the need for extensive consideration of policy implications, marketing, public information, supporting facilities and services, and other factors in the development of HOV projects, especially those converting a general-purpose lane.

C. Effectiveness

HOV facilities have proven to be effective enhancements to the transportation system in many metropolitan areas. Examples of a few of the HOV lanes experiencing high levels of use are highlighted next.



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

Figure 2-2. Growth in Total Kilometers of Operating HOV Lanes on Freeways and in Separate Rights-of-Way

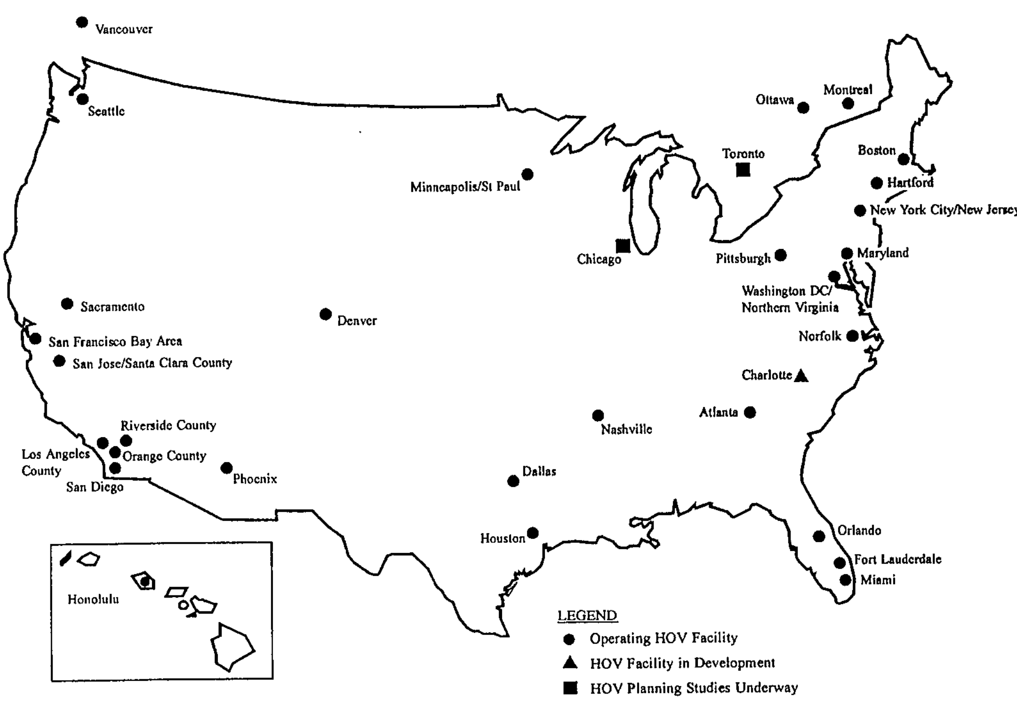


Figure 2-3. HOV Facilities on Freeways and in Separate Rights-of-Way in North America

Dallas, Texas. A contraflow HOV lane, using a moveable barrier, is in operation on the East R. L. Thornton Freeway (I-30E) in Dallas. The facility represents the first use in the United States of a moveable barrier with an HOV facility. Opened in late 1991, the HOV lane carries an average of 1,200 vehicles and 4,000 passengers during the morning peak hour.

Denver, Colorado. The 16th Street Transit Mall in Denver was constructed during the 1980s. The Mall, which is approximately 1.6 kilometers (1 mile) long, includes transit centers at both ends. These centers include underground bus facilities with multiple bus bays, passenger waiting areas, and other amenities. Approximately 36 regional and express bus routes entering the downtown terminate at the transit centers. Passengers transfer to the free mall shuttle buses to reach destinations along the mall. The mall shuttle buses operate on 70-second headways for most of the day. This system has removed between 300 and 400 daily bus trips from the parallel downtown streets. A portion of the mall also includes a wide center median with benches, fountains, and food vendors.

Houston, Texas. HOV lanes are in operation on five radial freeways in Houston. These facilities account for 106 kilometers (66 miles) of a planned 170-kilometer (106-mile) HOV system. The HOV lanes are primarily barrier-separated, one-lane, reversible facilities located in the freeway median. Park-and-ride lots, transit centers, and bus services all support the HOV lanes. The North Freeway (I-45N) currently carries some 1,250 vehicles and 5,560 passengers during the morning peak hour, while the Northwest Freeway (U.S. 290) averages nearly 1,500 vehicles and 4,000 passengers during the same time period.

Los Angeles and Orange County, California. Several HOV lanes are in operation in the Southern California area. The San Bernardino Freeway (I-10) Transitway is one of the older HOV lanes in the country. The two-lane, two-direction facility is 21 kilometers (13 miles) in length. Open to buses, vanpools and carpools, the facility is supported by park-and-ride lots and transit centers at strategic locations. Currently some 1,440 vehicles carrying 7,100 passengers, use the facility in the peak direction during the morning peak hour. Other HOV lanes are in operation on Route 55, I-40S, Route 57, Route 91, and I-5. Most of the lanes are used primarily by carpools. For example, the 1,300 vehicles and 3,100 passengers using the Route 91 HOV lane are all carried in carpools or vanpools.

New York City/New Jersey. Three contraflow HOV lanes are in operation in the New York City/New Jersey area. These include lanes on Route 495 on the approach to the Lincoln Tunnel, the Long Island Expressway, and the Gowanus Expressway. As many as 725 buses, carrying 35,000 people, have been recorded using the New Jersey Route 495 HOV lane during the morning peak hour. This represents the highest passenger use of any HOV lane in the United States.

Minneapolis, Minnesota. An HOV facility is in operation on I-394, extending 17 kilometers (11 miles) from downtown Minneapolis through the western suburbs. The facility includes a three-mile segment of two-lane, barrier-separated, reversible HOV lanes and eight miles of concurrent flow HOV lanes. The lanes, which provide direct access to new parking garages on the edge of the downtown area and offer low cost parking for carpools, average about 1,100 vehicles in the morning peak hour.

New York City. New York City has an extensive system of bus-only lanes in Manhattan. These include two bus malls, curb bus lanes, and curb and second lane bus facilities. In some cases these facilities operate as bus lanes only during the peak-period, while in other cases they are reserved for buses over extended periods of the day. These lanes allow buses to maintain schedules on congested roadways.

Norfolk/Virginia Beach, Virginia. The 24 kilometers (15 miles) of HOV lanes on the Virginia Beach-Norfolk Expressway, I-64, and I-564 were opened in 1992. An average of 800 vehicles carrying 1,500 passengers use the facility during the morning peak hour.

Ottawa, Canada. Approximately 24 kilometers (15 miles) of an exclusive 2-lane, 2-direction transitway system are in operation in Ottawa, Ontario. About 180 buses, carrying 11,000 passengers, operate on the facility in the peak hour peak-direction.

Pittsburgh, Pennsylvania. Two, two-lane, bus-only facilities, located in separate rights-of-way, have been in operation since 1977 and 1983. The East Busway is 11 kilometers (7 miles) and the South Busway is 6 kilometers (4 miles). The opening of both facilities greatly reduced bus travel times. For example, bus travel times on some routes on the East Busway were reduced from 25 minutes to 10 minutes. This facility currently carries some 6,000 passengers in 103 buses during the morning peak hour. A 6-kilometer (4-mile), two-lane, reversible, barrier-separated HOV facility also is located in the median of I-279 on the north side of the city. In addition, another HOV facility is being planned to connect downtown Pittsburgh and the airport to the southwest.

Seattle, Washington. Currently, HOV lanes are in operation on I-5 North, I-5 South, I-90, I-405, SR 167, and SR-520 in the Seattle area. Additional lanes are also in operation on arterial streets, and more projects are in different stages of planning, design, and construction. The system is supported by a 2 kilometer (1.3 mile) bus tunnel in the downtown area, as well as park-and-ride lots and enhanced transit services. Utilization levels average between 400 and 1,600 vehicles carrying 3,600 to 5,700 people during the peak hour on the different HOV lanes.

Northern Virginia/Washington, D.C. The Shirley Highway (I-395) HOV lanes in the Northern Virginia suburbs of the Washington, D.C. area were the first HOV lanes developed on a freeway facility in the United States. The facility has been extended over the years and currently extends approximately 35 kilometers

(22 miles) along I-395 and I-95. The facility carries about 2,800 vehicles and 18,400 passengers during the morning peak hour.

IV. TYPES OF HOV FACILITIES

A variety of HOV facilities are currently in use throughout North America. The major types of HOV facilities and supporting services and policies are briefly highlighted in this section. More detailed information on each approach is presented in later chapters of the manual.

A. HOV Lanes in Separate Rights-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. Further, most are two-lane, two-direction facilities. Examples of this type of HOV treatment are the South and East Busways in Pittsburgh, the University of Minnesota Busway in the Minneapolis/St. Paul metropolitan area, and the transitway system in Ottawa, Ontario. The Ottawa system is illustrated in Figure 2-4.

B. HOV Lanes on Freeways

Three types of HOV lanes are commonly found on freeways. These are exclusive HOV lanes, concurrent flow HOV lanes, and contraflow HOV lanes. In addition, two different operating strategies are used with exclusive HOV lanes; two directional and reversible. The following descriptions highlight the major characteristics, advantages, and disadvantages of these types of HOV facilities.

Exclusive Two-Directional HOV Facilities. Exclusive two-directional facilities are lanes constructed within the freeway right-of-way that are physically separated from the general purpose freeway lanes and are 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 two-directional HOV facilities in freeway rights-of-way are usually open to all types of HOVs—buses, vanpools, and carpools. Exclusive HOV lanes often have limited access points, and may include direct ramps and other exclusive ingress and egress treatments. Examples of exclusive two-directional HOV facilities include the San Bernardino Transitway in Los Angeles, illustrated in Figure 2-5, and the I-84 Freeway HOV lanes in Hartford.

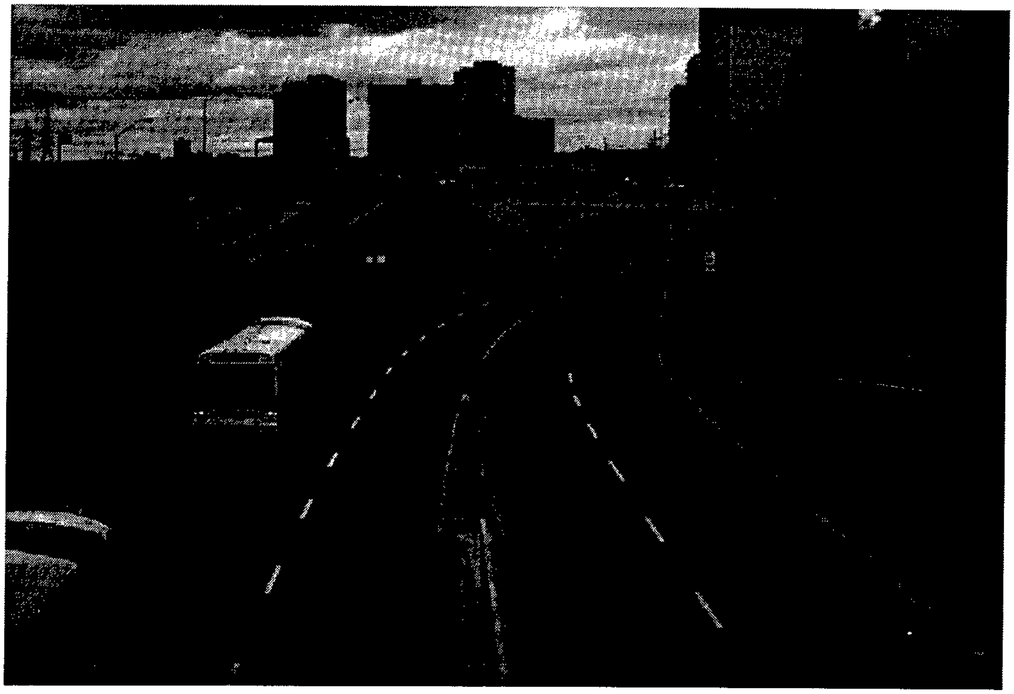


Figure 2-4. Bus-only Facility in Separate Right-of-Way—Ottawa Transitway

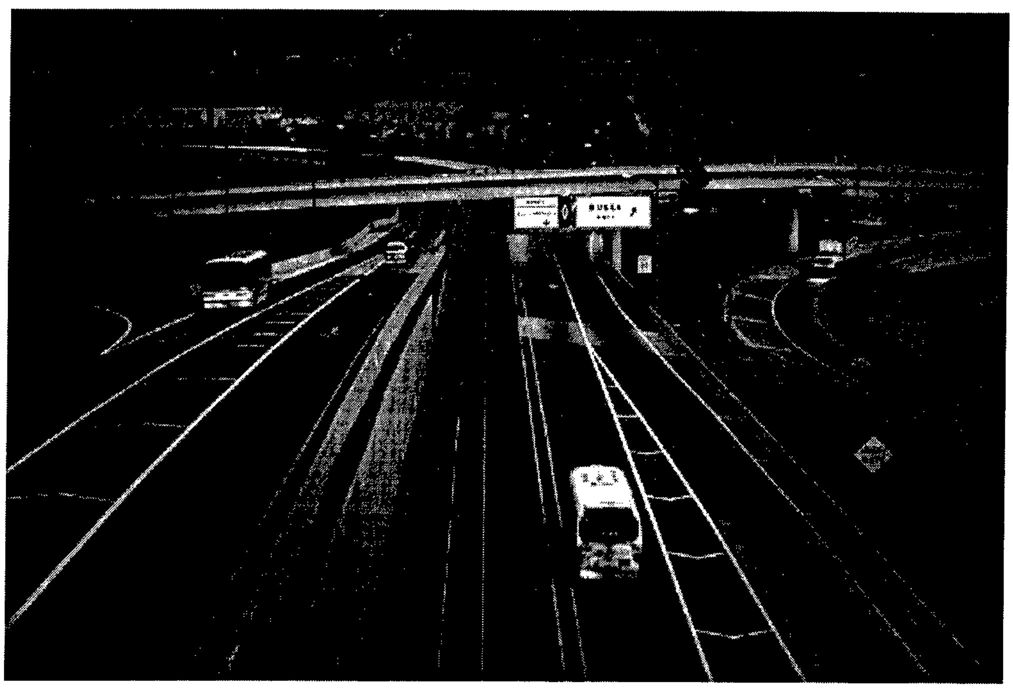


Figure 2-5. Exclusive Two-Direction HOV Facility—
San Bernardino Transitway in Los Angeles

Exclusive Reversible HOV Facilities. The other type of exclusive HOV treatment is a reversible lane or lanes. Like a two-directional facility, this approach involves a lane or lanes within the freeway right-of-way that are physically separated from the general purpose freeway lanes and used exclusively by HOVs for all or a portion of the day. Reversible HOV lanes, which are separated from the general-purpose lanes by concrete barriers, are usually open to buses, vanpools, and carpools. Exclusive reversible HOV facilities, usually operate inbound toward the central business district (CBD) or other major activity center in the morning and outbound in the afternoon. Some type of daily set up is required with reversible facilities. Examples of exclusive reversible HOV lanes include US 290, I-45N, I-45S, US 59, and I-10W in Houston; I-395 and I-95 (Shirley Highway) in Northern Virginia/Washington, D.C. area; I-15 in San Diego; I-25 in Denver, and a portion of the I-394 in Minneapolis. The I-10 West (Katy) Freeway HOV lane, which is a one-lane reversible facility, is shown in Figure 2-6, and the Shirley Highway HOV lanes in Northern Virginia approaching Washington, D.C., which is a 2-lane reversible facility, is shown in Figure 2-7.

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, Washington, Route 55 in Orange County, California, and Route 101 in San Jose, California. Examples of the concurrent flow HOV lanes on I-5 in Seattle and I-405 in Orange County are shown in Figures 2-8 and 2-9, respectively.

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 Expressway. The East R. L. Thornton (I-30E) contraflow lane in Dallas and the Southeast Expressway contraflow HOV lane in Boston both use the moveable concrete barrier technology. Figure 2-10 shows the contraflow HOV lane on I-495 in the New York/New Jersey area, and Figure 2-11 illustrates the moveable barrier system on the East R. L. Thornton contraflow lane in Dallas.

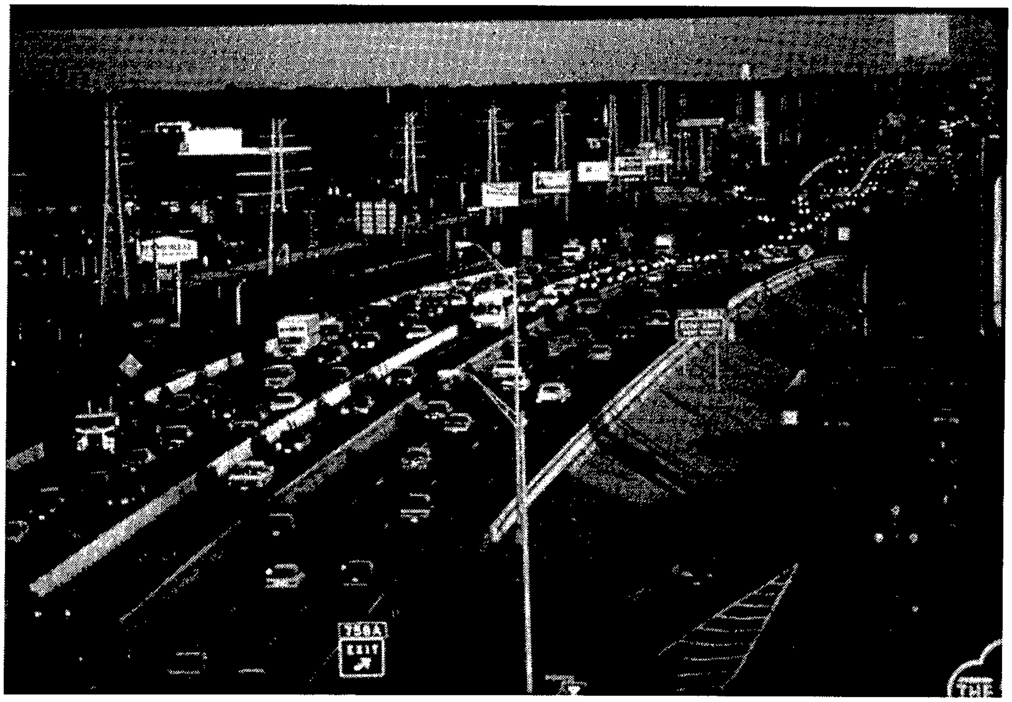


Figure 2-6. Exclusive One-Lane Reversible HOV Facility—
I-10 West (Katy) Freeway HOV Lane in Houston

Figure 2-7. Exclusive Two-Lane Reversible HOV Facility—
I-395 (Shirley Highway) HOV Lanes in Northern Virginia/Washington, D.C.

Figure 2-8. Concurrent Flow HOV Facility—
I-5 North HOV Lanes in Seattle

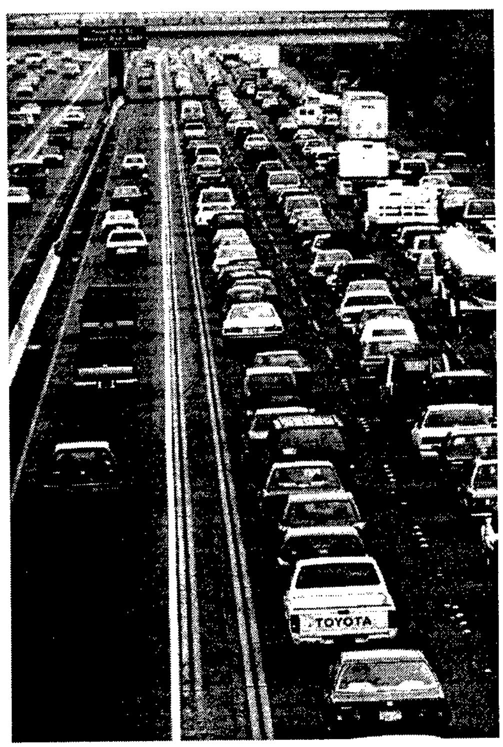


Figure 2-9. Concurrent Flow HOV Facility—
I-405 HOV Lane in Orange County, California

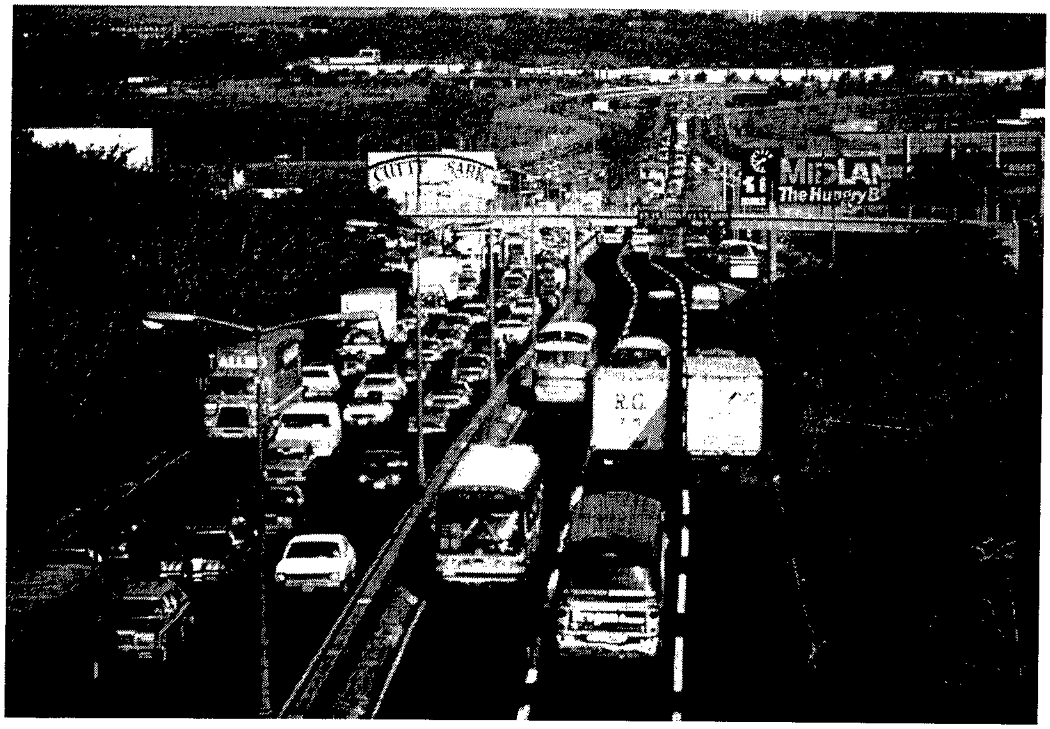


Figure 2-10. Contraflow HOV Lane on I-495 in Union City, New Jersey

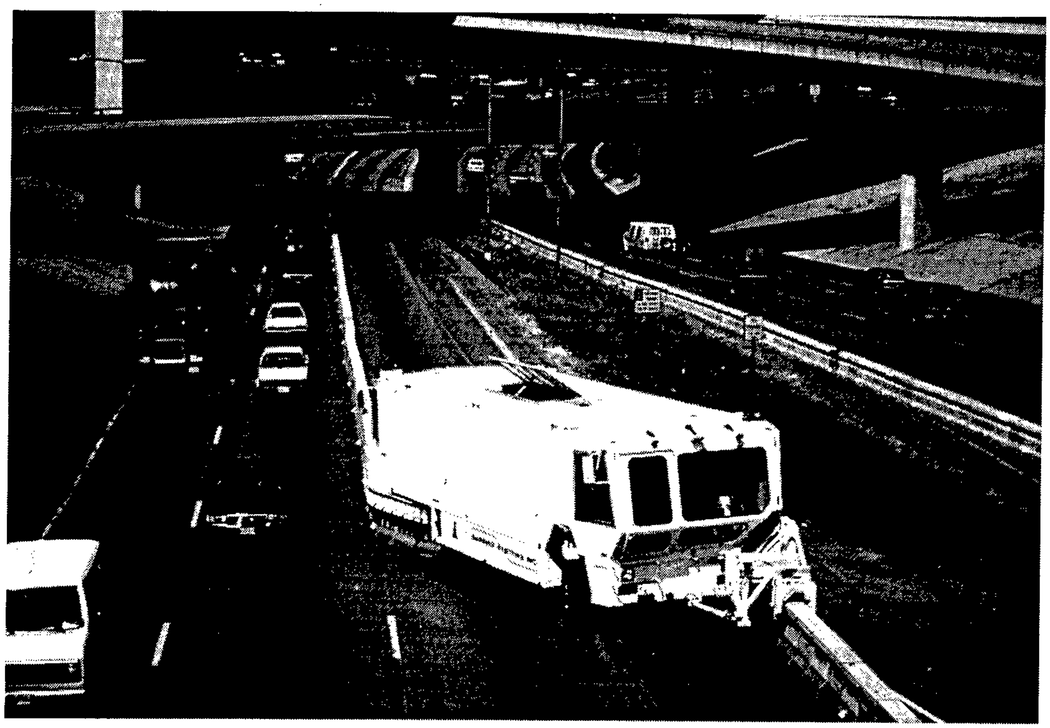


Figure 2-11. Moveable Barrier and Contraflow HOV Lane on the East R. L. Thornton Freeway in Dallas (I-30E)

In addition to these three types of freeway HOV lanes, two other approaches may also be used on freeways. As described next, these are HOV bypass lanes at metered freeway entrance ramps and priority pricing on HOV facilities.

HOV Bypass Lanes at Metered Freeway Entrance Ramps. This type of HOV facility is used to provide priority treatment for buses, carpools, and vanpools at metered freeway entrance ramps. A separate lane is provided adjacent to the general-purpose lane so that HOVs do not have to stop at the ramp meter signal, but rather move around the traffic queue and directly enter the freeway. HOV bypass lanes are in operation on freeways in Minneapolis/ St. Paul, Seattle, urban areas throughout California, and other locations. Figure 2-12 illustrates an HOV bypass lane at a freeway entrance ramp in Southern California.

Priority Pricing on HOV Facilities. Priority pricing or high-occupancy toll (HOT) lanes focus on allowing either single occupant vehicles or lower occupant vehicles to use an HOV facility for a charge. Priority pricing represents a variation of congestion pricing. Examples of these approaches include the SR 91 Express Lanes, which allow carpools with three or more persons to travel for free on the toll road, and the I-15 demonstration project in San Diego, which allows single-occupant vehicles to use the HOV lane for a fee. A demonstration project on the Katy (I-10 West) HOV lane in Houston will allow carpools with 2 people to use the facility for a fee during the morning and afternoon peak hour when a 3+ vehicle occupancy requirement is in effect.

C. Ingress and Egress Alternatives

A variety of treatments can be used to provide access to and from an HOV lane. Ensuring that buses, vanpools, and carpools can easily and safely merge into and out of an HOV facility is critical to the success of the facility. The following types of approaches can be used to provide ingress and egress to HOV lanes.

Direct Merge. This approach allows HOVs to merge directly into and out of the HOV lane from the adjacent general-purpose lane. Continuous ingress and egress may be allowed, as illustrated in the facilities in previous Figures 2-10 and 2-11, or specific access points may be designated, as highlighted in Figure 2-13. Direct merges are usually used with concurrent flow HOV lanes and represent the lowest capital cost alternative. A potential disadvantage with this approach is that conflicts may arise with HOVs merging across the general-purpose lanes to enter the HOV lanes and with HOVs merging back into the regular traffic lanes.

Slip Ramps. Slip ramps may be used at the start, end, and intermediate points of an exclusive HOV lanes. As illustrated in Figure 2-14, slip ramps provide a break in the barrier or buffer, allowing HOVs to enter and exit the HOV lane. Slip ramps are less expensive than direct access ramps, but conflicts may arise with vehicles merging into and out of the adjacent freeway lanes.

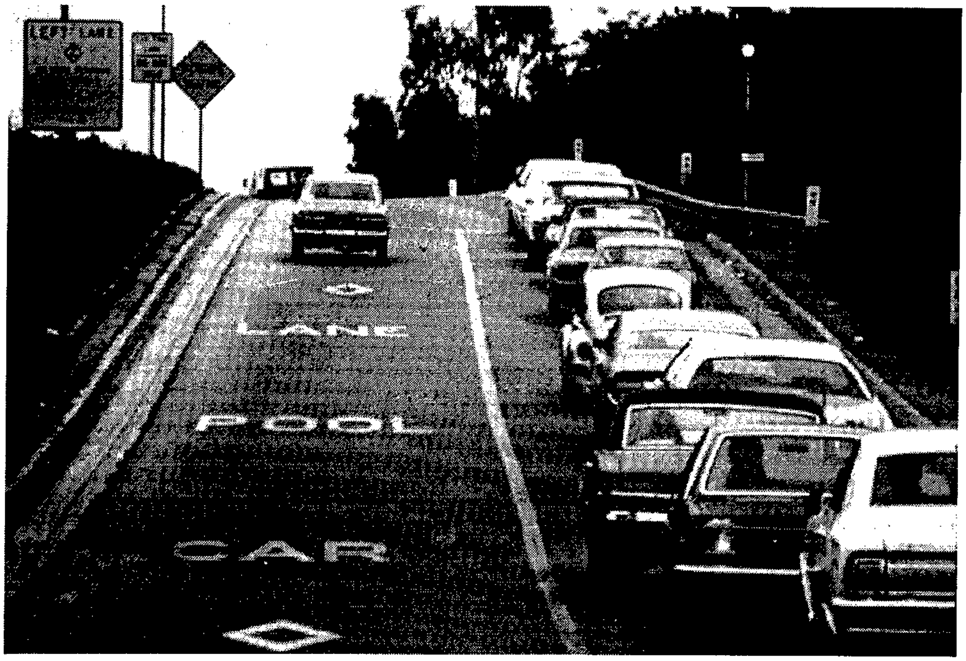


Figure 2-12. HOV Bypass Lane at Metered Freeway Entrance Ramp in Southern California

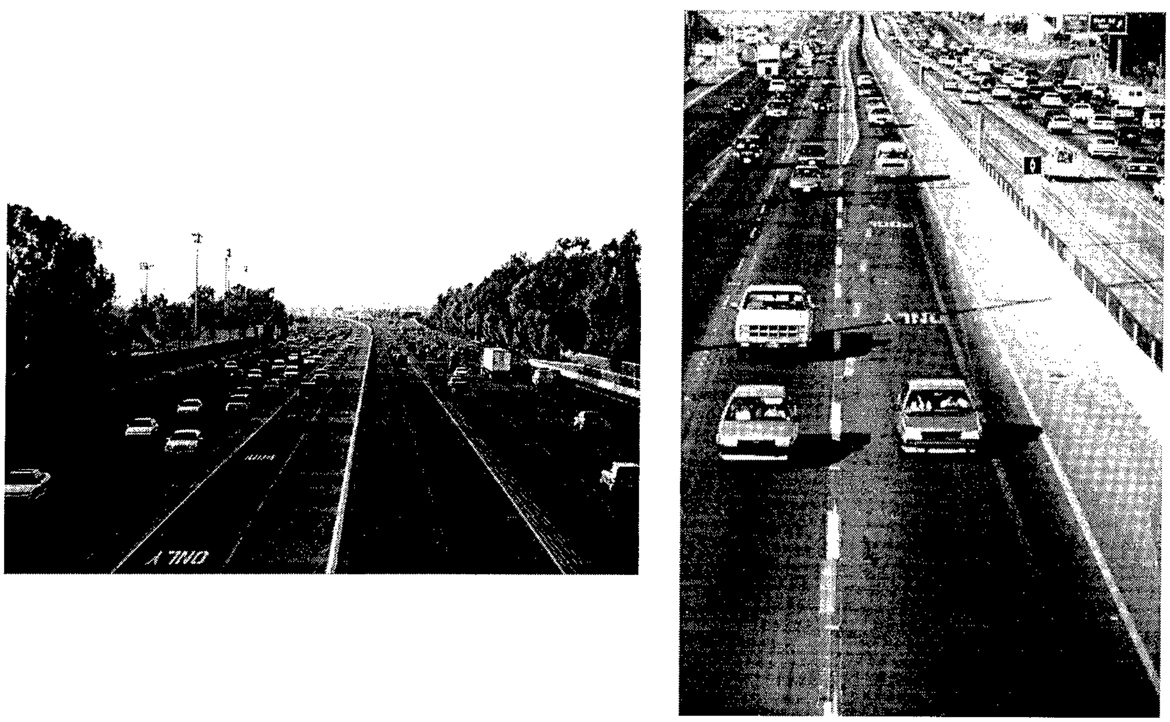


Figure 2-13. Concurrent Flow HOV Lanes with Limited Access in Southern California

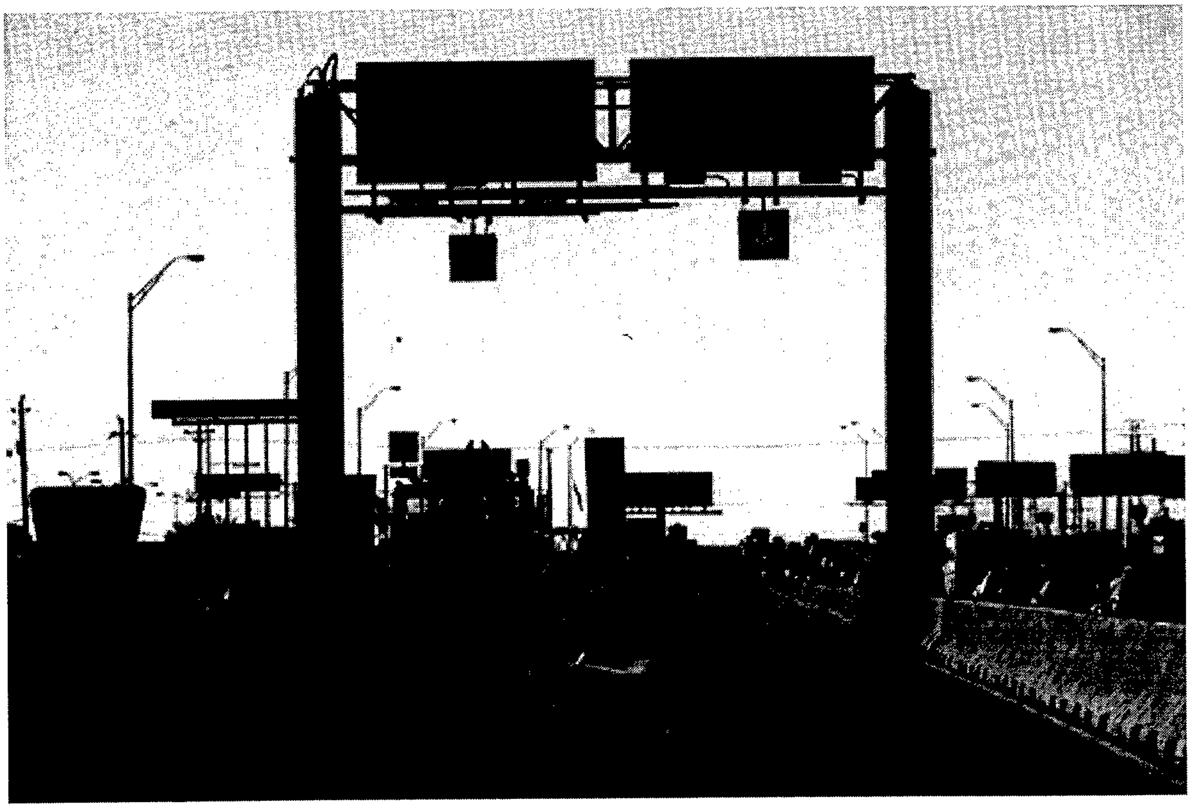


Figure 2-14. Slip Ramp with Exclusive HOV Lane in Houston

Direct Access Ramps. Grade separated or direct access ramps provide exclusive ingress and egress for HOVs. A variety of design treatments may be used, including drop ramps, T-ramps, Y-ramps, and flyover ramps. Figure 2-15 provides an example of a T-ramp, and Figure 2-16 illustrates a drop ramp. Further, direct ramps may provide access from adjacent roadways, park-and-ride lots, and transit stations. Direct access ramps may involve significant capital costs, but the travel time savings provided to HOVs and the safety benefits may justify the additional costs associated with these types of treatments.

Direct Freeway HOV-to-Freeway HOV Lane Connection. These facilities provide direct connections from an HOV lane on one freeway to an HOV lane on another freeway. Freeway-to-freeway HOV lane connections involve significant capital costs, but may be appropriate in areas with extensive networks of HOV facilities and where travel demand warrants.

D. Arterial Street HOV Lanes and Priority Treatments

Arterial Street HOV applications include the use of bus or transit malls, bus-only lanes, and lanes open to buses, vanpools, and carpools. Each of these applications are briefly described next.

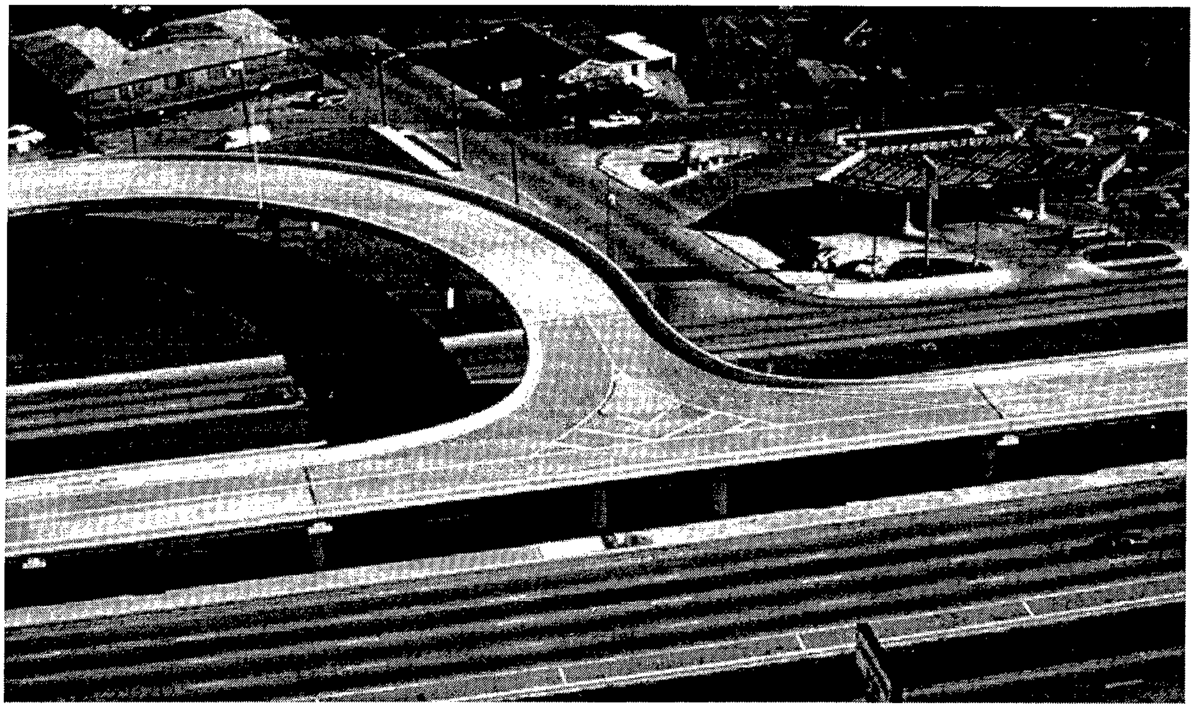


Figure 2-15. T-Ramp in Houston

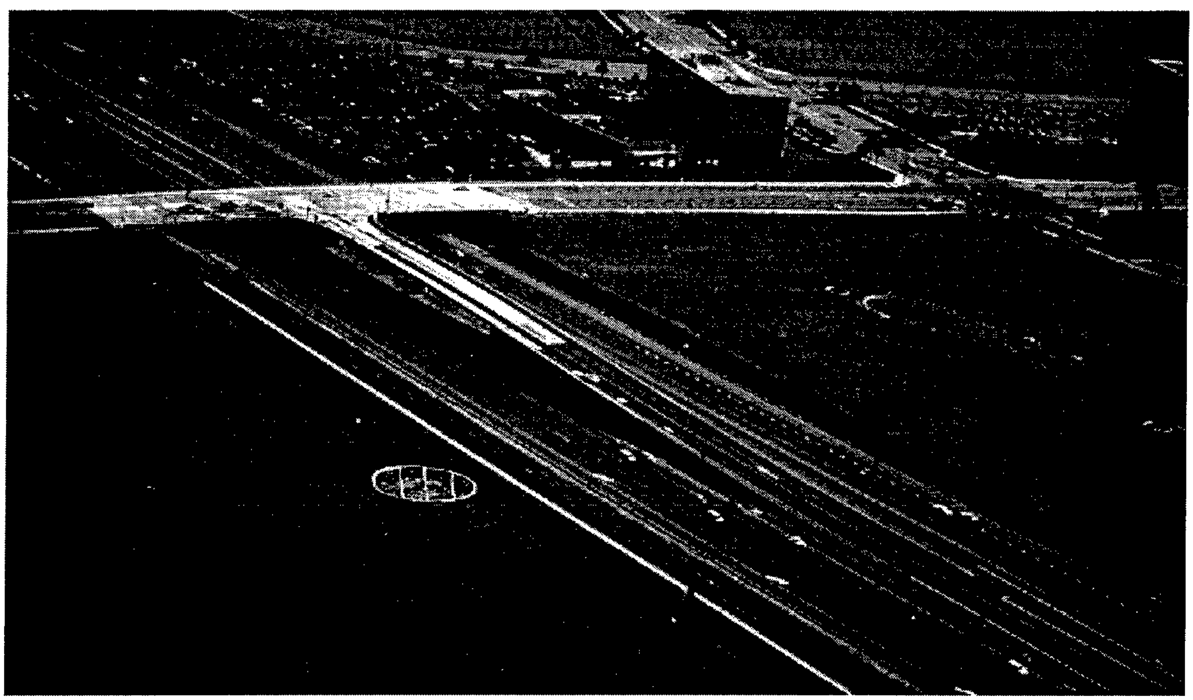


Figure 2-16. Drop Ramp in Orange County, California

Transit Malls. Transit malls are streets that are reserved exclusively for use by public transit vehicles. Most facilities provide access for emergency vehicles, and some allow use by taxis. Transit malls are usually found in downtown areas, although some are located in major suburban activity centers. Existing transit malls range in length from only a few blocks to major facilities covering 10 to 15 blocks. A number of cities developed transit and pedestrian malls in the 1970s. Some of these facilities have been removed or modified, but a number are still in operation. Two of the best examples of successful bus malls are found in downtown Denver, which is illustrated in Figure 2-17, and downtown Minneapolis. In addition, two bus malls are in operation in New York City, 49th and 50th Streets between Third and Eight Avenues in Manhattan, are reserved for buses only.

Bus-Only Lanes. This type of HOV treatment reserves an existing or new lane for use by buses only. A number of different design treatments may be used with bus only lanes. Often the bus lanes are not physically separated from the other traffic lanes and many projects operate only in the peak-periods. The most common technique is to use the curb lane although the second lane from the curb is used in a few areas. New York City has an extensive system of bus lanes in the downtown area. A second approach is a contraflow lane. Contraflow arterial street bus lanes are found on Spring Street in downtown Los Angeles and on Marquette, Second, and Hennepin Avenues in downtown Minneapolis. These lanes are separated from the general-purpose traffic lanes by special curbs and appropriate signing. A third technique is the use of special bus lanes over longer distances. The bus lanes on Broadway Boulevard and 22nd Street in Tucson provide one example of this technique in the U.S. More extensive applications of this approach are found in Toronto and in a number of European cities. Figures 2-18 through 2-20 provide examples of these treatments.

HOV Lanes. This type of HOV treatment provides priority lanes on arterial streets for buses, vanpools, and carpools. Only a few examples of this technique are currently in operation. One example is located in the Toronto suburb of Mississauga. This arterial street HOV lane, which is located on Dundas Street, is open to buses, vanpools, and carpools with three or more persons. Other examples include the San Thomas and Montague Expressways in San Jose, SR 99 and Airport Road/128th Street in Seattle, and North Washington Street in Alexandria, Virginia.

In addition to these three types of arterial street HOV lanes, HOV queue by-pass lanes at signalized intersections and priority treatments for buses at signalized intersections are being used in a few areas. These approaches are used to provide HOVs with additional travel time savings at congested locations on urban arterial streets. Both of these techniques are briefly described next.

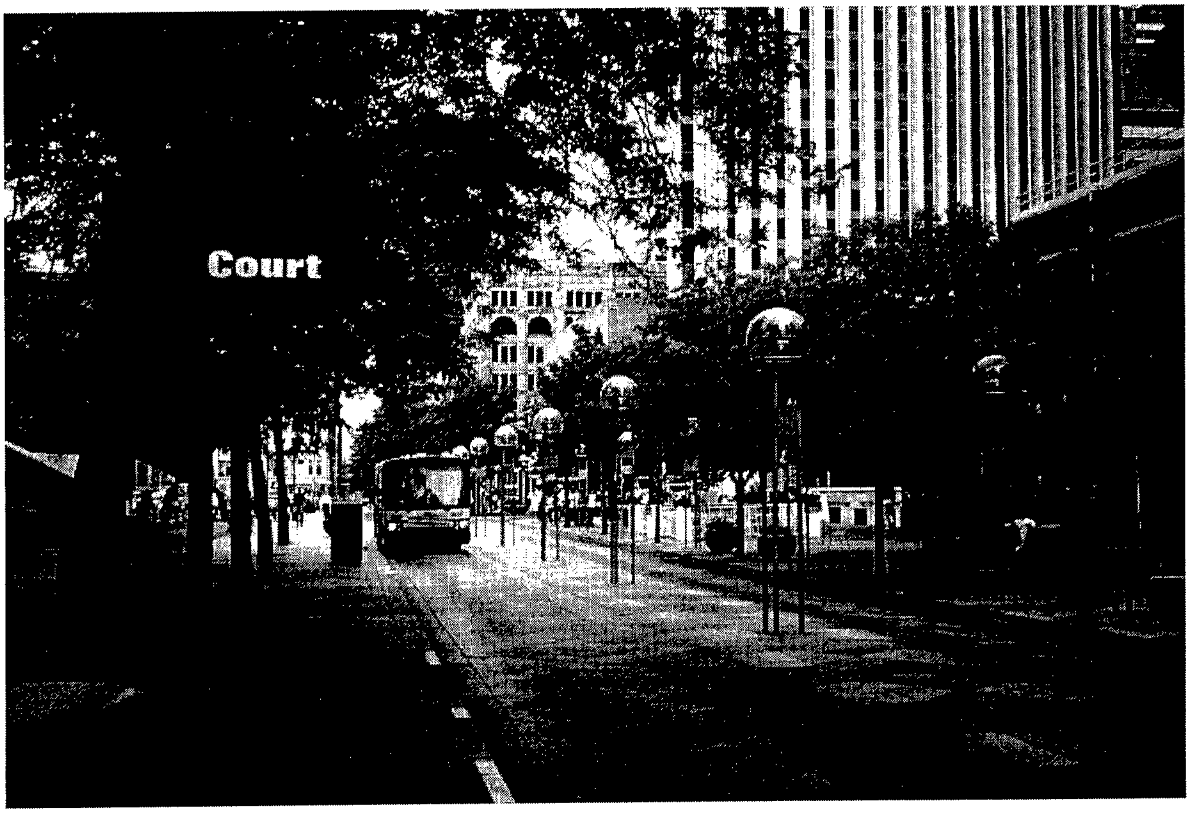


Figure 2-17. 16th Street Mall in Denver

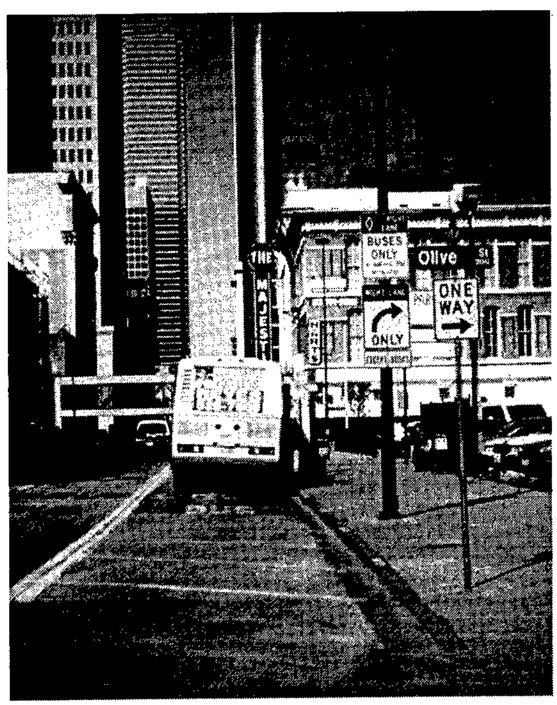


Figure 2-18. Downtown Dallas Bus-only Lane

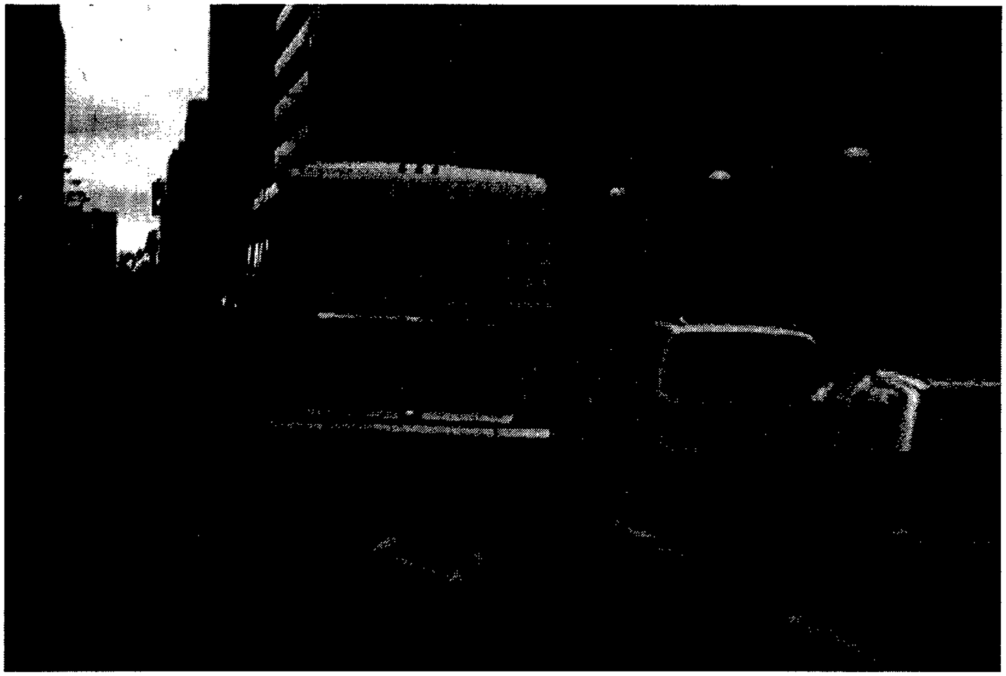


Figure 2-19. Bus Lane in Downtown Ottawa

Figure 2-20. Bus-only Curb and Second Lanes in New York City

HOV Queue By-Pass Lanes at Signalized Intersections. An example of a bus by-pass lane at a signalized intersection currently in operation is in Mission Valley in the San Diego area. This facility, which is illustrated in Figure 2-21, provides a lane for buses between the right turn lane and general-purpose lane. A separate traffic signal is provided for this lane and is activated when a bus is detected in the lane. A similar queue jump signal is in operation in the Everett, Washington area.

A slightly different approach, called a bus advance area, is being used in a few cities in Great Britain. The bus advance area is a segment of road before a signalized intersection. A set of pre-signals are used to hold general-purpose traffic at this location, while allowing buses to advance around the general traffic queue. This allows buses to move to the front of the traffic stream at the intersection. This concept is currently being tested in a few applications in London.

Signal Priority for Buses. Other priority techniques for buses have been implemented at signalized intersections. These have usually focused on altering the timing of the traffic signal by either extending the green phase or truncating the red phase for oncoming buses. These approaches involve altering the signal algorithms. Concerns over potential negative impacts on cross street traffic were a major factor in many of the early signal priority demonstration projects implements in the 1970s. Recent advances in traffic signal ITS technologies have resulted in renewed interest in examining different approaches to providing priority treatments to buses at signalized intersections. For example, it may be possible to selectively give priority to buses that are full or behind schedule, rather than providing priority to all buses. Recent demonstrations have been conducted on the Ritchie Highway in Ann Arundel County, Maryland; selected roadways in Bremerton, Washington; and Arbemorle Road in Charlotte, North Carolina. An advanced detection demonstration project, which provides buses with priority, is underway on Roesser Road in Phoenix. In Charlotte, priority for buses is provided at 11 signalized intersections. The results from this project indicate that bus delays at signals have been reduced by 67 percent, and ridership has increased.

E. Supporting Facilities and Services

1. Supporting Facilities

Four general types of supporting facilities are commonly found with HOV lanes on freeways and in separate rights-of-way. These are park-and-ride and park-and-pool lots, transit stations, intermodal facilities, and bus stops and shelters. Supporting facilities associated with arterial street HOV applications include bus stops and shelters, transit stations, and intermodal facilities. A general description of these facilities is provided in this section. More detailed information on the various types of supporting facilities are contained in Chapter 9.

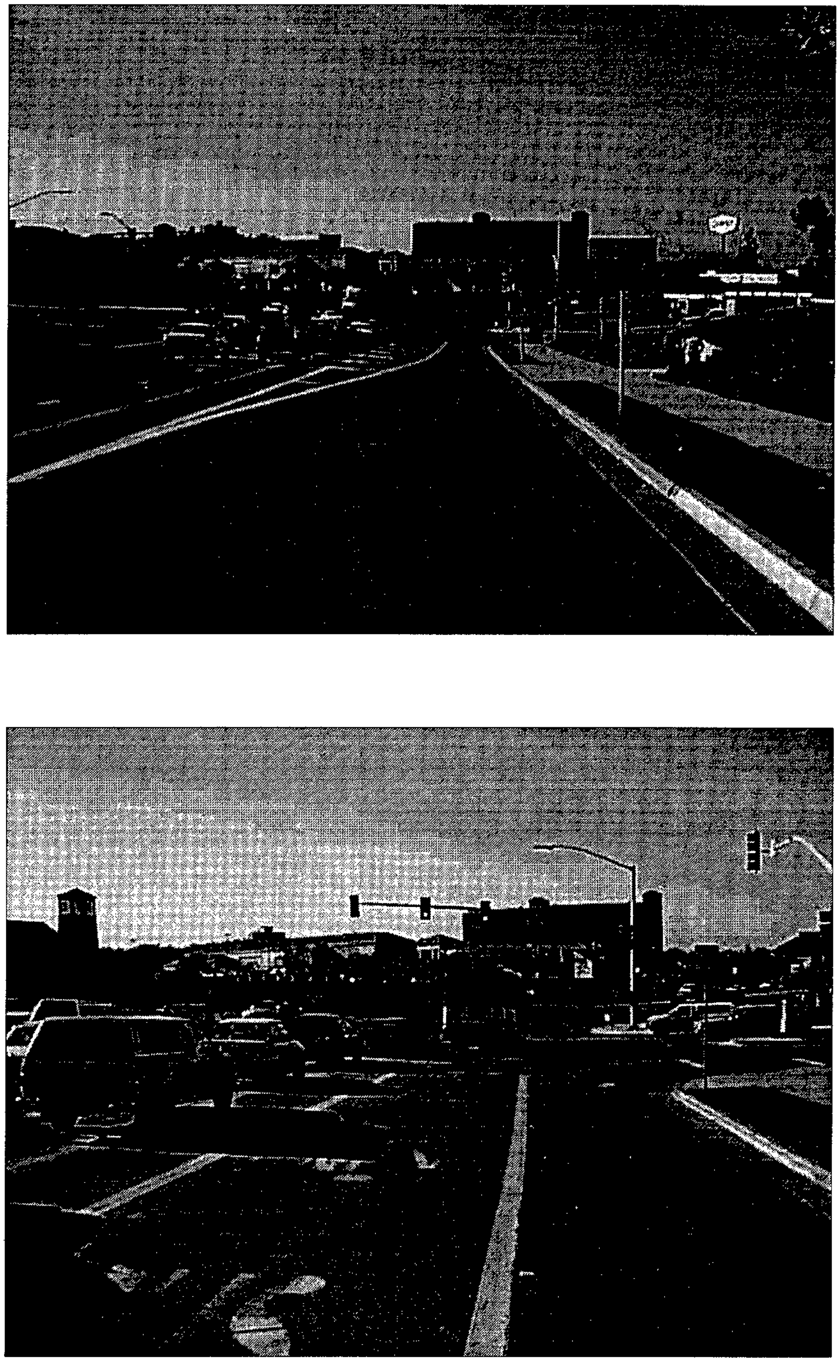


Figure 2-21. Bus Bypass Lane in San Diego

Park-and-Ride Facilities. Park-and-ride and park-and-pool lots are integral parts of most HOV facilities in North America. Although the size, location, and design of park-and-ride facilities vary among different HOV projects, all share a common purpose. Park-and-ride and park-and-pool lots provide users with the opportunity to change between low and high occupancy vehicles, affording an effective combination of automobile and bus, vanpool, and carpool use. Park-and-ride lots are usually oriented toward commuters changing from an automobile to a bus or a rail system, while park-and-pool facilities assist in the formation of carpools and vanpools. Access to the lots may also be accomplished by walking or bicycling, and some park-and-ride facilities provide bicycle storage lockers or bicycle racks. In addition, some travelers may be dropped off and picked up, rather than leaving their vehicle in the lot all day. Figure 2-22 illustrates examples of large park-and-ride lots in Houston, and Figure 2-23 highlights a smaller park-and-ride lot.

Transit Stations. Transit stations or transit centers are used with many HOV lanes. Transit stations provide convenient, safe, and sheltered locations for passengers to wait for buses and to transfer between different routes or services. Most transit centers include enclosed waiting areas for passengers and multiple bus bays. Route and schedule information is usually provided and some facilities include amenities such as bus pass sales outlets, newspaper racks, small convenience stores, and other services. Many transit stations, although not all, associated with HOV facilities are incorporated into park-and-ride lots. The type and design of a transit station is related to the nature of the HOV facility and the bus operating concept to be served. The two basic types of stations are on-line centers, which are located on the HOV lane, and off-line stations which are located adjacent to the lane or freeway. Figures 2-24 and 2-25 provide examples of transit stations with HOV facilities.

Intermodal Facilities. Intermodal facilities serve multiple modes, providing travelers with the opportunity to change from one transportation service to another. Intermodal facilities enhance the connectivity of all modes and make it easier for individuals to transfer between different services. Intermodal facilities are usually relatively large, providing amenities such as waiting areas, ticket sales and passenger information, convenience services, and other activities.

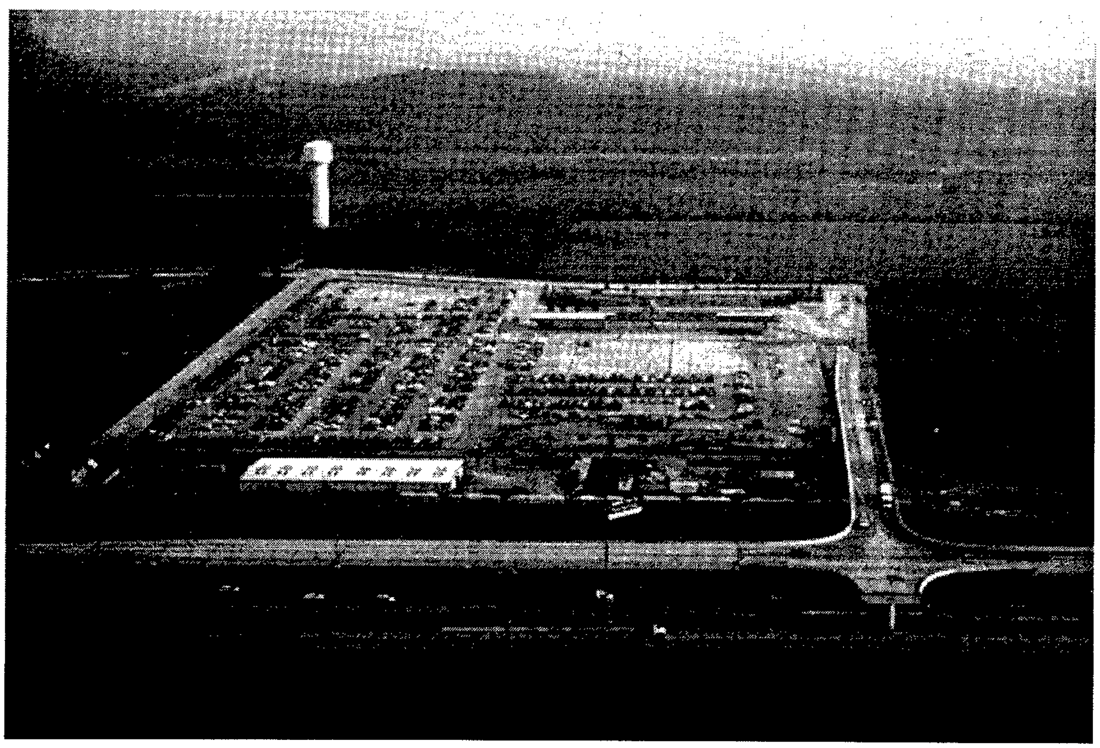


Figure 2-22. Examples of Large Park-and-Ride Lots with the Houston HOV Lanes

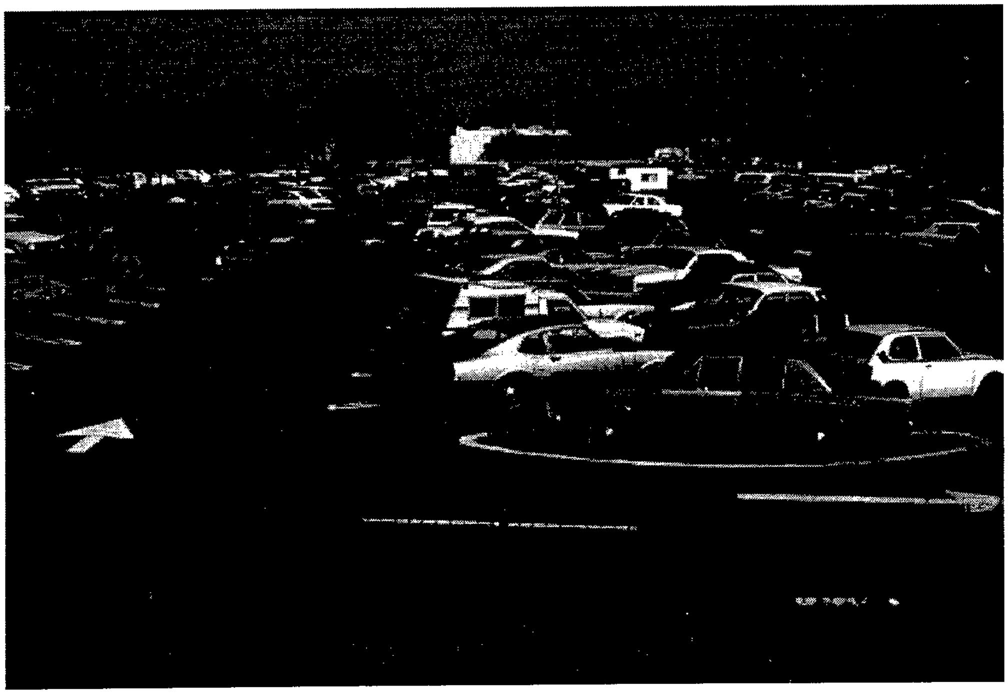


Figure 2-23. Example of Smaller Park-and-Ride Lot

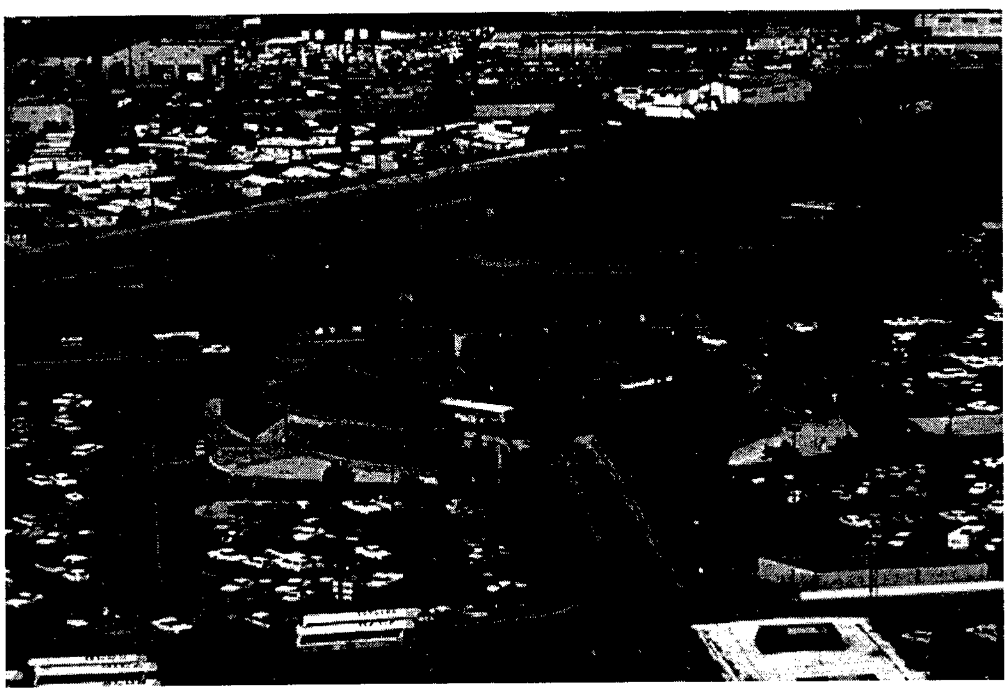


Figure 2-24. Los Angeles San Bernardino Freeway El Monte Bus Station

Figure 2-25. On-line Station on the Pittsburgh Busway

Bus Stops and Shelters. Bus stops are the basic point of access for passengers. Transit stops are thus integral parts of HOV facilities, especially those located along arterial streets. Even HOV lanes on freeways and in separate rights-of-way are served by buses that operate on local streets in downtown areas, major activity centers, and neighborhoods. Ensuring that bus stops are located appropriately, well situated and designed, maintained adequately, provide information on routes and schedules, and include shelters, benches, and other amenities as needed are important factors in the development of a comprehensive HOV system.

2. **Supporting Services**

A variety of bus services and bus operating strategies can be used with HOV facilities. The wide range of operating scenarios indicates the flexibility in service orientation and service levels offered by HOV facilities. For example, bus services can be tailored to the specific travel patterns and travel needs of residents and the unique characteristics of an area. In addition, modifications to route structures and service levels can easily be made in response to changing conditions. The six bus operating strategies most often found with HOV facilities in separate rights-of-way and on freeways are illustrated in Figure 2-26 and summarized next. In addition, HOV facilities may be used by paratransit or demand responsive services. More detailed information on each approach and case study examples is provided in Chapter 9.

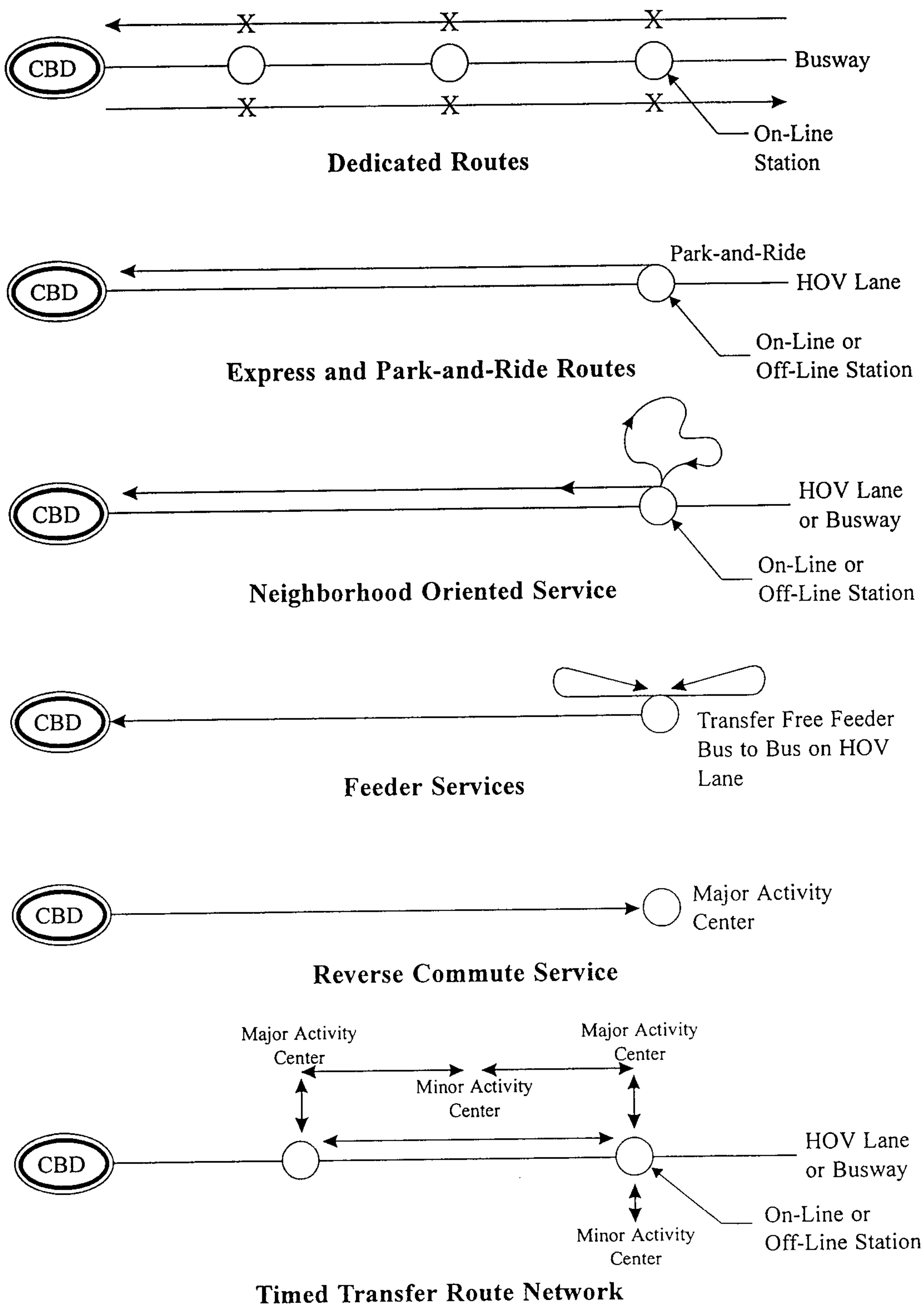


Figure 2-26. Bus Operating Strategies Frequently Used with HOV Facilities

All of these transit services may use arterial street HOV facilities, including those in a downtown area, a major activity center, or in the major travel corridor. More detailed information on arterial street HOV applications is provided in Chapter 7.

Dedicated Services. Dedicated bus service operates only on a busway or an HOV lane. The route is dedicated to the HOV facility and does not deviate off of the lane. Routes of this nature provide service similar to an LRT or a heavy rail line. Passengers generally access dedicated routes by walking to a station, using a connecting route, driving to a station or park-and-ride facility, or being dropped off at a station. Operating speeds are usually in the range of 56 to 69 kph (35 to 40 mph), but may reach 80 to 89 kph (50 to 55 mph) on longer segments. Service is offered on these routes throughout the day, with frequent buses operating during the peak hours. Dedicated services are usually found with bus-only facilities.

Express and Park-and-Ride Services. Express services, or park-and-ride routes as they are called in some areas, are routes that initiate from park-and-ride lots or other areas close to the HOV lane and operate as express service to major activity centers. This type of route provides high-speed service using the HOV lane. Most express or park-and-ride service is oriented toward the downtown or other major activity center. Speeds for the line-haul portion of the trip on the HOV lane usually average 80 to 89 kph (50 to 55 mph). These services are usually oriented toward peak-period commuters. Thus, many areas provide express or park-and-ride services only during the peak-periods, with little or no off-peak service. Express transit service is found with all types of HOV lanes.

Neighborhood Oriented Routes. These routes offer local service in neighborhood areas and then access the HOV lane for the trip to the downtown area or to another major activity center. Operating speeds in the neighborhood areas tend to be in the range of 8 to 16 kph (5 to 10 mph), while speeds on the HOV segment average between 72 to 89 kph (45 and 55 mph). Neighborhood routes provide commuters with the advantage of not having to drive to a park-and-ride lot or to transfer from a local feeder route. Further, neighborhood oriented routes may serve areas with concentrations of transit dependents. Neighborhood routes may operate only during the peak-periods, or they may operate throughout the day.

Feeder Services. These routes provide linking service from a neighborhood area or major activity center to a transit station or park-and-ride facility where riders transfer to dedicated, park-and-ride, or express routes for the major portion of their trip. Although feeder services are more commonly found with LRT or heavy rail systems, feeder routes are being used successfully with some HOV facilities.

Reverse Commute and Suburb-to-Suburb Routes. The transit routes described previously focus primarily on serving trips oriented toward the downtown or to other activity centers. This network structures reflects the traditional orientation of transit services, which has historically provided service from suburban areas to central cities and downtown areas. Less service has been focused on providing residents of central cities with access to suburban areas or serving trips between suburbs. Reverse commute and suburb-to-suburb services have been implemented in some areas to meet these travel needs. Reverse commute routes provide central city residents with access to jobs, shopping, and other opportunities in suburban areas. Suburb-to-suburb routes provide service between suburban communities.

Timed Transfer Services. Timed transfer systems are oriented around a network of transit routes designed to facilitate fast and convenient transferring between different routes. Timed transfer systems are set up so that routes and buses are linked at major interchange points, which are usually major transit centers. Buses on all routes serving the transfer points operate on the same headways or service frequencies. Buses are scheduled to arrive at the interchange point at the same time to allow passengers to transfer between routes. The advantage of this system is that passengers do not have to go downtown to transfer, as in a traditional radial system, allowing riders to reach more destinations more conveniently and quickly.

Paratransit and Demand Responsive Service. The previous types of transit services all operate on fixed-routes and fixed-schedules. Paratransit and demand responsive service operate only in response to a specific request. These services may be oriented toward individuals with special needs or the general population. The Americans with Disabilities Act (ADA) of 1990 requires that all transit systems providing regular route services also provide paratransit or other services to individuals with special needs. The paratransit services must be comparable to the fixed-route system in terms of coverage, hours of operation, fares, and other factors. In addition, paratransit options are used in some areas in place of fixed-route service for evening, weekend, and other off-peak periods. Although not documented extensively, paratransit services may use HOV facilities when convenient.

F. Supporting Programs and Policies

A variety of programs and policies are being used through the country to encourage greater use of HOVs and alternative commute modes. Most of these strategies fall into the broad category of travel demand management (TDM). TDM includes a wide variety of techniques and actions aimed at managing the demand on transportation facilities by encouraging commuters to change from driving alone to using an HOV or shifting into less congested travel periods. As a result, TDM programs may promote ridesharing and transit use, alternative work schedules, parking management and parking pricing, and peak-period travel spreading. Strategies may also focus on deterrents to driving alone, as well as growth, land use, and zoning controls. Supporting programs and policies in use with HOV facilities are highlighted next.

Ridesharing. Helping commuters form carpools and vanpools is the major focus of most ridesharing efforts. Most ridesharing programs provide a combination of ridematching services, vanpool programs, marketing and public information efforts, employer assistance activities, guarantee ride home programs, and other support services. Vanpools may be supported and organized by rideshare agencies, other public agencies, businesses and third-party groups. For example, public agencies in San Francisco, Seattle, Tennessee, and Connecticut own and operate vanpool fleets. In other areas, companies such as 3M have vanpool programs for their employees.

Parking Management and Parking Pricing. Approaches in this category focus on parking incentives for HOVs and disincentives for commuters who drive alone. Examples include providing preferential parking for HOVs, pricing strategies to encourage HOV use or to discourage driving alone, parking cash out policies, and other strategies. Parking management and pricing strategies can be applied at a regional level, within a major activity center, and at a specific employment site.

Guaranteed Ride Home Program. These programs provide commuters who ride the bus, carpool, or vanpool with a backup means of transportation in case of an emergency or a change in work schedule. A variety of approaches may be offered by a regional agency, a local group, or an individual employer.

Employer Programs. Many employers have implemented programs and policies to encourage their employees to use HOVs or other alternative commuter modes. These efforts may be undertaken in response to specific federal, state, and local regulations or they may be initiated to address site specific issues. Employer programs may include approaches described previously, such as ridesharing and parking management activities, or they may include financial incentives to encourage HOV use.

Trip Reduction Ordinances. These ordinances, which are usually passed at the state or local levels, are aimed at reducing or limiting the number of commute trips from new or existing developments. Trip reduction ordinances may contain requirements for employers or developers to reduce employee commute trips or to increase the use of HOVs.

Growth Controls, Land Use Policies, and Zoning Ordinances. A variety of growth controls, land use policies, and zoning techniques can be used to encourage the use of HOVs and HOV facilities. These policies and ordinances may be adopted at the state or local level.

G. Comprehensive HOV Systems Approach

Ensuring that a comprehensive approach is taken in planning, designing, implementing, and operating a comprehensive HOV system is important to the success of individual projects and the network, as well as addressing the overall needs of the freeway and roadway system in an area. The intent of this approach is to focus policies, programs, and resources on the common goals and objectives relating to increasing the use of HOVs and other related strategies. A comprehensive approach should include consideration of all of the elements described previously in this section. These include not only the HOV facility but also supporting facilities, services, policies, and programs.

In addition, this approach includes coordinating the HOV facilities with other elements of the surface transportation system. HOV facilities should represent just one part of the overall plan for improving the transportation system in an area. A coordinated strategy that may include HOV facilities, roadway and transit improvements, enhance transportation management, ITS, and other elements is needed to address the transportation issues and opportunities in most metropolitan areas today.

V. KEY ELEMENTS OF SUCCESSFUL HOV FACILITIES

Experience with successful and unsuccessful HOV facilities has helped identify the key elements to achieving the desired project goals and objectives. As described next, these factors relate to the characteristics of the area, the working relationships among agencies, and the supporting policies and programs. These factors are discussed in more detail throughout the remainder of the Manual.

Congested Corridors. HOV facilities are most appropriate and are most needed in corridors with high levels of travel demand and traffic congestion. In these situations, HOV facilities can provide the travel time savings and improved travel time reliability necessary to encourage commuters to change from driving alone to using a bus, vanpool, or carpool.

Interagency Coordination. HOV facilities require that staff from agencies responsible for the freeway and roadway system, transit services, rideshare programs, and other programs work together. Interagency cooperation and coordination is critical to the success of an HOV project. Interagency teams or project management committees are often used to help facilitate the needed coordination and cooperation.

Lead Agency. Although interagency cooperation is critical to the success of an HOV project, experience indicates that one agency or group needs to have overall responsibility. The lead agency may vary by projects. For example, state departments of transportation are often the lead agencies on freeways HOV facilities, while transit agencies usually take the lead on busways.

Project Champion. Experience also indicates that one individual, or a small group of individuals, has been instrumental in the development, promotion, and support of most HOV projects. The support of these individuals, who are usually top officials with the state department of transportation or the local transit agency can be critical to the success of projects. A project champion must be in an influential position and have the respect of policy makers and others in the transportation community.

Public Involvement and Support. An HOV facility must have public support to be successful. Ensuring that the public is involved early and throughout the planning, design, and implementation stages can help ensure this support. A variety of methods can be used to encourage the participation of commuters, travelers, neighborhood groups, and other organizations. These include meetings, workshops, surveys, focus groups, charettes, hearings, and other techniques. The involvement of organizations such as the local chapter of the American Automobile Association (AAA) should also be encouraged.

Logical HOV Segments. Ensuring that logical segments of an HOV project are opened for operation enhances the chance for a successful facility. For example, projects that allow HOVs to bypass congested freeway segments and provide good access may be better received than projects located where there is no congestion or those which funnel HOVs back into sections of heavy traffic.

Comprehensive HOV Systems Approach. As noted in the previous section, ensuring that a comprehensive approach is taken in planning, designing, implementing, and operating HOV facilities can help ensure successful projects. This approach should include all of the key elements noted above and should be coordinated with other roadway and transit improvements to ensure an integrated multimodal transportation system.

Education and Marketing Programs. Building on the early involvement of the public, ongoing public education, and marketing activities can also enhance the chance for a successful HOV project. The ongoing reinforcement of travel options is important for new residents as well as long-term commuters.

Supporting Facilities and Service. Successful HOV projects encompass more than just the HOV facility. Elements such as park-and-ride and park-and-pool lots, new or expanded bus services, transit stations, and other supporting components all contribute to the success of an HOV project. These elements provide commuters with a range of alternatives to driving alone.

Supporting Programs and Policies. The existence of other supporting programs and policies also enhances the likelihood of a successful project. Ridesharing programs, guaranteed ride home programs, parking management and pricing policies, employer efforts, trip reduction ordinances, growth controls, land use policies, and zoning ordinances may all encourage HOV use.

Enforcement. Public acceptance of an HOV project is closely linked to the perception that the facility is well used and that the vehicle occupancy requirements are enforced. Support for an HOV facility will be lessened if commuters traveling in the adjacent freeway lanes feel the privilege of using the HOV lanes is being abused. Ensuring that the project design includes adequate and safe enforcement areas, and that visible ongoing enforcement is provided are important to the success of an HOV project.

VI. REFERENCES

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CHAPTER 3—POLICY CONSIDERATIONS WITH HOV FACILITIES

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I. INTRODUCTION

This chapter discusses the development and use of HOV policy guidelines. The role of HOV facilities in the overall transportation system are described first. The evolution of HOV policies in North America are summarized, and examples of policies currently in use are highlighted. Policy considerations that may influence the development and operation of HOV facilities are also identified. These include items such as air quality and environmental legislation, congestion management initiatives, trip reduction programs, and other federal, state, and local efforts. Potential funding sources for HOV facilities are identified. The process of developing HOV policies are highlighted, including the groups involved and the key elements that should be considered. The chapter is divided into five sections covering the following topics.

- **HOV Facilities as Part of an Intermodal Transportation System**. This section discusses HOV facilities as one element in a comprehensive intermodal transportation system. It provides an overview of the roles and responsibilities of the various agencies at the federal, state, and local levels involved with different aspects of the transportation system. The development of national, state, and local transportation policies and plans are summarized. How HOV policies fit into this process and how highway, transit, parking, and land use policies are coordinated is discussed.

- **HOV Policy Development in North America**. This section summarizes the evolution of policies related to HOV facilities. Examples of current HOV policies in use at the federal, state, and local levels are highlighted. These include policies relating to all types of HOV projects, including converting a general purpose lane and congestion pricing on HOV facilities. The impact of other policy considerations, such as air quality and environmental legislation, congestion management initiatives, and trip reduction programs are also discussed.

- **Steps in Developing HOV Policies**. This section presents the steps usually followed in developing a comprehensive set of HOV policies. The roles and responsibilities of the agencies commonly involved in the policy development process are summarized and the need for interagency cooperation and coordination is highlighted. The various elements that should be considered in the development of HOV policies at the state, regional, and local levels are presented. These include the development of realistic goals, objectives, policy statements, and criteria. The policies that are often more difficult to reach consensus on are highlighted along with approaches to overcome these problems.

- **Funding HOV Facilities**. Funding is often a key consideration in determining the viability of transportation alternatives. This section discusses the different sources of federal, state, and local funding that may be used to support the development and operation of HOV facilities. Examples of current approaches, including innovative financing techniques, are highlighted.

- **Additional Research Needs**. The chapter concludes with a discussion of additional research needs related to HOV policy considerations.

The references cited are provided at the end of the chapter along with a listing of additional sources of information related to HOV policy considerations.

II. HOV FACILITIES AS PART OF AN INTERMODAL TRANSPORTATION SYSTEM

This section provides an overview of the intermodal transportation system. The role HOV facilities play in enhancing this system are described first. The responsibilities of federal, state, and local governments and agencies involved with the different aspects of the transportation system are discussed. HOV policy development is summarized, along with coordination with other transportation and land use policies.

A. HOV Facilities in an Intermodal Transportation System

The surface transportation system is comprised of a number of different elements and modes. Major components include the roadway system, public transit services, railroads, and bicycle and pedestrian facilities. Each of these contains numerous elements. For example, the roadway system includes freeways, arterial roads, and local streets. Public transit modes and services may include bus, light rail transit (LRT), heavy rail, commuter rail, paratransit, and ridesharing.

These components have different characteristics and often serve different functions and travel markets. The goals of an intermodal transportation system are to build on the strengths of the various modes, to utilize the most cost-effective and efficient approaches in specific areas, and to ensure the integration and coordination among modes. HOV facilities represent one element of the intermodal transportation system in many areas.

As discussed previously in Chapter Two, the concept behind HOV facilities is to provide travel time savings and travel time reliability to buses, vanpools, and carpools to encourage commuters to change from driving alone to using these modes. HOV projects are not intended to force individuals to make this change against their will. Rather, the objective is to provide travel alternatives that a significant number of commuters will find attractive enough to change from driving alone to using a higher occupancy mode to realize the travel time savings and the travel time reliability offered by HOV facilities. Additional supporting elements and programs may also be utilized to provide further incentives to commuters.

All types of HOV projects, including those on freeways, in separate rights-of-way, and on arterial streets, represent important components of the overall transportation system. These facilities can help manage traffic in congested travel corridors by increasing the number of people, rather than vehicles, that can be carried on the system. Further, HOV projects often improve the efficiency of a transit system by allowing buses to maintain a more constant operating speed.

HOV facilities support the intermodal transportation concept in a number of ways. First, HOV projects provide travelers with the opportunity to change from a lower occupancy mode to multi-occupancy vehicles. Possible access modes to an HOV facility include walking, driving, bicycling, or taking a shuttle bus or regular route bus. Some HOV lanes also provide connections between buses and LRT or heavy rail transit. Further, commuters may use a variety of modes to reach their final destination.

It is important to remember that HOV facilities may not be appropriate in many situations. The planning process described in the next chapter should be used to identify and evaluate potential HOV strategies and other alternatives. The challenge for transportation professionals and policy makers is to match the most appropriate approaches to the issues and opportunities in a specific corridor or area.

B. Roles and Responsibilities of Federal, State, and Local Governments and Agencies

Planning, designing, funding, constructing, operating, and enforcing the various elements of the surface transportation system is the responsibility of federal, state, and local governments and agencies. The roles of these governmental units and agencies vary. Table 3-1 identifies the various levels of government and the agencies involved in different aspects of the transportation system. The roles and responsibilities of each group, including those related to HOV policies, are highlighted in the table and described in more detail below.

Federal Government and Agencies. The federal government is responsible for establishing national transportation policies, programs, and funding levels. The Congress and the President are responsible for authorizing legislation, which is administered by the federal agencies. Currently, the Transportation Equity Act for the 21st Century (TEA-21) provides the overall direction for the transportation system, establishes specific programs, and authorizes funding levels. TEA-21 and other Acts provide policy level guidance related to HOV facilities, as well as establishing specific program requirements. The Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA) are the two modal agencies within the U.S. Department of Transportation with responsibilities for HOV facilities. These responsibilities include developing specific rules and program guidelines in response to legislative directives, reviewing plans and designs, approving project funding, and providing technical assistance. For example, HOV facilities may be the only type of new capacity that can be considered on freeways in some air quality non-attainment areas, although general-purpose lanes may be added if they are part of an approved Congestion Management System.

Table 3-1. Roles and Responsibilities of Federal, State, and Local Governments, Agencies, and Groups

Government Level or Agency	Potential Roles and Responsibility
Federal Government and Federal Agencies	• Establish national transportation policies. • Establish programs and requirements. • Authorize and appropriate funding. • FHWA and FTA responsible for administering programs and funding.
State Government and State Departments of Transportation	• Establish state transportation policies and plans. • Establish state programs and requirements. • Authorize and appropriate state funds and the expenditure of federal funds. • State departments of transportation responsible for administering programs and funding. • Plan, design, construct, operate, and maintain Interstate system and state-owned roadways and other transportation components. • Assist in multi-agency coordination and public involvement.
Metropolitan Planning Organizations (MPO)	• Conduct '3-C' planning process. • Develop and adopt plans and policies. • Conduct project selection process. • Assist in multi-agency coordination and public involvement.
Transit Agencies	• Establish plans and policies for public transit. • Receive federal and state funds. • Construct, develop, and operate services.
Local Municipalities	• Establish local policies and plans. • Plan, design, construct, and operate local roadway and traffic sign system and other elements. • Responsible for land use and development controls.
Rideshare Agencies	• Policies and plans relating to ridesharing. • Plan, administer, and operate rideshare services. • Coordinate with overall TDM initiatives.
State and Local Police	• Enforce laws on roadways and other transportation elements. • Coordination with judicial personnel. • Provide input on planning, operation, and enforcement of TDM and TSM elements.
Judicial System—State and Local Courts	• Enforce fines and penalties for violation of motor vehicle laws, settle lawsuits, and address other legal actions.
Transportation Management Organizations, Transportation Management Associations, Downtown Councils	• Employer support activities. • Promotion of bus use and ridesharing. • Specialized information and marketing.

State Government. State governments have responsibility for the Interstate highway system within their borders and state-owned transportation facilities. State governments establish the programs, funding mechanisms, and policies related to the various components of the state transportation system. For example, the legislative or executive branch may establish financing methods such as a state gasoline tax or other taxes and fees, adopt policies relating to the types of facilities and services that will be provided by the state, and authorize state agencies to carry out specific responsibilities related to planning, designing, constructing, and operating various transportation elements. States also have responsibilities in a number of areas that may influence the transportation system. These include land use and growth control regulations, trip reduction requirements, and other related programs.

The state department of transportation or highway department is the agency usually charged with planning, designing, constructing, operating, and maintaining the Interstate system, the state-owned roadway system, and other state transportation facilities. The responsibilities of these agencies have expanded in many states and may include airports, ports, rail facilities, ferries, and public transportation services. A state department of transportation will usually have the lead responsibility for HOV facilities on freeways and state-owned roadways. These agencies often play important supporting roles with projects in separate rights-of-way and on local arterial streets. In many areas, state departments of transportation have been responsible for organizing, staffing, and chairing the multi-agency project management team associated with an HOV project.

Metropolitan Planning Organization (MPO). Metropolitan Planning Organizations (MPOs) were created in 1964 by federal legislation to coordinate the transportation planning process and the project selection process in urban areas. MPOs were charged with conducting the "3 C—Continuous, Cooperative, and Coordinated"—transportation planning process in these areas. The roles and responsibilities of MPOs have been modified over the years. Further, some MPOs have been given additional authority based on state legislation.

In general, MPOs are responsible for developing and adopting the long-range transportation plan, the short-range transportation improvement program, other policies and plans, and conducting the public involvement process. The policy boards of MPOs are usually comprised of local elected officials and appointed representatives. Further, most MPOs utilize an advisory committee structure involving policy makers, technical staff from other agencies and jurisdictions, and the public. Representatives from an MPO are usually members of the multi-agency planning groups associated with HOV facilities and may head the coordinating committee on regional studies, including Major Investment Studies (MIS). Staff from the MPO may help facilitate meetings or implementation strategies, as well as assist with multi-agency coordination and the public involvement process. The policies, goals, and objectives included in the transportation plans completed by MPOs usually address HOV facilities.

Transit Agency. Most metropolitan regions, smaller communities, and rural areas are served by some type of public transportation system. The exact agency or organizational structure may take a variety of forms and may provide a range of services. Regional transit agencies have been created in most large metropolitan regions throughout the country based on some combination of state legislation, authorization from local jurisdictions, and voter approval. These agencies are responsible for planning, designing, implementing, and operating transit modes which may include paratransit, local and express fixed route, LRT, heavy rail, commuter rail, people movers, and carpool and vanpool services. Public transit agencies may finance these services and accompanying fixed facilities through a combination of federal, state, and local funds, and revenues from users. Transit agencies often have the lead responsibility with HOV facilities in separate rights-of-way and may be a co-sponsor or play a supporting rôle with projects on freeways and arterial streets. Further, transit agencies may be responsible for enforcing vehicle eligibility, vehicle-occupancy, and other requirements associated with HOV facilities. Policies encouraging HOV facilities, providing priority treatments to buses and other HOVs, and supporting greater coordination among all modes are usually included in the long- and short-range plans of many transit agencies.

Local Municipalities. Cities and counties are responsible for local roadways and other local components of the transportation system. As a result, these jurisdictions have authority over planning, designing, funding, implementing, and operating the local street and traffic signal systems. Local municipalities usually have the lead responsibility on arterial street HOV applications and often have important supporting roles with HOV facilities on freeways and in separate rights-of-way. Local municipalities may have policies and plans relating to HOV facilities. In addition, local jurisdictions have authority for land use and development controls, including zoning, site design, and subdivision regulations. Local governments thus play an important role in coordinating land use and transportation planning and development.

Rideshare Agency. In many metropolitan areas, the transit agency operates not only bus or rail services, but also provides ridematching services, vanpool programs, and other ridesharing services. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, the rideshare agency may participate in the metropolitan transportation planning process, adopt policies relating to HOVs, and provide technical assistance and services to public agencies, private businesses, and other groups.

State and Local Police. State and local police are responsible for enforcing the laws and regulations related to the safe operation of roadways and other elements of the transportation system. Although the fines and other penalties imposed on violators are determined by state and local legislation, the police are responsible for enforcing these regulations. Involving police personnel throughout all aspects of planning, designing, constructing, implementing, and operating transportation systems, including HOV facilities, is important to ensure that the completed projects can be safely and efficiently enforced. Experience indicates that including state, local, and transit police, and other enforcement personnel throughout all phases of the development process is critical to the success of an HOV project.

Judicial System. The federal, state, and local court systems are responsible for determining the validity of any appeal on the constitutionality of enforcement techniques, fines, or other legal issues. In addition, lawsuits brought by neighborhoods, businesses, or other groups related to a specific transportation project are decided in the judicial system. For example, some highway projects have been delayed and even stopped by legal actions taken by neighborhood or citizen groups. The court system may also be used by individuals who wish to have a citation overturned. Ensuring that the fines and citations issued by enforcement personnel are handled appropriately in the local or state court system is an important aspect to the success of HOV facilities.

Transportation Management Organizations (TMOs), Transportation Management Associations (TMAs), Downtown Councils, and Other Groups. These types of voluntary organizations, which are usually composed of major employers in an area, often promote specific transportation improvements, help facilitate programs and activities among members, and may assist in funding projects. They can also help promote the use of an HOV facility or other program among their employees. These organizations may have policies related to HOV systems, transit, ridesharing, and other related projects.

C. Development of Transportation Policies

Transportation policies at the federal, state, regional, and local levels provide the overall direction for the allocation of funding for new facilities, operational strategies, maintenance of the existing infrastructure, and other elements of the system. The policies and plans adopted at different levels establish the priorities and the focus for investments in the various elements of the transportation system. Thus, policies reflect the values placed on different transportation components, and help direct project funding decisions. The role policies and plans play at all levels is not unique.to transportation, as most elements of society are influenced in some way by the goals and objectives developed by different governmental units and groups.

Transportation policies in the United States have evolved over the last 50 years. During the 1950s, 1960s, and much of the 1970s, the major focus of national transportation policies was on developing the Interstate highway system and addressing local needs for new facilities. This direction was reflected at the state and local levels in the construction of the Interstate highway system, state roadways, and local streets. During this same time period, transit systems in most urban areas changed from private operators to public ownership, and significant capital investments were made in new vehicles, facilities, and systems.

With the completion of most elements of the Interstate system during the 1970s and 1980s, and in response to the Arab Oil Embargo, the energy crisis, and growing concerns over air quality and other environmental impacts, more emphasis was placed on managing the existing transportation system rather than building new facilities. The use of transportation system management (TSM) and travel demand management (TDM) techniques, including HOV facilities, emerged during this period.

TEA-21 provides the current federal vision, direction, and scope for the transportation system in the U.S. The policies and programs contained in both the ISTEA of 1991 and TEA-21 of 1998 represent significant changes from those governing the surface transportation system in the past. The tone and direction of the ISTEA which was "to develop a National Transportation System that is economically efficient, environmentally sound, provide the foundation for the Nation to compete in the global economy and will move people and goods in an energy efficient manner (*1*)" has been continued with TEA-21.

The ISTEA modified existing programs and created new programs; altered the policies, requirements, and agency roles and responsibilities relating to the transportation planning process, the project development and selection process, and the public participation process; provided greater funding flexibility to respond to local problems and priorities; and implemented many of the transportation provisions contained in the 1990 Clean Air Act Amendments. The ISTEA represented a significant change in the federal goals, policies, and programs relating to the surface transportation system and stressed the interrelationships among the various infrastructure elements. These elements have been continued in TEA-21.

A greater focus was placed on HOV facilities and supporting policies and services in the ISTEA and TEA-21. For example, HOV facilities may be the only type of new capacity that can be considered on freeways in some air quality non-attainment areas. General-purpose lanes may be considered if they are part of an approved Congestion Management System. These changes have also been reflected in the policies and plans developed at the state, regional, and local levels.

As noted in the previous section, state departments of transportation, MPOs, transit agencies, and local jurisdictions, all have important roles and responsibilities related to various aspects of the surface transportation system. These responsibilities include the development of policies and plans to govern state, regional, and local investments and programs. HOV facilities and priority treatments for HOVs are often included in these policies and plans.

In addition, agencies at the federal, state, regional, and local levels are responsible for developing and implementing plans and projects related to land use, housing, economic development, education, water and sewer, police and fire protection, parking, and many other services. There is a strong interrelationship between these elements and the transportation system. For example, the location of freeways and roadways will influence where economic development occurs. Decisions relating to the siting of major industries and developments will also place demands on the transportation infrastructure. Policies related to land use densities, parking, and the provision of water, sewer, police, fire, and schools will influence where people live and work, as well as their commute modes.

It is often difficult to coordinate the policies and plans of the agencies and groups responsible for all of these different elements. As a result, decisions may be made by one group that will have a negative impact on another element of the infrastructure. For example, a land use decision to locate a major development adjacent to a freeway that is already over-capacity will result in further traffic congestion. As a result, emphasis is being placed in many areas on enhancing the coordination among the governmental levels and agencies responsible for the various elements. MPOs can play an important role in facilitating the coordination of land use decisions made by local governments and transportation decisions made by the state and other jurisdictions. Although this approach is not easy, all groups will benefit from greater coordination among transportation, land use, economic development, housing, and other policies, plans, and projects.

III. HOV POLICY DEVELOPMENT IN NORTH AMERICA

A. Overview of HOV Policy Development

As noted in the previous sections, policies related to HOV facilities are commonly found at the federal, state, regional, and local levels. A number of general factors are appropriate for consideration in the development of HOV policies by all agencies and jurisdictions. In most cases, the identification and adoption of goals and policies relating to HOV facilities does not occur in a vacuum. Rather, HOV policies represent one component of a larger planning effort.

For example, goals, policies, and objectives related to HOV facilities may be included in long- and short-range plans developed by state departments of transportation, MPOs, transit agencies, and local governments. In other cases, more detailed policies and guidelines relating to planning, designing, funding, operating, and enforcing HOV projects may be developed based on the general goals outlined in the long-range plans adopted by the various agencies.

A few general suggestions can enhance the development and use of HOV policies. First, the consideration of HOV policies should be part of the overall planning process for an agency or area. Policies related to HOV projects should be part of a comprehensive approach and a set of policies that address the needs of an area.

Second, the development of transportation policies, including those relating to HOV projects, should reflect the overall goals of the agency, jurisdiction, and community. Finally, HOV policies should also be coordinated with the goals and policies related to land use, economic development, and other elements in a community.

The development of policies which accurately reflect the goals of an area and which provide direction for decision makers and professional staff is not an easy process. Clearly articulating the intent and focus of policies is important, however, to guide future decisions and projects. As a result, the time spent developing policies relating to the transportation system and to HOV facilities will have long term benefits. These policies should be reviewed on a regular basis and updated as needed to reflect changing conditions and demands, such as new growth and changing travel patterns.

B. Examples of HOV Policies

As noted, policies related to HOV facilities may be developed and adopted at the federal, state, and local levels. Federal agencies, state departments of transportation, MPOs, transit agencies, and local jurisdictions may all have policies relating to HOV facilities. Examples of agencies at the various levels that have adopted HOV policies are described in this section. Examples of multi-agency policies are also highlighted.

State Departments of Transportation. A number of state departments of transportation or State Highway Departments have developed policies related to HOV facilities. In some cases these policies are a simple statement identifying when an HOV facility should be considered, while in other cases a comprehensive set of policies have been adopted to guide the development, design, and operation of HOV projects. Further, examples exist of both statewide policies, as well as those relating to a specific facility or corridor.

Missouri Highway and Transportation Department. The *Policy on High-Occupancy Vehicle Facilities* (*2*) presents a series of general guidelines for use in planning, designing, and operating HOV facilities in Missouri. The policies were developed by an HOV Task Force and were adopted by the senior management of the Missouri Highway and Transportation Department (MHTD). The policies establish general criteria related to congestion levels, travel time savings, impact on mixed-flow lanes, HOV volumes, person movement, local support, enforcement, safety, cost, support facilities and programs, environmental factors, and bus services to guide the consideration of HOV facilities on freeways and on arterial streets in the state.

New York State Department of Transportation. The New York State Department of Transportation (NYSDOT) utilizes the guidelines contained in the 1993 draft report, *Scoping Procedure Manual* (*3*), for considering HOV projects. Appendix C of this document references the AASHTO report (4) and the Parsons Brinckerhoff (5) report.

Washington State Department of Transportation. The *Washington State Freeway HOV System Policy* (6) outlines objectives of the HOV system in the state and provides policy guidelines relating to different elements of the HOV system. Elements addressed in the policies include minimum thresholds for HOV lanes, agency and mode coordination, carpool definitions, hierarchy of HOV facility development, hours of operation, enforcement, lane location (inside vs. outside) and separation, general purpose lane conversion, HOV system performance, promotion, design standards, land use coordination, and supporting programs, services and facilities. Examples of some of these policies are provided in Table 3-2 to highlight one of the more comprehensive set of HOV policies currently in use. The policies were developed by a multi-agency stakeholder group and adopted by senior management and the Transportation Commission.

Metropolitan Planning Organizations. Policies relating to HOV facilities and supporting services and programs have been incorporated into the long-range plans of many MPOs. These may include general policies encouraging implementing agencies to consider HOV facilities and more specific policies recommending HOV projects in certain corridors or areas. The following case studies provide examples of MPOs with policies related to HOV facilities, services, and programs.

Metropolitan Council of the Twin Cities Area. Goals and policies related to HOV facilities in the Minneapolis-St. Paul metropolitan area are included in a number of documents developed and adopted by the Metropolitan Council. These include the *Transportation Development Guide/Policy Plan* (7) and the *Regional Transit Facilities Plan* (8). The philosophy presented in the *Transportation Guide* recognizes that the region cannot meet growing demand by simply adding new roads and services. Support for HOV facilities and other related elements are contained in the philosophy and in specific goals and policies (7). The vision presented in the *Transit Facilities Plan* focuses on four major elements. These are strong transportation management, incentives for HOV use, strengthened transit services, and more efficient and transit friendly land uses. Specific corridors where HOV facilities and supporting services should be considered are highlighted (8).

Transit Agencies. Many transit agencies, especially those in large and medium sized metropolitan areas, have plans and policies addressing HOV facilities, transit needs, and project priorities. Providing preferential treatments to buses, vanpools, and carpools are usually important components of these plans. A few examples of transit agencies with plans and policies relating to HOV facilities are highlighted below.

Table 3-2. Examples of Washington State HOV Policies

Policy Area	Policy
General HOV Policy Statement	• WSDOT regards the HOV system as a high capacity transportation system whose goal is to maximize people moving capability of the state highway system, mitigate transportation-related pollution and reduce dependency on fossil fuels. • Through the state transportation planning process and regional transportation planning organizations, WSDOT shall take a pro-active role in promoting and coordinating the development of HOV systems, transportation demand management activities and related transportation system management activities. This will be accomplished through support of local jurisdictions and participation in their transportation and land-use planning efforts statewide. • WSDOT recognizes that an HOV system may not be the only high capacity transit system in a region depending on adopted regional funding strategies and transportation policies. It is believed that in regions such as the Puget Sound, a completed HOV system must be in place to meet federal environmental clean air standards, and support overall mobility needs and high capacity transportation systems of the future. • All policies adopted by WSDOT regarding this system shall be based on providing incentives for people to shift from single occupant vehicles to ridesharing modes. • WSDOT's aim is to enhance Washington's quality of life, protect the natural environment, preserve mobility for people today and ensure personal mobility in the year 2000 and beyond.
Coordination Between Agency and Mode	• Coordination is an essential aspect of a successful HOV program. WSDOT shall coordinate HOV efforts with regional and local transportation agencies throughout the planning, design, construction and operation phases. • Intermodal considerations and coordination shall take place throughout the HOV planning and development phases. • When changes are to occur to the HOV System, it is the responsibility of WSDOT to coordinate such change with those agencies and jurisdictions specifically affected by the change.
HOV Lane Minimum Thresholds	• Facility demand exceeds capacity for more than an hour each day as evidenced by level of service E or F. • Evidence exists that during peak hours of operation, the HOV lane will move more people than the per lane average of the adjacent general purpose lanes. • Local support for construction of the HOV lane is demonstrated through active regional support or public surveys. • An HOV route segment may also be justified if it enhances HOV system continuity, for example by providing a link between HOV corridors identified for completion in the year 2000 HOV Core lane system.
General-Purpose Lane Conversion to HOV	• When new capacity options are proposed, one of the alternatives to be considered shall be the conversion of a general-purpose lane to an HOV lane.
Hours of Operation	• HOV lanes shall be reserved for buses, motorcycles, carpools and vanpools meeting minimum occupancy requirements, 24-hours per day, seven days a week. • WSDOT shall solicit private, local transit and local government support in increasing regional efforts to market and educate the general public about the need for a 24-hour, seven day HOV lane operating policy. • This policy allows for variable carpool definitions based on time of day.

Dallas Area Rapid Transit (DART). DART's *Regional Transit System Plan* (9) provides the framework for the development of a multimodal system in the Dallas area. The plan includes policies relating to HOV facilities, LRT, commuter rail, regular-route and specialized services, and other related programs. The plan identifies the various types of HOV lanes that may be appropriate in the area and the corridors where HOV facilities should be considered (9).

Metropolitan Transit Authority of Harris County (METRO). Policies relating to HOV facilities in the Houston area are contained in METRO's long-range plan and other documents (10). Policies in these plans support the development of the HOV lane system, park-and-ride lots, transit centers, transit services, as well as those related to the general mobility, traffic management, and other programs.

Suburban Bus Division of the Regional Transportation Authority (Pace). Pace is the transit agency serving the Chicago suburbs in Cook, DuPage, Kane, Lake, McHenry, and Will counties. The *2010 Vision: Pace Comprehensive Operating Plan* (11) provides the future vision for Pace services and facilities. The plan outlines the various services, park-and-ride lots, transit centers, and other facilities anticipated to be developed and offered by the year 2010. Policies and plans relating to the application of restricted use facilities, such as HOV lanes on freeways and arterial streets, and traffic signal priority treatments are included in the plan (11).

Cities and Counties. The comprehensive plans developed by cities and counties include policies relating to the transportation and transit systems. Arterial street HOV facilities and other supporting components may be included in these plans. In addition, larger cities may have specific transportation plans or subarea plans which include transportation components. The following examples examine HOV related plans and policies adopted by local jurisdictions.

Minneapolis, Minnesota. The *Minneapolis Metro Center: Metro 2000 Plan* (12), which was prepared by the Minneapolis Planning Department and the Downtown Council, presents the vision, goals, policies, and direction for downtown Minneapolis. The plan builds on the concepts contained in previous plans completed in 1959, 1970, and 1979. Transportation and transit have been important elements of all these plans. The Nicollet Mall, bus services, and transit and pedestrian amenities represent significant components of previous plans and the current plan. The *Metro 2000 Plan* provides further guidance on policies and programs to support transit in the downtown area including priority treatments for buses and HOVs (12).

Multi-Agencies. In some areas, policies related to a specific corridor area, or freeway have been developed through multi-agency coordination. The following examples from Phoenix, Arizona and Minneapolis, Minnesota provide an indication of how multiple agencies are working together in some areas to develop HOV facilities.

Arizona Department of Transportation, Maricopa Association of Governments, and Regional Public Transportation Authority. The *High-Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System*, (13) was prepared by consultants for these three agencies. The first phase of this project developed policies to guide HOV facilities—including HOV lanes, exclusive freeway-to-freeway ramps and freeway-to-arterial ramps, park-and-ride lots, and bus stations—on the freeway system in the Phoenix area. The HOV mission statement, HOV commitment statement, and policies for roles and responsibilities were adopted by all three agencies. Policies included in the document address the decision making and coordination process; the planning and programming process; the implementing, monitoring and evaluating process; marketing; and preserving the capacity of HOV facilities. A second phase of the study developed a recommended system-wide HOV plan for the area.

Minnesota Department of Transportation, Metropolitan Council, Metropolitan Transit Commission, and City of Minneapolis. The *Transportation System Management Plan for I-394* (14) represents a multi-agency effort to coordinate the various components of the I-394 HOV system. The plan included the TSM policies for I-394. These policies address the movement of people rather than vehicles in the corridor, provide support for bus service and rideshare programs, and provide direction on other elements. The plan was used by all agencies to guide investments in fixed facilities and new services in the I-394 corridor.

IV. STEPS IN DEVELOPING HOV POLICIES

Numerous agencies may have policies addressing HOV facilities. This section discusses the agencies and groups that may be involved in articulating and adopting HOV policies, the general steps that are commonly followed in developing HOV policies, and examples of HOV policy elements.

A. Groups Involved in Developing HOV Policies

As noted in Section I, federal, state, regional, and local jurisdictions and agencies are responsible for various elements of the surface transportation system. All of these agencies have policies and plans which articulate the goals, objectives, and priorities for the area and which help guide the project development and project selection process.
Table 3-1, provided in Section II of this chapter, identifies the agencies with responsibilities for the various components of the surface transportation system. All of these agencies may have policies relating to HOV facilities. Further, through the MPO process, representatives from these agencies may be involved in the development of policies that will guide regional decisions related to HOV facilities. The topics and areas of interest to these various agencies are highlighted next. Practitioners can use the information in Table 3-1 to help ensure that all appropriate groups are involved in the development of policies relating to HOV facilities. The exact approach, as well as the agencies and individuals to involve, will vary by area.

B. Steps in Developing HOV Policies

The development of policies relating to HOV facilities and supporting services should follow the same process used to develop other transportation and transit policies. Although the exact approach will vary by area and by agency, the steps identified in Figure 3-1 and described next can be used to help guide the process.

Figure 3-1. Steps in Developing HOV Policies

Identify Appropriate Agencies and Groups

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Public Involvement

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Identify Future Vision and Goals from Community, Agency, or Area

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Develop Draft Policies to Accomplish These Goals

↓

Public and Agency Review

↓

Finalize and Adopt Policies

Identify Appropriate Agencies and Groups. The first step in the development of HOV policies is to identify the appropriate groups to involve in the process. The information provided in Sections II.B and IV.A of this chapter can be used to assist in this effort. The exact agencies and organizations will vary by area and by level. For example, the development of regional policies addressing HOV facilities is the responsibility of MPOs. Representatives for the state, transit agency, and local communities will be involved in this process. On the other hand, developing policies related to bus priority treatments in a downtown area as part of a city comprehensive plan will likely involve representatives from the city, transit agency, downtown association, downtown businesses, and citizen groups.

Public Involvement. Public involvement is an important component of policy development at all levels. For example, if the policies are part of a state plan, MPO plan, or a community comprehensive plan, surveys, public meetings, and techniques may be used to obtain information on public perception related to traffic congestion, transportation issues, possible solutions, and HOV facilities.

Identify Future Vision and Goals. The information provided through the public participation process and information on current conditions and future trends is used by technical staff and decision makers to outline a future vision for the community, area, or agency. Overall goals can then be developed to achieve this vision.

Develop Draft Policies to Accomplish Goals. After the vision and goals have been identified, the next step is to develop more specific policies that will guide decisions and actions to accomplish these goals. The policies may be general or specific depending on the planning level they are being used in. The more specific the policies are, however, the better they will be able to provide direction and guide investment decisions.

Public and Agency Review. The public, affected agencies, and other groups should be given the opportunity to review and comment on the draft policies. Techniques that can be used during this step are discussed in Chapter 12.

Finalize and Adopt Policies. The draft policies are modified as needed based on public and agency review and finalized in this step. The policies, and plan or document they are contained in, is then adopted by the appropriate policy board or governing group. Depending on the level, the policies may be formally approved by the state transportation commission, the MPO board, or the city council.

C. HOV Policy Elements

HOV policies may be oriented toward a number of levels and elements. First, policies may provide general support or encouragement for the consideration and development of HOV facilities. At a more detailed level, policies may provide specific direction on the conditions which should exist for various types of HOV projects to be considered. At an even greater level of detail, policies may guide decisions related to vehicle-occupancy levels, hours of operation, and other operating and design requirements. These different levels of detail represent a cascading of policies starting at a general level and moving toward more specific applications. Examples of HOV policy elements that may be appropriate for consideration at these various levels are described in this section.

Support for HOV Facilities. General policies may provide support for HOV facilities and services. These policies may go further by indicating a preference or priority in the project selection process for facilities and services focusing on HOVs, or by directing that any additional capacity will be for HOVs only.

Identifying the Need for HOV Facilities. Policies may provide direction for determining when HOV facilities should be considered. For example, policies may establish guidelines related to traffic congestion, level of service, or other benchmarks for use in identifying the need for HOV facilities.

Agency Roles, Coordination, and Cooperation. Policies may provide an indication of the roles and responsibilities of various agencies and groups relating to the different elements associated with HOV projects. Policies may also indicate the need for multi-agency coordination and cooperation and provide guidance on how to accomplish enhanced working relationships.

HOV Facility Location and Design Treatment. Policies may help guide the location and design of HOV facilities. For example, Washington State has a policy to help guide decisions relating to locating an HOV facility on the outside or the inside lane of a freeway. Policies may also be appropriate to identify the general types of designs to be considered in different situations.

Hours of Operation. Policies may be developed to govern the hours of operation of HOV facilities in an area.

Allowable Vehicles. The vehicles that will be allowed to use the HOV facilities in an area or a specific facility may be established by policy.

Vehicle-Occupancy Requirements. The vehicle-occupancy level constituting a carpool in an area or the vehicle-occupancy requirement on a specific facility may be established through policy.

Changing Vehicle-Occupancy Requirements. Policies may also be established to help guide decisions on changing vehicle-occupancy requirements.

Enforcement. Policies relating to enforcement may address the level of enforcement, enforcement techniques, and acceptable violation rates.

Penalties and Fines. Policies may be adopted to guide the type of penalty and the level of the fine assessed for violating the HOV operating requirements.

Marketing and Public Information. Policies may be adopted to help guide the public involvement, education, and marketing activities for an HOV facility.

Funding. Policies may address funding for HOV facilities. These may include the identification of different funding sources and financing techniques.

Converting a General-Purpose Lane. Policies may be adopted to guide consideration of converting a general-purpose lane on a freeway or an arterial street to an HOV lane. These policies may establish general criteria to use in assessing conversion projects or may just support considering lane conversion in certain cases.

Supporting Services and Facilities. Policies may be established encouraging transit services, park-and-ride lots, transit centers, rideshare services, and other supporting elements with HOV facilities.

Coordinating Land Use and Development. Policies may be adopted to encourage greater coordination among decisions relating to HOV facilities, transit services, land uses, and developments.

These represent just some of the elements that may be considered in the development of a comprehensive set of HOV policies. Coordinating policies among agencies is not always easy. The use of multi-agency teams and the MPO planning process appears to be some of the best ways to encourage the development of uniform policies relating to HOV facilities. As noted previously, the clear articulation of policies that all groups can agree on is not an easy process because a consensus must occur during the planning process and in the future when the project is implemented, when it matures, and when it must be replaced. The time spent developing clear policies and guidelines is a good investment, however, as it will enhance planning, designing, implementing, operating, and enforcing HOV projects.

V. FUNDING HOV FACILITIES

The availability of needed funding is often a key consideration in assessing the viability of transportation alternatives and in the project selection process. A variety of financing programs are available to support planning, designing, constructing, operating, marketing, and enforcing HOV facilities and supporting elements. This section reviews the federal, state, and local funding sources commonly used with HOV facilities. Innovative financing approaches that may be appropriate for consideration with HOV projects are also described.

A. Federal Funding

Federal funding is often used for many of the elements associated with planning, designing, constructing, implementing, marketing, and enforcing HOV facilities. The FHWA and the FTA are the agencies responsible for administering the national programs associated with HOV facilities and supporting services. The TEA-21 provides the program requirements and funding authorization for the six-year period from 1998 through 2003. The specific funding levels for the various programs and projects are appropriated by Congress on an annual basis.

The major federal programs used to fund planning, designing, constructing, and operating HOV lanes and supporting services include the National Highway System (NHS), the Interstate System, the Surface Transportation Program (STP), the Congestion Mitigation and Air Quality Improvement Program (CMAQ), and Sections 3 and 9 transit grant programs. The key elements of these programs are highlighted next. More detailed information on financing approaches for transit services associated with some HOV facilities are provided in Chapter 9.

National Highway System (NHS). The NHS was designated by Congress in 1995. It consists of the Interstate system, and key principal roadways. Funding from the NHS may be available to support HOV projects on these facilities.

Interstate System. This program is part of the NHS, but receives separate funding. It is comprised of the Interstate Completion, Interstate Substitution, and Interstate Maintenance elements. HOV lanes, auxiliary lanes, and construction projects that do not add capacity are eligible under the Interstate maintenance component.

Surface Transportation Program (STP). The STP is a block grant program that can be used by states to fund any roadway, including NHS, not functionally classified as local or minor collectors. HOV projects on these facilities may be eligible for funding through the STP. Transit capital projects, which could include elements such as HOV lanes, park-and-ride facilities, and bus centers, are also eligible for funding through the STP.

Congestion Mitigation and Air Quality Improvement Program (CMAQ). This program is intended to support projects in air quality non-attainment areas to help meet the requirements. States without non-attainment areas also receive a CMAQ allocation. HOV facilities and supporting components may be eligible for funding under this program.

Section 3 Transit Capital Program. The Section 3 program provides funding for major transit capital needs, and it includes four programs; discretionary and formula capital, new starts, rail modernization, and bus and other elements. The bus capital components HOV facilities may be eligible for funding through the Section 3 programs.

Section 9 Program. Section 9 is a formula grant program for capital and operating assistance for transit systems in urban areas with populations of 50,000 or more.

B. State Funding

State funding for roadways and public transit comes from a variety of sources. State funds are used as match for federal programs, as well as supporting state initiated projects. State financing programs may be established by legislation, administrative action, voter approval, or other methods. Commonly used funding mechanisms include state gasoline taxes, vehicle registration and license fees, general revenues, sales taxes, property taxes, lottery or gambling proceeds, and bonds, as well as other techniques.

C. Local Funding

A wide range of funding sources may also be used at the local level to support roadway, signal, and transit projects, including HOV facilities. Commonly used financing methods at the local level include local sales and property taxes, hotel or beverage taxes, special use fees, general revenue bonds, and other approaches. Locally generated revenues may be used to match state or federal funds or to support local initiatives.

D. Innovative Financing Techniques

Given limited resources at all levels of government, there continues to be a good deal of interest in innovative financing techniques to support the development, construction, and operation of different elements of the transportation system. These include public/public and public/private partnerships and other new financing techniques. The following represent a few examples of innovative financing techniques that maybe appropriate for consideration with HOV facilities:

Joint Development. This technique involves the joint development, improvement, or use of a piece of property. In most cases, joint developments involve a public agency and a private entity, but multiple public agencies may also pursue projects. Examples of joint development techniques include leasing development rights, leasing facilities, cost sharing, and negotiated land leases. The use of joint development strategies with transit and HOV facilities is discussed in more detail in Chapter 9.

Toll Facilities or Privatization. Toll roads, bridges, and tunnels represent a long-standing approach used in many areas to develop and operate transportation facilities. In some areas, toll facilities provide discounts for HOVs or priority treatments for HOVs at toll plazas. Other privatization techniques, such as the Route 91 Express Lanes in California, represent another innovative technique to finance needed infrastructure improvements. Further, the use of priority pricing or high-occupancy toll (HOT) lanes are being considered and implemented in some areas. These approaches, which may allow lower occupancy vehicles or single occupant vehicles to use an HOV lane for a fee, may be considered to help manage demand or fill available capacity on an HOV lane, or to generate additional revenue.

State Infrastructure Banks (SIB). The National Highway System Designation Act of 1995 established a pilot program that allows for the establishment of State Infrastructure Banks (SIBs) in at least 10 states. Subsequent legislation has opened the SIB program to all states. The intent of the SIBs is to provide a mechanisms for states to use a variety of innovative financing techniques for all modes of transportation. The program is intended to provide states with the flexibility to implement a variety of financial assistance, including loans, subsidized interest rates, insuring letters of credit, bonding, or other debt-financing, lease guarantees, grant anticipation notes, and other techniques. The exact approaches and techniques are left up to the individual states, but HOV projects can be included in a SIB (15).

Public/Public Partnerships. Coordinating and leveraging funding from multiple public agencies represents another innovative financing technique. Sharing resources among agencies may provide cost savings, allow for leveraging additional funds, and maximize funding for all groups.

VI. ADDITIONAL RESEARCH NEEDS

Additional research is needed on a number of topics related to policy considerations with HOV facilities. The following research statements provide an indication of the major areas for further research to assess the impact of various policies, to explore techniques to enhance coordination among policies at different governmental levels, and to identify techniques to build support for HOV facilities.

Assess the Effectiveness of Policies Relating to HOV Facilities. As discussed in this chapter, states, MPOs, and cities are adopting policies relating to HOV facilities. While examples of these policies were examined during the development of this Manual, additional research is needed to evaluate the effectiveness of different goals, policies, and objectives. This research study would provide a comprehensive inventory of HOV policy directives currently in use at the federal, state, regional, and local levels. The effectiveness of various policies and approaches would also be examined. Guidelines would be outlined on the development and implementation of effective HOV policies for all levels of government. The study would also identify techniques to encourage the adoption and use of these policies by the appropriate agencies and groups. Policies related to the following elements and other issues would be examined:

-vehicle occupancy levels
-changing vehicle occupancy to manage demand
-congestion pricing on HOV lanes
-innovative funding strategies
-arterial street applications
-system wide planning

Assess Techniques to Enhance the Coordination of Policies Relating to HOV Facilities and Supporting Components. In many metropolitan areas, policies related to various aspects of the transportation system are not coordinated. For example, parking policies may encourage commuters to drive alone through the provision of convenient and inexpensive parking. Research is needed to examine the relationships among policies associated with parking, transit fares and services, HOV facilities, TDM strategies, and other elements of the transportation system. The research would help identify those policies, and the packaging of coordinated policies, that best maximize the use of all HOV modes.

Assess Coordination of HOV-Related Policies Among Different Metropolitan Areas. As discussed in this Manual, the extent, nature, and scope of policies related to HOV facilities and other supporting elements varies widely by state and by metropolitan areas.

Research is needed to determine the potential for greater coordination among states and metropolitan areas and the benefits of enhanced coordination. This research project would explore the advantages and disadvantages of coordinating HOV-related policies among different areas, the feasibility of improving coordination, and approaches to facilitate enhancing coordination.

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VIII. ADDITIONAL INFORMATION SOURCES

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CHAPTER 4—PLANNING HOV FACILITIES

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I. INTRODUCTION

This chapter provides a comprehensive overview of the steps involved in planning HOV facilities on freeways, in separate rights-of-way, and on arterial streets. Approaches appropriate for regional, corridor, and facility level planning are presented. Available tools and techniques for demand estimation are summarized along with approaches for assessing potential environmental impacts of HOV facilities. To accomplish these objectives, the chapter is divided into the following sections.

- **Overview of the Planning Process**. This section provides an overview of the metropolitan transportation planning process and the general concepts associated with planning HOV facilities. The agencies and groups normally involved in planning HOV projects are discussed, and the steps in the planning process are presented.

- **Planning HOV Facilities on Freeways and in Separate Rights-of-Way**. This section discusses planning for HOV facilities on a regional basis, at a corridor level, and on a specific facility. The elements to be considered in the planning process at these different levels are highlighted. Examples of regional, corridor, and facility studies are provided. The techniques and analytical tools used in planning studies at the various levels are discussed.

- **Planning for Arterial Street HOV Facilities**. This section discusses planning for HOV facilities on arterial streets. The elements that should be considered in planning different types of arterial street HOV facilities are outlined, and the issues that may need to be considered are highlighted. Planning techniques appropriate for use with arterial street HOV facilities are identified. Sketch planning approaches, operational analyses, demand estimation procedures, and cost effectiveness analyses are highlighted.

- **Special Planning Considerations**. This section outlines the special elements that should be included in the planning process when converting a general-purpose lane to an HOV lane and priority pricing projects are being considered. The inclusion of HOV alternatives in Major Investment Studies (MIS) is also discussed. The issues that may need to be considered in these cases are highlighted, and case study examples are provided.

- **Assessing the Potential Environmental Impacts of HOV Facilities**. This section reviews the available tools and techniques for evaluating the potential environmental benefits and impacts of HOV facilities. Approaches for assessing air quality, water quality, noise, and other environmental factors are outlined.

- **Planning Public Involvement**. This section highlights the need for, and the role of, public involvement related to planning all types of HOV facilities. Specific approaches and techniques that can be used to elicit and maintain public involvement are described in more detail in Chapter 12.

- **Additional Research Needs**. The chapter concludes with a discussion of the areas where additional research is needed related to planning HOV facilities on separate rights-of-way, on freeways, and on arterial streets.

The references used in the chapter are also provided, along with a listing of additional sources of information related to planning HOV facilities.

II. OVERVIEW OF THE PLANNING PROCESS

A. Groups Involved in Planning HOV Facilities

Like all aspects related to developing HOV facilities, a number of agencies and groups should be involved in the planning process. Table 4-1 identifies the various organizations that should be included in the planning process for HOV projects. The typical roles and responsibilities of each group are highlighted in the table and described in more detail below. Practitioners can use the information in Table 4-1 as a guide to help ensure that consideration has been given to including the appropriate groups in the planning process. The exact agencies and individuals may vary by area and by the type of HOV facility being considered.

State Department of Transportation. The state department of transportation or the state highway department is usually the lead agency with HOV facilities on freeways. The state may also be the lead agency for an HOV project on state-owned arterial streets. In these cases, the state department of transportation will have overall responsibility for the project, including the planning process. In many areas, state departments of transportation have been responsible for organizing, staffing, and chairing the multi-agency project management team associated with an HOV project. Consideration should be given to including representatives from a variety of departments within the agency. These might include the planning, design, marketing or public information, construction, legal, operation, traffic management, and highway assistance departments.

Transit Agency. The transit agency often has the lead responsibilities with HOV facilities on separate rights-of-way and may be a co-sponsor or supporting player on freeway and arterial street projects. If the transit agency has the overall responsibility for the project, they will also have the lead role in the planning process. If the transit agency is playing more of a supporting role, key responsibilities may focus on planning and evaluating bus services, park-and-ride lots, and other bus facilities.

Table 4-1. Agencies and Groups Involved in Planning HOV Facilities

Agency or Group	Potential Roles and Responsibility
State Department of Transportation	• Overall project responsibility on freeways and state-owned roads. • Responsible for planning process or assisting with planning. • Staffing multi-agency team or participating on team.
Transit Agency	• Overall project management with busways in separate rights-of-way • Supporting role on freeway and arterial street projects. • Responsible for planning process or assisting with planning. • Bus operations planning. • Staffing multi-agency team or participating on team.
State and Local Police	• Assist with planning process. • Lead role on planning for enforcement components. • Coordination with judicial personnel. • Participate on multi-agency team.
Local Municipalities	• Overall project management with arterial street and traffic signal applications. • Support role with other HOV facilities. • Responsible for planning process or assisting with planning. • Staffing multi-agency team or participating on team.
Rideshare Agency	• Assist with planning rideshare components. • Participate on multi-agency team.
Metropolitan Planning Organization (MPO)	• May lead regional HOV planning efforts or corridor studies. • Assist in facilitating meetings and multi-agency coordination. • Ensure that projects are included in necessary planning and programming documents. • May have policies relating to HOV facilities. • Participate on multi-agency team.
Federal Agencies—FHWA and FTA	• Funding support. • Overall approval of various steps. • Provide technical assistance. • Participate on multi-agency team.
Consultants	• May be hired to conduct overall planning, MIS, or other studies. • May staff or assist with multi-agency teams.
Public Groups	• Commuters and travelers. • General public, business and neighborhood groups.
Other Groups	• American Automobile Association (AAA) or other related groups. • Judicial system—state and local courts. • EMS, fire, and other emergency personnel. • Tow truck operators.

State and Local Police. The involvement of enforcement personnel should be encouraged throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities. Experience indicates that including state, local, and transit police or other groups responsible for enforcing the HOV occupancy requirements and other regulations early in the planning and development process is critical to the success of an HOV project. Ensuring that the needs of police personnel are considered in the planning process is important to developing a facility that can be safely and efficiently enforced.

Local Municipalities. City or County departments may have important supporting roles in planning HOV facilities on freeways and in separate rights-of-way. These departments often have the lead responsibility for planning HOV projects on arterial streets. On projects headed by a state or transit agency, local jurisdictions are likely to play supporting and coordinating roles in planning HOV facilities, especially where HOV access ramps connect to local roadways. Local staff may head a multi-agency team planning an arterial street HOV project and may participate on teams associated with facilities on freeways and in separate rights-of-way.

Metropolitan Planning Organization (MPO). Representatives from the MPO are usually members of the multi-agency planning group associated with planning HOV facilities and may head the coordinating committees on Major Investment Studies or regional HOV studies. The MPO may have policies relating to HOV facilities. For example, an MPO may have policies encouraging the development of HOV lanes rather than adding general-purpose lanes. Staff from the MPO may help facilitate meetings or sponsor planning activities, as well as assist with multi-agency coordination.

Rideshare Agency. In many metropolitan areas, the transit agency operates not only the bus service but also provides ridematching services, vanpool programs, and other ridesharing services. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, the rideshare agency should be included as a member of the multi-agency team and should be involved in the planning process for HOV projects.

Federal Agencies. Representatives from FHWA and FTA are often involved in planning studies for HOV facilities and may have approval authority over specific steps. Personnel from these agencies can often provide technical assistance on issues or suggestions on how certain problems have been addressed in other areas. Representatives from FHWA and FTA often participate on the multi-agency team.

Commuters, General Public, Businesses, and Neighborhood Groups. The public participation process represents an important component of any planning effort for an HOV project. Involving commuters and travelers on the roadway or corridor, the public, business groups, and neighborhood organizations early in the planning process and throughout the design and implementation phase of a project is important.

Representatives from these groups are a valuable resource for focus groups to obtain opinions on HOV facilities and general travel issues. The techniques that can be used to encourage public participation are discussed more extensively in Chapter 12.

Consultants. Private consulting firms may be hired to develop HOV plans, conduct specific studies, or assist with other tasks. Consultants may help provide expertise in travel forecasting, demand estimation, and other special needs. Consultants may also assist with staffing the multi-agency team.

Other Groups. Consideration should be given to including representatives from other groups or obtaining their input during the planning process as appropriate for each project or study. These may include representatives from the state and local judicial system who will be responsible for enforcing fines and citations; EMS, fire, and other emergency personnel who may have to respond to incidents and accidents on the facility; staff from the American Automobile Association or other related groups; and tow truck operators who may be responsible for removing disabled vehicles. Representatives from these groups may be included on the multi-agency team or their opinions and concerns may be solicited for consideration in the planning process.

B. General Transportation Planning Concepts

The transportation planning process focuses on developing a safe, efficient and effective system for the movement of people and goods. At the same time, environmental and quality of life considerations are important components of the planning process. The following concepts and objectives are often part of the transportation planning process (1).

Mobility. The transportation system should enhance the mobility of the traveling public. Providing individuals with the opportunity to move from location to location when and by the mode they desire may be one objective of the planning process. Increasing levels of traffic congestion represents one problem limiting mobility in many metropolitan areas today.

Safety. Providing a safe transportation system is a critical component in the transportation planning process. The transportation system should allow for the safe movement of people and goods.

Efficiency. The transportation system should allow for the efficient movement of people and goods. Efficiency may relate to raising the average vehicle occupancy, providing direct routes to major activity centers, reducing freeway congestion, limiting access on freeways, and other techniques.

Multimodal and Intermodal Systems. Providing connections among and between the various transportation modes and providing choices for travelers and commercial shippers represent important considerations during the planning process.

Land Use. Land use and transportation are interconnected. The transportation system will influence land uses and development patterns, and land uses will also impact the transportation system. Assessing the interrelationship between the transportation system and land use is often a major part of the planning process.

Environmental Considerations. The transportation planning process should consider the environmental impacts of the various alternatives. Environmental factors may include air quality, water quality, noise, visual impacts, and other issues. In air quality non-attainment areas, transportation alternatives may be limited based on expected impacts.

Financing. The funding of transportation improvements and system components should be considered in the planning process. Most areas have limited resources available for transportation improvements, and the level of available funding may influence the planning process. Exploring alternative financing techniques may also be part of the planning process.

Economic Considerations. The impact of transportation decisions on economic development and the economic vitality of an area should also be considered in the planning process. The interrelationships between different transportation alternatives and economic development are often examined during the planning phase.

C. Steps in Planning HOV Facilities

The planning process for an HOV facility commonly involves eleven major steps. These elements are highlighted in Figure 4-1 and briefly described below. The exact process used will depend on the scope of the effort, the type of facility being considered, and the institutional relationships and characteristics in an area. The process outlined is similar to that used for any capacity improvement, allowing for the fair assessment of all alternatives. The process outlined here can be modified to meet the needs and conditions in a specific area. Attachment 1 provides a checklist that can be used by practitioners to help ensure that all the appropriate steps in the planning process are considered.

Identification and Involvement of Appropriate Groups. The first step in the planning process is to ensure that all of the appropriate groups are involved in the effort. The exact agencies and organizations to include will vary by area. The information provided previously in Table 4-1 and Section A can be used to help identify the appropriate agencies to include in the planning process on a specific project. As noted, representatives from the state department of transportation, the transit agency, cities and counties, the rideshare agency, the MPO, federal agencies, and enforcement personnel often participate in the planning process. Other groups may also be involved, along with the public, businesses, and neighborhood organizations. A key element of many successful HOV projects is the use of multi-agency teams in the planning processes, as well as throughout the design, implementation, and operation phases.

Identify and Involve Appropriate Groups

↓

Identify Issues and Opportunities

↓

Initiate and Continue Public Participation

↓

Identify Objectives, Analysis Techniques, and Data Needs

↓

Identify Alternatives

↓

Collect Data

↓

Analyze Alternatives

↓

Public Input on Alternatives

↓

Identify Preferred Alternative

↓

Public Review

↓

Selection of Preferred Alternative

Figure 4-1. General Steps in Planning HOV Facilities

Identification of Issues and Opportunities. The issues and opportunities in an area, corridor, or a facility should then be examined. Traffic congestion levels, safety concerns, or other issues should all be assessed. Although the planning process should be proactive in anticipation of future events, planning is more frequently undertaken in response to issues or constraints with the current transportation system due to increasing traffic levels in most metropolitan areas.

Public Participation. The public should be involved throughout the planning process for an HOV facility. Providing opportunities early and throughout the planning process for involvement from the public, business representatives, neighborhood organizations, and other groups can help ensure that all relevant issues are identified and that appropriate alternatives are considered. It can also assist in reaching a consensus on a preferred alternative. A wide range of techniques can be used to elicit public involvement. These methods are discussed extensively in Chapter 12.

Identification of Objectives, Analysis Techniques, and Data Needs. Once the specific problem or opportunity has been identified, the next step is to outline the objectives for addressing these concerns. Input from the public participation process should be used in developing the objectives. Objectives may relate to maintaining a certain level of service or other performance measures. After the objectives have been established, the analysis techniques and data needs to evaluate these can be determined. There are two types of data that are important in the planning process—quantitative and qualitative data. Traffic volumes, vehicle-occupancy levels, and transit ridership represent quantitative data that are often used in the planning process, while public perceptions provides an example of qualitative information that may be used. The activities conducted in this step should be coordinated with those discussed in Chapter 13 relating to the ongoing monitoring and evaluation of an HOV facility.

Identification of Alternatives. The next step in the planning process is to identify a number of potential alternatives that will accomplish the established objectives. In the case of a freeway project, these may include adding new general-purpose lanes, different HOV lane concepts, light-rail transit, and other strategies.

Data Collection. In this step, the data needed to analyze the alternatives are collected and reduced. The way in which the information is collected, for both the quantitative and qualitative measures, is important. Ensuring consistency in the methodologies and techniques used is critical to maintaining an objective and valid planning process. Chapter 13 provides information on data collection techniques for monitoring and evaluating HOV facilities. Many of these approaches can also be used in the planning stage.

Analyze Alternatives. In this step, the alternatives being considered are analyzed based on the information obtained in the previous step and the techniques identified in the fourth step. The level of detail and the length of time needed to analyze the alternatives will depend on the scope and scale of the project, the number of options, and the magnitude of the issues in the area. For example, analysis of alternatives in a major freeway corridor will probably involve more time and resources than examining options on a short section of an arterial street.

Public Input on Alternatives. The alternatives being considered are presented to the public and other groups during this step. In many cases, an initial screening process may be completed based on the goals and objectives to narrow down the alternatives to those that are most realistic. These alternatives are then presented to the public along with an explanation of the screening process.

Identification of the Preferred Alternative. Based on the results of the analysis of alternatives and input from the public and other groups, the preferred alternative can be selected. The preferred alternative generally satisfies the largest number of objectives within the available financial resources.

Public Review. The recommended alternative is presented to the public for review and comment. Public meetings, newsletters, and open houses represent just a few of the methods that can be used to communicate the recommended alternatives to the public and to obtain feedback and input.

Selection of Alternative. Based on the results of public review process, the appropriate policy board can select the final alternative. Formal action approving or endorsing a specific alternative or course of action may be taken by the policy board or administrative staff within the responsible agency.

The planning process described above and illustrated in Figure 4-1 can be used in all types of situations. The exact approach may be modified as needed for specific projects or conditions. More detailed steps may be needed for complex corridors, while a simplified sketch planning approach may be used in other cases. The key for transportation professionals is to match the level of detail to the nature of the issues, characteristics of the area, and available resources.

III. PLANNING HOV FACILITIES ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

Planning for transportation improvements, including HOV facilities, usually occurs at different levels. A broad regional planning effort is often undertaken first. This level focuses on the general needs, issues, and opportunities throughout a metropolitan area. The outcome of this process is a long-range regional plan that identifies the general types of facilities anticipated in the major travel corridors and areas. Regional plans do not usually define the exact type of treatment or design, however.

These more detailed analyses are conducted in the planning process at the corridor and facility level. Planning at this stage is much more detailed, focusing on preliminary alternative design treatments, access options, vehicle-occupancy levels, and other issues. For example, a regional plan may identify the need for an HOV facility in a specific corridor, but the type of HOV lane and the preliminary design would be examined in later planning phases.

Thus, planning for HOV facilities can be thought of as a cascading or funneling process. Planning at the regional scale focuses on identifying an overall system plan and the general types of facilities that may be appropriate. Planning at the corridor and facility level is more detailed, resulting in projects that can be taken forward into the design stage.

Although the general planning process discussed in the proceeding section can be used at the regional, corridor, and facility levels, the exact approach may vary. Further, different analytical tools and techniques are needed at the various levels. Sketch planning techniques are often used for regional planning studies, with more detailed methods applied at the corridor and facility levels.

This section provides an overview of the general approaches to planning HOV facilities at the regional, corridor, and facility levels. The various analytical tools and techniques commonly used in the planning process are also discussed.

A. Planning HOV Facilities at the Regional Level

Planning for HOV facilities at the regional level may be part of the long-range transportation planning process conducted by an MPO, a special effort focusing on the development of a comprehensive HOV system, or other region-wide study. In any case, the planning process normally involves representatives from the MPO, the state department of transportation, the transit authority, local communities, the state police, and other groups.

The regional planning process should also focus on a continuous system of HOV facilities that may include HOV lanes, busways, arterial street applications, park-and-ride lots, transit centers, bus and rideshare services, and other supporting policies and programs. Examples of regional HOV planning studies and the development of regional long-range transportation plans that include significant HOV system components are highlighted in this section. The use of sketch planning techniques and other approaches often used at the regional level are discussed in later sections.

Dallas Freeway HOV System Plan. The Dallas Freeway HOV System Plan for the year 2015 was jointly developed by the Texas Department of Transportation (TxDOT), Dallas Area Rapid Transit (DART), and the North Central Texas Council of Government (NCTCOG). The Texas Transportation Institute (TTI) conducted the technical analysis supporting the planning process. The system plan was developed to provide a link between the long-range planning activities and the detailed corridor alternatives analyses.

The regional planning process focused on peak-hour passenger travel demand in the year 2015. The methodology used incorporated the costs associated with travel delay, construction, and operation while accounting for changes in travel behavior based on the travel time savings and the travel time reliability offered by HOV facilities. The desired outcome was to identify the lowest cost alternative in the various corridors for a given volume of person trips.

An iterative process was used to examine multiple alternatives in each major freeway corridor. Right-of-way costs, operating costs, congestion costs, and other factors were identified for each alternative. The alternatives were evaluated to determine the freeway HOV system which best balanced cost and traffic flow, while considering system continuity. The regional plan emerging from this process includes a mix of freeway HOV lanes and general-purpose lanes.

Los Angeles County HOV System Integration Plan. In 1995 and 1996, the Los Angeles County Metropolitan Transportation Authority (LACMTA) sponsored the development of a county-wide HOV system plan. The planning process was coordinated with the California Department of Transportation (Caltrans), the Southern California Association of Governments, the California Highway Patrol, the City of Los Angeles, other cities in the county, Los Angeles County, and the Automobile Club of Southern California. Representatives from local community groups, businesses, and environmental groups also participated in the study.

The HOV lane system in the County has been developed based on a preliminary plan prepared previously by Caltrans. At the time the County planning effort was initiated, approximately 30 percent of the planned HOV network was in operation. The purpose of the study was to identify a cost-effective approach for implementing the remainder of the system. To accomplish this objective, the remaining HOV lane segments and support facilities were evaluated based on regionally adopted multimodal performance criteria that included mobility, cost effectiveness, and environmental measures. The short, medium, and long term regional significance of the various segments and facilities were evaluated. Specific evaluation criteria included HOV travel time savings, HOV demand, general-purpose lane impacts, system continuity, design compatibility, cost, cost-effectiveness, environmental impacts, enforcement, and segment phasing.

The plan is being used to help guide future project selection and programming decisions in the county. It also provides all agencies and groups with a better understanding of anticipated priority for projects. In addition, the methodology and evaluation criteria developed during the planning process can continue to be used to assess additional projects and facilities.

Puget Sound High-Occupancy Vehicle Pre-Design Study. An extensive system of HOV lanes, park-and-ride lots, transit services, and supporting facilities and services has been implemented in the Seattle area. The Puget Sound HOV Pre-Design study was undertaken to help define the remaining parts of a comprehensive HOV system in the area and to assist in identifying the priority elements of this network. The

Washington State Department of Transportation (WSDOT) sponsored the study in cooperation with the Puget Sound Regional Council (PSRC), King County Metro, FHWA, and other local agencies and jurisdictions. A consulting team comprised of 12 firms conducted the various study components.

Eleven separate concurrent studies were conducted as part of the project. Although the evaluation criteria varied slightly for the different studies, the major evaluation measures included HOV travel time savings, HOV travel time reliability, person throughput, modal shift, transit system connectivity, HOV accessibility, impact on the general-purpose lanes, safety, cost, cost-effectiveness, enforcement, environmental impacts, social and land use factors, and construction phasing.

The results of the various studies were used to reevaluate the existing core HOV lane system plan and other supporting components. Additions, deletions, and modifications were made in the plan. The study is being used as input to the PSRC's Metropolitan Transportation plan and WSDOT's project design process.

Toronto Regional HOV Plan. The Municipality of Metropolitan Toronto has conducted a number of planning efforts focusing on the development of a regional HOV lane system. An HOV network was first proposed in 1990 as part of a congestion management strategy. This effort lead to a more detailed study examining the role HOV lanes could play in helping to manage traffic in the region, developing HOV facility planning and design guidelines, and identifying a potential regional HOV system network. Objectives of the study included identifying approaches to increase person movement, improve transit operations, and enhance air quality and environmental considerations. A number of alternatives were developed and evaluated based on factors such as bus ridership, HOV demand, connections to major developments, system connectivity, and air quality impacts. The results of the study indicated that an HOV system for the Toronto area is both feasible and warranted. The study presents a 30-year regional plan for freeway and arterial HOV facilities.

B. Planning HOV Facilities at the Corridor Level

Greater detail is needed in the planning process for HOV facilities at the corridor level. At this stage, HOV treatments may be one of a number of possible improvements being considered or alternative HOV facilities may be under investigation. These alternatives may involve different alignments, including those on an existing freeway as well as those in a new right-of-way. Adding a general-purpose lane or a mixed guideway transit line are just two examples of other alternatives that may be part of a corridor planning process.

Planning at the corridor level may be undertaken as part of a Major Investment Study (MIS) or an analysis of alternative improvements. The MIS process is discussed later in this chapter. Representatives from all appropriate agencies, local governments, and neighborhood and business organizations should be involved in a corridor level planning process. The following case studies highlight a few examples of corridor level HOV studies.

I-394 Minneapolis. Planning for the upgrading of U.S. Highway 12 on the west side of Minneapolis began in the 1960s. The facility, which was a signalized four lane divided roadway, was added to the Federal Aid Interstate System as I-394 in 1968. An initial planning study for the corridor conducted by the Minnesota Highway Department, now the Minnesota Department of Transportation (Mn/DOT), was started in 1970. A total of eight alternatives were evaluated, with four recommended for further study. Three of the four options that were dropped involved all or partially new alignments, and all four required significant right-of-way acquisition. The four alternatives recommended for further study involved variations of the existing TH 12 alignment. One of these was a no-build option, while the other three would have required additional right-of-way to widen the existing facility.

In response to concerns from neighborhood businesses and local groups related to the impact of these alternatives on adjacent land uses, additional transit alternatives were added to the study. The transit alternatives examined included an exclusive transit facility off of the TH 12 alignment, an exclusive transit facility on the TH 12 alignment, and an HOV facility on the TH 12 alignment with other priority bus treatments.

A consensus among the various agencies, as well as the public, did not emerge from the planning process on a preferred highway and transit alternative. In response to continued opposition by neighborhood groups in the corridor, the Minnesota Legislature passed a bill in 1975 requiring additional study of the corridor and limiting the final facility to not more than six traffic lanes.

As a result of this legislation, Mn/DOT and other agencies reexamined various alternatives. Options considered included a no-build, a metered freeway, a freeway plus LRT in the median, a freeway plus LRT on a separate alignment, a freeway with HOV lanes in the median, and a freeway plus two LRT lines on different alignments. Based on additional analysis that examined projected population, employment, and travel growth, the recommended alternative included a mix of concurrent flow HOV lanes and barrier separated reversible HOV lanes supported by enhanced transit services, rideshare programs, and parking management strategies.

I-279, Pittsburgh. The Pittsburgh Interstate Network was approved by the Pennsylvania Bureau of Public Roads, now the Pennsylvania Department of Transportation (PennDOT), in 1955. The network included a roadway on the north side of the city connecting with the Pennsylvania Turnpike. Planning in the corridor was initiated in 1957. Two general alignments were considered, with the alternative that followed a new right-of-way to the northwest emerging as the preferred route. Both draft and final environmental impact statements (DEIS/EIS) were prepared on the project. The design included a six lane freeway, with provisions for a HOV lane, a fixed guideway line, or two additional general-purpose lanes in the median. Additional consideration was given to the HOV component in the late 1970s. As a result, the final design for the freeway included a two lane, reversible barrier separated HOV facility located in the freeway median.

C. Facility-Based Planning

Planning at the facility level requires the greatest amount of detail. In general, facility-based planning is only initiated once a decision has been made to move forward with a selected alternative or alternatives. For example, if the recommended alternative from a corridor study or an MIS is a concurrent flow HOV lane, the facility-based planning process would examine the specific elements associated with implementing this option.

Planning at the facility level may focus on more pre-design planning elements, access treatments, demand projections at different vehicle-occupancy levels, the nature and location of bus services and park-and-ride lots, and other issues. A more detailed level of analysis is usually needed at this stage. Examples of facility-based HOV studies are highlighted next.

I-45 North Freeway, Houston. The I-45 North Freeway provides a good example of facility-based planning with an HOV project that evolved over time. Planning for a contraflow HOV lane on I-45 North started in the mid-1970s through the cooperative efforts of the Texas Highway Department, now the Texas Department of Transportation, and the City of Houston, now the Metropolitan Transit Authority of Harris County (METRO), Office of Public Transportation. A contraflow lane was considered by the agencies as a possible short-term approach to addressing significant levels of traffic congestion occurring on the freeway during the peak hours, in the peak direction of travel. Based on the results of an initial study, a contraflow HOV lane demonstration project was implemented in 1975. The HOV lane project operated very successfully, but was not intended to be a permanent facility. As a result, planning began on a replacement HOV lane shortly after the facility was opened. This planning process examined forecasted travel demand, origin and destination information, travel patterns, and other related data. This information was used to identify the most appropriate type of HOV lane, access points, access treatments, new transit services, and park-and-ride facilities. The recommendation from the planning process was to implement a one-lane reversible, barrier-separated HOV facility, with direct access points to park-and-ride lots at strategic locations. The contraflow HOV lane was discontinued in 1984 with the opening of the first phase of the new barrier separated HOV lane.

Route 91, Los Angeles. In the early 1980s, Caltrans initiated a study of lower cost techniques to address growing levels of traffic congestion on Route 91 in the Los Angeles area. The freeway had a high volume of existing two-person carpools, and the potential to add a concurrent flow HOV lane in the eastbound direction by taking the median shoulder was one of the alternatives considered. Caltrans formed a local advisory committee, comprised of representatives from agencies, cities, and citizen groups to provide input into the planning process. Meetings and workshops were held during the planning phase to discuss the possible alternatives and to present the results of the technical analyses. The analysis included an evaluation of travel forecasts, existing and projected carpool volumes and travel patterns, and potential access, safety, and enforcement issues. The recommended alternative was to implement a demonstration project providing a concurrent flow HOV lane in the eastbound direction using the median shoulder. The demonstration was implemented in 1984 and has been in operation ever since. In addition, the facility has been lengthened and a westbound lane was opened in the 1990s.

D. Sketch Planning Techniques

Sketch planning represents a general or broad level of analysis. Sketch planning is most frequently used at a regional level or as a preliminary screen at the corridor and facility level. Sketch planning is intended to be a relatively simple process to help identify candidate areas, corridors, or facilities in need of transportation improvements, those where HOV facilities appear to be warranted, and the most logical type of HOV treatment. Sketch planning may be a precursor to the more detailed planning process described previously, or it may be a subpart of this process. The models and techniques outlined in this section are also appropriate for use in other more detailed planning efforts. The basic elements of the sketch planning process are highlighted in Figure 4-2 and described next.

Identify Criteria to be Used in Screening Process

↓

Collect Needed Data

↓

Conduct Screening Process

↓

Develop Recommended Plan or Identify Candidate
HOV Treatments for More Detailed Analysis

Figure 4-2. Sketch Planning Process

Identify Criteria. A variety of criteria may be used at the sketch planning level. These criteria, which should be identified and agreed upon early in the planning process, may include one or two elements or a series of factors. The criteria for a preliminary screening process should flow from the evaluation criteria identified to access the achievement of established goals and objectives. Criteria commonly used in the sketch planning process are described below.

Congestion Levels. Existing and forecasted traffic congestion levels in a corridor or on a facility provide a good indication of the need for some type of improvement, including an HOV lane. For example, the presence of severe and recurring congestion indicates that an HOV facility or other alternative may be appropriate. Although the exact criteria should be based on local conditions, general guidelines of a level of service (LOS) D or E and recurring average speeds of 30 mph or less in the peak hour represent common measures used in many metropolitan areas.

Travel Patterns. Examining the travel patterns in an area or corridor can be an important criteria in the sketch planning process. Assessing the origins and destinations to be served by an HOV facility is critical to determining the viability of different alternatives. At the sketch planning level, this analysis usually focuses on travel producers, such as residential areas, and attractions, which include major employment and activity centers.

Current Bus and Carpool Volumes. Existing transit services, carpools, and vanpools in a corridor can be used to provide an indication of the potential use of an HOV facility. Existing HOVs would likely form the base for use of a facility. Vehicle occupancy counts and other available information on HOVs in a corridor can be used during the sketch planning process. A corridor with high levels of current HOVs usually represents a better candidate than a corridor with low levels. Table 4-2 provides an indication of the minimum operating thresholds often associated with the various types of HOV facilities. A more detailed discussion of these thresholds is provided in Chapter 5, Section V.

Table 4-2. General Minimum Operating Thresholds for HOV Facilities Based on National Experience*

Type of HOV Facility	Vehicles per Hour per Lane
Separate right-of-way, bus-only	200-400 vphpl
Separate right-of-way, HOV	800-1,000 vphpl
Freeway, exclusive two-directional	400-800 vphpl
Freeway, exclusive reversible	400-800 vphpl
Freeway, concurrent flow	400-800 vphpl
Freeway, contraflow, bus-only	200-400 vphpl
Freeway, contraflow, HOV	400-800 vphpl
HOV bypass lanes	100-200 vphpl

*These minimum thresholds are presented as general guidance for use in local areas. The minimum thresholds may vary by area and will depend on local characteristics.

Travel Time Savings and Travel Time Reliability. Estimating the potential travel time savings and travel time reliability offered by the HOV facility represents another sketch planning criteria. HOV facilities that provide a significant reduction in travel time and improved travel time reliability are obviously better candidates than those that do not offer these benefits. A general guideline that is often used is that line-haul HOV facilities should provide one minute per mile in travel time savings and an overall travel time savings of at least 5 minutes. An overall travel time savings of 8 minutes is desirable.

Trip Distance. The average distance of commute trips in a corridor can also provide a good indication of the possible candidates for HOV facilities. Longer distance trips may realize greater travel time savings, although short HOV treatments can help address specific bottleneck problems.

Person Throughput. Another major criteria of the HOV facility is to increase the person-moving capacity of a corridor or facility. To meet this criteria, the HOV lane should carry more people in fewer vehicles than the adjacent mixed-flow lanes. A criteria related to the desired person throughput for a project may be incorporated into the sketch planning process.

Projected Demand. The number of buses, carpools, and vanpools projected to use an HOV facility represents another important criteria in the sketch planning screening process. The minimum vehicle volumes identified through experience for the various types of HOV facilities are highlighted in Chapter 5. These general guidelines can be used to help establish a local criteria for use in the sketch planning process, as well as with more detailed analysis techniques. The projected increase in general travel and vehicle volumes in the corridor should also be examined.

Agency and Public Support. Support from local, regional, and state agencies and the public is important to the success of any transportation improvement, including an HOV facility. A criteria related to agency and public support of the various alternatives may be used during the sketch planning process.

Enforcement. Experience indicates that enforcement is a key component to the success of an HOV facility. As a result, enforcement may be an appropriate criteria to use in a sketch planning process. Ensuring that a facility can be enforced, and that a commitment exists to provide adequate enforcement, may be used as criteria.

Cost Effectiveness. Cost effectiveness represents another possible screening criteria. Cost effectiveness can be measured through a benefit to cost ratio (B/C) or similar approach. Benefits usually include reduced travel time and increased vehicle throughput, while costs generally include construction, operation, and maintenance of a facility. Additional considerations, such as air quality, fuel economy, and network wide reductions in vehicle kilometers in travel may be included as well.

Physical Characteristics of the Corridor or Roadway. The physical characteristics of a corridor or roadway may influence the ability to add an HOV lane or to make any type of improvement. Ensuring that an HOV facility or other improvement can be accommodated is usually an important screening criteria.

Support Facilities and Services. Supporting facilities, services, and policies are important to the success of an HOV facility. These may include park-and-ride lots, park-and-pool lots, transit services, rideshare programs, parking management strategies, employer-based TDM programs, and other elements. The presence of these types of supporting components in an area may be used as a screening criteria.

Safety. Any type of transportation improvement, including an HOV facility, should be operated safely. An HOV lane should be safe for buses, carpools, and vanpools and for motorists in the general-purpose lanes. Examining potential safety issues may be appropriate during the screening process.

System Continuity. The success of an HOV lane may be further enhanced if it is part of a larger system of HOV facilities. Consideration may be given during the screening process to those HOV elements that are critical parts of an overall network plan.

System Staging and Scheduling. Another possible sketch planning criteria may relate to the time needed to develop and implement an HOV facility, as well as how this schedule relates to other improvements. Consideration may be given to implementing a project that can be done quickly or as part of another improvement.

Operable Segments. Another criteria may address the need to implement operable segments of an HOV facility. Although this criteria relates to the previous element, consideration may be given to ensuring that HOV segments represent logical and operable segments, as well as providing the anticipated benefits.

Environmental Issues. Examining potential environmental benefits as well as possible negative impacts from an HOV facility represents another sketch planning criteria. Assessing the possible benefits and issues at a preliminary level of detail can be used to help examine alternative approaches.

Other Modes. Other fixed guideway transit systems in operation or planned for the corridor or area should be considered in the sketch planning process. If other modes exist, the trip characteristics of the various markets should be examined to ensure that the alternatives are compatible rather than competitive.

Collect Needed Data. The next step in the sketch planning process is to collect the data needed to analyze the screening criteria. Sketch planning usually relies on available information and does not require additional data collection activities. The following existing information sources may be appropriate for use in a sketch planning process.

Traffic Data. State departments of transportation, MPOs, transit agencies, and other groups conduct ongoing data collection activities related to many aspects of the transportation system. Information on traffic volumes, vehicle-occupancy levels, accidents, and origins and destinations may be available from existing sources. This information, if available, can be used in the sketch planning process.

Transit Data. Information on existing bus routes, park-and-ride lots, and ridership levels is usually available from the transit agency or operator. This information can be used in the sketch planning process to establish a base line level of transit service in the corridor or on a specific facility.

Rideshare Data. Information on existing carpools and vanpools may be available from the transit or rideshare agency. This information may help establish a base line for rideshare activities at the regional, corridor, or facility level.

Census Data. Census data on the number of households and residents in an area, income levels, automobile ownership, and travel characteristics may be of use in the sketch planning process. Although the census is conducted only once every ten years, and as a result may be somewhat outdated, it still may be of help in developing the base line characteristics in an area.

Aerial Photographs. Aerial photographs may be used during the sketch planning process to help identify possible market areas for transit services, access to major trip generators, and other information. Aerial photographs can also be of use in identifying available right-of-way, as well as right-of-way limitations for HOV facilities and other alternatives.

Land Use Maps. Along with aerial photographs, land use maps can be used to provide an indication of both existing and future land use patterns and densities in an area or a corridor. Reviewing land use maps, comprehensive plans, and zoning ordinances and maps provides a further indication of anticipated growth areas.

Geographic Information System (GIS). Many urban areas are developing and using comprehensive Geographic Information Systems. These systems may include transportation data in addition to land use and other data. GIS may provide an easy way to access a wide range of information for use in the sketch planning process.

Conduct Screening Process. In this step, the alternatives are evaluated based on the selected screening criteria. The screening process may be kept relatively simple, or a weighted evaluation process or other technique may be used. For example, at a basic level, the criteria could either be met or not met. Table 4-3 illustrates a slightly more detailed approach using three rating levels. A more complex approach may involve weighting the criteria. This technique places more value on key criteria. Another technique that may be used at this point is a *fatal flaw* analysis. This approach identifies a few key elements, called fatal flaws, that will eliminate an alternative from further consideration. A first-level screen may be conducted based on these elements. The alternatives emerging from this fatal flaw analysis are then carried through a more detailed sketch planning process or into a second phase analysis. If federal funds are anticipated to be used for a project, the "not build" alternative should be continued through the process.

Recommended Plan or Candidate HOV Treatments. The results of the sketch planning process may be a preliminary regional, corridor, or facility plan or the identification of HOV treatments or other improvements for more detailed analysis. Sketch planning is often the first step of a comprehensive analysis process, with the results used as input to more detailed corridor or facility planning.

E. Decision Tree Analysis

Figures 4-3 through 4-8 contain decision trees that can be utilized to aid in developing transportation improvement alternatives including HOV facilities. Figure 4-3 begins the decision tree process starting from left to right to aid in alternative selection. The first question in Figure 4-3 focuses on congestion in the corridor. If there is, the possible treatments can be considered. For example, if the line-haul HOV treatment is selected, decision-tree I is used. Figures 4-4 through 4-8 contain decision tree processes for line-haul HOV treatments, ramp/arterial treatments, mainline metering, and TDM/TSM treatments, respectively. To further illustrate the procedure, Figure 4-4 provides further information on the operational characteristics, location, and separation type of the line-haul HOV treatments. Figure 4-8 provides a decision-tree to aid in the determination of the HOV operational decisions including the type of treatment, time of day, occupancy restrictions, and related comments. Although Figure 4-8 may be beyond the scope of most sketch planning studies, it helps focus on the key elements of the analysis process.

Table 4-3. Possible Sketch Planning Criteria

Possible Criteria	Screening		
	High	Medium	Low
Congestion Levels			
Travel Patterns			
Current Bus and Carpool Volumes			
Travel Time Savings and Travel Time Reliability			
Person Throughput			
Projected Demand			
Agency and Public Support			
Enforcement			
Cost Effectiveness			
Physical Characteristics of the Corridor or Roadway			
Support Facilities and Services			
Safety			
System Continuity			
System Staging and Scheduling			
Operable Segments			
Environmental Issues			
Other Modes			

F. Demand Estimation Techniques

A number of techniques are available for estimating the anticipated demand for HOV facilities and other transportation improvements. These include manual methods, microcomputer based models, and main frame computer models. Since these models attempt to predict future demand, caution must be raised with the use of all of these techniques. Estimating future trends, especially those that involve changes in individual behavior, is not easy. Thus, the results of all demand estimation techniques should be reviewed carefully. The information in Table 4-2, and in Chapter 5, Section V provides an indication of the utilization levels that may be appropriate for various HOV facilities. The various techniques that may be used to estimate demand for an HOV facility are highlighted here.

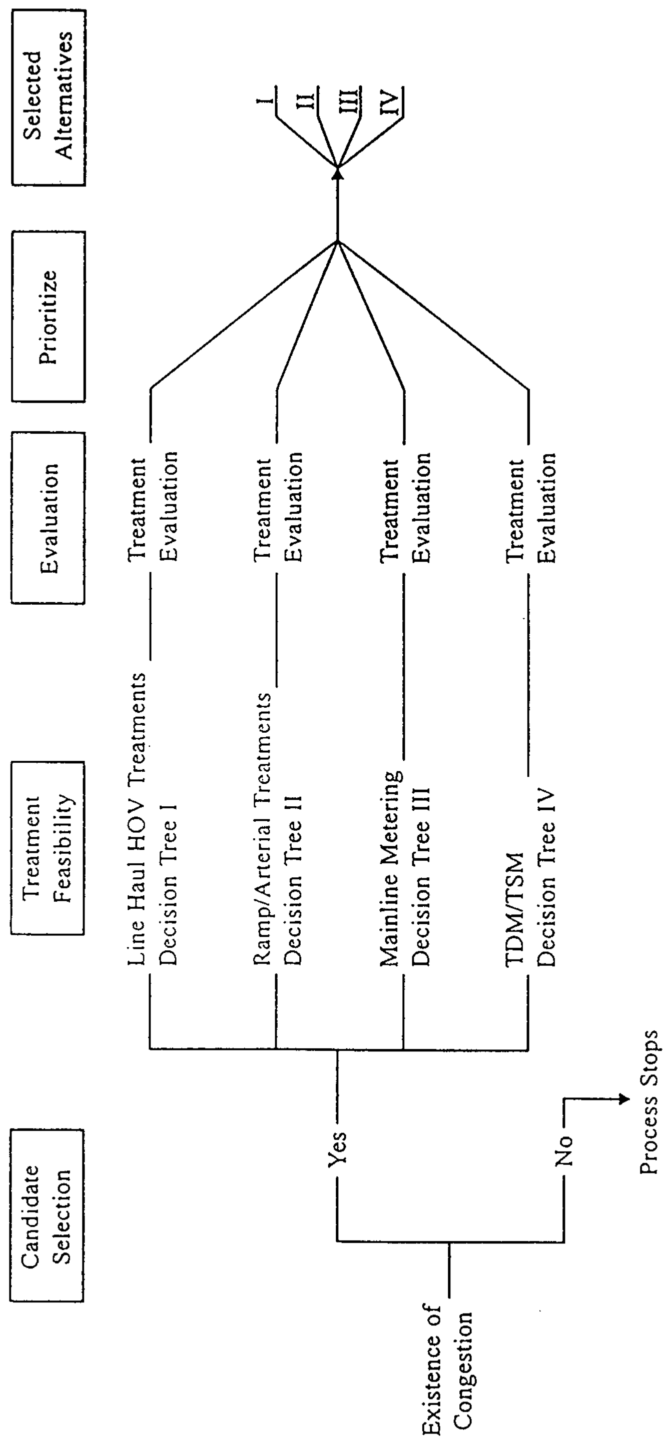

Figure 4-3. Alternative Selection Process–Decision Tree I-IV (Adapted from Reference 2)

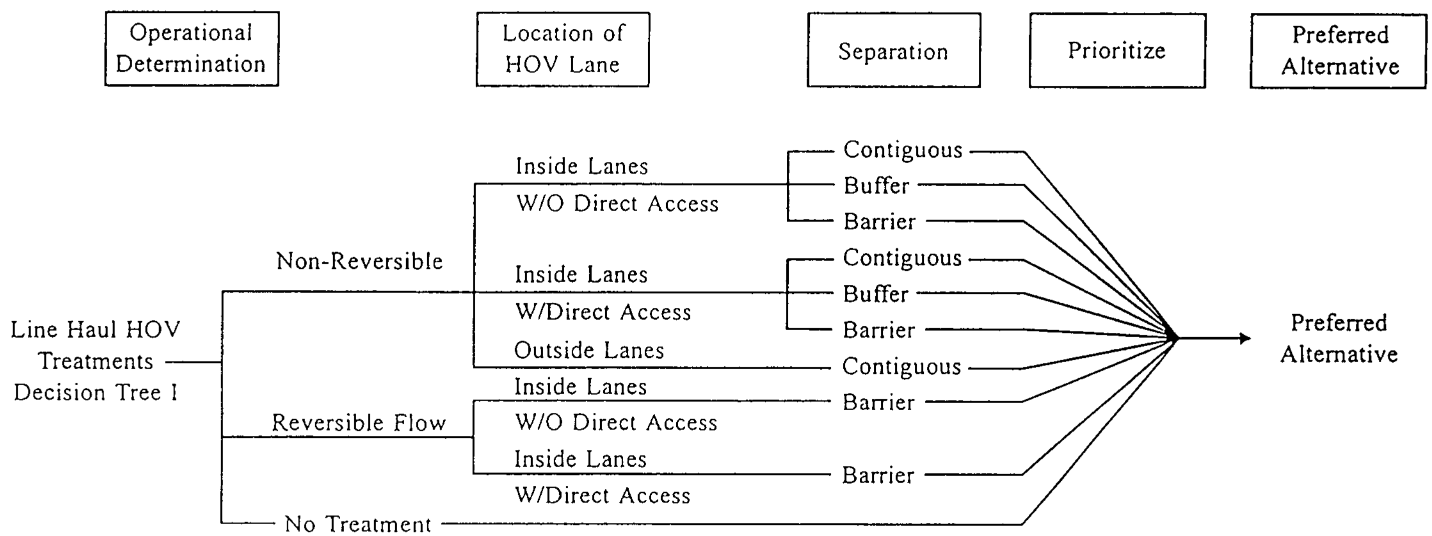

Figure 4-4. Line Haul HOV Treatments—Decision Tree I
(Adapted from Reference 2)

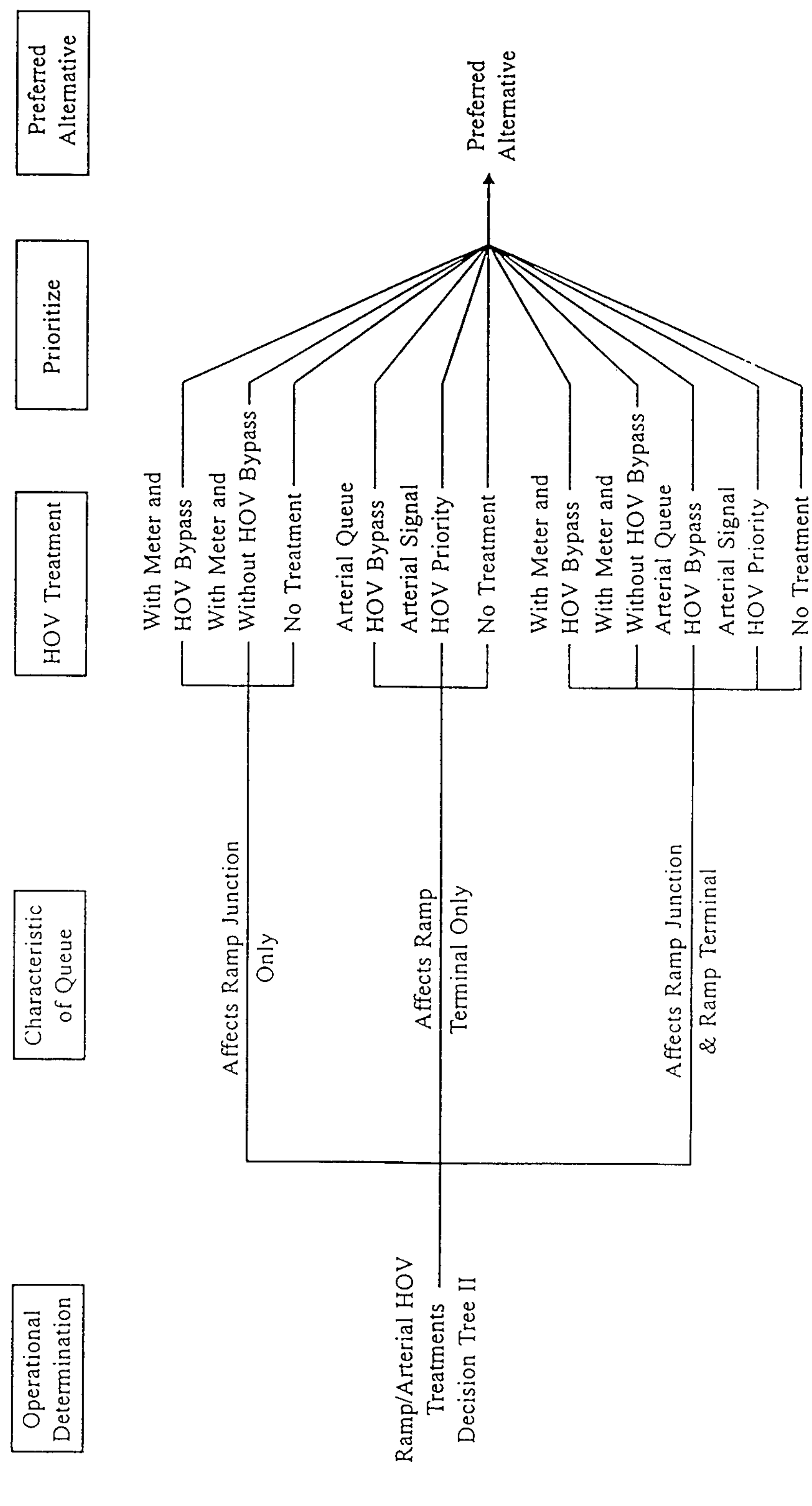

Figure 4-5. Ramp/Arterial HOV Treatments—Decision Tree II
(Adapted from Reference 2)

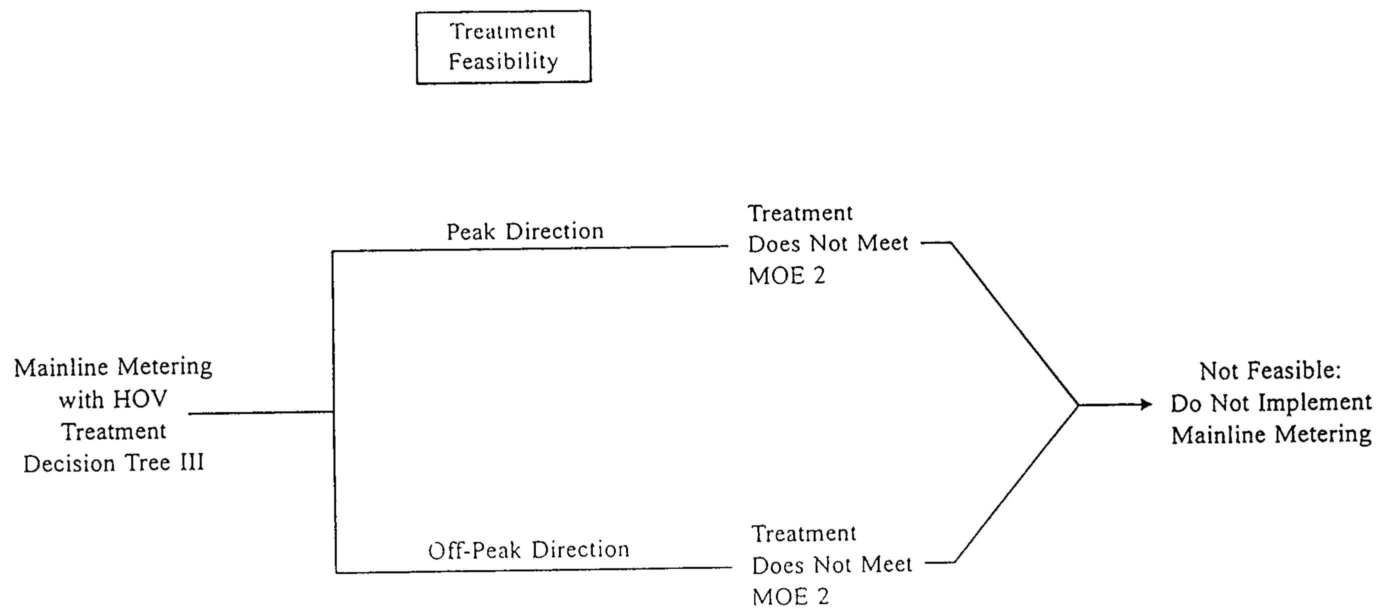

Figure 4-6. Mainline Metering HOV Treatments—Decision Tree I
(Adapted from Reference 2)

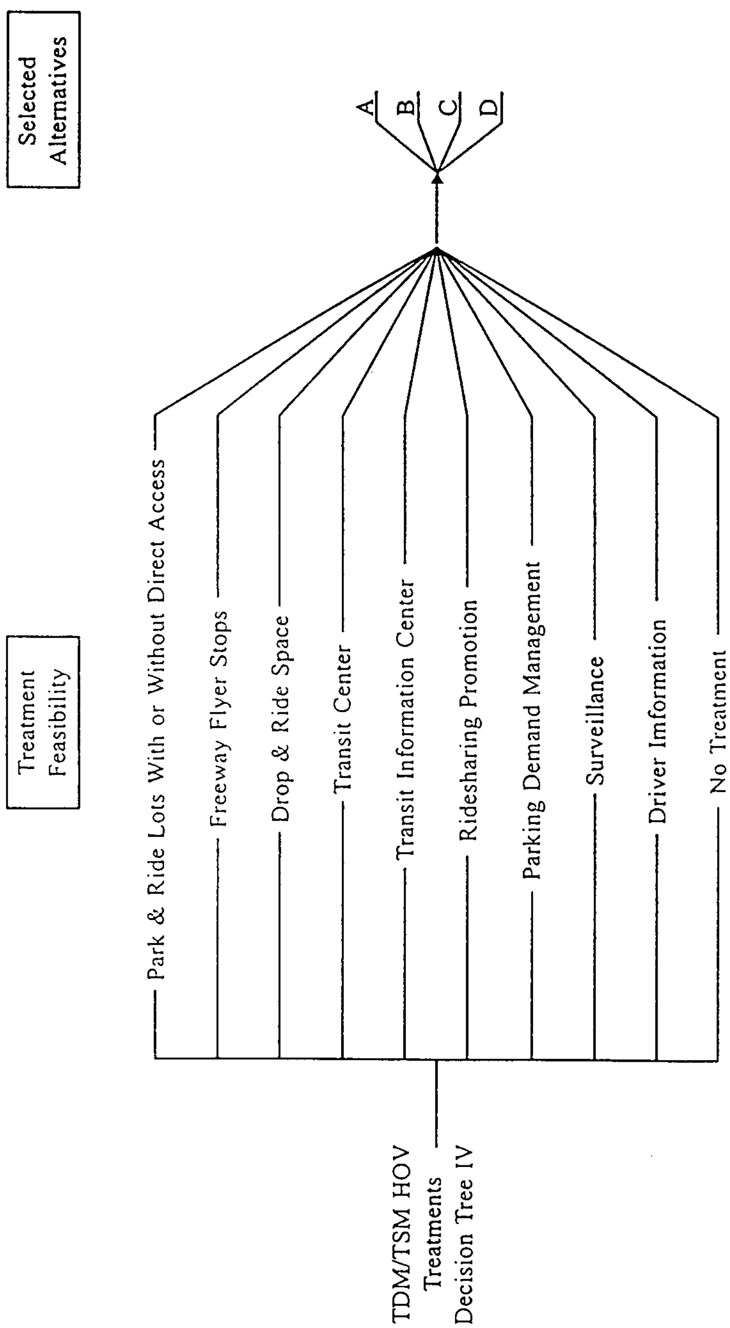

Figure 4-7. TDM/TSM HOV Treatments—Decision Tree I
(Adapted from Reference 2)

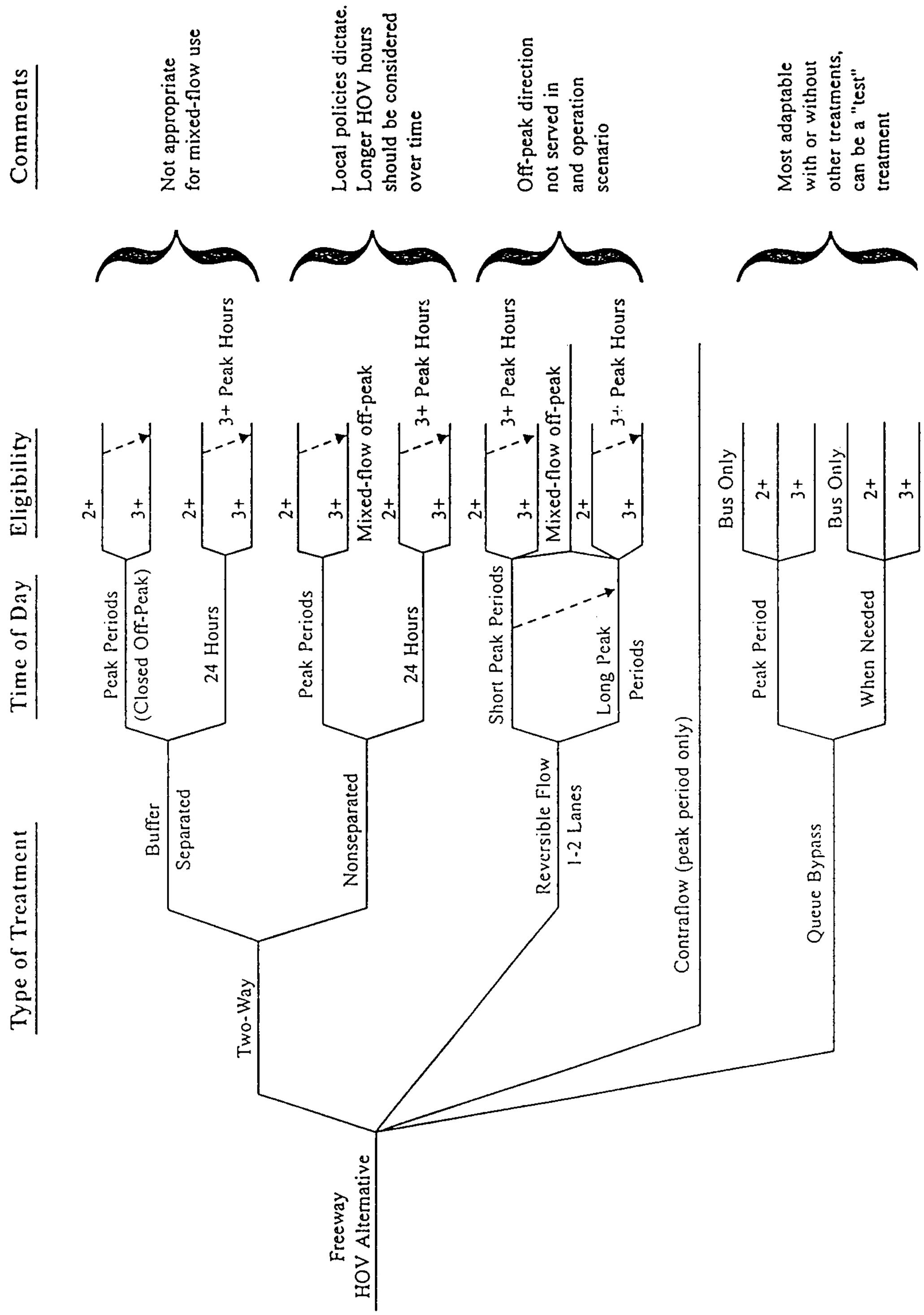

Figure 4-8. HOV Operational Decisions
(Adapted from Reference 2)

1. Sketch Planning Demand Estimation Techniques

Estimating Demand for Concept Viability. A relatively simple sketch planning approach has been developed by Parsons Brinckheroff (3). The concept viability technique is based on three primary sources of demand. These are existing HOVs diverted from the main-line freeway, existing HOVs on parallel routes, and latent demand. Figure 4-9 provides an example of the worksheet used with this approach. The steps in the concept viability process are outlined below. The procedure for estimating 2+ carpools is described first, followed by the procedure for estimating 3+ carpools.

Primary Diversion. The primary diversion is estimated by assuming that between 70 and 90 percent of the current mainline and service road HOVs will divert onto the HOV facility, assuming the average trip distance is adequate for the desired travel time savings.. The aggregate directional mainline and service road value is multiplied by 0.7 for a minimum estimate and 0.9 for a maximum estimate.

Secondary Diversion. The secondary diversion is estimated by assuming between 25 and 50 percent of the currently eligible parallel route HOVs will divert onto the HOV facility, assuming the average trip distance is adequate for the desired travel time savings. The aggregate HOV value on all parallel routes is multiplied by 0.25 for a minimum estimate and 0.5 for a maximum estimate.

Latent Demand. The latent demand is estimated by taking the low and the high estimates derived for the primary diversion and multiplying by 1.2 and 1.6, respectively, for a minimum and maximum estimate of latent demand. The general rule of thumb is that latent demand may represent up to two-thirds of the forecast use on a new HOV facility. The latent demand will be influenced by the travel time savings and travel time reliability offered by the HOV facility.

Current Demand. The subtotals for the various estimates are calculated (E+G and E+G+H) to obtain a low and a high demand estimate for the current year.

Growth. A local growth factor can be applied to the subtotal to project demand in a future year. The local growth factor may reflect different time periods.

Future Demand. The local growth factor is multiplied by the previous current demand subtotal to obtain the future year demand estimation.

A. 2+ HOV Demand Worksheet

	Data Requirements			Primary Diversion		Secondary Diversion		Latent Demand		Subtotals	
Location	A=Peak Hour Volume	B=Percent of 2+ Vehicles	Volumes of 2+ Vehicles	Low D = 70%	High D = 90%	Low D = 25%	High D = 50%	Low F = 120%	High F = 160%	Low Estimate	High Estimate
Freeway Location	A	B	A x B = C	C x D = E	C x D = E			E x F = G	E x F = G	E + G	E + G
Frontage Road Location [2]	A	B	A x B = C			C x D = H	C x D = H			H	H
									Subtotal	E + G + H	E + G + H
									Local Growth Factor[2]	x_____%	x_____%
									Total Initial 2+ HOV Demand Range		

B. 3+ HOV Demand Worksheet

	Data Requirements			Primary Diversion		Secondary Diversion		Latent Demand		Subtotals	
Location	A=Peak Hour Volume	B=Percent of 3+ Vehicles	Volumes of 3+ Vehicles	Low D = 70%	High D = 90%	Low D = 25%	High D = 50%	Low F = 300%	High F = 600%	Low Estimate	High Estimate
Freeway Location	A	B	A x B = C	C x D = E	C x D = E			E x F = G	E x F = G	E + G	E + G
Frontage Road Location [2]	A	B	A x B = C			C x D = H	C x D = H			H	H
									Subtotal	E + G + H	E + G + H
									Local Growth Factor[2]	x_____%	x_____%
									Total Initial 3+ HOV Demand Range		

[1] A parallel route should be located very close, typically within one mile of the freeway corridor. Frontage roads may be factored as a parallel route.

[2] Growth factors may be used if applicable to factor the estimate to the forecast year.

Figure 4-9. Initial HOV Demand Worksheet
(Adapted from Reference 3)

The same procedure is used to estimate current and future demand at the 3+ vehicle-occupancy level. Caution should be used when estimating the demand for an HOV facility at a 3+ level, as there may only be a small number of existing 3+ carpools using a facility. In many cases fewer than 5 percent of the traffic currently in the mixed-flow lanes are 3+ carpools. Such a small number is difficult to use for estimation purposes. With just a small change in the number of vehicles, a significant change may occur in the percentage of vehicles, potentially resulting in an overestimation of 3+ carpools.

FHWA/Charles River Methodology for Predicting Volumes for HOV Priority Treatments (4). This methodology uses readily-available traffic data to estimate modal changes from implementing new HOV facilities. Thus, the technique is intended to provide a relatively quick process since the data input is relatively minimal. As a result, this approach may also be considered as a sketch-planning tool. The methodology is based upon quantitative analysis of before-and-after studies of several HOV facilities. From this data, the methodology predicts the traffic demand in the general purpose and the HOV lanes. Utilizing blank worksheets that contain the initial data requirements and the necessary demand and supply, peak-hour flows can be determined for the mixed-flow traffic lanes, existing HOVs, new HOVs, and bus passengers on the HOV facility.

FHWA HOV Demand Model. In the mid 1990s, FHWA sponsored the development of a new model for predicting the demand for HOV lanes. A consulting team comprised of Dowling Associates, Cambridge Systematics, SYSTAN, Inc., and Adolf D. May conducted the study. The team reviewed available literature and conducted a survey of public agency personnel to better understand the current state-of-the-practice in HOV demand estimation procedures. The results of these tasks were used to develop a new HOV lane demand estimation methodology and software (5).

The HOV demand estimation model is a sketch planning methodology for predicting HOV lane and general-purpose lane demand and traffic performance, as well as limited environmental and energy impacts. The model uses the differences in travel times between the HOV and general-purpose lanes and between before-and-after conditions as input to the demand estimation process, and the differences in vehicle volumes in the HOV and the general-purpose lanes and between before-and-after conditions as the response to be predicted by the methodology (5).

The model uses several steps and iterations to develop the HOV lane and general-purpose lane demand estimates. The following seven individual modules are included in the model (5):

- Input Module—Accepts and edits the input data;
- Allocation Module—Distributes traffic to the HOV and mixed-flow lanes (occurs three times in the process);
- Supply Module—Predicts travel times for the HOV and mixed-flow lanes;
- Total Response Module—Predicts the total response by vehicle type;

- Equilibration Module—Checks closing criterion;
- Spatial and Modal Response Module—Allocates total response into spatial and modal components; and
- Output Module—Computes measures of performance including vehicle and person volumes, travel times, vehicle and person miles of travel, vehicle and person hours of travel, vehicle and person delay, air quality/emissions, and fuel consumption.

2. **Regionwide Logit Model Demand Estimation Techniques**
Regionwide logit models represent a more detailed approach to the demand estimation process. As a result, they may be beyond the scope of a sketch planning study. They may be used in some cases, however, and are briefly described in this section. These models are usually based on the traditional four-step transportation process of trip generation, trip distribution, modal split, and route assignment. These disaggregate models often consider carpool, transit, and solo driving conditions. Traditional logit models consider the utility that a particular mode has to an individual to influence the probability to taking a particular mode. The following are example inputs that are often necessary for these models.

Trip Characteristics
- Travel time: waiting time, carpool pick-up time, line-haul time, distribution time
- Trip distance
- Travel cost: parking charges, gasoline costs, tolls
- HOV time savings

Tripmaker Attributes
- Household income
- Workers/household auto availability
- Need for a car before, during, or after work
- Household size
- Length of residence

Trip-End Descriptors
- Employment density
- Employer incentives: subsidized parking, special parking privileges, flexible hours, transportation allowances

Regionwide logit models operate as either nested models or pivot point models. Nested models first make a distinction between auto and transit trips. The auto trips are then stratified between drive-alone trips and two- or three-person carpools. It is thought that this procedure closely replicates the choices commuters consider when selecting their travel mode. For example, it does not place transit in direct competition with drive-alone and carpool trips.

The pivot point logit modeling techniques estimate changes that can be expected in current travel behavior. Inputs generally include data concerning existing mode share and changes in the characteristics of the transportation service. These models tend to require less detailed data per analysis zone or household, for example. Table 4-3 provides a summary of selected regionwide logit models that have been developed for different geographical areas. The table lists elements such as the model origin, the mode selection utilized, the model type, and relevant variables (6).

The models shown in Table 4-4 are logit models and are intended for use within a regional urban transportation planning system (UTPS) network. Therefore, they require node-link input that is relevant to the region being studied. This requires a minimum of the following information.

- Highway network time and distance files;
- HOV network time and distance files;
- Transit network time and distance files; and
- Zonal data reflecting model parameters (i.e., parking costs, household income, auto occupancy tables, auto ownership, workers/household, HOV lane access, transit availability, transit fares).

The models also require a trip table linking origin and destination pairs, traffic counts, and transit ridership. These data are required to properly calibrate and validate the models for the region being studied. Developing a model that is appropriate for a region and calibrating and validating the model can require a significant commitment of time and resources (6).

The major advantage of regionwide models is their general understanding by the planning profession due to their wide use in the planning community and tractable mathematical operation. These models are useful in evaluating the impact of HOV facilities on a network since they incorporate a regionwide analysis of the diversion of carpool and solo trips from adjacent routes in the network (6).

Regionwide models are limited, however, in their ability to predict HOV facility operational impacts (e.g., delay, speed). As congestion increases within a region, the models become less able to estimate many of the needed parameters. For example, estimating the travel time savings realized by the use of an HOV facility may be difficult. The models may also not be able to represent the mode share choice impact of HOV facilities. This is largely due to the fact that many of the models are designed with logit modeling for only transit and auto travel modes (6).

Regionwide logit models are often used to evaluate the impact on a system of transportation alternatives. However, they are often not flexible enough to be applied to specific corridors or facilities. Logit models may provide an estimate of the diversion of carpool and solo driver trips to an HOV facility, but are limited in their ability to estimate mode choice and the operational impacts of HOV facilities (6).

Table 4-4. Summary of Selected Regionwide Logit Models (Adapted from Reference 6)

MODEL/AREA	REFERENCE	MODE SELECTION		MODEL TYPE		MODEL TYPE	
		First Stage	Second Stage	Regional	Corridor/ Freeway	Trip Descriptors	Socioeconomic/ Demographic
Metropolitan Washington COG	Barton Aschman, 1986 Ecosometrics	Drive Alone Transit Pool	Pool (2) Pool (3) Pool (4+)	Multinomial Logit		Modal Time Modal Cost HOV Savings	Household Auto Ownership
Southern California Association of Governments	SCAG, 1986	Transit	Walk Access Drive Access Pool Access				
	Barton Aschman, et al., 1987	Auto	Drive Alone Pool (2) Pool (3+)	Multinomial Logit		Modal Time Modal Cost/Intome	Autos/Household Drivers/Household Workers/Household Annual Income
Network Performance Evaluation Model	Carnigie Mellon/ Oak Ridge Janson, et al., 1987	Auto (1 or 2) Transit Pool (3) Pool (4+)		Multinomial Logit/ Iterative Assignment		Out-of-Pocket Cost In-Vehicle Time Pickup Dwell Time Bus Fare	Income/Traveler Zonal Land Area
San Francisco Bay Area Metropolitan Transportation Commission	Kullo, 1987 Purvis, 1988	Drive Alone Transit Pool (2) Pool (3+)		Multinomial Logit		Modal Time Modal Cost	Autos/Household Workers/Household Employment Density Household Income
North Central Texas COG	NTCOG, 1990	Drive Alone Pool (2) Pool (3+) Transit (Walk) Transit (Drive)		Multinomial Logit		Modal Time Modal Cost	CBD Attraction Autos/Person Mode-Specific Quadrants (Choice/ No Choice)
Travel Demand and Simulation Modeling Contract	JHK, March 1994	Will Accomodate Logit Nested Logit Table Look-Up		Will Accomodate Logit Nested Logit Table Look-Up	Simulation	Travel Times HOV Time Savings Mixed-Flow Congestion	Logit Modal Input

3. **Corridor Demand Estimation Modeling Techniques**
A number of models have been developed for estimating the demand for HOV facilities at the corridor level. Some of these models incorporate the logit modeling techniques described in the previous section, while others are based on linear regression relationships to determine desired parameters, such as travel time savings. Some models evaluate parallel routes with the corridor under evaluation, some focus only on a single route, and others focus along a critical point along the route. Examples of corridor-based modeling techniques for estimating demand are highlighted in Table 4-5 and described next.

Several of the models in Table 4-5 are logit models. The model developed by Cambridge Systematics for the Department of Energy utilizes a pivot point procedure to estimate carpool incentive impacts (7). The Institute for Transportation Studies at the University of California in Berkeley has developed a method for determining the impacts of HOV facilities on four competing travel modes (8). These modes are noncarpooling auto, carpools (2+ or 3+), bus with walk access, and bus with auto access (e.g., park-and-ride).

I-580, San Francisco. A disaggregate model was developed for use in San Francisco on the I-580 corridor (9). The model utilizes the logit model formulation for the first of three stages analysis. These are estimating demand, calculating LOS parameters, and equilibrating between demand and level-of-service estimates. Although this model does consider the combination of the freeway with the parallel arterial facilities, it is insensitive to changes in the highway capacity (6).

Metropolitan Washington Council of Governments. A model was developed by Mann (10) to estimate increased carpool usage on HOV facilities in Washington, D.C. The method utilizes nomographs that relate average vehicle occupancies to individual vehicle occupancies that can then be related to the impact of the HOV lanes on zone-to-zone auto occupancy rates.

The model utilizes data from 10 sites to develop the regression equations for both an optimistic and pessimistic estimate. There are two potential limitations with this estimation technique. The first is the limited number of data points used for development of the regression equations. The second is that HOV lanes with both 2+ and 3+ vehicle-occupancy levels were included in the 10 sites.

Table 4-5. Summary of Selected Corridor Demand Models (Adapted from Reference 6)

MODEL/AREA	REFERENCE	MODE SELECTION		MODEL TYPE		MODEL TYPE	
		First Stage	Second Stage	Regional	Corridor/ Freeway	Trip Descriptors	Socioeconomic/ Demographic
Cambridge Systematics	CSI, 1977	Drive Alone Transit Pool			Multinomial Logit Pive Point	Change in Travel Time and Cost by Mode	Possible to Segment Travelers by Location, Income, Auto Availability, etc.
U.C. Berkeley Thesis	Small, 1977	Noncarpool Carpool (3+) Bus (Walk Access) Park and Ride			Multinomial Logit	Travel Time and Cost Walk and Wait Time Bus Transfers	Income; Age; Length of Residence; Number of Children
I-580 San Francisco Bay Area	Talvitie, 1978	Drive Alone Shared Ride Bus; BART			Multinomial Logit	Service Access Times Line-Haul Travel Times	Household Characteristics
Metropolitan Wash./ COG Transportation Planning Board	Mann, 1983	Car Occupancy Distributions			Regression Nomograph	HOV Time Savings	
Charles River Associates	Parody CRA, 1984	Drive Alone Pool (2) Pool (3+) Transit			Pivot Point Regression	Change in Travel Time by Mode	None
Orange County	Wesemann, 1987	HOV Formation (% of base case)			Pivot Point Table Look-Up	HOV Time Savings Trip Length	None
Texas Transitway	TTI, 1988	Drive Alone Transit Pool			Trip Table	Modal Time	Destination Attractions
Riverside County	DKS, 1990	Drive Alone Pool			Nonlinear Function	HOV Time Savings	Hard-Core Drive ALone
Dallas	Poe, et al TTI, 1994	HOV Lane Use as a % of ADT			Regression	Congestion Level (ADT/Lane)	None

Charles River Associates. Charles River Associates developed demand models based upon regression relationships and supply models based upon speed-volume relationships after performing an extensive literature review encompassing travel volume prediction techniques for HOV facilities (4). The demand models were developed utilizing before-and-after data from seven HOV facilities. Additional observation pairs were added since five of these facilities were observed both before and after different priority requirements. The following equation is the demand model that produced the most favorable results for all types of modes (6).

$$\frac{Vm_1 - Vm_0}{Vm_0} = a_0 + \sum_i a_i \frac{(TI_1 - Ti_0)}{(Ti_0)}$$

Where:

Vm_0 = peak hour before volume for mode m;
Vm_1 = peak hour after volume for mode m;
Ti_0 = before travel times for modes i to m;
Ti_1 = after travel times for modes i to m; and,
$a_{0,i}$ = calibration coefficients.

UTPP Base/Socio-Economic Growth Approach Model (11). This approach was utilized by the Orange County Transit District in Southern California to estimate bus and HOV usage for a system of barrier- and buffer-separated facilities in the region. The model was used to develop detailed estimates of HOV usage to determine the size and location of the HOV facilities and supporting facilities in the region.

The model uses a spreadsheet approach supplemented with the use of BASIC programs. The U.S. Census Urban Transportation Planning Package (UTPP) is used to estimate journey-to-work trips for base projections. Locally established population and employment growth factors for both origins and destinations are then used to extrapolate the data to future years. This extrapolation is aided by incorporating trip distributions from the UTPP. The model can be used to estimate demand at different vehicle occupancy levels. In the Orange County study, two forecasts were performed to estimate the travel forecasts for both 2+ and 3+ vehicle occupancy restrictions.

Texas Transportation Institute. A demand estimation technique developed by the Texas Transportation Institute (TTI) uses trip tables representing the employment centers that are served by the HOV lanes in Houston. The following steps outline the process that was developed based on the experience from the Katy Freeway HOV lane in Houston (6).

Step 1: Define HOV Facility Market Area. The marketing area is determined in this step by defining the major activity centers that are served by the HOV facility;

Step 2: Compile Trip Tables. The expected origin of trips traveling to the major activity centers are identified through the use of Census tracts. Journey-to-work files from the Census are utilized to estimate the number of person trips that can be expected between each origin and destination.

Step 3: Estimate Carpool Mode Splits. Historical data is used in this step to determine the expected carpool mode splits to the activity centers. The procedure estimates mode splits of 20% to 25% (2+ carpool mode split) could be utilized in sketch-planning applications for activity centers with employee densities in the range of 3,000 to 3,500 employees per million square feet for trips greater than 10 miles.

Step 4: Assign Carpool Vehicle Trips to HOV facility. After determining the mode split, the trips are assigned manually to the HOV facility. This produces peak-period demand for 2+ carpools. The following conversion factors are provided by TTI based upon Houston experience if different conditions (e.g., occupancy restrictions, time periods) are desired.

- To convert vehicle movement to person movement, multiply by 2.2.
- To convert from peak-period to peak-hour, multiply by 0.50.
- To convert from 2+ carpool demand to 3+ carpool demand, multiply by 0.20.
- To convert unauthorized carpool demand to authorized carpool demand (i.e., if carpooling requires special identification or training), multiply by 0.60.

This approach relies only upon information from one source, and requires the reader to determine appropriate activity centers (6).

4. **Travel time savings estimation**

The level-of-service on freeway mixed-flow lanes is affected as motorists shift to an HOV lane. Large shifts of traffic to an HOV lane can cause a potential decline in the travel time savings incurred in the HOV lane. Without the travel time savings, there is a reduced incentive to commuters to use the HOV lanes. Estimating mode share demand is a function of the travel time savings that commuters gain when traveling in the HOV lanes. The sections that follow discuss some of the techniques that have been developed to aid in estimating the travel time savings achieved with an HOV facility.

Freeway speeds must be determined to estimate the potential travel time savings of HOV lane alternatives. The following are two common methods showing the speed-flow relationship.

The BPR Curve. The Bureau of Public Roads (BPR) developed a speed-flow relationship that is used in all regional planning models (e.g., UTPS, TRANPLAN, MINUTP, etc.). The volume/capacity ratio is used to reduce the free-flow speed to a congested speed in this relationship. The regional planning models often utilize the same curve for traffic flows resulting in v/c ratios less than and greater than zero. For speeds on arterials and when the v/c is greater than 1.00 (queuing conditions), the curve tends to over-estimate speeds due to this simplification. The following equation is used to compute the equation for the BPR curve (6):

$$Congested\ Speed = \frac{Free\ Flow\ Speed}{1 + 0.15\ (\frac{v}{c})^4}$$

Where:

$\frac{v}{c}$ = volume/capacity ratio.

Highway Capacity Manual Curve. Freeway speeds are estimated by using the volume/capacity ratio for the 1985 Highway Capacity Manual (HCM) as well. The curve includes the speed-flow relationship for ideal conditions for freeways with design speeds ranging from 50 mph to 70 mph. These curves are all valid until the volume on the facility approaches capacity. At this point, the speed quickly drops to one-half the free-flow speed. The 1994 HCM shows a much more gradual reduction in the speeds as the capacity of the facility is approached. Figure 4-10 illustrates the relationship for freeways between volume/capacity ratio and speed for the BPR curve and the HCM curves in 1985 and 1994. A cursory review of Figure 4-10 reveals that the BPR curve is between the two HCM curves. Further, the largest difference between the BPR and HCM curve occurs as the volume of the facility approaches the capacity. Since most HOV facilities are implemented when freeways are experiencing significant congestion, estimating speed-flow relationships in this range are important for measuring the impacts of HOV facilities (6).

5. Freeway Simulation Models

CORSIM. CORSIM is a computer traffic simulation model developed by FHWA. CORSIM represents the combination of two other computer models—NETSIM and FRESIM. CORSIM, which is a corridor-microscopic simulation model, represents the most detailed urban computer simulation of the FHWA package.

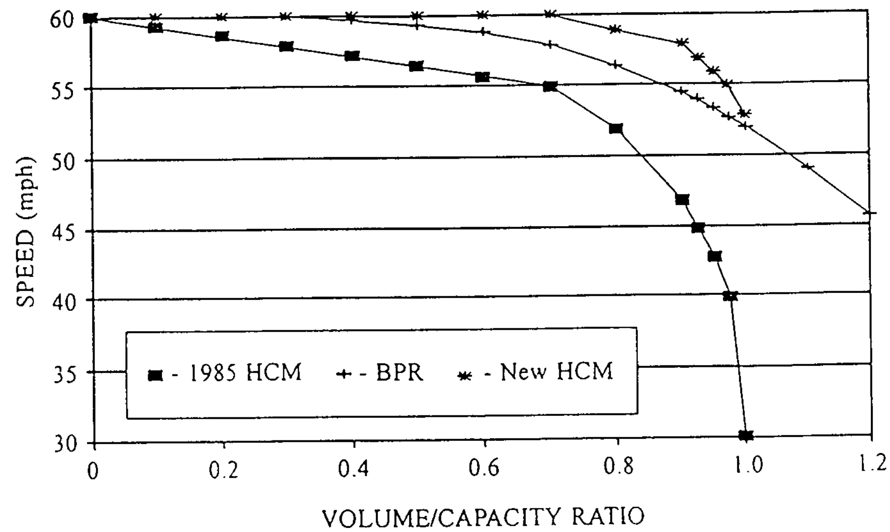

Figure 4-10. Comparison of Speed-Flow Curves

Source: (6)

CORSIM simulates the traffic and traffic control conditions of a network over a period of time. To accomplish this, the input must accommodate specifications that may differ from one point on the network to another, and may also change with time. The structure of the input stream also has to reflect the concept of network partitioning. CORSIM allows a user to specify up to 19 different time periods and the condition within each of these.

CORSIM can be used for a wide range of applications, including simulating HOV facilities. More detailed information on the capabilities and use of CORSIM can be found in the User's Manual (12).

FREQ. The FREQ model can be used for macroscopic modeling of HOV lanes, adjacent freeway lanes, and HOV ramp bypass facilities. FREQ simulates freeway sections by separating them into subsections and dividing the time period for the study into discrete time slices. On ramps and main freeway lanes, volumes are entered for each subsection and time slice. When the demand exceeds the capacity, the model begins to measure the queue propagation that is created and continues into later time slices as necessary. Demand on the main freeway lanes downstream of the bottleneck are reduced appropriately to account for the bottleneck (13,14).

FREQ has been used for simulating HOV facilities in a number of areas (15). The HOV facility is simulated in FREQ11 PL by separating the freeway into two parts—the HOV lanes and mixed-flow lanes—and then analyzing each element. The speed-flow curves and capacity restraints for the HOV lanes are different than those for the mixed-flow facilities. Additional modules in the model allow the analysis of modal splits and spatial shifts in traffic. The following scenarios can be simulated with the software:

- (Day -1) Before the implementation of the HOV lane
- (Day + 1) Immediately after the HOV lane has been implemented
- (Middle term) After the implementation of the HOV lane including spatial response
- (Middle term) After the implementation of the HOV lane including modal response

Spatial responses in FREQ are estimated by modeling a representative arterial that is parallel to the freeway. As motorists move from the mixed-flow lanes to the HOV facility, motorists traveling on adjacent roadways are induced to shift into the mixed-flow lanes. The capacity of these adjacent roadways is represented in the arterial that FREQ models to estimate spatial responses of the HOV lane.

Modal shifts, which are assumed to occur after spatial shifts, are also modeled by FREQ. A logit model developed based on data from San Francisco is used to predict the modal shifts (14). The user can recalibrate this logit model to reflect the local elasticities that are present in the study area. An iterative process is utilized that shifts a small number of vehicles to the HOV facility and recalculates the travel time savings. This process continues until the travel time savings is not large enough to induce a mode shift.

The FREQ model has been in use for several years to simulate mainlane freeway sections. The model allows for the macroscopic simulation of different alternatives under congested flow conditions. The model is not likely to be suitable for quick-response demand estimation due to the many necessary inputs to the model and the extensive equations to replicate the creation and promulgation of traffic flow shock waves. However, the model could be utilized as part of a screening process that includes the eventual use of more detailed screening techniques that are too complex to be modeled with quick-response demand estimation.

FREFLO. FREFLO is another method for the macroscopic modeling of freeway traffic operations including traffic flow, density, and speed. The model is part of the TRAF family of models produced by the FHWA, and it can be used for modeling mixed-flow and HOV lanes. The model simulates the traffic conditions by representing the corridor as a series of sections in which vehicles try to enter. The number of vehicles that can flow to subsequent downstream sections in a given time frame is determined by the capacity of the section (6).

6. Combined Modeling Approaches

Many methods that combine demand and supply models have been developed by modelers to aid in estimating the mode choice impact of HOV facilities. The most common method to provide this estimation is by iterating the application of mode shift equations and level-of-service estimates. This approach is followed by most regionwide network models and by several models for monitoring corridor impacts (9,16). JHK and Associates has combined the traditional regionwide planning models with a freeway simulation to improve the estimates of level-of-service in the region (17).

CALINK. Since traditional regionwide modeling techniques use the BPR curve to estimate traffic flow levels, they are limited in their ability to estimate the impacts along freeway sections of factors such as speed, delays, and traffic queues. Therefore, the models are unable to provide travel time differences that can be expected for carpools and single-occupant vehicles due to an HOV facility. JHK and Associates, in a project for CALTRANS (14), combined the FREQ freeway simulation model with a regionwide traffic planning model. The resulting model, termed CALINK, utilizes an iterative procedure between the planning and simulation activities. Mode split and assigning traffic volumes produced in the regionwide model are incorporated into FREQ to revise estimates of freeway speeds and also ramp delays. The adjusted travel time information is then integrated into the regionwide planning model to determine an updated mode split and traffic assignment. This process continues until the travel speeds and traffic volumes converge for subsequent iterations (6).

Three-Tiered Screening Procedure. A three-tiered methodology has been developed at U.C. Berkeley to aid in determining candidate sites for HOV facilities (13). The process begins with a qualitative investigation of candidate sites in tier one and then proceeds into more quantitative methods in tiers two and three (6).

Tier One. In the first tier, a qualitative evaluation is provided on each of the candidate locations by professionals that are familiar with them. The professionals answer a series of thirteen questions about each of the candidate sites to obtain this qualitative evaluation. The questions that are used in this evaluation are shown in Figure 4-11.

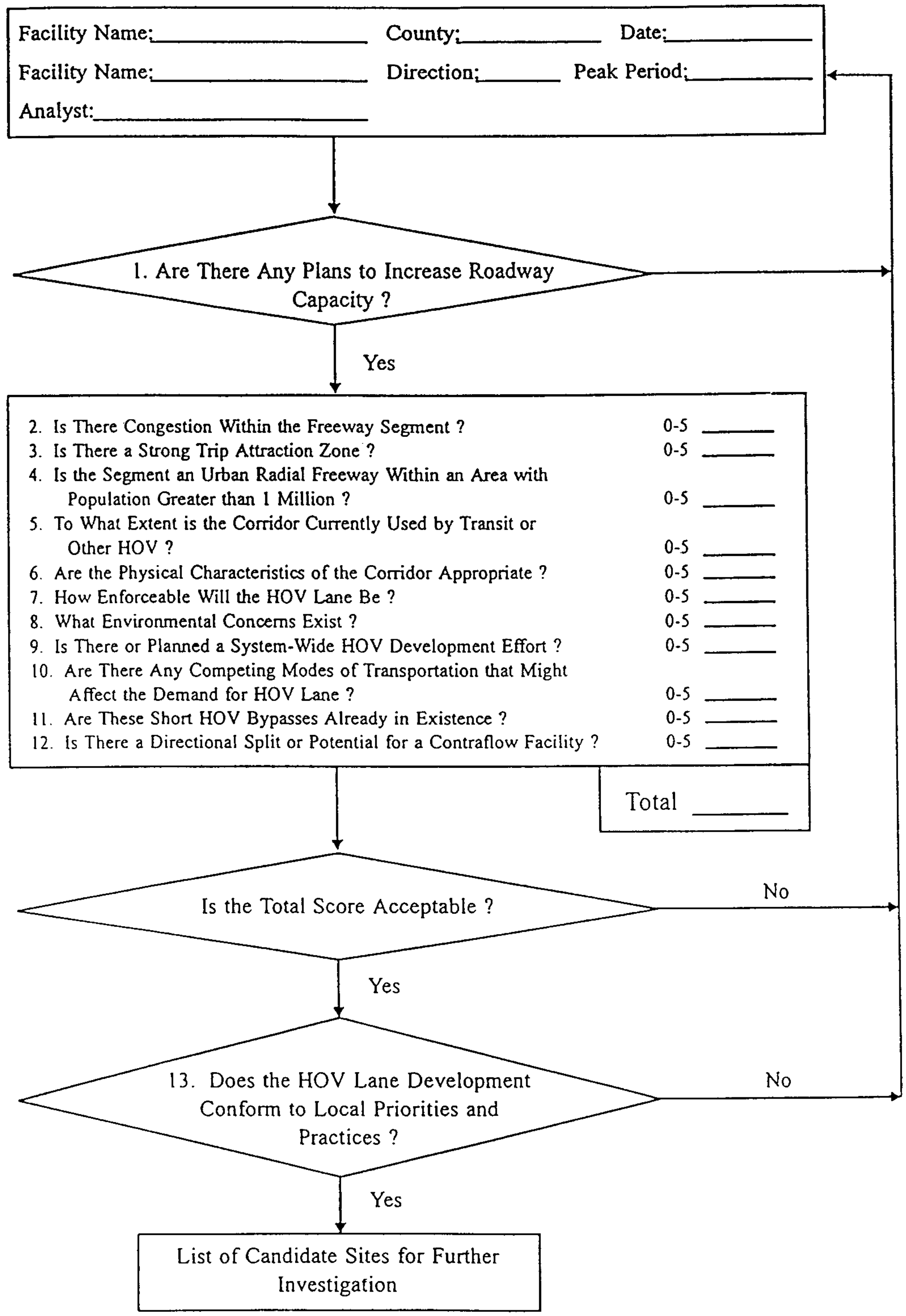

Figure 4-11. Scoring Sheet Used in the Tier One Evaluation
(Adapted from Reference 5)

Tier Two. Simple analytical models are utilized in this step to begin the quantitative analyses of the candidate locations. These models address the short- and medium-term operational issues of the freeway sections. The first phase of this process implements nomographs which determine the number of vehicles in the mixed-flow lanes and HOV lanes immediately after the HOV facility is implemented (i.e., prior to demand response). An example of such a nomograph that can be used to access lane conversion demand/capacity ratios is shown in Figure 4-12.

Tier Three. The final tier includes the use of macroscopic computer simulation of the remaining candidate locations using FREQ. Since considerable resources are necessary to perform the FREQ simulations on each candidate location, the authors recommend that a small number of sites be evaluated in this tier.

G. General Design and Cost Factors

Design and cost factors are often important elements in the planning process. As discussed previously, the availability of needed right-of-way and the cost associated with different alternatives are often screening criteria or evaluation measures. Additional design factors may be considered during the planning process to ensure that the selected options are viable.

The capital and operating costs associated with various types of HOV facilities will vary greatly depending upon local conditions. Tables 4-6 and 4-7 highlight the costs associated with recent HOV facilities. Local factors influencing cost include the availability of right-of-way and the purchase price of needed land; contracting procedures; soil, wetlands, and other environmental issues; weather factors influencing the construction season; and special considerations such as the need for seismic considerations in Southern California.

Tables 4-8 and 4-9 provide information on the unit construction and operating costs for HOV and freeway alternatives from a recent study in the Dallas area. The information provides a general indication of the costs associated with various approaches that may be used as general parameters in other areas.

Parsons Brinckheroff has also developed a cost estimation spreadsheet that can be used during the planning process to provide a preliminary indication of the costs associated with various alternatives. The spreadsheet, which is illustrated in Figure 4-13 examines the costs associated with the various components related to the roadway, structures, and right-of-way to develop a preliminary estimate.

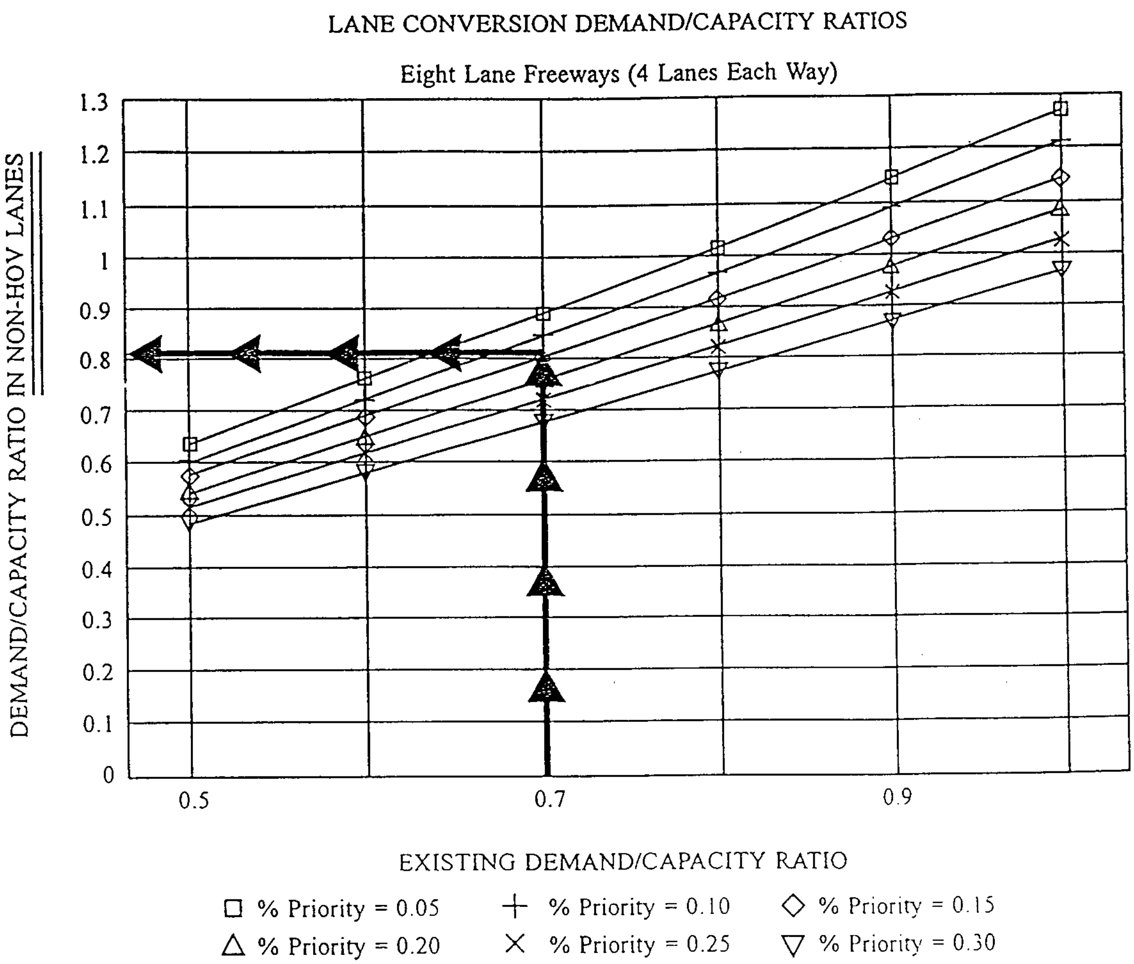

Figure 4-12. Sample Nomograph Used to Investigate HOV Lane Conversion Options in Seattle (Adapted from Reference 5)

H. Cost Effectiveness

Examining the cost of freeway HOV treatments may be part of the planning process. Cost effectiveness is usually determined by comparing the capital costs associated with an arterial HOV project with the anticipated benefits. The benefits may include quantifying the travel time savings of buses and HOVs and operational savings realized by public transit operators. The time savings to HOVs may be based upon a generalized or local cost per hour of day.

Table 4-6. Summary of Capital Costs from Selected Projects
(Adapted from Reference 3)

HOV Facility	Estimated or Incurred Capital Costs (millions $)		Route Mileage	Base Year for Estimate	Funding Sources
Barrier-Separated Separate R.O.W.					
● Ottawa, Canada	$450	Canadian (incl. design)	14.5	Varies 1980-1993	Province 75%, local 25%
● Pittsburgh					
South Busway	$27		4	1977	UMTA, state, local
East Busway	$93	(incl. design)	6.8	1983	UMTA, state, local
Barrier-Separated Freeway R.O.W.					
● Houston, TX					
I-45N (North)	$29		9.1	1988	UMTA 55%, local 45%
I-45S (South)	$27.3		6.5	1988	FHWA/state 80%, local 20%
I-10 (Katy)	$32		11.5	1989	UMTA 13%, FHWA/state 5%, local 82%
US 290 (Northwest)	$44		9.5	1988	UMTA 57%, FHWA/state 6%, local 37%
● Los Angeles, CA, I-10	$56		11	1973	UMTA, FHWA, state
(San Bernardino Fwy)	$35		0.7	1989	UMTA, FHWA, state
● San Diego, I-15	$31.4		8	1988	FHWA 90%, state 10%
Buffer-Separated Freeway R.O.W.					
● Los Angeles, Rte. 91	$0.3	(incl. design)	8	1984	FHWA, state
● Orange County, CA					
Rte. 55	$0.4		11	1984	FHWA, state
Rte. 405	$54		24	1988	FHWA, state
● Orlando, FL, I-4	$14		30	1980	FHWA 90%,state 10%,
● Santa Clara County, CA					
Montague Expwy.	$1.5		5	1985	FHWA, local
San Tomas Expwy.	$3.5		1	1985	FHWA, local
● Seattle, WA					
I-5	$7.6		6	1985	FHWA, state
SR 520	$0.1		2.8	1973	FHWA, state
I-405	$10.2		6	1986	FHWA, state
Contraflow Freeway R.O.W.					
● New Jersey, Rte. 495 (Lincoln Tunnel)	$0.5	(incl. design)	2.5	1970	state, local
● New York, NY					
Long Island Expwy.	$0.4		2.2	1971	state, local
Gowanus Expwy.	$0.4		0.9	1980	state, local
● Houston, I-45N (terminated 1984)	$1.8		9.6	1979	UMTA, state, local

Table 4-7. Summary of Operation Costs from Selected Projects
(Adapted from Reference 3)

HOV Facility	Daily Deployment Procedures	Daily Deployment Persons	Surveillance & Control System	Annual Operation & Maintenance Cost	Status (9/90)
Barrier-Separated, Separate R.O.W.					
Ottawa, Canada	None	0	No	-----	Operational
Pittsburgh, PA	None	0	No	$65,000[1]	Operational
Barrier-Separated, Freeway R.O.W.					
Houston, TX, I-10, I-45, US 290	Manual gates, signs & lane controls	5	Yes	$450,000[1]	Operational
Los Angeles, CA, I-10	Manual control, gates & signs	0	Yes	$35,000 maintenance	Operational
Virginia, I-395	Remote control, gates & signs	2-5	Yes	$500,000	Operational
San Diego, CA, I-15	Remote control, gates & signs	2	Yes	-----	Operational
Buffer-Separated, Freeway R.O.W.					
Los Angeles, CA, Rte. 91	None	0	Yes	$10,000 maintenance	Operational
Orange County, CA, Rte. 55	None	0	No	$15,000 maintenance	Operational
Miami, FL, I-95	None	0	No	-----	Operational
Orlando, FL, I-4	None	0	None	$205,000	Operational
Santa Clara County, CA, US 101	None	0	No	-----	Operational
Seattle, WA, I-5	None	0	Yes	$18,000	Operational
SR 520	Automatic Signs	0	Yes (television)	$7,500	Operational
I-405	None	0	Yes	$18,000	Operational
Contraflow, Freeway R.O.W.					
Honolulu, HI, Kalaniaole Hwy.	Cones & signs	---	No	$50,000 operation	Operational
New Jersey, Rte. 495 (Lincoln Tunnel)	Cones & signs	6	Yes	$265,000	Operational
New York, NY					
Long Island Expwy	Cones & remote control signs	5-6	No	$250,000[1]	Operational
Gownaus Expwy.	Cones & remote control signs	2-3	No	$84,000[1]	Operational
Marin County, CA	Cones & signs	5-6	No	$300,000[1]	Terminated 1985
Houston, TX, I-45N	Cones, manual signs & lane controls	10-12	No	$600,000[1]	Terminated 1984
Queue Bypass					
San Francisco, CA, I-80 (Bay Bridge)	Change signs	0	No	Minimal	Operational

----- No data available
[1] Not including enforcement costs

Table 4-8. Unit Construction Costs of Different Transportation Alternatives (Adapted from Reference 17)

Construction Item	Width Meters (feet)	Cost - $ Million per Kilometer (per mile)
Mainlane (one lane at grade)	3.7m (12')	$1.6 per km ($2.5 per mile)
Mainlane (one lane elevated)	3.7m (12')	$2.2 per km ($3.5 per mile)
HOV lanes w/ramps (one lane at grade)	6.1m (20')	$3.1 per km ($5 per mile)
HOV lanes w/ramps (one lane elevated)	6.1m (20')	$4.3 per km ($7 per mile)
HOV lanes w/ramps (two lanes at grade)	12.2m (40')	$4.3 per km ($7 per mile)
HOV lanes w/ramps (two lanes elevated)	12.2m (40')	$6.2 per km ($10 per mile)
Express lanes (two lanes at grade)	12.2m (40')	$3.7 per km ($6 per mile)
Express lanes (two lanes elevated)	12.2m (40')	$5.6 per km ($9 per mile)
Express lanes (three lanes at grade)	17.1m (56')	$6.2 per km ($10 per mile)
Express lanes (three lanes elevated)	17.1m (56')	$9.3 per km ($15 per mile)
Noise abatement walls	N/A	$0.68 per km ($1.1 per mile)
Surveillance, communication and control (SC&C)	N/A	$0.31 per km ($0.50 per mile)

Table 4-9. Operating Costs of Different Transportation Alternatives (Adapted from Reference 17)

Operating Item	Annual Cost ($ Million)
Enforcement for separate HOV lane	$ 0.10 per facility
Reversible lane (Express and HOV)	$ 0.25 per facility
Surveillance, communication and control (SC&C)	$ 0.10 per facility

Quantifying these benefits may not be an easy process. The value of a traveler's time will depend on the type of trip and the local economic environment. A standard $10.00 an hour rate is often used in calculating the value of time spent in congestion. Estimating potential benefits to transit operations may be easier, as the savings in travel time and potential to reduce vehicle needs can be estimated.

DESCRIPTION

Project Manager ____________ Current Estimate Date ____________
Route ____________ Previous Estimate Date ____________
Revision Amount ____________

Project Description ____________

COST ESTIMATE

		UNIT COST	SUBTOTALS
ROADWAY			
Pavement removal		______	
Street/highway work			
Pavement type		______	
Pavement base		______	
Ramp/shouder work			
Pavement type		______	
Pavement base		______	
Concrete barriers		______	
Sound walls		______	
Retaining walls		______	
Signals, lighting and signs (including surveillance & control systems)		______	
Landscape and erosion control		______	
Excavation		______	
SUBTOTAL ROADWAY (A)			A= ______
Traffic Handling (B=15% of A)	B=	______	
Traffic Management Plan (optional)			
Miscellaneous (C=20% of A+B)*	C=	______	
Mobilization (D=10% of A+B+C)	D=	______	
Contingencies (E=25% of A+B+C)	E=	______	
SUBTOTAL ROADWAY FACTORS (F=B+C+D+E)			F= ______
STRUCTURES			
Structures			
Demolition			
Non-Bridge items (pumping plants)			
SUBTOTAL STRUCTURES (G)			G= ______
Traffic Control (H=15% of G)	H=	______	
Mobilization (I=10% of G+H)	I=	______	
Contingencies (J=25% of G+H)	J=	______	
SUBTOTAL STRUCTURES FACTORS (K=H+I+J)			K= ______
RIGHT-OF-WAY COSTS			
Utility Relocation		______	
Right-of-Way Costs		______	
Contingency (varies, 25% minimum)		______	
SUBTOTAL RIGHT-OF-WAY (L)	L=		______
TOTAL PROJECT COSTS (A+F+G+K+L)			______

Figure 4-13. HOV Planning Cost Estimate Worksheet
(Adapted from Reference 3)

IV. PLANNING ARTERIAL STREET HOV FACILITIES

This section discusses planning for HOV facilities on arterial streets. The various types of arterial street HOV treatments were summarized in Chapter 2. More detailed information on operating and enforcing arterial street HOV projects is provided in Chapter 7, and the design of arterial HOV facilities is presented in Chapter 8. General planning approaches appropriate for arterial street projects are described, and elements to be included in evaluations of alternative treatments are outlined. Specific planning techniques including operational analyses, demand estimation procedures, and cost effectiveness assessments, are described.

A. Overview of Planning for Arterial Street HOV Facilities

As discussed in more detail in Chapter 7, the operating environment on arterial streets is very different from freeway operations. Freeways serve long distance, high speed travel, with limited access points. Arterial streets serve short trips, provide access to local streets and land uses, and operate at relatively low speeds. Signalized intersections, driveway access, on-street parking, delivery vehicles, pedestrians, and bicyclists can all add complexity to the arterial street environment. These, and other factors, must be considered in planning, implementing, operating, and enforcing arterial street HOV facilities.

At the same time, arterial street HOV facilities are different than those found on freeways. Arterial street treatments often focus on providing priority to buses in the downtown area or other congested locations. Community applications include the use of the curb lane during the peak-periods for buses for HOVs, queue jump treatments for buses at busy intersections, and bus signal priority applications. A few longer distance arterial street HOV lanes are currently in operation, and there is growing interest in this approach in many areas. There is also interest in using arterial street facilities to link freeway HOV lanes to major activity centers.

The general planning process outlined previously in Section II is appropriate for use with arterial street HOV facilities. Consideration should be given, however, to customizing the process to match the characteristics of the area, the type of project being considered, and the complexity of the situation. For example, the planning process to address a bottleneck for buses at a signalized intersection will be simpler than the process for examining a long distance arterial HOV lane in a suburban area.

As noted in Section II, the first step in the process should be the identification of the appropriate agencies, groups, and individuals to include in the planning effort. Depending on the ownership of the roadway and the type of project being considered, the state, local jurisdiction, or transit agency may have the lead responsibility for the planning process. The other agencies will most likely be involved in supporting roles, however.

In addition, local businesses, property owners, neighborhood groups, and representatives from special land uses like schools and hospitals should be involved early and throughout the planning process. These groups may have special concerns about on-street parking, access to businesses, delivery vehicles, and pedestrian safety. Identifying potential issues early in the planning process is critical to ensuring that they are adequately addressed and resolved. Examples of possible concerns with arterial street projects include loss of on-street parking, limitations on delivery vehicles, restrictions on turns at intersections, and loss of driveway access.

The exact steps, techniques, and tools to be used in planning arterial street HOV facilities should be matched to the issues being addressed, the scope and scale of the project, and local conditions. The possible approaches or techniques are presented in this section. These are sketch planning approaches, operational analyses, demand estimation procedures, and cost effective assessments.

B. Sketch Planning Level

Sketch planning may be used as the first step in the process to help identify the need for some type of arterial street HOV treatment. Sketch planning represent a general level of analysis and is often used as a first step to determine if a more detailed assessment is warranted. The same process described previously in Section III.D can be used with arterial street projects. The screening criteria will probably need to be changed, however. The following factors based on preliminary goals and objectives may be considered as possible criteria in a sketch planning process to help identify the need for an arterial street HOV facility or other priority treatment.

Level of Congestion. The level of congestion on an arterial street can be used as one measure to help identify the need for an HOV treatment. A level of service in the C to F range indicates a facility approaching or over capacity. The level of service should be examined both along the facility and at intersections.

Bottlenecks. There may be specific bottlenecks or congestion points on an arterial street causing significant delays. The existence of bottlenecks may point to the need for some type of priority treatment for buses and HOVs.

Level of Transit Service. The level of transit service on a roadway can provide an indication of the need for an HOV facility. High volumes of buses may justify consideration of some type of priority treatment. Criteria may include the number of buses, as well as ridership levels.

Transit Delay. In addition to the number of buses using a facility, consideration should be given to conditions delaying these vehicles. Traffic signals, turning vehicles, and general congestion levels may all influence the travel time and speed of buses operating on arterial streets. Identifying specific problems causing delays to buses is the first step in developing an approach to address these problems.

Carpools and Vanpools. The number of existing HOVs using an arterial roadway can be used as another criteria for projects anticipated to allow carpools and vanpools. Roadways with high volumes of carpools and vanpools may be good candidates for some type of HOV treatment.

HOV Links or HOV System Connectivity. The presence of an HOV facility on a freeway or in a separate right-of-way may point out the need for an arterial street HOV lane to provide a link to a major activity center. For example, HOVs may experience significant delays accessing an exclusive freeway facility in a suburban area and exiting the facility into a downtown area. Providing arterial street HOV treatments may significantly reduce the total trip travel time and increase the travel time savings for HOVs.

Roadway Improvements or New Developments. Planned roadway improvements or the construction of new buildings and developments may provide opportunities for the consideration of HOV treatments. For example, an HOV lane or bus queue jump could be added as part of a road widening project or an HOV-only entrance could be provided as part of a new development. Further, the implementation of a new traffic signal system may provide the opportunity to consider priority treatments for buses or HOVs.

Physical Constraints. The ability to implement an arterial street HOV project will be influenced by the availability of needed right-of-way and physical constraints in the area.

Operational viability. Consideration may be given in the screening process to possible operational issues associated with the HOV alternatives to ensure that a project is viable and worth further consideration.

Financial viability. The cost of possible improvements and available funding may be used to identify the financial viability of various options.

Public acceptance. The reaction or preferences of businesses, neighborhood organizations, and other groups may be used as a screening criteria.

A variety of information may be examined as part of a sketch planning process. This information may be reviewed at a fairly general level, or an initial screening process may be conducted to identify candidate locations for more detailed analyses. The following elements should be considered for inclusion in a sketch planning process.

- Current and forecast level of service for roadways and intersections.
- Current and forecast through volumes and turning volumes.
- Number of buses.
- Transit ridership levels and bus stop locations.

- Existing and forecast vehicle-occupancy levels.
- HOV facilities on freeways or in separate rights-of-way.
- Traffic signal equipment and capabilities.
- Adjacent land uses or development patterns.
- Travel patterns.
- Posted speed limits.
- Peak-period travel speeds.
- Existing on-street parking and loading regulations.
- Current pedestrian peak and off-peak period volumes.
- Accident information.
- Roadway and intersection geometry.
- Available right-of-way.
- Supporting policies and programs.

The candidate locations and alternatives that emerge from the sketch planning process may be carried through a more rigorous level of analysis. The next three sections highlight techniques that may be used to conduct more detailed analyses of possible arterial street HOV treatments.

C. Demand Estimation Techniques

The demand estimation techniques for use with HOV facilities on freeways and in separate rights-of-way were discussed previously. Some of these techniques may be appropriate for use with arterial street projects. Although transit riders, bus operators, and carpools and vanpools may realize benefits from arterial street HOV facilities, arterial street treatments alone may not greatly influence mode shift in a corridor or region. As a result, estimating the demand for the new arterial HOV facilities is often difficult.

Little analysis has been done on demand estimation techniques with arterial street projects. The Charles River Associates (CRA) model has been the most widely used technique over the past 15 years. The CRA method utilizes a series of worksheets in an iterative procedure. Although the model was developed for estimating the demand for freeway HOV facilities, it was adapted for use with arterial street projects.

A new model has recently been developed by Cambridge Systematics, Inc. (CSI) for FHWA. The study provides a summary of techniques available for predicting HOV lane demand and presents a proposed method for estimation of HOV lane demand. Both the CRA and CSI methods do not require extensive data inputs, and can be used to produce relatively quick demand estimates.

D. Operational Analysis Tools

Alternatives that emerge as viable alternatives from the sketch planning level may be examined in more detail. Although operational viability may be included as a sketch planning criteria, the operational impacts of the various alternatives may be evaluated as a second step or a second level of screening. Examples of approaches and techniques that may be used to assess the operational impacts of various arterial street HOV alternatives, especially those with traffic signal treatments, are discussed in this section.

Although there are several sources of motorist delay along arterial corridors, the largest amount of delay is from signalized intersections. As a result, operational analyses of arterial HOV treatments usually focus on the delay experienced along a corridor. The following procedures can be used to estimate base-case delay, delay with signal priority projects, and delay with an HOV treatment to general-purpose vehicles.

Determining Base-Case Delay. The base-case delay is the delay that can be expected in the design year without the benefit of an HOV treatment. Programs that analyze and quantify intersection delay such as ICAP (Intersection Capacity Analysis Package) are useful for such analysis. The analysis technique should provide delay estimates for all movements at the intersection, such as through traffic and all turning movements. Examining delay by each of these movements is critical since an HOV lane treatment may be utilized to address a specific traffic movement through the corridor. For example, when considering a dual left-turn treatment the left-turning delay is critical.

Determining Delay with Signal Priority. Experience with the limited number of signal priority treatments has indicated a reduction in delay experienced by transit vehicles of approximately one-third. As a result, the following equation has been used in some studies, in the absence of detailed analysis, to provide an estimate of delay for vehicles that are eligible for the signal priority (3).

$$Signal\ Priority = (Base\text{-}Case\ Delay)\ x\ 66\%$$

It is important to include only those transit vehicles that would be properly equipped and eligible for signal priority into this analysis since the results will be equated to the appropriate MOEs (e.g., cost effectiveness, person throughput) for the evaluation of alternatives. From these MOEs, the alternatives will be evaluated and ranked.

Determining Delay with HOV Lane Treatments. HOV lanes and signal queue jump treatments provide significant travel time savings to buses and HOVs. The travel time savings in a queue jump lane will be partly dependent upon the amount of queuing in the HOV lane itself. If the HOV lane is restricted to transit use only, the only queuing in the lane will be from buses, and the only delay experienced will be due to the cycle phase. The calculations for delay estimation for the treatments should consider the savings attainable by passing the queues at the signal.

Conversely, HOV lanes with a 2+ designation will have queuing resembling the general-purpose lanes. To aid in visualizing this situation, consider a situation with one HOV lane and 2 general-purpose lanes with a traffic mix of 30% HOVs. This would result in approximately two-thirds of the traffic utilizing the two general-purpose lanes and approximately one-third of the traffic using the HOV lane. Delay estimation of HOVs for a designated lane treatment that provides a queue bypass can be estimated using the following equation (3).

$$D = \frac{R^2}{2C(1-Y)}$$

Where:

D = Delay in seconds per vehicle for the leg to which the treatment will be applied;
R = Base-case red time for the leg to which the treatment will be applied per cycle;
C = Base-case cycle length; and
Y = Arrival rate/saturation flow rate.

Calculation of Y:
Saturation flow rate can be estimated at 1,750 vehicles per lane. Arrival rate is defined as the number of vehicles in a given lane that approach the intersection during a peak hour.

For the HOV lanes, the arrival rates are typically equal to the number of HOVs in the traffic stream. However, HOV lanes may be shared with general-purpose vehicles turning at signalized intersections. With this configuration, the arrival rate is equal to the sum of both the HOVs and the right-turning vehicles minus the vehicles that take advantage of the right-turn-on-red, if applicable since they do not experience any delay. It is possible that the right-turn-on-red may not be taken advantage of if there is an HOV in front of a right turning general-purpose vehicle. The lighter the HOV volume, the higher the likeliness that the right-turn-on-red can be utilized. Since center and left-side HOV lanes turning movements are controlled by the signal operation, it is not necessary to consider these concerns for lane designations of this type.

The following equation can be used to estimate the arrival rate considering the right-turn-on-red influence with a lane that is shared between HOVs and right-turning traffic.

If the HOV lane volume is less than or equal to 50 vehicles per hour, reduce the right turn volume by 25%, yielding:

Arrival rate = (# of HOVs) + [(# of right turning vehicles)(0.75)]

If the HOV lane volume is greater than 50 vehicles per hour, assume that no right-turn-on-red movements will be made, yielding:

Arrival rate = (# of HOVs) + (# of right turning vehicles)

Combined Treatments. Combining both treatments (i.e., implementing a signal priority treatment with a designated lane treatment) may be warranted in a corridor to provide a greater travel time savings. If combined treatments are being considered, the analysis can add the combined delay savings for vehicles that are eligible for both treatments. For example, if the combination of transit-only signal priority treatment and a lane designation of HOV 2+ is being considered, transit vehicles in the corridor would gain an additive travel time savings of both the HOV lane and the signal priority, while other HOVs, carpools, and vanpools would benefit only from the HOV lane.

Delay Impacts of an HOV Treatment to General-Purpose Vehicles. Although total intersection delay is not necessary for the calculation of HOV delay, it should be investigated to ensure that the HOV treatment does not increase the delay to general-purpose vehicles. The impacts on general-purpose traffic should then be compared among alternatives. If a project adds an HOV lane to an existing roadway, all vehicles will realize a travel time savings along the corridor. HOVs shift from the general-purpose lanes to the HOV lane, thus freeing up space for general-purpose vehicles. Some treatments, however, include the restriping and designation of HOV lanes or signal queue jump lanes. When this is done, general-purpose vehicles will be impacted because the capacity allotted for these vehicles is reduced.

E. Cost Effectiveness

Examining the cost effectiveness of arterial street HOV treatments may be part of the planning process. Cost effectiveness is usually determined by comparing the capital costs associated with an arterial HOV project with the anticipated benefits. The benefits may include quantifying the travel time savings of buses and HOVs and operational savings realized by public transit operators. The time savings to HOVs may be based upon a generalized or local cost per hour of delay.

Quantifying these benefits may not be an easy process. The value of a traveler's time will depend on the type of trip and the local economic environment. A standard $10.00 an hour rate is often used in calculating the value of time spent in congestion. Estimating potential benefits to transit operations may be easier, as the savings in travel time and potential to reduce vehicle needs can be estimated.

V. SPECIAL PLANNING CONSIDERATIONS

The planning approaches described previously are appropriate for use with all types of HOV facilities. Some projects may require special considerations during the planning process, however. These include converting an existing general-purpose lane to an HOV lane and priority pricing on an HOV facility. Additional factors that may need to be examined if these alternatives are included in the planning process are discussed in this section. The Major Investment Study (MIS) process is also highlighted.

A. Planning for Converting a Freeway General-Purpose Lane to an HOV Lane

The general planning process outlined in Section II should be used if converting a general-purpose lane to an HOV lane is among the alternatives being considered. A number of additional factors should be examined during the planning phase, however. These factors, which include policy guidance, public perception, political support, impact on adjacent lanes and roadways, system connectivity, and environmental impacts are briefly highlighted in this section. Although these elements should be part of any HOV planning process, extra emphasis may be appropriate if a lane conversion alternative is being considered.

Policy Guidance. If converting a general-purpose lane to an HOV lane is anticipated to be included as an alternative, one of the first steps in the planning process should be a review of relevant policies or objectives related to lane conversion. Goals, policies, objectives, and measures of effectiveness that have been established should be identified and used to help guide the planning process. For example, the Washington State Department of Transportation's (WSDOT) *Freeway HOV System Policy* states that "when new capacity options are proposed, one of the alternatives to be considered shall be the conversion of a general-purpose lane to an HOV lane" (19). This policy addresses situations where new capacity is being added as the WSDOT *Design Manual* precludes conversion of an existing general-purpose lane to an HOV lane (18). The WSDOT policies do note the need to examine legal, environmental, operational, and public perception issues prior to making any decision on a lane conversion project.

Public Perception. The experience with the Santa Monica Diamond Lanes, the Dulles Toll Road HOV lanes, and other projects illustrate the importance public support or lack of support plays in the success or failure of a lane conversion project. Although these projects can be described as successful from a technical standpoint, they were not successful from the public's perspective. If converting an existing lane is being considered, the planning process should include research or studies to help gauge public attitudes toward this approach. As discussed in Chapter 12, techniques that can be used to obtain this input include focus groups, surveys, interviews, public meetings, workshops, and transportation fairs.

Recent studies in Seattle and California have attempted to measure public reaction to converting a general-purpose lane to an HOV lane. Focus groups and surveys were used in both cases to obtain input from the public on lane conversion issues. The results from the California study indicate that although lane conversion was not rated as highly as adding a new HOV lane or converting a shoulder lane, there was some support for lane conversion in specific cases. The Seattle study also indicated that lane conversion is less preferred than other approaches. Factors identified that increase the public's willingness to consider a conversion project included connecting existing HOV facilities, significant environmental benefits, no major negative impacts on existing freeway traffic or parallel arterials, and major financial savings.

Political Support. Experience indicates that political support is also critical to the success of a lane conversion project. Policy makers react to public concerns, and if the public does not support a project, it is less likely that politicians will. Thus, along with gaining insight into the perception of the public toward a lane conversion project, the planning process should also examine the attitudes of policy makers, key administrative staff, and other influential stakeholders. As discussed more extensively in Chapter 12, focus groups, surveys, interviews, and meetings can all be used during this process.

Impact on General Traffic and Parallel Roadways. The planning process should analyze the impact of a lane conversion project on traffic flow and congestion levels in the remaining general-purpose lanes, as well as on adjacent roadways. Although these issues would normally be included in the planning process, special attention should be given to them if lane conversion is one of the alternatives being considered. Additional analysis or extra rigor in the evaluation process may be appropriate when lane conversion is being considered.

System Connectivity. As noted previously, lane conversion projects may have greater public and political support if they are completing missing links in an existing HOV network or if they provide a vital connection that cannot be accommodated any other way. As a result, the examination of system connectivity should be included in the planning process.

Environmental Impacts. Some of the recent interest in lane conversion projects is coming from environmental groups in different parts of the country. These organizations argue that converting existing lanes to HOV lanes is the only way to change commuter's behavior and to realize significant environmental benefits. Although assessing the environmental impacts of HOV facilities should be included in any planning process, additional analyses may be appropriate if a lane conversion alternative is being considered. Methods for examining environmental impacts during the planning phase are discussed in the next section of this chapter.

B. Planning for Converting an Arterial Street General-Purpose Lane to an HOV Lane

Converting a general-purpose lane on an arterial street to an HOV lane has occurred more frequently than freeway lane conversion projects. Existing traffic or curb lanes have been converted to bus-only lanes or HOV lanes for all or a portion of the day in a number of cities. For example, the curb lane on selected downtown streets are reserved for use by buses-only during the peak periods in many areas. Examples also exist of longer distance arterial street HOV lanes that have been created by converting a general-purpose or curb lane. For example in Alexandria, Virginia, a northbound one-way street that serves Washington D.C. and National Airport provides curbside lanes that are restricted to 2+ HOVs.

The same issues identified with converting freeway general-purpose lanes should be examined with arterial street projects. These include policy guidance, public perception, political support, impact on adjacent lanes and roadways, system connectivity, and environmental impacts. Further, more detailed consideration should be given in the planning process to the impacts on bus operations, adjacent land uses, and on-street functions such as parking and service delivery with arterial street conversion projects. These elements are briefly highlighted below.

Bus Operations. Public transportation operators and passengers often realize the most significant benefits from converting a curb or general-purpose lane on an arterial street. As a result, the planning process should include an assessment of the potential operational advantages, cost savings, and passenger benefits that may result from the project.

Impact on Adjacent Land Uses. The planning process should examine the impacts of the lane conversion on adjacent land uses and developments. For example, access to driveways, parking facilities, and alleys may all be affected. Consideration of these and other issues should be included in the planning phase.

On-Street Functions. Possible impacts affecting on-street functions should also be examined in the planning process. On-street parking and space for delivery vehicles are the two most common factors that should be included in this analysis. Other issues may emerge during the planning process, however. Involving representatives from businesses and land uses along the roadway early and throughout the planning process can help ensure that all issues related to on-street functions and adjacent developments are identified and addressed.

C. Planning for Priority Pricing on HOV Lanes

Congestion pricing involves charging motorists for the use of freeways and roadways during periods of heavy use. The technique is based on the economic concept of charging users, in this case motorists, the "price" that represents the cost they create by using a roadway. For example, the addition of a vehicle to a congested freeway creates further delay to vehicles already using the facility. The intent of this approach is to price the use of a roadway facility so that a sufficient capacity is provided for those willing to pay.

A related approach that is being considered and implemented in some areas is priority pricing on HOV lanes or high-occupancy toll (HOT) lanes. This concept focuses on the use of congestion or priority pricing on an HOV facility. Examples of this technique might include charging 2+ carpools to use the lane, but allowing 3+ carpools travel for free or charging single occupant vehicles a fee, but allowing 2+ carpools to travel for free. The use of advanced technologies, including automatic vehicle identification (AVI) and electronic toll collection, provides the opportunity to use variable pricing techniques based on the level of traffic congestion.

The ISTEA contained a congestion pricing demonstration program, which has been continued in TEA-21. As a result of this program and other initiatives, congestion and priority pricing projects are being considered and implemented in a few areas. Currently, priority pricing techniques are being used on the Route 91 Express Lanes in Southern California, the I-15 HOV lanes in San Diego, and the I-10 West (Katy) HOV lane in Houston. The major elements of these projects are briefly highlighted next. A more detailed discussion of each project is provided in Chapter 5.

Route 91 Express Lanes, Southern California. The Route 91 Express Lanes represent the first application of the HOT lane concept in the U.S. The Route 91 Express Lanes were one of four innovative toll financing projects approved by the California Legislature in 1990. The facility, which was opened in December 1995, includes two lanes in each direction in the center of SR 91 in Orange County. The toll facility is fully automated using AVI technology. A variable pricing system is used based on a pre-published pricing schedule, with tolls varying by time of day. As required by the enabling legislation, 3+ carpools can use the lanes for free, although they must have an AVI tag.

I-15 HOV Lanes, San Diego. A priority pricing demonstration project is in operation on the I-15 HOV lane in San Diego. This project is being led by the San Diego Council of Governments (SANDAG), in coordination with Caltrans, the Metropolitan Transit Development Board (MTDB), and the California Highway Patrol. The demonstration is allowing single-occupant vehicles to use the I-15 HOV lanes for a fee, while 2+ carpools continue to use it for free. A $50 monthly charge was used with the first 500 participants. This fee was raised to $70 and 1,000 monthly passes were made available. A variable fee schedule using toll tags was implemented in March of 1998.

Katy (I-10 West) HOV Lane, Houston. The *QuickRide* demonstration was implemented in January 1998. The project, sponsored by TxDOT and Houston METRO, allows 2+ carpools to use the HOV lane for a fee during the morning and afternoon peak hours when a 3+ occupancy requirement is in effect. Carpools with three or more people continue to use the lane for free. As of June 1998 there were approximately 400 active participants in the demonstration, and daily use averaged between 125 to 150.

Based on the limited experience with these projects, it appears that a number of additional factors should be included in the planning process if priority pricing strategies are being considered. These factors, which are briefly described next, include examining the target markets, pricing alternatives, impact on HOVs, use of revenues, public perception, and operational approaches.

Target Markets. The potential market or markets being considered for the priority pricing project should be examined during the planning process. Possible target markets include drivers of lower-occupant vehicles and single-occupant vehicles. For example, the I-15 project is allowing single-occupant vehicles to use the HOV lane for a fee, while the possible demonstration on the Katy HOV lane would allow 2+ carpools to pay for use of the lane during the period currently restricted to 3+ carpools. The Route 91 Express lanes use a different approach. As a toll facility, all vehicles except those with three or more people pay a fee. The planning process will need to consider the potential target markets and the alternative approaches that may be appropriate for consideration in an area, corridor, or facility.

Pricing Alternatives. Examining the amount the target market may be willing to pay to use an HOV lane should be considered during the planning process. A number of factors may be included in this assessment. One of the major elements that will need to be examined is the estimated demand at various pricing levels. An economic analysis should be conducted to assess the potential use of the facility at different prices. The market price to be considered for a facility would incorporate consideration of the traditional cost to demand relationship. In basic economic terms, it is the price that is defined by the elastic nature of the supply, demand, and cost relationship in the market for the particular service. Other factors, such as the bus fares in the corridor, may also need to be considered.

Impact On Current HOV Users. The planning process will need to consider the impact on existing HOV lane users from a priority pricing strategy. Ideally, there should be no impact on current HOV users in the facility. A number of negative impacts might result from priority pricing, however, and these should be considered during the planning process. For example, increased congestion in the HOV lane might occur as a result of lower or single-occupant vehicles using the facility. This situation could result in slower travel speeds, reduced travel time savings, and lower levels of travel time reliability. Current HOV volumes may decline if existing bus riders, carpoolers, and vanpoolers decide to change to driving alone for a fee. On the other hand, if revenues generated from the project are used to enhance bus service in the corridor, to reduce bus fares, or to make other improvements benefitting HOVs, bus ridership, and carpool and vanpool use may increase. These potential impacts should be examined during the planning process.

Use of Revenues. How the revenues generated by the priority pricing project will be used should also be considered in the planning process. The focus groups conducted during the planning process for the Katy demonstration, as well as findings from other congestion pricing studies around the country, indicate that public reaction to a possible project is influenced by how the revenues are used. Public support appears to be higher if the revenues are used for transit and transportation improvement, than if they are used for other purposes. The revenues for the I-15 project are funding additional transit services in the corridor. The proposal for the demonstration on the Katy HOV lane would also use the projected revenues for transit or other transportation improvements in the corridor.

Public Perception. The reaction of the public toward a priority pricing project should be considered in the planning process. Motorists and current HOV users may have a negative reaction to the concept of congestion pricing, since freeways and roadways have already been paid for through tax dollars. In addition, inequity issues or concerns that only the rich will be able to afford to use the lanes have been voiced in many areas. As a result, research on public perception in the planning process should be strongly considered for priority pricing projects. Focus groups, surveys, and other approaches can be used to obtain a better understanding of public opinion towards priority pricing. The use of these techniques is described in Chapter 12.

Operational Approaches. A number of operational strategies can be used with priority pricing projects. The two general types of approaches are a manual or static technique or the use of automated vehicle identification or toll tags. There are several elements that should be considered in comparing manual and automated technique during the planning process. The first is the payment method. In most cases, a motorist will pay a specific amount for a manual tag regardless of how often the facility is used. The automated method allows an individual to pay just for the times they actually use the facility. Manual approaches can be implemented for lower costs, however, but may be more difficult to enforce. The advantages and disadvantages of each technique should be considered in the planning process as the type of approach used will influence the demand for the facility and the operating characteristics.

D. Planning for Commercial Vehicle Use of HOV Facilities

Currently, commercial vehicles—such as heavy trucks—are not allowed to use any operating HOV facilities in North America. Recently, however, there has been interest in some areas in considering truck use of HOV lanes. A variety of different use scenarios have been suggested. These include allowing trucks onto HOV facilities during normal operating hours and providing trucks with exclusive use during off-peak periods.

A number of elements should be included in the planning process if truck use of a new HOV facility is being considered. These include projected HOV demand levels, truck origins and destinations, projected truck demand levels, design limitations, operating and safety issues, and other factors. These same elements, which are briefly discussed in this section, may also be examined if truck use of an existing HOV facility is being considered.

Projected HOV Volumes. The forecasted HOV volumes should be the first element examined in considering the potential use of HOV facilities by trucks. The predicted HOV volumes provide a good indication of available capacity that may be considered for other user groups, including trucks. Facilities with high levels of forecasted HOVs, or existing facilities with high HOV volumes, indicate that trucks use may not be feasible without degrading the travel time savings and travel time reliability for HOVs.

Truck Origins and Destinations. The origins and destinations of trucks in the corridor should be examined. The travel patterns of trucks provide an indication of the potential use of an HOV facility by commercial vehicles, as well as the possible benefits that may be realized. Truck origins and destinations can be matched with HOV lane access points to better determine potential use. This analysis is especially important with limited access HOV facilities. For example, barrier-separated HOV lanes with direct access through park-and-ride lots may be less desirable to commercial vehicles than concurrent flow lanes with unlimited access.

Design Concerns. The planning process should assess any special design issues associated with allowing commercial vehicles to use an HOV facility. These may include examining turning radii, lane widths, clearance under structures, and pavement conditions.

Operating and Safety Issues. Potential operating and safety issues associated with truck use of an HOV facility should also be considered in the planning process. Factors that may be included in this analysis are additional personnel needs and other associated costs, the need for additional or specialized maintenance vehicles, safety concerns with mixing HOVs and commercial vehicles, and other potential concerns.

Other Factors. There may be other issues unique to a specific area or corridor that should be examined during the planning process. For example, the location of a plant, port, airport, or other facility generating high volumes of trucks may warrant special consideration during the planning process.

E. Major Investment Studies

In response to requirements in the ISTEA, FHWA and FTA issued additional regulations in 1993 concerning the metropolitan transportation planning process. These regulations strengthened the comprehensive, continuing, and cooperative (3 'C') planning process and implemented many of the policies contained in the ISTEA. One portion of the regulations incorporated Major Investment Studies (MIS) into the metropolitan transportation planning process.

MISs are to be undertaken in corridors or subareas being considered for major transportation improvements. The intent of an MIS is to identify and evaluate appropriate improvements, including HOV facilities, and to select the preferred alternative or alternatives. The MPO, state department of transportation, or transit agency may be responsible for conducting an MIS. The lead agency must involve all of the affected agencies, however, and the MIS must include a public participation process. The recommendations from an MIS are incorporated into the Metropolitan Transportation Plan and Transportation Improvement Program developed by the MPO.

An MIS must be conducted when a major transportation investment is being considered. The regulations define a major investment as a highway or transit improvement of substantial cost that is expected to have a significant effect on capacity, traffic flow, level of service, or mode share. Examples of major investments include adding lanes to a freeway, adding an HOV facility, developing or expanding a fixed guideway transit system, or other significant improvements.

The general elements of the MIS process are highlighted in Figure 4-14. As illustrated, an MIS should be coordinated with the National Environmental Policy Act (NEPA) and the Environmental Impact Statement (EIS) process. The major elements of an MIS include defining the problems in the corridor or area, developing realistic alternatives for consideration, and evaluating these alternatives. Public involvement should be included throughout all of these steps.

A full range of multimodal alternatives should be considered in an MIS. These alternatives should cover a range of approaches, costs, and benefits. The following examples provide a general indication of the types of alternatives that may be appropriate for inclusion in an MIS.

- No build or a no build plus TDM/TSM alternatives
- Highway-based alternatives
- HOV alternatives
- Transit fixed guideway alternatives

The major part of an MIS focuses on evaluating the identified alternatives. A variety of evaluation measures may be used to analyze and compare the alternatives. Possible criteria usually focus on the following general categories, with the specific measures of effectiveness determined as part of the local planning process.

- Transportation system performance
- Mobility and/or accessibility
- Environmental and energy impacts
- Cost and financial viability
- Land use and development impacts
- Equity and socioeconomic impacts

A number of MISs have been or are currently being conducted throughout the country. One or more HOV alternatives are usually included in these studies. A few examples of current studies are highlighted next in order to provide a general indication of the agencies and alternatives typically associated with an MIS.

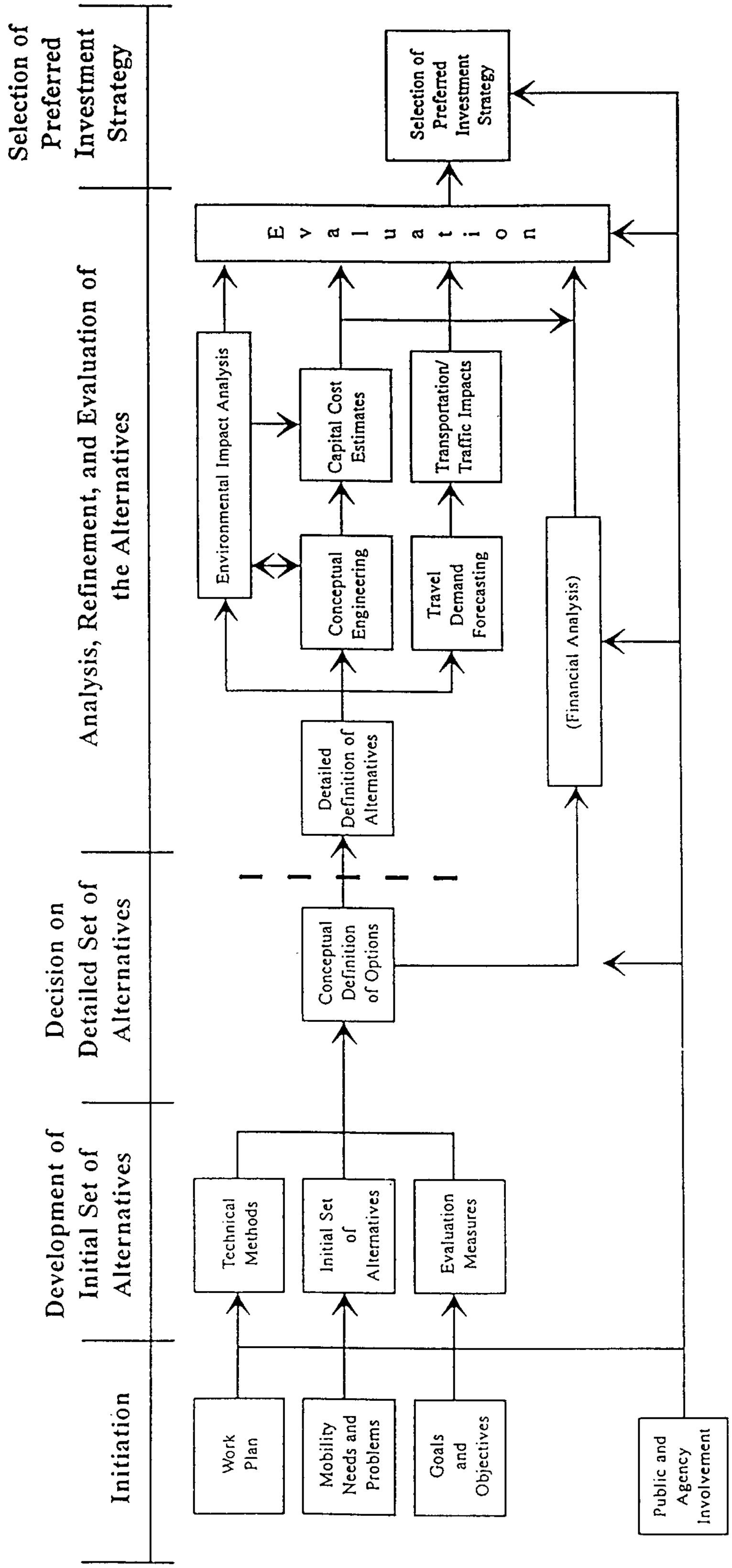

Figure 4-14. Technical Work Flow of MIS Process

U.S. 301 South Corridor, Maryland. An MIS is currently underway on a 50-mile segment of U.S. 301 from Bowie, Maryland to the Virginia state line. The Maryland Department of Transportation is the lead agency on the MIS. A number of alternatives are being examined, including upgrading to a six-lane limited access highway, adding LRT, adding commuter rail, adding HOV lanes, and other TDM and TSM strategies.

East-West Multimodal Corridor, Miami. SR 836 serves as the main east-west corridor in Miami, linking the airport to the downtown and Miami Beach areas. An MIS is currently being conducted on the corridor. The Florida Department of Transportation (FDOT) is the lead agency on the MIS. Representatives from other agencies and local jurisdictions are actively involved in the study through a series of technical and policy committees. Alternatives under consideration include TSM and expanded bus service, adding a general-purpose lane and an HOV lane, adding LRT, adding heavy rail, and a combination of HOV lanes and rail.

I-435, Kansas City. The Missouri Highway and Transportation Department (MHTD) is conducting an MIS on the I-435 corridor in the Kansas City area. The study is being coordinated with the MPO, the transit agency, local governments, and federal agencies. Alternatives being considered include no-build, freeway improvements with ITS, freeway improvements with ITS and expanded transit services, freeway and HOV facility improvements with ITS and expanded transit services, and adding an HOV facility with ITS and expanded transit services.

Southeast Corridor, East Corridor, and West Corridor, MIS, Denver. Three MISs are underway in the Denver area. The studies are being conducted in the Southeast (I-25 and I-225) corridor, the East (I-70) corridor, and the West (6th Avenue) corridor. The MISs are being jointly sponsored by the Colorado Department of Transportation (CDOT), the Regional Transit District (RTD), and the Denver Regional Council of Government (DRCOG). Each agency has the lead responsibility on one study, and a multi-agency advisory committee is overseeing and coordinating all three studies. HOV facilities are included as options in each corridor. Examples of the screening criteria being used in the Southeast corridor MIS include mobility and accessibility, affordability and cost-effectiveness, community and neighborhood impacts, business and economic development impacts, air quality and environmental issues, and equity.

VI. ASSESSING THE POTENTIAL ENVIRONMENTAL IMPACTS OF HOV FACILITIES

Assessing the environmental impacts of alternative transportation improvements, including HOV facilities, is an important part of the planning process. As noted previously, the examination of air quality and environmental factors is required by federal legislation and federal agency regulations. Environmental issues must be included in Major Investment Studies and other planning processes on projects using federal funds. Further, many states and local jurisdictions have requirements relating to environmental considerations during the planning process for projects funded by these levels.

In addition to these requirements, there has been a good deal of interest recently in the air quality and environmental impacts of HOV facilities. Environmental groups in some areas have suggested that HOV facilities may have negative impacts on air quality and other environmental factors. These organizations argue that HOV lanes add more vehicles to a facility and thus are not environmentally friendly. Some groups further suggest that converting a general-purpose lane to an HOV lane is the only alternative with positive environmental impacts.

A comprehensive assessment of the air quality and environmental impacts of HOV facilities has not been conducted. As a result, it is not possible to answer many of the questions relating to the environmental effects of various types of HOV facilities. In addition, existing techniques for modeling air quality and environmental elements may not provide the accuracy or the level of detail needed to fully assess the impacts of HOV facilities and other transportation alternatives. Available information on the environmental effects of HOV facilities and current analysis techniques are reviewed in this section.

A. Air Quality, Vehicle Emissions, and Energy Consumption

Studies of existing HOV lanes have identified positive impacts on air quality, vehicle emissions, and energy consumption. The results of studies on HOV facilities in Northern Virginia/Washington, D.C., Los Angeles, and Houston are highlighted below.

Shirley Highway HOV Lanes, Northern Virginia/Washington, D.C. The initial evaluation of the Shirley Highway Express-Bus-on-Freeway demonstration reported reductions in automobile use, automobile pollutant emission, and gasoline consumption as a result of the HOV lane. A reduction of 2,000 automobiles in the morning peak-period were documented in 1971 as a result of the HOV lanes and the new express bus service. This reduction grew to 7,000 automobiles by 1974, and the introduction of carpools further reduced single-occupant vehicles by some 350 automobiles. Reduction in daily vehicle emissions were estimated based on the reduction of vehicle kilometers of travel at 32,000 pounds of carbon monoxide, 3,800 pounds of hydrocarbons, and 2,000 pounds of nitrogen oxides. Further, total savings in gasoline for the period from July 1971 to December 1974 were estimated at 6.9 million gallons (20).

San Bernardino Transitway, Los Angeles. Studies of the initial impact of the San Bernardino Transitway estimated use of the facility had reduced carbon monoxide emissions by 5 percent and hydrocarbon emissions by 15 percent. These estimates were based on a simple calculation of the estimated number of vehicles removed from the freeway due to the HOV lane. The study also estimated fuel savings of 5,400 to 6,500 gallons of gasoline per day.

HOV Lanes, Houston. Assessments of the Houston HOV lanes have estimated energy and air quality benefits when compared to the alternatives of making no change or adding a general-purpose lane. Computer simulations estimated that adding an HOV lane rather than adding a general-purpose lane or making no improvement resulted in the lowest levels of vehicle emissions and gasoline consumption (22).

As noted previously, groups in some areas have questioned the potential environmental benefits of HOV facilities. Representatives from these groups suggest that implementing an HOV facility does not always result in reducing vehicle volumes in the general purpose lanes, and may result in more total vehicles using the facility. Further, some groups question the use of park-and-ride lots since approximately half the emissions from a vehicle are produced during the "hot" start or warm up period and the cool-down phase.

Several modeling techniques are available for estimating vehicle emissions and fuel consumption for different types of transportation improvements, although cautions are given on the accuracy for most of these techniques. Available models and analytical techniques for estimating the air quality, emissions, and energy consumption associated with various transportation improvements are summarized next.

COMSIS Corporation TDM Model. This model was developed for analyzing TDM alternatives, including HOV facilities, by COMSIS Corporation. The model examines the impact on home-based work trips of different TDM strategies. The model estimates changes in vehicle trips, VMT, and modal split for the selected TDM measures. The COMSIS TDM model is based on a disaggregate logit mode choice or pivot point model (23).

A series of default coefficients are used in the model to calculate modal split, based on the values for approximately 20 metropolitan areas of varying location, character, and size. These default coefficients can be used in the absence of local data or local information can be substituted and the default values can be modified. The COMSIS TDM model can be used for regional, sub-regional, or site specific analyses. Trip tables by purpose and mode, and highway distance matrices are required as input to use this model. The model is structured to directly read the trip tables produced by the regional travel demand models used in most metropolitan areas. Although this model does not directly estimate vehicle emissions for the various alternatives, the model can be used to estimate emissions using other software.

San Diego Association of Governments Model. Another model for estimating the impacts of TDM strategies, including HOV facilities, was developed by Sierra Research, Inc. and JHK & Associates for the San Diego Association of Governments (SANDAG). The SANDAG method estimates the travel, emissions, and cost effectiveness of various TDM alternatives. The SANDAG model includes a transportation module, an emissions module, and a cost-effectiveness module. The transportation and cost-effectiveness modules are spreadsheet based. The emissions module is a FORTRAN program that combines the travel impacts of the transportation module with the emissions factor data from the EMFAC7E and BURDEN7C computer models to develop an estimate of the emission benefits for each TDM strategy. The travel impacts module estimates the changes in trips, VMT, and vehicle speeds that can be expected from a particular TDM technique. Inputs to the model include baseline travel characteristics and TDM-specific parameters (23).

The SANDAG model uses several elasticities based on empirical data from experiences in California, and thus relies heavily on default values. However, these values may be modified by the user to reflect local conditions. The model is only applicable on an areawide basis and cannot currently be used at the subarea level. The emission rates, which are based on emission factor models used only in California, cannot be changed by the user to reflect more applicable local rates.

Systems Applications Internal (SAI) Model. The SAI model was developed for the Environmental Protection Agency (EPA) for use by transportation professionals throughout the country. The SAI model is partially based on the concepts of the SANDAG model, but focuses only on the travel and emission impacts of alternative TDM strategies (23).

The SAI method provides a step-by-step procedure to estimate the impacts of selected TDM measures on trips, VMT, and vehicle speed. The input requirements are similar to the SANDAG model, but the SAI method does not require that these input variables be programmed or entered into any supporting software. The SAI model is applicable to all regions of the country, and any emission rates can be used in this method. A process of estimating the combined impacts of several TCMs, which are not necessarily additive, is also provided in this methodology. The SAI model does require that TDM participation rates be provided as input. This method, like the SANDAG method, is also only applicable on an areawide basis.

FREQ, NETSIM, and FRESIM. Macroscopic models such as FREQ11, and microscopic models, such as NETSIM or FRESIM can also be used for estimating air quality, emission, and energy consumption impacts of HOV facilities. These models allow analyses of fuel consumption and emission rates based on geometric conditions and travel volumes associated with different transportation alternatives, including HOV lanes.

These models require the user to enter the expected traffic volumes and other input values for the different alternatives being considered. The potential emissions, pollutants, and energy consumption levels are then estimated. These models do not predict latent demand that may occur on the mainlanes as vehicles enter the HOV lane since these traffic volumes are estimated and entered by the user. In addition, the models determine air quality estimates based on average speed. Since emissions and fuel consumption vary during different driving phases, the model output should be considered a general indication of the potential impacts. Thus, these models may not account for the difference in average speeds on the general-purpose lanes and an HOV lane. The FREQ model has been used in a number of areas to assess the benefits of HOV lane alternatives over general-purpose lanes with respect to air quality.

Texas Transportation Institute Model. The Texas Transportation Institute (TTI) developed a TDM Analyst that combines elements of both the SANDAG and SAI models. This program uses a spreadsheet form for the evaluation of selected TDM strategies. These include telecommuting, flextime, compressed work week, ridesharing, transit fare changes, transit changes, parking management, HOV lanes, traffic signalization, and intersection improvements.

B. Water Quality

Potential water quality issues with HOV facilities are similar to those associated with general-purpose lanes, parking lots, and other related transportation components. The planning process should include an examination of possible water quality impacts and approaches to mitigate any identified problems.

An assessment of the water quality impacts of the HOV facility and any other alternatives being considered should be included in the planning process. This analysis should examine possible water run-off levels, potential receptors, impacts on receiving waters and wetlands, and other sensitive water quality issues in the area. The pollutants, sources, and impacts can be analyzed for the various alternatives.

The planning process should also consider mitigation techniques for identified water quality problems. Possible approaches may include the use of control measures such as detention or retention ponds, vegetation, biofiltration, and other strategies. These techniques can then be incorporated into the facility design plans. In addition, use of Best Management Practices (BMPs) should be considered during the construction and operation phases.

Specific issues relating to water quality should be coordinated with the requirements and regulations of the EPA's Office of Water Resources, the U.S. Corps of Engineers, state departments of transportation, state environmental agencies, and local jurisdictions. Sources of additional information on water quality planning and issues are provided in Section X.

C. Other Potential Social and Environmental Impacts

Other possible environmental and social impacts should be examined during the planning process. These may include issues associated with noise, environmental justice, and land use. Elements related to the concerns that may need to be examined during the planning process are highlighted next.

Noise. Noise impacts may be a concern with HOV facilities located on separate rights-of-way or arterial streets, as well as with park-and-ride lots. Noise is less likely to be a major issue if an HOV lane is being added to an existing freeway. The potential noise impacts on adjacent neighborhoods and land uses should be examined during the planning process. Noise modeling and monitoring techniques can be used to estimate the possible impact from an HOV facility, and appropriate mitigation treatments can be identified. The use of noise walls, fences and landscaping with berms and trees can all be used to help address noise issues.

Environmental Justice. The term environmental justice is frequently used to refer to the potential for a transportation project or the development of other major facilities to negatively impact low income and minority groups. The planning process for any transportation improvement, including an HOV facility, should consider the impact on special groups. For example, the effect of a transportation project on low income or minority housing units, businesses, and neighborhoods should be examined during the planning process. Any potential adverse effects should be identified, along with strategies to mitigate these concerns.

Land Use. The planning process should assess the impacts of the various alternatives on land use and development in the area. Elements to be considered in this assessment may include existing buildings that may need to be demolished or relocated, compatibility with existing development and planned land uses, and potential joint development projects.

D. HOV Facilities as Transportation Control Measures

The Clean Air Act Amendments of 1990, the ISTEA and TEA-21, and subsequent regulations issued by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Transportation require the use of transportation control measures (TCMs) in areas not meeting EPA air quality standards. Regions which must consider TCMs include severe and extreme ozone non-attainment areas, and serious, severe, and extreme carbon monoxide non-attainment areas.

The specific requirements of the Clean Air Act Amendments, the ISTEA, and federal regulations vary by the type of pollutant and the non-attainment area classification. The actions and requirements are more numerous and more stringent as the air quality problems worsen. Deadlines for meeting the requirements also vary by non-attainment area classification. In general, future transportation plans and specific transportation projects cannot create new air quality violations or delay attainment of the standards. Non-attainment areas must consider and implement TCMs that will help them meet the requirements.

Table 4-10 highlights the TCMs identified in the various Acts and regulations. The TCMs include both supply and demand strategies to reduce vehicle trips, vehicle use, vehicle kilometers of travel, vehicle idling, and traffic congestion. All of these techniques focus on reducing motor vehicle emission levels.

HOV facilities, ridesharing, transit services, and TDM programs are all considered TCMs. As a result, these strategies are being given additional consideration in many air quality non-attainment areas. The use of TCMs must be considered and evaluated in the MPO and statewide planning process. The measures selected to help areas meet the attainment standards must be incorporated into the required planning documents including the MPO Transportation Improvement Program (TIP) and the State Implementation Plan (SIP).

Table 4-10. Transportation Control Measures

- Improved public transit services.
- HOV lanes and HOV facilities.
- Employer-based transportation management plans.
- Trip-reduction ordinances.
- Traffic flow improvements.
- Fringe and corridor parking facilities serving ridesharing and transit, and parking management programs.
- Programs limiting or restricting vehicle use in major activity centers.
- All forms of ridesharing and areawide ridesharing incentives.
- Programs limiting the use of roads to pedestrians and non-motorized vehicles.
- Paths, tracks, or areas for pedestrian and non-motorized vehicles.
- Bicycle lanes, storage facilities, and bicycle programs.
- Programs to control extended idling of vehicles and accelerating the retirement of older vehicles.
- Programs and ordinances to facilitate non-automobile travel.

VII. PLANNING PUBLIC INVOLVEMENT

Public involvement is an important part of the planning process on an HOV project or any transportation improvement. The participation of the neighborhood groups, businesses, elected officials, and other interested individuals can help ensure that all potential issues are identified, that all groups have an opportunity to voice their opinion on alternatives, and that all interested parties have access to the planning process. Further, public participation is required by federal legislation, as well as by many state and local regulations. Federal legislation calls for proactive public participation early and throughout the transportation planning process.

Chapter 12 provides a detailed discussion of public involvement and marketing programs with HOV facilities. Key elements relating to public participation during the planning process include background research, public meetings, and communication techniques. Approaches that can be used in these areas during the planning phase of a project are highlighted in this section. More detailed information on developing and implementing a comprehensive public participation and marketing program is provided in Chapter 12.

A. Background Research

It may be appropriate as part of the public involvement process to start by probing for the opinions, attitudes, and reactions of individuals and groups in the corridor or area where the HOV facility is being considered. This information can be evaluated and used as input into the planning process. The following approaches may be used in the public involvement process to assist with preliminary research.

Literature Searches. Information can be obtained through literature searches on the background of a project, public reaction to previous projects in the area, and the national experience with HOV facilities.

Focus Groups. Focus groups can be conducted with commuters in a corridor, area residents, representatives from the business community, government officials, and other groups to obtain information on perceptions related to traffic congestion, alternative transportation improvements, HOV facilities, using HOV modes, and other topics.

Surveys. A variety of surveys can be used to obtain more detailed information from different groups about issues, alternative strategies for addressing these concerns, and HOV facilities.

Executive or Stakeholder Interviews. Interviews can be conducted with key policy makers and other stakeholders to obtain their thoughts, ideas, and concerns about issues in the corridor or area, as well as alternative transportation improvements, including HOV facilities.

B. Public and Stakeholder Meetings

A variety of meetings and forums can be used to provide additional information on the project and to gather and analyze more detailed information on public opinions, attitudes, and reactions relating to the HOV project or to other elements being considered as part of the facility. The following approaches represent some of the public meeting and workshop techniques that can be used to solicit and encourage input throughout the planning process for an HOV facility.

Kick-Off Meetings. Kick-off meetings and briefings can be used to introduce an issue or a project to the public, neighborhood groups, businesses, policy makers, and other key stakeholders. The meetings can be used to initiate an ongoing process, to explain the problems in an area and the process that will be used to address these concerns, and to generate an understanding of the goals, objectives, process, and timing of a project among all groups.

Community, Jurisdictional, Elected Official Briefings. Community, jurisdictional, and elected official briefings give the project team a mechanism for direct interaction with three important and powerful constituency groups. These briefings can fulfill multiple purposes; they build constituencies, create partnerships, foster support, develop accurate expectations, and provide information which enhances future project planning activities.

Public Meetings and Hearings. Public meetings and hearings have been the traditional, and sometimes the only, mechanism used to secure public input on transportation projects. Public meetings provide an excellent opportunity to present information on a project. Formal presentations by project staff are appropriate to describe issues, possible alternatives, preferred approaches, the selection process, and ultimately the recommended alternative. These approaches have a number of limitations, however, which should be taken into account when considering the use of hearings and meetings. One problem is that public meetings are often sparsely attended due to lack of interest or a perception that public participation does not matter. Conversely, an issue may be so controversial that the public meeting disintegrates into heated, unprofitable debate.

Visioning Sessions. Visioning sessions represent one approach that can be used to help in the development of long-range plans. This technique usually involves a series of meetings where participants focus on identifying and defining their vision for the future of a neighborhood, community, transportation corridor, or other area. The desired outcome of these sessions is a collective or shared vision for the future. Information on current and projected characteristics of the area is usually provided to participants prior to the meetings, and alternative future development scenarios may also be prepared and presented. Visioning sessions can be used in the transportation planning process to assist in the development of alternative solutions and the identification of a preferred approach. Visioning sessions can be an effective approach for public and policy maker involvement in the transportation planning process. This technique provides the opportunity for all groups to discuss their ideas and concerns, and helps to develop a shared vision for the future.

Charrettes. Charrettes are a special type of meeting that usually focuses on addressing a specific problem or situation during a pre-specified time period, which might include multiple sessions. Charrettes may include the participation of outside experts, who are called upon to provide their ideas about potential solutions. A common format for a charrette may include defining the problems, analyzing the problems, identifying alternative solutions, analyzing the alternatives, presenting and discussing the advantages and disadvantages of the alternatives, and selecting a preferred approach. Charrettes provide the opportunity for all invited groups to be heard and to participate in the discussion and analysis of issues, and ultimately the recommended solution. Potential disadvantages of charrettes include the time and costs involved in organizing and conducting them. In addition, participation may need to be limited due to cost and space constraints.

Brainstorming Sessions. Brainstorming is a simple technique that allows the public or participants at a meeting to identify and voice their ideas about specific issues and solutions. Brainstorming may be an appropriate technique to use as part of a public or stakeholder meeting to identify issues and problems in a specific corridor, possible solutions, advantages and disadvantages of different improvements, and supporting components. These sessions may also provide information on the types of incentives or disincentives that would influence commuters to change from driving alone to using an HOV mode. Brainstorming sessions provide a good way to identify issues and potential solutions. The use of this technique needs to be managed correctly, however, so that it does not build unrealistic expectations among participants.

Transportation Fairs. Transportation fairs can be used to provide information on a specific project or multiple projects. This approach attempts to generate public interest and involvement by providing information in a more relaxed setting. Maps, displays, videos, models, and interactive methods may all be used to communicate information. Transportation fairs provide a good mechanism for disseminating information, but may be less effective than other techniques for obtaining input and helping to reach a consensus. Transportation fairs may be held at the beginning of a project to introduce the study to the public and to initiate input. They may also be held when the alternatives have been evaluated to obtain public response on the options.

Workshops. Like a transportation fair, workshops provide another technique that can be used with projects that have distinct components or alternatives that should be closely reviewed by a community. Workshops provide the opportunity to discuss the details of a project. The public can provide input about specific features and react to design elements and other features of a project.

Collaborative Task Forces and Community Partnerships. Community partnerships, such as citizen steering committees, advisory committees, commissions, and collaborative task forces all offer the public a role in the planning process. Neighborhood organizations and communities that are represented on these types of groups learn firsthand about the goals and constraints of a project and have the opportunity to provide input into the planning process. As a result, citizens may be more likely to understand the parameters and rationale for decisions. These techniques provide a constructive means for interested parties to become involved in a project. Keys to successful community partnerships are clearly defining the roles and responsibilities of all participants, as well as regular communications about project progress and decisions.

C. Communication Techniques

A variety of methods and techniques can be used to communicate information about an HOV project to the public and other groups during the planning process. Providing clear, accurate, and timely information throughout the planning process and subsequent phases is an important component of public involvement programs. The following communication methods represent some of the available techniques that can be used to explain the issues, project elements, alternatives, and the recommended approach.

Media Relations. Media comprise a very special stakeholder group, not only because of their functional role as the disseminator of information, but because of the inherent power of media to shape attitudes toward a project or issue. Targeted media activities should extend beyond the traditional news releases and press conferences to include editorial board briefings, media tours of the facilities, regular phone calls, and one-on-one meetings.

Newsletters. Newsletters are very efficient and effective communication tools. Newsletters can be used to address issues and questions raised concerning a project and provide timely information about different elements. They can educate readers to an organization's mission and can be a mechanism to publicly recognize and compliment constituency groups. Finally, a newsletter is especially helpful in explaining the details of a project in an orderly and consistent fashion.

Standing Displays. Standing displays can be placed at any number of visible community locations to provide information on a project during the planning process. Displays, which can be updated as the planning process progresses, provide the opportunity to communicate detailed project information with a minimum investment of staff time and resources. Displays can be designed to include comment cards for the public to provide suggestions and input on the project. These provide citizens with the opportunity to make suggestions on the project or to request additional information. Effective displays emphasize visual and graphic information, as well as printed information. They can be rotated through a variety of locations such as shopping centers, fairs, public libraries, civic centers, and government buildings.

Speakers Bureau. Public speaking engagements and participation in public forums are effective and timely methods for disseminating information about an HOV project during the planning process. Presentations can be made at meetings of community and civic clubs, business organizations, city councils, state agencies, and other groups.

Speakers Kits. Speakers Bureaus are often supported by speakers kits. These kits are self-contained units that assist speakers with slides or other visual aids, presentation outlines, and additional information. Speakers kits help ensure that all agency representatives provide a consistent message about the project. A typical speakers kit might include the following items:

- A point paper or speech outline
- Overheads, slides or videos
- Handouts for the audience
- Feedback forms for audience input on key issues
- Address cards, so that members in the audience can be added to the project database or request additional information.

VIII. ADDITIONAL RESEARCH NEEDS

The development of this Chapter identified a number of areas where additional research is needed to advance the state-of-the-practice related to planning HOV facilities. As highlighted next, additional research on estimating the demand for various types of HOV facilities, forecasting the environmental impacts of HOV projects, and developing planning techniques for special conditions, such as priority pricing and converting a general-purpose lane, are especially critical.

Enhanced HOV Demand Estimation Techniques. Although a recent FHWA-sponsored study (2) developed a sketch planning tool for estimating the potential demand for an HOV facility, additional research is still needed in this area. This research should focus on developing enhanced techniques for forecasting both short-range and long-range use of HOV facilities. This research should include assessing the techniques for estimating new HOV users for various types of facilities, as well as the demand at different vehicle-occupancy levels.

Planning and Demand Estimation Techniques for Arterial Street HOV Applications. As discussed in this Chapter most of the available planning and demand forecasting methodologies focus on HOV facilities on freeways and in separate rights-of-way. Few approaches and techniques are available for practitioners interested in planning arterial street projects. Research should be conducted on the methods that are being used to plan bus-only lanes, HOV lanes, and bus and HOV signal priority projects in the arterial street environment. The development of a comprehensive planning guide for these types of facilities, which would update the current chapter in this Manual, should be the desired outcome of the study.

Planning Techniques for Converting a General-Purpose Lane to an HOV Lane. This Chapter presented a general set of factors that should be included in planning the conversion of an existing general-purpose lane to an HOV lane. These elements were identified based on the very limited experience with past projects and recent studies. More research is needed, however, to better define the key issues associated with this approach, the conditions which appear necessary for public and political support, techniques to estimate HOV demand and the impact on general-purpose lane traffic, and other factors that should be considered in the planning process.

Planning Techniques for Priority Pricing Projects with HOV Facilities. This Chapter presented a list of general criteria for use in planning priority pricing projects with HOV facilities. These factors were based on the limited experience to date with HOV priority pricing projects and related studies. More research is needed in this area to better define the key elements that should be considered in planning for these types of projects. This research should include an assessment of demand estimation techniques, including predicting demand at different pricing levels, factors that influence public and political acceptance, and other considerations.

Assessing the Impact of HOV Improvements on Air Quality and the Environment. The research conducted for this Chapter points out the lack of good information on the air quality impacts of HOV facilities. In general, the impacts of HOV lanes on air quality are more complex and less well understood than generally thought. Research is needed to quantify the vehicle occupancy and congestion tradeoffs involved in HOV lane implementation, and model the impacts of HOV lanes on air quality and other environmental considerations. Issues to be examined include how to model HOV networks to estimate air quality, the impact of HOV lanes on traffic operations and air quality, the effects of lane conversions compared to adding an HOV lane, and the impact of HOV facilities on noise, water quality, and other issues.

Planning Techniques to Estimate the Impacts of Changing Vehicle-Occupancy Requirements. As discussed in this Chapter, little documentation exists on the impacts of changing vehicle-occupancy levels on HOV facilities, especially with increasing occupancy requirements. Additional research is needed to assess the impacts of both increasing and decreasing vehicle-occupancy requirements. This study should include an analysis of changes in carpool and bus use, impacts on general-purpose lane traffic, enforcement issues, and other factors. The research should also develop techniques for better estimating changes in HOV demand and other impacts from increasing or decreasing vehicle-occupancy requirements.

Planning Techniques for Developing Regional HOV Systems. Examples of regional HOV system plans, and the procedures used to develop these plans, were highlighted in this Chapter. A variety of approaches and analysis methods are currently being applied to conduct region-wide HOV planning. Additional research is needed to explore these techniques in more detail, to assess the advantages and limitations of the various approaches, and to develop enhanced techniques for planning regional HOV systems and for incorporating HOV facilities into existing regional long-range transportation plans. The research should also examine techniques to ensure greater coordination, cooperation, and communication among the various governmental levels and agencies responsible for planning, operating, and enforcing the various elements of the surface transportation system, including all types of HOV facilities. Guidelines on methods to foster improved coordination should be identified.

Planning Techniques for Enhancing the Interaction of HOV and Rail Facilities in the Same Corridor. Additional research is needed to examine the interaction and coordination among HOV lanes and rail transit systems operating in the same corridor. Differences of opinion currently exist on whether these services can be complimentary and serve different markets, or whether they are in competition and serve the same markets. Research is needed to assess the markets served by these modes, to identify techniques that can be used to enhance coordination among HOV facilities and rail services, and to explore other potential issues that may emerge in planning both types of facilities in the same corridor.

Assessing the Maximum Capacity of an HOV Facility. One of the issues that often emerges during the planning process for an HOV facility is determining the maximum capacity of an HOV lane. This issue is especially important when HOV lanes are considered with or are being compared to other types of improvements, including rail transit alternatives. Further research should explore the capacity of various types of HOV facilities using different vehicle-occupancy and vehicle eligibility requirements.

Assessing the Influence of HOV Facilities on Land Use and Development Patterns. Little information exists on the impact various types of HOV facilities have on land use patterns in an urban area. There have been some suggestions that HOV lanes may contribute to urban sprawl, by allowing people to live longer distances from their place of work while maintaining similar travel times by carpooling, vanpooling, or taking the bus. Additional research is needed to better understand the complex dynamics influencing land use and development patterns, and the possible influence HOV facilities may have on these trends.

Planning Techniques for Special Use Lanes. As discussed in this Chapter, little information is available on allowing trucks or other special user groups to access HOV lanes. Additional research is needed to explore the potential issues and opportunities associated with opening HOV lanes to trucks and additional user groups. The research should also examine the advantages and disadvantages of different approaches, develop planning guidelines for use in considering multiple user groups, and identify other factors that should be considered in the planning process.

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ATTACHMENT 1—HOV Facility Planning Checklist

This table highlights the various activities typically conducted as part of the planning process for an HOV facility. The checklist can be used by practitioners to help ensure that all the appropriate steps are considered.

Step	Responsible Agency or Group	Completed
1. Identify and Involve Appropriate Groups • May include state department of transportation, transit agency, MPO, cities, counties, rideshare agency, federal agencies, and other groups.		
2. Identify Issues and Opportunities • Identify problems and issues. • Identify opportunities.		
3. Public Participation • Identify groups and individuals • Hold meetings, workshops, charrettes, and other techniques.		
4. Identify Objectives, Analysis Techniques, and Data Needs		
5. Identify Alternatives		
6. Collect Data		
7. Analyze Alternatives • Use appropriate techniques for scale and scope of project.		
8. Public Input on Alternatives • Hold meetings, workshops, charrettes, and other methods to obtain input.		
9. Identify Preferred Alternative		
10. Public Review • Hold meetings, workshops, charrettes, and other methods to obtain input.		
11. Selection of Alternative		

CHAPTER 5—OPERATION AND ENFORCEMENT OF HOV FACILITIES ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

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I. INTRODUCTION

Understanding the operating characteristics of different types of HOV facilities is critical for a number of reasons. First, a knowledge of the various approaches for operating and enforcing HOV facilities will help identify elements to be considered in the design process. Further, alternative operating strategies will influence the capital costs, as well as the ongoing operating costs associated with different types of HOV facilities. Various operation and enforcement issues may also influence the potential for a successful project. This chapter discusses the operation and enforcement of various types of HOV facilities. The chapter is divided into the following ten sections.

- **Developing an HOV Operation and Enforcement Plan**. Developing an overall plan for operating and enforcing an HOV facility should be the first step once a decision has been made to move forward with a project. This section discusses the agencies and groups that should be involved in this process and the various elements that should be included in an operation and enforcement program. Each element is discussed in more detail in subsequent sections.

- **HOV Operational Alternatives**. This section describes the various HOV facility design and operation alternatives. The discussion expands on the summary presented in Chapter 1. The basic operating characteristics of each type of facility are presented, along with their advantages and disadvantages. Examples of HOV facilities in separate rights-of-way and on freeways are summarized.

- **Ingress and Egress Alternatives**. This section discusses the different types of ingress and egress treatments that may be used with HOV facilities. The operational advantages and disadvantages of merge access, slip ramps, direct connections, and freeway-to-freeway connections are described, and case study examples are highlighted.

- **Vehicle Eligibility and Vehicle-Occupancy Requirements**. This section discusses the factors that should be considered in determining the types of vehicles allowed to use an HOV facility and the vehicle-occupancy requirements. The advantages and disadvantages of different vehicle mixes and occupancy levels are presented. The requirements currently in use on different HOV facilities in North America are highlighted.

- **Transit and Support Services and Facilities**. This section summarizes the various types of transit and support services that may be provided with HOV facilities. A more detailed discussion of transit, park-and-ride, park-and-pool, and other services and facilities is contained in Chapter 9.

- **Hours of Operation**. This section presents the various operating hour scenarios that may be used with HOV facilities. These include 24-hour, less than 24-hour, and peak-period only operation. Factors to consider in establishing operating hours, including regional consideration for continuity among facilities, are discussed.

- **Enforcement**. This section examines enforcement techniques on HOV lanes on freeways and in separate rights-of-way. It provides an overview of the role enforcement plays in the success of HOV facilities, the various approaches that can be used to enforce HOV operating hours and vehicle-occupancy requirements, the involvement of enforcement personnel throughout the HOV planning and design phases, and other aspects related to HOV enforcement. Guidelines are presented for the development and implementation of an enforcement plan.

- **Incident Management**. This section discusses incident management on HOV facilities on freeways and in separate rights-of-way. Incident management is addressed from two points of view—clearing incidents on HOV facilities to ensure their efficient operation and the use of HOV facilities to assist with incident management on the freeway or in the travel corridor. Guidelines for the development and implementation of an incident management plan are presented.

- **Special Operational Considerations**. This section discusses some of the current initiatives and special operational elements being considered and implemented with HOV facilities in North America. Topics covered include converting a general purpose lane into an HOV lane, priority pricing, Intelligent Transportation Systems (ITS), truck use of HOV facilities, slow vehicles, and future conversion to fixed guideway transit facilities.

- **Additional Research Needs**. The chapter concludes with a discussion of areas where further research is needed relating to operating and enforcing HOV facilities.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information related to operating and enforcing HOV facilities on freeways and in separate rights-of-way.

II. DEVELOPING AN HOV OPERATION AND ENFORCEMENT PLAN

A. Groups Involved in Developing an HOV Operation and Enforcement Plan

Similar to the planning phase for an HOV facility, numerous agencies and groups will be involved in developing the operation and enforcement plan for a project. The participation of the appropriate agencies and individuals is key to ensuring that all groups are involved in discussing the different operational strategies and enforcement techniques, that potential issues are discussed and resolved prior to implementation, and that all groups have a common understanding of the project.

One approach used in many areas is to continue the multi-agency team formed during the planning phase of a project through the development of the operation and enforcement plan. A special subgroup or committee, comprised of the operation and enforcement personnel from various agencies, may be formed to ensure that the individuals responsible for operating and enforcing the facility are involved in developing the plan. In addition, consideration should be given to other groups that may need to be involved or consulted, such as members of the judicial system responsible for enforcing fines or penalties.

Table 5-1 identifies the various agencies and groups that should be included in the development of an operation and enforcement plan. The roles and responsibilities of each group are highlighted in the table and described in more detail below. Practitioners can use the information in Table 5-1 as a guide to help ensure that consideration has been given to including the various groups in the development of the recommended operation and enforcement plan. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

State Department of Transportation. The state department of transportation or the state highway department is usually the lead agency with HOV facilities on freeways. As a result, these agencies have overall responsibility for the project, including developing the operation and enforcement plan and operating the completed facility. In many areas, state departments of transportation have been responsible for organizing, staffing, and chairing the multi-agency project management team associated with an HOV project. Consideration should be given to including representatives from a variety of departments within the agency. These might include the planning, design, marketing or public information, construction, legal, operation, traffic management, and highway assistance departments.

Transit Agencies. Transit agencies often have the lead responsibilities with HOV facilities on separate rights-of-way. In other cases, the transit system may be a co-sponsor or a supporting agency. If the transit agency has the overall responsibility for the project, they will also have the lead role in developing the operation and enforcement plan. If the transit agency is playing more of a supporting role, key responsibilities may focus on the bus operations, enforcement, and overall project coordination.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities was stressed earlier in this Manual. Experience indicates that including state, local, and transit police in the development of the operation and enforcement plan is critical to the success of an HOV project. Ensuring that the needs of enforcement personnel are considered early in the planning process is important to developing a facility that can be enforced. Enforcement personnel may take a lead role in the development of the enforcement section of the plan.

Table 5-1. Agencies and Groups Involved in
Developing an HOV Operation and Enforcement Plan

Agency or Group	Potential Roles and Responsibility
State Department of Transportation	• Overall project management. • Developing operation and enforcement plan. • Designing facility. • Operating facility. • Staffing multi-agency team or committee.
Transit Agency	• Overall project management or supporting role. • Developing or assisting with operation and enforcement plan. • Bus operations. • Enforcement or assisting with enforcement.
State Police	• Assist with development of operation and enforcement plan. • Usually responsible for enforcement of freeway HOV facilities. • Coordination with judicial personnel.
Local Police	• Assist with development of operation and enforcement plan. • May assist with enforcement. • Coordination with judicial personnel.
Local Municipalities	• May have overall project management with arterial street and traffic signal applications. • Support role with other HOV facilities. • Developing or assisting with operation and enforcement plan. • Designing facility. • Operating facility. • Staffing multi-agency team or participating on team.
Rideshare Agency	• Assist with development of operation and enforcement plan. • Participate on multi-agency team.
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multi-agency coordination. • Ensure that projects are included in necessary planning and programming documents. • May have policies relating to HOV facilities.
Federal Agencies—FHWA and FTA	• Funding support. • Overall approval of various steps.
Other Groups	• Judicial system—state and local courts. • EMS, fire, and other emergency personnel. • Tow truck operations.

Local Municipalities. City or County departments may have important supporting roles on HOV facilities on freeways and in separate rights-of-way. On projects headed by the state or transit agency, local jurisdictions are likely to play a supporting and coordinating role in the development of the operation and enforcement plan.

Metropolitan Planning Organization (MPO). As discussed in Chapter 4, representatives from the MPO are usually members of the multi-agency planning group associated with HOV facilities and may head the coordinating committees on Major Investment Studies. The MPO may have policies relating to various aspects associated in the operation and enforcement of an HOV facility. For example, an MPO may have policies enforcing the carpool occupancy requirements preferred with HOV lanes. Staff from the MPO may help facilitate meetings or the development of the plan, as well as assisting with multi-agency coordination.

Rideshare Agency. In many metropolitan areas, the transit agency operates not only the bus service but also provides ridematching services, vanpool programs, and other ridesharing services. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, the rideshare agency should be included as a member of the project management team and should be involved in the development of the operation and enforcement plan.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least to monitor development of the operation and enforcement plan. Personnel from these agencies can often provide technical assistance on specific issues or suggestions on how certain issues have been addressed in other areas. Representatives from FHWA and FTA often participate on the multi-agency team.

Other Groups. Consideration should be given to including representatives from other groups or obtaining their input during the development of the operation and enforcement plan. These may include representatives from the state and local judicial system who will be responsible for enforcing fines and citations; EMS, fire, and other emergency personnel who may have to respond to incidents and accidents on the facility; and tow truck operators who may be responsible for removing disabled vehicles. Representatives from these groups may be included on the multi-agency team or their opinions and concerns may be solicited for consideration in the development of the operation and enforcement plan.

B. Elements of an HOV Operation and Enforcement Plan

A number of elements or factors should be considered in the development plan for operating and enforcing an HOV facility. These elements relate to the type and design of a project, the vehicles allowed to use the facility, the vehicle-occupancy requirement, the type and orientation of the transit services provided, the hours of operation, enforcement techniques and strategies, incident management techniques, and special operating considerations. These elements are discussed briefly in this section and are described in more detail in the remaining sections of the chapter.

HOV Operational Alternatives. The type of HOV facility considered will influence the operation and enforcement plan. For example, the operating strategies with reversible or contraflow HOV lanes will be very different than those used with concurrent flow lanes. The enforcement requirements and techniques will also vary based on the nature of the HOV facility. Enforcement techniques appropriate for use with a barrier-separated facility are much different from those used with a concurrent flow lane.

Ingress and Egress. The nature and number of access points will also influence the operation and enforcement of an HOV facility. Access considerations are closely linked to the type of HOV facility being considered. Some access treatments are more appropriate with certain kinds of HOV lanes, while others may be realistic only with specific types of facilities.

Vehicle Eligibility and Vehicle-Occupancy Requirements. The types of vehicles allowed to use an HOV facility and the number of people required in a vehicle will influence the operation and enforcement of a project. Issues to be considered in determining the appropriate vehicle mix and occupancy requirement include safety, demand, project objectives, and special features.

Transit Facilities and Services. The nature and orientation of transit services using the HOV facility, as well as the supporting features will impact the operation and enforcement of a project. For example, a facility with high volumes of buses will require a different operational approach than one oriented toward carpools. Considering the type, level, and orientation of anticipated transit services is important for the development of an adequate operation and enforcement program.

Hours of Operation. The operation and enforcement plan should identify the anticipated hours the HOV facility will be open for use. HOV facilities may be operated on a 24-hour basis, during major portions of the day, or only during the peak-periods. The plan should also detail how the facility will be used during non-HOV operating periods. Options may include allowing general-purpose traffic to use the facility, closing the lane, or other alternatives such as varying vehicle eligibility requirements by time of day. The type and orientation of the HOV facility will influence the hours of operation.

Enforcement. A major element of the plan should focus on the enforcement strategies to be used on the facility. Elements that should be included in this portion of the plan include the enforcement techniques, design features, violation penalties and fines, and roles and responsibilities of the various police agencies. The development of the enforcement plan should include communication and coordination with representatives from the state and local judicial systems to ensure that citations will be upheld in court.

Incident Management. The incident management portion of the operation and enforcement plan should focus on two major components. The first should outline the procedures and techniques that will be used to respond to incidents and accidents on the HOV facility. The second element should focus on whether or not the HOV lane will be used to help manage incidents and accidents on the freeway-general purpose lanes, and if so, the procedures and techniques that will be used on these instances. The application of advanced transportation management systems (ATMS) and other ITS technologies may also be appropriate for consideration in this portion of the plan.

Special Operational Considerations. Depending on the type of HOV facility being planned, the objectives of the project, and the local situation, there may be other special considerations to include in the operation and enforcement plan. Factors that may need additional consideration include converting a general-purpose lane to an HOV lane, priority pricing strategies, truck use, ITS, future conversion to a fixed-guideway transit system, and slow vehicles.

Developing and conducting an ongoing monitoring and evaluation program for an HOV facility is discussed in Chapter 13. The results of this effort can be used for a number of purposes. One of these is updating and revising the operation and enforcement plan for an existing HOV facility. In addition, the results of an ongoing evaluation program can also benefit the development of operation and enforcement programs on new HOV projects.

III. HOV OPERATIONAL ALTERNATIVES

This section discusses the operational alternatives that are usually found with different HOV facilities. The various types of HOV lanes and access considerations are described and the advantages and disadvantages of different approaches are summarized. More detailed information on the design considerations associated with the various treatments is presented in Chapter 6.

A. Separate Rights-of-Way—Bus Only

This type of HOV facility is a roadway or lanes developed in a separate right-of-way and designated for exclusive use by buses. Most existing busways are two-lane, two-direction facilities. Examples of this type of HOV treatment are the South and East Busways in Pittsburgh, the University of Minnesota Busway in the Minneapolis/St. Paul metropolitan area, the Miami Busway, and the transitway system in Ottawa, Ontario. Figures 5-1 and 5-2 provide examples of the busways in Pittsburgh and Ottawa.

Busways on separate rights-of-way offer a number of advantages. These facilities provide the highest level of service for transit operations. Dedicated solely to buses, these lanes can carry high volumes of people in fewer vehicles than other types of HOV facilities. Bus-only lanes are also less prone to non-recurring traffic incidents that often cause congestion on freeways. As a result, they provide a high degree of reliability to commuters and enhanced operating efficiencies to transit agencies. Enforcement may also be easier on transitways since only buses are allowed to use the facility and access points are limited.

Bus-only facilities are appropriate in corridors with high levels of current or planned transit services. Busways can be implemented in developing areas or in older, established neighborhoods. Corridors where origins and destinations are densely located or are served by sufficient collection and distribution systems may be good candidates for busways.

There are also limitations with bus-only facilities in separate rights-of-way. As noted, high volumes of buses are necessary for this alternative to be considered and many corridors may not meet this criteria. The capital costs associated with this type of facility can be significant. Variables that will influence the capital cost include right-of-way availability, the number and location of stations, design considerations, and access alternatives.

B. Separate Rights-of-Way—HOV

This type of facility expands on the busway concept by allowing access to vanpools and carpools. The HOV facility is a roadway or lanes developed in a separate right-of-way open to buses, as well as vanpools and carpools. No facilities of this type are currently in operation in North America. The Airport Busway/Wabash HOV facility under construction in Pittsburgh will allow buses, vanpools, carpools, and airport shuttle services to use a portion of the facility, while other sections will be restricted to just buses and airport shuttle services.

Figure 5-1. Martin Luther King Jr. (East) Busway in Pittsburgh

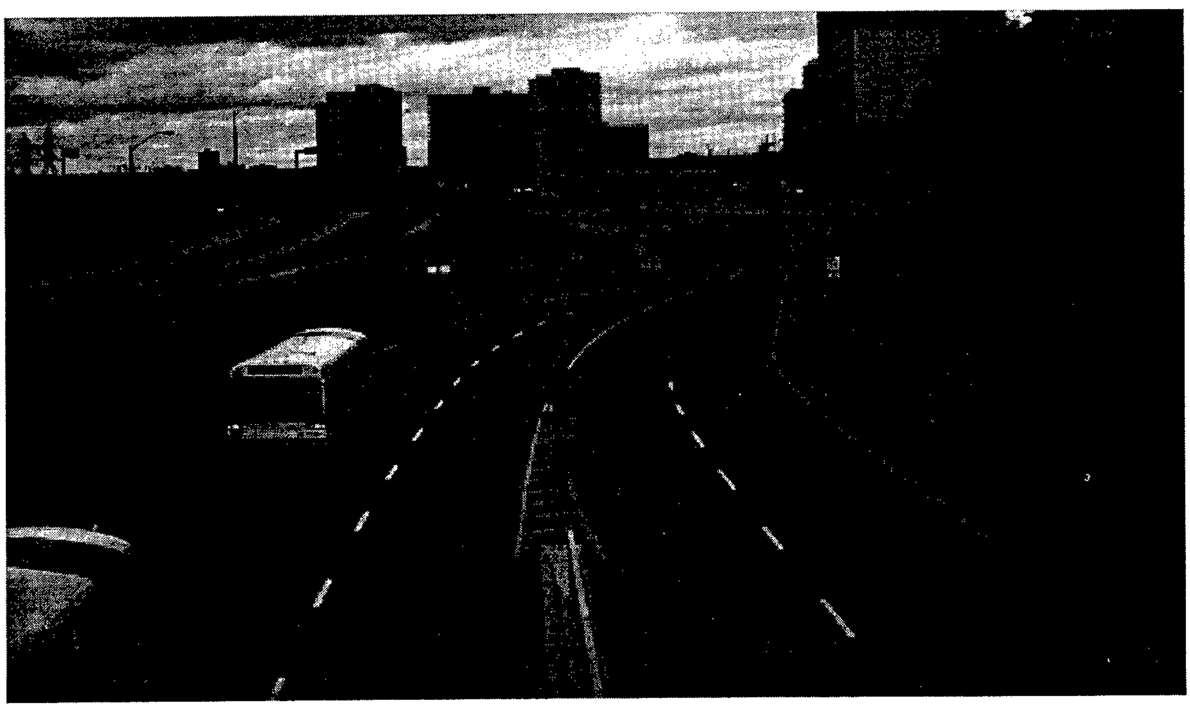


Figure 5-2. Ottawa Transitway

Potential advantages of this operating scenario include encouraging carpooling and vanpooling by providing access to these user groups, increasing the person movement capacity of the facility at little or no public cost, and expanding support for the facility. Opening a bus-only facility to other HOVs may also have a number of disadvantages, however. Potential disadvantages include degrading transit operations by too many vehicles on the facility and losing transit riders who change to carpooling or vanpooling. This approach may also make enforcement more difficult. Design issues related to access points, station layouts, and adequate space for vehicles to pass at stations will need to be addressed if carpools and vanpools are allowed to use the facility. These issues may limit consideration of this approach in many areas.

C. HOV Lanes on Freeways

Three types of HOV lanes are commonly found on freeways. These are exclusive HOV lanes, concurrent flow HOV lanes, and contraflow HOV lanes. In addition, two different operating strategies are used with exclusive HOV lanes—two-directional and reversible. The following descriptions highlight the major characteristics, advantages, and disadvantages of these types of HOV facilities.

1. **Exclusive Two-Directional HOV Facilities**. Exclusive two-directional facilities are lanes constructed within the freeway right-of-way that are physically separated from the general purpose freeway lanes and are 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 two-directional HOV facilities in freeway rights-of-way are usually open to all types of HOVs—buses, vanpools, and carpools. Exclusive HOV lanes often have limited access points, and may include direct ramps and other exclusive ingress and egress treatments. As illustrated in Figures 5-3 and 5-4, examples of exclusive two-directional HOV facilities include the San Bernardino Transitway in Los Angeles and the I-84 Freeway HOV lanes in Hartford.

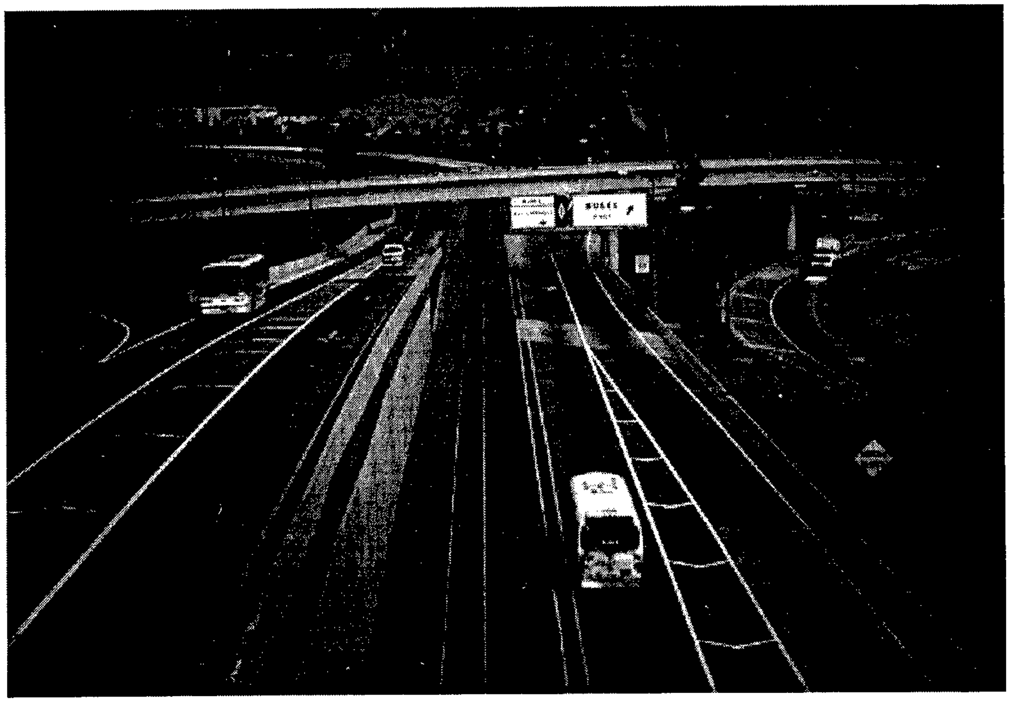


Figure 5-3. San Bernardino Transitway in Los Angeles

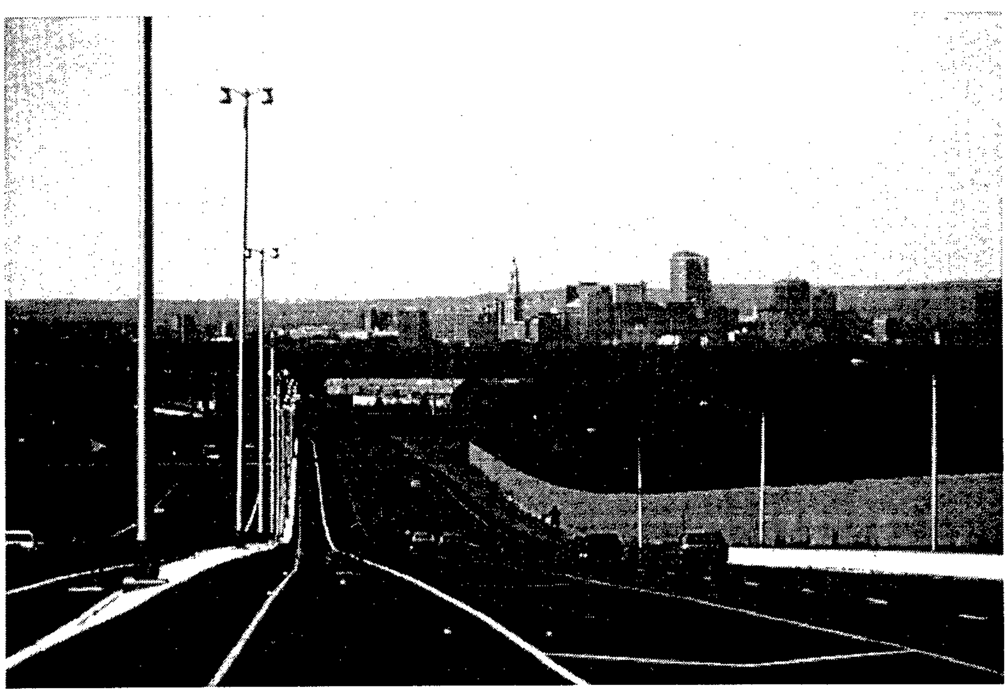


Figure 5-4. I-84 Freeway HOV Lanes in Hartford

This type of HOV facility is appropriate for consideration in corridors with fairly even directional splits and large volumes of existing or projected HOVs., usually in the range of at least 400 to 800 vehicles an hour. Advantages of two-direction exclusive HOV lanes include providing travel time savings and travel time reliability benefits to a wider range of commuters and enhancing the operating environment for buses and HOVs. Enforcement of exclusive two-directional facilities is also easier than non-exclusive facilities. Potential disadvantages include the right-of-way requirements, and the costs associated with this increased right-of-way, as well as the cost of the barrier or lane separation treatment, and supporting facilities. Given the higher costs associated with this alternative, significant volumes of HOVs traveling in both directions are needed to consider this approach.

2. **Exclusive Reversible HOV Facilities**. The other type of exclusive HOV treatment is a reversible lane or lanes. Like a two-directional facility, this approach involves a lane or lanes within the freeway right-of-way that are physically separated from the general purpose freeway lanes and used exclusively by HOVs for all or a portion of the day. Reversible HOV lanes, which are separated from the general-purpose lanes by concrete barriers, are usually open to buses, vanpools, and carpools.

Exclusive reversible HOV facilities, usually operate inbound toward the central business district (CBD) or other major activity center in the morning and outbound in the afternoon. Some type of daily set up is required with reversible facilities. Steps in this process often include opening the lanes in the morning, closing the lanes to inbound traffic, reopening the lanes in the reverse direction of travel in the afternoon, and closing the lanes in the evening. Both manual and automated techniques are used to open and close these types of HOV facilities.

The Houston HOV lanes represent the largest network of single-lane exclusive reversible HOV facilities in the country. Currently, approximately 103 kilometers (64 miles) of a planned 176-kilometer (110-mile) system are in operation in 5 radial freeway corridors. The I-395 (Shirley Highway) HOV lanes in Northern Virginia/Washington, D.C. area, the I-15 HOV lanes in San Diego, the I-25 Express lanes in Denver, and a portion of the I-394 HOV lanes in Minneapolis all represent two-lane exclusive reversible HOV facilities. The I-10 West (Katy) Freeway HOV lane is shown in Figure 5-5, and the Shirley Highway HOV lanes in Northern Virginia/Washington, D.C. are illustrated in Figure 5-6.

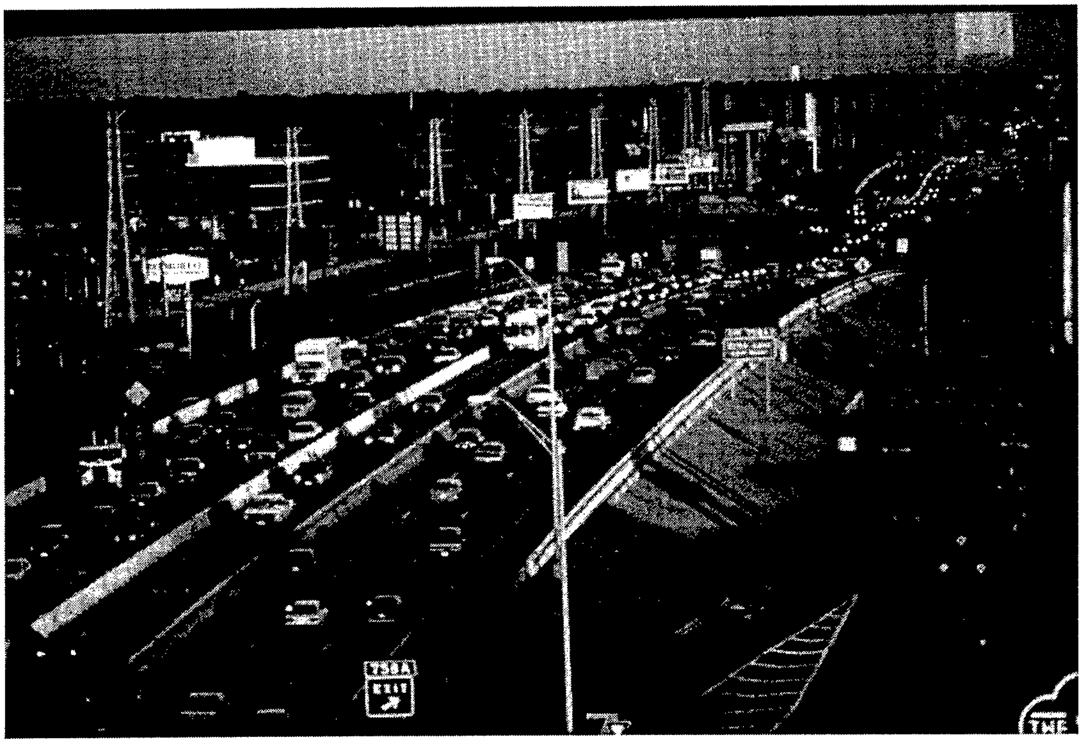


Figure 5-5. I-10 West (Katy) Freeway HOV Lane in Houston

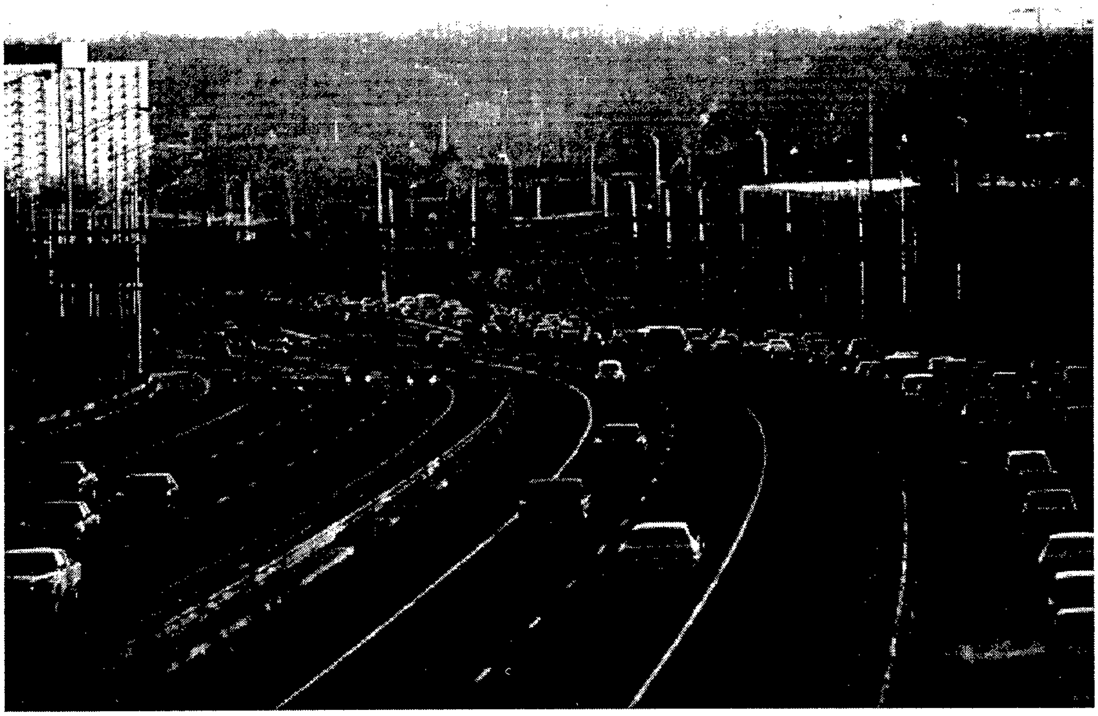


Figure 5-6. I-395 (Shirley Highway) HOV Lanes in Northern Virginia/Washington, D.C.

Reversible HOV facilities may be appropriate in corridors with high directional splits. Substantially higher volumes of vehicles traveling in one direction are needed for this type of treatment. Unequal traffic distribution may exist in many radial corridors with large numbers of commuters traveling to the CBD or other major activity center.

Exclusive reversible HOV lanes offer a number of potential advantages. First, available right-of-way may exist in a freeway median to allow for the addition of an exclusive reversible HOV lane. Second, since this type of facility operates in the peak-direction of travel, it may provide a cost-effective approach to add extra capacity during the peak-hours. In addition, the exclusive nature of these facilities enhance both operation and enforcement. Potential disadvantages with this approach include the capital and operating costs associated with the lane, access facilities, park-and-ride lots, and other supporting components. The availability of needed right-of-way may be a limiting factor in some corridors. Finally, if travel demand increases in the off-peak direction, consideration may need to be given to expanding a reversible lane into a two-directional facility.

3. **Concurrent Flow HOV Facilities**. 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 exclusive use by HOVs for all or a portion of the day. Concurrent flow HOV lanes are usually open to buses, vanpools, and carpools. A few facilities are open only to buses, however, allowing transit vehicles to bypass specific bottlenecks.

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. As discussed in Chapter 6, in some cases a 0.3 meter to 1.2 meter (1 foot to 4 foot) separation is provided between the HOV lane and the general-purpose lane, while in other cases no additional separation, other than the normal paint striping, is provided. Unlimited ingress and egress may be allowed with a concurrent flow HOV lane or only specific access points may be provided.

Concurrent flow HOV facilities are the most common HOV application in North America. Concurrent flow HOV lanes are used extensively in Seattle and metropolitan areas in California, as well as other cities throughout the country. Examples of concurrent flow lanes are SR 520, I-405, I-5, and SR 167 in Seattle; Route 55, I-405, SR 91, SR 57, I-5 in Los Angeles/Orange County; Route 101 in San Jose; I-280, I-80, SR 237 in San Francisco; US 36 in Denver; I-10 in Phoenix; I-394 in Minneapolis; I-65 in Nashville; I-4 in Orlando; I-95 and SR 112 in Miami; and SR 44 and I-564 in Norfolk/Virginia Beach. Figures 5-7 and 5-8 provide examples of the concurrent flow HOV lanes in Seattle and Southern California.

The I-405 HOV lanes in Seattle provide one example of an HOV facility located on the outside lane. This facility is shown in Figure 5-9. There are plans to shift these lanes to the inside lanes.

Concurrent flow HOV lanes offer a number of advantages as well as some disadvantages. The cost of developing and implementing concurrent flow HOV lanes is usually lower than other alternatives. This approach requires less right-of-way than other techniques. As a result, concurrent flow HOV facilities can often be implemented faster than other types of HOV lanes. On the negative side, concurrent flow HOV lanes are easier to violate, which means they are harder to enforce. The travel-time reliability may be lower due to the potential for incidents in the general-purpose lane to impact the HOV lane. In addition, HOVs may have difficulty merging across the general-purpose lanes to enter and exit the HOV lane.

4. **Contraflow HOV Facilities**. 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 or a moveable barrier. Contraflow lanes are usually operated only during the peak-periods, with some operating only during the morning peak-period. During other times of the day, the lanes revert back to normal use in the peak direction of travel. Some contraflow HOV lanes are open to buses-only, while others are open to buses and vanpools, and still others are open to all HOVs.

Several examples of contraflow HOV lanes 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. These three facilities all use plastic pylons to create the HOV lane, operate only in the morning peak-period, and are restricted to buses-only or buses and vanpools. The contraflow lane on I-495 in Union City, New Jersey, approaching the Lincoln Tunnel is shown in Figure 5-10.

The East R. L. Thornton (I-30 East) contraflow lane in Dallas and the Southeast Expressway contraflow lane in Boston use the moveable concrete barrier technology to create the HOV lane. These facilities operate in the morning and the afternoon peak-periods and are open to buses, vanpools, and carpools. Figure 5-11 shows the moveable barrier creating the contraflow HOV lane on the East R. L. Thornton Freeway.

Figure 5-7. I-5 North HOV Lanes in Seattle

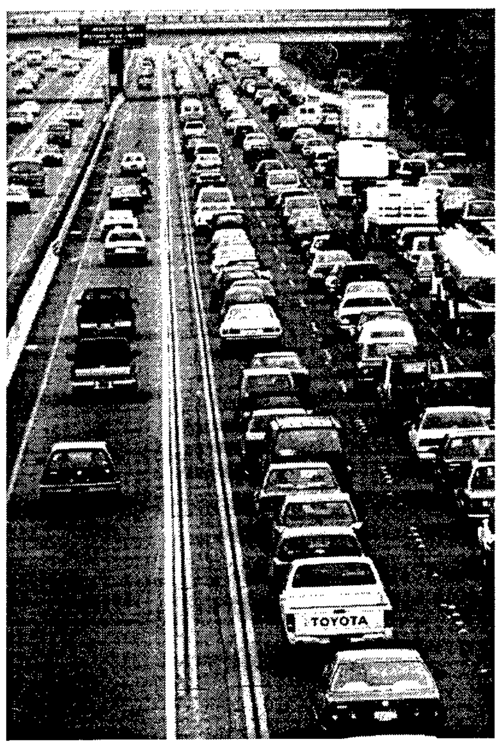


Figure 5-8. I-405 HOV Lane in
Orange County, California

Figure 5-9. I-405 HOV Lane in Seattle

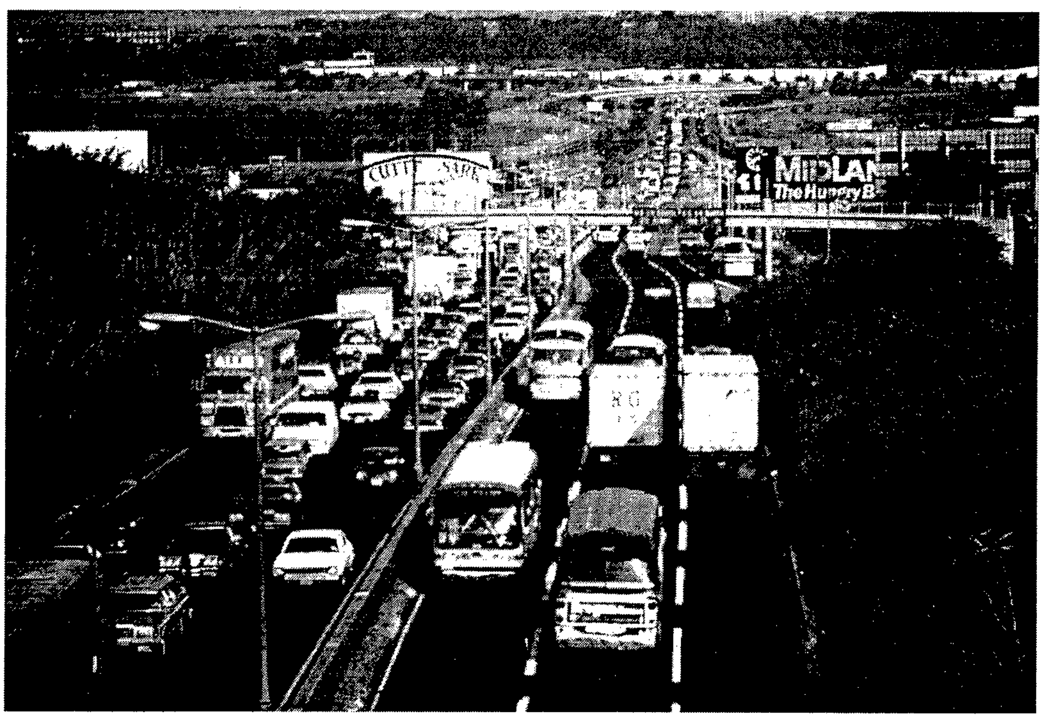


Figure 5-10. Contraflow Lane on I-495 in Union City, New Jersey

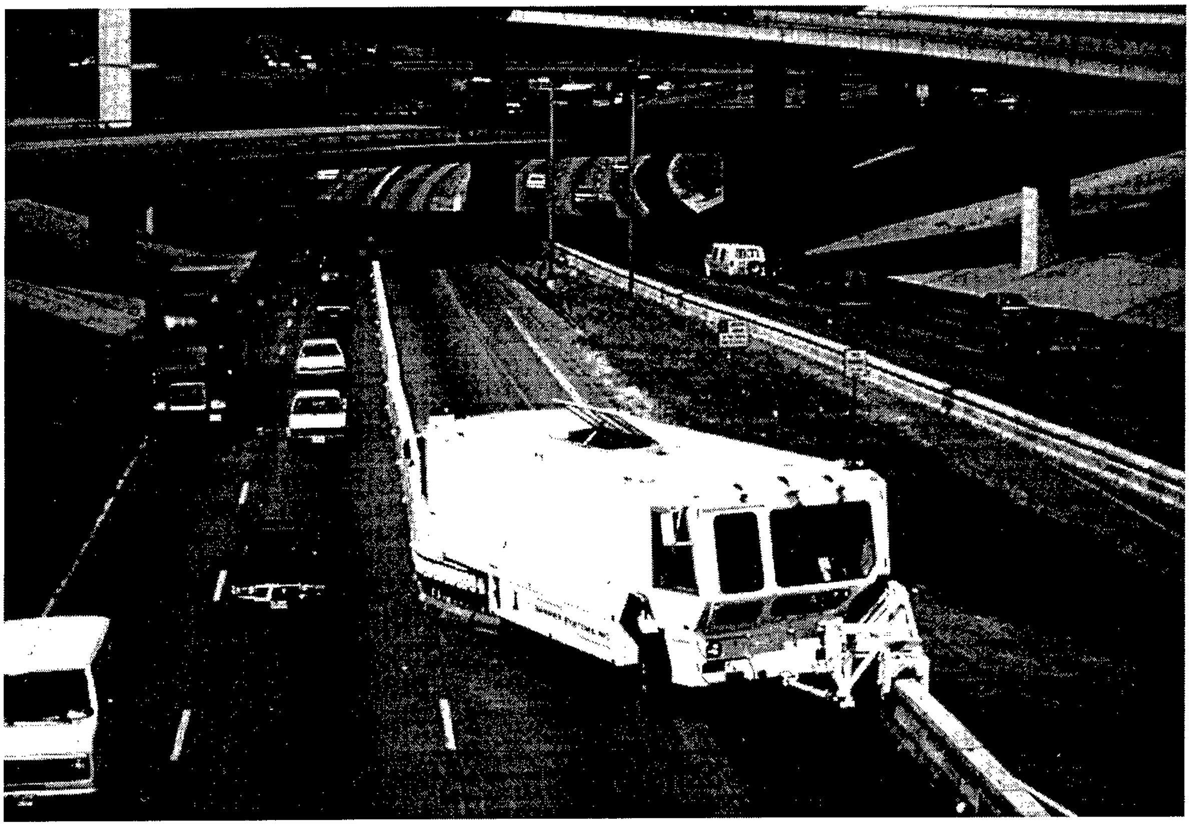


Figure 5-11. Moveable Barrier and Contraflow HOV Lane on the East R. L. Thornton Freeway in Dallas (I-30)

Contraflow lanes are appropriate for consideration where there is a high directional split and where the off-peak direction of travel will not be adversely affected by the loss of a lane. Contraflow HOV lanes may provide a relatively low cost way of addressing traffic congestion in some corridors, although significant costs may be involved in creating and removing the lane in response to peak-period traffic demands. The ongoing operating costs may be higher than other approaches. Safety concerns may also be higher with contraflow facilities, requiring consideration of exclusive use by professional drivers.

5. **HOV Bypass Lanes at Metered Freeway Entrance Ramps and Toll Plazas:** This type of HOV facility is used to provide priority treatment for buses, vanpools, and carpools at metered freeway entrance ramps or at toll plazas. On freeway entrance ramps, a separate lane is provided adjacent to the general purpose lane so that HOVs do not have to stop at the ramp meter signal, but rather move around the traffic queue and directly enter the freeway. HOV bypass lanes are in operation on freeways in the Minneapolis/St. Paul metropolitan area,

Seattle, cities throughout California, and other areas. Figure 5-12 shows an HOV bypass lane at a metered freeway entrance ramp in Southern California.

In addition to freeway entrance ramps, HOV bypass lanes have been incorporated at several bridge toll plazas across the country. The George Washington Bridge in New Jersey, the Coronado Bridge in San Diego, and various bridges in the San Francisco area provide examples of HOV bypasses at toll plazas. The HOV lanes on the Bay Bridge between Oakland and San Francisco are shown in Figure 5-13.

IV. INGRESS AND EGRESS ALTERNATIVES

A variety of treatments can be used to provide access to and from an HOV lane. Ensuring that buses, vanpools, and carpools can easily and safely merge into and out of an HOV lane is critical to the success of the facility. In addition, in some areas the travel time savings provided by direct access ramps is as important as that provided by the HOV lane. The following types of approaches can be used to provide ingress and egress to HOV lanes.

A. Direct Merge

This approach allows HOVs to merge directly into and out of the HOV lane from the adjacent general-purpose lane. Continuous ingress and egress may be allowed or specific access points may be designated. Figures 5-14 provides an example of continuous access, while Figure 5-15 illustrates the use of specific access points. Direct merges are usually used with concurrent flow HOV lanes and represent the lowest capital cost alternative. Frequent and uncontrolled access can increase the number of potential users of an HOV facility. This approach also provides the greatest flexibility. A disadvantage with this approach is that conflicts may arise with HOVs merging across the general-purpose lanes to enter the HOV lanes and with HOVs merging back into the regular traffic lanes. Less frequent access points reduce the potential for conflict, but may exclude some users. Enforcement of direct merge access is more difficult than with other treatments. Concurrent flow HOV lanes in many areas, including Seattle, San Francisco, San Jose, Los Angeles, Orange County, Phoenix, Nashville, Minneapolis, Miami, Orlando, Norfolk/Virginia Beach, Baltimore/Washington, D.C., and New Jersey/New York City use these approaches.

B. Slip Ramps

Slip ramps may be used at the start, end, and intermediate points of an exclusive HOV lanes. Slip ramps provide a break in the barrier or buffer, allowing HOVs to enter and exit the facility. In addition, slip ramps can be provided for either ingress or egress rather than both movements. Slip ramps are used with exclusive HOV lanes in San Diego, Los Angeles, Houston, Minneapolis, and Washington, D.C./Northern Virginia. Advantages of slip ramps include lower capital costs than direct access facilities and the potential to serve more HOVs. Potential disadvantages include conflicts with vehicles merging into and out of the adjacent freeway lanes. Enforcement may also be more difficult with slip ramps than with direct access facilities. Figure 5-16 illustrates a slip ramp in Houston.

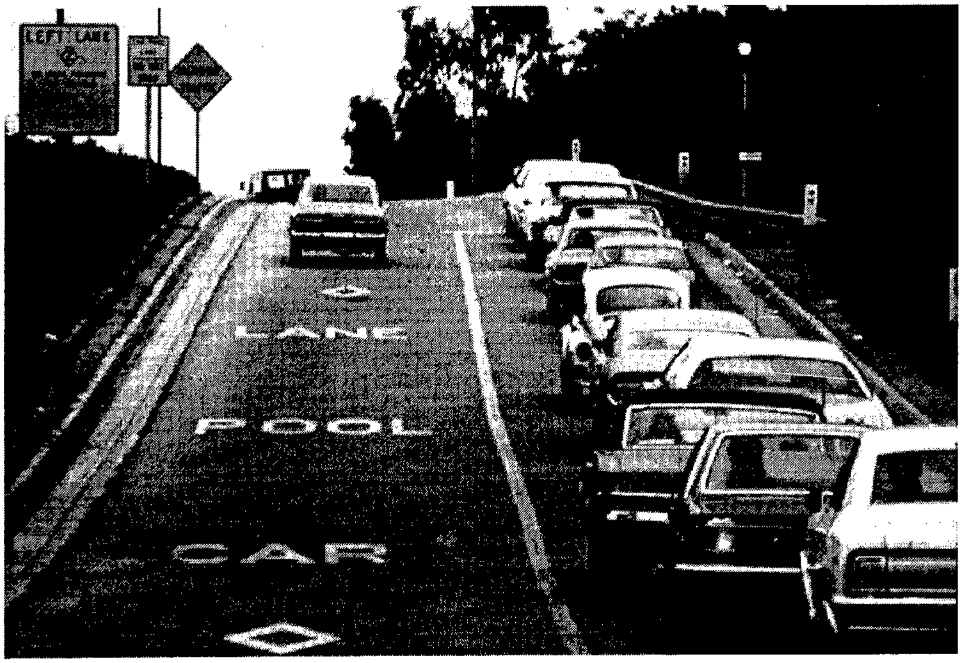


Figure 5-12. HOV Bypass Lane at Metered Freeway Entrance Ramp in Southern California

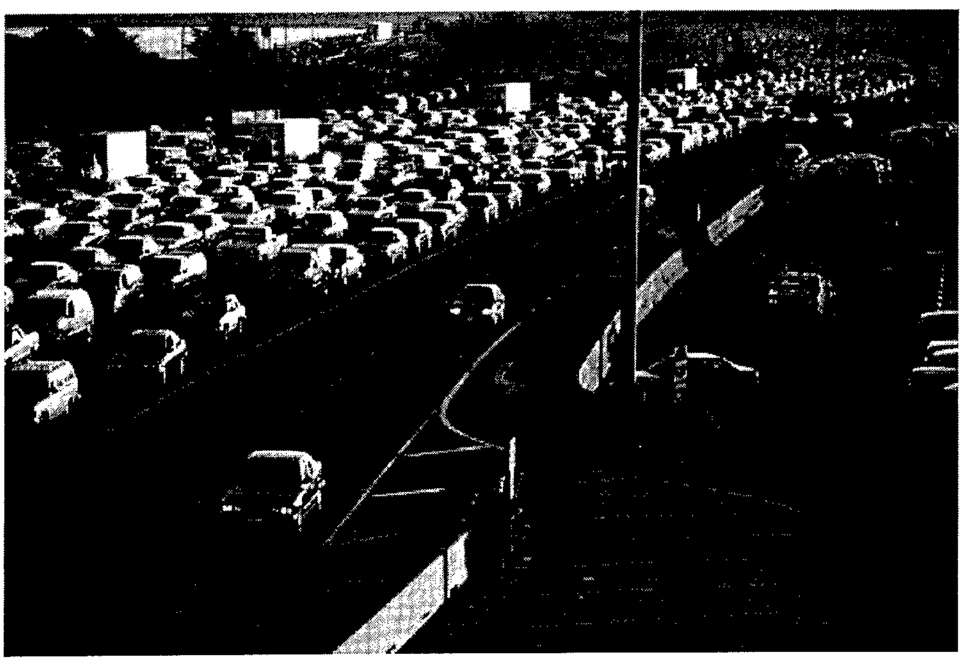


Figure 5-13. HOV Bypass Lane on the Bay Bridge in Oakland

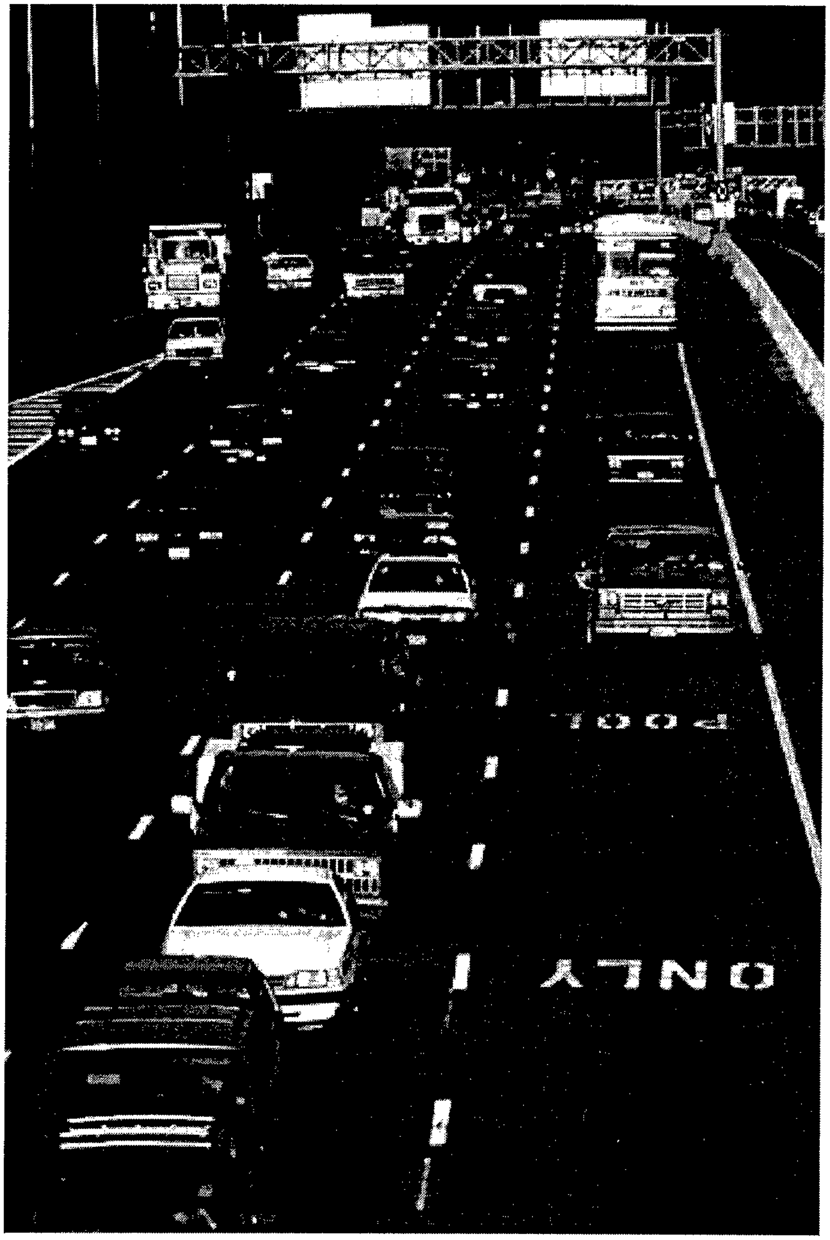


Figure 5-14. Concurrent Flow HOV Lane
with Unlimited Access in New Jersey (I-80)

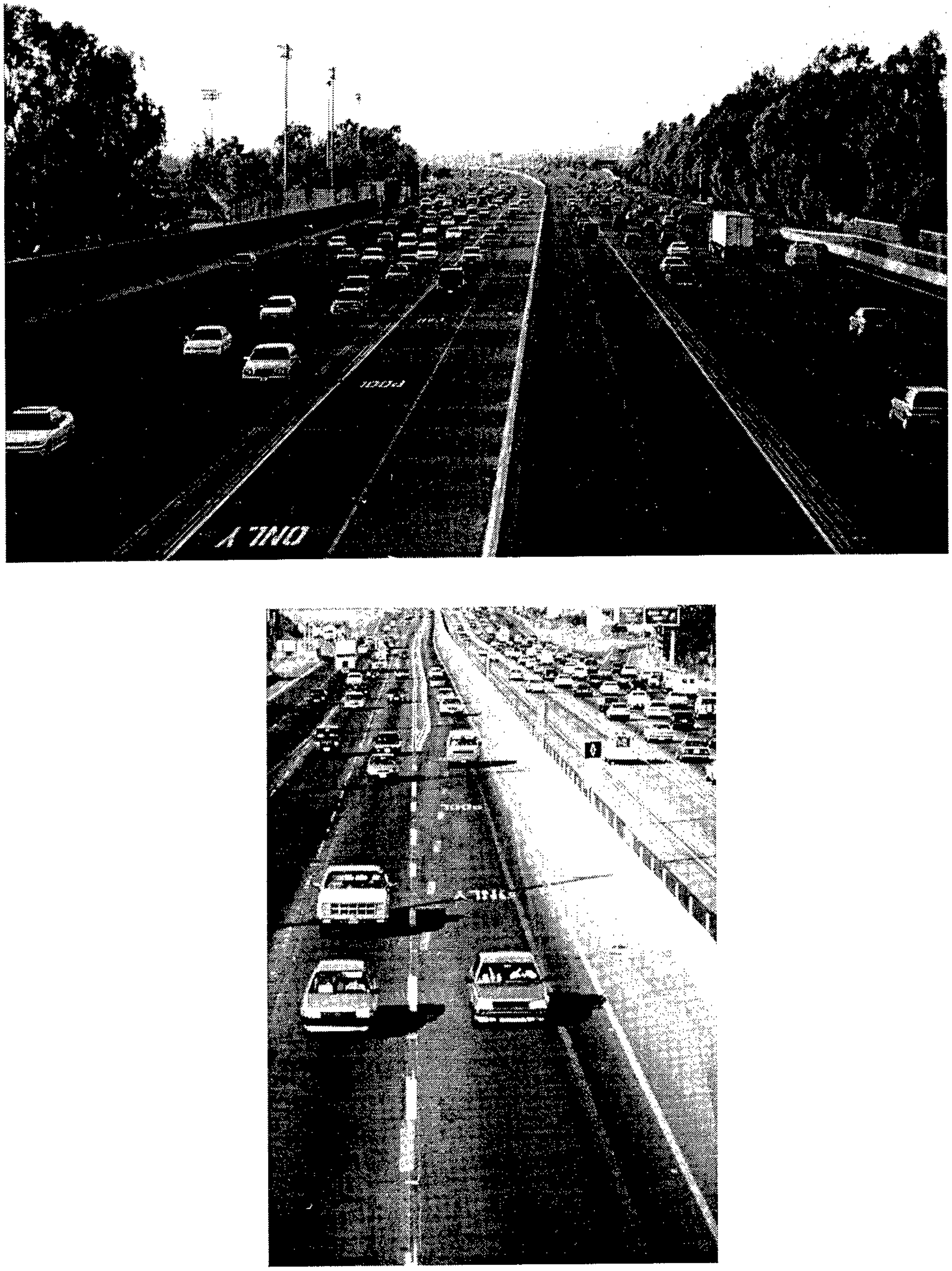


Figure 5-15. Concurrent Flow HOV Lanes with Limited Access in Southern California

C. Direct Access Ramps

Grade separated or direct access ramps provide exclusive ingress and egress for HOVs. A variety of design treatments may be used, including drop ramps, T-ramps, Y-ramps, and flyover ramps. Direct ramps may provide access from adjacent roadways, park-and-ride lots, and transit stations. Direct access ramps are usually found with exclusive HOV facilities. As illustrated in Figures 5-17 through 5-19, a variety of direct ramp designs are in use with HOV lanes in Houston, Los Angeles/Orange County, Minneapolis, and Washington, D.C./Northern Virginia. Direct access ramps may involve significant capital costs, but the travel time savings provided to HOVs and the safety benefits may justify the additional costs associated with these types of treatments.

Advantages of direct connections include the ability to move high volumes of HOVs into and out of an HOV facility without disrupting flow in the freeway general-purpose lanes, additional travel time savings, improved travel time reliability, and enhanced safety. Potential disadvantages include the need for additional right-of-way and the capital costs associated with different design treatments. Direct connections can be the most efficient means of managing these conflicting movements at locations where there is substantial congestion in the general purpose lanes and a large volume of vehicles accessing the HOV lane.

D. Direct Freeway-HOV-to-Freeway HOV Lane Connections

These facilities provide direct connections from an HOV lane on one freeway to an HOV lane on another freeway. Freeway-to-freeway HOV connections allow HOVs to continue through regional highway interchanges without exiting the HOV facility. This approach provides additional travel time savings and reduces potential conflicts with weaving movements into the general purpose lanes. Examples of freeway-to-freeway HOV direct connections include the I-105/I-405, the I-105/I-110, and the I-105/I-710 interchanges in Los Angeles and the I-5/SR 55 interchange in Orange County, California. This type of connection involves significant capital costs, but may be appropriate in areas with extensive networks of HOV facilities where travel demand warrants. Due to the right-of-way requirements and the costs associated with this approach, only limited applications are probably appropriate in most areas.

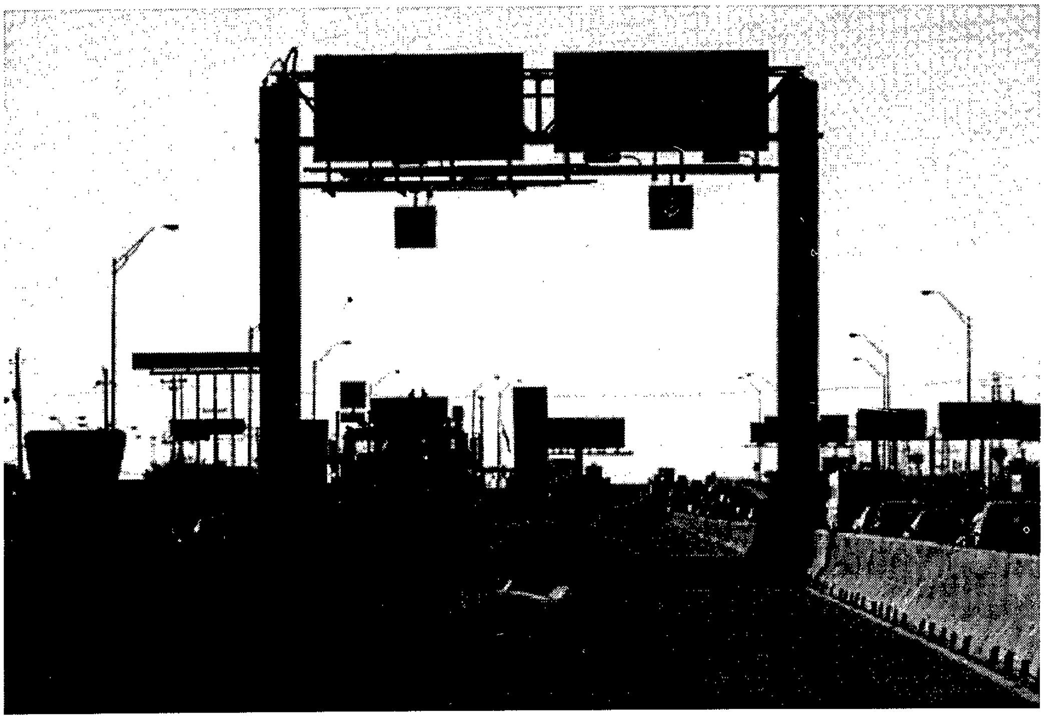


Figure 5-16. Slip Ramp with Exclusive HOV Lane in Houston

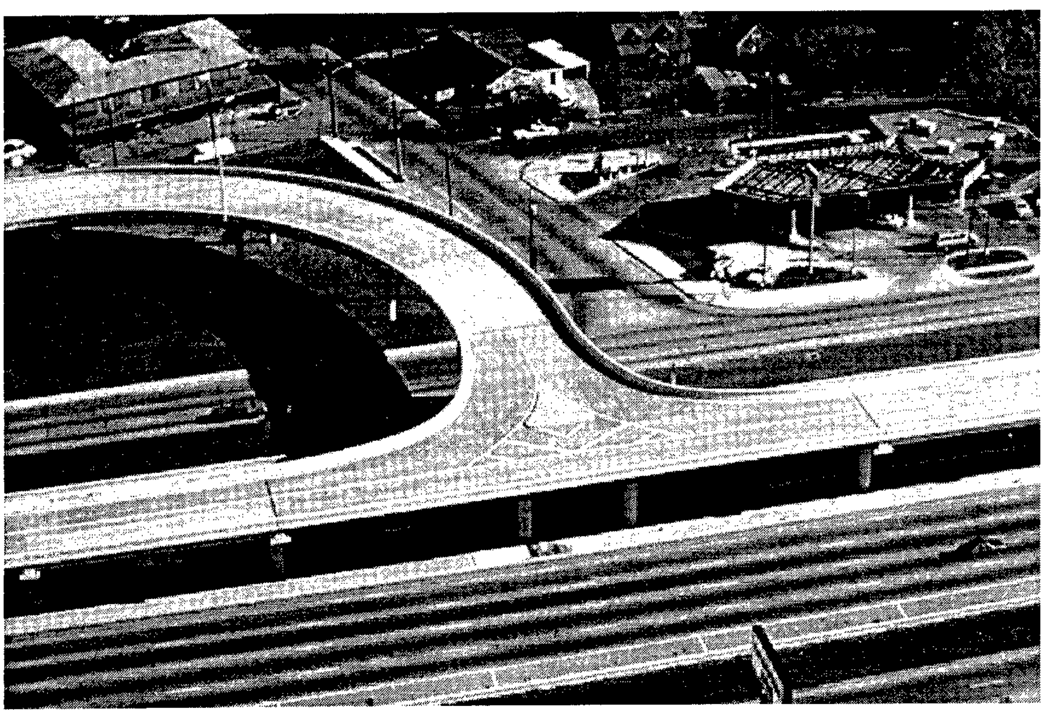


Figure 5-17. T-Ramp in Houston

Figure 5-18. Drop Ramp in Orange County, California

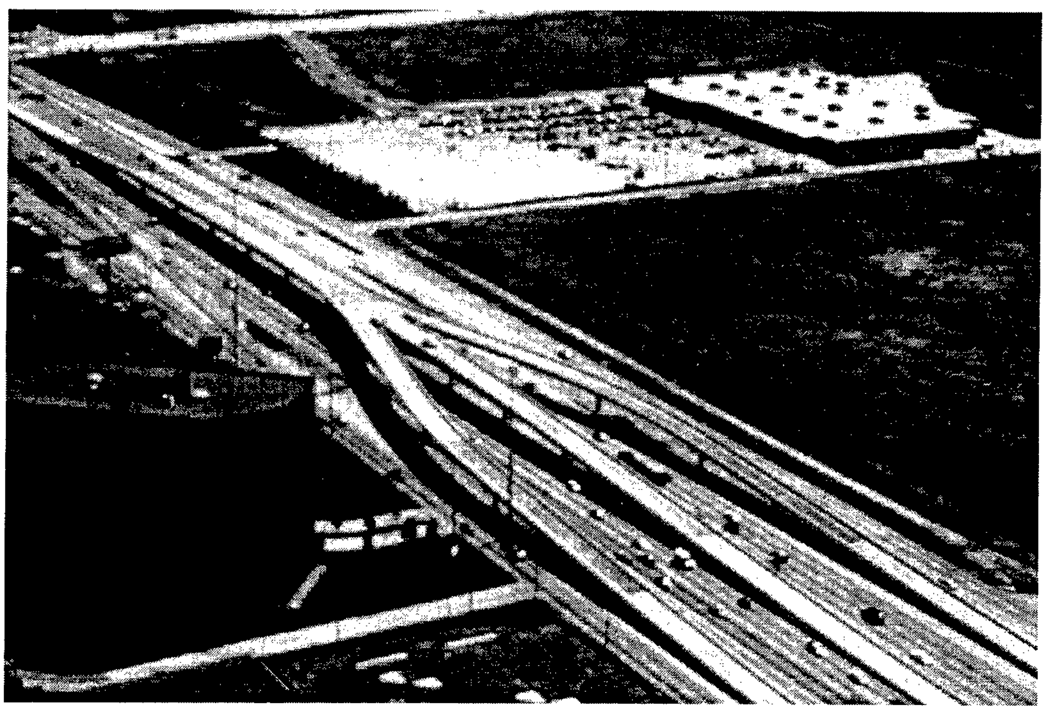


Figure 5-19. Y Ramp in Houston

V. VEHICLE ELIGIBILITY AND VEHICLE-OCCUPANCY REQUIREMENTS

One benefit offered by HOV facilities is the ability to match vehicle eligibility criteria and vehicle-occupancy requirements to the demand for the lane. The types of vehicles allowed to use a facility and the vehicle-occupancy levels can be changed to maximize the person-carrying capacity of a facility, while preserving free flow travel conditions and travel time advantages to HOVs. As discussed in Chapter 3, the development of state, regional, and local policies can help guide decisions on establishing and changing vehicle eligibility and vehicle-occupancy requirements.

This section identifies the types of vehicles usually considered for use of an HOV facility and alternate vehicle-occupancy levels. The advantages of allowing various vehicles and vehicle-occupancy levels are highlighted along with some of the issues associated with various approaches. Other topics covered include variable requirements, minimum operating thresholds, managing vehicle demand, and regional considerations.

A. Vehicle Eligibility Requirements

Establishing eligibility requirements that identify the types of vehicles that will be allowed to use an HOV lane is a first step in developing an operation plan. Determining vehicle eligibility is important, as it will influence other decisions relating to the operations of the facility. The following types of vehicles may be considered for use of an HOV facility.

- Buses
- Vans and Vanpools
- Carpools in automobiles and light trucks
- Motorcycles
- Stickered vehicles
- Tolled vehicles
- Commercial vehicles and trucks
- Deadheading buses
- Taxis
- Airport shuttles and other special services
- Emergency vehicles
- Low emitting vehicles

The general characteristics of these vehicles are described next. The advantages, disadvantages, and potential issues associated with allowing each type of vehicle to use an HOV facility are presented in Table 5-2 and summarized in this section. Figure 5-20 illustrates some of the vehicles commonly allowed to use HOV lanes.

Table 5-2. Vehicle Eligibility Considerations

Vehicle Type	Advantages	Disadvantages
Buses	• Highest person-moving capacity. • Greatest potential for increasing corridor throughput.	• Unless there are high numbers of buses, the lane will look unused, creating an empty lane syndrome.
Vanpools	• High person-moving capacity.	• Unless there are high numbers of vanpools, the lane will look unused, creating an empty lane syndrome.
Carpools using automobiles and pickup trucks	• Adds users at no public cost. • Adds to person-moving efficiency. • Helps avoid empty lane syndrome.	• Too many carpools may create congestion in the HOV lane, reducing travel time savings and travel time reliability. • May be safety concerns with some facilities.
Motorcycles	• Adds vehicles in lanes.	• Potential safety concerns. • Possible public perception problems of single-occupant vehicle.
Stickered vehicles	• Maximize available capacity. • Manage demand. • Expand eligible user group. • Address actual or perceived low use.	• Makes enforcement more difficult. • Time and cost to administer program. • Possible confusion among users. • May add too many vehicles to the facility.
Tolled vehicle	• Maximize available capacity. • Manage demand. • Expand eligible user group. • Address actual or perceived low use. • Generate new revenues.	• Makes enforcement more difficult. • Time and cost to administer program. • Possible confusion among users. • May add too many vehicles to the facility. • Cost of automated toll equipment. • Public and policy maker concerns related to equity, double taxation, and use of revenues.

Table 5-2. Vehicle Eligibility Considerations, continued

Vehicle Type	Advantages	Disadvantages
Commercial vehicles and heavy trucks	• Exclusive use of HOV lanes during off-peak hours by trucks may help reduce truck traffic in freeway lanes. • Enhances good movement and economic development.	• Potential safety concerns if trucks mixed with HOVs. • Safety concerns during transition period. • Access points may not serve commercial origins and destinations. • Geometric restrictions may not accommodate trucks. • Does not provide incentive to use transit or rideshare. • Does not enhance people moving capability.
Deadheading buses	• Enhance bus operating efficiencies.	• Potential public perception problems if only operator. • Reduces transit operating costs or allows more revenue service for the same cost.
Taxis	• Adds vehicles if meet occupancy requirements.	• Potential public perception problems if only operator.
Airport shuttles and other special services	• Adds vehicles if meet occupancy requirements.	• Potential public perception problems if only operator.
Emergency vehicles	• Travel time savings and enhanced reliability to emergency vehicles.	• Potential public perception problems if only operator.
Low emitting vehicles (LOVs)	• May encourage use of LOVs. • Adds vehicles to HOV lane.	• Potential public perception problems if vehicles do not meet the occupancy requirements. • Potential to make enforcement more difficult. • May cause congestion on the facility if too many LOV with only the driver.
Authorized vehicles	• May be appropriate if HOV facility has physical design or operational constraints.	• Adds extra effort to train and register drivers. • May not have enough authorized vehicles to make the lane looked used.

Figure 5-20. Examples of Vehicles Commonly Allowed to Use HOV Facilities

Buses. Buses are usually given first consideration in the use of an HOV facility. High volumes of buses offer the greatest potential benefit for increasing the people carrying capacity of a facility, as well as energy savings and air pollution reductions. Buses may be the only vehicles allowed to use a facility or buses may be one of many eligible users. Examples of the former include the busways in Ottawa, Pittsburgh, and Minneapolis-St. Paul; the contraflow HOV lane on Route 495 approaching the Lincoln Tunnel in New York City; and the bus-only shoulder freeway lanes on U.S. 36 in Denver, Highway 99 in Vancouver, and freeway sections in the Minneapolis-St. Paul area. The bus-only facilities in Ottawa, Pittsburgh, and Minneapolis-St. Paul are all located in separate rights-of-way. These facilities were developed and designed to provide high quality service to large numbers of buses. The other facilities are restricted to buses-only due to safety concerns or the desire to provide priority treatments for buses around specific freeway bottlenecks. Although buses provide the greatest person carrying capacity, corridors in many metropolitan areas in North America do not have high enough current or projected transit vehicle volumes to warrant limiting the use of a facility to buses only. Thus, most HOV lanes allow other vehicles meeting the vehicle occupancy requirement along with buses.

Vans and Vanpools. The next vehicles often considered for HOV lane use are vanpools. Although vans have operating characteristics similar to automobiles, vanpools have higher vehicle-occupancy levels than carpools. As a result, vanpools may be given preference over carpools in some situations. Vanpools are currently authorized to use all of the non-bus only HOV facilities in North America.

Carpools Using Automobiles and Pickup Trucks. With the exception of the HOV lanes noted under the previous two vehicle eligibility categories, all other HOV lanes are open to carpools operating in automobiles or light trucks. Allowing carpools to use an HOV lane can help avoid the empty lane syndrome, can add vehicles at no additional public cost, and can enhance the person carrying capacity of a facility. A potential disadvantage of allowing carpools in an HOV lane is that congestion may be created by too many vehicles, which may negatively impact the travel time savings and travel time reliability of buses. Increasing the vehicle-occupancy requirement on a facility is one way to address this problem.

Motorcycles. The advantages and disadvantages of allowing motorcycles to use HOV facilities have been debated over the years. The Intermodal Surface Transportation Efficiency Act of 1991 authorized the motorcycle use of HOV facilities, regardless of the number of riders. Previous federal regulations provided some flexibility for states and other agencies in determining if motorcycles would be allowed to use a facility based on safety concerns. Several states, particularly Virginia, Pennsylvania, Florida and Texas, excluded motorcycles on HOV lanes prior to the new regulations. There is a lack of good data on the safety impacts associated with motorcycle use of HOV lanes.

Stickered Vehicles. One possible approach to managing demand on an HOV facility is through the use of a sticker program. The basic concept of this technique is to allow vehicles with a valid sticker or electronic device like an automated vehicle identification (AVI) tag to use an HOV facility. Currently, this approach is in use on the Southeast Expressway contraflow HOV lane in Boston. A 3+ vehicle-occupancy requirement is in use on this facility, but 2 person carpools with valid stickers may access the lane. The stickers were distributed by the Massachusetts Highway Department (MassHighways), which is responsible for the project. To ensure that the HOV lane does not become too congested through this program, the stickers are color coded and use of the lane is regulated. Vehicles with license plates ending in an odd number have blue stickers and are allowed in the lane on odd numbered days. Vehicles with license plates ending in even numbers have red stickers and may access the lane on even numbered days. Potential advantages of this approach, which is described in more detail in Section V.G., include maximizing available capacity in the HOV lane, managing demand, expanding the eligible user groups, and addressing actual or perceived perceptions of low use. Potential disadvantages include making enforcement more difficult, adding extra administrative functions and costs to manage the program, confusing users, and adding too many vehicles to the lane.

Tolled Vehicles. Another possible approach is to allow lower or single-occupant vehicles to use an HOV facility for a fee. This technique, which may be referred to as priority pricing, value pricing, or high-occupancy toll (HOT) lanes, is discussed more extensively in Section X.B. Potential advantages of this technique include maximizing available capacity, managing demand, expanding the eligible user groups, addressing real or perceived low use levels, and generating new revenues. Possible disadvantages include making enforcement more difficult, adding costs to administer the program, adding costs associated with automated toll collection, confusing users, and adding too many vehicles to the lane. This approach may also raise concerns from the public and policy-makers relating to equity, double taxation, and use of revenues.

Commercial Vehicles. Commercial vehicles or semi-trucks are not allowed to use any HOV facility in North America, regardless of the number of passengers. This restriction has been applied for safety reasons and because allowing trucks would not encourage ridesharing or reduce VKT. Recently, groups in some areas have suggested providing commercial vehicles with exclusive use of HOV facilities during off-peak periods or allowing trucks to share the lanes with HOVs during normal operating hours. These ideas have been raised partially to segregate commercial vehicles from general-purpose traffic, to provide commercial vehicles with travel time savings to increase their competitiveness, and to gain extended use of the HOV lanes. Potential concerns with opening HOV facilities to commercial vehicles during peak and off-peak periods include lack of compatibility with policies and objectives to increase ridesharing and vehicle occupancy levels, lack of access points to meet the origins and destinations of trucks, design limitations which may not accommodate truck movements, and conflicts between commercial vehicles and HOVs.

Deadheading Buses. Deadheading refers to the operation of buses in non-revenue service. Deadheading usually occurs in the morning and evening as buses are going to and from the garage to the start or the end of a route. Deadheading also occurs with express services, as buses travel back out to start another trip. Operating efficiencies may be realized by allowing deadheading buses to use the HOV lanes. For example, allowing deadheading buses to use an HOV facility may reduce transit operating costs or increase revenue service at no additional operating cost. Buses with only an operator in an HOV lane may create public perception problems, however.

Taxis. Taxis meeting the vehicle-occupancy requirements are considered carpools and are allowed to use the HOV lanes in North America open to carpools. Taxi operators in some areas have requested use of the HOV lanes even when they are not carrying passengers to save time and increase their operating effectiveness. Concerns over public perception and making enforcement of the occupancy-requirements more difficult for police are the two factors commonly cited for not allowing taxis with only the driver to use HOV facilities. An additional factor considered in some areas for not allowing taxis meeting the HOV requirement from using the facilities is that they do not enhance people moving capabilities nor do they result in fewer vehicle trips.

Airport Shuttles and Other Special Services. Vans, buses, and limousine services that meet the vehicle-occupancy requirement are allowed to use many HOV facilities. These services are often oriented toward airports or other major trip generations in an area. Like taxis, the operators of these services in some areas have requested authorization to use HOV facilities even when they are not carrying passengers. Concerns over public perception and enforcement are the two factors commonly cited for not allowing these vehicles to use an HOV facility with only a driver. An additional factor considered in some areas for not allowing airport shuttles and other special services meeting the HOV requirement from using the facility is that they do not enhance people moving capabilities nor do they result in fewer vehicle trips.

Emergency Vehicles. Emergency vehicles are usually allowed on all HOV facilities, even when not on an emergency trip. In most cases, emergency vehicles do not make extensive use of HOV lanes, however, due to access limitations, hours of operation, and other factors. The inclusion of emergency vehicles as an authorized user group should not significantly affect the design of the facility. It is suggested that emergency vehicles be properly identified, as use of the lane by unmarked vehicles may raise public perception concerns.

Low Emitting Vehicles. Consideration has been given in some areas to allowing electric vehicles and other non-polluting or low emitting vehicles to use HOV facilities without regard to the vehicle-occupancy requirements. The ISTEA encourages the inclusion of these vehicles on HOV lanes. Supporters of this approach suggest that providing low emitting vehicles with access to HOV facilities would encourage more widespread use of these technologies. The major concern with allowing low emitting vehicles with only the driver to use an HOV facility relates to enforcement. Alternatively fueled vehicles with only the driver are allowed to use the Houston HOV lanes, and legislation allowing low emitting vehicles to use HOV lanes came close to being approved by the California legislature in 1996. An additional factor considered in some areas for not allowing low emitting vehicles with only the driver to use the facility is that they do not enhance people moving capabilities nor do they result in fewer vehicle trips.

Authorized Vehicles. Some HOV facilities have physical designs or operational constraints that are severe enough to limit their use to trained drivers only. In these cases, an HOV lane may be better suited to a smaller volume of users who are trained and authorized to use the lane. These could include bus drivers, taxi drivers, vanpool drivers, and, in some cases, authorized carpools. Different approaches may be used to identify authorized vehicles and to train drivers.

B. Vehicle-Occupancy Requirements

If carpools are allowed to use an HOV facility, the vehicle-occupancy requirement will need to be considered. As discussed in Chapter 4, the planning process should include an analysis of the demand for a facility at different vehicle-occupancy levels and the impact these requirements will have on traffic flow. The goal is to set the occupancy requirement at a level that will encourage the use of carpooling, vanpooling, and taking the bus, but will not create too much demand to make the lane congested.

Currently, operating HOV facilities that allow carpools are almost evenly split between those requiring two or more persons (2+) per vehicle and those requiring 3 or more people (3+). Although no HOV facility currently requires four or more (4+) occupants, this level has been used in the past. Changing the occupancy requirement by time of day is another possible alternative. The characteristics, advantages, and disadvantages of the various vehicle-occupancy requirements are briefly described in this section and highlighted in Table 5-3. The minimum and maximum operating thresholds are discussed in Sections C and D. Elements to be considered in developing guidelines for minimum and maximum operating levels are presented in Table 5-4 and Table 5-5.

Table 5-3. Vehicle-Occupancy Requirement Criteria

Vehicle-Occupant Level	Advantages	Disadvantages
Two or more (2+) persons per vehicle	• Easiest level of carpools to form. • Often significant numbers of existing 2+ carpools in a corridor.	• May be too many 2+ carpools resulting in congestion in an HOV lane. • May not provide incentive to carpool if high number of existing 2+ carpools or help reduce vehicle trips.
Three or more (3+) persons per vehicle	• Can address congestion problems at the 2+ level. • Higher person moving capacity.	• Harder for individuals to form 3+ carpools. • May not have enough 3+ carpools to make lane look used, causing the empty lane syndrome.
Four or more (4+) persons per vehicle	• Can address congestion problems at the 3+ level. • Higher person moving capacity.	• Hard for individuals to form 4 person carpools. • Harder to operate on a regular basis due to individual travel needs and schedules. • May not have enough 4+ carpools to make lane look used, causing the empty lane syndrome.
Variable requirements by time of day (3+ peak hours, 2+ other operating hours)	• Can address congestion problems during peak-periods.	• May be confusing for users, especially during transition periods. • May make enforcement more difficult, especially during transition periods.

Table 5-4. Elements for Developing Minimum Operating Threshold Guidelines for HOV Facilities

Possible Elements	Comments/Possible Minimum Thresholds
Goals and Objectives of Project	The goals and objectives of a project may influence the minimum operating thresholds. For example, a project intended to give buses priority around a congested freeway segment could be expected to have a lower threshold than an exclusive HOV lane. Local policies on carpool definitions or other elements may also influence the operating thresholds and should be considered in the development of local guidelines.
Type of HOV Facility	The type of HOV facility will probably have the most influence on the development of local minimum operating guidelines. The following general levels provide an indication of the national experience and can be used in developing local guidelines. Separate right-of-way, bus only—200-400 vphpl Separate right-of-way, HOV—800-1,000 vphpl Freeway, exclusive two-directional—400-800 vphpl Freeway, exclusive reversible—400-800 vphpl Freeway, concurrent flow—400-800 vphpl Freeway, contraflow, bus-only—200-400 vphpl Freeway, contraflow, HOV—400-800 vphpl HOV bypass lanes—100-200 vphpl
Vehicle Eligibility Requirements	Lower minimum vehicle thresholds can be expected, and are usually accepted, with bus-only facilities than with facilities open to buses, vanpools, and carpools.
Vehicle-Occupancy Requirements	Lower minimum vehicle thresholds can be expected with higher vehicle-occupancy requirements.
Level of Congestion Corridor	The minimum vehicle threshold may be higher in a heavily congested corridor than in one with lower levels of congestion. Non-users in heavily congested areas may be much more vocal about a facility they feel is under-utilized than commuters in a corridor where congestion is not at serious levels.
Local Conditions	The perceptions of commuters and the public, as well as any unique local conditions, should be considered in developing minimum operating thresholds.

Table 5-5. Elements for Developing Maximum Operating Threshold Guidelines for HOV Facilities

Possible Elements	Comments/Possible Maximum Thresholds
Goals and Objectives of Project	The goals and objectives of a project may influence the maximum operating thresholds. For example, a project intended to give buses priority around a congested freeway segment could be expected to have a lower threshold than an exclusive HOV lane. Local policies on carpool definitions or other elements may also influence the operating thresholds and should be considered in the development of local guidelines.
Type of HOV Facility	The type of HOV facility will probably have the most influence on the development of local maximum operating guidelines. The following general levels provide an indication of the national experience and can be used in developing local guidelines. Separate right-of-way, bus only—800-1,000 vphpl Separate right-of-way, HOV—1,500-1,800 vphpl Freeway, exclusive two-directional—1,200-1,500 vphpl Freeway, exclusive reversible—1,500-1,800 vphpl Freeway, concurrent flow—1,200-1,500 vphpl Freeway, contraflow, bus-only—600-800 vphpl Freeway, contraflow, HOV—1,200-1,500 vphpl HOV bypass lanes—300-500 vphpl
Vehicle Eligibility Requirements	Lower maximum thresholds can be expected, and are usually accepted, with bus-only facilities than with facilities open to buses, vanpools, and carpools.
Vehicle-Occupancy Requirements	The vehicle-occupancy requirements will influence use of a facility and the potential for congestion. A higher threshold may be needed with a 2+ requirement.
Level of Congestion Corridor	The maximum operating threshold may be higher in a heavily congested corridor than in one with lower levels of congestion.
Design Considerations	An HOV facility with geometric constraints or sections with less than standard designs may have lower maximum operating thresholds than those with standard designs.
Local Conditions and Perceptions	The perceptions of HOV lane users, commuters and the public, as well as any unique local conditions, should be considered in developing maximum operating thresholds.

Two or More (2+) Persons per Vehicle. Two or more persons (2+) per vehicle represents the lowest level of carpooling. Forming a two person carpool is much easier than forming a three or four person carpool. Many two person carpools are comprised of family members, co-workers, or friends. Corridors may have significant numbers of existing 2-person carpools, providing a target market for an HOV facility. Using a 2+ vehicle-occupancy requirement level initially provides the greatest opportunity to avoid the empty lane syndrome. On the other hand, if the number of 2+ carpools in the corridor is already relatively high, such as 30 percent on a 4-lane facility, this designation may not improve the person movement capacity of a facility. Implementation of 2+ eligibility level may also represent a staged commitment to ridesharing. If an HOV lane becomes too congested at the 2+ occupancy level, the requirement can be increased to 3+. A general guideline used in many areas is that vehicle volumes at the 2+ level should not exceed 1,200 to 1,500 vehicles an hour per lane. At this level, consideration of raising the occupancy requirement may be appropriate.

Three or More (3+) Persons per Vehicle. The next level for defining a carpool is to require three or more persons (3+) per vehicle. Vehicle volumes at the 3+ level are usually lower than at a 2+ requirement. It is more difficult for individuals to form three person carpools, so some potential carpoolers may not be able to use a facility at a 3+ requirement. Others may form 3+ carpools from existing 2+ carpools, reducing vehicle volumes in the HOV lane. As a general guideline, peak hour HOV lane demand of approximately 800 vehicles is appropriate for consideration of a 3+ vehicle requirement, with a minimum of 400 vehicles per hour.

Four or More (4+) Persons per Vehicle. The highest carpool requirement used with an HOV facility is four or more (4+) persons per vehicle. This requirement was used during the initial stages of the Shirley Highway HOV lanes in the Northern Virginia/Washington, D.C. area and the Katy HOV lane in Houston.

It is difficult for most individuals to not only form carpools with four or more persons, but also to operate those that are formed on a regular basis. Most metropolitan areas probably do not have enough demand at the 4+ level to make this a viable option, especially during the early stages of a project. Estimated volumes of 400 to 800 vehicles an hour per lane at the 4+ level, which is comparable to those identified for the 3+ level, should be present to consider this alternative.

Variable Vehicle-Occupancy Requirements by Time of Day. Another approach is to change the HOV occupancy requirement by time of day. This technique represents one approach to managing demand on an HOV lane. For example, a 3+ requirement may be used during the morning and afternoon peak hours, with a 2+ level in effect during other operating hours. The Katy (I-10

West) HOV lane in Houston is the only facility in the country currently using a variable occupancy requirement.

C. Minimum Operating Thresholds

As discussed previously, the goal of an HOV facility is to provide travel time savings and travel time reliability to buses, vanpools, and carpools. The vehicle-occupancy requirement should be established at a level that will encourage use of the facility and the formation of new carpools, but that will not create too much demand to make the lane congested. Consideration of a minimum operating threshold to ensure that the facility does not look under-utilized, thus creating the empty lane syndrome, is discussed in this section. Managing demand for a facility and maximum flow levels are discussed in the next section.

The number of vehicles using a lane on opening day and during the initial phases of a project should be high enough to justify the facility. Ensuring that the lane is well utilized will help build support among users, non-users, and the general public. If a facility is perceived to be under-utilized, pressure may be exerted to change vehicle-occupancy requirements, operating hours, or to open the lane to mixed traffic.

A number of factors should be considered in assessing the minimum operating thresholds for an HOV facility. The exact minimum threshold for a specific project will depend on the goals and objectives of the project, the type of facility, the vehicle eligibility and vehicle-occupancy requirements, the level of congestion in the general-purpose lanes, and local conditions and perceptions. For example, the minimum threshold will be lower for a bus-only HOV lane used during the peak hours than for a barrier separated exclusive HOV facility. Table 5-4 outlines some of the elements practitioners may wish to consider in developing local guidelines for minimum operating thresholds. The general levels that are commonly used throughout the country are highlighted and discussed below.

As noted in Table 5-4, the type of HOV facility being considered will probably have the most significant influence on the minimum operating threshold. In general, a minimum of at least 400 to 800 vehicles per hour per lane (vphpl) is needed for most HOV facilities. The exceptions to this general guideline are bus-only facilities, HOV bypass lanes, and other special treatments.

D. Maximum Operating Thresholds

While issues may arise if there are not enough vehicles using an HOV facility, problems may also emerge with too many vehicles. Maintaining a level of service in the HOV lane that provides the travel time savings and the travel time reliability bus riders, vanpoolers, and carpoolers have come to expect is important. Along with developing guidelines for the minimum operating thresholds, criteria on the maximum flow rates should also be considered. Further, traffic volumes on HOV facilities should be monitored to help identify when the maximum flow rates are being approached so that appropriate actions can be taken. Chapter 13 provides a detailed discussion of developing and conducting an ongoing monitoring and evaluation program for HOV facilities.

Maintaining a desired level of service on an HOV facility should focus on the operating capacity rather than the design capacity. It is generally recognized that volumes of 1,200 to 1,500 vphpl on most types of HOV facilities will begin to experience degradations in travel time savings and travel time reliability. The exact maximum flow will vary by facility, however. Some HOV lanes serving primarily carpools have operated successfully with up to 1,700 or 1,800 vphpl during the peak hour. Others, like the bus-only contraflow lane approaching the Lincoln Tunnel, reach capacity at 700 to 800 vphpl.

The same factors described for the minimum operating thresholds will also influence the maximum operating thresholds. These include the goals and objectives of a project, the type of HOV facility, vehicle eligibility criteria, vehicle-occupancy requirements, the general level of congestion in the corridor, and local conditions. In addition, design considerations may also influence maximum flow levels. These factors are highlighted in Table 5-5. The guidelines described in the next two sections can be used to help establish local vehicle eligibility and vehicle-occupancy requirements, and to determine when vehicle-occupancy levels or vehicle eligibility requirements need to be changed.

E. Guidelines for Developing Vehicle Eligibility and Vehicle-Occupancy Requirements

A number of factors should be considered in establishing vehicle eligibility and vehicle-occupancy requirements for an HOV facility. The exact factors and threshold levels will vary by metropolitan area depending on local goals and objectives, facility types, design treatments, system connectivity issues, and local conditions. The elements discussed in this section can be used to help develop local criteria for vehicle eligibility and vehicle-occupancy requirements on HOV facilities.

- Metropolitan and Project Goals and Objectives
- Type of HOV Facility
- Specific Design or Operating Limitations
- Segment and Areawide Continuity
- Existing Vehicle-Occupancy Levels
- Travel Time Savings and Travel Time Reliability
- Carpool and Vanpool Formation and Increased Transit Use

Metropolitan and project goals and objectives. The goals and objectives of a specific HOV project or an HOV system should be used in the development of the vehicle eligibility and vehicle-occupancy criteria. These may be reflected in the overall policies discussed in Chapter 3 or they may relate specifically to an individual project. For example, the goals and objectives for an HOV ramp meter bypass, a bus-only facility on a separate right-of-way, and a concurrent flow HOV lane serving primarily carpools, may be different. The vehicle eligibility and vehicle-occupancy requirements may also be different to reflect various goals and objectives.

Type of HOV facility. As noted above, the type of HOV facility being considered will influence the vehicle eligibility and vehicle-occupancy requirements. Bus-only lanes on separate rights-of-way obviously do not require consideration of vehicle occupancy requirements. Most exclusive, concurrent, and contraflow freeway HOV projects do require consideration of both vehicle eligibility and vehicle-occupancy requirements. These facilities usually provide a good deal of flexibility in both vehicle eligibility and vehicle-occupancy criteria.

Specific design and operating limitations. The vehicle eligibility criteria, and, to a lesser extent, the vehicle-occupancy requirement, may be influenced by design or operating constraints associated with a specific facility. For example, facilities with specific design or operating limitations may be restricted to buses, or to buses, vanpools, and 3+ to maintain a lower volume of vehicles than opening it to 2+ carpools.

Segment and areawide area continuity. If there is more than one HOV facility in operation or in the planning stage in a metropolitan area, consideration should be given to uniform vehicle eligibility and vehicle-occupancy requirements. Maintaining the same requirements on multiple facilities can improve public understanding and simplify enforcement. This approach may not be appropriate if there are different types of HOV facilities in an area or if significantly different travel and mode share characteristics exist in various corridors. Several metropolitan areas use different vehicle eligibility and vehicle-occupancy requirements on HOV facilities, while other areas use the same regulations on all HOV lanes.

Existing vehicle-occupancy levels. Vehicle-occupancy levels in a corridor or metropolitan area provide a good indication of the potential for use of a facility by existing carpools at different occupancy levels. A corridor with vehicle occupancy levels of 1.4 persons per vehicle or higher indicates a strong existing carpool market. In this case, it may be appropriate to consider a 3+ vehicle occupancy requirement. On the other hand, a corridor with average vehicle-occupancy levels of 1.1 to 1.2 suggest a 2+ requirement would be more appropriate. The number of existing or planned general-purpose lanes should also be considered. For example, if 25 percent of the existing traffic on a 5-lane facility is comprised of 2+ carpools, a 2+ designation may not provide much of an incentive, whereas a 25 percent 2+ volume on a 3-lane facility might provide more of an incentive.

Travel time savings and travel time reliability. The travel time savings and travel time reliability provided to HOVs using different vehicle eligibility and vehicle occupancy levels should also be considered in establishing guidelines. Minimum speeds and speed reliability are often used in association with travel time savings and travel time reliability. The requirements should maximize the person-moving capacity of the facility, while not degrading operations. Lower vehicle-occupancy requirements usually mean increases in HOVs, which may cause congestion on the lane. It is desirable to establish the vehicle eligibility and vehicle-occupancy requirements to accommodate growth in HOVs without adversely affecting travel times and travel time reliability.

Carpool and vanpool formation, and increased transit ridership. An objective of most HOV projects is to encourage individuals to change from driving alone to riding the bus or forming carpools or vanpools. Vehicle-occupancy requirements should be set at levels that will encourage these shifts. If there are few carpools in a corridor, a 2+ requirement may be an appropriate starting point. The requirements should also allow for growth as more commuters switch to transit, carpooling, and vanpooling. As discussed next, vehicle-occupancy requirements can be increased if needed.

F. Guidelines for Changing Vehicle Eligibility and Vehicle-Occupancy Requirements

As noted previously, one of the advantages of HOV facilities is the flexibility to change vehicle-occupancy or vehicle eligibility requirements in response to increasing demand. For example, if an HOV lane becomes congested at a 2+ vehicle-occupancy level, consideration can be given to raising the vehicle-occupancy requirements to three or more persons. Decisions on changing vehicle-occupancy and vehicle eligibility requirements should not be taken lightly, however. Careful consideration should be given to a number of factors before any decision is made to change vehicle eligibility or vehicle-occupancy criteria. Further, adequate public information should be provided to commuters prior to any actual change.

Consideration should be given to developing policies and criteria for use in guiding the decision-making process on changing vehicle eligibility and vehicle-occupancy requirements. These policies and criteria can serve a number of purposes. First, they can help focus the technical analysis on the key elements that should be examined in the decision making process. Second, they can help communicate the factors that will be considered and the need for a change on a specific project to decision makers and the public. This information is important to help develop an understanding among these groups on when changes may be needed and to build support for changes on a specific facility.

The guidelines developed by the Washington State Department of Transportation (WSDOT) provide one of the best examples of criteria for determining if changes are needed in vehicle eligibility and vehicle-occupancy requirements. The WSDOT policies focus on the minimum average speed and speed reliability on an HOV facility. Thus, the policies support providing reliable travel speeds and travel time reliability to

HOVs. The measures used by WSDOT indicate that HOV lane vehicles should maintain or exceed an average operating speed of at least 45 mph 90 percent of the time over a consecutive six-month period (1). If this criteria is not met, approaches for addressing the problem will be examined. These approaches may or may not include changing vehicle-occupancy or vehicle eligibility requirements.

In addition to these two factors, consideration of other elements may also be of help in determining when changes need to be made in vehicle eligibility and vehicle-occupancy criteria. Four factors that may be appropriate for consideration in the development of guidelines for an area are outlined next. These are followed by a discussion of other approaches that may be used to help manage demand on an HOV facility.

- Vehicle volumes
- Vehicle speeds
- Travel time savings
- Travel time reliability

Vehicle volumes. One criteria that can be used to help identify if changes are needed in vehicle-occupancy requirements and vehicle eligibility criteria is the number of vehicles using the facility. As discussed in the previous section on maximum operating thresholds, the guidelines should be matched to the type of facility, design and operating concerns, project goals and objectives, and local conditions. The general ranges provided in Table 5-5 can be used to assist with the development of project or areawide guidelines on maximum vehicle volumes.

Vehicle speeds. The speed of vehicles traveling in an HOV lane can be used as another criteria to help identify the need to change vehicle eligibility requirements or to increase vehicle-occupancy levels. The desired operating speed for a facility should first be identified based on the speed limit for the facility, the general travel speeds in the corridor or freeway, and any special design and operating characteristics. Speeds on the HOV facility can then be monitored. Recurring speeds that fall below the desired level may indicate the need to re-evaluate the existing vehicle-occupancy requirements and possibly the vehicle eligibility criteria.

Travel time savings. This criteria relates to both vehicle volumes and travel speeds in the general-purpose lanes, as well as those on the HOV facility. Providing travel time savings to HOVs is critical to the ongoing success of a project. It is possible, however, for travel speeds to decrease slightly on a HOV lane, while still maintaining significant travel time savings over the general-purpose lanes. To use this criteria, a desired travel time advantage for HOVs should first be established, and a program to monitor travel times on both the HOV and general-purpose lanes should be established. If this level is not maintained on a regular basis, consideration can be given to changing the vehicle-occupancy requirements or vehicle eligibility.

Travel time reliability. Surveys of carpoolers, vanpoolers, and bus riders indicate that the travel time reliability provided by HOV facilities is as important as the travel time savings in the decision to change from driving alone to using an HOV. Thus, one measure for consideration in developing criteria for changing vehicle eligibility and vehicle-occupancy requirements is the travel time reliability provided by an HOV facility. Once a desired level of reliability has been established for an HOV project or an HOV system, changes and degradations in the level can be monitored and appropriate action can be taken as needed.

G. Other Techniques for Managing Demand

In addition to changing vehicle eligibility and vehicle-occupancy requirements, other techniques may be appropriate for consideration in managing demand on an HOV facility. As discussed in this section, these approaches focus on managing demand on the facility and on alternative operational strategies. It may be appropriate to consider these strategies first, before focusing on changing vehicle eligibility or vehicle-occupancy requirements.

- Encouraging voluntary higher vehicle-occupancy levels
- Encouraging alternative work or commute schedules
- Metering access points
- Adding HOV capacity

Encouraging voluntary higher occupancy levels. Prior to changing to a higher vehicle-occupancy level, it may be appropriate to first encourage the voluntary formation of carpools at the higher level. Marketing and public information campaigns could be undertaken to encourage the formation of carpools with higher occupancy levels. If a 2+ vehicle occupancy requirement is in effect, the campaign could focus on encouraging the formation of 3+ carpools. Further, supporting programs and policies could be used to encourage higher vehicle-occupancy levels. For example, providing free parking for 3+ carpools, while charging 2+ carpools a reduced rate over single occupant vehicles, may encourage an increase in 3 person carpools. This approach may result in enough 3+ carpools to reduce congestion in the HOV lane. The limited experience with this approach indicates that significant numbers of carpoolers are not likely to increase vehicle-occupancy levels voluntarily, however.

Encouraging alternative work or commute schedules. A second approach focuses on encouraging commuters to shift their travel to less congested time periods. If congestion is occurring during the peak-hour or the peak-period, HOV users could be encouraged to shift their travel to the shoulders of the peak-period or outside of the peak. Greater use of alternative work schedules by employers can help facilitate this shift.

Metering access points. Freeway ramp metering has been used in many areas to improve the flow and increase the capacity of freeways. This approach could also be used on HOV facilities to help manage demand. For example, vehicles entering an HOV lane from a direct ramp at a park-and-ride lot could be metered, or 2+ carpools could be metered with 3+ carpools allowed to bypass the meter. This approach may have limited application due to the design of most HOV projects. It may be appropriate for considering in specific cases, however.

Adding HOV Capacity. Another approach is to add HOV capacity in the corridor. Depending on available right-of-way, the characteristics of the existing HOV facility, and projected demand, options that might be considered include adding a lane to a single lane facility, developing an HOV lane on an adjacent freeway or roadway, and adding exclusive access treatments.

VI. TRANSIT AND SUPPORT SERVICES AND FACILITIES

A. Transit Service Orientation

A variety of bus services and bus operating strategies can be used with HOV facilities. The wide range of operating scenarios indicates the flexibility in service orientation and service levels offered by HOV facilities. For example, bus services can be tailored to the specific travel patterns and travel needs of residents and the unique characteristics of an area. In addition, modifications to route structures and service levels can easily be made in response to changing conditions. The six bus operating strategies most often found with HOV facilities are summarized next. More detailed information on each approach, as well as case study examples, is provided in Chapter 9.

Dedicated Services. Dedicated bus service operates only on a busway or an HOV lane. The route is dedicated to the HOV facility and does not deviate off of the lane. Routes of this nature provide service similar to an LRT or a heavy rail line. Passengers generally access dedicated routes by walking to a station, using a connecting route, driving to a station or park-and-ride facility, or being dropped off at a station. Operating speeds are usually in the range of 56 to 69 kph (35 to 40 mph), but may reach 80 to 89 kph (50 to 55 mph) on longer segments. Service is offered on these routes throughout the day, with frequent buses operating during the peak hours. Dedicated services are usually found with bus-only facilities.

Express and Park-and-Ride Services. Express services—or park-and-ride routes as they are called in some areas—are routes that initiate from park-and-ride lots or other areas close to the HOV lane and then operate as express service to major activity centers. This type of route provides high-speed service using the HOV lane. Most express or park-and-ride service is oriented toward the downtown or other major activity center. Speeds for the line-haul portion of the trip on the HOV lane usually average 80 to 89 kph (50 to 55 mph). These services are usually oriented toward peak-period commuters. Thus, many areas provide express or park-and-ride services only during the peak-periods, with little or no off-peak service. Express transit service is found with all types of HOV lanes.

Neighborhood Oriented Routes. These routes offer local service in neighborhood areas and then access the HOV lane for the trip to the downtown area or to another major activity center. Operating speeds in the neighborhood areas tend to be in the range of 8 to 16 kph (5 to 10 mph), while speeds on the HOV segment average between 72 to 89 kph (45 and 55 mph). Neighborhood routes provide commuters with the advantage of not having to drive to a park-and-ride lot or to transfer from a local feeder route. Further, neighborhood oriented routes may serve areas with concentrations of transit dependents. Neighborhood routes may operate only during the peak-periods, or they may operate throughout the day.

Reverse Commute and Suburb-to-Suburb Routes. The transit routes described previously focus primarily on serving trips oriented toward the downtown or to other activity centers. This network structures reflects the traditional orientation of transit services, which has historically provided service from suburban areas to central cities and downtown areas. Less service has been focused on providing residents of central cities with access to suburban areas or serving trips between suburbs. Reverse commute and suburb-to-suburb services have been implemented in some areas to meet these travel needs. Reverse commute routes provide central city residents with access to jobs, shopping, and other opportunities in suburban areas. Suburb-to-suburb routes provide service between suburban communities.

Timed-Transfer Services. Timed transfer systems are oriented around a network of transit routes designed to facilitate fast and convenient transferring between different routes. Timed transfer systems are set up so that routes and buses are linked at major interchange points, which are usually major transit centers. Buses on all routes serving the transfer points operate on the same headways or service frequencies. Buses are scheduled to arrive at the interchange point at the same time to allow passengers to transfer between routes. The advantage of this system is that passengers do not have to go downtown to transfer, as in a traditional radial system, allowing riders to reach more destinations more conveniently and quickly.

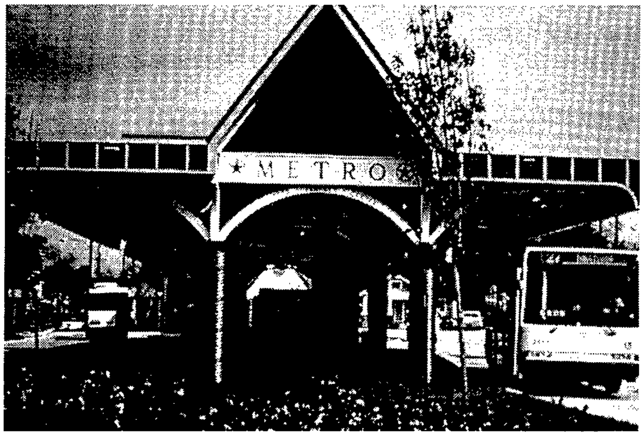
B. Supporting Facilities

Four general types of support facilities are commonly found with HOV lanes on freeways and in separate rights-of-way. These are park-and-ride and park-and-pool lots, transit stations, intermodal facilities, and bus stops and shelters. Supporting facilities associated with arterial street HOV applications include bus stops and shelters, transit stations, and intermodal facilities. A general description of these facilities is provided in this section. More detailed information on the various types of supporting facilities are contained in Chapter 9. Figure 5-21 highlights examples of these facilities.

Park-and-Ride Facilities. Park-and-ride and park-and-pool lots are integral parts of most HOV facilities in North America. Although the size, location, and design of park-and-ride facilities vary among different HOV projects, all share a common purpose. Park-and-ride and park-and-pool lots provide users with the opportunity to change between low and high occupancy vehicles, affording an effective combination of automobile and bus, vanpool, and carpool use. Park-and-ride lots are usually oriented toward commuters changing from an automobile to a bus or a rail system, while park-and-pool facilities assist in the formation of carpools and vanpools. Access to the lots may also be accomplished by walking or bicycling, and some park-and-ride facilities provide bicycle storage lockers or bicycle racks. In addition, some travelers may be dropped off and picked up, rather than leaving their vehicle in the lot all day.

Transit Stations. Transit stations or transit centers are used with many HOV lanes. Transit stations provide convenient, safe, and sheltered locations for passengers to wait for buses and to transfer between different routes or services. Most transit centers include enclosed waiting areas for passengers and multiple bus bays. Route and schedule information is usually provided and some facilities include amenities such as bus pass sales outlets, newspaper racks, small convenience stores, and other services. Many transit stations—although not all—associated with HOV facilities are incorporated into park-and-ride lots. The type and design of a transit station is related to the nature of the HOV facility and the bus operating concept to be served. The two basic types of stations are on-line centers, which are located on the HOV lane, and off-line stations which are located adjacent to the lane or freeway.

Intermodal Facilities. Intermodal facilities serve multiple modes, providing travelers with the opportunity to change from one transportation service to another. Intermodal facilities enhance the connectivity of all mode and make it easier for individuals to transfer between different services. Intermodal facilities are usually relatively large, providing amenities such as waiting areas, ticket sales and passenger information, convenience services, and other activities.



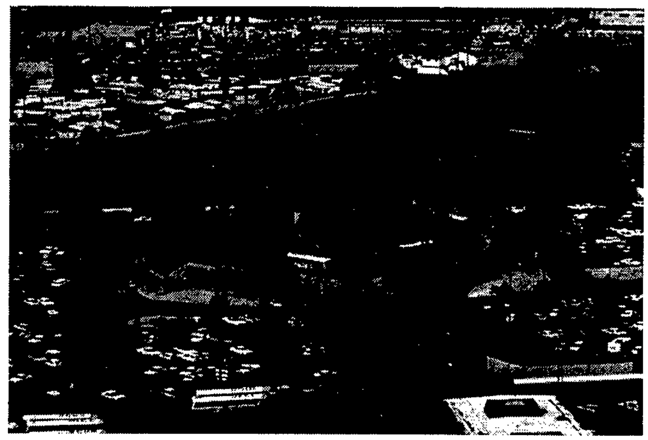


Figure 5-21. Examples of Supporting Facilities Frequently Found with HOV Lanes

Bus Stops and Shelters. Bus stops are the basic point of access for passengers. Transit stops are thus integral parts of HOV facilities, especially those located along arterial streets. Even HOV lanes on freeways and in separate rights-of-way are served by buses that operate on local streets in downtown areas, major activity centers, and neighborhoods. Ensuring that bus stops are located appropriately, are well situated and designed, are adequately maintained, provide information on routes and schedules, and include shelters, benches, and other amenities as needed, are important factors in the development of a comprehensive HOV system.

VII. HOURS OF OPERATION

A. Factors Influencing HOV Operating Hours

In general, the operating hours of HOV facilities can be characterized by three different scenarios. These are continuous 24-hour use, extended morning and afternoon operating hours, and peak-period only operation. In addition, some facilities are open additional hours for sporting events or other special activities. Factors to be considered in determining the most appropriate operating schedule include the project goals and objectives, the type of HOV facility, the level of congestion in the corridor, system or regional connectivity, and enforcement and safety concerns. Each of these considerations is described briefly, followed by a discussion of the characteristics associated with the various operating scenarios. Also described are the various alternatives available for consideration during non-HOV operating periods.

Metropolitan and project goals and objectives. The goals and objectives contained in the transportation plan for a metropolitan area and those related to the specific project may influence the hours of operation. For example, areas such as Seattle and Southern California have policies relating to providing HOVs with priority treatment during all times of the day and night. As a result, HOV lanes in these areas operate on a 24-hour basis.

Type of HOV facility. Although no one specific operating scenario necessarily equates to a certain type of HOV facility, the orientation and design of a facility will influence the operating hours. For example, projects designed to provide HOVs with priority treatment around a specific bottleneck may operate only during congested time periods, as may contraflow facilities. Reversible lanes also require some time to open, close, reverse the direction of traffic flow, reopen, and close.

Congestion levels in the corridor. The level of traffic congestion on the freeway and in the travel corridor may also influence the hours of operation for an HOV facility. In some areas, such as Southern California, congested freeway conditions extend over long periods of day. As a result, the HOV lanes operate on a 24-hour basis. In other areas, HOV facilities may operate only during the most congested periods of the day.

System or regional connectivity. If there are multiple HOV lanes in an area, consideration may be given to coordinating the operating hours of the various facilities. Uniform operating hours can make it easier for commuters and enforcement personnel. Similar operating hours may not always be possible, however, depending on the type of HOV facilities in an area.

Enforcement and safety. The need for enforcement during all operating periods may influence the hours an HOV facility is open. In addition, safety concerns, such as the potential for vehicles to enter a lane in the wrong direction of travel, should be considered in assessing alternative operating scenarios.

B. Alternative HOV Operating Hour Scenarios

The characteristics of the three general operating hour scenarios—24 hour, extended hours, and peak-only—for HOV facilities are described in this section, along with the use of HOV lanes during special events. Examples of the use of different operating hours are provided and the advantages, limitations, and issues associated with different scenarios.

24-hour Operation. This approach maintains the HOV designation and operation of a facility on a 24-hour basis. In these cases, the HOV lane is open during all operating periods. Continuous 24-hour operation tends to be found with HOV lanes in separate rights-of-way and with freeway concurrent flow and exclusive two-way facilities. As could be expected, this approach is not used with contraflow or exclusive reversible HOV facilities. Examples of HOV facilities operating on a 24-hour basis include the bus-only facilities in Pittsburgh and Ottawa; the exclusive two-directional HOV lanes on I-84 in Hartford and the San Bernardino Busway in Los Angeles; and the concurrent flow lanes in Seattle and Southern California.

The 24-hour operating scenario is based on the premise or policy that HOVs should be provided with priority treatment at all times. Since congestion or incidents may occur at any time, the 24-hour designation provides HOVs with travel time savings and travel time reliability throughout the day and night. This operating scenario also allows travelers to use the HOV facility during non-commute hours. For example, recreational trips often include more than one person in a vehicle. The 24-hour operating scenario allows these individuals to use the HOV lanes, which may promote wider acceptance of the facility. Off-peak use by travelers may also help encourage peak-period use by commuters.

The 24-hour designation may also help to minimize potential confusion on the part of motorists on whether or not the HOV designation is in effect. Since the vehicle- occupancy requirement is always in effect, motorists know they should not use the lane unless they have the correct number of passengers. As a result, the continuous HOV designation can also make enforcement easier, as there is no question on the operation requirements. Twenty-four hour operation may simplify signing and lane marketings. Also, there may be no need for additional general-purpose capacity during the off-peak if the facility is not congested. If congestion does exist, priority may be given to HOVs to meet specific transportation goals and objectives in an area.

Limitations and issues associated with 24-hour operation of an HOV facility include possible negative public perception if the facility is not well used during off-peak hours, the need for ongoing enforcement, and potential safety concerns. The advantages and limitations should be examined in determining the appropriate operating scenario for a specific facility.

Extended Operating Hours. Extended operating hours encompass a major portion, but not all, of the day. In most cases, HOV lanes using extended hours are open for major portions of the morning and afternoon. Although the exact hours of operation vary by facility, this scenario often encompasses the time periods from 6:00 A.M. to 11:00 A.M. and the 3:00 P.M. to 7:00 P.M. These times correspond to the major commuting periods, when traffic congestion is heaviest.

Extended operating hours are currently in use with exclusive reversible HOV lanes, concurrent flow lanes, and contraflow lanes. Examples of specific facilities using this operating approach include the exclusive reversible HOV lanes in Houston, San Diego, Denver, Minneapolis, and the Northern Virginia/Washington, D.C. area; the concurrent flow HOV lanes in Miami, Orlando, and Minneapolis; and the contraflow lanes in Dallas and Boston.

Extended operating hours provide HOVs with travel time savings and travel time reliability during the periods when the general purpose freeway lanes are most likely to be congested. This approach may also represent the most logical or the only realistic scenario for some types of HOV facilities. For example, extended hours are often the most appropriate approach with exclusive reversible facilities and contraflow lanes using a separation that allows access to all HOVs.

Potential limitations of extended operating hours include confusion on the part of motorists, which makes enforcement more difficult, and the need for additional signing and pavement markings. As discussed more extensively in Section C, the use of the facility during non-HOV operations may influence the level of these concerns. If an HOV facility is closed during non-HOV operating hours, which is usually the case with exclusive reversible lanes, these may not be major problems. A concurrent flow HOV lane that is open to general traffic during non-HOV operating periods will probably have to address these concerns.

Peak-Period Only Operation. The final operating scenario is to use the HOV lane only during the peak-periods in the morning and afternoon. Peak-period operation is defined more narrowly than the extended hours, usually encompassing the hours from 6:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:00 P.M., although variations are found in these hours. Some facilities use the HOV restriction only in the peak-direction of travel, while others may operate only in the morning peak-period in the peak-direction.

Peak-period operating hours are used primarily with concurrent flow and contraflow HOV lanes. Currently, concurrent flow lanes in Minneapolis, Miami, Orlando, San Francisco, and San Jose are restricted to HOVs only during the peak-hours. The concurrent flow HOV lanes on US 36 in Denver, and the contraflow lanes on Rt. 495, the Long Island Expressway, and the Gowanus Expressway in New York operate only in the morning peak-period in the inbound direction.

Peak-period only operations present many of the same advantages, disadvantages, and issues as extended operations. Advantages include providing priority to HOVs at critical times of the day and addressing specific bottleneck problems. Depending upon the use of the facility during non-HOV operating periods, possible disadvantages include confusion on the part of commuters, more difficult enforcement, safety issues, and increased signing needs.

Extended Operating Hours for Special Events and Other Activities. A few HOV facilities throughout the country are open on a periodic basis outside the normal operating hours for special events and other activities. These may include sporting events and special activities. A number of examples highlight the use of HOV lanes to help traffic during special events. The I-394 HOV lanes in Minneapolis are open in the evening and on weekends for professional baseball, football, and basketball games and University of Minnesota football games at facilities in downtown Minneapolis. Vehicles using the HOV lanes must meet the 2+ vehicle-occupancy requirement. The I-279 HOV lane in Pittsburgh is open extended hours in the outbound direction after baseball and football games at Three Rivers Stadium in the downtown area. All traffic is eligible to use the facility to exit the stadium.

Opening these and other HOV facilities for special events can provide a number of benefits. First, the HOV lanes can help manage traffic during major events and can improve the traffic flow into and out of the sports stadium or other facility. Second, opening an HOV lane for special events provides opportunities for travelers to use the facility who might not be able to use the lanes during their regular commute. Using an HOV lane during a special event can be a good way to introduce the facility to non-users and to build public acceptance and support.

Opening an HOV lane for special events is not without possible concerns, however. Since many travelers may be first time users, care should be taken to provide advance information on access points, vehicle-occupancy requirements, and other operating instructions. Additional or special signs and enforcement may also be needed to ensure safe operation of an HOV facility during special events.

C. Use of Facility During Non-HOV Operating Periods

The operating hour scenarios discussed in the previous section correspond to two general operating philosophies. One approach, which equates to 24-hour operation, is a dedicated facility that is reserved for HOVs at all times. The other general approach, which covers both extended hours and peak-period operation, provides HOVs with priority use only during specific times of the day. These facilities may be open for general-purpose vehicles, revert to shoulders, or be closed to all traffic during non-HOV operating hours.

As discussed in Chapter 4, the planning process should assess the demand for an HOV facility over all operating hours, as well as the opportunities for providing HOVs with priority during the peak-periods. The alternatives for use of an HOV facility during non-HOV operating hours relates to the type of facility, as well as the goals and objectives of the project, and potential operating, enforcement, and safety concerns. The current practices associated with different types of HOV facilities are described in this section, along with elements to be considered in assessing alternatives for non-HOV operating periods.

Separate Right-of-Way. Currently, all of the bus-only facilities located in separate rights-of-way operate on a 24-hour basis. These facilities were designed and developed to provide relatively high speed transit service during all times. Thus, other vehicles are not allowed to use the facility at any time.

Exclusive Facilities on Freeways. All of the exclusive lanes on freeways, with two exceptions, are reserved for HOVs on a 24-hour basis or are closed during non-HOV operating periods. These include both the two-directional HOV facilities which operate on a 24-hour basis, and the reversible lanes, which have extended opening hours or are open only during peak-periods.

The two exceptions are the I-279 HOV lanes in Pittsburgh and the Shirley Highway HOV lanes in the Northern Virginia/Washington, D.C. area. As noted previously, the I-279 HOV lanes operate in the outbound direction for all traffic after sporting events and other activities at Three Rivers Stadium. The Shirley Highway HOV lanes are open to general traffic during non-HOV operating hours. On weekdays the lanes are open to general-purpose vehicles in the inbound direction in the morning and the outbound direction in the afternoon. On weekends the lanes are open in the outbound direction to all traffic to help accommodate many of the weekend special events in Washington, D.C.

Concurrent Flow HOV Lanes. A mix of operating philosophies is found with existing concurrent flow HOV lanes. In some areas, such as Seattle and Southern California, the concurrent flow lanes are dedicated for HOV use on a 24-hour basis. In other cases, the HOV lanes revert back to mixed-flow lanes or shoulders during non-HOV operating periods. For example, the concurrent lanes in Miami, Orlando, Minneapolis, Nashville, Phoenix, San Francisco, San Jose, and Honolulu are open to general traffic during non-HOV periods. The concurrent flow HOV lanes on US 36 in Denver and Highway I-99 in Vancouver revert back to shoulders.

Contraflow HOV Lanes. All of the contraflow HOV lanes revert back to general purpose use during non-HOV operating hours. These facilities utilize available capacity in the off-peak direction for HOVs moving in the peak-direction of travel. The lanes are needed for general purpose traffic when the off-peak direction becomes the peak-direction of travel during other times of the day.

A number of factors should be considered in assessing fully dedicated or part-time HOV facilities. Part-time facilities provide HOVs with priority treatment during the critical times of the day. As congestion increases in many areas, however, it may be desirable to provide HOVs with priorities during all operating periods. For example, midday use on some HOV lanes in Southern California is approaching 70 percent of the peak-period volumes.

Issues relating to informational signs and pavement markings, enforcement, and safety should also be examined with part-time facilities. Signs providing information on operating hours and vehicle-occupancy requirements should be clearly visible and easily understood. Enforcement may be more difficult with part-time facilities and a grace period at the beginning of the HOV restricted period may be needed for vehicles that entered the lane prior to the start of the HOV-only time period to exit. Safety may be a concern with the use of shoulder lanes for HOVs.

Different approaches have been used with shoulder HOV lanes. In Seattle, HOV lanes are in operation on a 24-hour basis on the outside lanes of I-405 and SR 520. These projects have effectively served bus operations in the two corridors. Minimal conflicts have been experienced with general purpose traffic merging and diverging from local access ramps. As noted in Chapter 3, WSDOT has developed guidelines for consideration of HOV operations on shoulders.

A major safety concern with shoulder use is that motorists may continue to stop in the shoulders in an emergency, creating a dangerous situation. Providing adequate signing for these situations is important. Enforcement may also be more difficult with the part-time use of shoulders.

VIII. ENFORCEMENT

A. Role of Enforcement Policies and Programs

Enforcement is a critical element to the successful operation of an HOV facility. The role of an HOV enforcement program is to ensure that operating requirements, including vehicle-occupancy levels, are maintained to protect HOV travel time savings, to discourage unauthorized vehicles, and to maintain a safe operating environment. Visible and effective enforcement promotes fairness and maintains the integrity of the HOV facility to help gain acceptance of the project among users and non-users. On the other hand, there may be a perception on the part of some motorists that enforcement is greater on HOV lanes than on the general-purpose lanes which may discourage use by some eligible groups.

Enforcement policies and programs perform a number of important roles. First, the development of enforcement policies and programs will help ensure that all of the appropriate agencies are involved in the process and that all groups have a common understanding of the project and the need for enforcement. Thus, the participation of representatives from enforcement agencies, the courts and legal system, the state department of transportation, the transit agency, and other groups throughout the development and implementation of enforcement policies and programs is critical.

Second, this same information can be provided to the public, especially travelers in the corridor to help introduce the HOV facilities and to communicate the guidelines for use of the lanes. Third, the enforcement policies and programs should be followed to maintain the integrity of the facility by deterring possible violators and to promote the safe and efficient use of the lane.

B. Groups Involved in Developing Enforcement Policies and Programs

As discussed in Section II A of this chapter, representatives from a number of agencies and groups should be involved in the development of HOV enforcement policies and programs. The various groups to be included in the development of enforcement programs and their specific roles are highlighted next.

State Department of Transportation. The state department of transportation or the state highway department is usually the lead agency with HOV facilities on freeways. As a result, these agencies have overall responsibility for the project, including developing the enforcement plan and ensuring that the completed facility is adequately enforced. Representatives from the state may take the lead in developing the enforcement program, working with individuals from other agencies, or enforcement agency staff may take the lead in this element.

Transit Agencies. Transit agencies often have the lead responsibilities with HOV facilities on separate rights-of-way. In other cases, the transit system may be a co-sponsor or a supporting agency. If the transit agency has the overall responsibility for the project, they will also have the lead role in developing the enforcement plan and ensuring that the completed facility is adequately enforced. If the transit agency is playing more of a supporting role, they may assist with the development and implementation of the enforcement program.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities has been stressed throughout this Manual. The active involvement of enforcement personnel is obviously critical in the development and implementation of an enforcement program. Police personnel may take a lead role in the development of the enforcement plan.

State and Local Judicial Systems. Representatives from the state and local courts and legal system should be consulted and involved during the development of the enforcement program. These individuals will be responsible for enforcing fines and citations for improper use of the HOV facilities. Ensuring that they are informed about the purpose and scope of the project and that the proper legal fines, citations, and procedures are being applied will help ensure that violations are upheld in the legal system.

Local Municipalities. Representatives from City or County departments may play important supporting roles in the development of enforcement programs on HOV facilities on freeways and in separate rights-of-way.

Metropolitan Planning Organization (MPO). Representatives from the MPO are usually members of the multi-agency planning group associated with HOV facilities. As a result, MPO staff may play important roles in assisting with the development of an enforcement program. The MPO may have policies relating to various aspects associated in the operation and enforcement of an HOV facility.

Rideshare Agency. If a separate agency or organization is responsible for ridesharing in an area, representatives from these organizations should be part of the project management team and should be involved in the development of the enforcement plan.

Federal Agencies. Representatives from FHWA and FTA may also assist with the development of the enforcement plan through participation on the multi-agency committee. Personnel from these agencies can often provide technical assistance on specific enforcement issues and can provide guidance on the use of federal funding for enforcement activities.

C. Elements of an HOV Enforcement Program

An effective enforcement program should include a number of components. The six general elements that should be considered in developing an enforcement program include the legal authority to enforce a facility, the nature of citations for violations and the level of fines, the general enforcement strategies, the specific enforcement techniques, funding, and communicating the program elements to users, non-users, and the public. Each of these elements is summarized in this section and is discussed in more detail in the following sections.

Legal Authority. The appropriate agencies must have the legal authority to enforce the HOV operating regulations, including vehicle eligibility and vehicle-occupancy requirements. Existing statutes should be reviewed during this task and the need for changes in current regulations or new legislation should be identified.

Citations and Fines. The type of citation that will be issued for different violations and the accompanying fine should be examined. Ensuring that the appropriate classification is used will help ensure that citations are upheld in the court system. Establishing fines at levels high enough to deter possible violators is also important.

General Enforcement Strategies. Four general enforcement approaches or strategies are usually considered with HOV facilities. These are routine enforcement, special enforcement, selective enforcement, and self-enforcement. The specific techniques used with each of these approaches may vary slightly.

Specific Enforcement Techniques. A variety of specific techniques can be used with each of the general enforcement strategies. For example, different surveillance and detection methods may be used by stationary or roving patrols, including the use of advanced technologies.

Funding. A variety of funding sources may be used to support enforcement activities. These include enforcement, construction, and other transportation funds from federal, state, and local sources available to various agencies. Innovative financing techniques may also be considered for enforcement.

Communication Techniques. The various elements of the enforcement program, including the operating requirements, the penalties and fines for violations, and the techniques used to monitor a facility should be communicated to users, non-users, and the public. This step is important to ensure that all groups have an understanding of the proper use of the HOV facility and the consequences of improper use.

D. Legal Authority for Enforcement

The agency responsible for enforcing the operating requirements of an HOV facility must have the legal authority to do so. This authority must include the ability to issue citations to individuals violating vehicle eligibility regulations, vehicle-occupancy requirements, hours of operation, speed limits, and other operating regulations.

Although the agency charged with enforcement of HOV facilities, which is usually the state patrol or local police, may have specific authority related to many of these violations, others may need additional legal definition. For example, police have the authority to enforce posted speed limits. Enforcing vehicle-occupancy requirements on an HOV facility, however, may not be specifically identified in the statutes outlining the powers and authority of the state or local police.

Ensuring that the enforcement agency has the power to issue citations, and that these tickets will be upheld in the court system, is a critical first step in developing an enforcement program for an HOV facility. New or modified legislation has been needed in some areas to address enforcement of HOV facilities. For example, in Houston, city ordinance was revised to give METRO police the authority to issue citations to drivers of vehicles violating the vehicle-occupancy requirements and other HOV lane regulations. In other areas, these violations have been included under the broad heading of "moving vehicle violations" or "failure to obey posted signs" that the state patrol or police have regulatory authority over.

E. Citations and Fines

Related to the legal authority to enforce the operating requirements of an HOV lane is the type of citation that will be issued for various infractions and the fine associated with these violations. As one might expect, the general experience with fines for non-compliance with HOV facility operating requirements is that higher fines equate to lower violations.

Table 5-6 identifies the type of citation issued and the fines applied with selected HOV facilities in the country. As noted, some areas use a graduated scale, with fines increasing for repeated offenses. In other areas, additional penalties, such as payment of court costs or demerits on the driver's record, are part of the fine. Posting the fines for violating the HOV facilities can be an effective technique for self-enforcement. Also, consideration should be given to uniform and consistent citations and fines for HOV facilities within a state.

F. General Enforcement Strategies

Enforcement strategies for HOV facilities can generally be categorized into four basic approaches. These are routine enforcement, special enforcement, selective enforcement and self-enforcement. All of these strategies may be appropriate for consideration with the various types of HOV projects. The most effective approaches and techniques will vary somewhat for different facilities. For example, enforcement of barrier-separated facilities is easier than for buffer-separated facilities. The four general enforcement approaches are described in this section. Figures 5-22 through 5-25 illustrate examples of different enforcement techniques used with HOV facilities.

Routine Enforcement. Routine enforcement represents the normal level of police patrols in an area, regardless of the presence of an HOV facility. This approach does not include extra patrols or other special activities because of the HOV lane. Rather, the normal level of policing in a corridor is provided and monitoring HOV lane use is just one of many responsibilities of the enforcement personnel.

Table 5-6. Examples of Citations and Fines for Violating HOV Requirements

HOV Facility	Type of Citation	Fine
Separate Right-of-Way		
Ottawa Transitway	Trespassing	$54 (Canadian)
Pittsburgh Busways	Citation	$300 plus court costs
Exclusive Freeway		
Hartford, I-84	Citation	$40
Houston HOV lanes	Citation	$75
Los Angeles-San Bernardino	Citation	$100/$150-200/$250-500 plus court costs
Minneapolis, I-394	Citation	$44/$55/$66
Pittsburgh, I-279	Citation	$82.50
Northern Virginia/Washington, D.C., I-395, I-66	Citation	$50
Concurrent Flow		
California, all facilities	Citation	$100/$150-200/$250-500 plus court costs
Florida	Citation	$52
Phoenix, I-10	Citation	$250
Seattle	Citation	$47 and reported as moving violation on driver's record
Contraflow		
Boston	Citation	
Dallas	Citation	
New York City	Citation	$65 and 2 points toward license revocation

Routine enforcement may be considered in a number of situations. First, this approach may be appropriate once an HOV lane has become well established and the violation rate is at a low or locally accepted level. Second, routine enforcement may be used when the design or operation of a facility makes it relatively easy to monitor. Finally, if resources are not available to fund other approaches, routine enforcement may be the only alternative available.

Special Enforcement. Special enforcement involves the dedication of additional personnel and resources to monitoring and policing an HOV facility. Approaches may include assigning a patrol car specifically to an HOV lane, adding extra patrols in a corridor with an HOV facility, or locating enforcement personnel along a facility during all operating hours. Special enforcement activities may be accomplished by reallocating existing personnel or by adding additional enforcement during key operating periods.

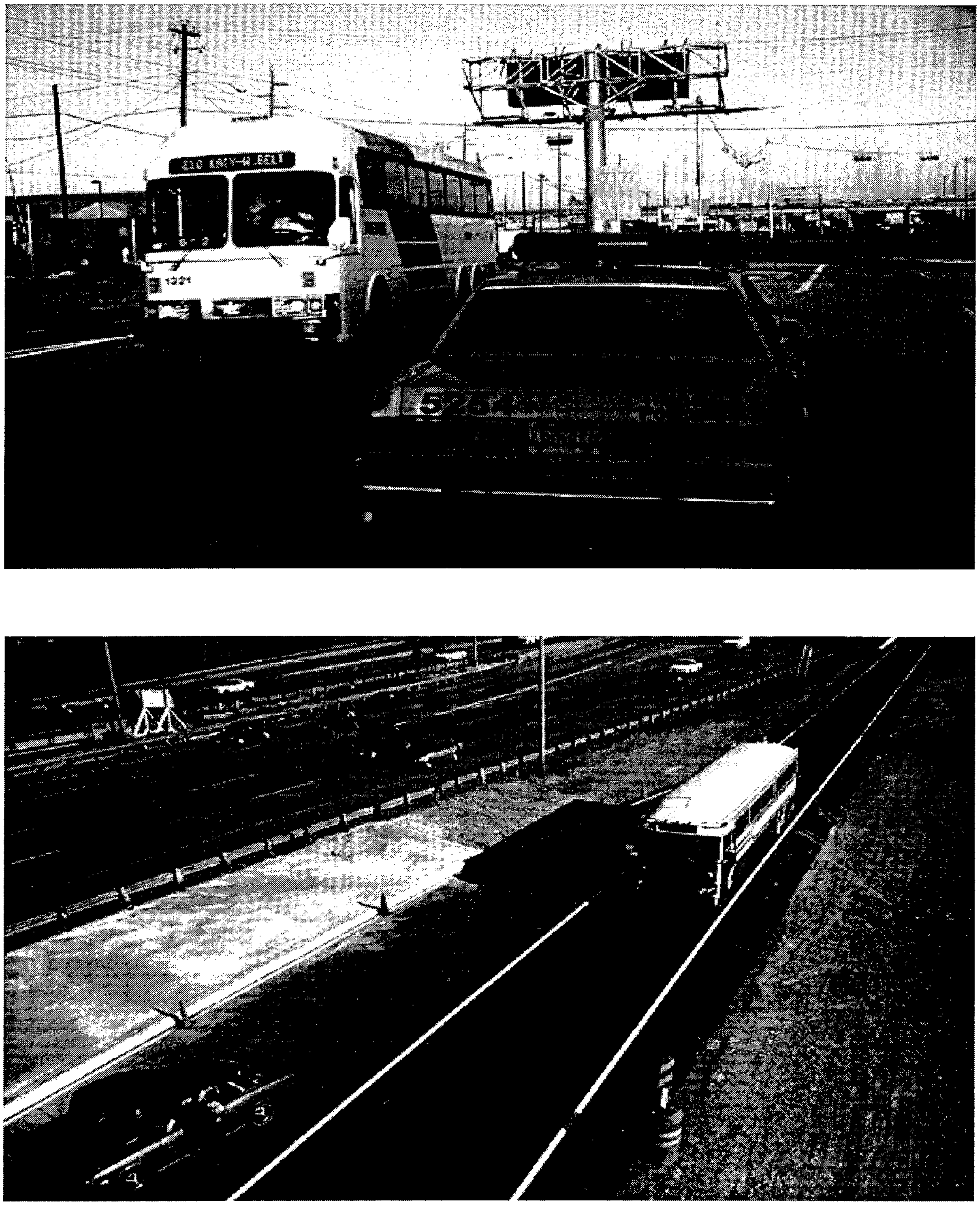
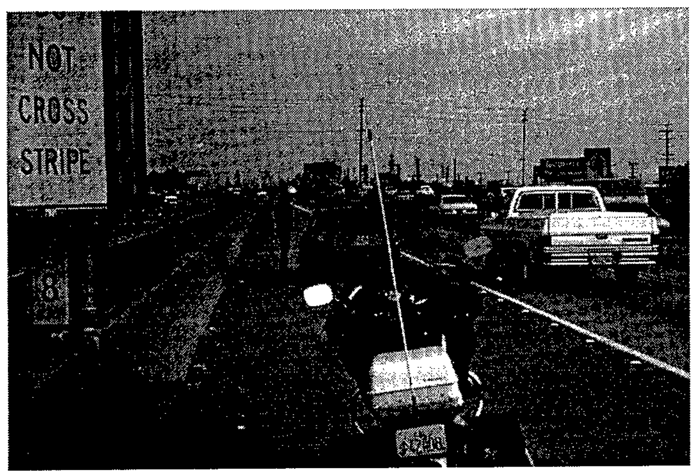


Figure 5-22. Examples of Enforcement on Barrier Separated HOV Lanes



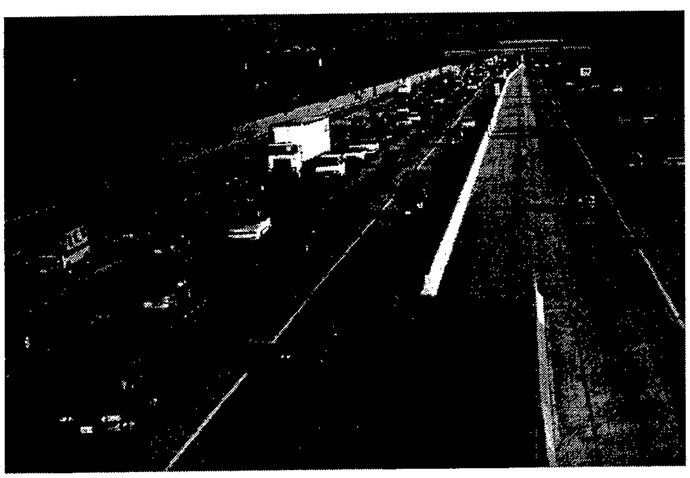


Figure 5-23. Examples of Enforcement on Concurrent Flow HOV Lanes in Southern California

Figure 5-24. Examples of Enforcement on Contraflow HOV Lanes in New Jersey/New York Area

Figure 5-25. Example of Self Enforcement Technique—HERO Sign in Seattle

Selective Enforcement. Selective enforcement may be undertaken in response to a number of different factors, or it may be scheduled on a somewhat regular basis to provide periodic saturation of an HOV facility. As noted with special enforcement, selective enforcement may be an appropriate approach to utilize when a new HOV facility is open. It may also be used when other significant operating changes have been made, such as increasing the vehicle-occupancy requirements or extending operating hours. Selective enforcement may also be used in response to high violation rates or to target problems in a specific area or section.

Self-Enforcement. The last general approach is self-enforcement. This strategy involves self-regulation by HOV lane users and motorists in the general purpose lanes. Self-enforcement is usually used with other approaches, rather than as the only enforcement strategy. The HERO program provides the best example of a self-policing HOV enforcement effort. This approach was first developed in Seattle and has subsequently been used in other areas including Houston and the Northern Virginia/Washington, D.C. area.

The HERO program uses signs and other communication techniques to provide users and non-users with a telephone number they can call to report HOV lane violators. The individuals, who remain anonymous, report the sighting of a violator and give the license number, time of day, location, and any other supporting information to the HERO telephone operator. The vehicle data are checked for accuracy in the vehicle registration files, and, if they are correct, an information brochure providing information on proper use of the HOV facility, along with notification that the vehicle was seen violating these requirements is mailed to the vehicle owner.

If the same vehicle is reported a second time, another brochure and a personalized letter is sent along with information regarding the reported offense. A third reported violation results in a warning from the enforcement agency. After the fourth report, the license number, description of the vehicle, and information on violation pattern are forwarded to the police officers who may target the vehicle in subsequent routine, special, or selective enforcement activities.

This strategy has been considered successful in those areas where it has been applied. Self-enforcement is believed to have reduced dependency on other enforcement strategies and to have contributed toward lowering the violation rates. In addition, repeat offenders appear to be few. Public opinion has also been favorable toward these programs, which provide both an ongoing informational as well as an enforcement focus.

G. Specific Enforcement Techniques

A variety of enforcement techniques can be used to monitor HOV facilities. These techniques focus on providing surveillance of the lanes, detecting and apprehending violators, and issuing citations or warnings to violators. The following enforcement techniques are summarized in this section. As discussed at the end of this section, most areas use a combination of enforcement techniques.

- Stationary patrols
- Roving patrols
- Team patrols
- Multipurpose patrols
- Electronic monitoring
- Citations or Warnings by Mail

Stationary Enforcement Patrols. Stationary patrols involve the assignment of enforcement personnel at specific locations along an HOV facility. These may be dedicated enforcement areas or locations that provide the necessary vantage points and space for enforcement personnel. As discussed in the design section, enforcement areas should provide adequate space and a safe environment for enforcement personnel to perform all necessary duties. These include monitoring the facility, pursuing a violator, and stopping the violator to issue a citation.

Enforcement areas may be located at the beginning or end of a facility or at specific locations along the lane. Stationary enforcement may be used during all operating hours or on a selective or special basis. Stationary enforcement may be provided with patrol cars, motorcycles, or other types of vehicles. In addition, monitoring and surveillance may be performed visually by enforcement personnel or with the aid of advanced technology.

Roving Enforcement Patrols. This technique involves enforcement vehicles patrolling the length of the HOV facility. Patrol cars—either marked or unmarked—or motorcycles may operate either on the HOV facility or on the adjacent freeway. Further, patrols may cover the total facility or they may be assigned to specific segments or zones. Enforcement personnel can monitor the use of the lane and the vehicle-occupancy requirements, and apprehend violators. A safe area to pull violators over to issue citations is still needed with this technique, and advanced technologies can be used to enhance roving enforcement.

Team Patrols. This technique uses various combinations of stationary and roving patrols working in unison to monitor an HOV facility and to apprehend violators. Potential combinations may include multiple stationary patrols, multiple roving patrols, or a combination of stationary and roving patrols. In one example, a stationary patrol located at the beginning or mid-point of an HOV facility is responsible for monitoring vehicle-occupancy requirements. Vehicle and license plate information on potential violators is radioed to a stationary patrol located at the end of the facility, where the actual apprehension takes place. As with other techniques, advanced technology may be used to enhance the monitoring function with team patrols.

Multipurpose Patrols. This technique utilizes patrols or personnel that are assigned multiple functions, including HOV lane enforcement. Responsibilities of these groups may include incident detection and response, operation of the HOV facility, general policing, and enforcement. This approach may be used in combination with other techniques and may be supported by advanced technologies to monitor a facility.

Electronic Monitoring. Electronic and other advanced technologies may be used to help monitor an HOV facility and to assist in detecting violators. Closed circuit television cameras (CCTV), infrared cameras, photographs of vehicles and license plates, and other technologies may help identify potential violators. Although various technologies have been tested to assist with the identification of vehicles not meeting the occupancy requirements, to date no approach appears to provide adequate coverage during all times. Specifically, technology is currently not available that can overcome problems associated with seeing inside a vehicle with tinted windows, seeing inside a vehicle prior to and after daylight hours, and seeing passengers in a reclining position or young children. These problems have limited the widespread use of advanced technologies to assist with enforcement. There continues to be a good deal of interest in the use of advanced technology to help enforce vehicle-occupancy requirements, however, and systems that can overcome the current problems may be available in the future.

Citations or Warnings by Mail. If the legal authority exists, enforcement personnel may be able to issue warnings or citations by mail, eliminating the necessity of stopping a vehicle violating the HOV requirement. The violators may be observed by police officers on the spot or with the aid of cameras and other advanced technologies. This approach, which is often referred to as "ticketing by mail" can enhance the safety of enforcement personnel, since they do not have to pursue and stop vehicles. It can also improve the efficiency of police patrols since officers need only monitor the vehicle-occupancy requirements and record information on violators. The process does involve additional paperwork and procedures by office personnel to mail the citations. In addition, providing an onsite police presence and issuing tickets in person initially or periodically may be considered to build public perceptions that violators are caught.

Currently, no provisions for issuing citations by mail are currently in effect with HOV facilities. In 1989, the Virginia Legislature authorized state police to record the license plate numbers of HOV lane violators and to issue tickets by mail. Problems arose in the legal system, however, and many citations were not upheld. As a result, the Virginia State Patrol changed procedures to stop the vehicle and record information on the driver. The actual citation is then sent through the mail.

H. Funding Enforcement Programs

A variety of funding sources at the federal, state, and local levels may be used to support enforcement programs associated with HOV facilities. As discussed in Chapter 6, planning, designing, and constructing enforcement areas or other special physical elements needed to enhance monitoring and policing of the facility are usually eligible for federal funding. Depending on the specific federal program, a state or local match may be required.

Funding for the ongoing enforcement of an HOV facility may be more difficult, and the exact sources may depend partially on the agency with enforcement responsibility, although construction and operating funds may be used in some cases. The state patrol or police are responsible for enforcing most freeway HOV facilities. As a result, enforcement of the HOV lanes may have to compete for the limited financial and personnel resources available to the state patrol, as well as with other more critical responsibilities. If transit police or other agency personnel are charged with enforcement, a higher priority may be given to the allocation of resources. The enforcement of HOV and transit facilities may be the only responsibility or one of the major responsibilities of these individuals, whereas state and local police have many other law enforcement priorities.

Usually a combination of state and local funding sources are used for ongoing enforcement efforts. Federal transportation funds have been used to support initial enforcement activities during the opening and initial operation of an HOV facility. After the initial phase of a project, however, state and local transportation funds, as well as normal funding for the state patrol, are usually used.

I. Communicating Enforcement Information

The development of a comprehensive public information and marketing program for an HOV facility is discussed extensively in Chapter 12. Providing information on the requirements for use of the HOV lanes, as well as the penalties for violating these requirements and the enforcement techniques that will be used, should be key parts of these programs. This information should be provided on an ongoing basis through signing along the facility, as well as in marketing brochures and materials.

Individuals who violate an HOV facility may be divided into two general categories. The first is motorists who may not know the requirements or who may inadvertently be on a facility during an HOV-only time period. The second group are motorists who knowingly violate the requirements to gain the travel time savings and travel time reliability offered by the HOV lanes. It is the second group of individuals that most enforcement programs focus on.

Public perception toward enforcement can also influence proper use of a facility. Visible enforcement can obviously keep violators from using the facility. It also builds a positive perception among non-users that the requirements are being enforced and that the integrity of the facility is being maintained. This perception can help build support for a project and can help prevent a mentality among motorists that since others get away with violating the requirements they will too.

J. Application of Enforcement Strategies to HOV Operations

An enforcement program can be considered successful if compliance rates on an HOV facility are within the established goals and if the enforcement function is accomplished in a safe and a cost effective manner. To accomplish these objectives, the most appropriate enforcement techniques should be used with the various types of HOV facilities. Although no one enforcement technique equates specifically to one type of HOV facility, some approaches may be more appropriate for consideration with certain HOV projects. In addition, most areas use more than one technique. The approaches currently in use with different types of HOV facilities are summarized in this section, along with some of the issues that may need to be considered in developing enforcement programs for various types of HOV lanes. The information can be used to help develop enforcement plans for a specific project or for a HOV system. Table 5-7 highlights the enforcement strategies and techniques commonly found with various types of HOV facilities.

Table 5-7. Examples of Enforcement Strategies Commonly Found with Various Types of HOV Facilities

HOV Facility	Enforcement Strategies and Techniques
Separate Right-of-Way	• Stationary patrol at beginning-end of facility.
Freeway-Exclusive	• Stationary patrol at beginning or end of lane. • Team patrols. • Multipurpose patrols. • Self enforcement.
Freeway-Concurrent Flow	• Stationary patrols at enforcement enclaves. • Roving enforcement. • Team patrols. • Multipurpose patrols. • Self enforcement.
Freeway-Contraflow	• Stationary patrols at beginning or end. • Multipurpose patrols. • Self enforcement.

Separate Rights-of-Way. Enforcement of HOV facilities in separate rights-of-way, especially bus-only lanes, is usually relatively straightforward and does not involve many of the issues associated with other types of HOV projects. Two major factors simplify enforcement of these facilities. First, the bus-only restriction makes it easy to identify vehicles that should not be using the facility. Second, since access points are limited and are usually oriented toward bus facilities, it is often difficult for other vehicles to enter the lanes. As a result, transit police and other personnel usually need to spend less time on enforcement issues and more time on monitoring the operations of the facility. Roving personnel may be used to insure the safe and efficient operation of the facility and to deal with any violators who happen to enter the lane. In addition, foot patrols may monitor stations and ride buses to enhance the security of the system. Monitoring of station areas by closed circuit television may also be considered.

Exclusive Freeway HOV Facilities. Exclusive HOV facilities are also easier to enforce due to limited ingress and egress and the physical separation from the general-purpose lanes. Stationary patrols, team patrols, and multipurpose patrols may all be appropriate for consideration with exclusive HOV lanes. Enforcement areas can be provided at direct access ramps, and at the beginning and end of a facility. The use of team enforcement, with one officer located at the beginning or mid-point of a facility radioing information on violators to an officer at the end of the facility where the apprehension takes place, can be an effective technique. Consideration is also being given in some areas to the use of advanced technologies to assist with enforcing exclusive facilities.

Concurrent Flow HOV Facilities. These types of HOV lanes are the most difficult to enforce because violators are able to enter and exit at almost any time throughout the length of the facility. As a result, concurrent flow HOV lanes require extra consideration and increased enforcement. Selective enforcement using roving and team patrols, in combination with standard apprehension and citation procedures, are used with many concurrent flow facilities. Ensuring that safe and adequate enforcement areas are provided is also critical with this type of facility. The design requirements of enforcement areas are discussed in Section VI of Chapter 6. Without an effective enforcement plan, buffer separated facilities may be susceptible to high violation rates. Many areas are also considering the use of advanced technologies to assist with enforcing concurrent flow HOV lanes.

Contraflow HOV Facilities. Contraflow HOV lanes are often easier to enforce because of limited access—often just a single entrance and exit—and because of limited vehicle eligibility criteria. Enforcement personnel are usually stationed at the beginning and/or end of a lane, and violators can be stopped at these points. Enforcement of contraflow facilities can be further enhanced with the incorporation of a rejection lane at the entrance to the facility. The rejection lane enables enforcement personnel to apply stationary strategies and procedures to maintain compliance.

IX. INCIDENT MANAGEMENT

This section discusses incident management on HOV facilities on freeways and in separate rights-of-way. The role of incident management is reviewed first, followed by a description of the agencies and groups that should be involved in the development and implementation of an incident management program. The elements associated with incident management are described and general guidelines for developing an incident management plan are presented.

A. Role of Incident Management

There are two aspects related to incident management on HOV facilities. The first is the development of plans and procedures that can be implemented to respond to accidents, incidents, or special situations on the HOV facility. The second relates to the use of HOV lanes to assist with incident management on the freeway or in the travel corridor. Each of these roles are described briefly in this section.

A variety of incidents may happen on HOV facilities and freeways. Incidents can cause major problems, especially if they are not dealt with quickly. A general guideline for general-purpose lanes is that for each minute of delay, the congestion behind the incident takes three to four minutes to return to normal. Thus, responding quickly to incidents is important. Common incidents include traffic accidents, disabled vehicles, spilled loads, adverse weather conditions, and other problems. These incidents usually result in a lane or lanes being blocked, slowing traffic on the facility. In addition, drivers on portions of the facility not directly affected by the incident often slow down to look at the problem, causing further delays.

Being able to respond quickly and efficiently to accidents or incidents on an HOV facility is important for a number of reasons. First, an incident response program is critical to help ensure the safety of users of the HOV facility. Responding quickly to accidents can help save lives. Second, clearing problems quickly can help ensure that the travel time savings and the travel time reliability provided by an HOV facility is maintained. Since these benefits are critical factors, influencing commuters to change from driving alone to using an HOV lane, incident management programs represent an important element in the overall operation of a facility.

In addition, HOV facilities can play a role in incident management on the freeway or in the corridor. For example, HOV lanes may be used to help manage traffic when a major incident or accident has occurred on the freeway general-purpose lanes. Most HOV facilities are used to help with incident management on the freeway and may be opened to general traffic in the case of major accidents on the freeway, snowstorms, flooding, or other significant incidents. The use of HOV lanes to assist with incident management is discussed more extensively in Section D.

B. Groups Involved in Incident Management

As discussed in Section II A of this Chapter, representatives from a number of agencies and groups should be involved in the development and implementation of incident management plans and programs. The various groups to be included in these activities and common roles of the various agencies are highlighted next.

State Department of Transportation. Representatives from the state departments of transportation usually take the lead role in the development of incident management programs for HOV facilities located on freeways. The state is also usually the responsible agency for operating the HOV facility, including the incident management program. These efforts are often undertaken cooperatively with the other agencies involved in a project.

Transit Agency. If the transit agency has the overall responsibility for an HOV facility on a separate right-of-way, they will usually also have the lead role in developing and conducting the incident management program. On other projects, transit agencies may play more of a supporting role. Transit operators often have the lead responsibility with incidents involving disabled buses or other transit vehicles.

State and Local Police. Representatives from the state and local police should be actively involved in the development of the incident management program, since they usually share responsibility for responding to accidents and helping to manage incidents. Police personnel may take the lead in developing certain aspects of the program.

Emergency Medical Services (EMS), Fire Departments, and Other Emergency Personnel. These groups are also usually responsible for responding to incidents or accidents, especially those that involve personal injury or other special circumstances. Involving representatives from these organizations in the development of the incident management program will help ensure timely and appropriate responses to actual accidents or other emergencies.

Tow Truck Operators. If tow truck operators or other wrecking services are used to remove disabled vehicles from the HOV facility, they should also be involved or at least apprised of the development of the incident management plan.

Local Municipalities. Representatives from local municipalities should be involved in the development of incident management programs, especially if there is a potential that the local street system will be impacted.

Federal Agencies. Representatives from FHWA and FTA may wish to assist with the development of incident management programs. Personnel from these agencies can often provide technical assistance on specific issues or suggestions on how certain issues have been addressed in other areas.

C. Elements of an Incident Management Program

An incident management program should address the major elements necessary to detect a problem, to respond appropriately to clear the incident and return the facility to normal operations, and to communicate necessary information to other motorists to help manage the situation. These four elements—detecting, responding, clearing, and communicating—are summarized next.

Detection. An accident or incident must be reported for a response to be initiated. Detection refers to the ability to identify that an incident has occurred, and to obtain accurate information on the location, nature, and scope of the problem. The sooner an incident can be identified, and the proper responses initiated, the faster the problem can be cleared and the facility returned to normal. A wide variety of methods and technologies can be used to help detect an incident. These include more traditional approaches, as well as advanced technologies. Potential approaches are highlighted in Table 5-8.

Table 5-8. Surveillance and Detection Techniques with HOV Facilities

Level of Technology	Technique
Low/manual	• Visual detection by police, bus operators, motorist assistance patrols, or agency personnel. • Calls from motorists using cellular telephones. • Reports from roadside call boxes. • Information from commercial traffic reporters.
Mid level/semi-automated	• Loop detectors. • Closed-circuit television cameras.
High/automated	• Automated vehicle identification (AVI) and Automatic Vehicle Location (AVL). • Full advanced transportation management systems (ATMS) or integrated transportation management systems (ITMS).

Visual Detection by Enforcement and Operation Personnel. Police officers, bus drivers, and other operating personnel in the corridor usually provide a basic level of monitoring for incidents and accidents. These individuals can report problems by radio to the appropriate group to initiate the incident response program. In addition, some areas have implemented motorist assistance or courtesy patrols. These programs provide vans or trucks that regularly patrol a section of freeway. The patrols can assist motorists with flat tires and other routine problems or call tow trucks and emergency personnel for more serious incidents.

Calls from Motorists Using Cellular Telephones. The proliferation of cellular telephones has provided another technique for detecting traffic problems. In many metropolitan areas, the state department of transportation, commercial traffic reporting services, or other groups publicize toll free numbers for travelers to report accidents or other problems on the roadways. This approach can be a relatively inexpensive way of obtaining information on the status of highway conditions and accidents. The accuracy of the information may not always be the highest, however, as motorists may not always know the exact location of an incident.

Roadside Telephone Call Boxes. Some metropolitan areas have installed roadside telephone call boxes for motorists to use to report accidents, incidents, or other problems. Calls made from these boxes are received by state or other operating personnel and the appropriate responses can be initiated.

Commercial Traffic Reports. Most metropolitan areas have one or more commercial traffic reporting services. These businesses may use a variety of techniques, including helicopters, roving patrols, cameras, and calls from motorists to monitor the flow of traffic on major travel routes. This information is provided in regular traffic reports on radio and television stations. The same information can be provided to the state department of transportation and other agencies. As described in more detail later in this section, many metropolitan areas are developing advanced transportation management systems (ATMS). In many cases, the commercial traffic services are either located in these facilities or information is shared among the groups.

Loop Detectors. Loop detectors, usually induction loops located in the roadway pavement, are used in many metropolitan areas to obtain vehicle volume, lane occupancy, and speed data. In many cases, this information is analyzed at a later date rather than being used for real-time traffic monitoring. However, these systems can be used to help with detection capabilities by monitoring traffic speeds and stopped traffic on a real-time basis.

Closed-Circuit Television Cameras (CCTV). The use of closed-circuit television cameras and other advanced technologies is becoming more common in large and medium-sized metropolitan areas. Cameras are usually placed at regular intervals along a freeway or corridor and monitored from a remote location. CCTVs are integral parts of an ATMS and are monitored by agency personnel in a control center. CCTV provides an excellent technique for monitoring freeways and HOV facilities. Operating staff obtain a continuous picture of the situation along a facility, allowing them to take appropriate action, to respond to a situation.

Automated Vehicle Identification (AVI) and Automatic Vehicle Location (AVL). AVI and AVL technologies can also assist in monitoring the status of HOV and freeway facilities. For example, AVI tags and readers are being used to provide a real-time traffic information map in Houston. Operators monitoring this map and CCTVs can check on potential problems in areas that register stopped or stop-and-go traffic conditions. A bus AVL system could also be used to help monitor the status of vehicles and the general traffic flow on an HOV lane. The AVL system can help identify when buses have stopped unnecessarily or when travel speeds have slowed to levels that indicate a problem.

Advanced Transportation Management Systems (ATMS) or Integrated Transportation Management Systems (ITMS). These systems focus on the deployment of advanced transportation surveillance, monitoring, and communication systems using a wide range of advanced technologies. Surveillance systems transmit information on facility conditions to a central control center. This information is constantly monitored by operating personnel and appropriate responses, including dispatching emergency vehicles and communicating with motorists in the corridor, can be taken to incidents and accidents.

The use of these surveillance and detection techniques are not mutually exclusive. In most areas, multiple strategies and technologies are used in a corridor and throughout a metropolitan area. The various approaches can compliment rather than duplicate each other.

Response. Once an accident or incident has been identified, the proper response can be initiated. A variety of approaches can be used, depending on the nature, severity, and scope of the problem. The key is to match the response to the specific situation. Table 5-9 provides examples of response strategies that may be appropriate for different types of situations. The general types of response vehicles and personnel include Highway Helper or Courtesy Patrols, dedicated agency tow trucks, commercial towing services, police, EMS, fire, and specialized response teams. Figure 5-26 illustrates the response equipment used on the HOV lanes in Houston.

Clearing. This step in the incident response process involves removing the disabled vehicle or clearing the incident scene and returning the facility to normal operations. The types of vehicles and personnel highlighted in Table 5-9 are usually involved in both responding to, and clearing an incident or accident. For example, tow trucks will be needed to remove disabled vehicles, while a Highway Helper Patrol may be able to assist with a vehicle that has run out of gas. Traffic control and site management are also important elements of this process. The roles and responsibilities of personnel from the various agencies should be established to allow for the safe, efficient, and coordinated management of an accident or an incident site.

Table 5-9. Response Strategies to Incidents or Accidents

Incident	Potential Response Strategies
Disabled vehicle (flat tire, run out of gas, etc.)	• Highway Helper or Courtesy Patrol • Dedicated tow truck • Commercial towing service • Police to manage traffic
Disabled bus	• Transit operator tow truck and replacement bus • Highway Helper or Courtesy Patrol • Police to manage traffic
Accident/no injuries	• Highway Helper or Courtesy Patrol • Dedicated tow truck • Commercial towing service • Incident response team • Police to manage traffic
Accident/injuries	• Emergency Medical Services (EMS) and ambulance • Highway Helper or Courtesy Patrol • Dedicated tow truck • Incident response team • Commercial towing service • Police to manage traffic
Accident/special problems (toxic substance, etc.) or hazardous waste	• Highway Helper or Courtesy Patrol • Dedicated tow truck • Commercial towing service • Police to manage traffic • Fire • Incident response team
Snow, ice, flooding or other weather-related emergency	• Snow plows and other service vehicles • Highway Helper or Courtesy Patrol • Incident response team • Dedicated tow truck • Commercial towing service • Police to manage traffic

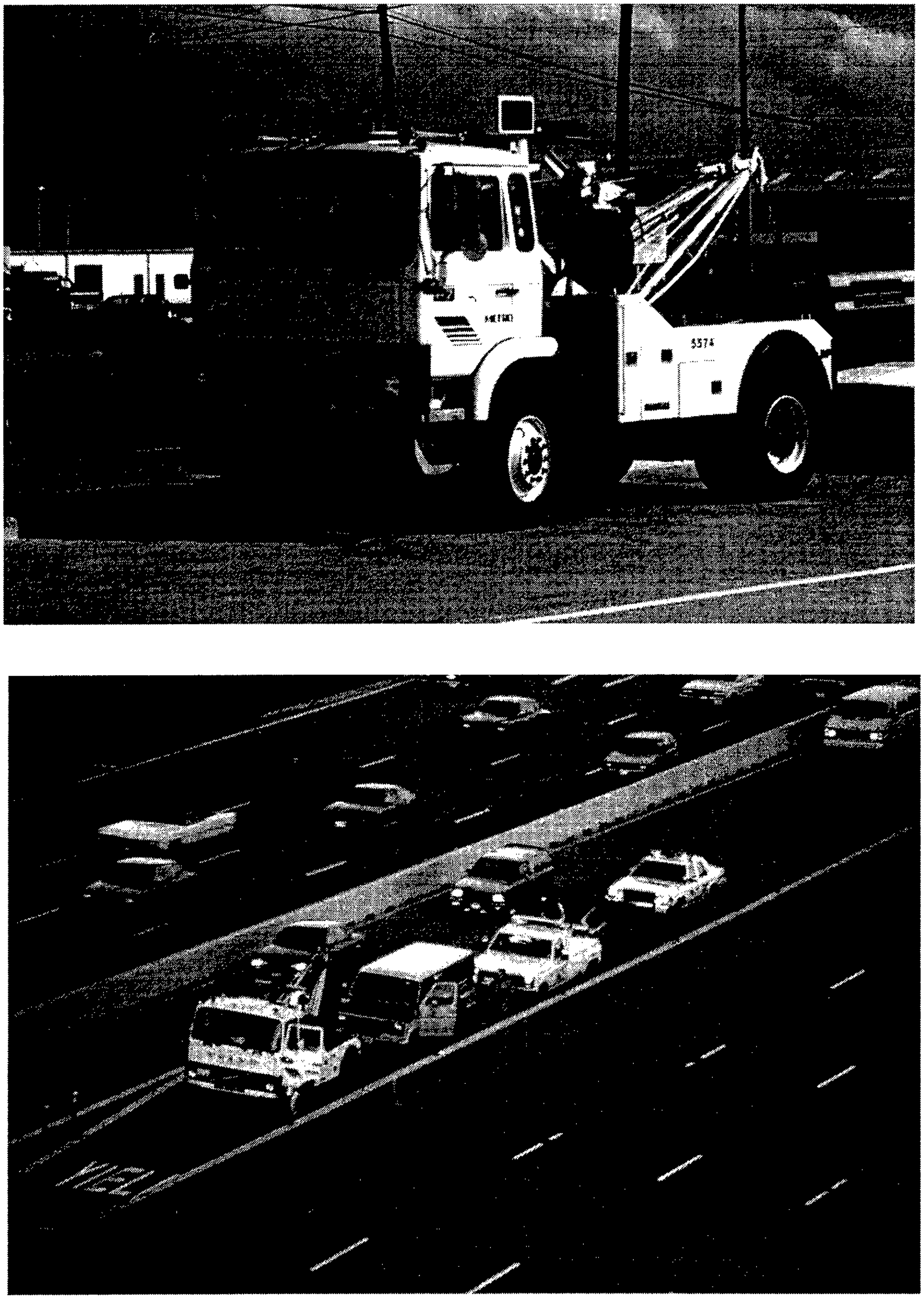


Figure 5-26. Examples of METRO Tow Truck and Incident Response on HOV Lane in Houston

Communication. This element of an incident management program focuses on communicating information on the status of the HOV and freeway facilities to other agencies and the motoring public. A variety of techniques and technologies can be used to provide current or real-time information to HOV lane users, motorists in the general-purpose lanes, and other agencies. This step is important to provide commuters and travelers with information on major problems and significant delays on a facility, as well as alternate routes that they may wish to take. The following approaches and technologies can be used to communicate with the traveling public.

Commercial radio and television stations. Information updates on the status of HOV, freeway, other facilities can be provided to commercial radio and television stations. Many radio and television stations in metropolitan areas provide regular traffic updates during the morning and afternoon peak-periods. The information for these updates may be obtained from public agencies, commercial traffic reporting services, or station personnel using the detection technologies described previously.

Highway Advisory Radio. Highway Advisory Radio (HAR) provides a dedicated radio channel for information on roadway and travel conditions. HAR is operated by a public agency, usually the state department of transportation, and is often broadcast out of an ATMS control center. HAR may cover a specific freeway or a portion of a metropolitan area. HAR broadcasts may be provided during the peak-periods or reports may be provided throughout the day. A low-frequency AM band width is usually used for most HAR stations.

Changeable message signs. Changeable message signs are used in many metropolitan areas to communicate with motorists on freeways and on HOV facilities. A variety of signs and technologies are commercially available. These signs can be used to provide short concise messages to motorists on traffic conditions, major incidents, alternate routes, and other critical information. The operation of changeable message signs is usually done from the ATMS control center. The signs can be preprogrammed, so that an operator only has to push a button to activate a message or an operator may type in a specific message in response to a situation. The location of changeable message signs should be carefully considered if they are indented to help divert or re-route traffic in response to incidents. Ensuring that the signs are located well in advance of points where motorists can take alternate routes or actions is important.

Advanced traveler information systems. More emphasis is being placed on communicating real-time information to commuters on the status of different travel modes to allow for more informed travel choices. Advanced traveler information systems (ATIS) focus on providing real-time information to individuals prior to starting a trip, en-route, or in-vehicle. Various technologies can be used to accomplish this objective. Some approaches, such as the Houston *Smart Commuter* operation test, are providing real-time information on conditions in the HOV and freeway lanes to encourage greater use of the HOV facilities. This project and the use of other ITS technologies, with HOV facilities are discussed more extensively in the next section.

D. Use of HOV Facilities to Assist with Incident Management

As noted previously, HOV facilities can be used to assist with managing incidents and accidents on the general-purpose freeway lanes or responding to other special circumstances. Most HOV facilities are used to assist with incident management under certain circumstances. These may include traffic accidents on the freeway, snowstorms, flooding, and other major incidents. The use of an HOV lane to help with incident management will depend somewhat on the type of facility, access points, and other factors.

The incident management plan should address the use of HOV lanes to help with incident management on other facilities. It is important that the plan clearly identify when and under what conditions the HOV facility will be used to help manage traffic, how it will be used, the specific procedures that will be followed, and the responsibilities of the various agencies.

These elements are critical to help ensure the safe operation of the HOV facility during an incident on the freeway or other condition. For example, additional signing or information may be needed for motorists who normally use the general-purpose lanes and may be hesitant to enter an HOV lane. In addition, in order to maintain the integrity of the HOV facility, consideration should be given to using the HOV lane only in response to extreme problems or specific situations.

The following examples illustrate the use of HOV facilities to assist with incident management on the freeway general-purpose lanes.

Shirley Highway HOV Lanes. The Shirley Highway HOV lanes have been open to all traffic during normal HOV-only periods on a few occasions, such as when major snowstorms have hit the Northern Virginia/Washington, D.C. area. For example, this procedure has been used when federal offices have closed early and workers have been sent home during major snowstorms. Opening the HOV lanes to all traffic has helped expedite the movement of people out of

Washington, D.C. The Virginia Department of Transportation (VDOT) is responsible for making the decision on when to open the lanes to non-HOVs.

Houston HOV Lanes. The Houston HOV lanes are used periodically to assist with incident management on the freeways. The HOV lanes have been open to mixed traffic in response to heavy rain storms and flooding, as well as major accidents which have blocked the freeway general-purpose lanes. These situations have been infrequent, however. The Texas Department of Transportation (TxDOT) and the Metropolitan Transit Authority of Harris County (METRO) are responsible for the decision on when to open the lanes to non-HOVs.

X. SPECIAL OPERATING CONSIDERATIONS

Current initiatives and special operational elements being considered and implemented with HOV facilities in North America are highlighted in this section. Information on converting general-purpose lanes to HOV lanes, priority pricing on HOV facilities, ITS and HOV facilities, truck use of HOV lanes, converting HOV lanes to fixed guideway transit facilities, and addressing concerns with slow moving vehicles in HOV lanes is presented. Potential issues that may need to be examined in considering these approaches are described, along with relevant examples.

A. Converting a General Purpose Lane into an HOV Lane

Planning considerations for converting a general-purpose freeway lane to an HOV lane were discussed in Chapter 4, Section IV. As discussed in Chapter 4, the few experiences with converting a general-purpose lane to an HOV facility have been mixed. In some cases, negative response resulted in the projects being discontinued. In other cases, the projects have gained public and political acceptance and continue to operate successfully.

There has been a good deal of interest recently in many metropolitan areas related to converting general-purpose lanes to HOV lanes. Further, studies have been conducted in some areas to better gauge public reaction to this concept and to identify the critical factors that should be considered in assessing the potential for converting a general-purpose lane.

Assuming that the planning process has indicated that a project is viable, a number of operational elements should be included in any assessment of converting a general-purpose lane to an HOV lane. These include ensuring that extensive public information and marketing programs are undertaken, that adequate signing and pavement markings are used, and that visible enforcement is provided at the initiation of the project and on an ongoing basis. Other factors may need to be considered based on local conditions. The following case studies provide examples of the experience with lane conversion projects.

Santa Monica Diamond Lanes, Los Angeles. The Santa Monica Diamond Lanes is the project usually referred to in the discussion of converting a general-purpose lane to an HOV lane. This project, which was in operation for only seven weeks in 1976, converted approximately 12 kilometers (7 miles of a general-purpose lane on the Santa Monica Freeway in Los Angeles to an HOV lane. Although the lane worked from an operational standpoint, the public reaction was negative and the project was discontinued. There appear to be numerous reasons for the failure of this project. The lack of an adequate public involvement and marketing program may be partly to blame. Although radio, newspaper, and television advertising and other techniques were used, these approaches were unable to overcome the large volume of negative publicity that was generated on the project. As a result, the California Department of Transportation (Caltrans) discontinued the operation of the HOV lanes after seven weeks.

I-80, Morris County, New Jersey. In the early 1990s, the New Jersey Department of Transportation (NJDOT) was widening a 16 kilometer (10 mile) segment of I-80 to add general-purpose travel lanes in Morris County. The Department conducted a feasibility study examining the potential for HOV lanes in the area. The study recommended that HOV lanes were needed in the area. Although segments of the project had been completed, and the new lanes had been opened to general-purpose traffic, NJDOT converted the lanes to HOV lanes in 1994. An extensive marketing and public information program was used to build support for the project, which continues to operate.

Dulles Toll Road HOV Lanes, Northern Virginia. The 20 kilometer (12 mile) Dulles Toll Road links Dulles International Airport to Tyson Corner. In 1992, the Virginia General Assembly approved legislation to add one lane in each direction to the facility and stipulated that these lanes be reserved for HOVs during the morning and afternoon peak hours. A 10-kilometer (six mile) segment was completed in 1991, one year in advance of the completion date for the full 20 kilometers (12 miles) and the anticipated implementation of the peak-period HOV restrictions. The lanes were opened to all traffic as the various segments were completed. When the HOV requirements were implemented, there was a vocal negative response, which included the formation of the Citizens Against Dulles HOV (CAD HOV) group. The efforts of this group were supported by the local Congressman. As a result of these activities, the Virginia Department of Transportation rescinded the HOV requirement.

State Route 85, Santa Clara County. In 1995, a segment of SR 85 through the I-280 interchange in Santa Clara County was converted from a general-purpose lane to an HOV lane by Caltrans. The project, which is approximately 1.6 kilometers (1 mile) in length, was initiated to provide an important link to the 30-kilometer (18 mile) HOV lanes on SR 85. Keys to the success of this project included public support, no adverse impacts on the remaining general-purpose lanes, local understanding of the HOV concept, and a general consensus that it was a logical change.

I-90 HOV Lanes, Seattle. In 1993 and 1994, a general-purpose lane in an 11-kilometer (7 mile) section of I-90 between Issaquah and Bellevue in the Seattle area was converted to an HOV lane by the Washington State Department of Transportation (WSDOT). The HOV lanes connect to the HOV lanes on the Lake Washington Bridge, which were in operation when consideration of the lane conversion project was initiated. The project converted one of the four general-purpose lanes in each direction to an HOV lane. A number of elements contributed to the success of this project. These included revision of the WSDOT policy on when lane conversion projects would be considered, a consensus building effort, a public involvement program, and a marketing and public information program.

B. Sticker Programs with HOV Facilities

As discussed in Section V.A., one possible approach to managing demand on an HOV facility is through the use of a sticker program. This technique allows vehicles with a valid sticker, AVI tag, or other electronic device to use an HOV lane. Unlike the priority pricing projects discussed in the next section, there is no charge for stickers. The use of this approach on the Southeast Expressway contraflow HOV lane in Boston is described in this section.

Southeast Expressway, Boston Massachusetts. The I-93 Southeast Expressway HOV lane was opened in November 1995. The 9.6 kilometer (6-mile) contraflow HOV lane is located on the southeast side of Boston. The project utilizes a moveable barrier system to create and remove the contraflow lane during the morning and afternoon peak-periods. The Massachusetts Highway Department (MassHighway) is responsible for the design and operation of the facility.

A 3+ vehicle-occupancy designation is used on the project. Concerns by some commuters that the facility was under utilized at the 3+ level resulted in support by state elected officials to reduce the vehicle-occupancy requirements. MassHighway was concerned that opening the lane to unrestricted 2+ carpools would overburden the facility. Working with the legislature, MassHighway developed a compromise approach, which was signed into law by the Governor in 1996. The resulting sticker program was implemented in September 1996.

Analysis conducted by the Department estimated that an additional 2,000 vehicles a day could use the HOV lane without degrading the level of service. Rather than issuing just 2,000 stickers, the agency developed a program to issue 4,000 stickers and to control use of the lane by the color of the sticker.

After an extensive education and commuter program, stickers were issues free on a first come, first served basis. 2,000 individuals with license plates ending in odd numbers received blue stickers and 2,000 individuals with license plates ending in even numbers received red stickers. Travelers with blue stickers and two people in a vehicle can use the HOV lane on odd numbered days, while travelers with red stickers are able to use the lane on even numbered days.

MassHighways has conducted an extensive monitoring and evaluation effort of the sticker program. The volume of vehicles in the HOV lane has increased steadily since the program was implemented. For example, in December 1995, an average of 2,080 3+ vehicles a day used the lane. In December 1996, 2,392 3+ and 2+ carpools used the lane. By March 1997, some 2,724 carpools were using the lane, representing a 35 percent increase over the 1995 levels, and by June 1997, 3284 carpools were using the lane (1).

C. Priority Pricing on HOV Facilities

Congestion pricing involves charging motorists for the use of freeways and roadways during periods of heavy use. The technique is based on the economic concept of charging users, in this case motorists, the "price" that represents the cost they create by using a roadway. For example, the addition of a vehicle to a congested freeway creates further delay to vehicles already using the facility. The intent of this approach is to price the use of a roadway facility so that a sufficient capacity is provided for those willing to pay.

A related approach that is being considered and implemented in some areas is being called priority pricing, value pricing, or high-occupancy toll (HOT) lanes. This concept focuses on the use of congestion or priority pricing on an HOV facility. Examples of this technique include charging 2 person carpools to use the lane, but allowing 3+ carpools to use the facility for free or charging single occupant vehicles a fee, but allowing 2 person carpools to travel for free. Further, the use of advanced technologies, including automatic vehicle identification (AVI) and electronic toll collection, provides the opportunity to use variable pricing techniques and other approaches.

The ISTEA contained a congestion pricing demonstration program. As a result of this program and other initiatives, congestion and priority pricing projects are being considered and implemented in a few areas. As highlighted next, some of these projects focus on priority pricing on HOV lanes or other related applications.

Route 91 Express Lanes, Orange County, California. The Route 91 Express Lanes provide an example of a toll facility that currently allows 3+ carpools and vanpools to travel for free, although it is anticipated that a reduced toll will be imposed in early 1998. The project also represent a unique public/private partnership in the development of a new freeway facility. The project was one of four special toll facilities authorized by the California Legislature in 1989. A franchise agreement, creating the California Private Transportation Company, was signed in December of 1990, and construction began in July of 1993. The facility was opened to traffic in December of 1995.

The Route 91 facility includes two lanes in each direction of travel, located in the median of SR 91. The facility is 10 miles in length with access provided only at each end. The state legislation authorizing the project requires that carpools and vanpools with three or more persons be allowed to use the facility for free during the first two years of operation and at a discounted level after that.

A fully automated electronic toll collection system is used on the Route 91 Express Lanes, with a variable pricing strategy. Currently, tolls vary by time of day based on a published schedule. The lowest toll is $.50 and the highest is $2.75 during the morning and afternoon peak-hours.

All vehicles using the Express Lanes must have a toll tag located on the front windshield. These tags must be purchased in advance. The tags are read each time a vehicle enters the lane, and the toll charge is automatically subtracted from the pre-paid account on the tag. Carpools with three or more persons using the facility must have a toll tag, but they are not charged a fee.

Enforcement of the occupancy requirements is done visually as carpools enter the facility. Enforcement of the toll offense is done electronically. In both cases, tickets are issued by mail, and the offenses are similar to a parking ticket. The fine is $100 for the first offense and goes up to $500 for repeated offenses.

Initially, it was anticipated that a real-time toll pricing strategy would be implemented on the project, with the fees tied to the level of congestion on the facility. This approach has not been implemented, however, based on general feedback from users.

Approximately 80,000 toll tags have been placed to date. The California Department of Transportation (Caltrans) has been monitoring traffic volumes on the Express Lanes, the SR 91 Freeway Lanes, and parallel freeways. During the first six months of operation, the increased capacity from the toll lanes resulted in substantially reducing peak-period congestion on the Route 91 general-purpose lanes. Further, the volume of 3+ carpools in the corridor increased from an average of 4.4 percent prior to opening of the toll lanes, to 5.8 percent in the first nine months of operation (4).

I-15 HOV Lanes, San Diego, California. The I-15 HOV lanes are located approximately 16.1 kilometers (10 miles) north of downtown San Diego. The I-15 Freeway HOV Lane Congestion Pricing project is one of the congestion pricing demonstrations funded as a result of the ISTEA. The project included two phases, called *Express Pass* and *FasTrak.*

The San Diego Council of Governments (SANDAG) is the lead agency on the project in cooperation with Caltrans, which owns and operates the I-15 HOV and freeway facilities. The other major participants in the demonstration are the Metropolitan Transit Development Board (MTDB), the transit agency in the San Diego metropolitan area, and the California Highway Patrol (CHP), which is responsible for enforcement.

The I-15 HOV facility comprise two lanes approximately 12.9 kilometers (8 miles) in length with access points at both ends. The lanes are located in the median of the freeway and are separated from the general-purpose lanes by concrete barriers. The lanes are reversible, operating inbound in the morning peak-period and outbound in the afternoon peak-period on week days only.

The HOV lanes were opened in October of 1988, with a 2+ vehicle occupancy requirement. The HOV lanes operate in the southbound direction from 6:00 a.m. to 9:00 a.m. and in the northbound direction from 3:00 p.m. to 6:30 p.m. The lanes are closed to traffic at other times.

The idea for the demonstration originated during the examination of potential transportation control measures in the regional air quality plan. The I-15 Corridor Committee identified three major problems in the corridor. These included traffic congestion in the general-purpose lanes, available capacity in the HOV lanes, and the need for expanded transit services (4).

Thus, the impetus for the project came from the local level. The concept was also supported by the mayor of a suburban community in the corridor. This individual was elected to the State Assembly and sponsored the enabling legislation needed for the demonstration project. The enabling legislation for the project requires that a level-of-service C or Caltrans HOV lane standard be maintained on the HOV lanes (4).

The objectives of the demonstration project, which allows drivers of single-occupant vehicles to use the HOV lanes for a fee, are to test congestion pricing as a method of managing congestion on the freeway lanes, managing demand on the HOV lanes, expanding transit and rideshare services in the corridor, and enhancing air quality in the region. Three major benefits are expected to be realized from the test. These include improving travel times for single-occupant vehicles paying to use the HOV lanes, improving traffic flow in the freeway general-purpose lanes, and expanding transit and carpool services and usage in the corridor.

The Interim Operations phase of the demonstration, called *Express Pass*, started in December of 1996. An initial set of 500 monthly permits were sold to motorists on a first-come, first-serve basis. For a fee of $50 a month, these drivers were able to use the HOV lanes during all operating hours without meeting the occupancy requirements. Carpools and vanpools with 2 or more persons are still able to use the lanes for free. During February, an additional 200 permits were sold, and the monthly fee was raised to $70 in March. By the end of the Interim Operations phase in March 1998, 1,000 passes a month were being sold. Enforcement during the Interim Operations phase was done manually.

FasTrak, the Full Implementation phase of the project started in March 1998 using an AVI toll collection and enforcement system. This phase is testing the use of a variable fee structure based on the level of congestion in the general-purpose lanes. Under normal driving conditions, the fees range from $0.50 to $4.00. During severe traffic, the fees could be as high as $8.00. As of April 1998, 3,500 transponders had been distributed to 2,500 customers. During the first week of operation, the variable tolls ranged from $0.50 to $4.00. Additional transit service funded by the revenues generated from the charges has been implemented in the corridor.

The sponsoring agencies are conducting an evaluation of the demonstration. An initial review of the project, conducted in March of 1997, provided a few preliminary results. First, although more vehicles are using the HOV lanes, the travel time savings and travel time reliability of the facility has not been degraded. Second, it appears that actual use of the lanes by permit holders is less than anticipated. Approximately 65 percent of the permits appear to be used on a regular basis (5).

The preliminary findings also indicate that the number of 3+ carpools using the HOV lanes has increased during the demonstration. The percentage of HOVs has increased from 85 percent of the total traffic to 89 percent. It also appears that HOV violation rates have been reduced. Finally, there is a waiting list for the purchase of permits, even with the increase in price (5).

I-10 (Katy) HOV Lane, Houston, Texas. A demonstration project, called *QuickRide*, was implemented in January 1998 on the Katy HOV lane in Houston. The demonstration is testing allowing 2 person carpools to use the HOV lane during the morning and afternoon peak hours when a 3+ vehicle occupancy requirement is in effect. The project is the result of a study conducted jointly by METRO and TxDOT in 1997. The initial feasibility study was funded by METRO and FHWA. TxDOT and METRO are responsible for different aspects of the HOV facilities in Houston. TxDOT owns and maintains the HOV lanes, and METRO is responsible for operating and enforcing the lanes and owns and operates many of the supporting facilities and services.

The Katy HOV lane is 20.9 kilometers (13 miles) in length. It is a one-lane, barrier-separated, reversible HOV lane located in the freeway median. The facility was opened in stages between 1984 and 1990. The vehicle-occupancy requirement on the lane has changed a number of times. Only buses and authorized vanpools were allowed to use the facility when it was first opened in 1984. Due to low utilization, it was opened to authorized carpools with four or more persons in 1985. The occupancy requirement was dropped to 3+ later in 1985, and to 2+ in 1986.

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 am. 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 facility is the only HOV lane in the country that uses variable hour occupancy requirements.

A number of key elements were examined during the feasibility study. These included assessing the available capacity and the potential demand at different pricing levels, legal issues, and public reactions. A variety of potential operating strategies were explored, including manual and automated techniques. A major question was how many 2 person carpools will use the facility at different pricing levels. This analysis was critical to ensure that the lane does not become congested again as a result of the demonstration.

A number of legal and institutional issues were examined in the assessment. These included the ability to charge for use of the HOV lane, the ability to enforce fines and penalties associated with not paying the toll, and other policy changes needed to implement the demonstration. The other analyses indicated that METRO has the authority to charge for use of the lanes under specific conditions, that the fines are enforceable with minor modifications to local ordinances, and that there are no critical policies prohibiting a demonstration.

Like other priority congestion pricing projects, a critical issue appears to be public acceptance. Two focus groups were conducted in Houston as part of the feasibility study. One focus group was comprised of commuters who use the Katy Freeway and the other was composed of residents throughout Houston. The preliminary results indicated that participants were somewhat skeptical about the concept. Both groups were also interested in how the revenue from the demonstration would be spent.

Based on the feasibility study, METRO and TxDOT made a decision to implement a demonstration project, called *QuickRide.* The demonstration, which uses AVI tags and an electronic toll collection system, was initiated in January

1998. A price of $2.00 per trip is charged to 2 person carpools for use of the lane during the 3+ vehicle occupancy time period. As of June 1998, there were some 400 active accounts for the *QuickRide* project and 521 active transponders. Daily use in April and May averaged in the range of 125 to 150 two person carpools.

Based on the limited experience with these projects, it appears a number of issues should be examined when pricing strategies are being considered on a new or an existing HOV lane. As described next, these issues include the project objectives, target markets, pricing alternatives, potential impact on HOVs, use of revenues, public and policy maker perceptions, and operational approaches.

Project Objectives. Pricing or sticker programs may be considered for a number of reasons. Determining the specific goals and objectives of a project is a critical first step. Possible objectives for a pricing project include improving HOV lane utilization or maximizing available capacity by allowing lower occupancy vehicles, restoring free flow to HOV lanes by charging lower occupancy vehicles, generating additional revenues, introducing another travel option, and supporting other secondary impacts such as air quality.

Target Markets. The potential market or markets being considered for the pricing project should be examined. Possible target markets include drivers of lower-occupant vehicles and single-occupant vehicles. For example, the I-15 project is allowing single-occupant vehicles to use the HOV lane for a fee, while the demonstration on the Katy HOV lane will allow 2 person carpools to pay for use of the lane during the period currently restricted to 3+ carpools. The Route 91 Express lanes use a different approach. As a for-profit toll facility, all vehicles are expected to pay a fee, although the pricing goal is adjusted to favor the formation of 3+ HOVs.

Pricing Alternatives. Examining the amount the target market may be willing to pay to use an HOV lane should also be considered. A number of factors may be included in this assessment. One of the major elements that will need to be examined is the estimated demand at various pricing levels and quality of service. In addition to the traditional cost-to-demand relationship, other factors to consider include the bus fares in the corridor and the cost of other transit alternatives.

Impact on Existing or Projected HOV Lane Users. The impact on existing or projected HOV lane users from a pricing strategy will also need to be considered. Ideally, there should be no impact on current HOV users. A number of negative impacts might result from pricing, however. For example, increased congestion in the HOV lane might occur if tolls are set too low or if too many stickers are distributed, resulting in too many lower or single-occupant vehicles using the facility. This situation could result in slower travel speeds, reduced travel time savings, and lower levels of travel time reliability. Current HOV volumes may decline if existing bus riders, carpoolers, and vanpoolers decide to change to driving alone for a fee. On the other hand, if revenues generated from the project are used to enhance bus service in the corridor, to reduce bus fares, or to make other improvements benefitting HOVs, bus ridership, and carpool and vanpool use may increase.

Level and Use of Revenues. The level of revenues generated and the use of the revenues should also be considered. The funds generated by the pricing project and the cost to operate and administer the program should be carefully examined, along with how any excess revenues will be spent. The focus groups conducted during the planning process for the Katy demonstration, as well as findings from other congestion pricing studies around the country, indicate that public reaction to a possible project is influenced by how the revenues are anticipated to be used. Public support appears to be higher if the revenues are used for transit and transportation improvements, than if they are used for other purposes. The revenues for the I-15 project are funding additional transit services in the corridor. For State Route 91 Express Lanes, where net revenues are used to provide a return on private investment, the public approval of the overall project has been high, but the approval of private for-profit aspect has been low compared to other features, only recently climbing above the 50 percent level (3).

Public Reaction. The reaction of the public toward a pricing project should be considered. Motorists and current HOV users may have a negative reaction to the concept of pricing, since freeways and roadways have already been paid for through tax dollars. In addition, equity issues or concerns that only the rich will be able to afford to use the lanes have been voiced in many areas, although survey data from the 91 Express Lanes do not support these concerns (3).

Operational Strategies. A number of operational strategies can be used with pricing projects. The two general types of approaches are a manual or static technique and the use of automated vehicle identification or toll tags. There are several elements that should be considered in comparing manual and automated techniques. The first is the payment method. In most cases, a motorist will pay a specific amount for a manual tag regardless of how often the facility is used. The automated method allows an individual to pay just for the times they actually use the facility. Manual approaches can be implemented for lower costs, however, but may be more difficult to enforce.

D. Intelligent Transportation Systems (ITS) and HOV Facilities

A major focus of recent transportation research and development activities has been on a variety of technologies being examined under the general heading of Intelligent Transportation Systems (ITS). These systems include the application of a wide range of advanced technologies that share the common goal of improving the efficiency of the overall transportation system. More specifically, ITS technologies are directed at improving mobility and transportation productivity, enhancing safety, maximizing current transportation facilities, and enhancing the environment.

The interest in ITS and the development of projects and operational tests has accelerated rapidly over the past few years. Numerous federal, state, and local agencies; private consultants, private industries and vendors; defense industries; university research institutes; and other groups are all actively involved. The development of many ITS technologies, products, and tests is being jointly funded and conducted by consortiums involving both public and private sector groups. In addition, numerous ITS projects and research activities are being conducted in European countries and Japan.

ITS and other advanced technologies can be used in numerous ways to enhance the implementation, operation, management, and evaluation of HOV facilities, park-and-ride lots, transit operations and management, TDM actions, and the freeway system. First, advanced traffic management systems (ATMS) can enhance the overall operation of the freeway system, including HOV facilities. Second, ITS technologies can provide pre-trip and en-route real-time information to commuters on traffic conditions, transit alternatives, weather, and other elements to help individuals select the most appropriate travel mode and to encourage greater use of HOV facilities. Third, the application of advanced technologies can enhance the convenience and ease of use for all types of HOVs. Fourth, ITS technologies can help manage and enforce HOV facilities and priority pricing programs. Examples of ITS applications with HOV facilities are described next.

Advanced Transportation Management Systems (ATMS). As discussed in Section IX on incident management, a number of metropolitan areas in the country have or are in the process of developing ATMS. New systems are being designed to include more sophisticated technologies, and many existing systems are being upgraded. ATMS cover freeways, HOV facilities, and arterial roadways. As a result, ATMS provide real-time surveillance and incident management capabilities, as well as enhancing enforcement and overall operations of these facilities. Currently, metropolitan areas with ATMS covering HOV facilities include Seattle, Los Angeles/Orange County, Minneapolis-St. Paul, Houston, and Northern Virginia/Washington, D.C. Figure 5-27 illustrates an ATMS control room. The following case studies highlight a few examples.

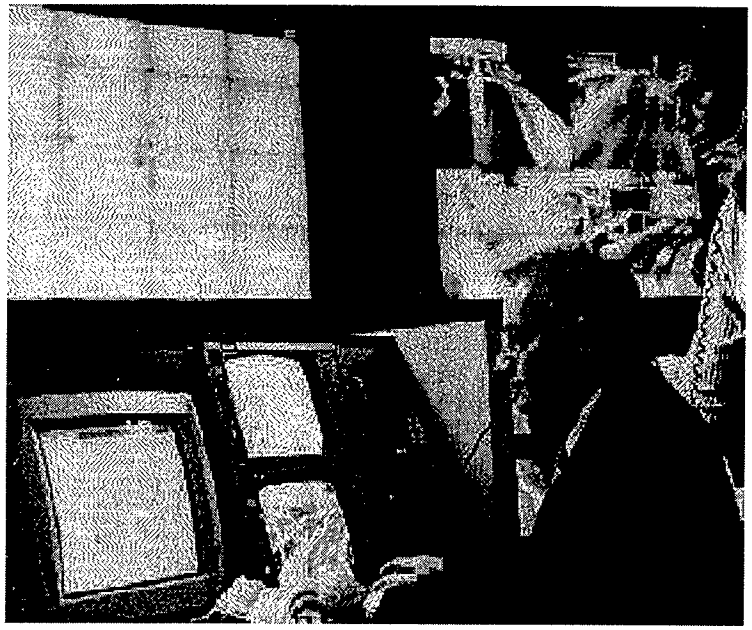


Figure 5-27. Example of Advanced Transportation Management Center Control Room

HOV Facilities, Houston. TranStar, the Greater Houston Transportation and Emergency Management Center, represents the coordinated efforts of the Texas Department of Transportation (TxDOT), the Metropolitan Transit Authority of Houston County (METRO), the City of Houston, and Harris County. TranStar currently covers a majority of the freeway system in the Houston area, including the HOV lanes. System components include inductive loop detectors, closed circuit television cameras, the AVI traffic monitoring system and real-time traffic map, changeable message signs, the flow metering system at ramps, Highway Advisory Radio, and other elements. Functions and groups currently located in TranStar include TxDOT and METRO freeway and HOV lane surveillance, the Motorist Assistance Program (MAP), the Houston Police Department, the Harris County Sheriff's Department, the Houston Fire Department, the City and County Traffic Departments, emergency management and evacuation services, and METRO transit police. METRO bus dispatchers will be moving into TranStar in 1998.

I-394 and I-35W HOV Lanes, Minneapolis. The traffic management system on I-35W in the Minneapolis-St. Paul Metropolitan area was one of the first to be implemented in the country. The system has been expanded to include other freeways since its initial development in the mid-1970s.

The system currently includes a coordinated system of surveillance and monitoring cameras, control of ramp metering rates, changeable message signs, a traffic information radio station, and direct connections to emergency personnel. The I-394 and I-35E are covered by the system. The Autoscope system, which is an advanced wide area vehicle detection and automatic surveillance device, is also being tested on I-394. Autoscope utilizes a video camera and computer software for real time video image analysis and traffic parameter extraction. The Minnesota Department of Transportation (Mn/DOT) is responsible for the overall development and management of the system.

Shirley Highway and I-66 HOV Lanes, Northern Virginia/Washington, D.C. Area. The Shirley Highway HOV lanes and the I-66 facility are monitored by the Virginia Department of Transportation's Traffic Management System. The management system includes the use of cameras for surveillance and monitoring activities, incident response, ramp metering, variable message signs, access gate control, and roadway lighting. The Traffic Management System represents one application of current technologies with HOV facilities.

HOV Facilities, Seattle. The FLOW system in Seattle includes a freeway management element, including a ramp metering system, closed circuit television surveillance and loop detector monitoring, a variable message sign system, highway advisory radio, and a system to graphically display traffic conditions. The ramp metering system utilizes a real-time traffic responsive algorithm that calculates metering rates on the basis of system wide traffic conditions. This real-time traffic map is available over the Internet.

Advanced Traveler Information Systems (ATIS). The provision of real-time information on traffic conditions and transit alternatives to individuals in their home and workplace represents an important step to allow commuters to make more informed decisions regarding their travel and mode choices. These approaches can also be used to enhance the use of HOV facilities. To influence commuters to change from driving alone to using some form of HOVs, this information needs to be provided in advance of the first mode selection. The real-time traffic and transit information may be obtained and coordinated through the use of ATMS, automated vehicle identification (AVI), automatic vehicle location (AVL), and other advanced technologies. The information could be provided to individuals through the use of a wide range of technologies including personal information devices, touch tone telephones, cellular telephones, televisions, microcomputers, Videotext terminals and in-vehicle devices. The following case studies highlight a few examples of ATIS with HOV facilities.

Smart Commuter Operational Test, Houston. The Houston Smart Commuter Operation Test is examining the provision of real-time traffic and transit information to commuters in the I-45 North Corridor on changes in travel mode, travel route, and time of travel. The real-time information is being provided to a test group through a handheld information device and a touch tone telephone system.

The Sony Magic Link™ is the handheld information device used on the project. A number of enhancements were made to the Magic Link™ for the project. First, information on METRO services was added, including bus routes, schedules, and fares. Maps showing the locations of the park-and-ride lots in the I-45 North corridor, as well as in the downtown area, were developed and incorporated into the Magic Link™.

Participants are also able to access real-time traffic information on the I-45 North HOV lane and Freeway, as well as the Hardy Toll Road. The real-time traffic information from the TranStar facility is being sent through an FM subcarrier subsystem. A radio antenna has been attached to the Magic Link™. To obtain the real-time information, a participant simply turns on the Magic Link™device. The real-time information is updated every 10 seconds or as needed.

Figure 5-28 illustrates the Houston real-time traffic map, which is also available over the Internet. Approximately 500 commuters are currently participating in the test. An initial evaluation indicate that some participants are making changes in the time of travel, their travel routes, and in a few cases their mode of travel, due do the real-time information.

Real-Time Traffic Map, Seattle. A number of ATIS components are being implemented in the Seattle area. Many of these elements have been in operation for a few years, while others are being developed as part of the Model Deployment program and other initiatives.

The real-time traffic map, illustrated in Figure 5-29, provides one example of the techniques being used in the Seattle area to disseminate information on freeway travel speeds and traffic conditions. Travelers can access the map through the Internet, as well as at computers and kiosks located in buildings and at other strategic points.

Advanced Public Transportation Systems (APTS). The application of ITS technologies can also enhance operating and managing public transit systems. These include making the use of HOV facilities, park-and-ride lots, and all HOV modes more convenient and attractive to commuters. Examples of some technologies and applications with public transit are highlighted in this section.

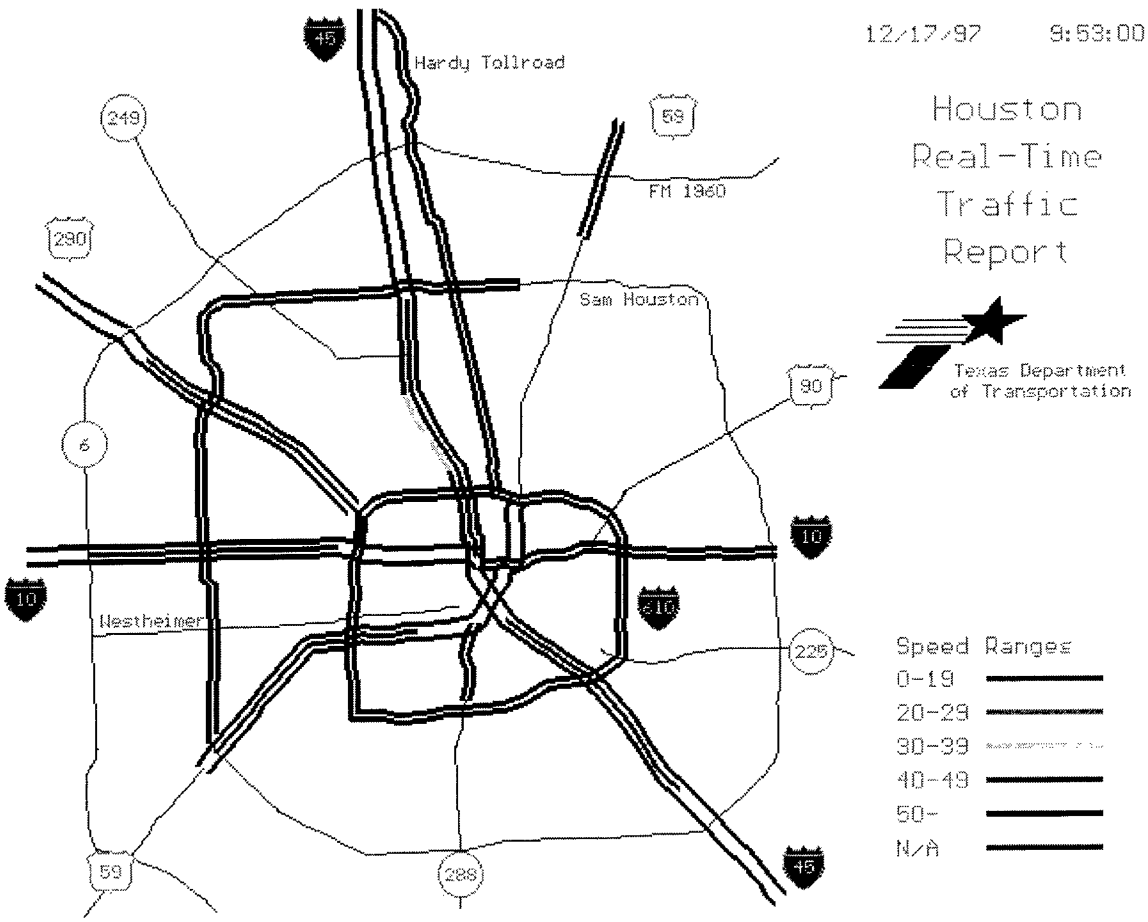


Figure 5-28. Houston Real-Time Traffic Map

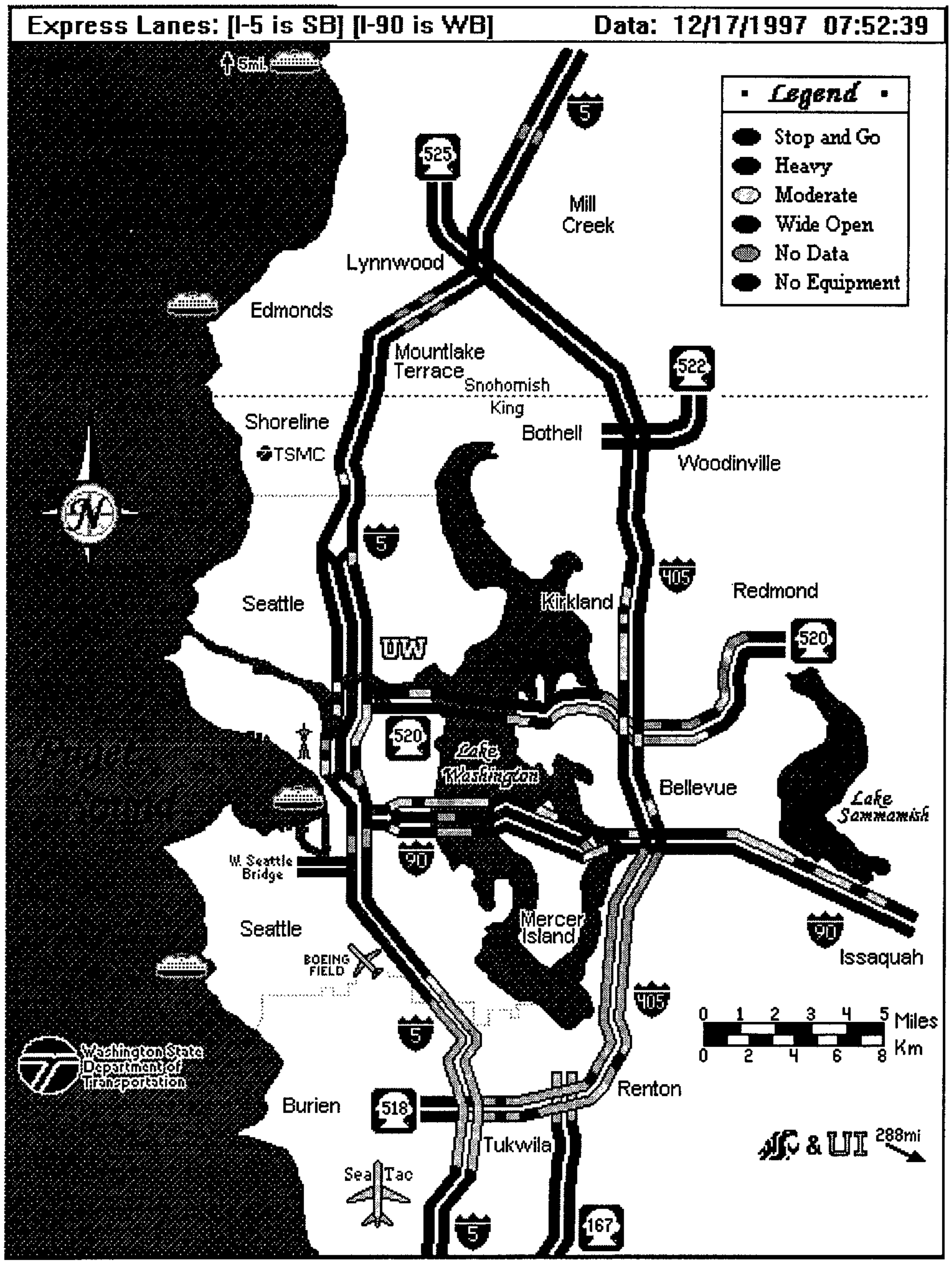


Figure 5-29. Seattle Real-Time Traffic Map on the Internet

Automatic vehicle location (AVL) systems represent one technology that can enhance bus operations and making using public transit more convenient. A number of technologies, including both ground-based systems and global positioning satellites (GPS), can be used to monitor the location and movement of buses.

The real-time information from these systems can be used to better manage bus operations and can be provided to passengers. Both real-time and scheduled time can be provided through the Internet, kiosks, cable television, touch-tone telephones, and other technologies. Figure 5-30 illustrates the RiderLink Web Page in Seattle. Developed by King County Metro and the Overland Transportation Management Association, the RiderLink Web Page provides information on Metro bus routes and schedules, ridesharing services, and ferry schedules. It also has a link to the Seattle real-time traffic map.

In another example, fare payment methods can be simplified and made more convenient through the use of *Smart Cards* and other automatic fare payment methods. These technologies focus on the use of prepaid fare media ranging from a relatively simple pass to a more advanced programmable memory chip card. *Smart Cards* can be used to provide integrated fare payment among different transit modes in an area. In addition, they can be expanded into multi-purpose cards linking transit, parking facilities—including the ability to charge lower rates for carpools and vanpools—and other services such as banking and credit card purchases.

Smart Cards can also be used by businesses to help track the use of HOVs by employees as part of an incentive program or to charge more for the use of parking for commuters who drive alone. Other ITS technologies could be used to provide real-time carpool matching capabilities, enhanced guaranteed ride home programs, and other techniques to make the use of all HOVs more convenient. For example, the University of Washington tested a real-time ride matching system using electronic mail (e-mail).

Advanced Vehicle Control systems (AVCS), Automated Highway System (AHS), and Intelligent Vehicle Initiative (IVI). These types of ITS applications range from enhancing vehicle control and operation to a fully automated highway network. Examples of projects under development and testing including detection of obstacles or other vehicles, smart cruise control, collision avoidance systems, lateral and longitudinal control functions, and fully automated vehicles.

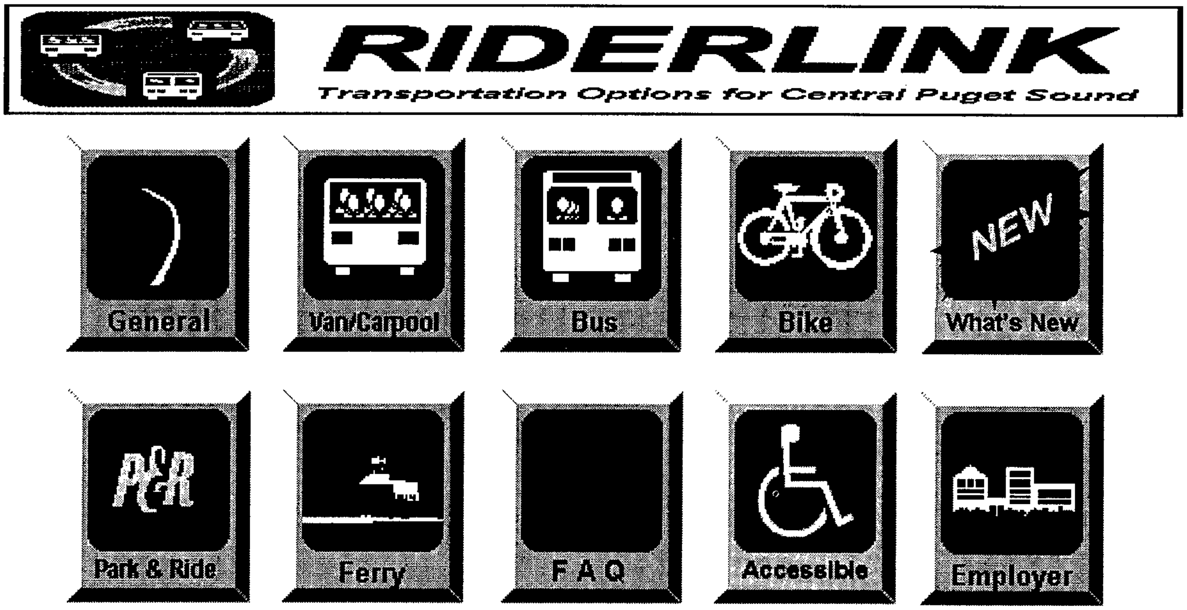


Figure 5-30. Seattle RiderLink Web Page

HOV facilities have played a role in the development and testing of these applications, and it appears they will continue to be used in the future. The I-15 HOV facility in San Diego provides the best example of the use of HOV lanes in the testing and deployment of AVCS, AHS, and IVI.

The I-15 HOV lanes have been used by Caltrans and the PATH program to test initial applications of automated vehicle braking systems and longitudinal and lateral collision avoidance systems. The I-15 facility was also used for the AHS On-Lane Vehicle Demonstration in August 1997. This demonstration showcased a number of vehicles and technologies. These included two METRO buses demonstrating "hands off" driving and in-vehicle videos, and automobiles with various features. Figure 5-31 highlights the METRO buses in operation during the demonstration. A second smaller demonstration was held on the Houston HOV lanes in December 1997. This demonstration highlighted the METRO buses and other IVI applications. METRO plans to continue to explore the use of these technologies on the Houston HOV lanes.

Figure 5-31. METRO Buses in the 1997 AHS Demonstration on the I-15 HOV Lanes in San Diego

E. Potential Truck Use of HOV Lanes

The potential use of HOV lanes by trucks during all operating hours or just the off-peak periods has been suggested in some areas. In many instances, these comments have focused on providing commercial vehicles with exclusive use of HOV facilities during all or a portion of the off-peak periods, although use during peak-periods has also been suggested. Segregating trucks from general-purpose traffic for safety reasons, providing goods movement and commercial vehicles with travel time savings to increase their competitiveness, and gaining additional use of the lanes all represent reasons for these suggestions.

Currently, commercial vehicles are not allowed on any HOV facilities. The feasibility of considering allowing trucks to use an HOV facility should consider the type of HOV facility, safety issues, and the potential benefits to commercial vehicle operators. The following elements are suggested for consideration in any feasibility assessment of truck use of HOV lanes.

- Type of HOV Facility
- Travel Time Benefits to Goods Movement
- HOV Access Points and Origins and Destinations of Commercial Vehicles
- Safety
- Additional Operating Costs

Type of HOV Facility. For the most part, consideration of allowing trucks to use HOV lanes will be limited primarily to exclusive and concurrent flow HOV lanes. Contraflow lanes, which operate only during the peak-periods in the peak-direction of travel, may be less logical candidates. Bus-only facilities on exclusive rights-of-way may also not be appropriate given significant bus volumes throughout the day and limited access points, which are often through transit facilities.

Travel Time Benefits to Goods Movement. Consideration should be given to the travel time savings and travel time reliability that the HOV lanes may provide to commercial vehicles. Determining the potential benefits to the movement of goods and comparing these to the person-moving benefits of an HOV facility should be part of the assessment process. During the off-peak periods, the HOV lane may not provide any travel time advantage over the general-purpose lanes.

HOV Access Points and Origins and Destinations of Commercial Vehicles. The origins and destinations of commercial vehicles should be compared to the HOV facility access points. In some cases, the limited access points of exclusive facilities may not match the origins and destinations of commercial vehicles. For example, a study conducted in Houston in the 1980s found that the access points on the HOV lanes did not meet the needs of commercial operators and that little if any benefits would be realized by allowing trucks to use the facilities.

Safety. Safety concerns should also be considered. Potential safety issues that should be examined during a feasibility assessment include conflicts between commercial vehicles and HOVs, trucks weaving across the general-purpose lanes to enter and exit a facility, and design geometrics that may not accommodate trucks.

Additional Operating Costs. Any extra resources associated with goods movement on an HOV facility should also be identified and analyzed. For example, off-peak use by commercial vehicles on a facility normally closed during these times may require added resources. Additional operating personnel, enforcement officers, incident response personnel, and maintenance personnel may be needed to accommodate commercial vehicles on an HOV facility.

F. Potential for Converting HOV Lanes to Fixed Guideway Transit Facilities

It may be appropriate to consider the potential for converting an HOV lane to some type of fixed guideway transit system at some point in the future. Ideally, the possible need to convert an HOV facility to a higher capacity transit alternative will be identified during the planning process. If a corridor is forecast to experience travel demands that warrant a fixed guideway system, the facility can be designed so that conversion can occur in the future or is at least not precluded.

A variety of fixed guideway transit systems may be appropriate for future consideration. These include the guided bus system, such as those in operation in Adelaide, Australia and Essen, Germany, as well as LRT and other rail systems. From an operational perspective a number of issues should be examined if conversion is being considered. These include assessing the origins and destinations of HOV lane users, access points, feeder services, travel times of different modes, and other elements. Further, all of the basic elements needed to sustain a fixed guideway system should be assessed and public perception related to taking lane away from motor vehicles should be considered. Design issues that may need to be considered include availability of right-of-way, the physical envelope, the need for on-line or off-line stations, existing and planned feeder bus services, and connections to major activity centers.

Although these issues are not insurmountable, there are probably only limited cases where conversion to a fixed guideway transit system is a realistic alternative. For example, the downtown bus tunnel and the I-90 HOV lanes in the Seattle area were designed to allow for conversion to rail in the future if an LRT system is implemented in the area. The Ottawa Transitway system has also been developed so as not to preclude the use of rail at a future date.

G. Slow Moving Vehicles

In order to maintain free flow conditions on an HOV lane, vehicles should travel at the posted speed limit. Providing a free flow condition is important for HOVs in order to maintain the travel time savings and the travel time reliability. As discussed previously, congestion in the lane can reduce the operating speeds. In addition, problems may be experienced on some facilities with slow moving vehicles or vehicles that do not maintain the posted speed limit.

Slow moving vehicles may be caused by a number of different factors. First, individuals who are not familiar with the HOV facility or who are first time users may drive more cautiously than normal. Second, some motorists may naturally drive slower, especially if an HOV lane has reduced geometrics. Third, buses may travel slower than automobiles under some conditions. For example, a full articulated bus going up a grade may travel slower than carpools on the same stretch.

Although there is no one specific approach that can be used to respond to these situations, the following techniques can be considered to address problems with slow vehicles. First, higher design speeds and wider cross-sections may encourage faster moving traffic as some drivers may slow down in reaction to HOV lanes with tight geometrics. Second, if right-of-way is available a passing lane in areas where it is anticipated that problems may arise due to grades or other conditions can be provided. Third, enforcement or other operation personnel can stop slow moving vehicles and communicate speed limit information to the driver. Finally, informational campaigns using different communication methods may be appropriate if there are continuing problems on a facility.

XI. ADDITIONAL RESEARCH NEEDS

The development of this chapter identified a number of issues associated with operating and enforcing HOV facilities that need further research. The following research statements provide an indication of the major areas for additional research related to operating and enforcing HOV facilities on freeways and in separate rights-of-way.

Assessment of Effective HOV Enforcement Procedures. As discussed in this chapter, effective enforcement is critical to the success of an HOV facility. The variety of HOV lane designs and operating scenarios present an increasing range of enforcement options and problems. At the same time, police agencies are facing funding cutbacks which limit the personnel available for assignment to HOV enforcement. To maximize available personnel, more efficient and effective enforcement approaches must be developed, evaluated, and implemented. This study would examine the design and placement of enforcement areas, the use of automated enforcement techniques and ticket by mail programs, impacts of design features on violation rates and enforcement requirements, the deterrent effects of publicized penalties, the role and effectiveness of HERO programs, and other related efforts. The project would identify deployment levels, enforcement techniques, and design features that maximize compliance with HOV regulations. It would also develop HOV enforcement guidelines for police and other agencies. The study would explore and identify approaches to build strong working relationships between enforcement agencies and the court systems to help ensure that HOV lane violations will be upheld. Further, funding alternatives for enforcement programs would be examined.

Experience with HOV Eligibility and Operational Definitions. The vehicle-occupancy requirements, vehicle eligibility regulations, and hours of operation currently in use with HOV facilities were all discussed in this chapter. Decisions on these factors and other elements will influence the operation of an HOV lane and public perception. It may also be necessary to reassess these requirements in response to too high a demand, as well as under-utilization of a facility. Additional research is needed to assess the full range of approaches for managing demand on HOV facilities and the operational steps required to implement these techniques. Strategies to be considered include changing vehicle-occupancy requirements, variable time of day restrictions, allowing lower occupancy or single occupancy vehicles to use the lane for a fee, and other options. This study would examine these issues and would document the experience with HOV facilities that have used different techniques to manage demand. The results of this analysis would be used to develop guidelines for managers and operators faced with the problem of HOV lanes which are either too crowded or too empty.

Analysis of Mode choice on Existing HOV Facilities. Several studies have documented the increase in HOV usage on effected freeways immediately following the implementation of an HOV facility. Less research is available, however, examining the formation of new carpools in response to a new HOV lane, as well as existing carpools that change their routes to take advantage of the time savings offered by the lanes. Further, few studies have tracked the growth of carpool formation over time as an HOV lane matures or have documented the impact of HOV facilities on parallel transit lines. Improving the ability to assess the short- and long-term impact of HOV lanes on carpooling and transit ridership would benefit planners and would assist in developing and calibrating mode choice models. This study would analyze existing data on the growth of carpooling and transit use in HOV lanes over time. It would attempt to isolate the impact of the HOV lanes on mode choice alternatives.

Comparison of Actual and Perceived Travel Time Savings and Travel Time Reliability for HOVs. Studies have indicated that people using HOV facilities often wrongly estimate their travel times and travel time reliability. HOV lane users tend to overestimate the time savings from using a facility, while non-users tend to underestimate the potential savings. In addition, HOV lane users and non-users may have different perceptions of the travel time reliability of HOV facilities. Since research has shown that people make transportation decisions based on their perceived travel times as well as travel time reliability, it is important that this issue be examined. This research would assess the perception of travel time savings and travel time reliability by HOV lane users and non-users, the elements that affect these perceptions, and techniques to communicate more accurate information on travel times and travel time reliability to users and potential users of HOV facilities.

Developing HOV Systems to Improve Efficiency. The information examined in this chapter indicates that HOV lanes are more effective when applied in conjunction with a variety of complementary treatments, such as queue-jump treatments at freeway entrance ramps, park-and-ride lots, and transit centers. A full understanding does not exist, however, of what techniques and approaches have the most influence on encouraging greater use of HOV modes. This research would examine the strategies used by various agencies in developing a variety of HOV facilities and HOV networks. It would also develop approaches to integrating all aspects of the highway-based transportation system, including bus transit and bus-to-rail connections, with HOV networks.

Assessment of Operational Issues Associated with Lane Conversion Projects. As discussed in the chapter, experience to date indicates that converting an existing general-purpose lane to an HOV lane has not generally been accepted by the public or by policy makers. Recent market research conducted in California and Seattle suggests that commuters may be more amenable to considering lane conversion in specific cases. Research is needed to more thoroughly explore the potential for lane conversion projects, the factors that seem to influence public and political acceptance, and other issues associated with these types of projects. Based on this assessment, the study would develop guidelines to assist in determining the feasibility of lane conversion projects.

Assessment of Incident Management Strategies. As discussed in this chapter, a variety of techniques are currently being used to respond to incidents and accidents on HOV facilities. In addition, different policies and approaches are in use to govern opening HOV facilities to help manage incidents on the adjacent freeway or street. Additional research is needed to better document the current practices and to develop alternative approaches for enhancing incident response capabilities on HOV facilities, as well as the use of HOV lanes to manage incidents on adjacent facilities.

Assessment of ITS to Enhance the Operation of HOV Facilities. The application of ITS with HOV facilities was discussed in this chapter and in other reports (7). It has also been a topic of discussion at conferences and other meetings. In most areas, ITS applications are still in the testing and initial deployment phases. As a result, experience is still being gained on the use and benefits of various ITS and other advanced technologies with HOV facilities. Additional research is needed to document and analyze current projects, and to further explore innovative techniques and applications.

Assessment of Techniques to Link Freeway and Arterial Street HOV Operations. Few examples exist of regional HOV networks that include linking facilities on freeways or in separate rights-of-way with those on arterial streets. Since congestion levels on arterial streets often contribute significantly to the travel time delays experienced by carpools, vanpools, and buses, enhancing the connection between HOV facilities on all types of freeway and roadways may have significant benefits. This research would examine existing examples of links between freeway and arterial street HOV facilities and would identify techniques and approaches that could be used to encourage additional connections.

Assessment of Operational Issues Associated with Priority Pricing Projects. As discussed in this chapter, only a few examples currently exist of priority pricing on HOV facilities. Additional research is needed to examine the operating experience with these projects, as well as with new facilities. This ongoing assessment should examine public acceptance, utilization, and operation of these projects. The results of this study can be incorporated into future updates of the HOV Systems Manual.

Enhancing HOV Simulation Models. Currently, many HOV operational considerations cannot be modeled. Improvements in existing simulation models and new models are needed to better assess HOV lane alternatives and operational strategies. This project should examine improved simulation models for assessing HOV lane alternatives, as well as access options, and when and where to terminate an HOV facility. The results of this study would provide practitioners with enhanced models for simulating various HOV lane, access, and end treatments.

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CHAPTER 6—DESIGN OF HOV FACILITIES ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

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I. INTRODUCTION

This chapter discusses the design elements associated with HOV facilities on freeways and in separate rights-of-way. It presents information on the basic elements of the design process, general design considerations, specific design features and cross sections for different types of HOV facilities, and design elements related to enforcement, signing and pavement markings, ingress and egress, and other special features. The chapter is intended to address the most frequently encountered design issues. It does not attempt to address every possible design unique to a specific situation. The chapter is divided into eight sections covering the following topics.

- **Design Process for HOV Facilities on Freeways and in Separate Rights-of-Way**. This section provides an overview of the design process commonly used with HOV facilities on freeways and in separate rights-of-way. The agencies and groups usually involved in designing these types of projects are identified, and the steps in the design process are summarized.

- **Overview of Design Considerations for HOV Facilities on Freeways and in Separate Rights-of-Way**. This section provides an overview of the general design elements that should be considered with HOV facilities. Information on the design vehicle, the design driver, design speed, and roadway alignment geometry is presented.

- **Design Considerations and Cross Sections**. This section presents design considerations for HOV facilities on freeways and in separate rights-of-way. Typical cross-sections and design guidelines for busways and freeway HOV facilities are presented. Cross sections for reduced and desirable standards are illustrated, and the issues associated with different design treatments are discussed. Design elements and cross sections are also provided for on-line transit stations and different types of access treatments. Design considerations related to system connectivity are also presented.

- **Design Considerations for HOV Facilities Associated with Freeway Ramps, Mainline Meters, Connector Meters, Toll Plazas, and Ferry Loading Areas**. This section summarizes the design considerations for typical types of HOV bypass applications related to freeway ramp meters, mainline meters, connector meters, toll plazas, and ferry loading areas. Examples of typical layouts and current projects are presented.

- **Design Considerations for Enforcement**. This section examines the general design elements that should be considered with HOV facilities. The enforcement design consideration for the various types of HOV facilities are also presented.

- **Regulatory and Guide Signing and Pavement Markings for HOV Facilities**. This section provides information on the signs and pavement markings commonly used with the different types of HOV facilities. Examples of regulatory and guide signs and pavement markings are provided.

- **Special Design Considerations**. This section discusses the design issues that may need to be considered with special projects. These include lane conversion projects, priority pricing on HOV facilities, ITS and HOV lanes, truck use of HOV lanes, converting HOV lanes to fixed-guideway transit systems, and slow moving vehicles.
- **Additional Research Needs**. The chapter concludes with a discussion of further research needs related to the design of HOV facilities on freeways and in separate rights-of-way.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information relating to designing HOV facilities on freeways and in separate rights-of-way.

II. DESIGN PROCESS FOR HOV FACILITIES ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

A. Groups Involved in Designing HOV Facilities on Freeways and in Separate Rights-of-Way

Similar to the planning phase for a freeway HOV facility or a busway, numerous agencies and groups will be involved in designing a project. The participation of the appropriate agencies and individuals is key to ensuring that all groups are involved in discussing the different design elements, that potential issues are identified and resolved prior to implementation, and that all groups have a common understanding of the project.

If a multi-agency committee or a multi-department team within an agency was formed during the planning phase of a project, this group may continue through the design process. A special subgroup or committee, comprised of the design personnel from various agencies, may be organized to address the specific design issues with HOV facilities on freeways or in separate rights-of-way. In addition, consideration should be given to other groups that may need to be involved or consulted during the design phase.

Table 6-1 identifies the various agencies and groups that should be considered for inclusion in the design of an HOV project on a freeway or in a separate right-of-way. The roles and responsibilities of each group are highlighted in Table 6-1 and described in more detail below. Practitioners can use the information in Table 6-1 as a guide to help ensure that consideration has been given to including the various groups in the development of the recommended design for an HOV facility. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

State Department of Transportation. The state department of transportation or the state highway department usually has overall responsibility for HOV facilities on freeways. As a result, the state agency will most likely be responsible for designing the project and for organizing and staffing the multi-agency coordinating team. The state may play a supporting role on busways or other HOV facilities in separate rights-of-way.

Table 6-1. Agencies and Groups Involved in Designing HOV Facilities on Freeways and in Separate Rights-of-Way

Agency or Group	Potential Roles and Responsibilities
State Department of Transportation	• Overall project management responsibilities with freeway projects. • Supporting role if transit agency is lead on projects in separate right-of-way. • Responsible for design of facilities on freeways. • Staffing of multi-agency or multi-division team.
Transit Agency	• Overall project management on busways in separate rights-of-way. • Supporting role with HOV facilities on freeways. • Design facility or assist with design. • Staffing multi-agency team or participating on team.
State and Local Police	• Assist with design, especially enforcement elements. • Participate on multi-agency team.
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multi-agency coordination. • Ensure that projects are included in necessary planning and programming documents. • Assist with design of projects. • May have policies relating to designing HOV facilities.
Rideshare Agency	• Assist with design of projects. • Participate on multi-agency team.
Local Municipalities	• Assist with design of projects. • Coordinate with local HOV lanes. • Participating on multi-agency team.
Federal Agencies—FHWA and FTA	• Funding support for facility design. • Technical assistance. • Possible approval of design or steps in design process. • Participate on multi-agency team.
Other Groups	• EMS, fire, and other emergency personnel. • Tow truck operations. • Businesses. • Neighborhood groups. • Judicial system—state and local courts.

Transit Agency. A transit agency usually has the lead responsibility with busways in separate rights-of-way. In these cases, the transit agency will have the lead role in designing the facility as well as organizing and staffing the multi-agency team. A transit agency may be a co-sponsor or may assist with HOV facilities on freeways. In these cases, transit agency personnel may focus on assisting with the design to ensure safe and efficient bus operations, enforcement, and overall project coordination.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities is stressed throughout this Manual. Representatives from the state, city, county, or transit police departments should be involved in the design of HOV facilities on freeways and in separate rights-of-way. Since these agencies are usually responsible for enforcing HOV projects, their participation in the design process can help ensure that the HOV facility can be adequately and safely enforced.

Metropolitan Planning Organization (MPO). Representatives from the MPO are usually members of a multi-agency team for HOV projects on freeways and in separate rights-of-way. MPO staff may chair these groups or help facilitate multi-agency cooperation. They may also assist with the design of freeway HOV projects.

Rideshare Agency. In many areas, the transit agency is also responsible for providing ridematching, vanpooling, and other ridesharing services. In some areas, however, these responsibilities are handled by a separate agency. In these cases, the rideshare agency should be a member of the multi-agency project team and may assist in the design of the facilities.

Local Municipalities. City or county departments may participate in the multi-agency team with a HOV project on a freeway or in a separate right-of-way. Local municipalities may assist with the design of these facilities, especially in coordination projects with the local roadway system and with arterial street HOV projects. The engineering and planning departments most frequently are responsible for these activities, although staff from other departments may also be involved.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least monitor the design of HOV facilities on freeways and in separate rights-of-way. Federal agencies may have design approval of HOV facilities on the Interstate system and other projects. Representatives from FHWA and FTA usually participate on the multi-agency team, and may provide technical assistance on specific issues or suggestions on how certain elements have been addressed in other areas.

Other Groups. Consideration should be given to including representatives from other groups or obtaining their input during the design process for HOV facilities on freeways and in separate rights-of-way. These may include representatives from the judicial system who will be responsible for enforcing fines and citations; EMS, fire, and other emergency personnel who have to respond to incidents and accidents on the facility; tow truck operators who may be responsible for removing disabled vehicles; businesses; and neighborhood groups.

B. Steps in Designing HOV Facilities on Freeways and in Separate Rights-of-Way

The design process for HOV facilities on freeways and in separate rights-of-way will normally involve a number of steps. These include reviewing the results and recommendations from the planning process, considering operational issues and opportunities, obtaining input from the public and local organizations, assessing the specific characteristics of the freeway or corridor, developing a preliminary design, reviewing the preliminary design with the public and local organizations, and finalizing the design plans. The steps in the design process are highlighted in Figure 6-1 and summarized next. The public involvement process started during the planning process should continue through the design, implementation, and operation phases for an HOV project.

Review Recommendations from Planning Process. The first step in the design process usually involves reviewing the results or recommendations from the planning process. The major elements included in planning HOV facilities on freeways and in separate rights-of-way are discussed in Chapter 4. The outcome of the planning process will usually be a recommended alternative or a limited number of alternatives. These recommendations will form the basis for the start of the design process.

Consider Operational Issues and Opportunities. The operating characteristics associated with the recommended HOV application should be considered early in the design process. Reviewing the operational issues and the opportunities related to the selected HOV alternative can assist in identifying critical elements that may need to be addressed in the project design. Approaches to address these concerns can then be incorporated into the facility design.

Obtain Input from the Public and Local Organizations. The public involvement process started in the planning phase of a project should continue through the design process. Providing the public, business and neighborhood groups, and other organizations with the opportunity to participate early in the design process will help identify any issues and concerns that will need to be addressed. As discussed in Chapter 10, a variety of techniques can be used to involve the public at this point in the process. These may include meetings, focus groups, surveys, and individual interviews.

Assess Specific Characteristics of Freeway or Corridor. The characteristics of the freeway, corridor, or other facility being considered for the HOV project are examined in this step. Possible activities include detailed assessment of traffic volumes, available right-of-way, intersection spacing, existing bus services, and adjacent land uses. Although many of these items will have been examined in the planning stage, a more detailed analysis is usually needed in the design process.

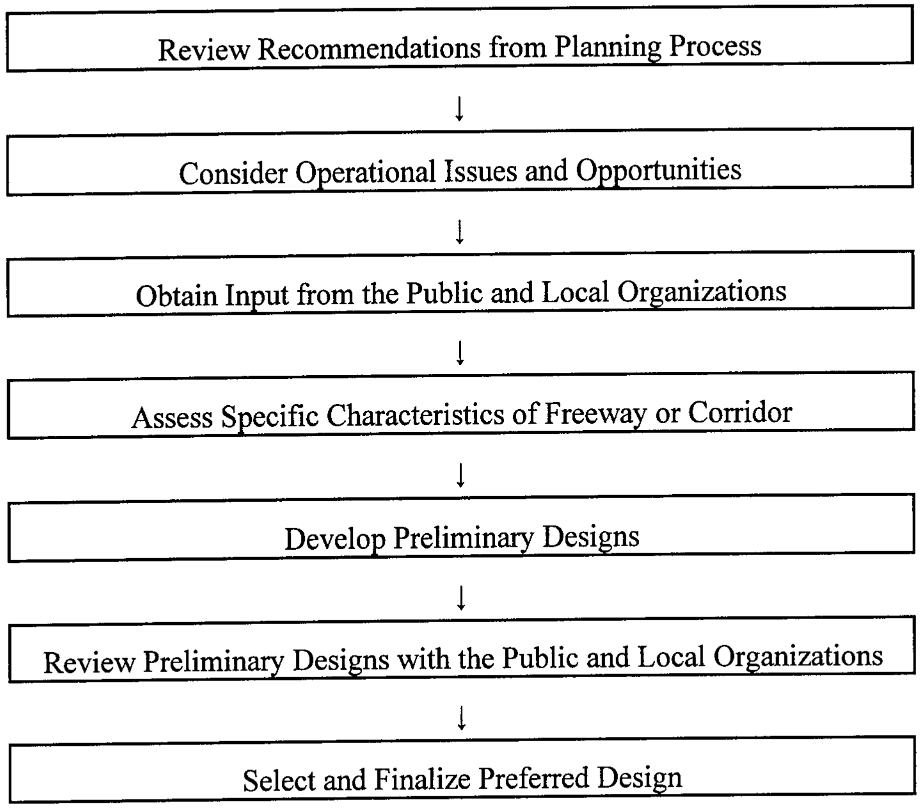


Figure 6-1. Steps in Designing HOV Facilities on Freeways and in Separate Rights-of-Way

Develop Preliminary Designs. This step includes the development of the preliminary designs for the specific HOV project. Although the complexity and level of detail will vary depending on the type of treatments considered, the design should be completed to a stage that allows all groups to understand the key components of the facility, to develop realistic cost estimates, and to outline an implementation schedule. It should also include the links to supporting facilities or the local roadway system if appropriate.

Review Preliminary Designs with the Public and Local Organizations. The preliminary designs should be reviewed by the public, business and neighborhood groups, and other organizations along the freeway or corridor. As discussed in Chapter 10, techniques for public involvement at this stage may include hearings, meetings, workshops, outreach efforts, newsletters, and other approaches.

Select and Finalize Preferred Design. The comments received through the public involvement process should be reviewed, the preferred design selected, and any needed modifications should be made to the design plans. The design can then be finalized and used to develop the plans and specifications for the project. The actual construction and implementation process can then be initiated. A detailed discussion on the implementation process is provided in Chapter 11.

III. OVERVIEW OF DESIGN CONSIDERATIONS FOR HOV FACILITIES ON FREEWAYS AND IN SEPARATE RIGHTS-OF-WAY

Several elements, criteria, and controls should be considered in the design process for HOV facilities on freeways and in separate rights-of-way. These factors are important for the safe and efficient operation of an HOV facility. These criteria, which are similar to those applied to any type of roadway, relate to the vehicle design, driver design, design speed, and roadway alignment geometry.

The desirable and reduced requirements for these design factors are based primarily on the standards recommended by the American Association of State Highway and Transportation Officials (AASHTO), the Institute of Transportation Engineers (ITE), and the Transportation Research Board (TRB). The desirable and reduced standards of design for different types of HOV facilities have been examined by these organizations and other groups, and are documented in numerous reports (1,2,3,4,5,6,7,8,9). In addition, several states have HOV design guidelines or other documented criteria. These include Texas (10), California (11), and Washington (12).

The design of HOV facilities on freeways and in separate rights-of-way is often a challenging process. In many cases, right-of-way limitations and roadway constraints may make it impossible to meet all desirable design standards. Unless an HOV facility is being developed as part of a new project or major reconstruction of an existing facility, some compromise in design may need to be considered. The design of a facility will depend on the local conditions, accepted practices in the area, and other issues.

Realizing that using desirable design elements may not always be realistic, this Manual includes information on both desirable and reduced design features. The desirable criteria include all the preferred design elements. Desirable designs generally reflect those associated with a permanent or new facility, and meet AASHTO and other standards.

Designs with reduced features reflect the inability to meet the desirable criteria due to lack of available right-of-way or other significant limitations. Reduced designs do not reflect those associated with permanent facilities. Consideration of reduced designs should be considered on a case-by-case basis based on sound engineering practice. The reduced values presented in this Manual are not intended as a standard of practice.

This section highlights the various design and control criteria that should be considered with HOV facilities. The design vehicle criteria are presented first, followed by a discussion of design driver criteria, design speed, and roadway alignment.

A. Design Vehicle

The physical and operating characteristics of eligible vehicles will influence the design of HOV facilities on freeways and in separate rights-of-way. Standard and articulated buses, as well as carpools and vanpools, are often part of the allowed vehicle mix on these types of HOV facilities. These vehicle types are illustrated in Figure 6-2 and the vehicle design dimensions are provided in Table 6-2. The typical dimensions for a 12.1 meter (40 foot), a 13.7 meter (45 foot), and an articulated bus are shown in Figures 6-3 through 6-5. The turning radii for a 12.1 meter (40 foot) bus and an articulated bus are illustrated in Figures 6-6 and 6-7. These dimensions, which will also accommodate vanpools and carpools, can be used by practitioners to assist with the design of HOV projects on freeways and in separate rights-of-way. As noted in Figure 6-7, the turning radii for articulated buses is being reexamined by AASHTO.

These templates can be used in determining lane and shoulder widths, lateral and vertical clearances, bus stops, and other elements associated with a project. In addition, the path of the vehicle overhang beyond the outside turning radius should be considered in the design process. Double-deck buses, which may operate in some areas, have essentially the same characteristics as a standard bus except for vehicle height. Tractor-trailer buses, which do have different design characteristics, are not usually considered in the design process in most areas due to their very limited use.

The design vehicles should be used to control the geometrics of the different HOV facility design elements. For example, speed change lanes and corner radii should be based on a bus or other large design vehicle, while alignment geometry is typically based on the stopping sight distance of a passenger car driver. Larger design vehicles are not usually used in alignment design because the higher eye height of the driver allows them to see objects from a longer distance, which may partially compensate for the longer stopping distances of these vehicles. Larger design vehicles, however, should be used for vertical alignment design when sight restrictions occur on long downgrades. In these situations, the speed of a bus may exceed those of a passenger car (2).

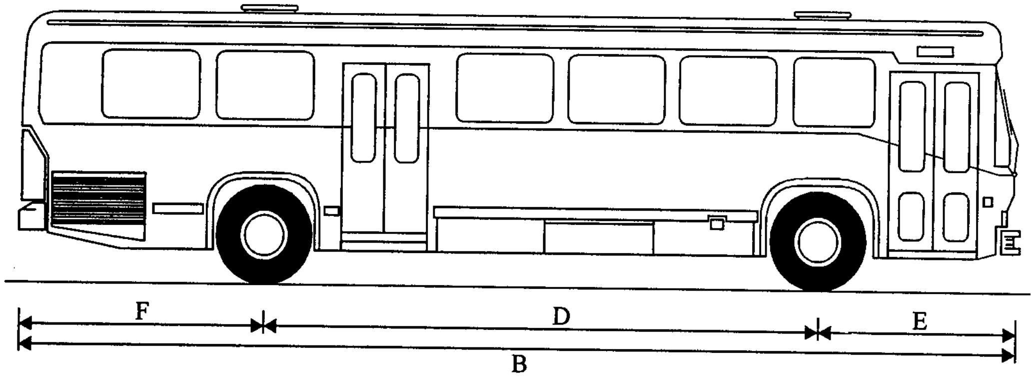
HOV facilities on separate rights-of-way are typically restricted to buses, while most freeway HOV facilities are also open to carpools and vanpools. As a result, buses are usually used as the design vehicle for most HOV facilities. In many cases, however, passenger car and bus designs are both considered. Further, if a facility is planned to be used for HOVs on a part time basis and opened to general traffic at other times, consideration may be given to using a truck as the design vehicle.

Figure 6-2. Examples of Vehicles Allowed to Use HOV Facilities

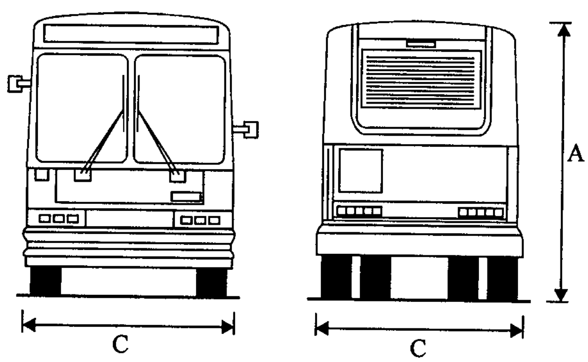
Table 6-2. Design Vehicle Dimensions

Design Vehicle Type	Height	Width	Length	Overhang		Wheel Base
				Front	Rear	
Passenger Car	1.3 m (4.25 ft)	2.1 m (7.0 ft)	5.8 m (19 ft)	0.9 m (3.0 ft)	1.5 m (5.0 ft)	3.4 m (11.0 ft)
Van	2.0 m (6.5 ft)	2.3 m (7.5 ft)	5.1 m (17 ft)	0.7 m (2.5 ft)	1.2 m (4.0 ft)	3.2 m (10.5 ft)
12.1 meter (40 foot) Bus*	3.0-3.4 m (9.9-11.1 ft)	2.5-2.6 m (8.2-8.5 ft)	12.1 m (40 ft)	2.1 m (7.2 ft)	2.4 m (9.3 ft)	7.7 m (25.0 ft)
13.7 meter (45 foot) Bus*	3.7 m (12.2 ft)	2.6 m (8.5 ft)	13.7 m (45 ft)			6.9 m (22.9 ft)
Articulated Bus*	3.1 m (10.5 ft)	2.6 m (8.5 ft)	18.3 m (60 ft)	2.6 m (8.5 ft)	2.9 m (9.5 ft)	Front 5.3-5.7 m (17.5-18.6 ft) Rear 7.1-7.4 m (23.3-24.2 ft)
Double-deck Bus*	4.3 m (14.2 ft)	2.6 m (8.6 ft)	12.1 m (40 ft)	2.1 m (7.1 ft)	2.6 m (8.7 ft)	6.2 m (20.4 ft)

*Exact dimension may vary by bus manufacturer.



ITEM		
A	Overall Height	3.0 m (9.9 ft) - 3.4 m (11.1 ft) *
B	Overall Length	12.1 m (40 ft)
C	Overall Width	2.5 m (8.2 ft) - 2.6 m (8.5 ft) *
D	Wheel Base	7.2 m (23.7 ft) - 7.6 m (24.9 ft) *
E	Front Axle to Bumper	2.1 m (7.2 ft)
F	Rear Axle to Bumper	2.4 m (9.3 ft)



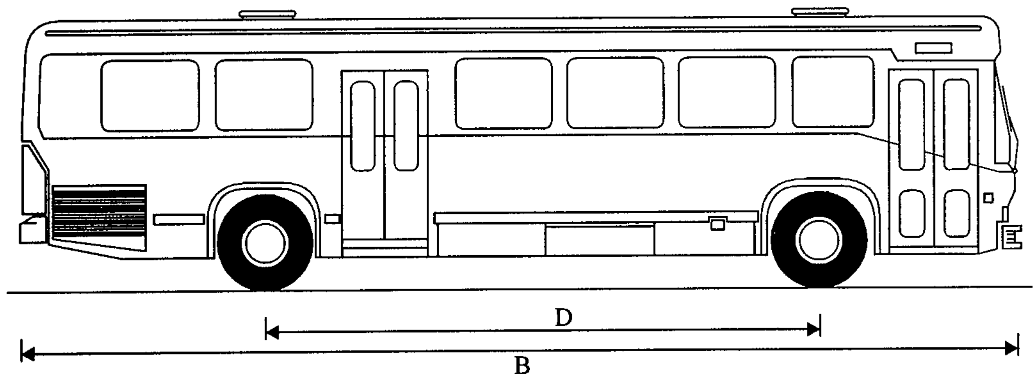
NET/GROSS VEHICLE WEIGHT **	
Front Axle	3,370/5,440 kg (7,420/11,980 lbs)
Rear Axle	8,200/11,200 kg (18,060/24,660 lbs)
Seating Capacity	46 - 51*
Standing Capacity	20 - 25*

NOTES

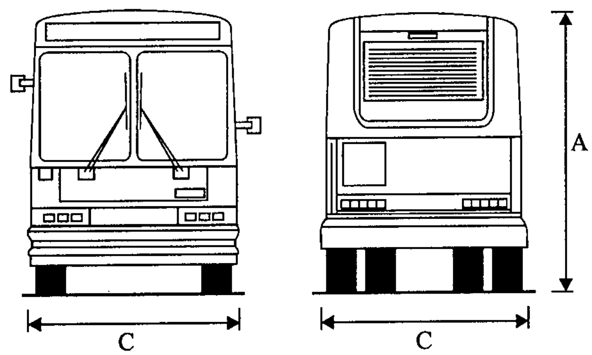
* Varies for different types of 12.1 m (40 ft) buses
** Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 6-3. Typical Dimensions for a 12.1 Meter (40 Foot) Bus

Source: (13,14)



ITEM		
A	Overall Height	3.7 m (12.2 ft)
B	Overall Length	13.7 m (45 ft)
C	Overall Width	2.6 m (8.5 ft)
D	Wheel Base	6.9 m (22.9 ft)



NET/GROSS VEHICLE WEIGHT **

17,326/22,777 kg (38,150/50,150 lbs)

Seating Capacity	50 *
Standing Capacity	28 *

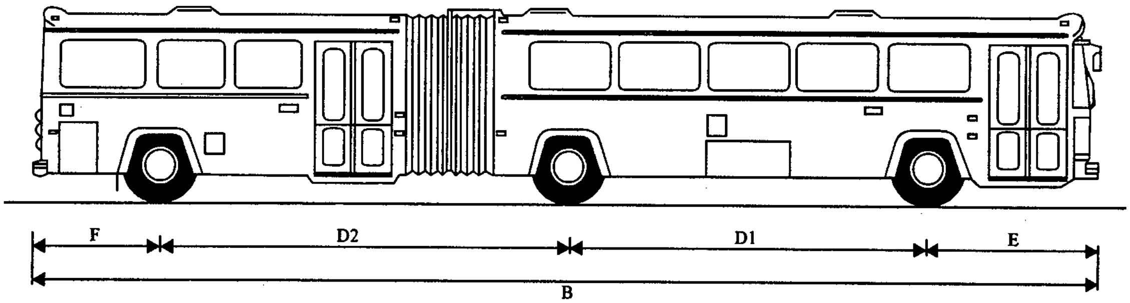
NOTES

* Varies for different types of 13.7 m (45 ft) buses

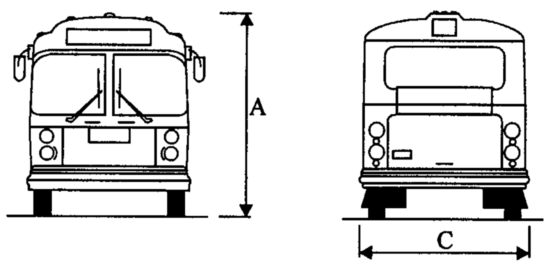
** Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 6-4. Typical Dimensions for a 13.7 Meter (45 Foot) Bus

Source: (14)



ITEM		
A	Overall Height	3.2 m (10.2 ft)
B	Overall Length	18.3 m (60 ft)
C	Overall Width	2.6 m (8.5 ft)
D1	Wheel Base - Front	5.3 m (17.5 ft) - 5.7 m (18.6 ft)*
D2	Wheel Base - Rear	7.1 m (23.3 ft) - 7.4 m (24.2 ft)*
E	Front Axle to Bumper	2.6 m (8.5 ft)
F	Rear Axle to Bumper	2.9 m (8.7 ft)



NET/GROSS VEHICLE WEIGHT **	
Front Axle	5,360/7,450 kg (11,800/16,420 lbs)
Rear Axle	5,510/7,420 kg (12,130/16,420 lbs)
Center Axle	6,800/11,010 kg (14,970/24,250 lbs)

MAXIMUM BEND ANGLE	
Horizontal	± 36 deg
Vertical	± 11 deg

Seating Capacity	70 - 76*
Standing Capacity	38*

NOTES

* Varies for different types of articulated buses

** Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 6-5. Typical Dimensions for an Articulated Bus

Source: (13,14)

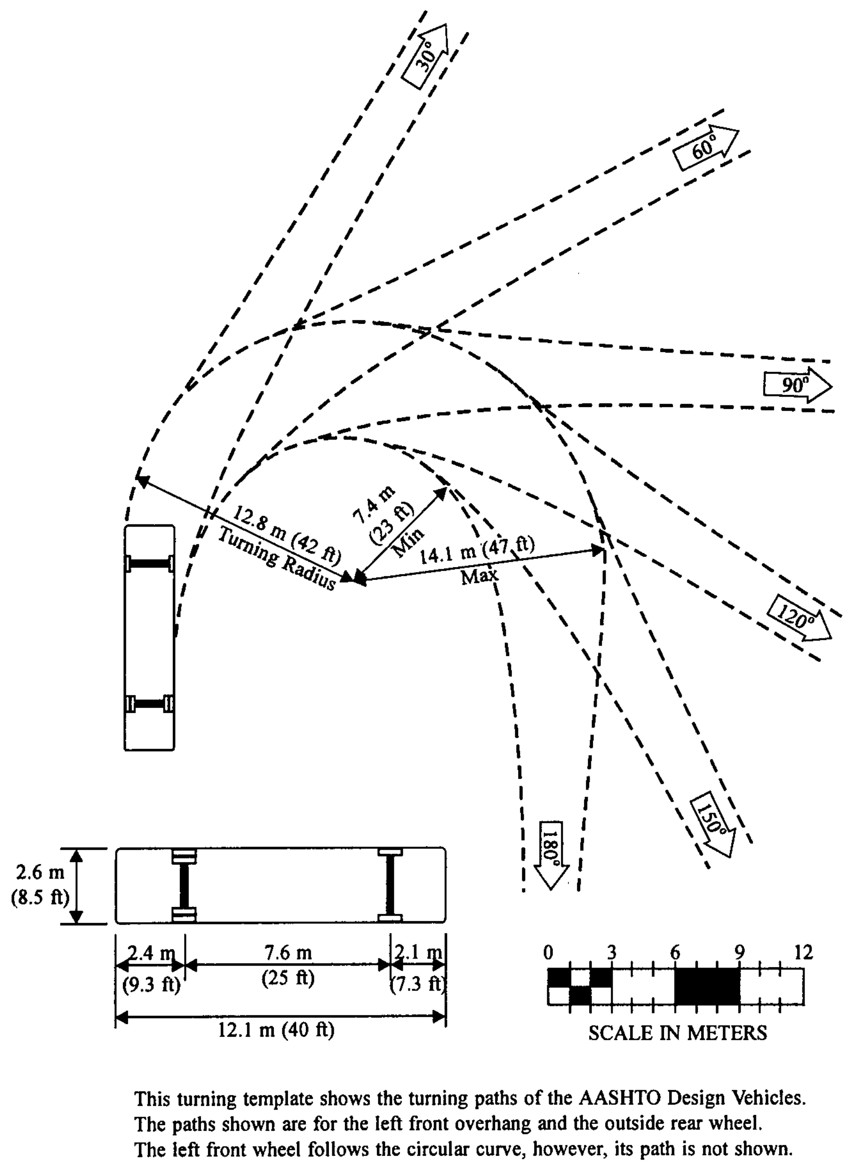
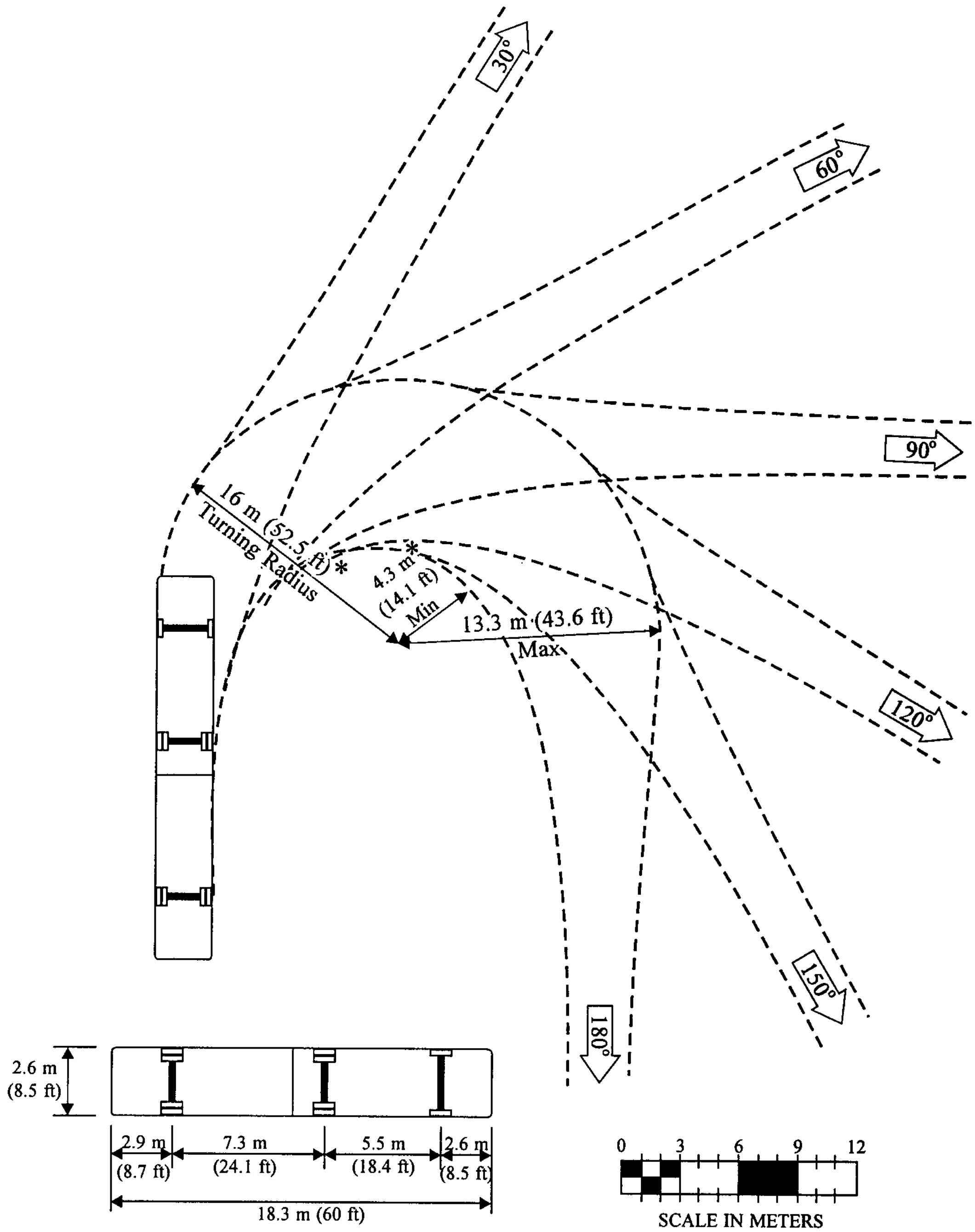


Figure 6-6. Design Template for 12.1 Meter (40 Foot) Bus

Source: (2)



This turning template shows the turning paths of the AASHTO Design Vehicles. The paths shown are for the left front overhang and the outside rear wheel. The left front wheel follows the circular curve, however, its path is not shown.

* Note: These values are being reexamined by AASHTO.

Figure 6-7. Design Template for an Articulated Bus

Source: (2)

B. Design Driver

The identification of a design driver impacts several design elements for an HOV facility. Design drivers are typically defined by their experience with the facility being considered. For example, commuters would be more familiar with an HOV lane than non-commuters. In addition, professional bus drivers are usually considered to be more aware of potential conflicts on a roadway than other motorists. In most cases, roadways and HOV facilities are designed for the unfamiliar driver who has had no professional training. Exceptions to this approach may be made on busways or other HOV lanes that will be restricted to buses or authorized vehicles.

C. Design Speed

Roadway alignment design features are impacted by the designated design speed of the facility. In most cases, the design speed of an HOV facility on a freeway will be the same as that used on the adjacent general-purpose lanes. There may be limited instances where the design speed of the HOV lane is lower than the adjacent general-purpose lanes, however, due to the geometrics of the HOV facility or other limitations. The design speed for HOV facilities on separate rights-of-way, which do not have adjacent general-purpose lanes, are usually based on the facility functional classification, topography, and adjacent land uses.

The designated design speed should relate to the maximum speed the design features of the HOV facility are expected to accommodate as noted in Chapter 11 of the AASHTO Green Book (2). Further, the design speed should accommodate the vast majority (85 percent) of users. For example, concurrent flow HOV lanes should be expected to have the same design speed as the adjacent freeway lanes. A ramp meter HOV bypass lane will obviously have lower speed expectations.

AASHTO recommends design speeds of 100 km/h to 110 km/h (60 mph to 70 mph) on most urban freeways (2). Table 6-3 summarizes the design speeds typically associated with various types of HOV lanes. This information is provided to give a general idea of potential design speeds. The design speed for a specific facility should consider the anticipated user groups, the use of on-line and off-line stations, gradients, and local conditions. For example, in New York State, the design speed for freeway HOV lanes is based on the maximum off-peak speed observed in the general-purpose lanes unless other circumstances prevent such a speed being used.

D. Roadway Alignment Geometry

A number of geometric factors should be considered in the design of an HOV facility. Elements to be examined often include horizontal clearance, vertical clearance, stopping sight distance, superelevation, cross slope, horizontal curvature, vertical curvature, and gradient. The design recommendations, standards, and guidelines of AASHTO, ITE, individual states, and other groups should be used in determining these features for a specific HOV project. Each of these elements is discussed briefly in this section.

Table 6-3. Examples of Typical Design Speeds for HOV Facilities

Type of HOV Lane	Typical Design Speed	
	Reduced	Desirable
Separate Right-of-Way		
Bus-only	80 km/h (50 mph)	120 km/h (70 mph)
Bus and HOVs	60 km/h (40 mph)	100 km/h (60 mph)
Freeways-HOVs		
Barrier separated	80 km/h (50 mph)	120 km/h (70 mph)
Concurrent flow	80 km/h (50 mph)	100 km/h (60 mph)
Contraflow	40 km/h (30 mph)	80 km/h (50 mph)

Source: (6)

Horizontal Clearance. There is a good deal of variance in the horizontal or lateral clearance with existing HOV lanes. As a minimum, at least a 0.6 meter (2 foot) lateral clearance should be provided to adjacent barriers, columns, or other obstructions for both HOV and general-purpose traffic lanes, although 1.2 meters (4 foot) is desired. Exceptions to this minimum should be considered only in temporary situations, such as construction or reconstruction of a facility where speeds are reduced, or for very short distances where other options do not exist.

Vertical Clearance. The height of the tallest vehicle anticipated to operate in the HOV facility should be used to determine the vertical clearance. As discussed previously, buses are usually the tallest vehicle using an HOV lane. As a result, buses are commonly used to determine the vertical clearance. In the case of HOV lanes on freeways, the standard 10.3 meters (16.5 feet) used for the adjacent freeway lanes will also be used for the HOV lane. This same standard is also commonly used with HOV facilities on separate rights-of-way, unless special limiting conditions exist.

Stopping Sight Distance. The design of an HOV facility should provide adequate sight distance for a bus, van, or car to come to a controlled stop. As noted previously, the automobile is usually used as the design vehicle for determining stopping sight distance. AASHTO guidelines (2) should be used in determining stopping sight distances for various travel speeds. The stopping sight distance should be checked if barriers are used as they may restrict the stopping sight distance.

Superelevation. Superelevation rates should be applicable to curvature over a range of design speeds. Buses and vans, which have a higher center of gravity than passenger automobiles, typically require slightly higher superelevation rates. Where a curve radius cannot be increased, a higher rate of superelevation should be considered since vehicles with high centers of gravity require additional superelevations to avoid rolling over. AASHTO (2) guidelines should be used to determine the appropriate superelevation of a specific HOV facility.

Cross Slope. The cross slope of an HOV lane on a freeway is often the same as the cross slope of the adjacent general-purpose freeway lanes, which is commonly 2.0 percent. An HOV lane located in the center median of a freeway may straddle the roadway crown, however. In this case, the HOV lanes may be crowned to provide a 2.0 percent cross slope to both sides. The standard 2.0 percent cross slope is also used with busways and HOV lanes in separate rights-of-way. AASHTO (2) guidelines should be used to determine the appropriate cross slope for a specific project.

Horizontal Curvature. Horizontal curvature is based on the relationship of design speed, pavement side friction, and superelevation. The horizontal alignment of an HOV facility should be designed to ensure that curves can be safely negotiated by all design vehicles, including buses. AASHTO (2) and state guidelines should be used to determine the appropriate horizontal curvature for a specific HOV facility. Consideration may need to be given to providing extra lateral lane width on curves for buses or semi-trucks on part-time HOV facilities.

Vertical Curvature. The length of vertical curvature depends on stopping sight distances and gradients. HOV lanes on freeways typically follow the existing vertical curvature of the facility. For busways and HOV facilities on separate rights-of-way, K-factors are used to determine the necessary vertical curvature. K-factors are determined by applicable design speeds. The length of a curve is determined by multiplying the K-factor by the algebraic difference in grade. Minimum lengths of crest vertical curves are based on stopping sight distance requirements (2). Vertical curves are based on headlight distance, rider comfort, drainage control and general appearance (2). Vertical curves longer than the minimum are desired. AASHTO (2) and state guidelines should be used in determining the appropriate K-factor for a specific HOV facility.

Gradients. AASHTO (2,3) provides guidelines for gradients on freeways and roadways. These guidelines can also be applied to HOV facilities on freeways and in separate rights-of-way. Consideration should be given to the operating characteristics of the vehicles anticipated to use the HOV lane to ensure the facility functions safely. For example, a fully loaded bus will operate at slower speeds than an automobile on a sustained grade. The AASHTO Green Book (2) indicates that maximum grades of about 5 percent are considered appropriate for a design speed of 110 km/h (65 mph) and maximum grades of 7 to 12 percent for design speeds of 50 km/h (30 mph), depending on topography.

IV. DESIGN CONSIDERATIONS AND CROSS SECTIONS

This section discusses the design elements associated with busways and HOV facilities on separate rights-of-way and the various types of freeway HOV lanes. Photographs of these facilities are provided in Chapter 5. Examples of cross sections are provided, and the issues associated with different approaches are described. Information and cross sections are also presented on terminal and access treatments, on-line bus stations, and connectivity considerations.

A. Design Considerations for HOV Facilities in Separate Rights-of-Way

The cross section of a busway or HOV facility in a separate right-of-way consists of travel lanes, shoulders, and roadside areas. Figure 6-8 illustrates an example of desirable and reduced design widths for these cross section components. In some cases, a facility may also have a separation or median between opposing flows of traffic. Each of these elements is discussed briefly in this section.

Median Component. AASHTO suggests the use of a median barrier to separate opposing flows on facilities that allow carpools and/or have high speed operation (3). If a barrier is not used on these facilities, a flush median is recommended. These medians are recommended to be 2.4 to 3.0 meters (8 to 10 feet) wide and have appropriate pavement markings (3). From a safety and operational point of view, the use of medians to separate opposing high speed traffic flow is desirable. None of the existing busways use a median barrier or a flush median, however, due to bus-only operations. For example, the busways in Ottawa, Pittsburgh, and Minneapolis/St. Paul use two continuous solid yellow lines to separate the opposing traffic lanes.

Roadway Component. Existing busways typically have one lane in each direction of travel, except in station areas where passing lanes are provided. The number of lanes for a specific project should be based on the expected traffic volumes and the desired level of service. As illustrated in Figure 6-8, the width of these lanes are typically 3.6 meters (12 feet). Lane widths of 3.3 meters (11 feet) may be considered in some situations.

Travel lane cross slopes of 1.5 to 2.0 percent are recommended with a centerline crown (2,6). Although areas experiencing high rainfall may use a 2.5 percent cross slope for drainage purposes, this approach is not recommended from an operational standpoint. Shoulders should have a cross slope at least 1 percent higher than the adjacent travel lanes. Paved shoulders typically have a cross slope of between 2 and 6 percent. The difference between the cross slopes of a traveled lane and the adjacent shoulder should be below 8 percent at all points along the HOV roadway (2).

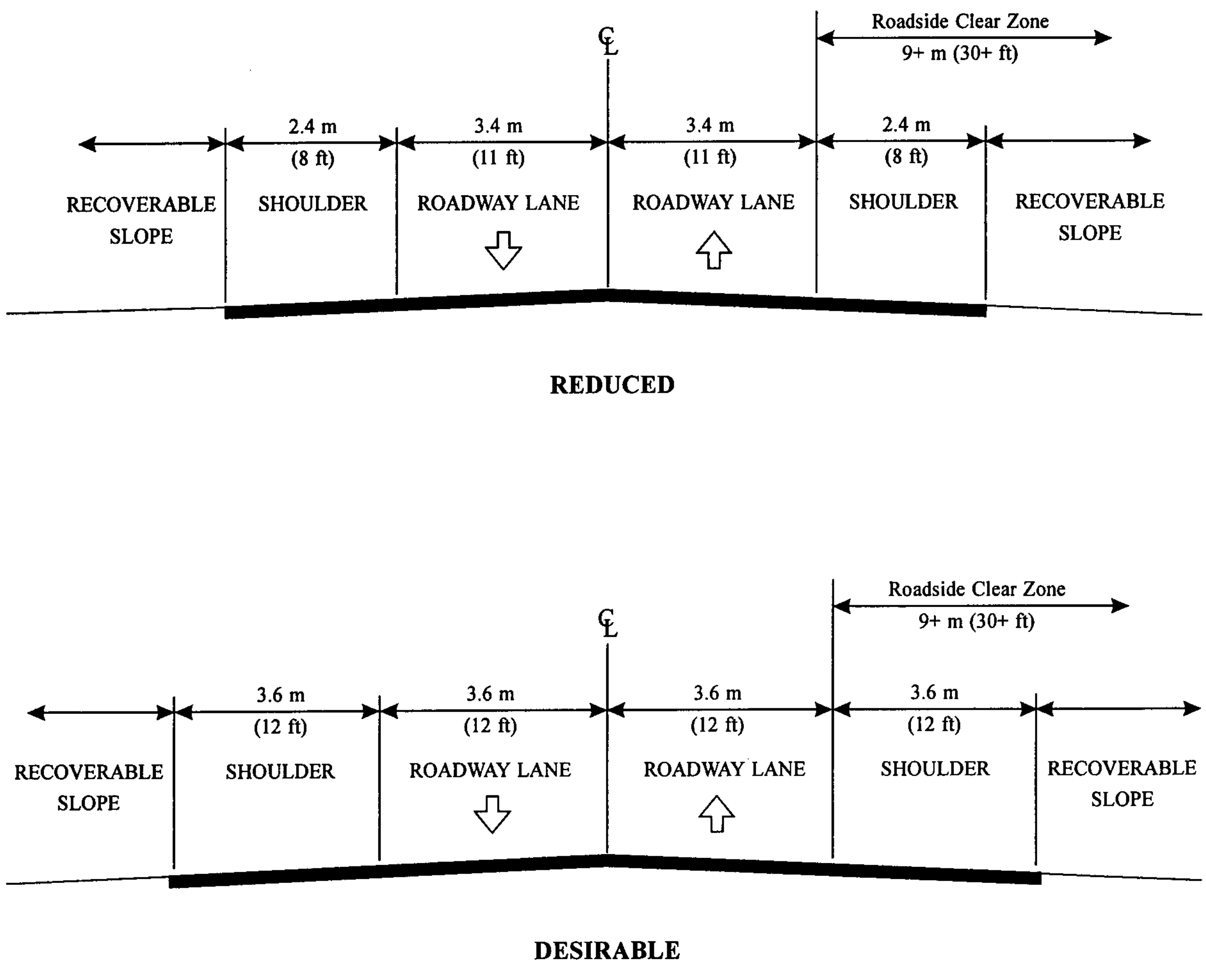


Figure 6-8. Examples of Cross Section for Busway or HOV Facility in Separate Rights-of-Way

Shoulder and Curb Component. Paved shoulders are recommended on busways due to the large design vehicle and relatively high operating speeds. The width of these shoulders normally ranges from 3.0 to 3.6 meters (10 to 12 feet). A vehicle stopped on the shoulder should be outside the through lane by 0.3 to 0.6 meters (1 to 2 feet). Narrower shoulder widths of 2.4 to 3.0 meters (8 to 10 feet) may be appropriate in special circumstances. Shoulder widths less than 2.4 meters (8 feet) wide are not recommended, except for short segments, as this width does not allow for efficient passing of disabled vehicles (3).

The use of non-mountable curbs at the edge of a travel lane is not generally recommended with design speeds over 60 km/h (40 mph) (2). The use of barrier curbs for design speeds under 80 km/h (50 mph) is controlled by the nature of the roadway. If used on a busway, curbs should be mountable and located outside the shoulder (2).

Roadside Area or Lateral Clearance Component. Similar to a two-lane arterial roadway or a freeway, the cross section of a busway or an HOV facility on a separate right-of-way should include clear zones. A clear zone or lateral clearance is the distance from the edge of the roadway lane to the nearest median barrier, obstacle, or obstruction (8). This distance is intended to allow for the safe recovery of an errant vehicle by drivers. Lateral clearance is especially important if the facility will be open to carpools and vanpools.

The *Roadside Design Guide* discusses the procedure to calculate adequate clear zone widths (8). A minimum clear zone width of 9 meters (30 feet) is desirable on each side of the roadway, but the width is also dependent upon design speed, daily traffic flow, type and steepness of the roadside slope, and horizontal degree of curvature. In order of preference, obstacles within the clear zone should be removed, relocated, redesigned to breakaway, shielded to redirect vehicles, or at least delineated. Cross slopes of 6:1 or flatter are desirable next to a high speed HOV or general-purpose roadway, but steeper slopes can be used in urban areas or on low speed facilities. A 4:1 slope is the recommended maximum. Steeper slopes or other obstacles in the clear zone may require the use of a protective roadside barrier (8).

Right-of-way for clear zones that are 9 meters (30 feet) wide are not always available in dense urban areas. Options that allow the clear zone width to be reduced include lowering the design speed or limiting the use of the facility to professional drivers that will not exceed the posted speed limit on the facility.

Barriers on both sides of the busway, with acceptable or desirable lateral clearance or shoulder width, is another design approach that can be used in areas of restricted right-of-way. A 0.6 to 1.2 meter (2 to 4 feet) minimum lateral clearance has been suggested for use when an HOV facility is located next to a barrier (4). A 1.2 meter (4 foot) offset between the travel lane and roadside barrier is a desirable minimum for facilities with speeds of 80 km/h (50 mph) or greater (3). A 0.6 meter (2 foot) width is recommended on low-speed (60 km/h or 30 mph), low volume facilities commensurate to a busway setting (2,6).

Cross Section Design Summary. A two-way busway or HOV facility on a separate right-of-way roadway should be designed to the geometric standards recommended by AASHTO and others (2,3,4,6). Reduced design standards should be considered only if available right-of-way is limited or if the facility is being retrofitted into an existing railroad or roadway alignment. If reduced design standards are used, an engineering study should be completed with respect to the safety and operational impacts of these geometric elements and their justification. In most cases, busways should be constructed to the same standards as a newly constructed two-lane arterial roadway or freeway. The safety impacts of using a less than desirable design elements will be magnified on these facilities if carpools, vanpools, or trucks are allowed.

B. Design Considerations for Exclusive Freeway HOV Facilities

These types of HOV facilities are physically separated from the adjacent freeway general-purpose lanes by a barrier or a wide buffer. Two types of exclusive HOV facilities may be considered in a corridor. These are reversible and two-way facilities. In addition, reversible facilities may be a single-lane or multiple-lanes. The design elements that should be considered with barrier-separated facilities are highlighted in this section. Like other types of HOV facilities, AASHTO, FHWA, state, and local standards should be used to guide the design process.

1. **Exclusive Two-Directional HOV Facilities**. Exclusive two-directional facilities are lanes constructed within the freeway right-of-way that are physically separated from the general-purpose freeway lanes and are 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 two-directional HOV facilities in freeways rights-of-way are usually open to all types of HOVs—buses, vanpools, and carpools. Exclusive HOV lanes often have limited access points, and may include direct ramps and other exclusive ingress and egress treatments. As illustrated in Chapter 5, examples of exclusive two-directional HOV facilities include the San Bernardino Transitway in Los Angeles and the I-84 Freeway HOV lanes in Hartford.

   In both cases, the HOV lanes are located on the inside lane of the freeway. As a result, the general design approach is similar to a normal freeway design, with the addition of some type of barrier or wide buffer between the HOV lane and the general-purpose lanes. The following design components should be considered with an exclusive two-directional HOV facility. These elements are highlighted in the example cross sections provided in Figure 6-9.

Median Component. Opposing direction HOV lanes are normally separated from each other by a median barrier. AASHTO (8), federal, and state guidelines should be used to design the median barrier. A 0.6 to 1.2 meter (2 to 4 feet) lateral clearance should be provided adjacent to the median barrier. If a median barrier design is not possible, a shared median shoulder of 3.0 to 4.3 meters (10 to 13.5 feet) may be considered as shown in Figure 6-9.

Lane Component. The existing exclusive two-directional HOV facilities have 3.6 meter (12 feet) travel lanes. Narrower lane widths should be considered only in special circumstances or for short distances due to limited right-of-way.

Lane Separation Component. Both buffers and buffers with pylons are currently used to separate two-directional exclusive HOV lanes from the general-purpose traffic lanes. The I-84 HOV facility in Hartford uses a 4.8 meter (16 feet) painted buffer as the separation treatment, while a 3.9 meter (13 foot) buffer with pylons in some locations is used on the San Bernardino Busway in Los Angeles. As shown in Figure 6-9, another approach is to provide a 2.4 to 3.6 meter (8 to 12 feet) shoulder and a barrier 0.6 meter (2 feet) wide as the separation treatment. Lateral clearance will also need to be provided adjacent to the general-purpose lanes with this approach.

Cross Section Design Summary. A total design envelope of 11.4 to 16.5 meters (33 to 54 feet) will generally be needed for a two-directional exclusive HOV facility. As discussed in Section E, a wider design envelope will be needed in some sections if on-line transit stations are provided. Reduced design standards should be considered only in special circumstances.

2. **Exclusive Reversible HOV Facility**. The second type of exclusive HOV treatment is a reversible lane or lanes. Like a two-directional facility, this approach involves a lane or lanes within the freeway right-of-way that are physically separated from the general-purpose freeway lanes and that are used exclusively by HOVs for all or a portion of the day. Reversible HOV lanes, which are separated from the general-purpose lanes by concrete barriers, are usually open to buses, vanpools, and carpools.

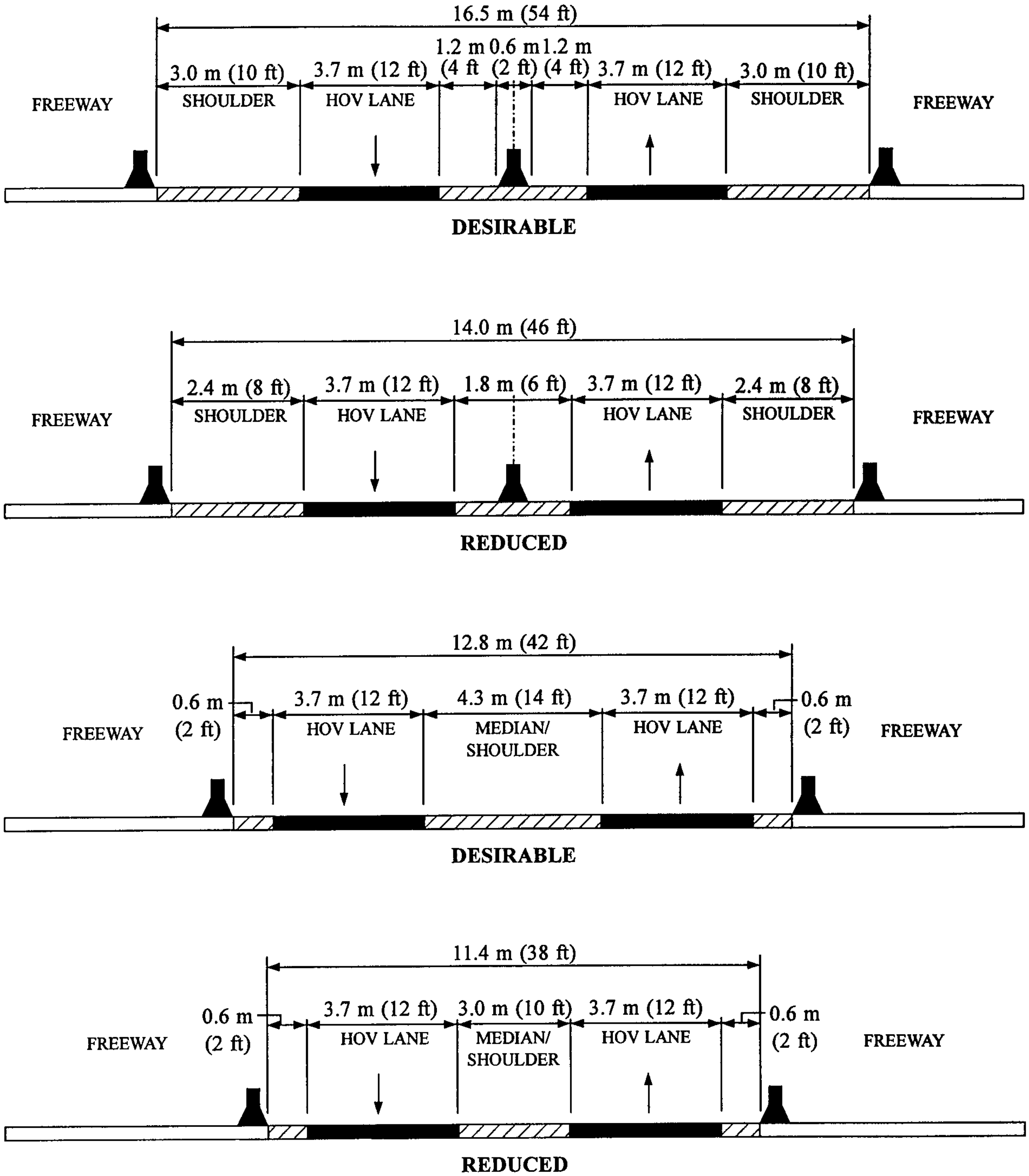


Figure 6-9. Examples of Cross Sections for Exclusive
Two-Directional HOV Facilities

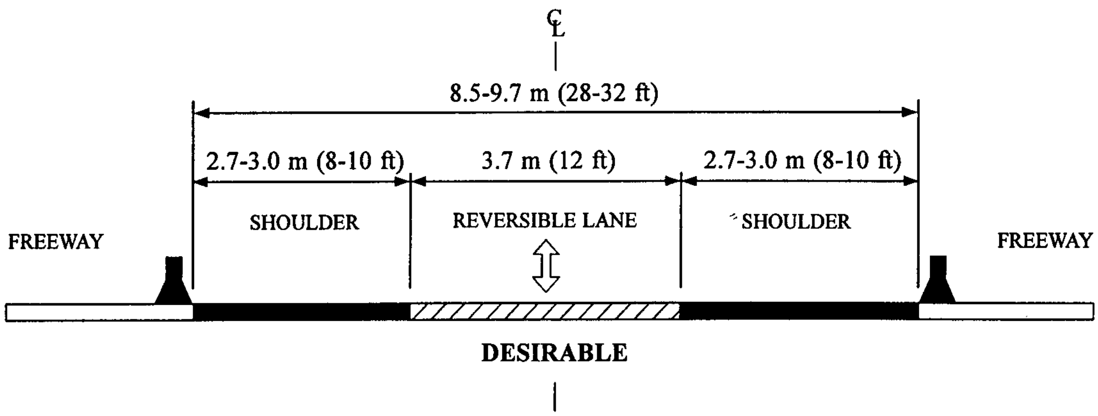
Exclusive reversible HOV facilities usually operate inbound toward the central business district (CBD) or other major activity center in the morning and outbound in the afternoon. Some type of daily set up is required with reversible facilities. Steps in this process often include opening gates to the lanes in the morning, closing the lanes to inbound traffic, reopening the lanes in the reverse direction of travel in the afternoon, and closing the lanes in the evening. Both manual and automated techniques are used to open and close reversible HOV facilities.

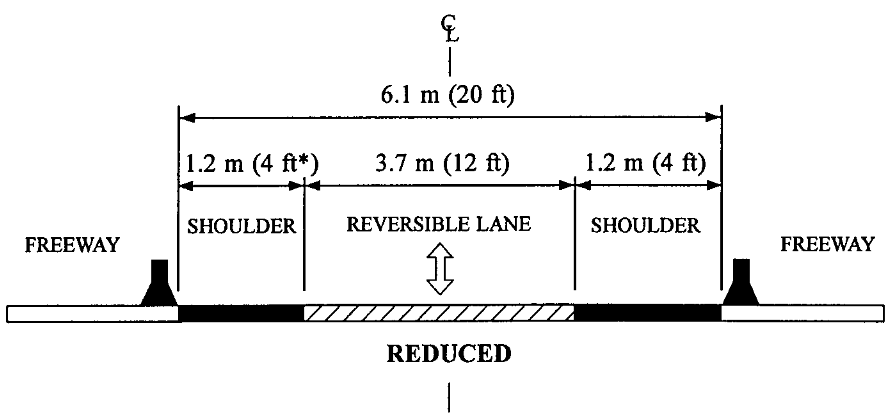
Currently, exclusive, barrier-separated reversible HOV lanes are in operation on the Shirley Highway (I-395) and I-64 in Northern Virginia/Washington, D.C.; I-279 in Pittsburgh; I-394 in Minneapolis; the North (I-45N), Northwest (US 290), Katy (I-10W), Southwest (US 59), and Gulf (I-45S) freeways in Houston; I-25 in Denver; I-15 in San Diego; and I-5 and I-90 in Seattle. Figure 6-10 illustrates cross section examples of the design components for a single lane barrier-separated reversible facility, and Figure 6-11 illustrates two-lane facilities. Table 6-4 highlights the design elements associated with existing facilities. The following highlight the design elements associated with these types of projects.

Lane Component. AASHTO (2,3) and other sources (5,6) recommend 3.6 meter (12 foot) HOV travel lanes for either a one or a two lane facility. All of the currently operating exclusive reversible HOV facilities meet these guidelines.

Shoulder, Lateral Clearance, and Separation Component. The major design differences among existing reversible HOV facilities relate to the width of the shoulder or lateral clearance provided on both sides of the HOV travel lane. As highlighted in Table 6-4, the one-lane reversible facilities in Houston include 1.2 meter (4 foot) shoulders on each side of the HOV lane and a 0.6 meter (2 foot) barrier. Most two lane facilities provide a 3 meter (10 foot) shoulder on one side and a 0.6 to 3 meter (2 to 10 foot) lateral clearance or shoulder on the other side. AASHTO (2,3) recommends at least one 3 meter (10 foot) shoulder. Shoulder widths between 1.2 meters (4 feet) and 2.4 meters (8 feet) should be avoided on freeways when adjacent to curbs or barriers as they may encourage the unsafe use of the shoulder as a breakdown or emergency stopping area.

Cross Section Design Summary. A design envelop of 8.5 meters (28 feet) is recommended for a single exclusive reversible HOV lane (2,3,6). A reduced envelope of 6.1 to 6.6 meters (20 to 22 feet) may be considered in special circumstances. A design envelope of 13.4 meters (44 feet) is recommended for a two-lane facility, with a reduced design envelope of 11 meters (36 feet). The main differences in the design envelope is the width of the shoulders and lateral clearance provided. The key design elements with reversible facilities include ensuring that vehicles can pass a disabled bus, van, or automobile, and providing for the safe and efficient operation of both the HOV and the freeway lanes.





* Lateral clearances may be combined to provide a dedicated 2.4 m (8 ft) shoulder on one side or the other, or a 7.3 m (24 ft) envelope may be striped with two 3.7 m (12 ft) travel ways with traffic always operated to the right of the center stripe

Figure 6-10. Examples of Cross Sections for One-Lane, Exclusive Reversible HOV Facilities

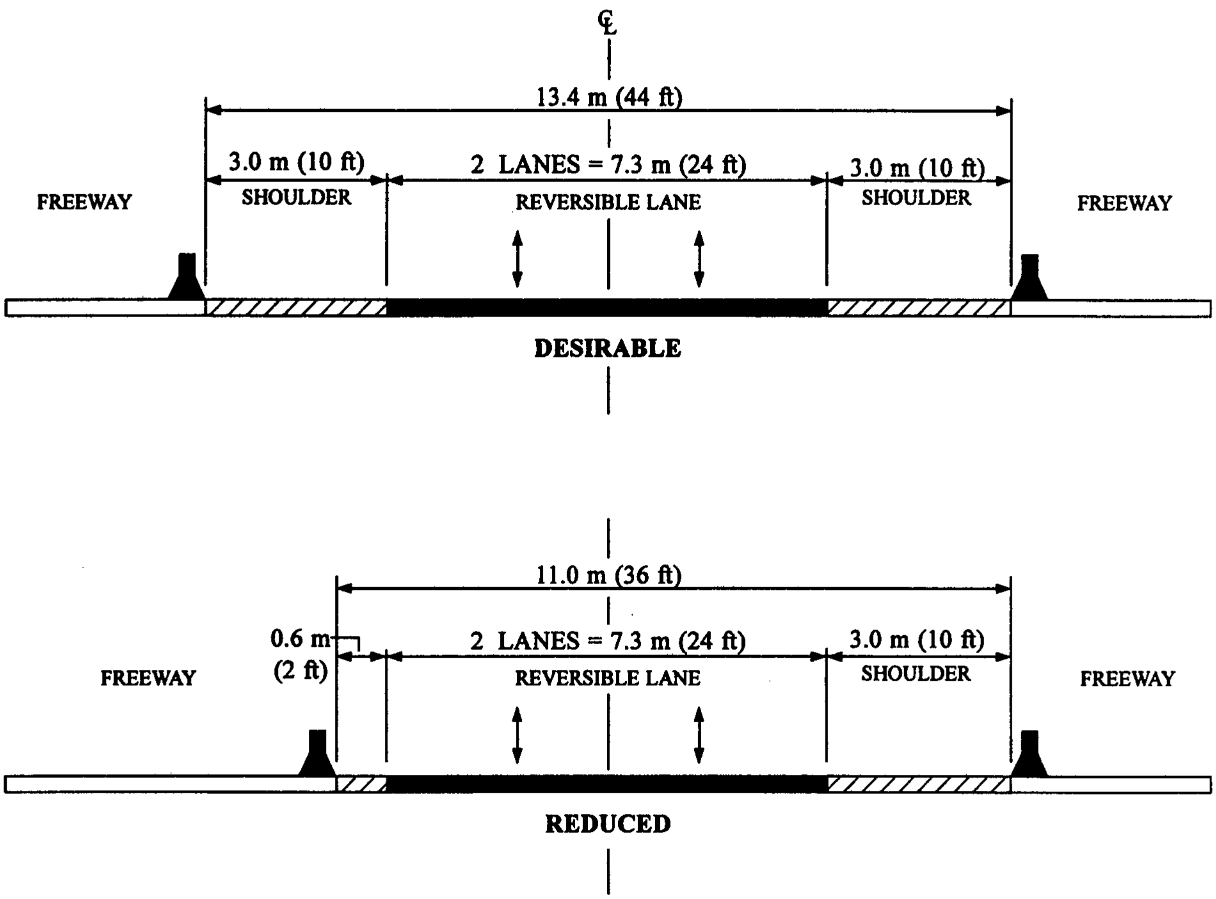


Figure 6-11. Examples of Cross Sections for
Two-Lane Exclusive Reversible HOV Facilities

Table 6-4. Examples of Design Elements for Existing Exclusive Reversible HOV Facilities

Location and HOV Facility	Number of HOV Lanes	Width of HOV Lanes	Lateral Clearances Width[1]		General-Purpose Lanes		
			Left	Right	Left Shoulder	Freeway Lane	Right Shoulder
Denver, CO, I-25	2	3.6 m (12 ft)	1.8-3.0 m (6-10[2] ft)	1.8-3.0 m (6-10[2] ft)	N/A	N/A	N/A
Houston, TX:							
Katy, I-10	1	3.6 m (12 ft)	1.1 m (3.75 ft)	1.1 m (3.75 ft)	.3 m (1 ft)	3.3 m (11 ft)	3.0 m (10 ft)
North, I-45N	1	3.6 m (12 ft)	1.1 m (3.75 ft)	1.1 m (3.75 ft)	.3 m (1 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Gulf, I-45S	1	3.6 m (12 ft)	1.2 m (4 ft)	1.2 m (4 ft)	.3 m (1 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Northwest, US 290	1	3.6 m (12 ft)	1.2 m (4 ft)	1.2 m (4 ft)	.3 m (1 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Southwest, US 59	1	3.6 m (12 ft)	1.2 m (4 ft)	1.2 m (4 ft)	.3 m (1 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Minneapolis, MN, I-394	2	3.6 m (12 ft)	1.5 m (5 ft)	3.0 m (10 ft)	3.0 m (10 ft)	3.6 m (12 ft)	3.6 m (12 ft)
Pittsburgh, PA, I-279/579	2	3.6 m (12 ft)	0.6 m (2 ft)	3.0 m (10 ft)	1.2-3.0 m (4-10 ft)	3.6 m (12 ft)	3.6 m (12 ft)
San Diego, CA, I-15	2	3.6 m (12 ft)	3.2 m (10.5 ft)	3.2 m (10.5 ft)	3.0 m (10 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Seattle, WA, I-90	2	3.6 m (12 ft)	2.4 m (8 ft)	2.4 m (8 ft)	1.3-2.4 m (6-8 ft)	3.6 m (12 ft)	2.4-3.0 m (8-10 ft)
Northern Virginia/ Washington, DC, Shirley, I-395	2	3.6 m (12 ft)	3.0 m (10 ft)	3.0 m (10 ft)	3.0 m (10 ft)	3.6 m (12 ft)	3.0 m (10 ft)

N/A—not available.
[1] Lateral clearance widths on reversible HOV lane refers to one direction of travel; shoulder widths are reversed for travel in other direction.
[2] Current plans are for one lateral clearance to be 1.8 meters (6 feet) and the other to be 3.0 meters (10 feet).

C. Design Considerations for Freeway Concurrent Flow HOV Lanes

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, and designated for exclusive use by HOVs for all or a portion of the day. Concurrent flow HOV lanes are usually open to buses, vanpools, and carpools. A few facilities are open only to buses, however, allowing transit vehicles to bypass specific bottlenecks.

Concurrent flow lanes are usually, although not always, located on the inside lane or shoulder. Paint striping is a common means used to separate these lanes. Unlimited ingress and egress may be allowed with a concurrent flow HOV lane or only specific access points may be provided.

Concurrent flow HOV facilities are the most common HOV application in North America. Concurrent flow HOV lanes are used extensively in Seattle and metropolitan areas in California, as well as other cities throughout the country. Examples of concurrent flow lanes are SR 520, I-405, and I-5 in Seattle; SR 55, I-405, SR 91, SR 57, I-5, I-605, I-105, I-210, SR 134, and SR 118 in Los Angeles/Orange County; SR 101 in San Jose; I-280, I-80, SR 237, and US 101 in the San Francisco Bay area; US 36 in Denver; I-10 and I-17 in Phoenix; I-394 in Minneapolis; I-65 in Nashville; I-95 and SR 112 in Miami; SR 44 and I-564 in Norfolk/Virginia Beach; I-270 in Maryland; I-20, I-75, and I-85 in Atlanta; and I-35E and I-635 in Dallas. The I-405 and SR 520 HOV lanes in Seattle provide examples of HOV facilities located on the outside lane, although the I-405 HOV lanes will be moved to the inside within the next five years. Examples of these facilities are provided in Chapter 5.

Concurrent flow HOV facilities are often developed by retrofitting an existing freeway cross section. For example, the inside shoulder or center median may be converted to an additional lane, or the freeway right-of-way may be expanded and a HOV lane added. As a result, a wide range of design treatments are found with these types of projects. The various approaches that are currently used and the design elements that should be considered with concurrent flow HOV lanes are described next and highlighted in Table 6-5 and Figures 6-12 and 6-13.

Median and Shoulder Component. As illustrated in Figure 6-12, the desirable cross section for a concurrent flow lane located on the inside includes a breakdown shoulder. AASHTO (2,3) and other sources (5,6) identify a shoulder width of 3.0 to 4.2 meters (10 to 14 feet) as desirable next to the median barrier. Many of the current projects have shoulders, although as noted in Table 6-5, a number use reduced designs. The application of reduced shoulders or limited lateral clearances should be examined carefully on a project by project basis.

Lane Component. A concurrent flow HOV lane should be designed to the same standards as the freeway general-purpose lanes. A standard 3.6 meter (12 foot) travel lane is used with most current projects. Narrower lanes should be considered only in special circumstances.

Table 6-5. Examples of Design Elements for Operating Freeway Concurrent Flow HOV Facilities

Location and HOV Facility	Left Shoulder or Lateral Clearance	HOV Lane Width	Separation	Mixed-Flow Freeway Lanes	Right Shoulder
Dallas					
I-35E	0.6 m (2 ft)	3.5 m (11.5 ft)	0.9 m (3 ft)	3.3 m (11 ft)	3.0 m (10 ft)
I-635	0.9 m (3 ft)	3.3 m (11 ft)	0.9 m (3 ft)	3.3 m (11 ft)	3.0 m (10 ft)
Honolulu, Moanalua Expwy	2.1 m (7 ft)	3.6 m (12 ft)	0	3.6 m (12 ft)	2.1 m (7 ft)
Los Angeles					
Century, I-105	varies	3.6 m (12 ft)	1.2 m (4 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Harbor, I-110	3.6 m (12 ft)	3.6 m (12 ft)	1.2 m (4 ft)	3.6 m (12 ft)	3.0 m (10 ft)
SR 91	0.9 m (3 ft)	3.3 m (11 ft)	0.6 m (2 ft)	(11.75 ft)	3.0 m (10 ft)
Miami and Ft. Lauderdale, I-95	3.0-3.6 m (10-12 ft)	3.6 m (12 ft)	0.6 m (2 ft)	3.6 m (12 ft)	3.6 m (12 ft)
Minneapolis, I-394	3.0 m (10 ft)	3.6 m (12 ft)	0[3]	3.6 m (12 ft)	3.6 m (12 ft)
Orlando, I-4	3.0 m (10 ft)	3.6 m (12 ft)	0	3.6 m (12 ft)	3.0 m (10 ft)
Orange County					
SR-55	0.6 m (2 ft)	3.3 m (11 ft)	.3 m (1 ft)	3.6 m (12 ft)	2.4 m (8 ft)
I-405	1.2 m (4 ft)	3.6 m (12 ft)	1.2 m (4 ft)	3.6 m (12 ft)	3.0 m (10 ft)
Phoenix, I-10	3.6 m (12 ft)	3.6 m (12 ft)	1.2 m (4 ft)	3.6 m (12 ft)	3.6 m (12 ft)
Marin County, US 101	(3-6 ft)	3.3-3.6 m (11-12 ft)	0[3]	3.3 and 3.6 m (11 and 12 ft)	2.4-3.3 m (8-11 ft)
Santa Clara County					
San Tomas Expwy	0	3.9 m (13 ft)[1,2]	0[3]	3.3 and 3.9 m (11 and 13 ft)	0-3.0 m (0-10 ft)
Montague Expwy	0	3.9 m (13 ft)[1,2]	0[3]	3.3 and 3.9 m (11 and 13 ft)	0
Rte. 237	0	3.9 m (13 ft)[1,2]	0[3]	3.3 and 3.9 m (11 and 13 ft)	0
US 101					
I-280					
Seattle					
I-5	3.0 m (10 ft)	3.6 m (12 ft)	0	3.3 and 3.6 m (11 and 12 ft)	3.0 m (10 ft)
I-405	1.2 m (4 ft)	3.6 m (12 ft)[2]	0	3.3 m (11 ft)	1.8 m (6 ft)
SR 520	0.3 m (1 ft)	3.6 m (12 ft)[2]	0	3.3 m (11 ft)	1.2-3.0 m (4-10 ft)

[1]Limited access facilities with some signalized intersections.
[2]HOV lane on outside shoulder.
[3]Peak-period-only operation, HOV lane reverts to another mixed-flow lane outside operation period.

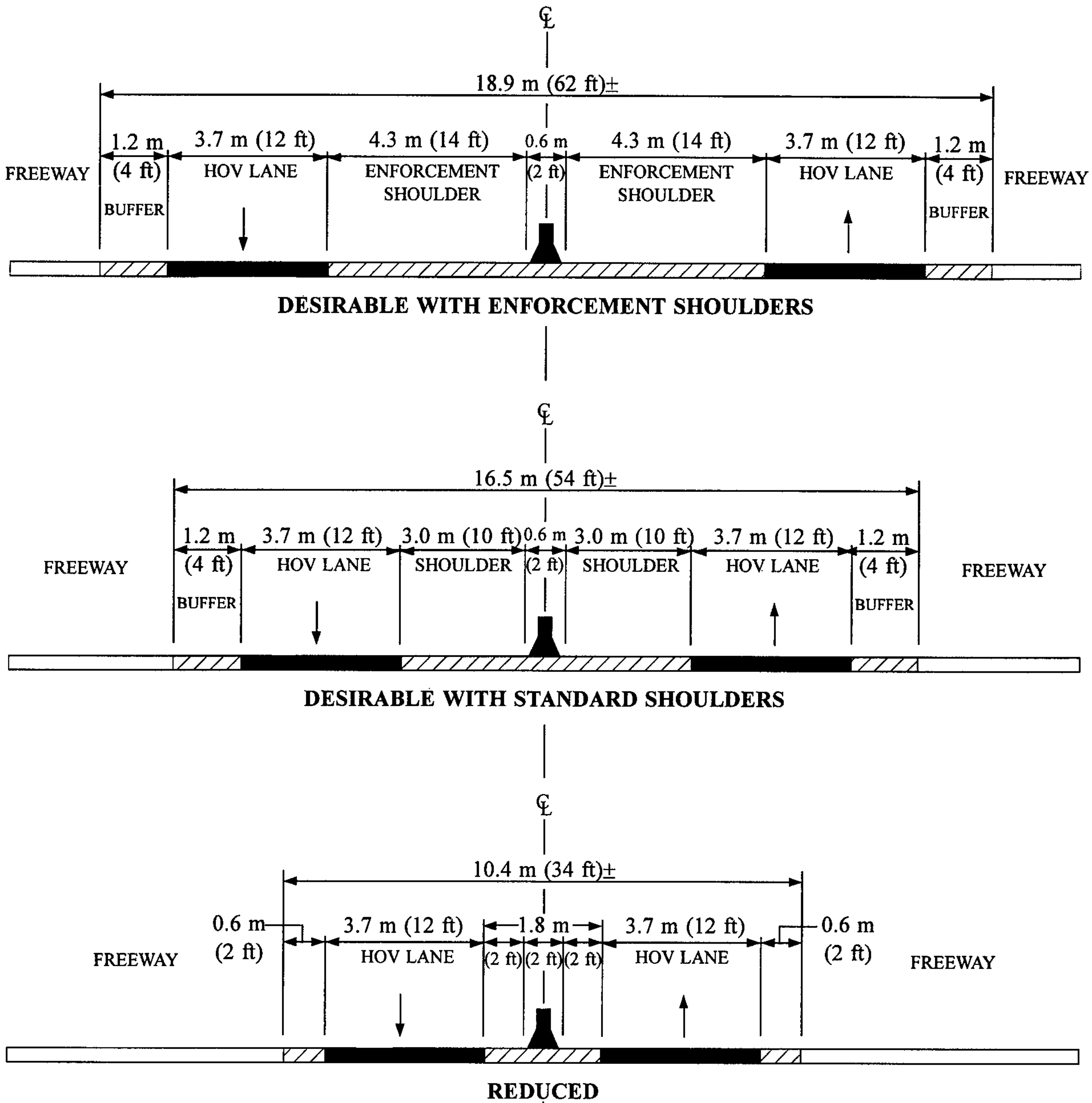


Figure 6-12. Examples of Cross Sections for
Concurrent Flow HOV Facilities Located on the Inside of a Freeway

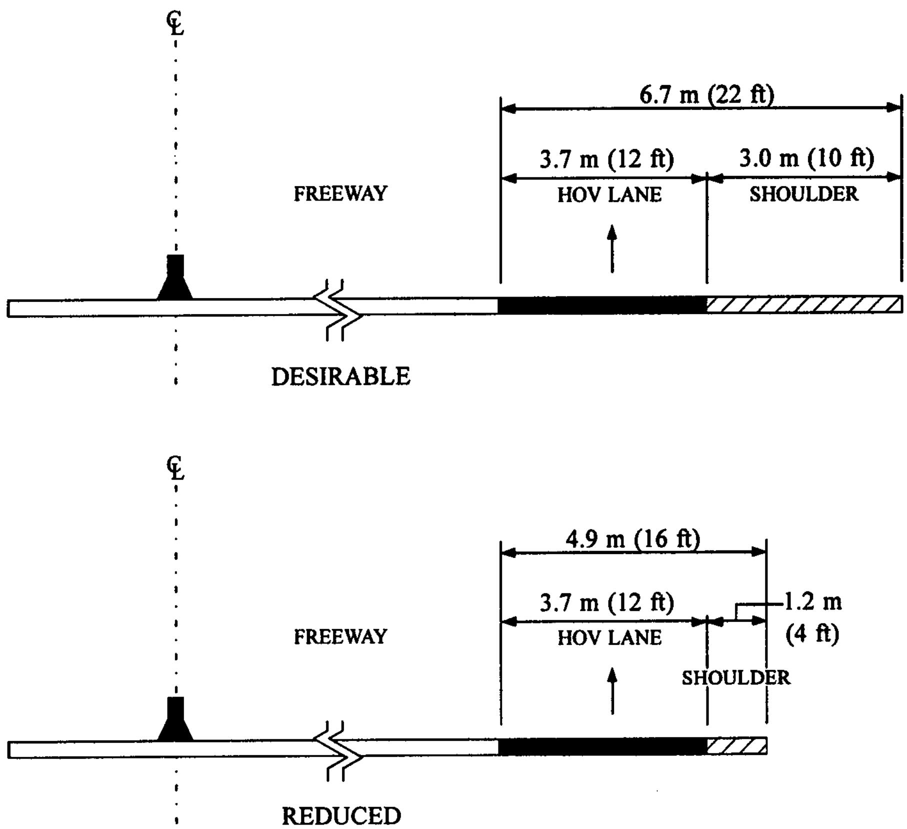


Figure 6-13. Examples of Cross Sections for
Concurrent Flow HOV Facilities Located on the Outside of a Freeway

Separation from General-Purpose Lane. A variety of treatments are currently used to separate the HOV lane from the general-purpose lanes. As illustrated in Figures 6-12 and 6-13, these range from no separation other than additional paint striping to a narrow buffer of 0.6 to 1.2 meters (2 to 4 feet). An advantage of a narrow buffer is the additional separation provided between the HOV and the general-purpose lane. A potential disadvantage of this approach is that some drivers may perceive and use the space as a breakdown lane causing a safety hazard. Further, if limited access points are used with this treatment, weaving movements may be concentrated in these areas making the effects of weaving worse than with other approaches.

Cross Section Design Summary. The desirable cross section for a concurrent flow HOV lane on the inside of a freeway includes the center median, a shoulder or lateral clearance, the HOV lane, and a paint strip or buffer separating the HOV lane from the general-purpose lane. The desirable general design envelope for all these elements is 16.3 to 18.8 meters (54 to 62 feet). Consideration may be given to reducing some of these elements under special circumstances. A reduced design envelope as narrow as 10.3 meters (34 feet) may be considered in these cases. Any reductions should not be made if they will adversely affect the safe and efficient operation of a facility, however. Figure 6-13 provides an example of a cross section for an HOV lane on the outside of a freeway. A paint stripe is the normal method of separation from the general-purpose traffic lanes, and, since the outside shoulder may be used for the HOV lane, there may be either no shoulder or only a very narrow one.

D. Design Considerations for Freeway Contraflow HOV Lanes

Contraflow HOV lanes borrow a lane from the off-peak direction of travel for use by HOVs in the peak-direction. Contraflow HOV lanes should be considered only in cases where there is a high directional split, where capacity exists in the off-peak direction of travel, and where the facility can be designed and operated safely. Since contraflow facilities involve traffic operating in opposing directions on the same side of a freeway, safety for both HOVs and general-purpose traffic should be a critical element in the design process.

Contraflow HOV lanes have two somewhat unique design elements. These are the treatment used to separate the lane from the general purpose traffic operating in the opposite direction of travel and the access to and from the lane. The separation treatments and other lane design elements are highlighted in this section. Access treatments are discussed in Section G.

Currently, five contraflow HOV lanes are in operation on freeways in the United States. Two of these facilities—Route 495 and the Long Island Expressway—which are in the New York City/New Jersey area—use plastic pylons inserted into holes in the pavement to separate the traffic lanes. The second approach uses a moveable barrier to create the contraflow HOV lane. This technique is used on the East R. L. Thornton Freeway (I-30 East) in Dallas and the Southeast Expressway in Boston.

Table 6-6 highlights the design elements of the five operating contraflow facilities. Figure 6-14 provides examples of cross section for contraflow HOV lanes facility using both types of treatments. These elements are described next.

Median and Shoulder Component. As illustrated in Figure 6-14, the existing freeway median and inside shoulder are on the right of vehicles using a contraflow lane. Since most contraflow lanes are retrofitted into an existing freeway, there may be little flexibility with the provision of an inside shoulder if one does not exist. A 3.0 meter (10 foot) shoulder is desirable, but as noted in Table 6-6, none of the existing contraflow facilities has a full shoulder. If a continuous shoulder cannot be provided, periodic breakdown areas should be considered for disabled vehicles.

Roadway Lane Component. Contraflow lanes typically use the inside general-purpose lane in the opposite direction of travel. As shown in Table 6-6, the width of these lanes are commonly the normal freeway lane width of 3.6 meters (12 feet), although examples of narrower lanes exist. Similarly, the width of the general-purpose lanes on most projects is 3.6 meters (12 feet). The one exception is the Route 495 Exclusive Bus Lane (XBL) on the approach to the Lincoln Tunnel which has narrower lanes.

Lateral Clearance Component. A lateral clearance of 0.6 meters (2 feet) is recommended next to the pylons or moveable barrier. A similar lateral clearance should be considered for the general-purpose lane adjacent to the plastic pylons or the moveable barrier. Providing this lateral clearance may not always be possible due to limited right-of-way, however. None of the existing contraflow projects has been able to obtain the recommended lateral clearance due to limited pavement widths.

Cross Section Design Summary. The design of a contraflow HOV lane should incorporate all the appropriate AASHTO, ITE, FHWA, state, and local guidelines. Careful consideration should be given to the design of a contraflow lane to ensure the safe operation for both HOVs and general-purpose traffic. As illustrated in Figure 6-14, a 6.6 to 7.2 meter (22 to 24 foot) envelope should be considered for the travel lane, breakdown shoulder, and pylons or moveable barrier. The available width will have a direct effect on the operating speeds of vehicles in the contraflow lane. Restricted widths may require lower operating speeds as evidenced by the facilities in the New York City area.

Table 6-6. Examples of Design Elements for Operating Contraflow HOV Lanes

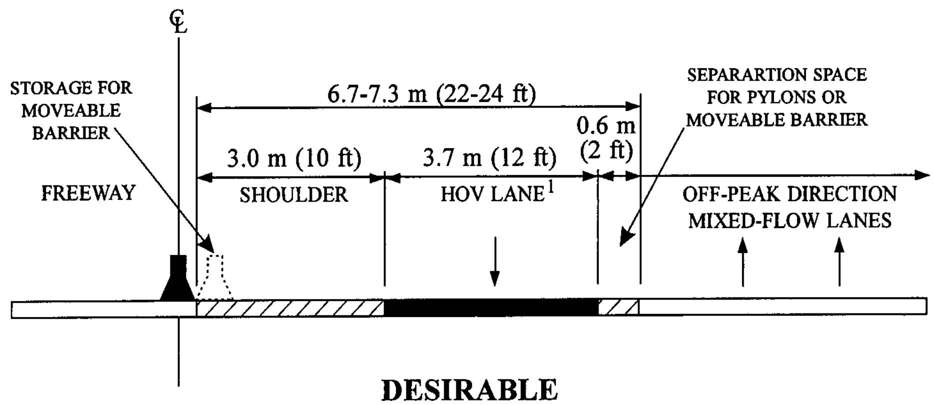
Location and HOV Facility	Left Lateral Clearance	HOV Lane Width	General-Purpose Lane Width
New York City/New Jersey Route-495	0	3.0-3.2 m (10-10.7 feet)	3.0-3.2 m (10-10.7 feet)
Long Island Expressway	0-1.8 m (0-6 feet)	3.6 m (12 feet)	3.6 m (12 feet)
Dallas East R. L. Thornton	2.4 m (8 feet)	3.6 m (12 feet)	3.6 m (12 feet)
Boston Southeast Expressway	0	3.6 m (12 feet)	3.6 m (12 feet)

Source: (6)

E. Safety Design Considerations

Ensuring that an HOV facility and the adjacent freeway operates in a safe and efficient manner is critical. Thus, safety should be a key element in the design process. As described in the previous sections, careful consideration should be given to the safety impacts of concurrent flow and contraflow HOV lanes. Key design factors influencing safety include the provision of shoulders, the methods used to delineate or separate the HOV and general-purpose lanes, and access treatments. Designers should review available information on accidents and safety issues associated with HOV lanes in the area as part of the design process.

Given the limited right-of-way available in most congested travel corridors and the fact that many HOV projects are retrofitted in existing freeway alignments, trade-offs or reduced design criteria may some times be necessary. These should only be considered if other options do not exist and if the safe operation of the facility is not jeopardized. Table 6-7 presents a potential design trade-off based on experiences in some areas for use in situations where full design standards cannot be met (3,6,11). Careful analysis should be conducted when considering design trade-offs.



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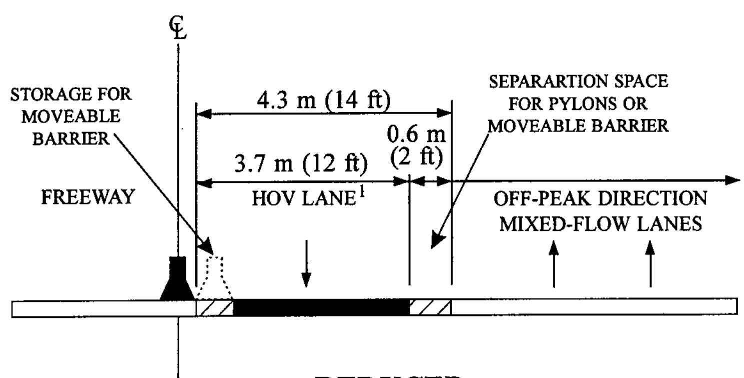

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Figure 6-14. Examples of Cross Sections for Contraflow HOV Lanes

Table 6-7. Potential Design Trade-Offs

Type of HOV Facility	Potential Design Trade-Offs
Two-Way Barrier-Separated HOV Lanes	• Reduce left HOV lane lateral clearance to no less than 0.6 m (2 feet). • Reduce right HOV lane lateral clearance to no less than 2.4 m (8 feet). • Reduce freeway left lateral clearance to no less than 0.6 m (2 feet). • Reduce freeway right shoulder from 3 m (10 feet) to no less than 2.4 m (8 feet). • Reduce HOV lane width to no less than 3.3 m (11 feet). Some agencies prefer reversing fifth and sixth steps when buses are projected to use the HOV facility. • Reduce selected general-purpose lane widths to no less than 3.3 m (11 feet), leave at least one 3.6 m (12 foot) outside lane for trucks. • Reduce freeway right lateral clearance shoulder from 8 feet to no less than 1.2 m (4 feet). • Convert barrier shape at columns to a vertical face.
Reversible Barrier-Separated HOV Lanes	• Reduce single-lane HOV envelope to no less than 6.1 m (20 feet), or two-lane envelope to no less than 8.6 m (28 feet). • Reduce freeway left lateral clearance to no less than 0.6 m (2 feet). • Reduce freeway right lateral clearance (shoulder) from 3 m (10 feet) to no less than 2.4 m (8 feet). • Reduce HOV lane width to no less than 3.3 m (11 feet). Some agencies prefer reversing fourth and fifth steps when buses are projected to use the HOV facility. • Reduce selected general-purpose lane widths to no less than 3.3 m (11 feet). Leave at least one 12-foot outside lane for trucks. • Reduce freeway right lateral clearance shoulder from 8 feet to no less than 4 feet. • Convert barrier shape at columns to a vertical face.
Concurrent Flow HOV Lanes	• Reduce left HOV lane lateral clearance to no less than 0.6 m (2 feet). • Reduce freeway right shoulder from 3 m (10 feet) to no less than 2.4 m (8 feet). • Reduce buffer separation to no less than 0.3 m (1 foot). • Reduce HOV lane width to no less than 3.3 m (11 feet). Some agencies prefer reversing fourth and fifth steps when buses are projected to use the HOV facility. • Reduce selected general-purpose lane widths to no less than 3.3 m (11 feet). Leave at least one 3.6 m (12 foot) outside lane for trucks. • Reduce freeway right lateral clearance shoulder from 2.4 m (8 feet) to no less than 1.2 m (4 feet). • Transition barrier shape at columns to a vertical face or remove buffer separation between HOV and general-purpose lanes.

Source: (6)

F. Design Considerations for Terminal and Access Treatments

Vehicles may enter an HOV facility at the beginning or in most cases at some point along the lane. Correspondingly, an HOV may exit a facility at the end or at other egress locations. As discussed previously, the type of access provided will depend on the nature of the HOV lane, the objectives of the project, land uses in the corridor, available right-of-way, and funding. Table 6-8 summarizes the objectives, advantages, and limitations of various access treatments.

This section examines the design elements associated with the different types of terminal and access treatments associated with HOV facilities. Design components relating to beginning and ending an HOV lane are presented first, followed by those associated with various ingress and egress approaches. Similar approaches may be used with both elements, however.

1. **Terminal Treatments for Beginning and Ending a Freeway HOV Lane**. The design of the start and end of an HOV facility is important for a number of reasons. First, the design should allow for HOVs to easily and safely enter and exit the facility. Carpoolers and vanpoolers, as well as professional bus operators, should be able to easily understand how to enter and leave the facility. Second, the terminal treatments should provide a safe transition for HOVs. Third, the start and end of an HOV facility should not adversely affect the operation of the general-purpose lanes and the safety of motorists on the freeway.

   Terminal treatments are further complicated by the fact that most HOV lanes on freeways are located in the center median or the left travel lane or left shoulder. Current practices indicate that these HOV lanes are usually added, and terminations require either merges from the left or extending the lane as a general-purpose lane. For example, the preferred approach is to open the HOV lane to all traffic and drop the right general-purpose lane at the next interchange. Few examples of right side HOV lanes exist. These facilities require merges to and from the right for HOVs.

   HOV Lane Entrances. The entry point to most freeway HOV lanes is usually located on the left side of the facility or as a direct access facility. The exact design of the entrance will depend on the type of HOV lane and local conditions. AASHTO, ITE, FHWA, state, and local guidelines should be used in the design of entrances and exits for HOV facilities.

   The starting point for most concurrent flow HOV lanes is a simple merge from the adjacent general-purpose freeway lane. Since these HOV lanes are not physically separated from the adjacent freeway general-purpose lanes, vehicles entering the HOV lane may simply merge into the new lane or a painted buffer may be used to help direct HOVs into the lane.

Table 6-8. Objectives, Advantages, and Limitations of Various Access Treatments

Direct Merge or At Grade Acess
- Lower cost.
- Easy to implement.
- Easy to modify.
- Possible safety concerns.

At-Grade Slip Ramp at Project Termination
- An effective way of feeding and distributing high lane volumes with the adjacent freeway.
- Requires left-hand entry/exit with the freeway.
- Can be designed as a safe and enforceable treatment.
- Low cost; easily modified if HOV facility is extended.
- Used as a "standard" termination treatment on most projects.

At-Grade Slip Ramp as an Intermediate Access
- Lowest-cost intermediate access approach; can be easily modified (relocated or removed).
- Most compatible with restricted envelopes; requires little widening.
- Not safe for high accessing volumes without inclusion of a parallel weave lane.
- Not the best traffic operation under high-volume conditions; can disrupt the adjacent freeway or HOV level of service.
- Cannot be safely enforced.
- Location is critical; if too close to nearby freeway intersections, weaving problems across the freeway increase.

Drop Ramp or T-Ramp with a Street
- Effective way of collecting and distributing all mixes of HOVs, as well as serving off-line support facilities.
- Provides opportunities to control or enforce entering volumes.
- Works for reversible-flow or two-way configurations.
- Best if not considered at an existing intersection with freeway access.

Drop Ramp or T-Ramp with a Park-and-Ride Lot or Off-Line Bus Transit Station
- A very effective way of extending preferential treatment into an off-line support facility, thereby increasing travel time savings.
- Not recommended for serving other HOV users that have no affinity for the support facility; poses circulation conflicts within the support facility.
- Generally requires high transit and/or rideshare volumes to be cost effective.
- Works best for two-way operations, although can be workable for reversible-flow if T-ramps are reversed as well.

Flyover Ramp
- Highest-speed design intended for high interfacing volumes; most closely approximates any other freeway ramp in design speed.
- Serves all HOVs well.
- Can be applicable as an intermediate access or termination treatment.
- Can be cost-prohibitive as a means of accessing support facilities.
- Least flexible treatment; sometimes overlooked on an interim HOV operation and added later as demand warrants.
- Equally appropriate for two-way or reversible-flow operations.

Source: (6)

Barrier-separated HOV lanes are physically separated from the adjacent freeway general-purpose lanes. As a result, some type of break in the barrier is needed. Figure 6-15 provides layout examples of the different entry treatments. In all cases, signing should be located at least 1.7 km (1 mile) in advance of the entry point.

HOV Lane Exits. The end of an HOV lane should be designed so that HOVs can safely merge back into the general-purpose lanes without causing problems or additional congestion for motorists in those lanes. The preferred approach in many areas is to open the HOV lane to all traffic and drop the right general-purpose lane at the next interchange. Another approach is to end an HOV lane by merging HOV traffic back into the general-purpose lanes. A similar approach, with a break in the barrier, may be used with exclusive lanes. Figure 6-16 provides examples of layouts for different end treatments with HOV lanes.

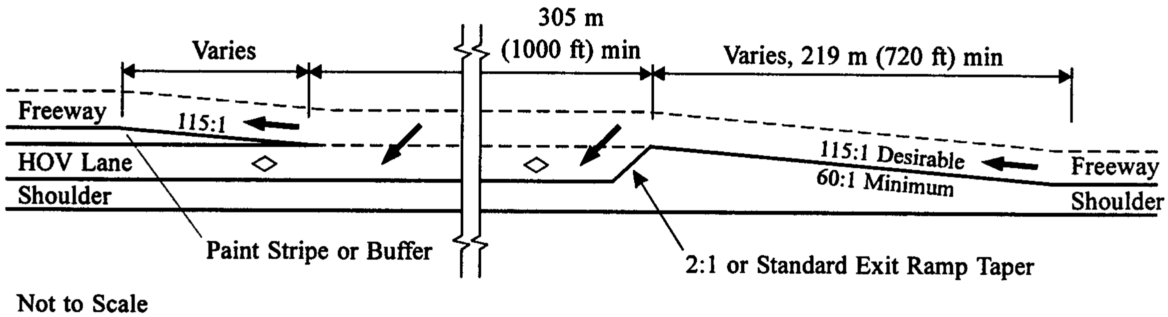
2. **Direct Merge or At-Grade Access**. Direct merge or at-grade access represents the most commonly used treatment with concurrent flow HOV lanes. Two types of approaches—unrestricted or unlimited access and restricted or limited access—are currently in use with concurrent flow HOV lanes in North America. Of the two, unrestricted ingress and egress is almost always used with HOV facilities operating only during the peak-periods. This approach allows the HOV lane to easily revert to a general-purpose lane at other times.

Unrestricted or unlimited access allows HOVs to enter and leave the lane at any point. No weave, acceleration or deceleration lane is provided. Rather, vehicles simply merge into and out of the HOV lane in the same way they would change general-purpose lanes.

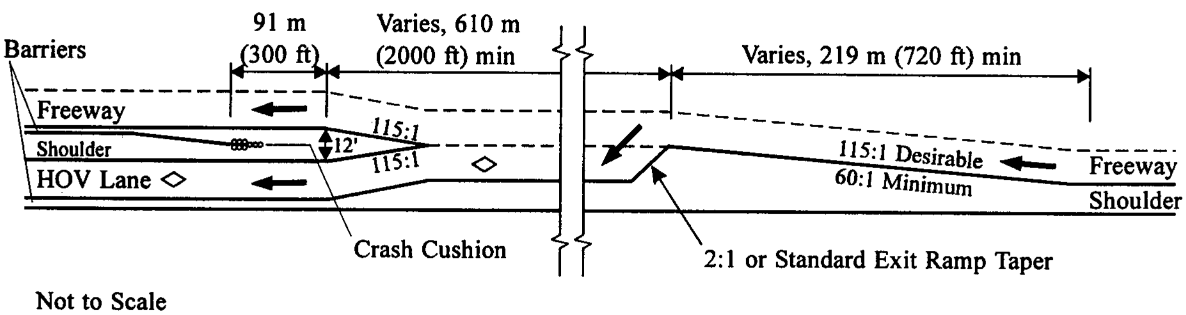
This approach has little impact on the design of a facility. The paint stripping used to separate the general-purpose and the HOV lanes, long with signing, and pavement markings should all indicate that access can occur at any point.

Restricted or limited access regulates the location vehicles can enter and leave an HOV lane. In most cases both movements are accommodated. In some situations, however, only ingress or egress may be allowed. No special weave or acceleration or deceleration lane is typically provided. Rather, vehicles merge directly from the general-purpose lane into the HOV lane or from the HOV lane into the general-purpose lane. An opening or merge area of 300 meters to 460 meters (1,000 to 1,500 feet) is desirable. Weave lanes are used on a few HOV projects in California and New York.

Signing, pavement markings, and special paint striping identifying the ingress and egress areas are the major design components associated with this type of access. Figure 6-17 presents examples of signing used on existing projects.

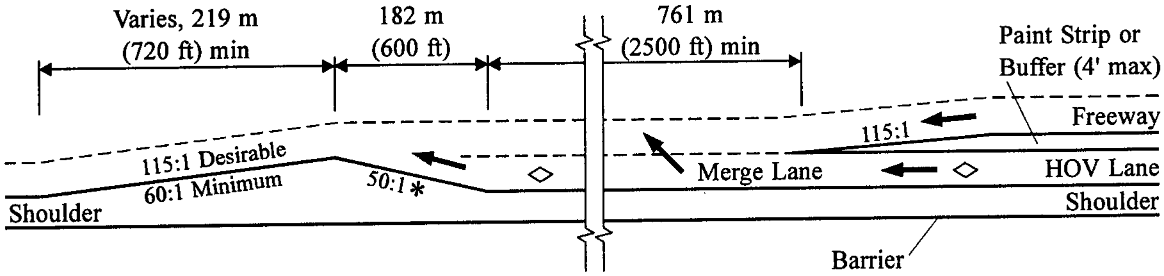


Example of Entrance to Concurrent Flow HOV Lane



Example of Entrance to Barrier-Separated HOV Lane

Figure 6-15. Examples of Layouts for HOV Lane Entry Points



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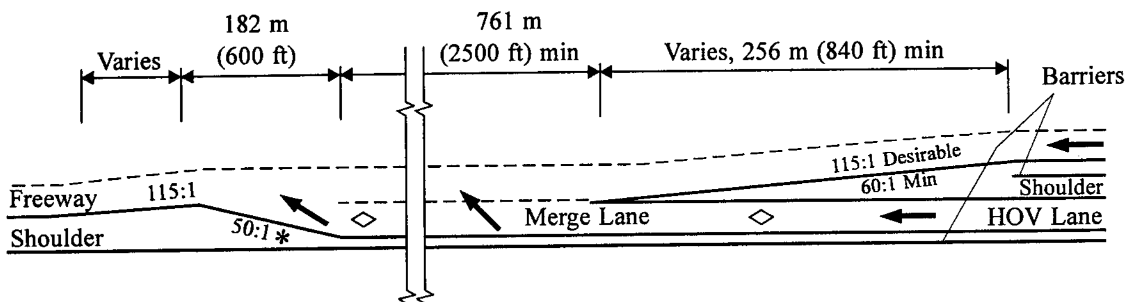
Example of Exit from Concurrent Flow HOV Lane



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* or Standard Entrance
Ramp Taper

Example of Exit from Barrier-Separated HOV Lane

Figure 6-16. Examples of Layouts for HOV Lane Exit Points

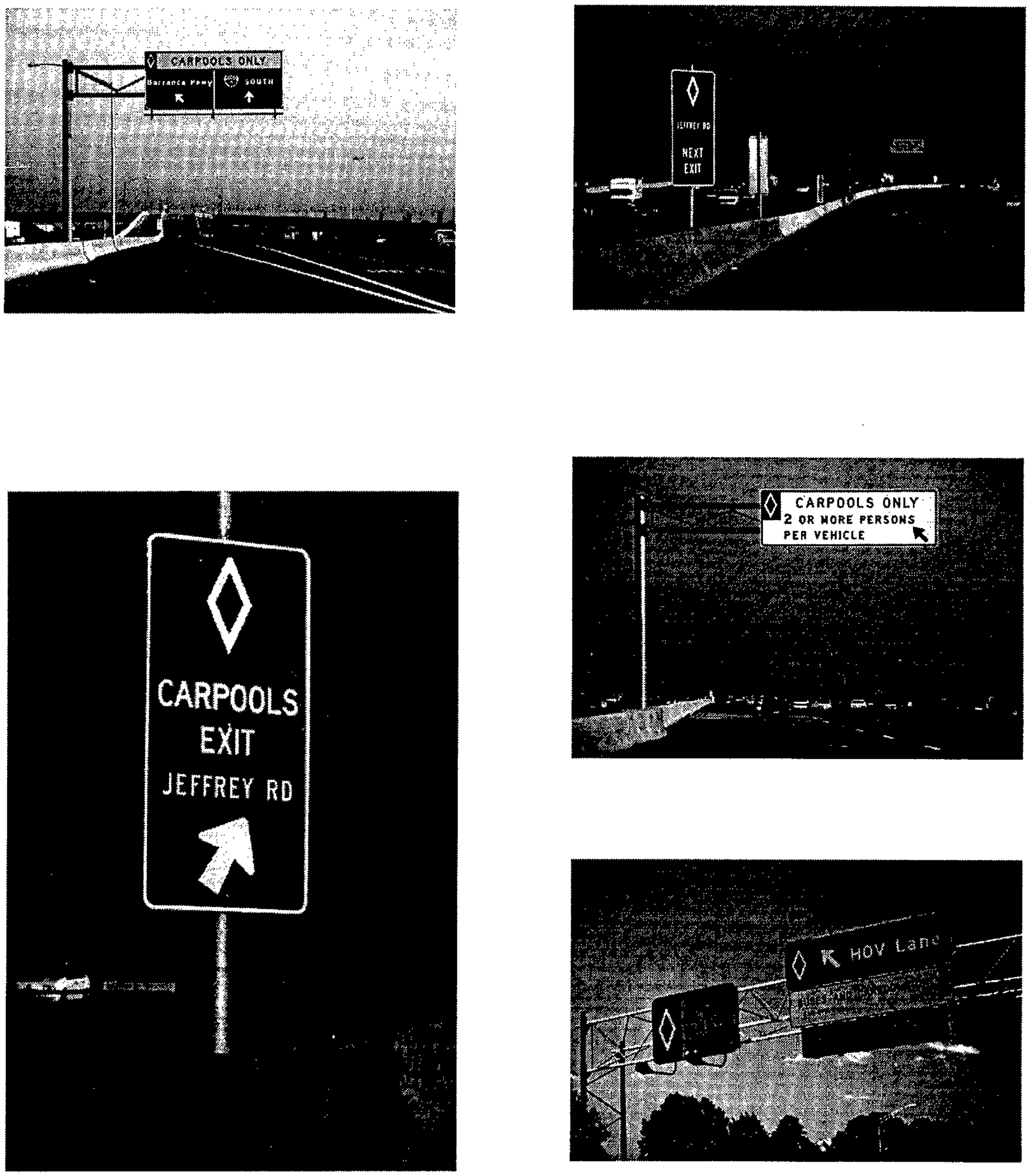


Figure 6-17. Examples of Signing with Concurrent Flow HOV Lane Access Treatments

Both types of direct merge or at-grade access treatments are relatively easy to implement. They are also the lowest cost access alternatives. These approaches provide a great deal of flexibility. Disadvantages with these techniques include the lack of control over vehicles entering and exiting the lane, which makes enforcement more difficult. Safety may be more of a concern with direct merges, based on the difference in travel speeds of vehicles in the HOV lane and the general-purpose lanes and to weaving problems created by allowing drivers to judge the distance required to merge across freeway lanes to exit ramps. Problems may also emerge with limited access points however, by concentrating weaving movements in a few areas.

3. **Slip Ramps**. Another relatively inexpensive access treatment is the use of slip ramps. This type of access may be used at the start, end, or intermediate points of an HOV lane. Slip ramps may be used with barrier-separated, buffer-separated, and contraflow HOV lanes. Slip ramps provide a break in the barrier or buffer, allowing HOVs to enter or exit the facility. Slip ramps can be provided for ingress or egress but not for both movements at the same time. Potential safety issues should be examined in the design slip. Figure 6-18 provides examples of layout for this type of access treatment. A merge area of approximately 460 meters (1,500 feet) downstream of the slip ramp is suggested, and volumes of more than 1,000 vehicles an hour may justify continuing the lane as a general-purpose lane.

   Identifying the best locations for slip ramps should be one of the key elements in the design process. Factors to consider in this step include the location of freeway entrance and exit ramps, the origins and destinations of HOVs, the demand projections, and traffic volumes. For example, safety concerns may arise if a slip ramp is located too close to a freeway on-ramp with high volumes of entering HOVs that want to merge across the general-purpose traffic lanes and into the HOV facility. Similar problems may result if a slip ramp is located too close to a freeway exit ramp used by HOVs. A distance of 750 meters (2,500 feet) or more is suggested between an entrance or exit ramp and a slip ramp.

4. **Direct Access Ramps**. Grade separated or direct access ramps can provide ingress and egress for HOVs where high vehicle volumes are anticipated or where additional time savings and operational efficiencies can be gained. A variety of design treatments may be used to provide direct access from adjacent roadways, park-and-ride lots, and transit stations. Direct access ramps are usually found with exclusive HOV facilities, but they may be used with any type of lane. Further, direct access ramps may be used at the start, end, or intermediate locations along an HOV facility.

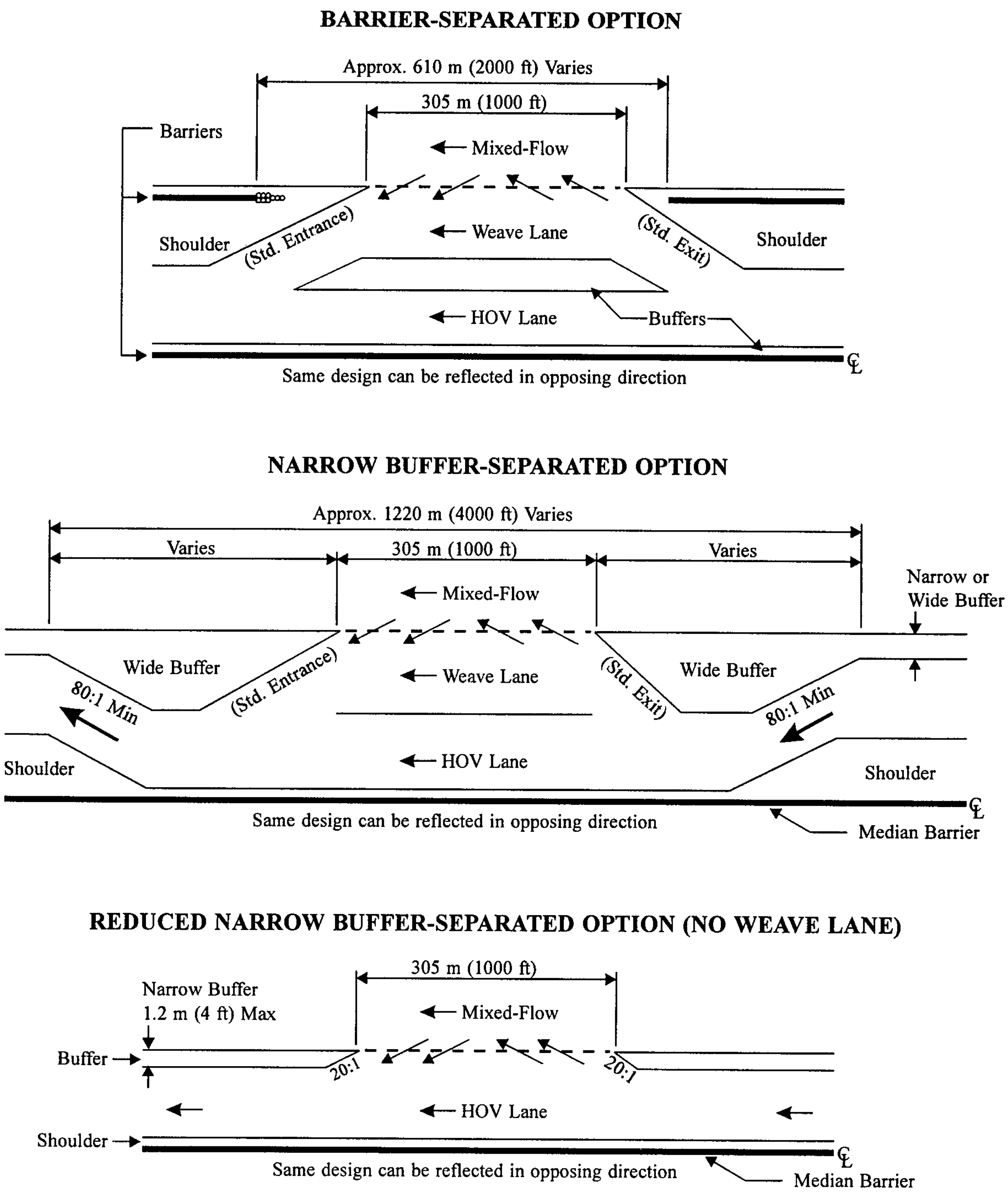


Figure 6-18. Examples of Layouts for Slip Ramps

Advantages of direct connections include the ability to move high volumes of HOVs into and out of an HOV facility without disrupting flow in the freeway general-purpose lanes, additional travel time savings, improved travel time reliability, ease of enforcement, and enhanced safety. Potential disadvantages include the need for additional right-of-way and the capital costs associated with different design treatments. Direct connections can be the most efficient means of managing these conflicting movements at locations where there is substantial congestion in the general-purpose lanes and a large volume of vehicles access the HOV lane. Enforcement can also be enhanced by the use of direct access ramps.

A variety of HOV ramp alignments, including drop ramps, T-ramps, Y-ramps, and flyover ramps are all examples of direct access connections. The exact design of these types of facilities will depend on the nature and design of the HOV lane and the adjacent roadway or facility, available right-of-way, and national and state design practices. The following information provides design examples for these types of access treatments.

Drop and T-Ramps. Figures 6-19 through 6-20 provide examples and layouts for different types of drop or T-ramps. These names reflect the fact that this type of direct access ramp looks like the letter T and drop from the HOV lane to the freeway, local roadway, park-and-ride lot, or other facility. These access treatments are usually used with barrier-separated exclusive HOV lanes, but they may also be considered with other types of HOV facilities. Figure 6-19 illustrates and a layout for a reversible flow T-ramp. Figure 6-20 presents a layout for a low volume busway T-ramp or intersection. The following elements should be considered in the design of drop or T-ramps.

The design speed for the drop or T-ramp should be based on the characteristics of the individual project. The HOV mainlane should not be adversely affected by the ramp design speed, however. Providing acceleration and deceleration lanes along the HOV mainlane is required to help ensure the safe and efficient operation of the HOV facility.

A shoulder should be provided for each direction of travel. If a full shoulder cannot be provided, other approaches may be used. A center barrier should be considered with two-way ramps, especially if high volumes of carpools and vanpools are projected to use the facility.

A cross section of 6.7 to 7.3 meters (22 to 24 feet) is desirable for a single direction or reversible flow drop or T-ramp. The desirable cross section for a two-way ramp is 14 meters (46 feet). A reduced cross section width of 11.5 meters (38 feet) for a two-way ramp may be considered in certain instances where low speeds are anticipated.

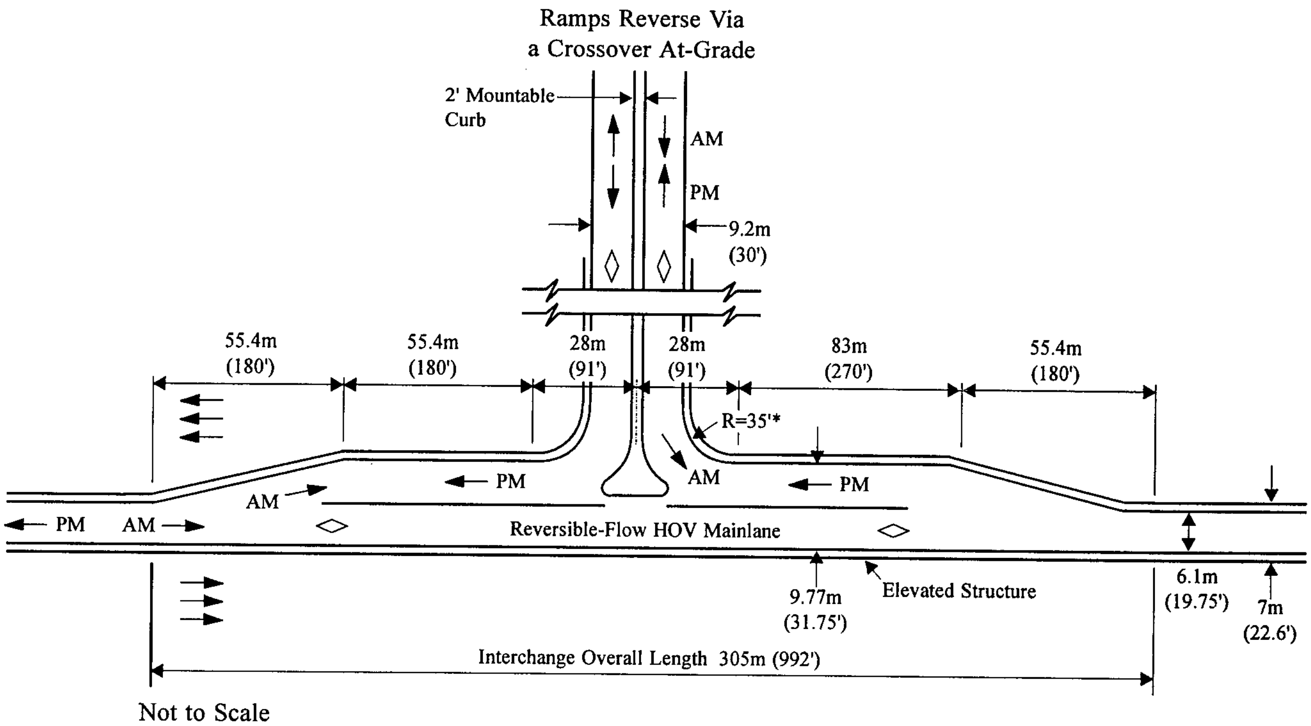


Figure 6-19. Example of Layout for Reversible Flow T-Ramp

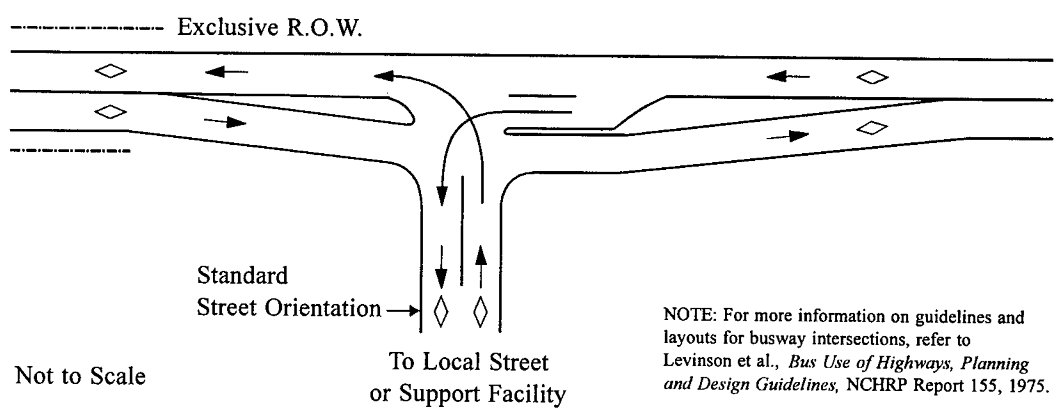


Figure 6-20. Example of Layout for Low Volume Busway T-Ramp or Intersection

Flyover and Y-Ramps. This ramp design accommodates high-speed, high-volume access to and from an HOV facility. The names reflect the design which look like the letter Y and flies over other facilities. The function of a flyover ramp is to provide direct, high-speed connections between the general purpose freeway lanes, park-and-ride lot, or other roadway, and the HOV facility. A variety of design treatments can be used with flyover ramps. Figures 6-21 and 6-22 illustrate layouts for flyover and Y ramps. Flyover ramps usually include extensive elevated structures which increases the cost of this technique. In addition, retrofitting a flyover ramp into an existing multilevel interchange can be both difficult and expensive.

If possible, the cross section for a flyover ramp should be similar to the HOV mainlane design. Based on this objective, the cross section for a flyover ramp would be in the range of 6.6 to 8.5 meters (22 to 28 feet) per direction, or 13.2 to 17 meters (44 to 56 feet) total, with a reduced cross section of 6.1 to 6.6 meters (20 to 22 feet).

5. **Freeway HOV-to-Freeway HOV Connections**. The development of a coordinated HOV system may include linking HOV facilities on multiple freeways. As highlighted in Table 6-9, freeway HOV-to-freeway HOV connections are currently in operation in Los Angeles/Orange County, California; Phoenix, Arizona; and Miami, Florida. Additional projects are also being planned, designed, and constructed in Seattle and Tacoma, Washington; Oakland, Los Angeles, and Orange County, California; and Rockville, Maryland.

   Although freeway HOV-to-freeway HOV connections can have major benefits in terms of travel time savings and improved operating efficiencies, they represent a significant capital cost. As discussed previously in Chapter 4, the need for freeway HOV-to-freeway HOV connections should be examined during the planning process. Elements that may be considered in this analysis include high levels of HOV demand, usually in the range of 800 to 1,000 vehicles per hour, safety and operational enhancements, and cost.

   The design of a freeway HOV-to-freeway HOV connection is similar to a general-purpose freeway-to-freeway ramp. The same design speeds, geometrics, cross sections, and other design elements used with a normal freeway-to-freeway ramp should be applied with a freeway HOV-to-freeway-HOV connection. Figure 6-23 provides an example of a layout for this type of facility.

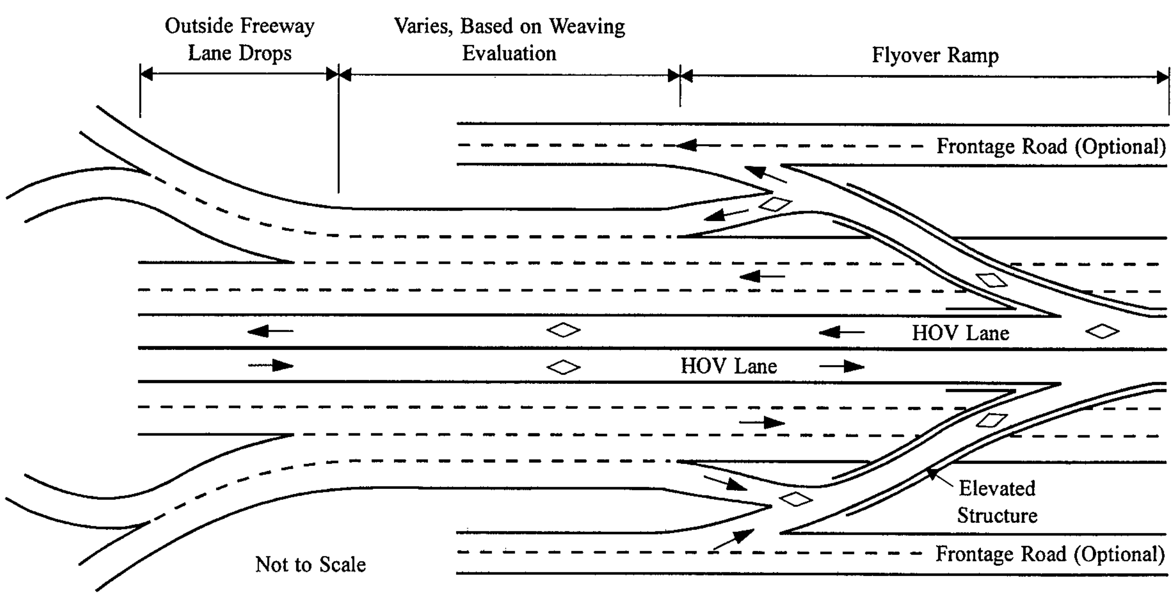


Figure 6-21. Example of HOV Flyover Ramp

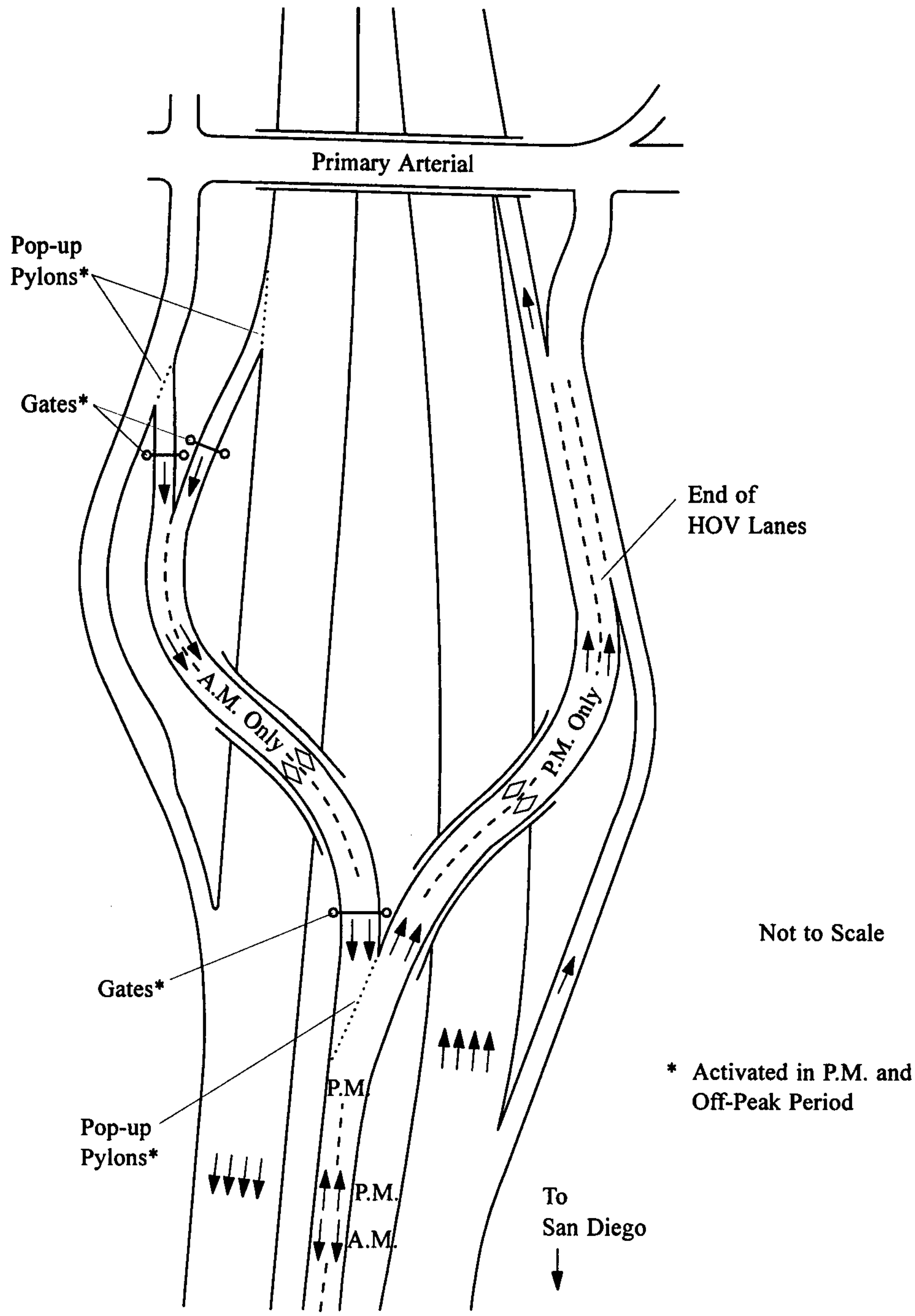


Figure 6-22. Example of Layout for HOV Y-Ramp

Table 6-9. Examples of Freeway HOV-to-Freeway HOV Ramp Connections

Location	Type of Design	Status
I-105/I-110, Los Angeles	Directional ramps from I-105 east and west to I-105 north	Open
I-5/I-405, Orange County, CA	Two-way common ramp between I-5 south and I-405	Open
I-5/SR 55, Orange County, CA	Two-way common ramp between SR 55 south and I-5 north	Open
I-5/SR 57, Orange County, CA	Two-way common ramp between I-5 south and SR 57	Open
I-10/SR 202, Phoenix	Directional ramps between SR 202 east to I-10 west	Open
SR 55/91, Orange County, CA	Directional ramps between SR 55 south and SR 91 east	Open
I-95, Miami	Two-way common viaduct through Golden Glades interchange	Open
I-270/I-270, eastern connector, Rockville, Maryland	Two-way common ramp between I-270 eastern connector and I-270 north	Open
I-5/SR 57, Los Angeles County	Two-way common ramp	Open
I-80/I-880, Oakland	Two-way common ramp	Construction
I-5/SR 91, Orange County, CA	Two-way common ramp between I-5 south and SR 91 west and SR 91 east and I-5 north	Construction
SR 57/91, Orange County, CA	Two-way common ramp between SR 57 south and SR 91 east	Construction
SR 55/I-405, Orange County, CA	Common and directional ramps between SR 55 north and I-405 north and south	Design
I-5/I-405, I-90/I-405, SR 167/I-405, Seattle	Various design concepts	Planning
I-5/SR 16, Tacoma, WA	Two-way common ramp between SR 16 west and I-5 north	Planning

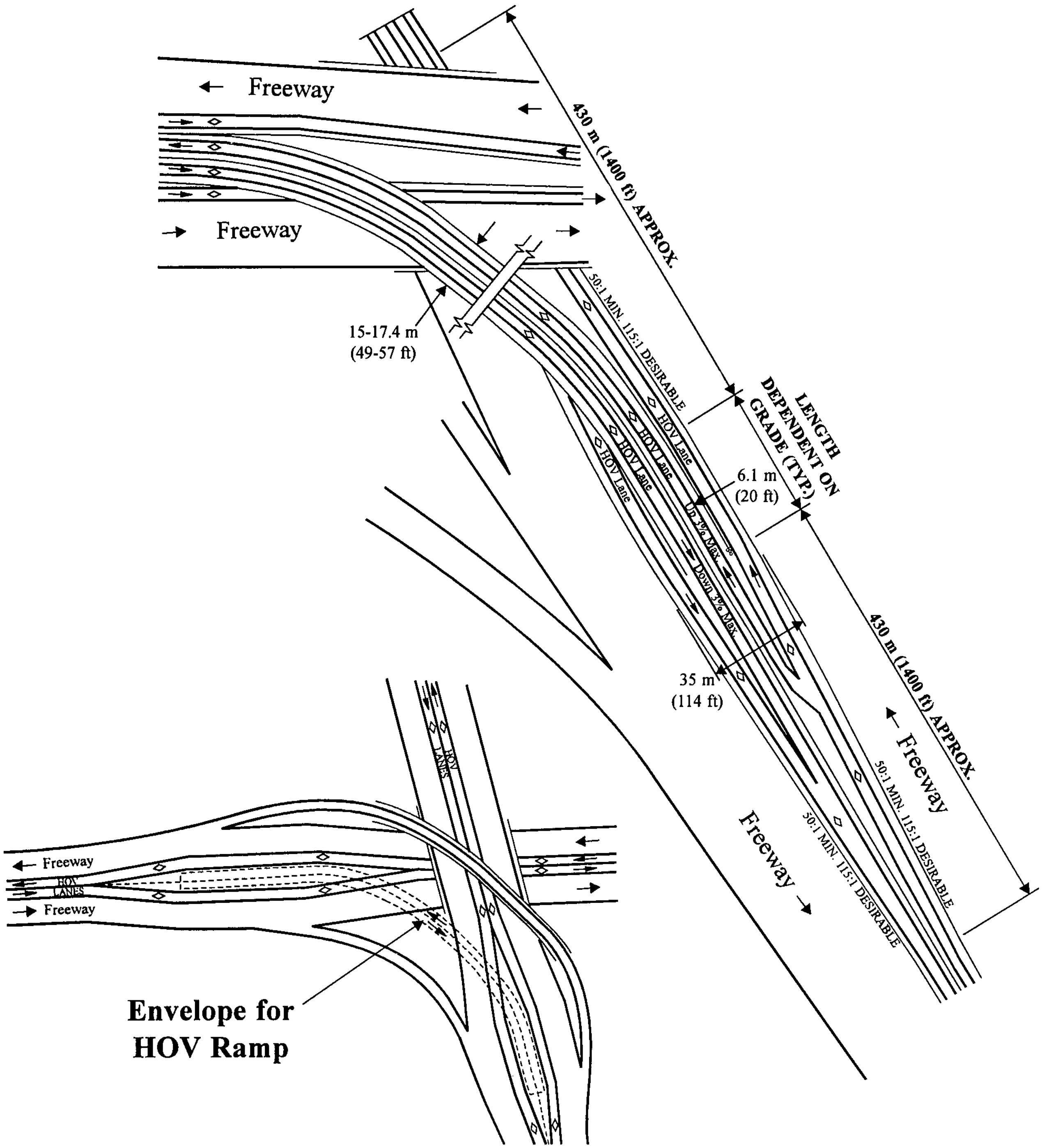


Figure 6-23. Example of Layout for Two-Way Freeway HOV-to-Freeway HOV Ramp

G. Design Considerations for On-Line Transit Stations

On-line transit stations are commonly used with busways on separate rights-of-way. In addition, on-line transit stations may be used with two-way exclusive lanes and other types of HOV facilities. Consideration should be given during the design process to on-line stations, as well as off-line stations, park-and-ride lots, and other supporting facilities. The design elements associated with on-line transit stations are presented in this section. The design of park-and-ride and park-and-pool lots are described in Chapter 9.

On-line transit stations, which are located directly on the busway or HOV lane, perform a number of functions. On-line stations provide access to bus services operated on the HOV facility. Passengers may access the station by walking, bicycling, feeder bus, or being dropped off. Further, local buses may access the HOV facility through a station. Figures 6-24 and 6-25 provide examples of layouts for on-line transit stations. Figure 6-26 illustrates cross section examples for various station configurations.

The design of an on-line station may take many forms. Many of the on-line stations in Pittsburgh and Ottawa have been integrated into the adjacent land uses and developments, although common design elements are used. Transit stations usually provide convenient, safe, and sheltered locations for passengers to wait for buses and to transfer between different routes and services. A number of elements will need to be considered in the design of an on-line station. These include the through travel lanes, the bus loading lane, the passenger platform or waiting area, deceleration and acceleration lanes for buses, shelters, and other amenities. These elements, which are described next, will be influenced by the operating character of the facility, anticipated passenger and bus demands, adjacent land uses, and other supporting facilities provided at the site.

Operating Characteristics. The operating characteristics of a facility will influence the design of on-line stations. For example, whether a facility is two-directional or reversible will have a major impact on design. All existing on-line stations are found with two-directional HOV lanes. Also, a two-directional HOV facility located in a freeway median will require different on-line station designs than a busway in a separate right-of-way. The vehicles authorized to use a facility will also influence the design of on-line stations. An HOV lane open to carpools and vanpools, which will mean significant volumes of through traffic at stations will require different design considerations than a bus-only facility.

Median Component. Normal design practice recommends a median barrier to separate opposing travel lanes in the station area (2,3). A median barrier is especially important if significant volumes of passenger automobiles and vans will be traveling through a station. A center median may not be as critical on bus-only facilities, where lower bus volumes traveling at slower speeds, and operated by professional drivers, are anticipated. For example, center medians are not used on either the Ottawa or the Pittsburgh busway systems.

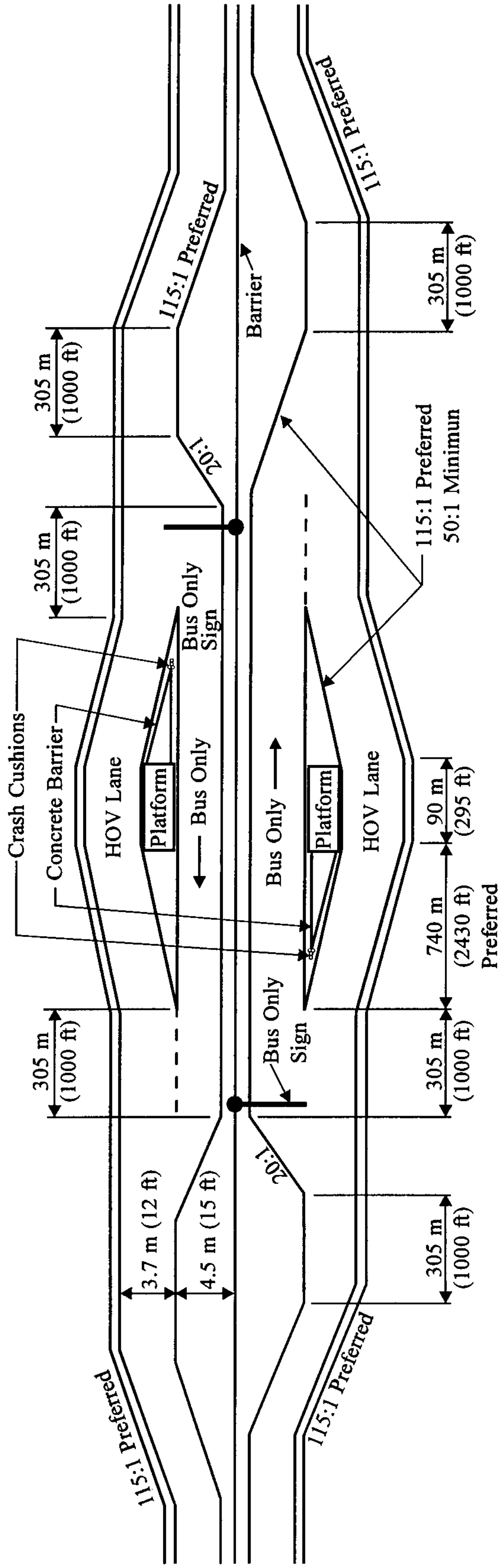
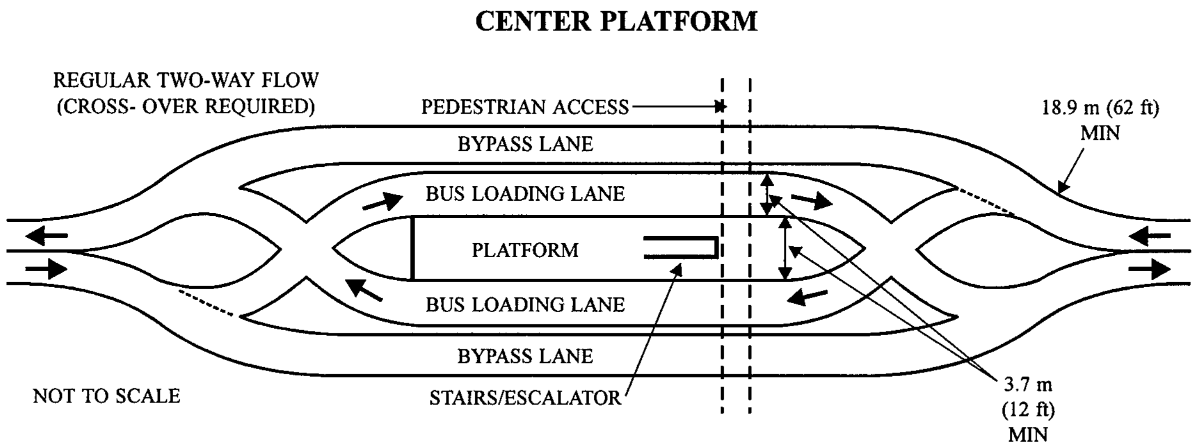


Figure 6-24. Example of Layout for Side Platform On-Line Transit Station



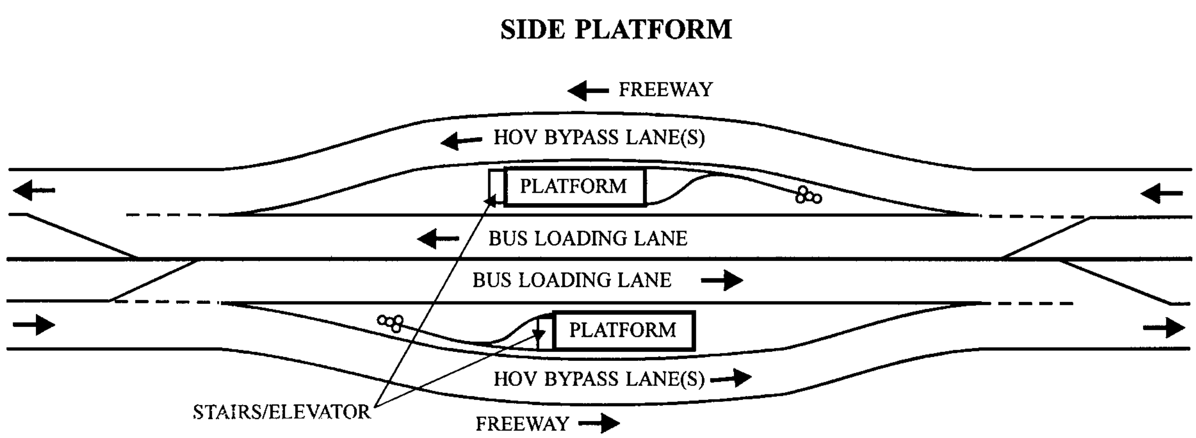
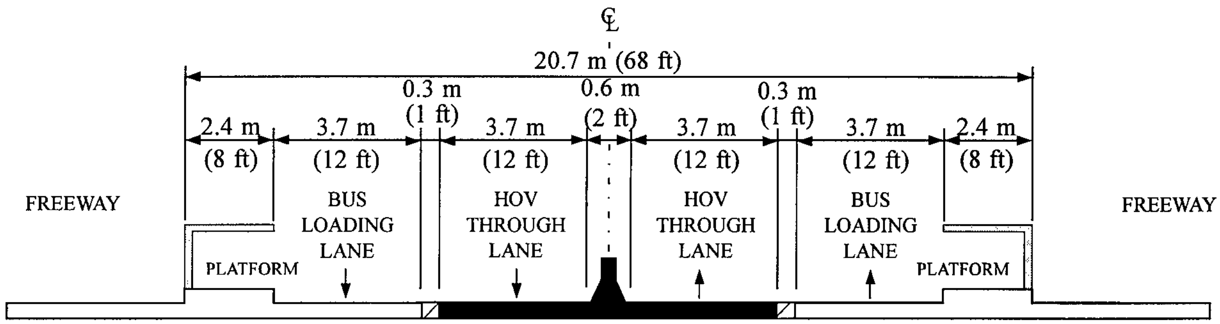
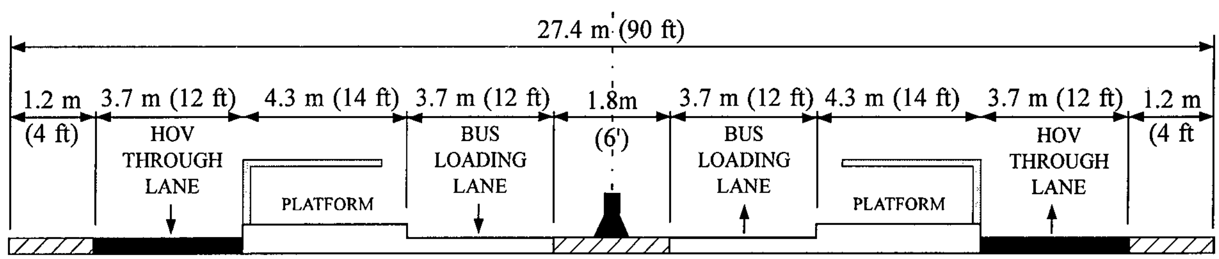


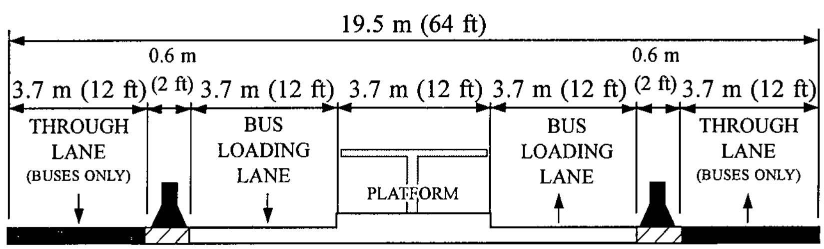
Figure 6-25. Example of Layouts for Center Platform and Side Platform for On-Line Transit Stations



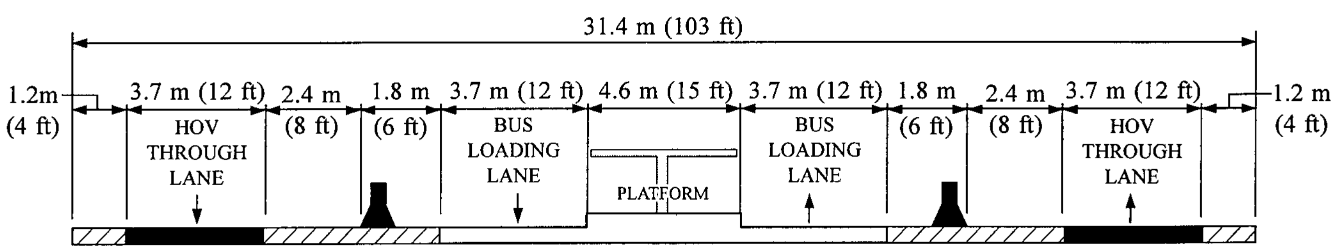
REDUCED SIDE PLATFORM STATION



DESIRABLE SIDE PLATFORM STATION



CENTRAL PLATFORM - REDUCED



CENTRAL PLATFORM - WITH DESIRABLE STANDARD DESIGN FEATURES

Figure 6-26. Examples of Cross Sections for On-Line Transit Stations

Through Lane Component. A lane should be provided to allow buses, as well as carpools and vanpools if authorized to use the facility, to travel through a station without stopping. If a through lane is not provided, these vehicles would have to stop and wait while buses drop-off and pick-up passengers, negatively impacting travel time savings. A 3.6 meter (12 foot) through lane should normally be considered.

Loading Lane and Platform Component. The design of the loading lane and platform will depend on the operating characteristics of the facility. Two general types of platforms and loading areas may be considered. These are parallel and sawtooth designs. The parallel design allows buses to simply pull to the curb at a designated spot. The bus then pulls away from the curb and merges back into the through lane after picking-up and dropping-off passengers. The sawtooth design provides staggered berths for buses to pull in and pull out.

The parallel design requires less width but more length than the sawtooth design. The parallel design is preferable from a transit operations standpoint as it does not require bus operators to maneuver in and out of bus bays. Parallel platforms are found more frequently with existing on-line stations, although sawtooth designs are found with park-and-ride and off-line stations.
The loading lane is located adjacent to the platform area. With parallel platforms, the loading lane is typically 3.6 meters (12 feet). Wider loading lanes are needed with sawtooth platforms to accommodate the necessary bus maneuvers. Typical widths for sawtooth platforms are in the range of 4.8 to 6.1 meters (16 to 20 feet).

Acceleration and Deceleration Lane. Space will also need to be provided to allow buses to decelerate to enter the station area and to accelerate and re-enter the main travel lane. The distance of the approach and departure area will depend on the mainline travel speeds, the length of the station or platform area, and the vehicle mix authorized to use the facility. For example, in Ottawa and Pittsburgh, travel speeds are restricted to 30 km/h to 40 km/h (25 to 30 mph) in station areas. The platform areas are approximately 85 to 152 meters (280 and 500 feet) in length, and the acceleration lanes are 121 to 220 meters (400 and 725 feet) in length. Based on this experience, acceleration and deceleration lanes of approximately 121 to 242 meters (400 to 800 feet) appear to be appropriate with through travel lane speeds of 60 km/h (40 mph) or less and relatively low vehicle volumes.

Vehicles on the San Bernardino Busway and the recently completed I-110 Transitway in Los Angeles, which include buses, carpools, and vanpools, maintain higher operating speeds through station areas. Longer deceleration and acceleration lanes should be provided on these types of facilities. Approach and departure lanes for buses in these cases are in the range of 636 to 848 meters (2,100 to 2,800 feet), based on California design criteria and posted speeds of 75 km/h (45 mph).

Platform Length. The length of the passenger platform area and the station will depend on the number of transit vehicles anticipated to use the facility, projected passenger demand, and the types of buses. The general length of platforms at existing on-line stations are 30 meters (100 feet) in Pittsburgh, 54 meters (180 feet) in Ottawa, and 61 meters (200 feet) or more on the San Bernardino Busway. At least 12 meters (40 feet) is needed at a parallel loading area for a standard bus and 18 meters (60 feet) is needed for an articulated bus. These figures do not include maneuvering space.

Platform Width. The width of a platform will depend on the number of passengers projected to use the facility, especially during the peak hour, and other features that may be provided. Passenger platform widths of 3.0 meters (10 feet) are used in Pittsburgh, with 3.6 meters (12 foot) used in Ottawa. Additional space will be needed for passenger waiting areas, pedestrian or feeder bus access, and other amenities.

Waiting Areas, Access, and Amenities. On-line stations frequently include additional features and amenities. Stairways, elevators, pedestrian ramps, benches, shelters, enclosed waiting areas, newspaper racks, vending machines, and other amenities may all need to be considered in the design process. The requirements of the Americans with Disability Act (ADA) and subsequent rules will need to be consulted to ensure the station is fully accessible to all individuals. The design of these elements should follow the appropriate federal, state, and local guidelines.

Design Summary. All of these elements will need to be considered in the design of on-line transit stations. In general, the total width required for on-line stations will typically range from 18 to 27 meters (60 to 90 feet). The exact width and design will depend on the variables outlined in this section.

H. Design Considerations to Enhance Connectivity

As discussed throughout this Manual, HOV facilities are more effective when developed as a comprehensive system or network. This system approach should encompass all of the HOV components in an area. These may include HOV lanes on freeways, in separate rights-of-way, and on arterial streets, as well as supporting facilities, services, and policies. The design process should consider how the various elements of a coordinated HOV system will be linked together.

The term connectivity is used to describe this linking function. It may encompass a number of elements including linking freeway HOV lanes together through freeway HOV-to-freeway HOV ramps, connecting freeway HOV lanes or busways to arterial street HOV lanes, and coordinating services, policies, and other supporting components.

The design elements discussed in this chapter, as well as those relating to arterial street HOV applications and transit services and facilities described in Chapters 8 and 9, respectively, can be used to guide the development of a coordinated HOV system in a metropolitan area or region. Key design issues may relate to ensuring links between HOV facilities under the jurisdictions of different agencies, agreeing on common signing and pavement markings, and developing uniform design practices.

In many cases, the institutional issues associated with planning, implementing, operating, and enforcing a coordinated HOV system may be more difficult to address than specific design issues. The use of the approaches discussed throughout this Manual, including multi-agency teams or committees, can help address the institutional issues that may arise in the development of a coordinated and connected HOV system.

V. DESIGN CONSIDERATIONS FOR HOV FACILITIES ASSOCIATED WITH FREEWAY RAMPS, MAINLINE METERS, CONNECTOR METERS, TOLL PLAZAS, AND FERRY LOADING AREAS

In addition to HOV lanes on freeways and busways in separate rights-of-way, special priority treatments are provided for HOVs at freeway ramp meters, at mainline and connector meters, at toll plazas, and at ferry landings in some areas. These types of treatments are frequently referred to as queue bypass projects as they allow HOVs to travel around other vehicles waiting in line at these facilities. The design elements associated with these types of projects are discussed in this section.

A. Design Considerations with HOV Bypass Lanes at Freeway Ramp Meters

Metering freeway entrance ramps is a technique being used by some state departments of transportation to better manage traffic on freeways in some metropolitan areas. Metering vehicles entering a freeway can improve the overall level-of-service by regulating the flow of traffic and by dispersing the platoons of vehicles that typically enter a freeway during the peak-periods. Ramp metering may also discourage drivers from using a freeway for a short distance trip that can be more effectively served on the local street system.

Providing HOVs with a way to bypass the queues that frequently form at ramp meters, especially during the peak-hours, can help encourage greater use of carpools, vanpools, and buses. HOV bypass ramps may be used in conjunction with a freeway HOV lane, or they may be provided as stand-alone treatments on freeways that do not have HOV lanes.

Two general types of treatments are usually used with HOV bypass lanes at metered freeway entrance ramps. These are providing an additional lane as part of the existing ramp and providing a separate ramp. The former approach, which uses the same ramp but involves a separate lane for HOVs around the meter, is more common. Figures 6-27 and 6-28 provide examples of layouts for two different approaches that can be used with HOV ramp meter bypass lanes. The design elements associated with these treatments are highlighted next.

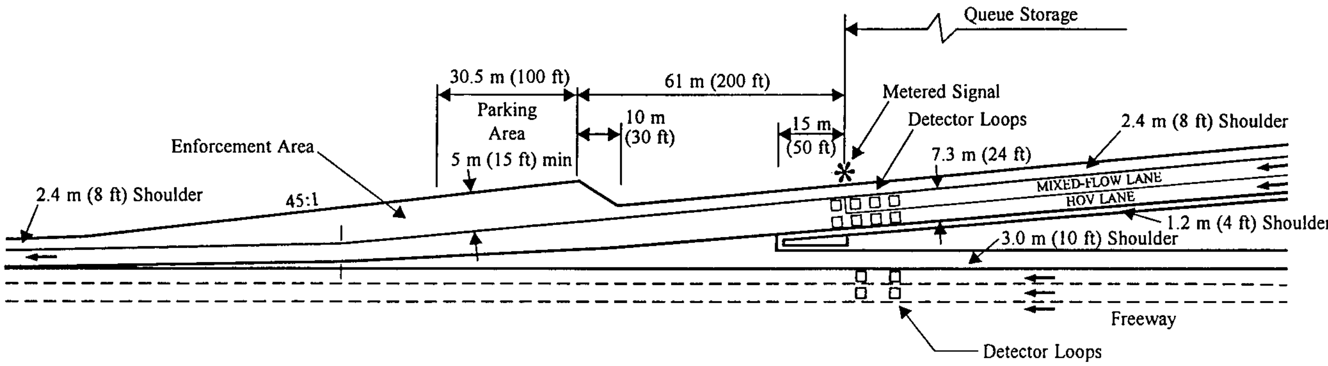


Figure 6-27. Example of Layout for HOV Bypass Lane at Metered Freeway Entrance Ramp

Source: (7,11)

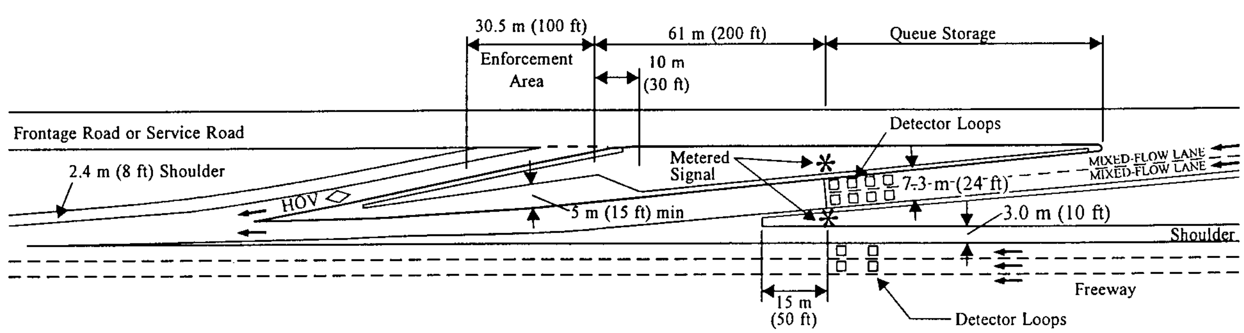


Figure 6-28. Example of Layout for Separate HOV Ramp on Metered Freeway

Source: (7,11)

As illustrated in Figure 6-27, a commonly used approach is to provide a lane for HOVs directly adjacent to the general traffic lane upstream from the meter. A lane width of 3.6 m (12 feet) with ramp shoulders is recommended by AASHTO (3). Adequate space within the existing freeway alignment or additional right-of-way may not be available to meet these criteria, however. As a result, narrowing the lane to 3.0 to 3.3 meters (10 to 11 feet) and dropping the shoulder may be considered in some cases. A distance of 91 meters (300 feet) from the meter to the freeway is also recommended by AASHTO to allow HOVs to merge with the metered ramp traffic (3).

The use of a solid line to separate the HOV bypass lane from the general traffic lane appears to be the most commonly used approach (6). A painted buffer or mountable curb may also be considered to provide further separation. The length of the bypass lane will depend on the length of the ramp and the location of the meter. As a general guide, the bypass lane should be long enough to allow HOVs to avoid the queue in the general-purpose lane.

An HOV bypass lane can be located on either the left or right side of the existing general traffic ramp lane. Advantages of a left side HOV lane include reinforcing the normal pass on the left orientation. A left lane location is also less likely to be blocked at the street or feeder route entrance. A possible disadvantage with the left orientation is that buses must merge to right after the meter. The visibility for bus operators making right merges is not as good as for left merges. Enforcement of a right side bypass lane may be easier if an enforcement area is provided, as more space is usually available on the right of an entrance ramp. A bypass lane located on the right side is more susceptible to being blocked by vehicles backed up from the meter onto the access roadway.

In a few cases, the freeway entry ramp may have two general-purpose lanes, with a third lane for HOVs-only. The same preferred lane width of 3.6 meters (12 feet) should be used in these cases, although modifications may be needed based on local conditions.

A second approach to providing HOVs with preferential treatment at metered ramps is to provide a separate entrance ramp. The design of these ramps should follow national and state guidelines on freeway entrance ramps. As in the previous case, the HOV ramp and the general-purpose ramp should merge into a common acceleration lane prior to entering the freeway. It is also suggested that separate HOV bypass lanes be located downstream of the general-purpose ramp. In some cases, the HOV lane may also be metered, although at a faster rate, to ensure a smooth flow of traffic.

Enforcement areas may be provided with either type of HOV meter bypass treatment. The location and general design of enforcement areas are shown in Figures 6-27 and 6-28. Due to limited right-of-way and lack of available personnel, enforcement areas are not commonly found with HOV bypass lanes. Enforcement tends to be provided by roving patrols or motorcycle police.

The exact location and design of an HOV bypass lane at a metered freeway ramp will depend on location conditions and site specific elements. Bypass lanes should be considered only at ramps with high volumes of current or projected buses, vanpools, and carpools. Further, the design of the existing ramp, the location of the ramp meter, the availability of needed right-of-way, ramp volumes, and the local street system should all be considered in the design of a bypass lane.

Additional signing and pavement markings should also be provided with HOV bypass lanes. Examples of signs and markings that can be used with these types of facilities are provided in Section VII.B.

B. Design Considerations with HOV Treatments at Connector Meters

In a few areas, meters are being used on freeway-to-freeway ramps or on major connectors to freeways. Examples of the use of these techniques, and HOV bypass ramps, include the connections from Highway 100 and Highway 18 with I-394 in Minneapolis and I-105 with I-80, I-605, I-170, I-405, and I-110 in the Los Angeles area. National and state guidelines for the design should be followed in the design of these facilities.

C. Design Considerations for Preferential HOV Treatment at Toll Plazas and Ferry Loading Areas

Priority treatments for HOVs are provided on some toll facilities in the United States. Techniques currently utilized include reduced pricing strategies, HOV lanes, HOV lanes approaching a toll plaza, and toll booths reserved for use by HOVs only. At least 23 toll facilities currently provide special pricing for HOVs, and at least 12 provide some type of priority treatment for HOVs on the roadway or at the toll plazas (15). The design elements associated with HOV lanes on these facilities have been described previously in this chapter.

Figure 6-29 illustrates the layouts for the bypass lanes at the toll plaza bypass lanes at the San Francisco-Oakland Bay Bridge. Pylons are used on the Bay Bridge to segregate HOV and non-HOV traffic. The Washington State Ferry system provides special lanes for HOVs at many ferry terminals. These lanes, which were illustrated in Chapter 5, give HOVs priority loading and unloading, allowing them to bypass the queue of vehicles waiting for a ferry. This approach does not require any special design considerations beyond signing and pavement marking.

The design issues associated with these types of HOV applications will depend on the site and the exact application. The information provided in this chapter can be used to help guide the design of specific projects.

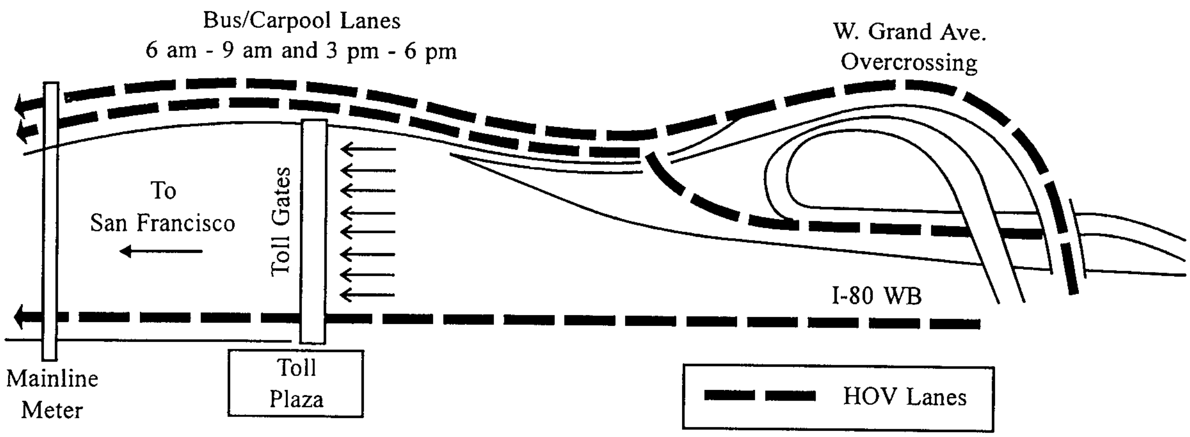


Figure 6-29. Example of HOV Bypass Lanes on the San Francisco Oakland Bay Bridge Toll Plaza

VI. DESIGN CONSIDERATIONS FOR HOV ENFORCEMENT

The important role enforcement plays in the success of an HOV project is stressed throughout this Manual. The involvement of representatives from the state and local police during the planning process was discussed in Chapter 4. The role of enforcement personnel in operating freeway HOV facilities was examined in Chapter 5. This section highlights the elements that should be considered in designing enforcement areas associated with the various types of HOV facilities on freeways and in separate rights-of-way.

HOV projects should be designed so that they can be safely and efficiently enforced. The safety of police personnel, as well as travelers in the HOV lane and the general-purpose lanes, should be key considerations in the design process. Experience indicates that poorly designed and unsafe enforcement areas will not be used.

As discussed in Chapter 5, a variety of enforcement techniques can be used with HOV facilities. These include stationary, roving, team, and multi-purpose patrols, electronic monitoring, self enforcement programs, and issuing tickets or citations by mail. The ease or difficulty associated with enforcement will be related to the type of HOV facility and specific issues in the area. Each HOV operating concept reflects different enforcement needs, requiring different provisions. Table 6-10 highlights some of the attributes associated with enforcing different types of HOV facilities. Busways on separate rights-of-way and barrier-separated HOV facilities are generally considered easier to enforce than other facilities because of the limited and controlled access they provide. Contraflow facilities and queue bypasses may be enforced through a single strategically located monitoring area. Concurrent flow HOV lanes, especially those allowing continuous access, are the most difficult to enforce.

Table 6-10. Enforcement Attributes Associated with Different Types of HOV Facilities

Type of HOV Facility	Preferred Enforcement Attributes	Minimum Enforcement Attributes
Exclusive Barrier Separated • Reversible	• Enforcement areas at entrances and exits.	• Enforcement areas at entrances or exits.
• Two-way	• Enforcement areas at entrances and exits.	• Enforcement areas at entrances or exits.
Concurrent Flow	• Continuous enforcement shoulders with periodic barrier offsets. • Continuous right side shoulders.	• Periodic mainline enforcement areas. • Monitoring areas. • Continuous right side shoulders.
Contraflow	• Enforcement area at entrance. • Continuous shoulder for enforcement.	• Enforcement area at entrance.
Queue Bypass Treatments	• Enforcement area on right side shoulder. • Continuous right side shoulder. • Duplicate head facing enforcement area.	• Enforcement monitoring pad with continuous right side shoulder downstream.

Typical enforcement design treatments are addressed in this section. The national experience and guidelines are highlighted for various types of projects. The enforcement operating scenarios discussed in Chapter 5 and the information presented in this section can be used as starting points for the design of enforcement areas with a specific HOV project.

A. General Enforcement Design Considerations

The term enforcement area is used to refer to a number of potential design treatments that provide space for police personnel to monitor an HOV facility, to pursue a violator, and to apprehend a violator and issue a ticket or a citation. Space adjacent to an HOV lane is required for these functions. The primary type of infraction enforcement officers confront is occupancy violations, which requires the ability to see inside a vehicle. Good lighting and good visibility from a safe vantage point is needed to perform these enforcement functions. The provision of continuous, full width shoulders adjacent to an HOV lane is the best method to meet this need. The design examples that follow assume this treatment.

As discussed in Chapter 5, a variety of enforcement practices may be used on a facility. The design of enforcement areas should be flexible to account for a variety of enforcement strategies. On barrier-separated facilities, enforcement actions are usually performed near the entrance or exit ramps where traffic is often moving more slowly. The enforcement area serves as both a monitoring and an apprehension site. For non-barriered facilities, enforcement areas may allow officers to monitor traffic, with the apprehension of violators occurring at a downstream location, which may be another enforcement area or a wide left or right shoulder.

Two general classifications for enforcement areas are often used. These categories relate to the exclusive or barrier-separated and non-barrier separated HOV treatments. The two approaches are low-speed enforcement areas at entrance and exit ramps, and high-speed settings along the HOV mainline. The general characteristics associated with these two approaches are described next, followed by specific examples of enforcement area designs with different types of HOV lanes.

Low-Speed Enforcement Area. Low-speed enforcement areas are usually located at access points on busways, HOV lanes on separate rights-of-way, and barrier-separated freeway projects. Specific locations may include ramps, reversible lane entrances, and queue bypasses where vehicle speeds are relatively slow, usually below 75 km/h (45 mph). Low-speed enforcement areas are often designed to provide for monitoring, apprehension, and citing of violators, and where practicable, violator removal from the HOV facility. The following design features may be considered with slow-speed enforcement areas.

- The enforcement area should be at least 30 meters (100 feet) in length and preferably up to 60 meters (200 feet) on high-volume facilities, not including approach and departure tapers.

- The enforcement area should be at least a width of 4.2 to 4.5 meters (14 to 15 feet).

- The enforcement area should have an approach taper of 2:1, or 9.1 meters (30 feet).

- The enforcement area should have a departure taper of 10:1 or 45.5 meters (150 feet) to allow for acceleration into the lane.

High-Speed Enforcement Area. If an HOV lane includes a number of high-speed 75 km/h (45 mph) or higher at-grade access locations or lacks continuous shoulders wide enough for enforcement, consideration should be given to periodically spaced enforcement areas. These areas are usually designed for monitoring traffic or for monitoring and apprehending violators. For either application, police personnel often prefer that periodic enforcement areas be designed in conjunction with full outside shoulders. Most apprehension activities are performed in the right shoulder, and some state vehicle codes require that motorists being pursued by police move to the right. The following elements should be considered in the design of high-speed enforcement areas.

- The length of a high-speed monitoring area should be at least 30 meters (100 feet), not including the approach and departure tapers. For monitoring and apprehension the length should be preferably 394 meters (1,300 feet).
- The enforcement area should be at least 4.2 to 4.5 meters (14 to 15 feet) in width.
- The enforcement area should have an approach taper of 20:1 and departure taper of 80:1 or higher, or controlled by general freeway criteria as required to fit in the design for proper acceleration to the design speed.
- Enforcement areas should be provided at minimum interval of 3.2 to 4.8 kilometers (2 to 3 miles) along the mainline HOV facility.

B. Enforcement Design Considerations for HOV Facilities in Separate Rights-of-Way

Special enforcement areas are not usually needed with busways due to the limited access points and the restricted vehicle mix. Access to busways is frequently through park-and-ride lots or transit stations, with limited local street access. In addition, buses are the only vehicles authorized to use these facilities. As a result, non-authorized vehicles, including passenger automobiles, vans, and motorcycles, can be easily spotted.

The existing busways in Pittsburgh, Ottawa, Miami, and Minneapolis/St. Paul, do not include enforcement areas. These facilities are designed and signed to limit the potential of unauthorized vehicles from entry. Enforcement is accomplished by bus operators and on-street supervisors reporting and dealing with violators.

C. Enforcement Design Considerations for Exclusive Freeway HOV Facilities

Enforcement of two-way and reversible exclusive barrier-separated HOV facilities, is easier than with concurrent flow lanes due to limited access points. Violators may be stopped at entry and exit points where travel speeds are usually lower. The enforcement designs used with reversible lanes are discussed first followed by the design approaches used with two-way facilities.

Reversible-Exclusive HOV Facilities. Reversible exclusive HOV lanes may be the easiest to enforce after busways. The design of these facilities significantly reduces the number of access points and prohibits random ingress and egress. Most HOV lanes of this type contain from one to no more than five access locations, making surveillance and apprehension at entrances or exits, efficient and effective. Barrier-separated lanes also act as a deterrent to potential misuse, as violators are trapped in the lanes. In addition, the geometric requirements for reversing a facility provides enforcement pockets available within the ramps that serve the opposing direction. In some cases these pockets are large enough to provide a means of removing violators by sending them out in the off-peak direction, thus penalizing the offending commuter with a travel delay as well. Designated shoulders or other enforcement pockets located along the lane can serve to facilitate enforcement activities. Figure 6-30 provides examples of cross section illustrating this approach. Enforcement officers may work in tandem, reporting violators at an entrance and allowing a second officer downstream to apprehend and cite the violator.

Two-Way Exclusive HOV Facilities. Two-way facilities offer the same advantage of limited ingress and egress as reversible HOV facilities. There are two differences, however, which make enforcement more difficult. First, there are no unused elements of the HOV roadway. Second, more options exist for accessing the lanes. As a result, there is less likelihood that enforcement can be performed exclusively at entrances or exits. Additional design features such as barrier offsets or wider than standard shoulders may need to be considered to help ensure safe places where enforcement can be performed. Enforcement areas at low-speed ramps may also be considered. As illustrated in Figure 6-31, full continuous shoulders wide enough for enforcement activities may be provided along the length of the facility.

D. Enforcement Design Considerations for Freeway Concurrent Flow HOV Lanes

Concurrent flow HOV facilities provide no physical separation from the adjacent freeway lanes. As a result, concurrent flow lanes are the most difficult type of HOV facility to enforce, as single occupant vehicles may merge in and out at will. The perception of enforcement, as much as an actual enforcement presence, is important attribute to managing HOV lane violations on these facilities, and the more effective the design is at meeting this objective, the better the design is at addressing enforcement needs.

Figures 6-31 and 6-32 provide examples of cross sections and layout for different types of enforcement techniques with concurrent flow for HOV lanes. Wide, continuous shoulders are used in many areas for enforcement. Where full shoulders are not available, mainline enforcement areas should be considered at regular intervals. Spacing is typically 3.2 to 4.8 km (2 to 3 miles). Enforcement areas should meet the guidelines defined previously for high-speed conditions. Augmenting the entrance areas with continuous outside shoulders along the freeway is also beneficial. A sufficient length should be provided to pull over a violator and once cited, allow the violator to safely reenter the traffic stream. The minimum length required for this operation is approximately 394 meters (1,300 feet), excluding tapers.

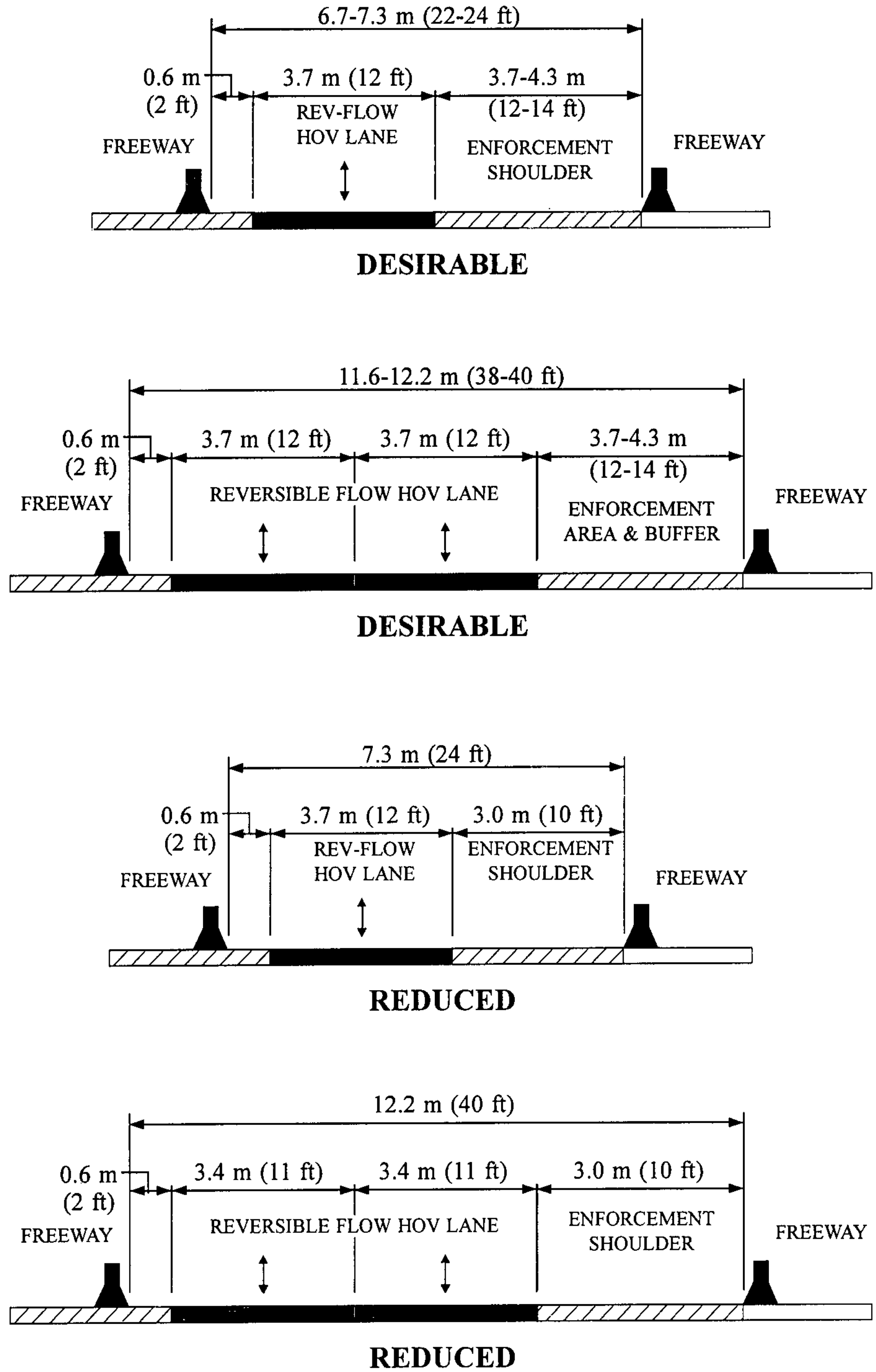


Figure 6-30. Examples of Cross Sections of Enforcement Areas Along a Reversible Barrier-Separated HOV Lane

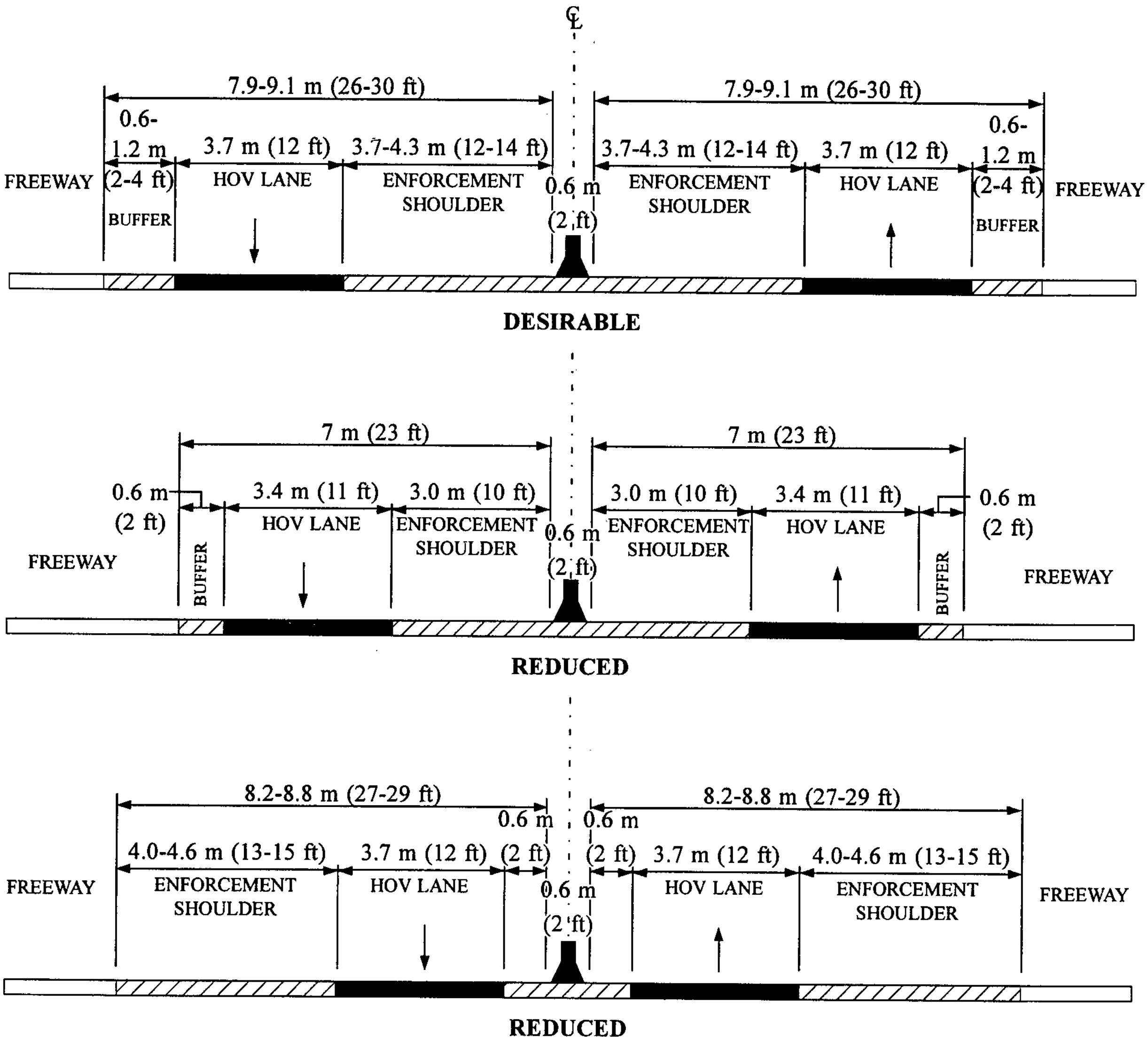


Figure 6-31. Examples of Cross Sections for Enforcement Areas Along Concurrent Flow and Exclusive Buffer-Separated HOV Lanes

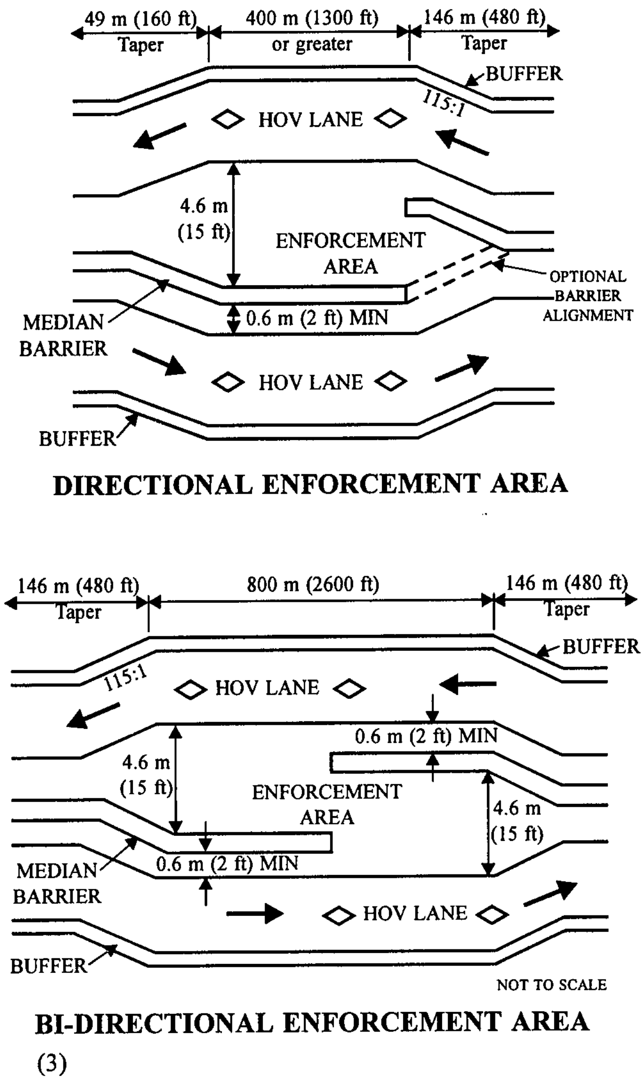


Figure 6-32. Examples of Directional and Bi-Directional Enforcement Area Layouts

Additional features, including an offset in the barrier to provide protection for the officer while monitoring traffic, a median opening that allows the officer to observe both directions of HOV operation, lighting, and removal of any glare screen on the barrier in the affected area should be considered. The opening is a particularly beneficial consideration for motorcycle officers who can maneuver within the median opening. The enforcement area should not be signed or otherwise draw attention to its function, but it may require extra lighting.

E. Enforcement Design Considerations for Freeway Contraflow HOV Lanes
Contraflow operations typically include a single entrance area and a single exit, although multiple access points may be provided. Setting pylons or moving barriers to define the borrowed lane requires a deployment crew at the beginning and the end of each operating period. During the operating period, safe and efficient operation is ensured by allowing the deployment crew to monitor the lane, operate wrecker services, and perform other functions. A wrecker is usually stationed on the downstream end, and enforcement personnel positioned at the upstream end.

To maintain safety for this type of operation, it is very important to stop and remove any errant motorists who accidentally enter the facility. This necessitates continuous monitoring at the entrance and some means of shunting ineligible users back into the mixed flow traffic stream. Enforcement is typically handled at the entrance to a contraflow lane.

VII. REGULATORY AND GUIDE SIGNING AND PAVEMENT MARKINGS FOR HOV FACILITIES

Providing a standard set of symbols, signs, and pavement markings for HOV facilities is important to building public awareness, understanding, and acceptance. Adequate regulatory and guide signs are critical for both users and non-users of the HOV facility. Signing also plays a key role in public education and enforcement strategies. Ideally, a uniform approach should be used with all HOV facilities, including projects on freeways, in separate rights-of-way, and on arterial streets.

The *Manual of Uniform Traffic Control Devices* (MUTCD) (16) should be used in designing and locating signs and pavement marking for HOV facilities on freeways and in separate rights-of-way. Section 2B-20, *Preferential Lane Signing*, and Section 3B-22, *Preferential Lane Markings*, relate specifically to HOV facilities. Other sections of the MUTCD address other types of signs and markings commonly used with HOV projects.

The traffic control signs and pavement markings used on HOV facilities are similar to those found on freeways and roadways. For example, common pavement markings may include flush median delineation, solid yellow center or left shoulder lines, solid white pavement edge lines, and turn-lane arrows and lane lines. Examples of common traffic control signs include those related to speed limits, wrong way or prohibited movements, vertical clearance, ramp locations, advance and action guide signs, and curve or other warning signs.

Although freeways and HOV facilities share many common signing and pavement markings, there are also many unique elements associated with signs and markings on HOV projects. Further, there are differences in the signing and pavement markings used on HOV facilities in different metropolitan areas, and even within some urban areas. An effort, lead by FHWA is underway to standardize pavement marking on freeways including those associated with HOV lanes. This section highlights the various signs and pavement markings commonly associated with HOV facilities on freeways and in separate rights-of-way. Practitioners can use this information in designing and locating signs and marking for specific projects.

A. Regulatory and Guide Signs

As noted previously, the MUTCD, AASHTO, and other federal and state guidelines should be used in the design and placement of signs associated with an HOV facility. Some states, including California, Texas, and Washington, have developed typical HOV sign applications and layouts to promote statewide consistency. The following general elements, which are based on the MUTCD, AASHTO, and other federal and state guidelines should be considered in the design of regulatory and guide signs with various types of HOV facilities. Figure 6-33 provides examples of different types of regulatory signs associated with HOV facilities.

- Regulatory signs should use the standard black lettering on a white background. A diamond symbol should be considered on all signs to help build awareness and to reinforce the special nature of HOV facilities.

- The size of a sign should be related to its location and the design speed of the facility. The same guidelines on letter size used with other highway signs should be followed with HOV signs.

- Signs relating to HOV lane restrictions, including vehicle-occupancy requirements and operating hours, should be provided at regular intervals along the facility. Overhead or side mounted signs may be appropriate for use.

- Additional signs should be considered at all access points, as well as in advance of the start of an HOV lane. Signs should be provided in advance of access points to alert users and non-users of the approaching ingress and egress. Static and changeable message signs may both be used with HOV facilities.

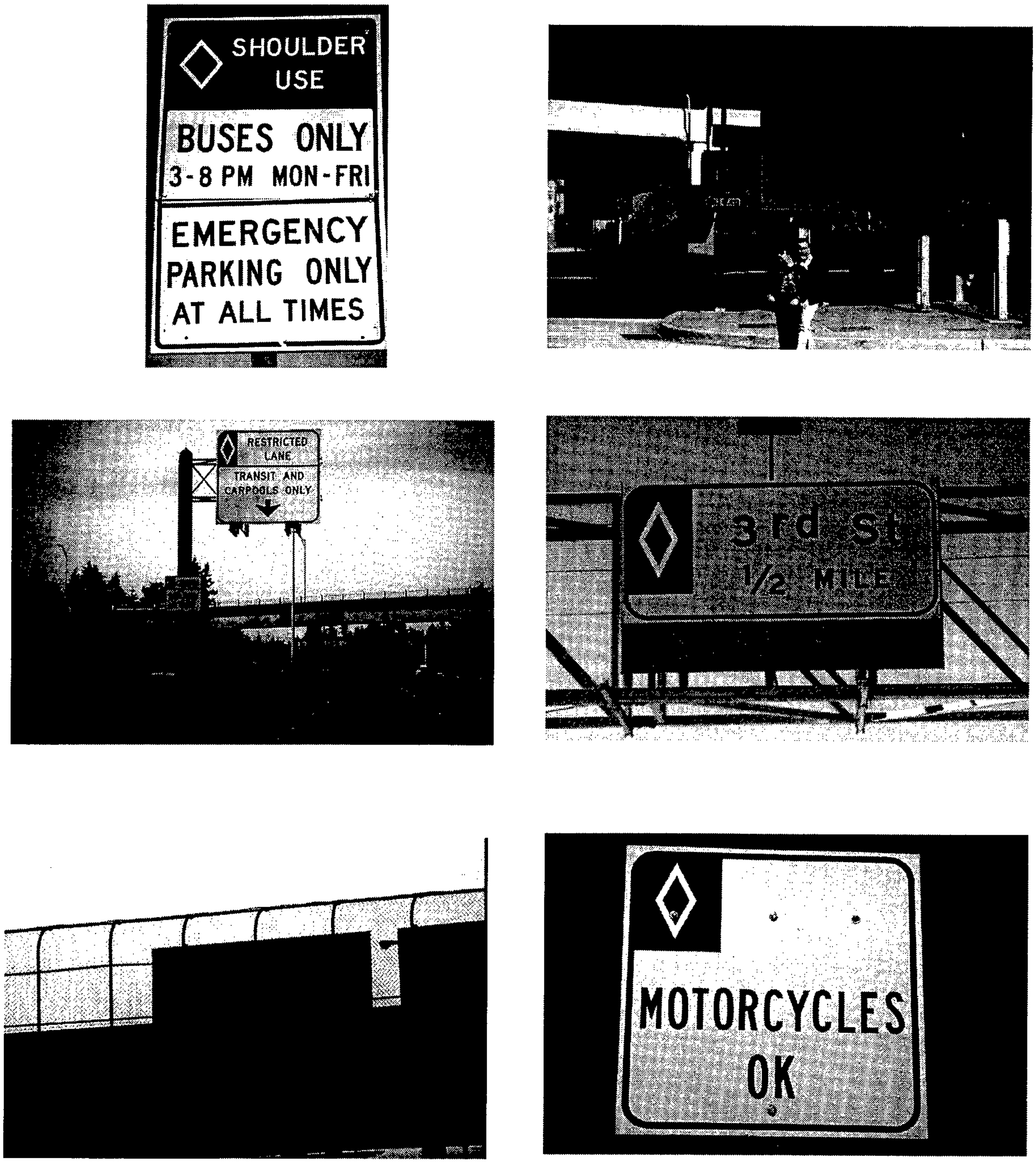


Figure 6-33. Examples of Regulatory Signs Used with HOV Facilities

♦ Guide signs may be used to alert motorists of park-and-ride and park-and-pool lots, transit facilities, and HOV lanes. A guide or trail blazer sign located along a freeway or other federal or state highway should conform to the MUTCD. Guide signs on these facilities are generally white lettering on a green background. Some states allow placing the transit rideshare agency logo on these signs. Information signs on federal and state highways are white on blue backgrounds. Information signs commonly associated with HOV facilities include telephone numbers for rideshare matching and transit services. Local sign ordinances and standards will guide the location and design of signs on local streets approaching HOV and supporting facilities. Like all traffic signs, the key elements to consider with guide and trail blazing signs is to keep the message simple, direct, and easy to understand.

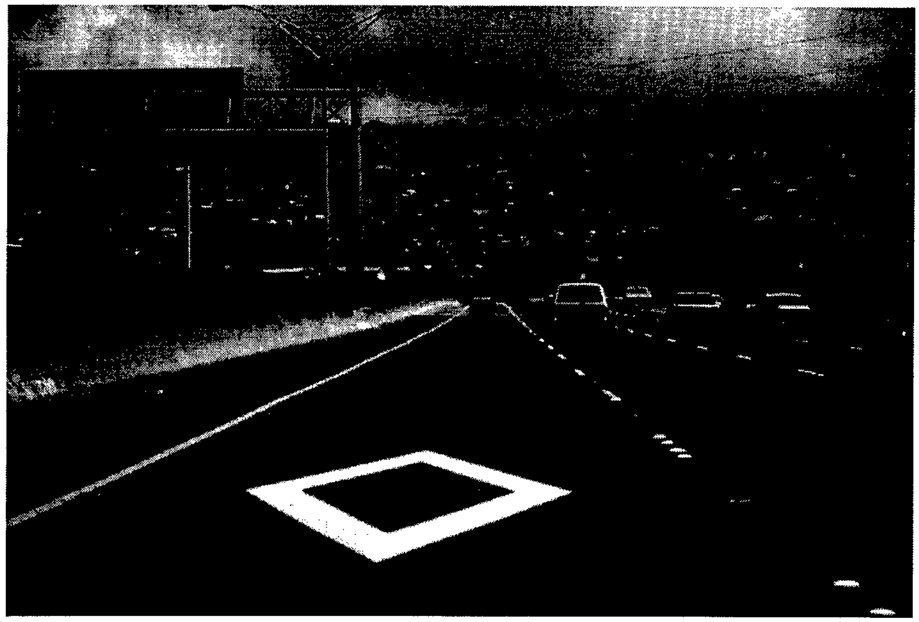
B. Pavement Markings

The use of a white diamond symbol painted on the pavement is commonly used to denote HOV facilities. Currently, the MUTCD recommends the use of the diamond symbol for HOV lanes, as well as for other special preferential non-HOV facilities. These may include bicycle lanes, truck-only lanes, and other special facilities. In many areas, however, it appears that the diamond symbol is being used exclusively with HOV facilities.

The AASHTO specifications for the white diamond symbol pavement marking should be used. The diamond should be 3.9 meters (13 feet) long and 0.9 meters (3.2 feet) wide. The exact placement and location of the symbol along a facility should be based on the operating characteristics of the lane and engineering judgment. The MUTCD and AASHTO recommend spacing the symbol 151 to 303 meters (500 to 1,000 feet) intervals. Their location on a specific facility should be frequent enough to remind users of the restricted nature of the lane.

In addition to the diamond symbol, many areas use wording to further communicate the restricted nature of the HOV facility. Common words associated with the diamond symbol include *HOV Lane Ahead*, *HOV Only*, *Bus Only*, and *HOV*. The use of unfamiliar acronyms should be avoided. Figures 6-34 and 6-35 provide examples of the pavement markings in use with existing HOV facilities. Consideration should also be given to the pavement markings in enforcement areas. Special striping or other techniques may be used to differentiate the enforcement area from the HOV and general purpose lanes.

Although the use of the MUTCD diamond symbol is widely accepted, there is less agreement on the paint striping that should be used to delineate an HOV lane from general-purpose traffic lanes. The following general practices are suggested for consideration. The paint color and striping for a specific project should be based on AASHTO, ITE, MUTCD, federal, state, and local guidelines and practices, as well as engineering judgment.



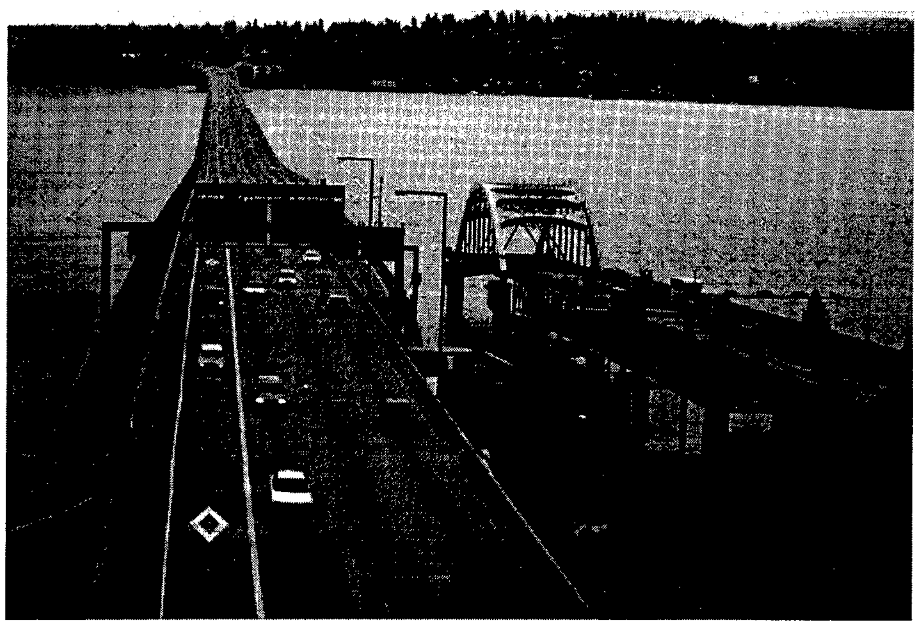


Figure 6-34. Diamond Symbol Pavement Marking

Figure 6-35. Examples of HOV Lane Pavement Markings

Busways in Separate Rights-of-Way. These facilities usually use the same pavement markings as a regular roadway except that a solid center line is frequently used to indicate that passing is not allowed. Additional striping may be needed if carpools and vanpools are allowed to use the facility.

Barrier-Separated Two-Way HOV Facilities. These lanes frequently use striping similar to busways. These include a solid white strip to delineate the right shoulders, and a solid white or yellow stripe in the center to separate the two travel lanes.

Buffer-Separated Exclusive HOV Facilities. Portions of the HOV lanes on I-84 in Hartford and the San Bernardino Freeway Busway in Los Angeles are separated from the adjacent general-purpose traffic lanes by wide painted buffers. A 3.0 to 4.8 meter (10 to 16 foot) painted buffer is used with these facilities.

Concurrent Flow HOV Lanes. The widest variety of paint striping is found with concurrent flow HOV lanes. HOV lanes that allow continuous access may use only the normal skip stripe to provide separation from the general-purpose traffic lanes. This approach is commonly found with part-time HOV lanes that revert back to general-purpose lanes for most of the day; double skip stripes are used in some areas to delineate continuous access. Concurrent flow lanes that allow ingress and egress only at specific locations often use a solid double line to delineate sections where access is not allowed and single skip striping in areas where access is allowed. Both solid white and solid yellow markings are used to define buffer areas. The MUTCD should be used to provide guidance on the appropriate markings.

Contraflow HOV Lanes. Contraflow lanes usually use some type of physical separation from the general-purpose lanes. Current techniques include drop-in traffic cones and the moveable barrier technology. Double skip stripes are used in some areas to delineate the buffer area for the placement of the traffic cones.

VIII. SPECIAL DESIGN CONSIDERATIONS

As discussed in the previous chapter on operations and enforcement, a number of initiatives and new approaches are being considered with HOV facilities. These include a renewed interest in converting general-purpose lanes to HOV lanes, priority pricing on HOV facilities, ITS and HOV projects, truck use of HOV lanes, converting HOV lanes to fixed guideway systems, and addressing concerns with slow moving traffic. Approaches to address the operating issues often associated with these types of projects were discussed in Chapter 5. The design elements that may need to be considered with these projects are described in this section. In some cases there may be little impact on the design of a facility, while in other cases, extensive design modifications may be needed.

A. Design Considerations with Lane Conversion Projects

Converting a general purpose lane to an HOV lane requires few design changes. As discussed previously, issues related to public and political acceptance and impacts on traffic in the remaining general-purpose traffic lanes are usually the major concerns that need to be examined with lane conversion projects.

Signing, pavement markings, and ingress and egress represent the major design elements that will need to be addressed if a general-purpose traffic lane is converted to an HOV lane. The signing and pavement markings used with a lane conversion project should follow MUTCD and AASHTO guidelines discussed in Section VI, as well as those provided by states. In addition, extra signing may be needed to introduce the project prior to implementation. This signing should communicate the upcoming restricted use of the lane, vehicle-occupancy requirements, operating hours, and other regulations. Enforcement provisions will also need to be addressed.

The lane delineation techniques described in Section IV.C. for concurrent flow HOV lanes can be used with lane conversion projects. The major decisions that will need to be made relate to access provisions. Allowing continuous ingress and egress and providing access only at specific points represent the two options usually considered. Once this decision has been made, the appropriate type of lane separation treatment and paint striping can be determined.

B. Design Considerations with Priority and Value Pricing Projects

The major design elements that will need to be considered with priority pricing projects on HOV activities relate to the toll collection technology, enforcement, and signing. Access issues may be more critical with these types of projects than with general HOV facilities. The type of payment method used will influence the extent of design modifications or changes. The use of a simple pre-paid hang tag, like those used during the initial phase of the I-15 project, may not require any design changes. On the other hand, the use of an automated payment system will require additional design considerations. The location and design of electronic toll tag readers, the possible use of toll booths, and other related elements will need to be addressed. The design features discussed in Section V and those associated with the Route 91 Express Lanes, the I-15 project, the Katy *QuickRide* demonstration, and existing toll facilities can all be used as models for a new project.

C. Design Considerations with ITS and HOV Facilities

A wide range of ITS technologies may be appropriate for use with HOV facilities. As discussed previously, ITS may enhance the operation and enforcement of HOV facilities and support services, improve the convenience and ease of use of transit and ridesharing, and provide real-time information to commuters. Further, HOV facilities are being used to test various elements of the Automated Highway System (AHS), and may be the location for the first deployment of the AHS.

Some ITS applications will influence the design features of HOV facilities while others will not. For example, the use of *Smart Cards* or GPS-based AVL systems by public transit operations will not impact the design of an HOV project. The deployment of automated enforcement technologies, AHS components, and ATMS, however, will require extra design considerations. Elements that may need to be considered with these and other ITS applications include the placement of cameras, video monitoring systems electronic lane demarcators, and related technologies. Many of these applications may have unique design impacts that will need to be addressed on a case-by-case basis. The design elements associated with these technologies should be considered within the approaches and guidelines suggested in this chapter. The deployment of any ITS technology should enhance, not degrade, the safe and efficient operation of an HOV facility.

D. Design Considerations with Truck Use of HOV Facilities

Allowing semi-trucks and other commercial vehicles to use an HOV lane would have a major impact on the design of a facility. As discussed previously in this chapter, buses and automobiles are currently used as the design vehicle for most HOV projects. If trucks are planned to be part of the vehicle mix allowed to use an HOV lane, they should be included in the design vehicle consideration.

A number of design elements will be influenced by allowing trucks to use an HOV facility. These include horizontal and vertical clearance, stopping sight distance, superelevation, cross slope, horizontal and vertical curvature, and the gradient. These and other design features should be examined carefully to ensure the safe operation of a facility if trucks are included in the allowed vehicle mix.

E. Design Considerations with Converting HOV Lanes to Fixed Guideway Transit Facilities

If an HOV lane is being planned in a corridor where travel demands are forecast to warrant a fixed guideway transit system in the future, consideration should be given in designing the facility so that conversion can occur or is at least not precluded. Design issues that may need to be addressed in this case include the design speed and design vehicle, on-line and off-line stations, access points for feeder buses and walk-up passengers, and connections to major activity centers. All of these factors may require additional right-of-way and other considerations in the design process.

These issues are not insurmountable and can be addressed during the planning and design stages if anticipated future demand warrants. There are probably a limited number of cases where future conversion to a fixed guideway system is a realistic alternative, however. For example, the Seattle bus tunnel was designed to allow for conversion to rail in the future if an LRT system is implemented in the area. Rails were incorporated into the tunnel pavement during construction to allow for easier transition to an LRT system in the future if needed. The Ottawa Transitway system has also been developed so as not to preclude an LRT system at a future date.

If it is anticipated that an HOV facility will be converted to rail at a future date, the design elements of both systems should be considered during the development of the initial design, and the requirements of the rail system should be incorporated to the extent practical and financially feasible. Consideration should also be given to any special design elements that will be needed during the conversion process.

F. Design Considerations for Slow Moving Vehicles

Providing free flow traffic conditions in an HOV lane is important to the success of a project. Maintaining travel time savings and travel time reliability for buses, vanpools, and carpools is critical to the ongoing operation of an HOV facility. Vehicles using the lane should travel at the posted speed limit to help ensure free flow conditions.

Slow moving vehicles, which may be caused by a number of different factors, can reduce the smooth operation of an HOV facility. First, individuals who are not familiar with the HOV facility or who are first time users may drive more cautiously than normal. Second, some motorists may naturally drive slower, especially if an HOV lane has reduced geometrics. Third, buses going up a grade travel at slower speeds than automobiles.

Special attention may need to be given to slow moving vehicles during the design process if the conditions noted above exist or other problems are anticipated. Appropriate design treatments can be examined to address these specific issues. Consideration could be given to providing a passing lane in areas with steep grades or where other conditions exist. For example, at least one state department of transportation recommends a passing lane along HOV facilities with sustained grades of greater than 4 percent for distances over .8 km (.5 miles). In many cases, right-of-way may not be available for passing lanes, however, and other operating strategies may need to be used, such as raising vehicle-occupancy requirements to reduce vehicle volumes.

IX. ADDITIONAL RESEARCH NEEDS

As discussed in this chapter, many agencies use formal design guidelines for HOV facilities on freeways and in separate rights-of-way, while other agencies use informal design practices. A number of design issues and concerns were identified by individuals responding to the survey and during the development of this Manual. Areas for additional research related to HOV facilities on freeways and in separate rights-of-way are discussed in this section. The research projects outlined here should be coordinated with the current standardization effort being undertaken by FHWA.

Assessment of Design Treatments for HOV Facility Access and On-Line Stations. The design of ingress and egress points associated with HOV lanes plays a significant role in the effectiveness of these facilities. The increased use of HOV lanes by buses and the development of multimodal links in urban transportation systems are also creating the need to explore on-line HOV station designs for mixed-vehicle use. A variety of ingress, egress, and on-line station design applications for HOV facilities are currently in operation throughout North America. This research would examine the issues associated with the safety and effectiveness of different design applications and would develop more detailed guidelines on the design of these facilities.

Assessment of Safety Aspects of Various HOV Lane Designs. As discussed in this Manual, a variety of design treatments are used with HOV facilities on freeways and in separate rights-of-way. These may include variations in the separation from the general-purpose travel lanes, the width of the separation, the terminal treatment, the presence or absence of median shoulders adjacent to HOV lanes, and other features that may affect the safety of the HOV and the general-purpose lane operation. Before and after comparisons, along with assessments of control freeways, are needed to document the impact of different design treatments on accidents and safety. This research study would examine the impact of various design treatments on safety issues, and would identify techniques to address specific concerns.

Assessment of Enforcement Design Treatments. The important role enforcement plays in successful HOV projects has been stressed throughout this Manual. A variety of enforcement areas, strategies, and design treatments are currently in use with HOV facilities throughout North America. Additional research is needed to examine the design issues associated with alternative enforcement approaches. This study would examine alternative designs for enforcement areas and other enforcement treatments, including design issues associated with the use of advanced technologies and remote enforcement. It would develop more detailed guidelines on designing various types of HOV enforcement approaches.

Assessment of Design Considerations for Part-Time Versus Full-Time HOV Facilities. Some HOV lanes are used only during the morning and afternoon peak-periods, while others are in operation during only one of the peak periods. These facilities revert to shoulders, general-purpose lanes, or other functions during the remainder of the day. Other facilities operate as HOV lanes on a 24-hour basis. Further research is needed on the design issues associated with part-time HOV facilities. This study should examine both reduced and full design standards, the issues associated with the use of different designs, and case study examples of various approaches. The study would develop more detailed guidelines on designing part-time HOV facilities that could be incorporated into future updates of this Manual.

Design Issues with Converting a General-Purpose Lane to an HOV Lane. This study would examine design elements associated with converting an existing general-purpose lane into an HOV lane. The design issues associated with the few existing projects, as well as previous efforts, would be reviewed, and the potential design consideration would be assessed. The results from the study would provide more detailed guidelines on design elements to be considered with lane conversion projects. The results could be incorporated into future updates of this Manual.

Assessment of Standardizing HOV Facility Signing and Pavement Markings. The use of different signing and pavement markings with HOV facilities in North America was discussed in this Manual. Additional research is needed to explore the potential to standardize these elements among various areas and states. This study would explore the issues associated with implementing a uniform approach. It would suggest a common set of signs and markings and would outline possible implementation techniques.

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12. Washington State Department of Transportation. *Design Manual—Section 1050, High-Occupancy Vehicle Priority Treatment.* Olympia, Washington: Washington State Department of Transportation.

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17. "Highway Capacity Manual." *Transportation Research Board Special Report 209.* National Research Council, Washington, D.C., Third Edition, 1994.

XI. ADDITIONAL INFORMATION SOURCES

The following sources also provide information on design elements related to HOV facilities.

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CHAPTER 7—OPERATION AND ENFORCEMENT OF ARTERIAL STREET HOV FACILITIES

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I. INTRODUCTION

This chapter discusses the operation and enforcement of HOV facilities on arterial streets. It describes the various approaches that can be used with arterial street HOV facilities, the advantages and disadvantages of different techniques, and the issues that may need to be considered with arterial street applications. It also outlines possible institutional issues associated with arterial street HOV facilities. The chapter is divided into the following nine sections.

- **Developing an Operation and Enforcement Plan for Arterial Street HOV Facilities**. Developing an overall plan for operating and enforcing an arterial street HOV facility should be the first step once a decision has been made to move forward with a project. This section discusses the agencies and groups that should be involved in this process and the various elements that should be included in an arterial street HOV operation and enforcement program. These elements are discussed in more detail in subsequent sections. An overview of the arterial street environment, the differences between freeways and arterial streets, and the influence these factors have on HOV operations on arterial streets is also provided. These include elements such as signalized intersections, transit stops, turning vehicles, pedestrians, driveways, on-street parking, and adjacent development.

- **Conceptual Alternatives for Arterial HOV Priority Treatments**. This section discusses alternatives for HOV priority treatments on arterial streets. Approaches examined include bus malls, bus-only lanes, HOV lanes, spot HOV treatments, signal queue bypasses, signal priority treatments, and bus stop treatments.

- **Vehicle Eligibility and Vehicle Occupancy Requirements**. This section examines alternative vehicle eligibility and vehicle occupancy requirements for arterial street applications. These include bus only facilities, as well as those open to buses, vanpools, and carpools. Different vehicle occupancy requirements are discussed, and the advantages and limitations of different approaches are identified. The minimum and maximum operating thresholds for various types of arterial street HOV facilities are also discussed, and general guidelines are presented for developing vehicle eligibility and vehicle-occupancy requirements.

- **Operating Hours**. This section discusses the various operating hours that are frequently used with arterial street HOV facilities. These include 24-hour operations, peak-period operations, and other alternatives. The advantages and disadvantages of different alternatives are summarized.

- **Enforcement**. This section discusses enforcement of arterial street HOV facilities. Topics covered include the role of enforcement policies and programs, enforcement strategies and procedures, violation penalties, and the development, implementation, and operation of enforcement plans.

- **Incident Management**. This section discusses incident management on arterial street HOV facilities. Incident management is addressed from two points of view—clearing incidents on arterial street HOV lanes and the use of arterial street HOV facilities to assist with incident management on the mix-traffic lanes. Guidelines for the development of an incident management plan are presented.

- **Ongoing Maintenance of Arterial Street HOV Facilities**. This section discusses the ongoing maintenance of arterial street HOV facilities. Topics addressed include routine cleaning and maintenance, snow removal, and more extensive repairs or improvements.

- **Intersection Control, Driveway Access, and Curb Use Considerations**. A number of elements related to intersection control, driveway access, and curb use may need to be addressed with arterial street HOV facilities. This section discusses these elements and the various approaches and techniques that can be used to overcome any potential issues. Topics covered include intersection control, approaches for addressing turning movements of other vehicles, on-street parking, transit stops, and pedestrian and bicycle considerations.

- **Additional Research Needs**. The chapter concludes with a discussion of further research needs related to operating and enforcing arterial street HOV facilities.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information on operating and enforcing arterial street HOV projects.

II. DEVELOPING AN OPERATION AND ENFORCEMENT PLAN FOR ARTERIAL STREET HOV FACILITIES

A. Groups Involved in Developing an Operation and Enforcement Plan for Arterial Street HOV Facilities

Similar to the planning phase for an arterial street HOV facility, numerous agencies and groups will be involved in developing the operation and enforcement plan for a project. The participation of the appropriate agencies and individuals is key to ensuring that all groups are involved in discussing the different operational strategies and enforcement techniques, that potential issues are identified and resolved prior to implementation, and that all groups have a common understanding of the project.

If a multi-agency team or a multi-department team within an agency was formed during the planning phase of a project, this group may continue through the development of the operation and enforcement plan. A special subgroup or committee, comprised of the operation and enforcement personnel from various agencies, may be formed to ensure that the individuals responsible for operating and enforcing the arterial street HOV facility are involved in developing the plan. In addition, consideration should be given to other groups that may need to be involved or consulted, such as members of the judicial system responsible for enforcing fines or penalties.

Table 7-1 identifies the various agencies and groups that should be considered for inclusion in the development of an arterial street HOV operation and enforcement plan. The roles and responsibilities of each group are highlighted in the table and described in more detail below. Practitioners can use the information in Table 7-1 as a guide to help ensure that consideration has been given to including the various groups in the development of the recommended operation and enforcement plan. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

Local Municipalities. City or county departments often have the lead responsibility on arterial street HOV facilities. As the lead agency, the city or county may be responsible for all aspects of a project including planning, designing, implementing, operating, and maintaining an arterial street HOV facility. In these cases, the local municipalities would also head the multi-agency team and would take the lead in the development of the operation and enforcement plan. In other cases, a transit agency may have overall responsibility for an arterial street project. City or county personnel still usually play a major role even in these cases, however, as they have authority over the local street and traffic signal systems. The engineering and planning departments most frequently are responsible for these activities, although staff from other departments may also be involved.

Transit Agency. A transit agency may have the lead responsibility with HOV facilities on arterial streets or may be a co-sponsor of a project. In either case, the transit agency usually works closely with the local municipality that has jurisdiction over the street and traffic signal systems. If the transit agency has the overall responsibility for the project, they will also have the lead role in developing the operation and enforcement plan. If the transit agency is playing more of a supporting role, key responsibilities may focus on the bus operations, enforcement, and overall project coordination.

State Department of Transportation. The state department of transportation or the state highway department may be a supporting agency with arterial HOV facilities on city or county roadways, especially if the project provides a link from a freeway HOV lane. The state may have the lead role with HOV projects on state-owned arterial streets. Representatives from the state may be involved in the multi-agency team or may provide assistance throughout the development, implementation, and operation of arterial street HOV projects.

Table 7-1. Agencies and Groups Involved in Development of an Operation and Enforcement Plan for an Arterial Street HOV Facility

Agency or Group	Potential Roles and Responsibility
Local Municipalities	• Overall project management responsibilities. • Major supporting role if transit agency is lead. • Developing or assisting with operation and enforcement plan. • Operating facility. • Staffing multi-agency team or participating on team.
Transit Agency	• Overall project management or supporting role. • Developing or assisting with operation and enforcement plan. • Operating and enforcement facility or focus on bus operations. • Staffing multi-agency team or participating on team.
State Department of Transportation	• Assist with operation and enforcement plan on city and county roads. • Lead role on state roadways. • Coordinate with freeway HOV facilities. • Participate on multi-agency team.
State and Local Police	• Assist with development of operation and enforcement plan. • Enforcement of facility. • Coordination with judicial personnel.
Rideshare Agency	• Assist with development of operation and enforcement plan if project includes vanpools and carpools. • Participate on multi-agency team.
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multi-agency coordination. • Ensure that projects are included in necessary planning and programming documents. • May have policies relating to HOV facilities.
Federal Agencies—FHWA and FTA	• Funding support. • Technical assistance. • Possible approval of various steps. • Participate on multi-agency team.
Other Groups	• Judicial system—local courts. • EMS, fire, and other emergency personnel. • Tow truck operations. • Businesses. • Delivery companies and vendors. • Neighborhood groups. • Schools, hospitals, and other land uses in the area.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities was stressed earlier in this Manual. Representatives from the state, city and county police departments should be involved in the development of an operation and enforcement plan for an arterial street HOV facility. Depending on the roadway classification, one of these agencies is usually responsible for enforcing arterial street HOV projects and may take a lead role in the development of the enforcement section of the plan.

Rideshare Agency. The rideshare agency in an area may be involved in the development, implementation, and operation of an arterial street HOV project if the facility will be open to carpools and vanpools. In these cases, the rideshare agency should be included as a member of the multi-agency team and should be involved in the development of the operation and enforcement plan.

Metropolitan Planning Organization (MPO). Representatives from the MPO may participate on the multi-agency team and may provide assistance with the development, implementation, and operation of arterial street HOV projects. Involvement of MPO staff may depend on the nature and scope of a project and the link to metropolitan-wide facilities.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least to monitor the development of arterial street HOV facilities, including the operation and enforcement plan. Personnel from these agencies may provide technical assistance on specific issues or suggestions on how certain elements have been addressed in other areas. Representatives from FHWA and FTA often participate on the multi-agency team.

Other Groups. Consideration should be given to including representatives from other groups or obtaining their input during the development of the operation and enforcement plan for an arterial street HOV facility. These may include representatives from the local judicial system who will be responsible for enforcing fines and citations; EMS, fire, and other emergency personnel who have to respond to incidents and accidents on the facility; tow truck operators who may be responsible for removing disabled vehicles; business; delivery companies and vendors; and neighborhood groups. Involving representatives from businesses and neighborhood groups may be especially important if the project will impact on-street parking or other elements.

B. Elements of an Arterial Street HOV Operation and Enforcement Plan

A number of elements or factors should be considered in the development of a plan for operating and enforcing arterial street HOV facilities. These elements relate to the type and design of a project, intersection control and driveway access, the vehicles allowed to use the facility, the vehicle-occupancy requirement, the hours of operation, enforcement techniques and strategies, incident management techniques, and special operating considerations. These elements are discussed briefly in this section and are described in more detail in the remaining sections of the chapter.

HOV Operational Alternatives. The type of arterial street HOV treatment being considered will influence the operation and enforcement plan. For example, the operating strategies for a contraflow bus-only lane will be much different than those used with a curb HOV lane or a signal priority strategy. The enforcement requirements and techniques will also vary based on the nature of the arterial street HOV facility.

Vehicle Eligibility and Vehicle-Occupancy Requirements. The types of vehicles allowed to use an HOV facility and the number of people required in a vehicle will influence the operation and enforcement of a project. Issues to be considered in determining the appropriate vehicle mix and occupancy requirement include safety, demand, project objectives, and special features.

Hours of Operation. The operation and enforcement plan should identify the anticipated hours the HOV facility will be open for use. Arterial street HOV facilities may be operated on a 24-hour basis, during major portions of the day, or only during the peak-periods. The plan should also detail how the facility will be used during non-HOV operation periods. Options may include allowing general-purpose traffic to use the facility, allowing parking and delivery vehicles, or other alternatives. The type and orientation of the HOV facility will influence the hours of operation.

Enforcement. A major element of the plan should focus on the enforcement strategies to be used on the facility. Elements that should be included in this portion of the plan include the enforcement techniques, design features, violation penalties and fines, and roles and responsibilities of the various police agencies. The development of the enforcement plan should include communication and coordination with representatives from the state and local judicial systems to ensure that citations will be upheld in court.

Incident Management. The incident management portion of an operation and enforcement plan for an arterial street HOV project may be simpler than for freeway facilities. The plan should still include two components. The first should outline the procedures and techniques that will be used to respond to incidents and accidents on the HOV facility. The second element should focus on whether or not the HOV lane will be used to help manage incidents and accidents on arterial street general-traffic lanes, and if so, the procedures and techniques that will be used in these instances.

Intersection Control, Driveway Access, and Curb Use Considerations. The approaches used to control turning movements at intersections and driveways, as well as curb considerations, will influence the operation and enforcement of an arterial street HOV lane. These elements are closely linked to the type of facility being considered and the characteristics of the corridor.

C. Overview of Arterial Street Environments and HOV Operations

The operating environment on arterial streets is much different from freeways. These differences relate primarily to the functions of freeways and arterial streets. Freeways are intended to serve long distance trips. As a result, they are designed to accommodate travel speeds of 55 to 70 miles per hour (mph). Freeways also have limited access points to help maintain a high volume of traffic.

Arterial streets, on the other hand, provide access to local streets and businesses. Arterial streets are designed to operate at travel speeds of 35 to 50 mph. Further, arterial streets have signalized intersections, and often have driveway access for businesses and other land use activities. The curb lane on many arterial streets is reserved for some combination of parking, delivery vehicles, and bus stops. Bicycles may also be allowed to use the curb lane in some areas.

In addition, arterial streets are found within a wide range of settings and environments in an urban area. These include the downtown or central business district, suburban activity centers, neighborhood commercial areas, strip development corridors, and major commuter travel corridors. These areas all have different characteristics, which need to be considered in planning, designing, and operating arterial street HOV facilities.

All of these elements, which provide a much different environment from a freeway, must be considered in the development, operation, and enforcement of arterial street HOV facilities. The intent of HOV projects on arterial streets is similar to those on freeways and in separate rights-of-way—that is to provide travel time savings and travel time reliability to buses, vanpools, and carpools. To accomplish these objectives, arterial street HOV facilities need to be coordinated with the other functions and elements of the roadway system. These include driveway access to businesses, schools, hospitals, and other land uses; signalized intersections; left and right turns for non-HOV traffic; on-street parking; delivery vehicles; pedestrians and bicyclists; and buses stopping to drop off and pick up passengers.

As discussed in the next section, a wide range of HOV strategies can be used in the arterial street environment. These include HOV facilities located in the curb lane, the second lane, and in the roadway median. Other potential approaches include spot or queue-jumper treatments, traffic signal phasing plans, traffic signal priority treatments, and bus stop treatments. These approaches may be focused on buses-only or on buses, vanpools, and carpools.

Since arterial street HOV facilities may require changes in on-street parking, loading zones, and turn restrictions, a larger group of constituents often needs to be involved in the planning process, as well as developing the operation and enforcement plan. As noted previously, representatives from the major businesses, schools, neighborhoods, and other groups should be involved throughout all phases of planning, implementing, and operating an arterial street HOV facility.

III. ARTERIAL STREET HOV OPERATIONAL ALTERNATIVES

This section discusses the operational alternatives that are commonly found with different arterial street HOV treatments. The various types of HOV lanes and traffic signal strategies are described, and the advantages and disadvantages of different approaches are summarized. More detailed information on the design considerations associated with the various treatments is presented in Chapter 8.

In most cases, arterial street HOV facilities utilize existing travel or curb lanes rather than adding new lanes. Figure 7-1 illustrates the basic types of arterial street HOV lanes. Many projects use the curb or parking lane for a portion of the day, while a few projects have converted a general-purpose travel lane. As discussed in this chapter, both of these conditions require special attention to the needs and safety of other user groups. These may include motorists, delivery vehicles, bus riders, pedestrians, and bicyclists.

A. Bus Malls

Bus or transit malls are streets that are reserved exclusively for use by public transit vehicles. Most facilities provide access for emergency vehicles, however, and some allow taxis. Transit malls are usually found in downtown areas, although some are located in major suburban activity centers. Existing bus malls range in length from only a few blocks to major facilities covering 10 to 15 blocks. Many malls include passenger amenities, such as waiting areas, information kiosks, and other elements. A number of cities developed transit and pedestrian malls in the 1970s. Some of these facilities have been removed or modified, but a number are still in operation. Examples of successful bus malls are found in downtown Denver, Minneapolis, Madison, Indianapolis, Des Moines, Portland, Ottawa, and Vancouver. Figure 7-2 highlights the 16th Street Mall in Denver, and Figure 7-3 shows the Nicollet Mall in Minneapolis.

Bus malls provide a number of benefits to transit operators. These facilities can provide a high level of service for bus operations and a focal point for transit within an area. Dedicated primarily to buses, these facilities can enhance the flow of transit vehicles through a congested downtown area or other major activity center. Additional benefits may be realized through coordinated traffic signal phasing or providing priority for buses at signalized intersections.

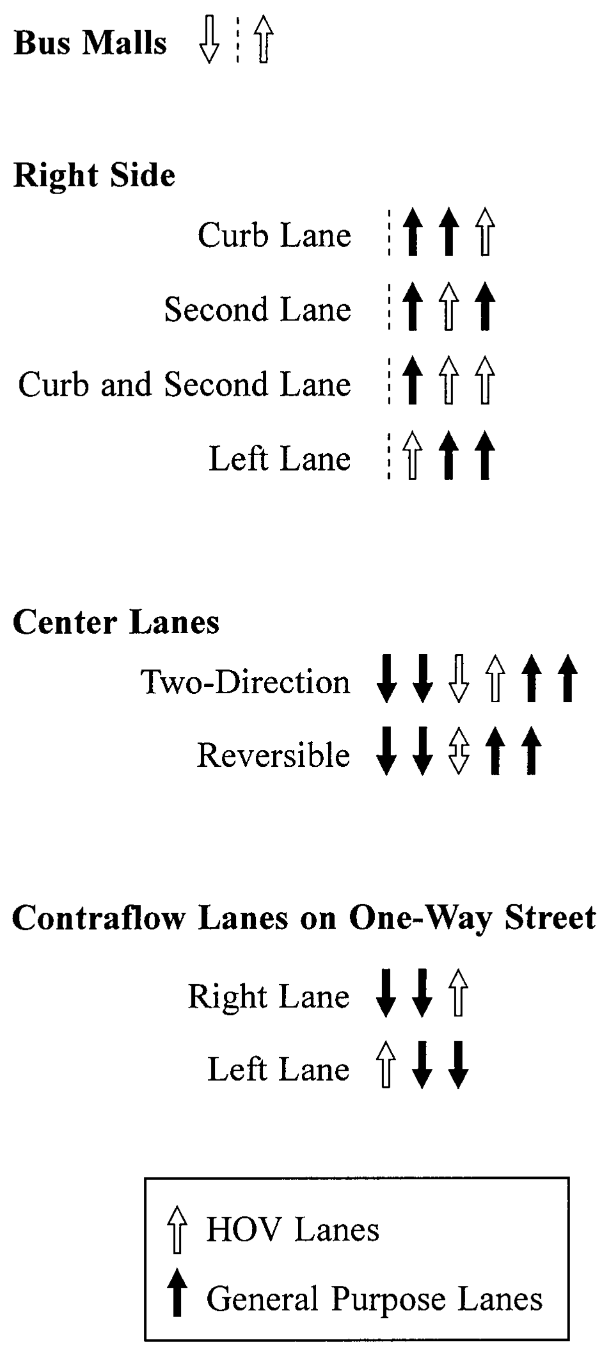


Figure 7-1. Arterial Street HOV Lane Operating Concepts

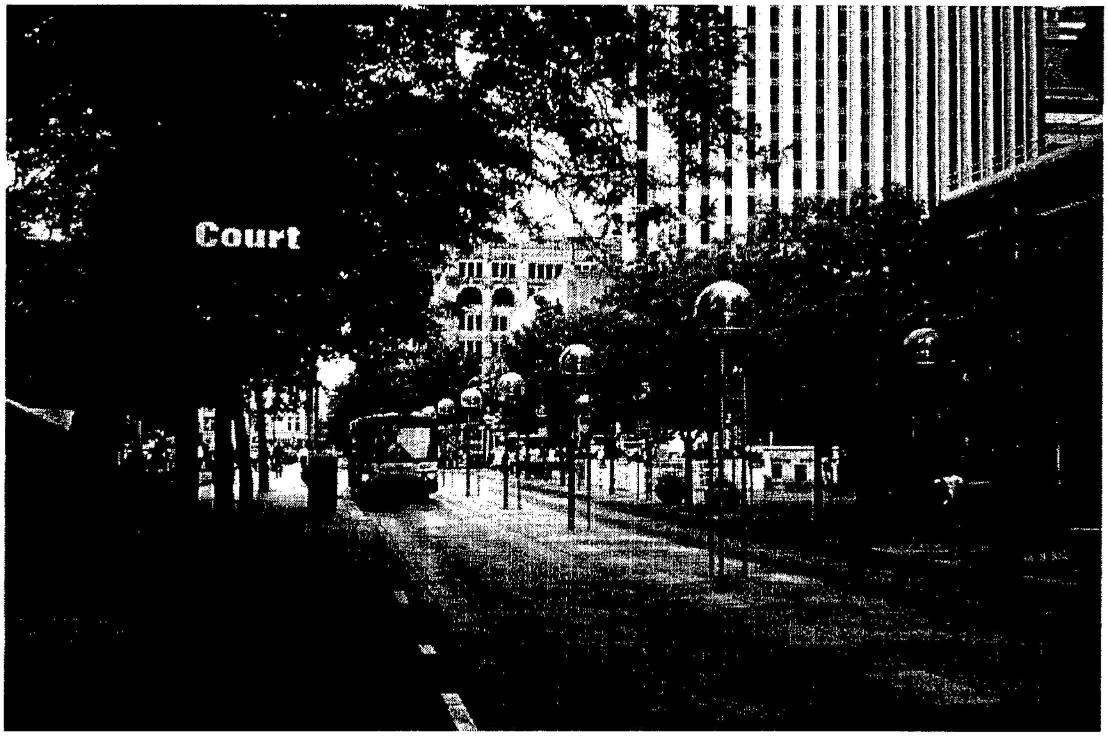


Figure 7-2. 16th Street Mall in Denver

Figure 7-3. Nicollet Mall in Minneapolis

Bus malls allow transit agencies to consolidate routes along one street. This approach can both enhance bus operations and make it easier for riders and potential passengers to use the system. In addition, other approaches such as the Denver Mall Shuttle system can be implemented. In Denver, bus terminals were constructed at both ends of the 16th Street Mall. Regional, express, and some local buses terminate at these stations, and passengers transfer to the free shuttle buses that operate along the mall. Frequent service is provided on the shuttle buses, with headways of 60 to 90 seconds during most of the day.

Transit malls may be appropriate to consider in major activity centers with high bus volumes and congested streets. Capacity must exist on the remaining street system, however, so that general-purpose traffic is not negatively effected. In many cases, bus malls have been one part of a larger downtown re-development program. Experience indicates that transit malls alone are not enough to reinvigorate declining activity centers. The successful malls do indicate, however, that this approach can be a critical component of a downtown plan.

The capital costs associated with bus malls may limit the application of this technique. The exact cost will depend on the specific elements included in a project. Variables that may influence capital costs include the length of the facility, modifications in street or sidewalk design, the number and type of passenger waiting areas or bus stations, links to buildings or skywalk connections, passenger amenities, trees, and other street furniture or enhancements.

B. Right Side Bus-Only and HOV Lanes

This type of HOV facility uses the right side lane on an arterial street for an HOV lane. The curb lane or the second lane may be used for HOVs. This approach is the most common application of HOV lanes on arterial streets. Right side HOV lanes may be open only to buses or buses, vanpools, and carpools may be allowed.

Bus-only lanes are found in many downtown areas. These facilities commonly operate only during the morning and afternoon peak-hours and help move buses through congested downtown areas. New York City has an extensive system of bus-only lanes in the downtown area. In some cases, these facilities operate as bus lanes only during the peak-periods, while in other cases they are reserved for bus use from 7:00 A.M. to 7:00 P.M. or 8:00 A.M. to 6:00 P.M. Longer distance bus-only lanes are also found in some areas, including Tucson, Pittsburgh, and Toronto.

Right side lanes open to buses, vanpools, and carpools are also in operation in a few areas. These include the San Tomas and Montague Expressways in San Jose; arterial streets in Toronto; North Washington Street in Alexandria, Virginia; and SR 99, and Airport Road/128th Street in the Seattle area.

Right side HOV lanes are compatible with transit boarding patterns, may provide easy connections with freeway access ramps, and may be less disruptive to intersection turning movements than other applications. Issues associated with right-side HOV lanes may include the need to address on-street parking, stopping areas for delivery vehicles, enforcement, turning movements at driveways and intersections, and potential conflicts between bus operations (i.e., bus stops) and carpool and vanpool movement. The following descriptions highlight the major characteristics, advantages, and disadvantages of different types of right-side arterial street HOV lanes.

1. **Curb Lane Bus-Only Facilities**. This approach utilizes the curb lane for buses-only during a portion or all of a day. This technique is commonly found in many downtowns as a way of helping move buses through congested areas. Figure 7-4 illustrates a bus-only curb lane in downtown Dallas, and Figure 7-5 provides an example of the signing used for the HOV lanes in downtown Toronto. In these cases, the curb lane is often reserved for buses-only during the morning and afternoon peak-periods. During other times of the day, parking, delivery vehicles or general traffic may be allowed to use the lane. A few longer distance bus-only curb lanes are currently in use. Examples of this approach include SR 522 in Seattle, Broadway Boulevard and 22nd Street in Tucson, Fifth Avenue in Pittsburgh, and a number of streets in the Toronto area.

   This type of arterial street HOV facility is appropriate for consideration in areas and corridors with relatively high volumes of buses and high levels of traffic congestion in the general-purpose lanes. Bus-only lanes can help speed the movement of transit vehicles through congested areas, providing increased operating efficiencies for transit agencies and travel time savings and improved travel time reliability for transit riders. Potential issues with this technique may include addressing the need for other vehicles to use the lane to make right turns at intersections or at other access points, illegally parked or stopped vehicles in the lane, and concerns by businesses about the loss of on-street parking and space for delivery vehicles. Figure 7-6 illustrates a potential conflict with an automobile in the curb bus lane in downtown Hartford, Connecticut.

2. **Bus-Only Facilities Using the Second Travel Lane**. A variation on the use of the curb lane is found in Ottawa, Ontario. As illustrated in Figure 7-7, in downtown Ottawa, the second lane from the curb is used as a bus-only lane on two parallel one-way streets. The use of the second lane, called the *Fast Acting Lanes*, leaves the curb lane open for buses to stop to pick-up and drop-off passengers, as well as for other functions. The *Fast Acting Lanes* connect to the Transitway at both ends of the downtown.

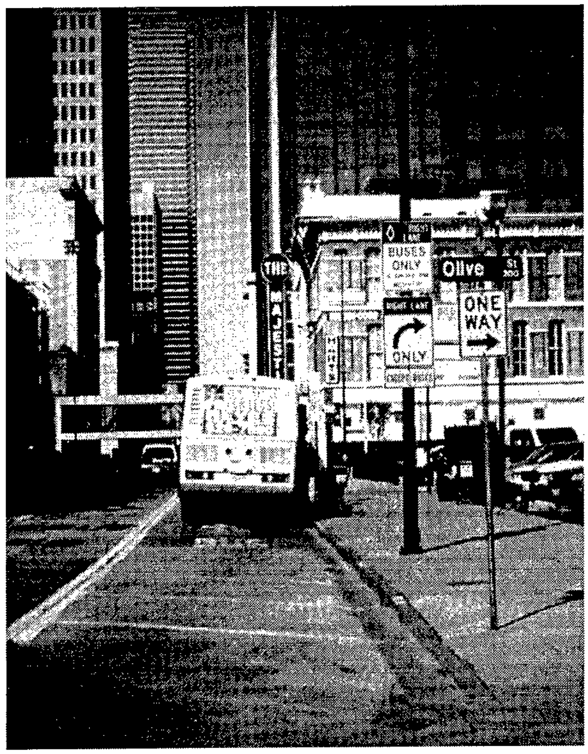


Figure 7-4. Downtown Dallas Bus-only Lane

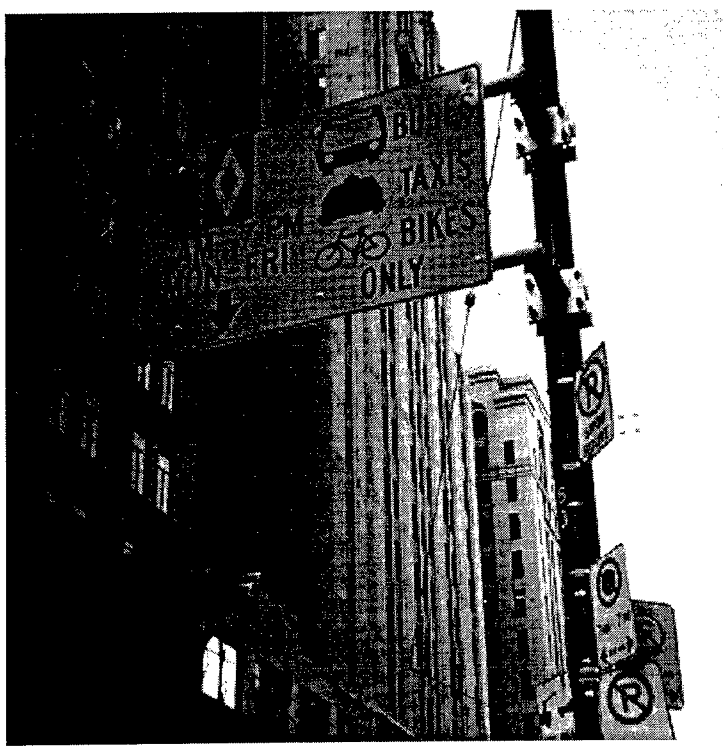


Figure 7-5. Example of Sign in Downtown Toronto for Bus Lane

Figure 7-6. Curb Bus Lane in Downtown Hartford, Connecticut

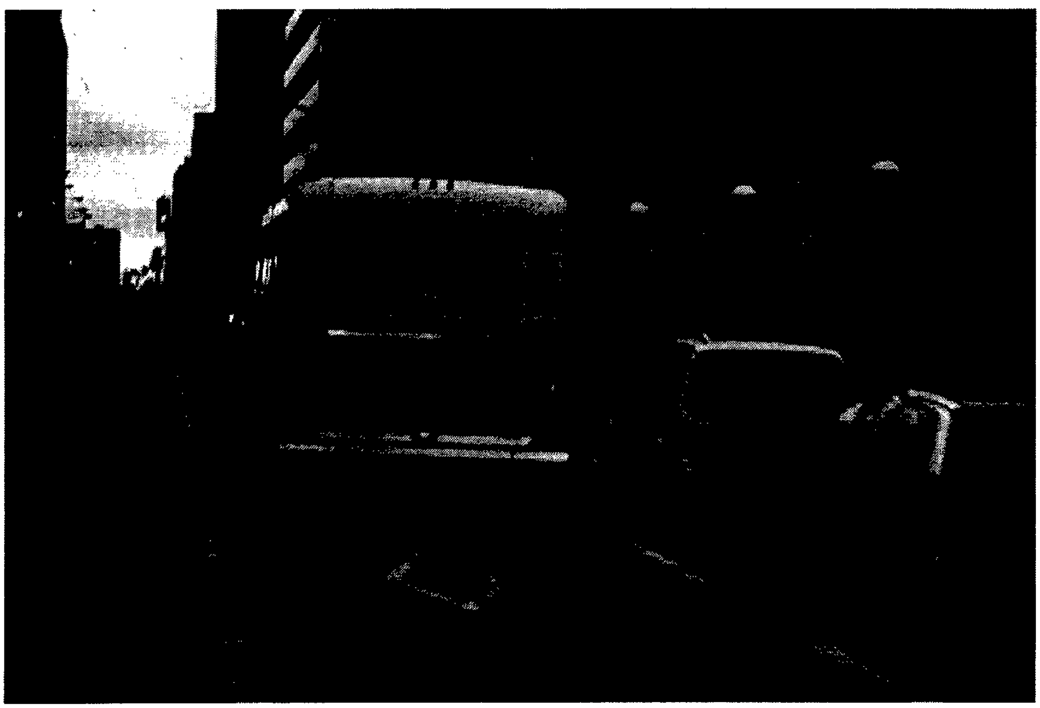


Figure 7-7. Fast Acting Lane in Downtown Ottawa

This approach may be appropriate for consideration in areas and corridors with high volumes of buses. It may also be a logical technique to use in downtown areas to link with other HOV facilities, such as the Ottawa Transitway. By maintaining the curb lane for other functions, such as stopping buses, delivery trucks, turning vehicles, and parking, this approach may eliminate some of the potential conflicts associated with other arterial street HOV techniques. Capacity must be available on the roadway, however, so that the general-purpose lanes are not adversely effected.

A bus-only second lane may be combined with a bus-only curb lane to provide extra capacity for buses. Figure 7-8 provides one example of this approach in New York City. This technique allows buses to pass other buses stopped in the curb lane to drop-off and pick-up passengers.

3. **Curb Lane HOV Facilities**. This type of HOV treatment provides priority lanes on arterial streets for buses, vanpools, and carpools. Only a few examples of this technique are currently in operation. These include the San Thomas and Montague Expressways in San Jose, Dundas Street in the Toronto area, North Washington Street in Alexandria, SR 99 and Airport Road in the Seattle area, and Hastings Street in Vancouver. In some cases, these facilities may be called HOV emphasis lanes depending on the exact operating guidelines. Figure 7-9 illustrates the HOV lane on the San Thomas Expressway in San Jose.

   This approach may be appropriate for consideration in corridors with high volumes of carpools and vanpools. It may also be a viable alternative to link freeway HOV facilities to a downtown area or to other major activity centers. Possible drawbacks to arterial street lanes open to all HOVs include addressing the needs of other curb lane users and turning vehicles, and not degrading the general-purpose lanes. In addition, conflicts may emerge between buses and carpools and vanpools unless bus-bays or pull-ins are provided for buses. Without these facilities, buses have to stop in the HOV lane to drop-off and pick-up passengers, causing delays to carpools and vanpools. Another possible issue with this approach may be HOVs weaving across the general traffic lanes to make a left turn.

4. **Second Lane HOV Facilities**. This type of HOV treatment uses the second lane from the curb as an HOV lane. As noted previously, the *Fast Acting Lanes* in downtown Ottawa represent an example of this approach for buses-only. This technique would require converting a general-purpose traffic lane to an HOV lane. The HOV lane on Airport Road in the Seattle area uses the second lane for a short section when the right lane becomes a right-turn only lane and drops at a downstream intersection.

Figure 7-8. Bus Only Curb and Second Lanes in New York City

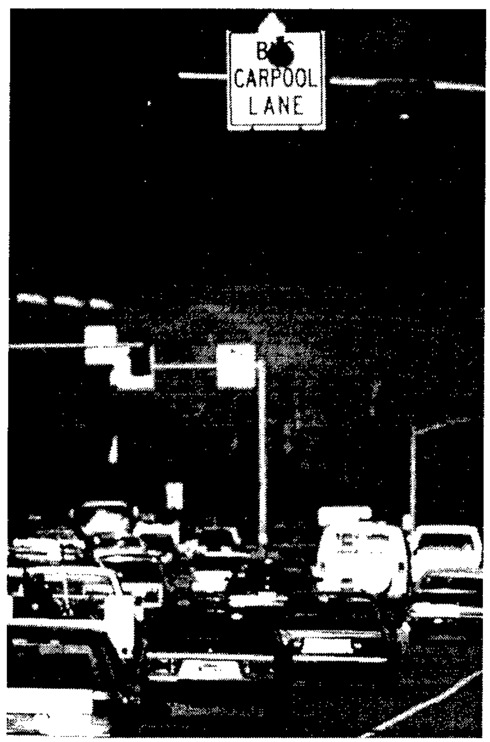


Figure 7-9. HOV Lane on the San Thomas Expressway in San Jose

A major advantage of this approach is that the curb lane can be maintained for on-street parking, delivery vehicles, bus stops, right turns, and other functions. The major issues with using the second lane include ensuring that available capacity exists on the roadway to not degrade the remaining general traffic lanes and addressing right-turn movements.

C. Left-Side Bus-Only and HOV Lanes

Left-side HOV lanes are a less common application of HOV lanes on arterial streets. Operating an HOV facility in the left lane of an arterial street eliminates the potential traffic conflicts related to curb lanes, such as on-street parking, delivery vehicles, and right turn movements at driveways and intersections. These advantages may result in higher travel speeds and reduced stops and delays for HOVs. As a result, this approach may be appropriate for longer-distance HOV facilities. Potential issues with this technique include accommodating left-turns for general traffic, as well as HOVs weaving across the general traffic lanes to make right turns. This treatment may also present significant problems to transit operations if buses must pull over to the curb to pick up and drop off passengers. An alternative is to provide passenger waiting platforms adjacent to the left lane, which requires additional right-of-way and capital expenditures.

D. Center Bus-Only and HOV Lanes

Center HOV Lanes. This type of facility provides bus-only or HOV lanes in the center of an arterial street. A number of different treatments can be used with this approach, including a single reversible lane or lanes in both directions. Further, the lanes may be physically separated from the general-purpose lanes or paint striping can be used.

1. **Two-Directional Center Bus-Only and HOV Lanes**. This approach provides an HOV lane in each direction of travel in the center of a roadway. Different treatments may be used to separate the HOV lanes from the general-purpose lanes, including barriers or paint striping. The two-way bus-only lanes in the median of Canal Street in downtown New Orleans, illustrated in Figure 7-10, provide one example of this approach. In addition, this approach is used with some LRT systems indicating its appropriateness for consideration with HOV facilities.

   Center HOV lanes eliminate many of the problems noted previously with curb HOV facilities. Potential problems with this approach include accommodation of left-turns by general-purpose traffic at intersections, providing bus stops in the center of a roadway, and other possible issues.

Figure 7-10. Center Bus-only Lanes on Canal Street in Downtown New Orleans

2. **Reversible Center Bus-Only and HOV Lanes**. This approach provides a reversible HOV lane in the center of a roadway. The lane may be open only to buses or buses, carpools, and vanpools and may be separated from the general-purpose lanes by barriers, buffers, or paint stripes. A reversible HOV lane may also be appropriate to consider in some areas or situations. For example, as illustrated in Figure 7-11, an interim reversible center HOV lane was used on the Highway 12/I-394 project in Minneapolis to help manage traffic during the multi-year construction period and to introduce the HOV concept to commuters in the corridor. A related approach is used on the Kalanianaole Highway in Honolulu, Hawaii, where a contraflow HOV lane is in operation.

   A reversible center HOV lane may be appropriate for consideration on an arterial street with a high directional split. This approach may have less negative impacts on general traffic lanes than other techniques. Possible limitations with reversible lanes include accommodating left turns from the general-purpose lanes at intersections, the operating costs and personnel needed to open and close the facility, access treatments for HOVs to enter and exit the lane, the potential for vehicles to enter the lanes in the wrong direction of travel at intersections, and passenger access. Accommodating left turns for general traffic at intersections may require an additional phase on the traffic signal cycle. For example, on the I-394 interim HOV lane, left turns from the general purpose lane were allowed before the HOV lane traffic was given the green phase and left turns were prohibited from the HOV lane. Although this approach accommodated left turns for general-purpose traffic, it also gave HOV users the perception that they were losing time since the general traffic lanes started first.

E. Contraflow Bus-Only or HOV Lanes on One-Way Arterial Streets

This approach uses a lane on a one-way arterial street for buses-only or HOVs operating in the opposition direction of travel. Currently, the only facilities of this type in North America are restricted to buses-only and operate in downtown areas. Examples of contraflow arterial street bus lanes are found on Spring Street in downtown Los Angeles and on Marquette, Second, and Hennepin Avenues in downtown Minneapolis. As illustrated in Figures 7-12 and 7-13, these lanes are separated from the general-purpose traffic lanes by special curbs, striping, and signs.

Arterial street contraflow lanes can be an effective approach for moving high volumes of buses and HOVs through a congested area, such as a downtown or a major activity center. This technique, which is fairly common with LRT systems, can provide benefits to transit operations by increasing the speeds of buses and enhancing travel time reliability. Routes can also be consolidated onto the contraflow lane, simplifying operations and providing a focal point for passengers.

Figure 7-11. Interim HOV Lane on Highway 12/I-394 in Minneapolis

Figure 7-12. Contraflow Bus-only Lane on Spring Street in Downtown Los Angeles

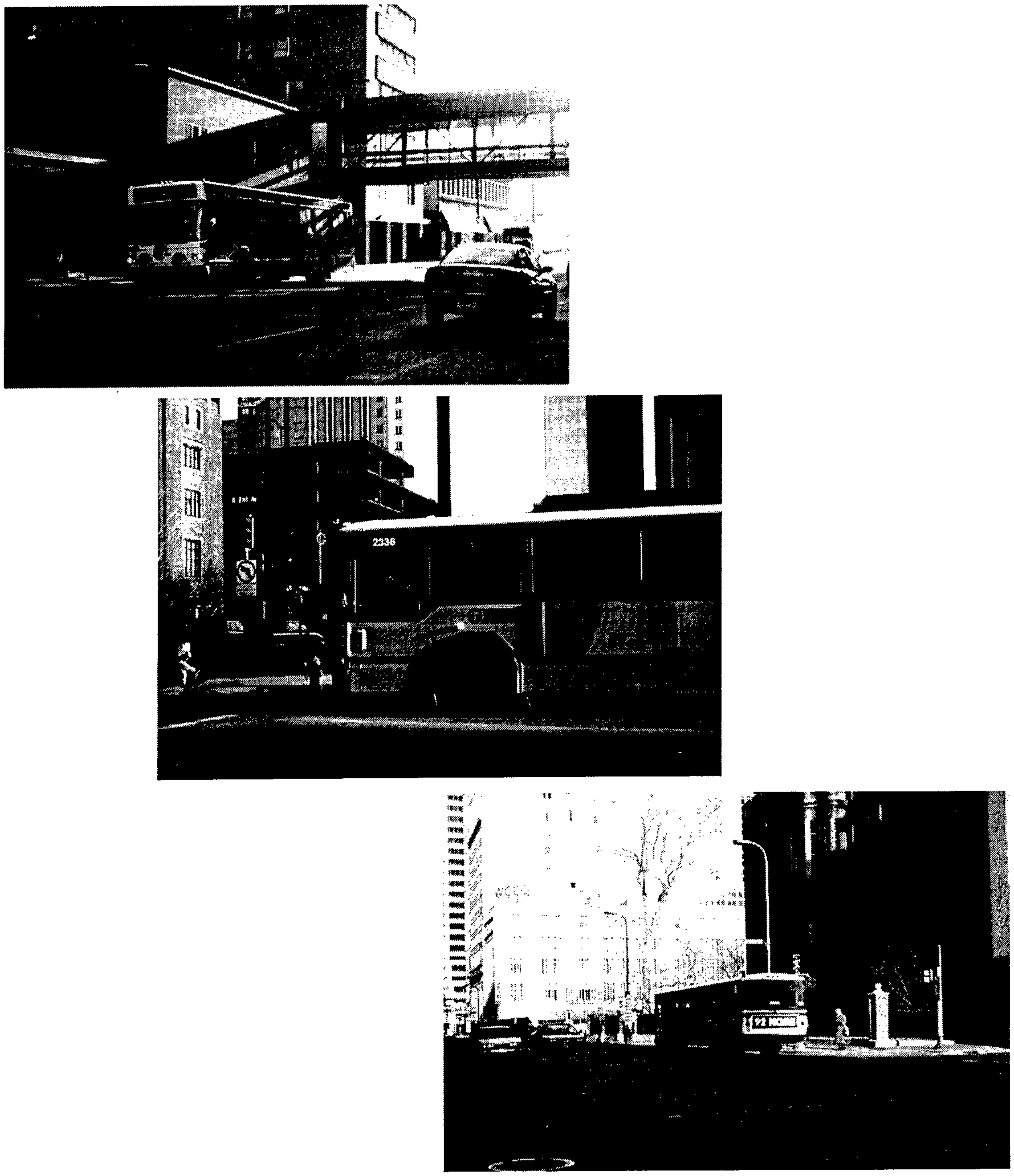


Figure 7-13. Contraflow Bus-only Lane in Downtown Minneapolis

One potential limitation with this approach is ensuring that capacity exists on the street system so that general-purpose travel is not degraded. Also, possible conflicts may emerge with access to buildings, alleys, and parking garages. Consideration will need to be given to allowing or restricting turns by general-purpose traffic at intersections. Pedestrians and other vehicles must also be alerted that buses will be traveling in the opposite direction. Additionally, the bus lane should be positioned to facilitate safe and efficient passenger access.

F. Spot HOV Treatments

A number of treatments may be used to give buses or HOVs priority around a specific bottleneck or with special access to a facility. These techniques can provide HOVs with travel time savings, enhanced travel time reliability, and improved access to specific developments or activity centers. The following highlight a few examples of the types of HOV spot treatments that may be appropriate for consideration on arterial streets. Other approaches may emerge during the planning process in specific areas. The key for transportation professionals is to match the best strategy to the specific issue or opportunity in an area.

1. **Bus-Only or HOV-Only Access**. Special access for buses-only or HOVs-only may be provided at a specific location. For example, a short arterial street lane or other treatment could be used to provide HOVs with direct or preferential access to a freeway entrance ramp, a park-and-ride facility, a major activity center, or a specific development. These facilities could be part of a larger HOV network, such as providing priority access from an arterial street to a park-and-ride lot which has direct connections to a freeway HOV lane, or as stand-alone treatments.

   One example of an existing HOV spot treatment is the HOV lanes approaching the ferry loading areas in the Puget Sound region. Figure 7-14 illustrates an HOV lane at one of the Washington State Ferry Terminals. Vehicles in these lanes are given priority entering and exiting the ferries. This priority provides significant time savings and can ensure HOVs access to crowded ferries.

2. **Buses or HOV Turn-Only Lane or Part of Dual Turn Lane**. Allowing buses or HOVs only to turn left or right at designated intersections represents another spot treatment. A second possible approach would reserve one lane of a dual left or right turn lane for HOVs only. These techniques can provide HOVs with significant travel time savings at congested intersections or direct access to a major activity generator, adding further incentives to individuals to use an HOV mode.

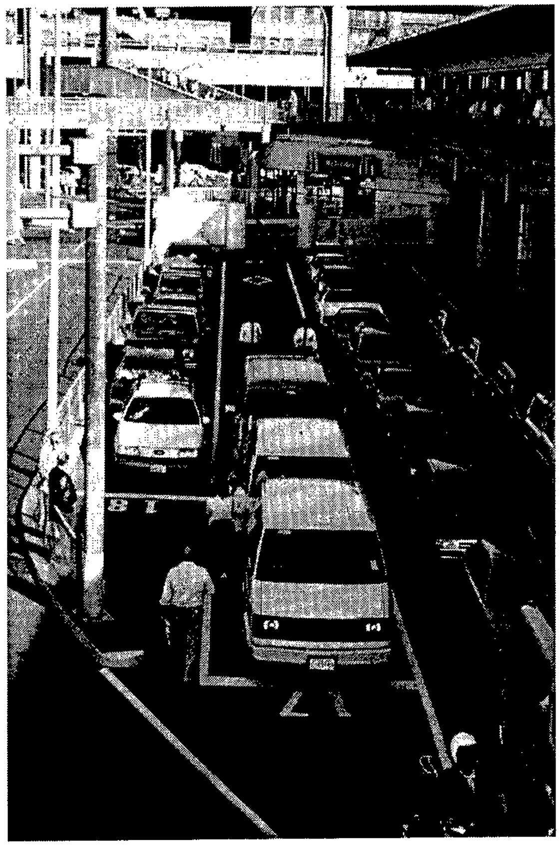
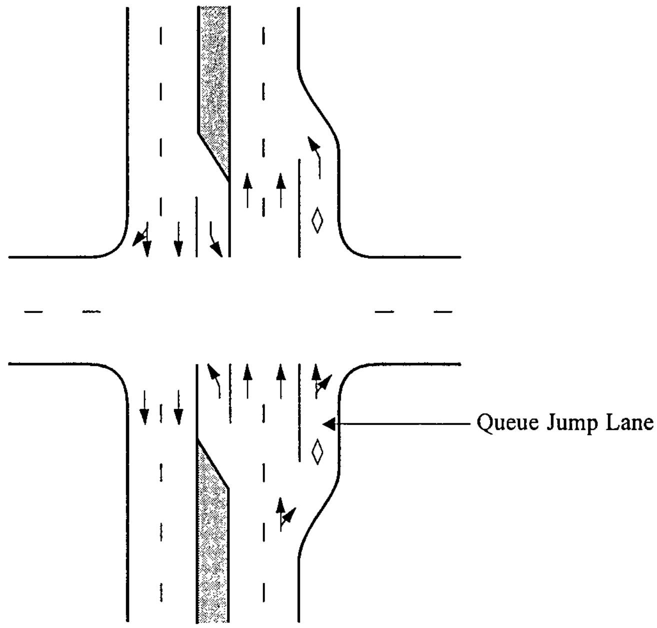


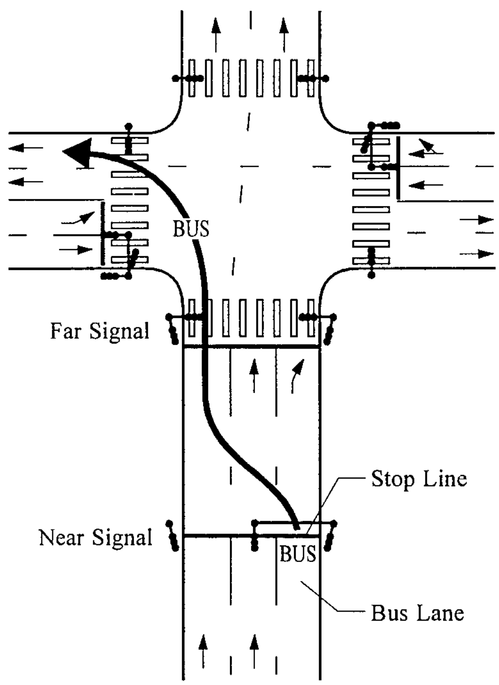
Figure 7-14. HOV Lane at Washington State Ferry Terminal

G. Signal Queue Priority

Another set of techniques which may be appropriate for consideration on arterial streets focus on providing priority for HOVs at signalized intersections through queue jump lanes or other approaches. Since traffic signals represent a major source of delay on arterial streets, time savings can be provided by allowing HOVs to bypass the queues at signals. The current use of these approaches are directed primarily at public transit vehicles. The various types of treatments that may be considered are illustrated in Figure 7-15 and described in this section.



Right-Side Queue Jump Lane



Bus Advance Area or Gating

Figure 7-15. Examples of Signal Queue Priority Treatments for Buses and HOVs

1. **Signal Queue Jump Lanes**. This approach provides short lanes at the approach to an intersection reserved for buses or HOVs. In some cases, these lanes may be used in combination with a bus stop or a bus pull-in. These lanes allow buses and HOVs to move around the line of general traffic at a signal and travel through the intersection. A way to merge back into the general traffic lane after the intersection must be provided with this approach. One technique is to provide a separate traffic signal head for the HOV queue jump lane and to give the lane an advance green light, while holding the general traffic lanes on red. This approach allows HOVs to move through the intersection and re-enter the general traffic lanes in advance of other traffic.

   Signal queue jump lanes are currently in operation in a few areas, including the Seattle region. A short curb side HOV lane and signal priority is located on Pacific Street at the intersection with Mountlake Boulevard near the University of Washington. As shown in Figure 7-16, buses and 3+ HOVs are allowed to use the lane, which provides travel time savings at a heavily congested intersection. A second bus-only queue jump lane is in operation in downtown Seattle on 2nd Avenue, as part of a multi-block bus lane. The lane and traffic signal gives buses priority over the general traffic lanes. An advance green signal is also provided at 112th Street as part of the Airport Road HOV lane in Snohomish County. The intersection is in the section of Airport Road where the HOV lane transitions from the right lane to the second lane due to a right turn-only lane. The signal allows HOVs to enter the intersection ahead of the general traffic lanes and move to the center lane.

   Another example of a bus bypass lane at a signalized intersection currently in operation is in Mission Valley in the San Diego area. As illustrated in Figure 7-17, this facility provides a lane for buses between the right turn lane and the general-purpose lane. A separate traffic signal is provided for this lane and is activated when a bus is detected in the lane.

2. **Bus Advance Areas or Gating**. A slightly different approach, called bus advance areas, or gating, is being used in a few cities in Great Britain and Switzerland. The bus advance area is a segment of road before a signalized intersection. A set of pre-signals are used to hold general-purpose traffic at this location, while allowing buses to advance around the general traffic queue. This allows buses to move to the front of the traffic stream at the intersection. This concept is currently being tested in a few applications in London and is in use in Berne, Switzerland.

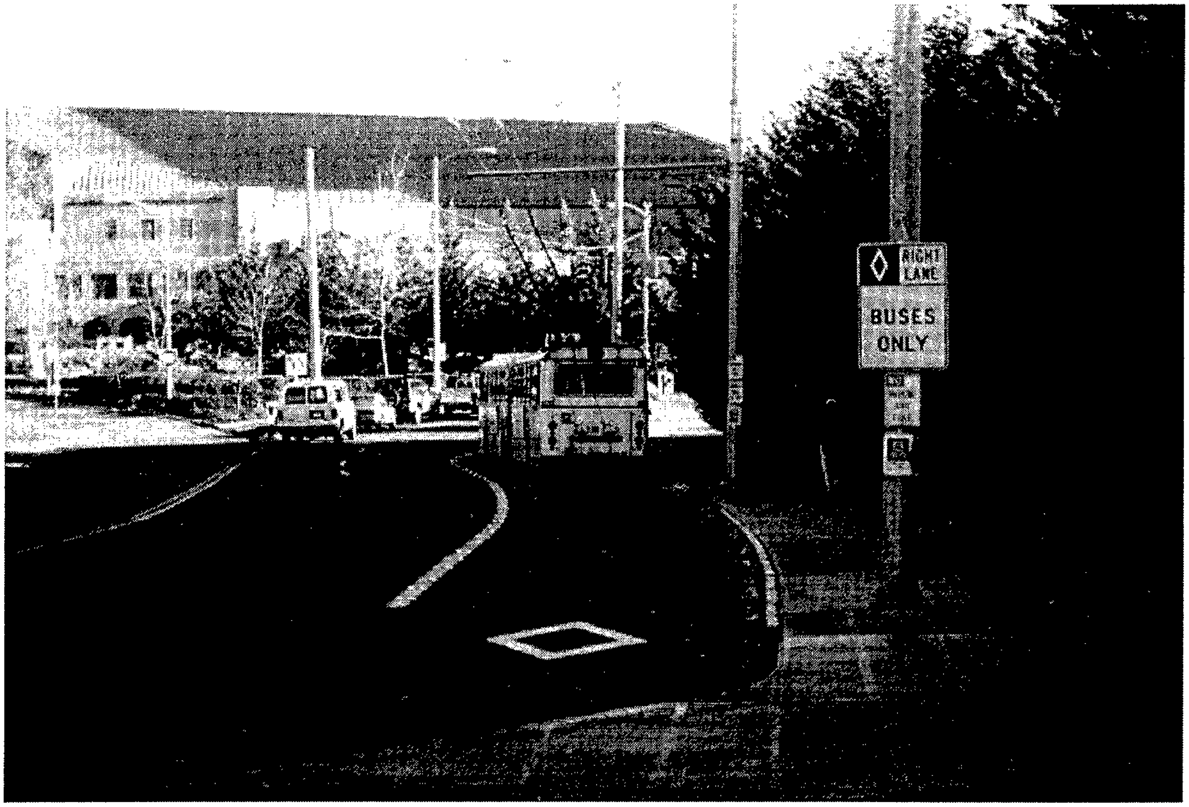


Figure 7-16. Signal Queue Jump Lane in Seattle

H. Signal Priority Treatments

Another related approach is to provide priority treatment for buses and HOVs at signalized intersections. These approaches may be used in combination with other techniques or as stand-alone elements. A number of different techniques and technologies can be used to provide HOVs with priority at signalized intersections. Most approaches use some type of technology to communicate with the signal controller. The timing of the signal cycle is then altered by either extending the green phase or truncating the red phase. These approaches involve modifying the signal algorithms.

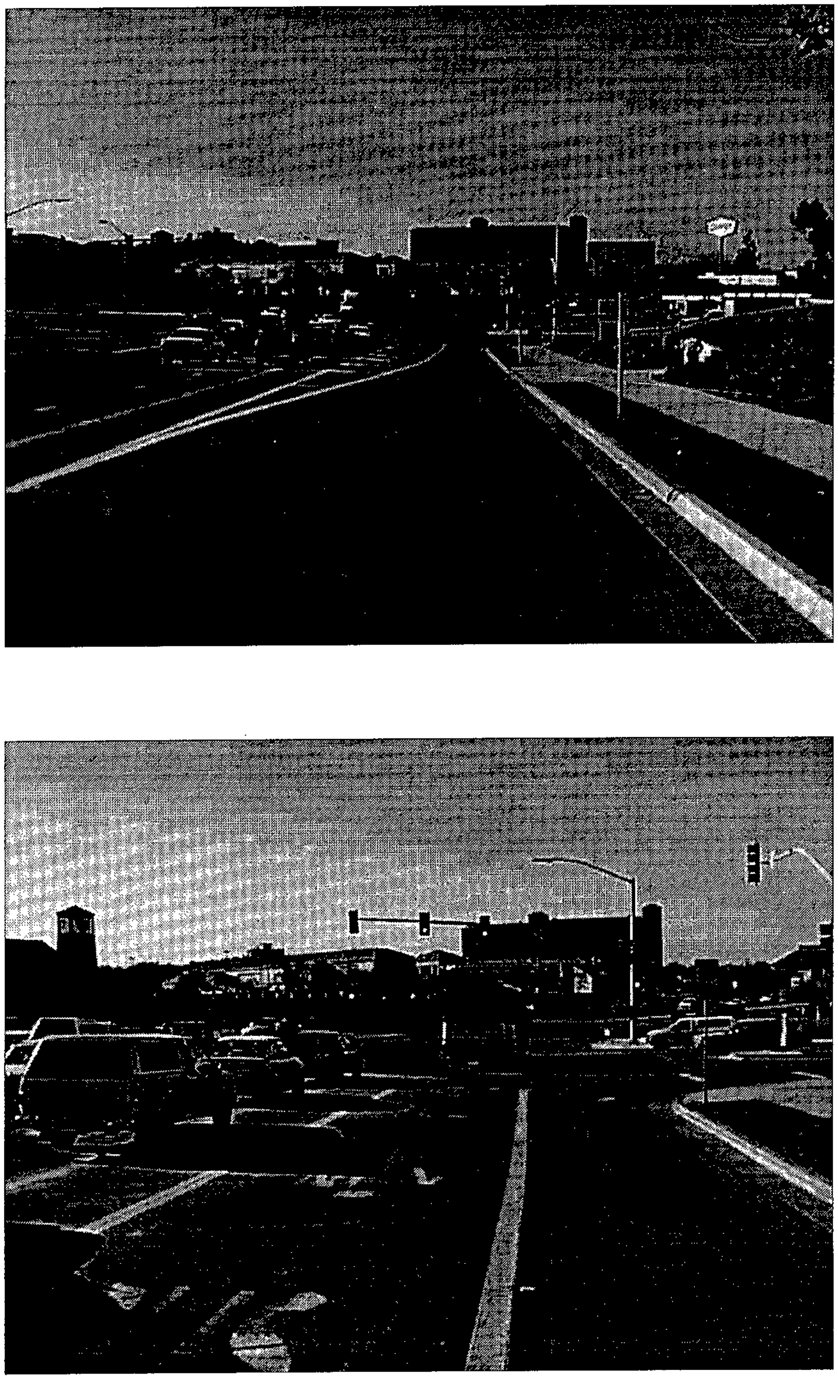


Figure 7-17. Bus Bypass Lane in San Diego

To date, most applications of signal priority treatments have focused on buses only. During the 1970s, a few demonstrations were conducted using bus pre-emption techniques. These approaches always gave priority to buses, regardless of the situation. A number of concerns were raised with these demonstrations, primarily relating to the impact on cross-street traffic. Advancements in technologies and traffic signal algorithms have renewed interest in examining approaches to provide buses and HOVs with priority at signalized intersections. For example, it is possible to selectively give priority to buses that are behind schedule or that are full, rather than arbitrarily giving all buses priority.

A number of issues will need to be examined if signal priority is being considered. Ensuring that cross street traffic is not adversely affected still represents the primary concern with this approach. Other issues that may need to be addressed include maintaining even traffic flow on the roadway, motorist and transit operator understanding of the system, coordination with emergency vehicle priority systems, integrating traffic signal systems in multiple jurisdictions, and the ability to operate and maintain the system. The following types of priority treatments may be appropriate for consideration with arterial streets HOV facilities.

1. **Timing of Traffic Signals**. One relatively simple approach that can be used with arterial street HOV lanes is to time the traffic signals to allow vehicles to progress along the roadway at the speed limit. This approach is used on arterial streets in many areas with and without HOV facilities. The one potential problem with this technique is that buses stopping to drop off and pick up passengers may get out of synch with the signal timing. This approach can work well with arterial street HOV lanes used by carpools and vanpools, and in areas where buses do not stop at every block.

   A number of arterial street HOV facilities utilize some type of signal timing to allow buses, and in some cases vanpools and carpools, to maintain a constant travel speed through a series of signalized intersections. Examples of coordinating signal timing with HOV facilities include the 16th Street Mall in Denver, the Nicollet Mall and contraflow bus lanes in downtown Minneapolis, and the bus and HOV facilities in the Toronto area.

2. **Signal Priority**. A number of approaches can be used to provide priority to buses at signalized intersections. The signal algorithm can be modified to extend the green phase, to truncate the red cycle, or to provide a special phase. These techniques allow buses to continue through an intersection without stopping, or to start through an intersection in advance of other traffic. The following techniques, identified in the *Traffic Control Systems Handbook* (1), may be considered to provide priority to buses or other HOVs at signalized intersections.

   Green Extension. This approach extends the green phase of the signal cycle. The use of this technique may be appropriate when a transit vehicle is approaching an intersection at the end of the green phase and where there is not a near-side bus stop. Extending the green phase by a few seconds allows the bus to continue through the intersection without stopping.

Starting Green Phase Early or Truncating the Red Phase. This approach truncates the red cycle phase and starts the green phase early to allow a bus approaching an intersection to continue through without stopping for a red light. Similar to extending the green phase, this technique works best with far-side or mid-block bus stops.

Interrupting Red Phase or Special Phase. These two techniques interject a special short green phase into the normal traffic signal cycle. Possible applications of these approaches include allowing buses to move through an intersection from a near-side stop or allowing buses in a queue jump lane to progress through an intersection on a separate light.

Suppressing or Skipping a Phase. This approach uses logic within the signal system to help ensure that fewer critical phases are missed. The decision to suppress or skip a phase can be determined depending upon conditions and traffic volumes. Logic could also be built into the system to determine if a bus is behind schedule or full.

Compensation Techniques. These approaches involve providing additional green time to make up for the time lost due to giving priority through some other technique or limiting the number of consecutive cycles in which priority can be granted.

Window Stretching. This technique allocates a core time to non-priority signal phases and uses a variable timer to adjust the phases as needed. The core time is normally given every cycle, but may be taken away for priority purpose through the use of the variable timer. Flexible window stretching is a variation on this approach. In this application, the core time is not fixed in position relative to the cycle.

Most traffic signal systems include NEMA controllers that can accommodate many of these features. The exact capabilities will vary by the type of signal system, the local installation, and conditions in the corridor. In addition, the use of these techniques require some method for detecting a bus or HOV at a specific location. A number of techniques, including optical or microwave, automatic vehicle identification (AVI), and inductive loops may be considered to provide the needed vehicle detection capabilities.

Transportation professionals will need to consider a number of factors in assessing the potential application of signal priority treatments. As highlighted below, these elements focus on bus flow in the corridor, general traffic and pedestrian conditions, and the signal system capabilities.

- **Number of Buses**. The number of buses operating on a roadway will influence the need for priority treatment and the type of priority considered. A street with large volumes of buses may dictate a different approach than a corridor with only a few buses. One study identified 100 daily buses or 10 to 15 peak-hour buses as a minimum criteria for considering a signal priority strategy (2), while other studies have suggested priority treatments may be justified with fewer vehicles.

- **Number of Buses Adversely Affected**. Providing priority to buses on one street may adversely impact transit vehicles on the cross street. Assessing these effects should be considered in the evaluation of different approaches, especially if there are high volumes of buses on the cross street.

- **Bus Stop Location**. The location of bus stops will influence the feasibility of some signal priority techniques. As noted previously, the use of near-side bus stops may limit the application of some approaches.

- **General Traffic and Pedestrian Conditions**. The level of general-purpose traffic on roadways and pedestrian movements will influence the feasibility of different signal priority treatments. It is important to ensure that the priority measure does not adversely affect the conditions in the general traffic lanes, cross street traffic, or pedestrians. The existing traffic levels will also impact the types of treatments that may realistically be considered. For example, a study conducted for Snohomish County in the Puget Sound region found that there is no room to take green time from any movement when an intersection is operating at a saturated level. Signal priority may still be considered in these cases during the off-peak period to provide speed and reliability benefits to buses.

- **Other Priority Measures**. Possible signal priority treatments will also be influenced by the other bus-only or HOV facilities in the corridor. For example, different approaches should be considered with a bus queue jump lane, a reversible center bus-only lane, and a transit mall.

- **Type of Signal and Detection Capabilities**. The techniques available for consideration may be limited by the capabilities of the signal hardware and software, as well as the technologies available for detection. These factors will need to be considered in the assessment of alternative approaches.

The benefits to transit operations and bus riders should be considered in the evaluation of different strategies, along with the impacts on general purpose traffic and pedestrians. Thus, the use of priority signal treatments for buses or

HOVs should ensure that the safe and efficient movement of other vehicles and pedestrians is not degraded.

Only a few bus signal priority projects are currently in operation. Recent demonstrations have been conducted on the Ritchie Highway in Anne Arundel County, Maryland; selected roadways in Bremerton and Tacoma, Washington; and Albemorle Road in Charlotte, North Carolina. An Advanced Detection demonstration project, which provides buses with priority, is underway on Roesser Road in Phoenix. In Charlotte, priority for express buses is provided at 11 signalized intersections. The results from this project indicate that bus delays at the signals have been reduced by 67 percent and ridership has increased.

I. Bus Stop Treatments

As noted previously, many arterial street HOV applications are oriented toward enhancing the movement of buses through congested areas. The travel times of buses are influenced not only by the general traffic conditions and signals along a roadway, but also by the need to pull into bus stops, drop off and pick up passengers, and re-enter the traffic stream. These movements can add significant travel time to the overall operation of public transit vehicles.

The location and design of bus stops, bus bays or bus pull-in areas, bus bulbs, and other treatments can enhance transit operations and traffic flow along arterial streets. Many of these techniques can be used with or without HOV lanes.

The general types of bus stop treatments that may be appropriate for consideration with arterial street HOV facilities are highlighted in this section. The advantages, disadvantages, and issues associated with the various techniques are highlighted. A recent TCRP Report, *Guidelines for the Location and Design of Bus Stops* (3), provides a much more detailed discussion of elements to consider in the use of these approaches.

1. **Bus Stop Location**. The location of bus stops affect transit operations, passenger safety and convenience, and general traffic. As a result, the location of bus stops should be carefully considered. Elements that should be included in examining alternative bus stop locations are the safe flow of buses in and out of the stop, transit operations, passenger access, passenger safety and security, and impacts on traffic in the general-purpose lanes.

   Three options are available for the location of bus stops along streets. As illustrated in Figure 7-18, these are near-side before an intersection, far-side after an intersection, and mid-block. As summarized next and highlighted in Table 7-2, each of these locations has advantages and disadvantages.

   In general, it is desirable to standardize the location of bus stops within an area to enhance driver and passenger expectations. A combination of approaches may be considered in some areas, however, to enhance bus operations and traffic flow. For example, if buses are always stopping at a traffic signal, a near-side stop may be appropriate. On the other hand, if buses usually have a green signal at an intersection, a far-side stop may be considered.

Near-Side Bus Stops. A near-side bus stop is located at the end of a block before an intersection. Buses stop prior to the intersection to drop off and pick up passengers and then travel through the intersection and either re-enter the mixed-traffic lane or continue on an HOV lane. Advantages of near-side stops for bus operators include ease of pulling into the curb, use of the intersection to re-enter general traffic lane, picking up and dropping off passengers during a red light, and enhanced ability to check for connecting buses on cross-streets. Advantages for passengers include convenience of bus stop close to crosswalk and ease of making connections with buses on the cross-street. Advantages to the general purpose traffic include less potential for buses to block the intersection.

Possible disadvantages with near-side stops for bus operations include additional delays due to the traffic signal, potential for cross-street traffic to block the intersection, and possible limitations for signal priority strategies. Near-side bus stops may block site distances for pedestrians at intersections. Possible disadvantages for general traffic are conflicts with right turn movements at the intersection, buses blocking curb-side signs, and buses stopping in the general traffic lanes waiting to enter a bus stop, unless a curb side HOV lane is in operation.

Far-Side Stops. Far-side bus stops are located at the beginning of a block, just after an intersection. Buses travel through the intersection and pull into the bus stop to pick-up and drop-off passengers. Buses then either continue in the curb HOV lane or re-enter the general-traffic lane.

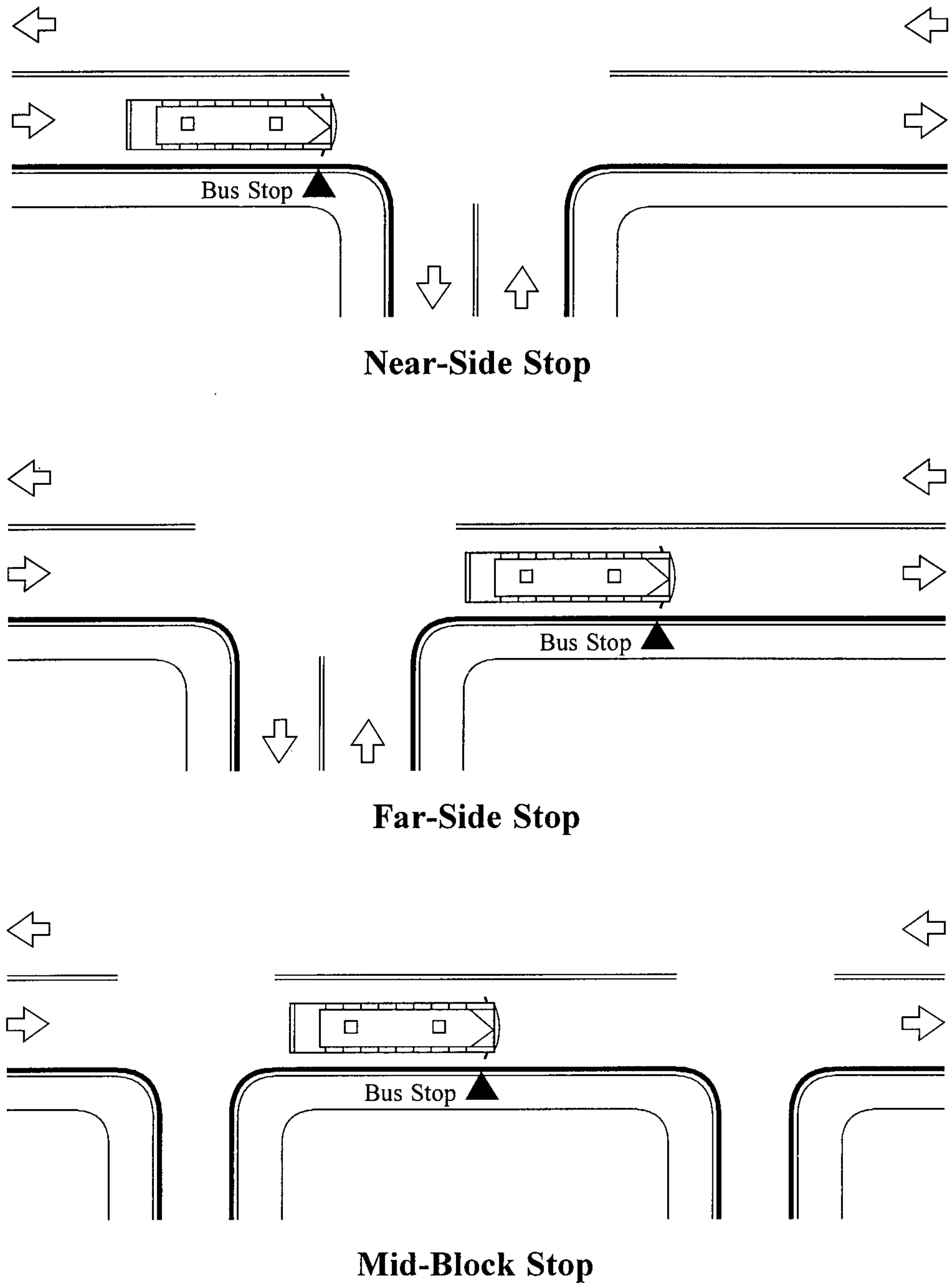


Figure 7-18. Alternative Bus Stop Locations

Table 7-2. Advantages and Disadvantages of Bus Stop Locations on Arterial Streets

Location	Advantages	Disadvantages
Near-Side Stop	<u>Bus Operations</u> • Ease of pulling into curb. • Use of intersection to re-enter general traffic lane. • Pick up and drop off passengers during red light. • Ability to check for connecting buses on cross streets. <u>Passengers</u> • Convenience of bus stop close to crosswalk. • Convenience for connecting bus route. <u>General Traffic</u> • Less potential for buses to block intersections. • Less interference for vehicles making right turns from cross street.	<u>Bus Operations</u> • May cause additional delays due to traffic signal. • Potential for cross-street traffic to block intersection. • May limit bus priority signal strategies. <u>Passengers</u> • Buses may block sight distance at intersection. <u>General Traffic</u> • Potential for conflicts with right turn movements. • Potential for buses to block curb side signs. • Potential for buses to stop in general traffic lane waiting to enter bus stop.
Far-Side Stop	<u>Bus Operations</u> • Reduces potential for buses to stop twice—once for passengers and once for red light. • Enhances potential for signal priority treatments. <u>Passengers</u> • Convenience of bus stop close to crosswalk. • Convenience for connecting bus routes. <u>General Traffic</u> • Reduces conflicts for right-turn movements to cross-street. • Reduces potential for buses to block curbside signs approaching intersection.	<u>Bus Operations</u> • Reduces ability to check for passengers in cross-street routes. • May be more difficult to merge back into general traffic lane. • Increases potential for rear end accidents from vehicles making right turns from cross street. <u>Passengers</u> • Less convenient since stop may be further from intersection. • Less convenient for connections from routes on cross street. <u>General Traffic</u> • Buses may block intersections. • May cause conflicts for vehicles making right turns from cross street. • Buses may reduce sight distance for other vehicles.
Mid-Block Stop	<u>Bus Operations</u> • Link to major developments and passenger waiting areas. • Adequate space for buses. • Reduces potential conflicts at intersections. • Enhances potential for signal priority treatments. <u>Passengers</u> • Potential for enhanced waiting areas and links to major developments. <u>General Traffic</u> • Reduces potential for buses to block intersection. • Reduces potential conflicts with right turning vehicles.	<u>Bus Operations</u> • May be more difficult to merge back into general traffic lane. <u>Passengers</u> • Less convenient access from pedestrian cross walks at intersections. • Less convenient for connecting with routes on cross streets. <u>General Traffic</u> • May cause congestion at mid-block with buses merging back into traffic lane. • May require removal of additional on-street parking.

Source: (2, modified).

Advantages of far-side stops to transit operators include reducing the potential for buses to stop twice—once to pick-up and drop-off passengers and once for a red light—and enhancing the possible application of signal priority treatments. Advantages to the general traffic include reducing potential conflicts with right turn movements at the intersection and reducing possible blocking of curb-side information signs by buses.

Disadvantages for bus operations include reduced ability to check for connecting passengers on cross-street routes, increased the difficulty of merging back into the general traffic lane, and increased potential for buses to be hit from behind by vehicles turning right from the cross street. Possible disadvantages for passengers include less convenient access to bus stops for pedestrian crossings at intersection and for connecting routes on cross streets. Disadvantages for general traffic may include buses blocking the intersection, conflicts with vehicles making right turns from the cross street, and reduced sight distance.

Mid-Block Stop. The final bus stop location is in the middle of a block. Potential advantages to transit operations from mid-block stops are linking into major developments and enhancing passenger waiting areas, providing adequate bus storage space, reducing potential conflicts at intersections, and enhancing the possible use of signal priority treatments at intersections. Advantages for passengers include the potential for enhanced waiting areas and connections to adjacent land uses. Potential advantages for general traffic are reduced conflicts at intersections with right turn movements and less chance of buses blocking intersections and curb-side signs.

Transit vehicles may have a more difficult time merging back into the general traffic lane with a mid-block stop if an HOV lane is not provided. Passengers may be required to walk further to mid-block stops and some may be tempted to jaywalk, causing safety concerns. Due to these safety concerns, mid-block stops are not used in some areas, or are considered only if a crosswalk is also provided. Transfer connections from routes on cross streets may be less convenient with mid-block stops. Possible disadvantages to general traffic may include conflicts at mid-block due to buses merging back into the general-purpose lanes. This approach may also require the removal of additional on-street parking spaces.

2. **Bus Stop Treatments**. A number of different approaches can be used with bus stops on arterial streets. The simple curbside stop is the most common treatment used throughout the country. The characteristics of different bus stop treatments, which are illustrated in Figure 7-19 are described in this section. More detailed information on these approaches is provided in the TCRP report (3).

   Curbside Stop. This is the simplest type of bus stop and the one most frequently found throughout the country. The bus stop is located along the curb lane and no special treatments or features are provided. Advantages of this approach include easy access for buses and riders, simple to design and implement, and easy to relocate. Potential disadvantages with curbside stops may include buses blocking traffic lanes waiting to pull into the curb and buses merging back into the general traffic lanes.

   Bus Bay. A bus bay provides a special area for buses to stop outside of the curb or the general traffic lanes. Bus bays are normally constructed by reducing the sidewalk or other area adjacent to the street. Bus bays allow buses to stop without negatively impacting the general-purpose traffic lanes and provide a safer area for passengers to board or alight. Possible disadvantages with the use of this technique is that buses may have difficulty reentering congested traffic lanes and sidewalk or other space must be available. Bus bays also involve capital expenditures. As a result, bus bays may be appropriate only at certain locations, such as stops with high volumes of passengers.

   Open Bus Bay. This approach provides an open end to the bus bay. The design allows buses to decelerate in the intersection and move into the bus stop. Although this treatment may reduce conflicts between buses slowing down at a bus stop and the general traffic, problems may still exist when buses try to reenter the traffic lanes.

   Bus Bulb or Bus Nub. These approaches extend a section of the sidewalk across the curb lane or parking lane to the edge of the general-purpose lane. This technique provides extra sidewalk space for waiting passengers and allows buses to stop in the traffic lane to pick-up and drop-off passengers. Since buses stop in the general traffic lanes, bus bulbs eliminate the problem with buses having to merge back in the main lanes. Bus bulbs also provide additional waiting areas for passengers. These techniques may negatively impact travel in the general purpose lanes, however, which may be slowed by stopped transit vehicles.

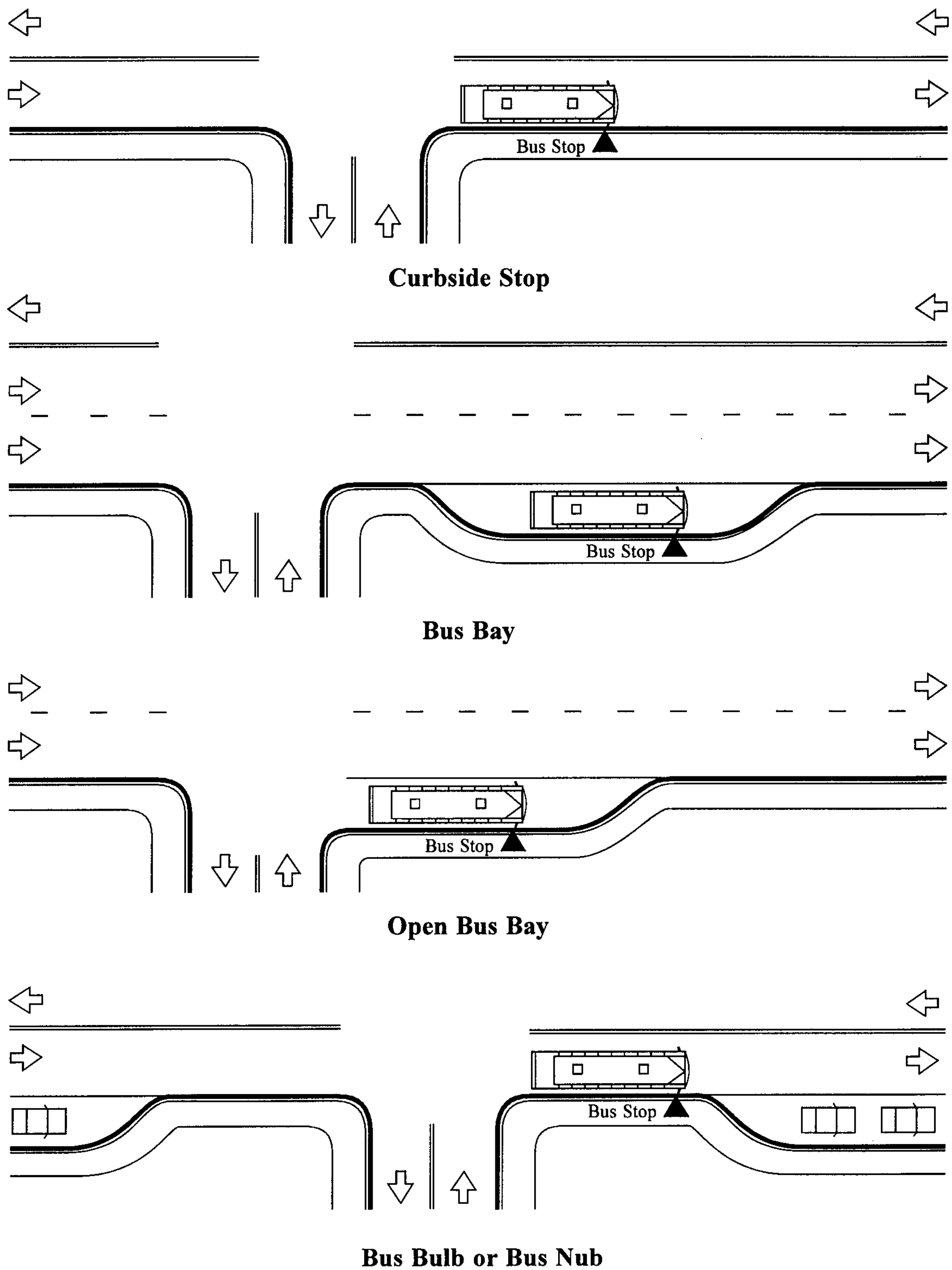


Figure 7-19. Alternative Bus Stop Treatments

A number of variations or combinations of different bus stop designs and priority treatments may be considered. For example, open bus bays may be used in combination with a signal queue jump lane to provide additional priority to transit vehicles.

IV. VEHICLE ELIGIBILITY AND VEHICLE-OCCUPANCY REQUIREMENTS

This section identifies the types of vehicles usually considered eligible for use of an arterial HOV facility and alternate vehicle-occupancy levels. The advantages of allowing various vehicles and vehicle-occupancy levels are highlighted along with some of the issues associated with various approaches. Other topics covered include variable requirements, minimum operating thresholds, and managing vehicle demand.

A. Vehicle Eligibility Requirements

Establishing eligibility requirements that identify the types of vehicles that will be allowed to use an arterial street HOV lane is a first step in developing an operation plan. Determining vehicle eligibility is important, as it will influence other decisions relating to the operations of the facility. The following types of vehicles may be considered for use of an arterial HOV facility.

- Buses
- Vans and Vanpools
- Carpools in automobiles and light trucks
- Bicycles
- Motorcycles
- Delivery vehicles
- Taxis
- Emergency vehicles
- Low emitting vehicles
- Special user groups

In many cases, one of the major questions with arterial street facilities will be whether to limit use to buses-only. The safety impacts of allowing access to other user groups represents a major element to be considered. For example, allowing carpools and vanpools to use an HOV lane on a roadway with two-way left-turn lanes may create safety problems. Vehicles queued in the general-purpose lanes may leave space for left turning vehicles in the two-way left-turn lane. Left turning vehicles moving across this gap can see an oncoming bus but cannot see a carpool approaching in an outside HOV lane. As a result, the potential for accidents may be greater in this situation if the HOV lane is open to carpools and vanpools. These and other safety related issues should be examined in assessing alternative vehicle eligibility requirements.

The general characteristics of these vehicles are described next. The advantages, disadvantages, and potential issues associated with allowing each type of vehicle to use an HOV facility are presented in Table 7-3 and summarized in this section.

The general characteristics of these vehicles are described next. The advantages, disadvantages, and potential issues associated with allowing each type of vehicle to use an HOV facility are presented in Table 7-3 and summarized in this section.

Buses. Buses are usually given first consideration in the use of an arterial HOV facility. High volumes of buses offer the greatest potential benefit for increasing the people carrying capacity of a facility, as well as provide energy savings and air pollution reductions. As noted previously, many arterial street HOV applications are reserved for buses-only. In other cases, buses may be one of many eligible users. For example, most transit malls are oriented primarily for buses-only, although taxis and other special vehicles may be allowed access. Other downtown HOV lanes are also usually restricted to buses-only, as are other longer distance arterial street HOV facilities.

Vans and Vanpools. The next vehicles often considered for an arterial street HOV lane use are vanpools. Although vans have operating characteristics similar to automobiles, vanpools have higher vehicle-occupancy levels than carpools. As a result, vanpools may be given preference over carpools in some situations. Vanpools are currently authorized to use a few arterial street HOV lanes in North America. These include the HOV lanes on Dundas Street in the Toronto area, Hastings Street in Vancouver, the San Thomas and Montague Expressways in San Jose, North Washington Street in Alexandria, and SR 99 and Airport Road in the Seattle area.

Carpools Using Automobiles and Light Trucks. Carpools represent the next group that may be considered for use of arterial street HOV facilities. Unlike freeway HOV facilities, carpools are not currently allowed on most arterial street HOV lanes. The exceptions to this approach are the eight arterial street HOV lanes noted above which allow carpools along with vanpools. Carpools have been excluded from most arterial street HOV lanes primarily due to the bus-only focus of most projects and safety and capacity concerns related to potentially high volumes of carpools. Interest has been expressed in a number of areas in developing arterial street HOV lanes to serve carpools and vanpools, and more projects of this nature may be implemented in the future.

Bicycles. Bicyclists represent another user group that may be allowed to use an arterial street HOV lane. Bicycles are becoming a more common commute mode in some areas. Allowing bicycles to use an HOV lane represents one possible way of segregating bicycles from general traffic lanes, providing a potentially safer environment for bicyclists. Many bus-only lanes also allow bicycles. In addition, some areas incorporate separate bicycle lanes adjacent to the HOV lane into the overall facility design. Large volumes of buses or HOVs may not be compatible with bicycles, however, and care should be taken to ensure a safe operating environment for bicycles and HOV traffic.

Table 7-3. Vehicle Eligibility Considerations

Vehicle Type	Advantages	Disadvantages
Buses	• Highest person-moving capacity. • Greatest potential for increasing corridor throughput. • Provides priority for buses in congested areas and corridors.	• May have empty lane syndrome if not enough buses.
Vanpools	• High person-moving capacity. • Help avoid empty lane syndrome.	• May be safety concerns with some facilities. • Too many vanpools may cause operational problems. • May not be compatible with bus use and bus operations.
Carpools using automobiles and light trucks	• Adds users at no public cost. • Adds to person-moving efficiency. • Helps avoid empty lane syndrome.	• May not be compatible with bus use and bus operations. • Too many carpools may cause operational problems. • May make enforcement more difficult. • May be safety concerns with some facilities.
Bicycles	• May provide safer environment for bicyclists.	• May be safety concerns, especially if high volumes of buses and HOVs.
Motorcycles	• Adds vehicles in lanes.	• Potential safety concerns, especially if high volumes of buses and HOVs. • Possible public perception problems of single-occupant vehicle.
Delivery vehicles	• Provides needed access to land uses in corridor. • Off-peak access may not cause major conflicts with HOVs.	• Potential safety, especially if high volumes of buses and HOVs.
Taxis	• Adds vehicles if meet occupancy requirements.	• Potential safety concerns, especially if high volumes of buses and HOVs.
Airport shuttles and other special services	• Adds vehicles if meet occupancy requirements.	• Potential public perception problems if only the operator.
Emergency vehicles	• Travel time savings and enhanced reliability to emergency vehicles.	• Potential public perception problems if only the operator.
Low emitting vehicles (LOVs)	• May encourage use of LOVs. • Adds vehicles to HOV lane. • May be appropriate to consider if allowed to use freeway HOV lanes.	• Potential public perception problems if vehicles do not meet occupancy requirements. • Potential to make enforcement more difficult. • May be problems with speed and reliability.
Special user groups	• May support special project or community goals and objectives.	• Potential safety and operational concerns.

Motorcycles. Unlike freeway HOV facilities, motorcycles are not allowed to use most arterial street HOV lanes. The ISTEA of 1991, which authorized the motorcycle use of HOV facilities on freeways, regardless of the number of riders, does not apply to arterial streets. Motorcycles are not allowed on bus-only arterial street HOV lanes, and may use the few facilities open to vanpools and carpools only if they meet the occupancy requirements.

Delivery Vehicles. Delivery vehicles are allowed to use some arterial street HOV lanes. In most cases, such as the reverse flow bus lanes in Minneapolis, delivery vehicles are allowed to use the HOV lanes only during the off-peak periods. In other cases, these vehicles may be provided access to a specific building or area through an HOV lane. Given the arterial street environment, special consideration may need to be given to delivery vehicles to ensure that adequate access is provided to commercial establishments, schools, hospitals, and other land users in the corridor.

Taxis. Taxis are allowed to use some bus-only arterial street HOV facilities. For example, taxis are allowed to use the Nicollet Mall in downtown Minneapolis. Taxis meeting the vehicle-occupancy requirements may use the arterial street HOV lanes open to vanpools and carpools. Allowing taxis on some facilities can help build support for a project and provide enhanced access to hotels and convention facilities without jeopardizing the major objectives of a project.

Emergency Vehicles. Emergency vehicles are usually allowed on all arterial street HOV facilities, even when not on an emergency trip. This use is important to ensure that police, fire, EMS, and other personnel have access to land uses adjacent to the arterial street HOV lane. The inclusion of emergency vehicles as an authorized user group should not significantly affect the design or operation of a facility.

Low Emitting Vehicles. As noted in Chapter 5, consideration has been given in some areas to allowing electric vehicles and other non-polluting or low emitting vehicles to use freeway HOV facilities without regard to the vehicle-occupancy requirements. The ISTEA encourages the inclusion of these vehicles on HOV lanes. If low emitting vehicles are allowed to use a freeway HOV lane in an area, it may also be appropriate to consider their use of arterial street facilities.

Special User Groups. Special user groups are allowed access to arterial street HOV facilities in some areas. For example, horse drawn carriages are allowed to use the 16th Street Mall in Denver during the evenings and weekends. Providing access to special user groups may help meet specific project or community goals and objectives, such as helping to revitalize a downtown area.

B. Vehicle-Occupancy Requirements

If carpools are allowed to use an arterial street HOV facility, the vehicle-occupancy requirement will need to be considered. As discussed in Chapter 4, the planning process should include an analysis of the demand for a facility at different vehicle-occupancy levels and the impact these requirements will have on traffic flow. The goal is to set the occupancy requirement at a level that will encourage use of the facility, but will not create too much demand to make the lane congested. As noted previously, only a few arterial street HOV projects currently allow carpools. The Dundas Street and the Allen Road/Dufferin Street HOV lanes in the Toronto area use a 3+ vehicle-occupancy requirement, while the Hastings Street HOV facility in Vancouver uses a 2+ regulation. The characteristics, advantages, and disadvantages of the various vehicle-occupancy requirements are briefly described in this section and are highlighted in Table 7-4.

Two or More (2+) Persons per Vehicle. Two or more persons (2+) per vehicle represents the lowest level of carpooling. Forming a two person carpool is much easier than forming a three or four person carpool. Many two person carpools are comprised of family members, co-workers, or friends. Corridors may have significant numbers of existing 2+ carpools, providing a target market for an HOV facility. Using a 2+ vehicle-occupancy requirement level initially provides the greatest opportunity to avoid the empty lane syndrome. It may result in too high a vehicle volume for an arterial street HOV lane, however. If an HOV lane becomes too congested at the 2+ occupancy level, the requirement can be increased to 3+. The Hastings Street arterial HOV lane in Vancouver currently uses a 2+ carpool definition, as does the Airport Road HOV lane in the Seattle area.

Three or More (3+) Persons per Vehicle. The next level for defining a carpool is to require three or more persons (3+) per vehicle. Vehicle volumes at the 3+ level are usually lower than at a 2+ requirement. It is more difficult for individuals to form three person carpools, so some potential carpoolers may not be able to use a facility at a 3+ requirement. Others may form 3+ carpools from existing 2+ carpools, reducing vehicle volumes in the HOV lane. The Dundas Street and the Allen Road/Dufferin Street HOV lanes in the Toronto area currently use a 3+ carpool requirement.

Four or More (4+) Persons per Vehicle. The highest carpool requirement used with an HOV facility is four or more (4+) persons per vehicle. It is difficult for most individuals to not only form carpools with four or more persons, but also to operate those that are formed on a regular basis. Most metropolitan areas probably do not have enough demand at the 4+ level to make this a viable option, especially during the early stages of a project. Currently, no arterial street HOV lane uses a 4+ carpool definition.

Variable Vehicle-Occupancy Requirements by Time of Day. As discussed in Chapter 5, changing the HOV occupancy requirement by time of day, represents one approach that has been implemented to help manage demand on freeway HOV lanes. The Katy (I-10 West) HOV lane in Houston is the only facility in the country currently using a variable occupancy requirement. A 3+ requirement may be used during the morning and afternoon peak hours, with a 2+ level in effect during other operating hours. This approach could be considered on arterial street HOV facilities if demand warrants, although it may make enforcement more difficult.

Table 7-4. Vehicle-Occupancy Requirement Criteria

Vehicle-Occupant Level	Advantages	Disadvantages
Two or more (2+) persons per vehicle	• Easiest level of carpools to form. • Often significant numbers of existing 2+ carpools in a corridor.	• May be too many 2+ carpools resulting in congestion on an arterial street HOV lane or other operating problems.
Three or more (3+) persons per vehicle	• Can address congestion problems at 2+ level. • Higher person moving capacity.	• Harder for individuals to form 3+ carpools. • May not have enough 3+ carpools to make lane look used, causing empty lane syndrome.
Four or more (4+) persons per vehicle	• Can address congestion problems at 3+ level. • Higher person moving capacity.	• Hard for individuals to form 4 person carpools. • Harder to operate on a regular basis due to individual travel needs and schedules. • May not have enough 4+ carpools to make lane look used, causing empty lane syndrome.
Variable requirements by time of day (3+ peak hours, 2+ other operating hours)	• Can address congestion problems during peak-periods.	• May be confusing for users, especially during transition periods. • May make enforcement more difficult, especially during transition periods.

C. Minimum Operating Thresholds

As discussed previously, the goal of an HOV facility is to provide travel time savings and travel time reliability to buses, vanpools, and carpools. The vehicle eligibility criteria and vehicle-occupancy requirement should be established at a level that will encourage use of the facility, but that will not create too much demand to make the lane congested. Consideration of a minimum operating threshold to ensure that the facility does not look under-utilized, thus creating the empty lane syndrome, is discussed in this section. Managing demand for a facility and maximum flow levels are discussed in the next section.

The number of vehicles using a lane on opening day and during the initial phases of a project should be high enough to justify the facility. Ensuring that the lane is well utilized will help build support among users, non-users, and the general public. If a facility is perceived to be under-utilized, pressure may be exerted to change vehicle-occupancy requirements, operating hours, or to open the lane to mixed traffic.

A number of factors should be considered in assessing the minimum operating thresholds for an arterial street HOV facility. The exact minimum threshold for a specific project will depend on the goals and objectives of the project, the type of facility, the vehicle eligibility and vehicle-occupancy requirements, the level of congestion in the general-purpose lanes, and local conditions and perceptions. For example, the minimum threshold may be lower for a short bus-only HOV lane used during the peak hours than for longer distance lanes open to vanpools and carpools. Table 7-5 outlines some of the elements practitioners may wish to consider in developing local guidelines for minimum operating thresholds. The general levels that are commonly used throughout the country are highlighted along with other factors that may be considered in developing local minimum thresholds.

D. Maximum Operating Thresholds

While issues may arise if there are not enough vehicles using an arterial street HOV facility, problems may also emerge with too many vehicles. Maintaining a level of service that provides free flow conditions on an HOV lane is critical to ensuring that the travel time savings and the travel time reliability that bus riders, vanpoolers, and carpoolers have come to expect is provided. Along with developing guidelines for the minimum operating thresholds, criteria on the maximum flow rates should also be considered. Further, traffic volumes on HOV facilities should be monitored to help identify when the maximum flow rates are being approached so that appropriate actions can be taken.

Maintaining a desired level of service on an arterial street HOV facility should focus on the operating capacity rather than the design capacity. Currently, little information is available on the vehicle volumes that an arterial street HOV lane can accommodate. Further, the exact maximum flow will vary based on specific characteristics in the corridor and the type of HOV facility.

The same factors described for the minimum operating thresholds will also influence the maximum operating thresholds. These include the goals and objectives of a project, the type of HOV facility, vehicle eligibility criteria, vehicle-occupancy requirements, the general level of congestion in the corridor, and local conditions. In addition, design considerations may also influence maximum flow levels. These factors are highlighted in Table 7-6. The guidelines described in the next two sections can be used to help establish local vehicle eligibility and vehicle-occupancy requirements, and to determine when vehicle-occupancy levels or vehicle eligibility requirements need to be changed.

Table 7-5. Elements for Developing Minimum Operating Threshold Guidelines for Arterial Street HOV Facilities

Possible Elements	Comments/Possible Minimum Thresholds
Project Goals and Objectives	The goals and objectives of a project may influence the minimum operating thresholds. For example, a project intended to give buses priority through a congested downtown area or other activity center segment could be expected to have a lower threshold than longer distance lanes open to vanpools and carpools. Local policies on bus-only and carpool definitions will influence the operating thresholds and should be considered in the development of local guidelines.
Type of HOV Facility	The type of HOV facility will probably have the most influence on the development of local minimum operating guidelines. The following general levels provide an indication of the national experience and can be used in developing local guidelines. Bus Malls—80-100 vphpl Right-Side Bus Only—50-80 vphpl Right-Side HOV—200-400 vphpl Left-Side Bus Only—50-80 vphpl Left-Side HOV—200-400 vphpl Center Two-Way—200-400 vphpl Center Reversible—80-160 vphpl Contraflow Bus Only on One-Way Street—50-80 vphpl
Vehicle Eligibility Requirements	Lower minimum vehicle thresholds can be expected, and are usually accepted, with bus-only facilities than with facilities open to buses, vanpools, and carpools.
Vehicle-Occupancy Requirements	Lower minimum vehicle thresholds can be expected with higher vehicle-occupancy requirements.
Level of Congestion Corridor	The minimum vehicle threshold may be higher in a heavily congested corridor than in one with lower levels of congestion. Non-users in heavily congested areas may be much more vocal about a facility they feel is under-utilized than commuters in a corridor where congestion is not at serious levels.
Local Conditions	The perceptions of commuters and the public, as well as any unique local conditions, should be considered in developing minimum operating thresholds.

Table 7-6. Elements for Developing Maximum Operating Threshold Guidelines for Arterial Street HOV Facilities

Possible Elements	Comments/Possible Minimum Thresholds
Goals and Objectives of Project	The goals and objectives of a project may influence the maximum operating thresholds. For example, a project intended to give buses priority through a congested downtown area or other activity center could be expected to have a lower threshold than longer distance HOV lanes open to carpools and vanpools. Local policies on bus-only lanes and carpool definitions will also influence the operating thresholds and should be considered in the development of local guidelines.
Type of HOV Facility	The type of HOV facility will probably have the most influence on the development of local maximum operating guidelines. The following general levels provide an indication of the national experience and can be used in developing local guidelines. Bus Malls—200-400 vphpl Right-Side Bus Only—100-200 vphpl Right-Side HOV—600-800 vphpl Left-Side Bus Only—100-200 vphpl Left-Side HOV—600-800 vphpl Center Two-Way—600-800 vphpl Center Reversible—400-600 vphpl Contraflow Bus Only on One-Way Street—100-200 vphpl
Vehicle Eligibility Requirements	Lower maximum thresholds can be expected, and are usually accepted, with bus-only facilities than with facilities open to buses, vanpools, and carpools.
Vehicle-Occupancy Requirements	The vehicle-occupancy requirements will influence use of a facility and the potential for congestion. A higher threshold may be needed with a 2+ requirement.
Level of Congestion Corridor	The maximum operating threshold may be higher in a heavily congested corridor than in one with lower levels of congestion.
Design Considerations	An HOV facility with geometric constraints or sections with less than standard designs may have lower maximum operating thresholds than those with standard designs.
Local Conditions and Perceptions	The perceptions of HOV lane users, commuters and the public, as well as any unique local conditions, should be considered in developing maximum operating thresholds.

E. Guidelines for Developing Vehicle Eligibility and Vehicle-Occupancy Requirements

A number of factors should be considered in establishing vehicle eligibility and vehicle-occupancy requirements for arterial street HOV facilities. This section outlines some of the elements that may be appropriate for consideration in developing local criteria. The exact factors and the threshold levels will vary depending on local goals and objectives, facility types, design treatments, system connectivity issues, and local conditions. The elements discussed in this section can be used to help develop local criteria for vehicle eligibility and vehicle-occupancy requirements on arterial street HOV facilities.

- Metropolitan, Community, and Project Goals and Objectives
- Type of HOV Facility
- Specific Design or Operating Limitations
- Segment and Areawide Continuity
- Existing Vehicle-Occupancy Levels
- Travel Time Savings and Travel Time Reliability
- Carpool and Vanpool Formation and Increased Transit Use

Metropolitan, community, and project goals and objectives. The goals and objectives of a specific arterial street HOV project or an HOV system should be used in the development of the vehicle eligibility and vehicle-occupancy criteria. These may be reflected in the overall policies discussed in Chapter 3 or they may relate specifically to an individual project. For example, the goals and objectives for a downtown transit mall, a bus queue jumper lane, a signal priority project, and a suburban bus and carpool lane will all be different. The vehicle eligibility and vehicle-occupancy requirements may also be different to reflect various goals and objectives.

Type of HOV facility. As noted above, the type of HOV facility being considered will influence the vehicle eligibility and vehicle-occupancy requirements. Transit malls and bus-only lanes in a downtown area obviously do not require consideration of vehicle-occupancy requirements. Other types of arterial street applications may require consideration of both vehicle eligibility and vehicle-occupancy requirements.

Specific design and operating limitations. The vehicle eligibility criteria, and, to a lesser extent, the vehicle-occupancy requirement, may be influenced by design or operating constraints associated with a specific facility. For example, space limitations in an HOV queue jumper lane may necessitate restricting use to buses-only.

Segment and areawide continuity. If there is more than one arterial street HOV facility in an area or if there are various combinations of freeway and arterial street lanes, consideration may be given to uniform vehicle eligibility and vehicle-occupancy requirements. Maintaining the same requirements on multiple facilities can improve public understanding and simplify enforcement. This approach may not be appropriate if there are different types of HOV facilities in an area or if significantly different travel and mode share characteristics exist in various corridors. Several metropolitan areas use different vehicle eligibility and vehicle-occupancy requirements on arterial HOV facilities.

Existing vehicle-occupancy levels. Vehicle-occupancy levels in a corridor or metropolitan area provide a good indication of the potential for use of a facility by existing carpools at different occupancy levels. A corridor with vehicle occupancy levels of 1.4 persons per vehicle or higher indicates a strong existing carpool market. In this case, it may be appropriate to consider a 3+ vehicle occupancy requirement. On the other hand, a corridor with average vehicle-occupancy levels of 1.1 to 1.2 suggest a 2+ requirement would be more appropriate.

Travel time savings and travel time reliability. The travel time savings and travel time reliability provided to HOVs using different vehicle eligibility and vehicle-occupancy levels should also be considered in establishing the guidelines. These elements may not be as important on arterial streets as they are on freeways, however. The factors noted previously are often more important in developing vehicle eligibility and vehicle-occupancy requirements on arterial street HOV facilities.

Carpool and vanpool formation, and increased transit ridership. An objective of most HOV projects is to encourage individuals to change from driving alone to riding the bus or forming carpools or vanpools. Vehicle-occupancy requirements should be set at levels that will encourage these shifts. If there are few carpools in a corridor, a 2+ requirement may be an appropriate starting point. The requirements should also allow for growth as more commuters switch to transit, carpooling, and vanpooling. As discussed next, vehicle-occupancy requirements can be increased if needed.

F. Guidelines for Changing Vehicle Eligibility and Vehicle-Occupancy Requirements

As noted previously, one of the advantages of HOV facilities is the flexibility to change vehicle-occupancy or vehicle eligibility requirements in response to increasing demand. For example, if an arterial street HOV lane becomes congested at a 2+ vehicle-occupancy level, consideration can be given to raising the vehicle-occupancy requirements to three or more persons. Decisions on changing vehicle-occupancy and vehicle eligibility requirements should not be taken lightly, however. Careful consideration should be given to a number of factors before any decision is made to change vehicle eligibility or vehicle-occupancy criteria. Further, adequate public information should be provided to commuters prior to any actual change.

Consideration should be given to developing policies and criteria for use in guiding the decision-making process on changing vehicle eligibility and vehicle-occupancy requirements. These policies and criteria can serve a number of purposes. First, they can help focus the technical analysis on the key elements that should be examined in the decision making process. Second, they can help communicate the factors that will be considered and the need for a change on a specific project to decision makers and the public. This information is important to help develop an understanding among these groups on when changes may be needed and to build support for changes on a specific facility.

Chapter 5 discussed the guidelines developed by the Washington State Department of Transportation (WSDOT) for determining if changes are needed in vehicle eligibility and vehicle-occupancy requirements on freeway HOV facilities. The WSDOT policies focus on two key measures relating to travel speeds in the HOV lanes and the travel time reliability provided to users of the facilities. Thus, the policies support providing reliable travel times and travel time advantages to HOVs on the freeway HOV facilities in the Seattle area.

Similar examples do not exist for arterial street HOV facilities. It appears that these two factors, along with vehicle volumes and travel time savings may be appropriate for consideration in the development of guidelines for determining when changes need to be made in vehicle eligibility and vehicle-occupancy criteria on arterial street HOV lanes. These criteria are discussed next. These are followed by a discussion of other approaches that may be used to help manage demand on an HOV facility.

- Vehicle volumes
- Vehicle speeds
- Travel time savings
- Travel time reliability

Vehicle volumes. One criteria that can be used to help identify if changes are needed in vehicle-occupancy requirements and vehicle eligibility criteria is the number of vehicles using the facility. As discussed in the previous section on maximum operating thresholds, the guidelines should be matched to the type of facility, design and operating concerns, project goals and objectives, and local conditions. The general ranges provided previously in Table 7-6 can be used to assist with the development of project or areawide guidelines on maximum vehicle volumes.

Vehicle speeds. The speed of vehicles traveling in an arterial street HOV lane can be used as another criteria to help identify the need to change vehicle eligibility requirements or to increase vehicle-occupancy levels. The desired operating speed for a facility should first be identified based on the speed limit for the facility, the general travel speeds in the corridor or freeway, and any special design and operating characteristics. Speeds on the HOV facility can then be monitored. Recurring speeds that fall below the desired level may indicate the need to re-evaluate the existing vehicle-occupancy requirements and possibly the vehicle eligibility criteria.

Travel time savings. This criteria relates to both vehicle volumes and travel speeds in the general-purpose lanes, as well as those on the arterial street HOV facility. Providing travel time savings to HOVs is critical to the ongoing success of a project. It is possible, however, for travel speeds to decrease slightly on a HOV lane, while still maintaining significant travel time savings over the general-purpose lanes. To use this criteria, a desired travel time advantage for HOVs should first be established, and a program to monitor travel times on both the HOV and general-purpose lanes should be established. If this level is not maintained on a regular basis, consideration can be given to changing the vehicle-occupancy requirements or vehicle eligibility.

Travel time reliability. Surveys of carpoolers, vanpoolers, and bus riders indicate that the travel time reliability provided by HOV facilities is as important as the travel time savings in the decision to change from driving alone to using an HOV. Thus, one measure for consideration in developing criteria for changing vehicle eligibility and vehicle-occupancy requirements is the travel time reliability provided by an HOV facility. Once a desired level of reliability has been established for an HOV project or an HOV system, changes and degradations in the level can be monitored and appropriate action can be taken as needed.

G. Other Techniques for Managing Demand

In addition to changing vehicle eligibility and vehicle-occupancy requirements, other techniques may be appropriate for consideration in managing demand on arterial street HOV facilities. As discussed in this section, these approaches focus on managing demand on the facility and on alternative operational strategies. It may be appropriate to consider these strategies first, before focusing on changing vehicle eligibility or vehicle-occupancy requirements.

- Encouraging voluntary higher vehicle-occupancy levels
- Encouraging alternative work or commute schedules

Encouraging voluntary higher occupancy levels. Prior to changing to a higher vehicle-occupancy level, it may be appropriate to first encourage the voluntary formation of carpools at the higher level. Marketing and public information campaigns could be undertaken to encourage the formation of carpools with higher occupancy levels. If a 2+ vehicle occupancy requirement is in effect, the campaign could focus on encouraging the formation of 3+ carpools. This approach may result in enough carpools at the higher level to reduce congestion in the HOV lane. The limited experience with this approach indicates that significant numbers of carpoolers are not likely to increase vehicle-occupancy levels voluntarily.

Encouraging alternative work or commute schedules. A second approach focuses on encouraging commuters to shift their travel to less congested time periods. If congestion is occurring during the peak-hour or the peak-period, HOV users could be encouraged to shift their travel to the periphery or outside of the peak. Greater use of alternative work schedules by employers can help facilitate this shift.

V. HOURS OF OPERATION

A. Factors Influencing Arterial Street HOV Operating Hours

In general, the operating hours of arterial street HOV facilities can be characterized by two different scenarios. These are continuous 24-hour use and peak-period only operation. Factors to be considered in determining the most appropriate operating schedule include the project goals and objectives, the type of arterial street HOV facility, the level of congestion in the corridor, system or regional connectivity, and enforcement and safety concerns. Each of these considerations is described briefly, followed by a discussion of the characteristics associated with the various operating scenarios. Also described are the various alternatives available for consideration during non-HOV operating periods.

Metropolitan, community, and project goals and objectives. The goals and objectives contained in the transportation plan for a metropolitan area or a community, as well as those related to the specific project may influence the hours of operation. With arterial street HOV lanes, many of these goals may relate to providing priority treatments to buses.

Type of HOV facility. Although no one specific operating scenario necessarily equates to a certain type of HOV facility, the orientation and design of a facility will influence the operating hours. For example, bus-only curb lanes in a downtown area may operate only during the morning and afternoon peak-periods in order to allow on-street parking and delivery vehicle access during other times of the day.

Congestion levels in the area or corridor. The level of traffic congestion on the arterial street, as well as in the area or travel corridor may also influence the hours of operation for an HOV facility.

System or regional connectivity. If there are multiple arterial street HOV lanes in an area or arterial and freeway HOV facilities, consideration may be given to coordinating the operating hours of the various facilities. Uniform operating hours can make it easier for commuters and enforcement personnel. Similar operating hours may not always be possible, however, depending on the type of HOV facilities in an area.

Enforcement and safety. The need for enforcement during all operating periods may influence the hours an HOV facility is open. In addition, safety concerns should be considered in assessing alternative operating scenarios.

B. Alternative Arterial Street HOV Operating Hour Scenarios

The characteristics of the three general operating hour scenarios for arterial street HOV facilities are described in this section. Examples of the use of different operating hours are provided, as well as the advantages, limitations, and issues associated with the different scenarios.

24-hour Operation. This approach maintains the HOV designation and operation of a facility on a 24-hour basis. In these cases, the HOV lane is open during all operating periods. Continuous 24-hour operation tends to be found with transit malls, some downtown bus lanes, and arterial street HOV lanes open to buses, vanpools, and carpools.

The 24-hour operating scenario is based on the premise or policy that HOVs should be provided with priority treatment at all times. Since congestion or incidents may occur at any time, the 24-hour designation provides HOVs with travel time savings throughout the day and night. This operating scenario also allows travelers to use the HOV facility during non-commute hours. For example, recreational trips often include more than one person in a vehicle. The 24-hour operating scenario allows these individuals to use the HOV lanes, which may promote wider acceptance of the facility. Off-peak use by travelers may also help encourage peak-period use by commuters.

The 24-hour designation may also help to minimize potential confusion on the part of motorists on whether or not the HOV designation is in effect. Since the vehicle- occupancy requirement is always in effect, motorists know they should not use the lane unless they have the correct number of passengers. As a result, the continuous HOV designation can also make enforcement easier, as there is no question on the operation requirements. Finally, 24-hour operation may simplify signing and lane marketings.

Limitations and issues associated with 24-hour operation of an HOV facility include possible negative public perception if the facility is not well used during off-peak hours, the need for ongoing enforcement, and potential safety concerns. The advantages and limitations should be examined in determining the appropriate operating scenario for a specific facility.

Peak-Period Only Operation. The second operating scenario commonly found with arterial street HOV lanes is peak-period only use. Peak-period operation is usually defined to encompass the hours from 6:00 A.M. to 9:00 A.M. and 4:00 P.M. to 6:00 P.M., although variations are found in these hours. Some facilities use the HOV restriction only in the peak-direction of travel, while others may operate only in the morning peak-period in the peak-direction.

Many arterial street HOV lanes operate only during the peak-periods. For example, downtown curb lanes are often restricted to buses-only during the peak-periods and revert to other uses during the remainder of the day. The Hastings Street HOV lane in Vancouver, which is open to 3+ carpools and buses, also operates only during the peak-periods.

Advantages of peak-period operation include providing priority to HOVs at critical times of the day and addressing specific bottleneck problems. It also allows other functions, such as on-street parking and goods delivery to occur during other times. Depending upon the use of the facility during non-HOV operating periods, possible disadvantages include confusion on the part of commuters, more difficult enforcement, safety issues, and increased signing needs.

Peak-Hour Only Operation. In some cases, HOV lanes on arterial streets may operate only during the peak hours in the morning and afternoon or during daylight hours. The HOV lanes on SR 522 in the Seattle area provide an example of this approach. This operating scenario represents a compromise to address community concerns.

Similar to peak-period operations, this approach provides priorities to HOVs at critical times of the day and can help address specific bottleneck problems. It can also help address possible neighborhood or business concerns.

C. Use of Arterial Street Facilities During Non-HOV Operating Periods

The operating hour scenarios discussed in the previous section correspond to two general operating philosophies. One approach, which equates to 24-hour operation, is a dedicated facility that is reserved for HOVs at all times. The other general approach, which covers peak-period operation, provides HOVs with priority use only during specific times of the day. These facilities may be open for general-purpose vehicles, or revert to curb lanes for parking and delivery vehicles, during non-HOV operating hours.

As discussed in Chapter 4, the planning process should assess the demand for an HOV facility over all operating hours, as well as the opportunities for providing HOVs with priority during the peak-periods. The alternatives for use of an HOV facility during non-HOV operating hours relates to the type of facility, as well as the goals and objectives of the project, and potential operating, enforcement, and safety concerns.

A number of factors should be considered in assessing fully dedicated or part-time HOV facilities. Part-time facilities provide HOVs with priority treatment during the critical times of the day. As congestion increases in many areas, however, it may be desirable to provide HOVs with priorities during all operating periods. On the other hand, HOV demand on arterial streets may not warrant 24-hour operation. Further, other functions, such as on-street parking and space for delivery vehicles, may need to be accommodated during parts of the day.

VI. ENFORCEMENT

Enforcement of arterial street HOV facilities may be much different than enforcement of freeway HOV lanes. Enforcement of arterial street HOV projects may be difficult for a number of reasons. These include the often short length of many facilities, the lack of available enforcement personnel, the need to allow turning movements for general-purpose traffic, and other issues. The groups involved, the enforcement strategies and techniques, and the fines and citations may all be different. Not a great deal of information is currently available about enforcement of arterial street HOV lanes. This section summarizes the role of enforcement on arterial streets, the groups usually involved in arterial HOV enforcement activities, the elements of an enforcement plan, and general enforcement strategies.

A. Role of Enforcement Policies and Programs

Enforcement is a critical element to the successful operation of arterial street HOV facilities. The role of an HOV enforcement program is to ensure that operating requirements, including vehicle-occupancy levels, are maintained to protect HOV travel time savings, to discourage unauthorized vehicles, and to maintain a safe operating environment. Visible and effective enforcement promotes fairness and maintains the integrity of the HOV facility to help gain acceptance of the project among users and non-users.

Enforcement policies and programs perform a number of important roles. First, the development of enforcement policies and programs will help ensure that all of the appropriate agencies are involved in the process and that all groups have a common understanding of the project and the need for enforcement. Thus, the participation of representatives from enforcement agencies, the courts and legal system, the local jurisdiction, the transit agency, businesses and land use along the corridor, and other groups throughout the development and implementation of enforcement policies and programs is critical.

Second, this same information can be provided to the public, especially travelers in the corridor to help introduce the HOV facilities and to communicate the guidelines for use of the lanes. Third, the enforcement policies and programs should be followed to maintain the integrity of the facility by deterring possible violators and to promote the safe and efficient use of the lane.

B. Groups Involved in Developing Enforcement Policies and Programs

As discussed previously in this chapter, representatives from a number of agencies and groups should be involved in the development of HOV enforcement policies and programs. The various groups to be included in the development of enforcement programs and their specific roles are highlighted next.

Local Municipalities. Representatives from city or county departments will usually have the lead role in planning and developing arterial street HOV lanes, including the enforcement programs. As a result, representatives from the local jurisdiction often take the lead in developing and coordinating the enforcement program.

Transit Agencies. The local transit agency may have the lead responsibility or be a co-sponsor of an arterial street HOV facility. In either case, the transit agency should be actively involved in the development of the enforcement plan and in ensuring that the completed facility is adequately enforced.

State Department of Transportation. Representatives from the state department of transportation will usually have the lead responsibility in developing enforcement policies and programs with HOV facilities on state-owned roadways. The state may play a support role with enforcement activities on HOV projects located on city or county arterial streets.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities has been stressed throughout this Manual. The active involvement of local enforcement personnel is obviously critical in the development and implementation of an enforcement program on arterial streets. The local police are usually responsible for enforcing arterial street HOV facilities, but the state patrol may be involved if a project is on a state-owned roadway.

State and Local Judicial Systems. Representatives from the local courts and legal system should be consulted and involved during the development of the enforcement program. These individuals will be responsible for enforcing fines and citations for improper use of the HOV facilities. Ensuring that they are informed about the purpose and scope of the project and that the proper legal fines, citations, and procedures are being applied will help ensure that violations are upheld in the legal system.

Metropolitan Planning Organization (MPO). Representatives from the MPO are usually members of the multi-agency planning group associated with HOV facilities. As a result, MPO staff may play important roles in assisting with the development of an enforcement program. The MPO may have policies relating to various aspects associated in the operation and enforcement of arterial street HOV facilities.

Rideshare Agency. If a separate agency or organization is responsible for ridesharing in an area, representatives from these organizations should be part of the project management team and should be involved in the development of the enforcement plan if the arterial street HOV facility includes carpools and vanpools.

Federal Agencies. Representatives from FHWA and FTA may wish to assist with the development of enforcement plans for arterial street HOV facilities, especially if federal funds are involved in the design or operation of a project.

C. Elements of an HOV Enforcement Program

An effective enforcement program should include a number of components. The six general elements that should be considered in developing an enforcement program include the legal authority to enforce a facility, the nature of citations for violations and the level of fines, the general enforcement strategies, the specific enforcement techniques, funding, and communicating the program elements to users, non-users, and the public. Each of these elements is summarized in this section and is discussed in more detail in the following sections.

Legal Authority. The appropriate agencies must have the legal authority to enforce the HOV operating regulations, including vehicle eligibility and vehicle-occupancy requirements. Existing statutes should be reviewed during this task and the need for changes in current regulations or new legislation should be identified.

Citations and Fines. The type of citation that will be issued for different violations and the accompanying fine should be examined. Ensuring that the appropriate classification is used will help ensure that citations are upheld in the court system. Establishing fines at levels high enough to deter possible violators is also important.

General Enforcement Strategies. The enforcement strategy for use with a specific arterial street HOV facility should be considered. Possible approaches include routine enforcement, special enforcement, selective enforcement, and self-enforcement. The specific techniques used with each of these approaches may vary slightly.

Specific Enforcement Techniques. A variety of specific techniques can be used with each of the general enforcement strategies. For example, different surveillance and detection methods may be used by stationary or roving patrols, including the use of advanced technologies.

Funding. A variety of funding sources may be used to support enforcement activities. These include federal, state, and local funding available to various agencies. Innovative financing techniques may also be considered for enforcement.

Communication Techniques. The various elements of the enforcement program, including the operating requirements, the penalties and fines for violations, and the techniques used to monitor a facility should be communicated to users, non-users, and the public. This step is important to ensure that all groups have an understanding of the proper use of the HOV facility and the consequences of improper use.

D. Legal Authority for Enforcement

The agency responsible for enforcing the operating requirements of an arterial street HOV facility must have the legal authority to do so. This authority must include the ability to issue citations to individuals violating vehicle eligibility regulations, vehicle-occupancy requirements, hours of operation, speed limits, turning restrictions, no-parking zones, and other operating regulations.

Although the agency charged with enforcement of arterial street HOV facilities, which is usually the local police or, in some cases, the transit police or transit on-street personnel, may have specific authority related to many of these violations, others may need additional legal definition. For example, police have the authority to enforce posted speed limits and no-parking zones. Enforcing vehicle-occupancy requirements on an arterial street HOV facility, however, may not be specifically identified in the statutes outlining the powers and authority of the local police.

Ensuring that the enforcement agency has the power to issue citations, and that these tickets will be upheld in the court system, is a critical first step in developing an enforcement program for an arterial street HOV facility. New or modified legislation or city codes may be needed in some areas to address enforcement of arterial street HOV facilities. In addition, some areas have allowed transit personnel to issue tickets or warnings to vehicles parked illegally in bus stops or bus lanes.

E. Citations and Fines

Related to the legal authority to enforce the operating requirements of an arterial street HOV lane is the type of citation that will be issued for various infractions and the fine associated with these violations. In most cases, the citations used with arterial street HOV lanes fall within the general categories of parking or stopping in no-parking zones and moving violations such as turning at a restricted intersection or traveling in a restricted lane. The fines associated with these violations vary greatly by urban area, but commonly range from $25 to $75.

F. General Enforcement Strategies

Enforcement strategies for HOV facilities on arterial streets can generally be categorized into four basic approaches. These are routine enforcement, special enforcement, selective enforcement, and self-enforcement. All of these strategies may be appropriate for consideration with the various types of arterial street HOV projects, although not all approaches are currently being used with arterial applications. The most effective approaches and techniques will vary by the type of HOV facility and the conditions in the area. The four general enforcement approaches are described in this section.

Routine Enforcement. Routine enforcement represents the normal level of police activity in an area, regardless of the presence of an arterial street HOV facility. This approach does not include extra patrols or other special activities because of the HOV lane. Rather, the normal level of policing along a roadway is provided and monitoring HOV lane use is just one of many responsibilities of the enforcement personnel.

Routine enforcement may be considered in a number of situations. First, this approach may be appropriate once an HOV lane has become well established and the violation rate is at a low or locally accepted level. Second, routine enforcement may be used when the design or operation of a facility makes it relatively easy to monitor. Finally, if resources are not available to fund other approaches, routine enforcement may be the only alternative available.

Special Enforcement. Special enforcement involves the dedication of additional personnel and resources to monitoring and policing an arterial street HOV facility. Approaches may include assigning a patrol car specifically to an HOV lane, adding extra patrols along a roadway with an HOV facility, or locating enforcement personnel along a facility during all operating hours. Special enforcement activities may be accomplished by reallocating existing personnel or by adding additional enforcement during key operating periods.

Selective Enforcement. Selective enforcement may be undertaken in response to a number of different factors, or it may be scheduled on a somewhat regular basis to provide periodic saturation of an HOV facility. As noted with specific enforcement, selective enforcement may be an appropriate approach to utilize when a new arterial street HOV facility is open. It may also be used when other significant operating changes have been made, as well as in response to high violation rates or to target problems in a specific area.

Self-Enforcement. The last general approach is self-enforcement. This strategy involves self-regulation by HOV lane users and motorists in the general-purpose lanes. Self-enforcement is usually used with other approaches, rather than as the only enforcement strategy. As noted previously, the HERO program in Seattle provides the best example of a self-policing HOV enforcement effort. The HERO program is used on both freeway and arterial street HOV facilities in the Seattle area.

G. Specific Enforcement Techniques

A variety of enforcement techniques can be used to monitor arterial street HOV facilities. These techniques focus on providing surveillance of the lanes, detecting and apprehending violators, and issuing citations or warnings to violators. The following enforcement techniques are summarized in this section. As discussed at the end of this section, most areas use a combination of enforcement techniques.

- Stationary Enforcement Patrols
- Roving Enforcement Patrols
- Team Patrols
- Multipurpose Patrols
- Electronic Monitoring

Stationary Enforcement Patrols. Stationary patrols involve the assignment of enforcement personnel at specific locations along an arterial street HOV facility. In the arterial street environment, stationary patrols will most likely be located in driveways, at intersections, or at other available spots along the roadway. Special enforcement areas are not usually considered or provided with arterial HOV facilities. In addition, stationary patrols may involve enforcement or transit personnel on foot at bus stops or other strategic points.

Roving Enforcement Patrols. This technique involves enforcement vehicles patrolling the length of the HOV facility. Patrol cars, motorcycles, and officers on bicycles and horses may all be used to monitor arterial street HOV facilities. Enforcement personnel can monitor the use of the facility and the vehicle-occupancy requirements, and apprehend violators. In most cases, violators are pulled over at appropriate areas along the roadway.

Team Patrols. This technique uses various combinations of stationary and roving patrols working in unison to monitor an arterial street HOV facility and to apprehend violators. Potential combinations may include multiple stationary patrols, multiple roving patrols, or a combination of stationary and roving patrols.

For example, a stationary patrol located at the beginning or mid-point of an HOV facility can monitor vehicle-occupancy requirements and radio vehicle and license plate information on potential violators to a stationary patrol located at the end of the facility, where the actual apprehension takes place.

Multipurpose Patrols. This technique utilizes patrols or personnel that are assigned multiple functions, including HOV lane enforcement. On arterial streets, the responsibilities of these groups may include monitoring parking meters, operation of the HOV facility, general policing, and enforcement. This approach may be used in combination with other techniques and may be supported by advanced technologies to monitor a facility.

Electronic Monitoring. Electronic and other advanced technologies may be used to help monitor an HOV facility and to assist in detecting violators. Although the use of advanced technologies are more likely to be considered with HOV facilities on freeways or in separate rights-of-way, they may be appropriate for consideration with some types of arterial street projects. For example, the use of video enforcement of red lights has been tested in England and considered in some cities in North America. This technique involves photographing a vehicle, including the license plate, going through a red light. A ticket can then be issued by mail. This approach could be used to enforce HOV-only turns, HOV by-pass lanes, or other facilities.

H. Funding Enforcement Programs

Funding sources to support enforcement programs associated with arterial HOV facilities may come from federal, state, and local levels. Since there are usually little or no capital costs associated with enforcement of arterial street HOV facilities, funding is primarily needed for ongoing enforcement activities. Funding for personnel may come from the city or county police department, transit agency, or other sources.

I. Communicating Enforcement Information

The development of a comprehensive public information and marketing program for HOV facilities, including those on arterial streets, is discussed extensively in Chapter 12. Providing information on the requirements for use of the HOV lanes, as well as the penalties for violating these requirements and the enforcement techniques that will be used, should be key parts of these programs. This information should be provided on an ongoing basis through signing along the facility, as well as in marketing brochures and materials. For example, the HERO program in Seattle provides ongoing educational reinforcement on the proper use of the HOV facilities in the area.

Individuals who violate an arterial street HOV facility may be divided into two general categories. The first group is motorists who may not know the requirements or who may inadvertently use a facility during an HOV-only time period. The second group are motorists who knowingly violate the requirements. It is the second group of individuals that most enforcement programs focus on.

Public perception toward enforcement can also influence proper use of a facility. Visible enforcement can obviously keep violators from using the facility. It also builds a positive perception among non-users that the requirements are being enforced and that the integrity of the facility is being maintained. This perception can help build support for a project and help ensure proper use of the facility.

VII. INCIDENT MANAGEMENT

This section discusses incident management on arterial street HOV facilities. Unlike HOV lanes on freeways and in separate rights-of-way, the extent of incident management on arterial street projects is very site specific. The role of incident management is reviewed first, followed by a description of the agencies and groups that should be involved in the development and implementation of an incident management program. The elements associated with incident management are described and general guidelines for developing an incident management plan are presented.

A. Role of Incident Management

There are two aspects related to incident management on arterial street HOV facilities. The first is the development of plans and procedures that can be implemented to respond to accidents, incidents, or special situations on the HOV facility. The second relates to the use of HOV lanes to assist with incident management on the roadway or in the travel corridor. Each of these roles are described briefly in this section.

A variety of incidents may happen on arterial street HOV facilities and roadways. Incidents can cause major problems, especially if they are not dealt with quickly. Common incidents include traffic accidents, disabled vehicles, adverse weather conditions, and other problems. These incidents may result in a lane or lanes being blocked, slowing traffic on the roadway. In addition, drivers on portions of the facility not directly affected by the incident often slow down to look at the problem, causing further delays.

Incident management on arterial roadways should be matched to the environment and nature of the area. For example, incident management strategies on an arterial street located in a major travel corridor with freeways and other facilities in close proximity should be developed and coordinated with those on the other facilities. Incident management on the downtown street system may be different, as may the approaches used in a major suburban activity center.

Being able to respond quickly and efficiently to accidents or incidents on an arterial street HOV facility is important for a number of reasons. First, an incident response program is critical to help ensure the safety of users of the HOV facility. Second, clearing problems quickly can help maintain the travel time savings and the travel time reliability provided by an HOV facility.

In addition, HOV facilities may play a role in incident management on the roadway or in the corridor. For example, an HOV lane may be used to help manage traffic when a major incident or accident has occurred on the roadway general-purpose lanes.

B. Groups Involved in Incident Management

As discussed previously, representatives from a number of agencies and groups should be involved in the development and implementation of incident management plans and programs. The various groups to be included in these activities and common roles of the various agencies are highlighted next.

Local Municipalities. Representatives from local municipalities often will take the lead in the development of incident management programs for HOV facilities located on city or county streets.

Transit Agency. A transit agency is often the sponsor or co-sponsor of an arterial street HOV facility. Representatives from the transit agency may have the lead or supporting role in developing and conducting the incident management program. Transit operators often have the lead responsibility with incidents involving disabled buses or other transit vehicles.

State Department of Transportation. Representatives from the state departments of transportation usually take the lead role in the development of incident management programs for HOV facilities located on state-owned roadways. These individuals may assist with incident management programs for HOV projects on city or county roadways.

State and Local Police. Representatives from the state and local police should be actively involved in the development of the incident management program, since they usually share responsibility for responding to accidents and help to manage incidents. Police personnel may take the lead in developing certain aspects of the program.

Emergency Medical Services (EMS), Fire Departments, and Other Emergency Personnel. These groups are also usually responsible for responding to incidents or accidents, especially those that involve personal injury or other special circumstances. Involving representatives from these organizations in the development of the incident management program will help ensure timely and appropriate responses to actual accidents or other emergencies.

Tow Truck Operators. If tow truck operators or other wrecker services are used to remove disabled vehicles from the HOV facility, they should also be involved or at least apprised of the development of the incident management plan.

Federal Agencies. Representatives from FHWA and FTA may wish to assist with the development of incident management programs. Personnel from these agencies can often provide technical assistance on specific issues or suggestions on how certain issues have been addressed in other areas.

C. Elements of an Incident Management Plan

An incident management program should address the major elements necessary to detect a problem, to respond appropriately to clear the incident and return the facility to normal operations, and to communicate necessary information to other motorists to help manage the situation. These four elements—detecting, responding, clearing, and communicating—are summarized next. As noted previously, the techniques and approaches used with arterial street HOV facilities should reflect the local environment, the type of facility, and any other unique features.

Detection. An accident or incident must be reported for a response to be initiated. Detection refers to the ability to identify that an incident has occurred, and to obtain accurate information on the location, nature, and scope of the problem. The sooner an incident can be identified, and the proper responses initiated, the faster the problem can be cleared and the facility returned to normal. A wide variety of methods and technologies can be used to help detect an incident. These include more traditional approaches, as well as advanced technologies. Potential approaches for use on arterial streets are highlighted in Table 7-7.

Visual Detection by Enforcement and Operation Personnel. Police officers, bus drivers, and other operating personnel on a roadway or in a corridor usually provide a basic level of monitoring for incidents and accidents. These individuals can report problems by radio to the appropriate group to initiate the incident response program. Currently, these are the most common approaches used to detect incidents on arterial roadways.

Calls from Motorists Using Cellular Telephones. The proliferation of cellular telephones has provided another technique for detecting traffic problems. In many metropolitan areas, the state department of transportation, commercial traffic reporting services, or other groups publicize toll free numbers for travelers to report accidents or other problems on the roadways. This approach can be a relatively inexpensive way of obtaining information on the status of highway or arterial street conditions and accidents. The accuracy of the information may be the higher on arterial streets than on freeways, as motorists may be better able to identify the exact location of an incident.

Roadside Telephone Call Boxes. Some metropolitan areas have installed roadside telephone call boxes on freeways for motorists to use to report accidents, incidents, or other problems. Calls made from these boxes are received by state or other operating personnel and the appropriate responses can be initiated. This technique may be appropriate for consideration in limited applications on major arterial roadways. Issues related to potential vandalism, as well as the proximity of pay telephones, should be explored when considering this approach.

Table 7-7. Possible Surveillance and Detection Techniques with Arterial Street HOV Facilities

Level of Technology	Technique
Low/manual	• Visual detection by police, bus operators, motorist assistance patrols, or agency personnel. • Calls from motorists using cellular telephones. • Reports from roadside call boxes. • Information from commercial traffic reporters.
Mid level/semi-automated	• Loop detectors. • Closed-circuit television cameras.
High/automated	• Automated vehicle identification (AVI) and Automatic Vehicle Location (AVL). • Full advanced transportation management systems (ATMS) or integrated transportation management systems (ITMS).

Commercial Traffic Reports. Most metropolitan areas have one or more commercial traffic reporting services. These businesses may use a variety of techniques, including helicopters, roving patrols, cameras, and calls from motorists to monitor the flow of traffic on major travel routes. This information is provided in regular traffic reports on radio and television stations. The same information can be provided to the state department of transportation and other agencies. These reporting services tend to focus primarily on freeway traffic conditions, but they may cover major arterial roadways as well.

Loop Detectors. Loop detectors, usually metal induction loops located in the roadway pavement, are used in many metropolitan areas to obtain vehicle volume data. In many cases, this information is analyzed at a later date rather than being used for real-time traffic monitoring. However, these systems can be used to help with detection capabilities by monitoring traffic speeds and stopped traffic on a real-time basis.

Closed-Circuit Television Cameras (CCTV). The use of closed-circuit television cameras and other advanced technologies is becoming more common in large and medium-sized metropolitan areas. Cameras are usually placed at regular intervals along a freeway or corridor and monitored from a remote location. CCTVs are integral parts of an advanced transportation management system (ATMS) and are monitored by agency personnel in a control center. CCTV provides an excellent technique for monitoring freeways and HOV facilities. Further, CCTV cameras are located or are being installed along arterial streets in some areas. For example, CCTV cameras are in use on arterial streets in Montgomery County, Maryland, and in Bellevue and Seattle, Washington.

Automated Vehicle Identification (AVI) and Automatic Vehicle Location (AVL). AVI and AVL technologies are being used to assist in monitoring the status of HOV and freeway facilities in some areas. These technologies may also be appropriate for consideration with arterial street HOV projects. A bus AVL system could also be used to help monitor the status of vehicles and the general traffic flow on an HOV lane. The AVL system can help identify when buses have stopped unnecessarily or when travel speeds have slowed to levels that indicate a problem.

Advanced Transportation Management Systems (ATMS) or Integrated Transportation Management Systems (ITMS). These systems focus on the deployment of advanced transportation surveillance, monitoring, and communication systems using a wide range of advanced technologies, including the components noted previously. Surveillance systems transmit information on facility conditions to a central control center. This information is constantly monitored by operating personnel and appropriate responses, including dispatching emergency vehicles and communicating with motorists in the corridor, can be taken to incidents and accidents. The initial development of ATMS and ITMS has been oriented to the freeway system. ATMS and ITMS is broader than just freeways, however. These systems are being expanded to include frontage roads and arterial streets.

The use of these surveillance and detection techniques are not mutually exclusive. In most areas, multiple strategies and technologies are used in a corridor and throughout a metropolitan area. The various approaches can compliment rather than duplicate each other.

Response. Once an accident or incident has been identified, the proper response can be initiated. A variety of approaches can be used, depending on the nature, severity, and scope of the problem. The key is to match the response to the specific situation. Unlike freeways response strategies described in Chapter 5, techniques on arterial roadways are more likely to be handled by traditional methods and local police and EMS personnel. Table 7-8 provides examples of response strategies that may be appropriate for different types of situations on arterial streets. The general types of response vehicles and personnel include commercial towing services, police, EMS, fire, and specialized response teams.

Clearing. This step in the incident response process involves removing the disabled vehicle or clearing the incident scene and returning the facility to normal operations. The types of vehicles and personnel highlighted in Table 7-8 are usually involved in both responding to, and clearing an incident or accident on an arterial street. As noted above, local police, EMS and fire personnel, and commercial tow truck operators are typically involved in clearing accidents on arterial roads.

Table 7-8. Response Strategies to Incidents and Accidents on Arterial Street HOV Facilities

Incident	Potential Response Strategies
Disabled vehicle (flat tire, run out of gas, etc.)	• Commercial towing service. • Police.
Disabled bus	• Transit operator tow truck and replacement bus. • Commercial towing services. • Police to manage traffic.
Accident/no injuries	• Police. • Commercial towing service.
Accident/injuries	• Emergency Medical Services (EMS) and ambulance. • Police. • Commercial towing service.
Accident/special problems (toxic substance, etc.) or hazardous waste	• Police. • Commercial towing service. • Fire, EMS, or other special response team.
Snow, ice, flooding or other weather-related emergency	• Snow plows and other service vehicles. • Commercial towing service.

Communication. The last element of an incident management program is communicating information on the status of an arterial street and HOV facility to other agencies and the motoring public. A variety of techniques and technologies can be used to provide current or real-time information to HOV lane users, motorists in the general-purpose lanes, and other agencies. This step is important to provide commuters and travelers with information on major problems and significant delays on a facility, as well as alternate routes that they may wish to take. The following approaches and technologies, which may be more commonly found on freeways, can be used to communicate with the traveling public on arterial roadways as well.

Commercial radio and television stations. Information updates on the status of HOV lanes, freeways, arterial streets, and other facilities can be provided to commercial radio and television stations. Many radio and television stations in metropolitan areas provide regular traffic updates during the morning and afternoon peak-periods. The information for these updates may be obtained from public agencies, commercial traffic reporting services, or station personnel using the detection technologies described previously. These traffic reports usually focus on the freeway system, but conditions on major arterial roadways and major incidents on the arterial street system may be covered.

Highway Advisory Radio. Highway Advisory Radio (HAR) provides a dedicated radio channel for information on roadway and travel conditions. HAR is operated by a public agency, usually the state department of transportation, and is often broadcast out of an ATMS control center. HAR may cover a specific freeway, roadway, or a portion of a metropolitan area. HAR broadcasts may be provided during the peak-periods or reports may be provided throughout the day. A low-frequency AM band width is usually used for most HAR stations. Most HARs currently focus on freeways. This technique may be appropriate for use with major arterials.

Changeable message signs. Changeable message signs are used in many metropolitan areas to communicate with motorists on freeways and on HOV facilities. A variety of signs and technologies are commercially available. These signs can be used to provide short concise messages to motorists on traffic conditions, major incidents, alternate routes, and other critical information. Although less suited to the arterial street environment, changeable message signs may be appropriate to use in some corridors or roadways. The location of changeable message signs should be carefully considered if they are intended to help divert or re-route traffic in response to incidents. Ensuring that the signs are located well in advance of points where motorists can take alternate routes or actions is important.

Advanced traveler information systems. More emphasis is being placed on communicating real-time information on the status of different travel modes to commuters to allow for more informed travel choices. Advanced traveler information systems (ATIS) focus on providing real-time information to individuals prior to starting a trip, en-route, or in-vehicle. Various technologies can be used to accomplish this objective. Including information on arterial street conditions may be appropriate for consideration in some metropolitan areas.

D. Use of Arterial Street HOV Facilities to Assist with Incident Management

As noted previously, HOV facilities can be used to assist with managing incidents and accidents on the general-purpose lanes or responding to other special circumstances. Although most HOV facilities on freeways are used to assist with incident management under certain conditions, there is less experience with arterial street HOV projects and incident management. In general, there may be less opportunity to assist with incident management due to the special nature and short length of many arterial street HOV applications. The use of an HOV lane to help with incident management will depend somewhat on the type of facility, access points, and other factors.

The incident management plan should address the use of HOV lanes to help with incident management on other facilities. It is important that the plan clearly identify when and under what conditions the HOV facility will be used to help manage traffic, how it will be used, the specific procedures that will be followed, and the responsibilities of the various agencies. These elements are critical to help ensure the safe operation of both the HOV facility and the general traffic lanes.

VIII. INTERSECTION CONTROL, DRIVEWAY ACCESS, AND CURB USE CONSIDERATIONS

As noted previously, a number of other factors often need to be addressed in the development and operation of arterial street HOV facilities. Consideration may need to be given to general-traffic turning movements at intersections, on-street parking and delivery vehicles, access to driveways, pedestrians, and bicyclists. The safety of HOV lane users, motorists, bus passengers, pedestrians, bicyclists, and other individuals should be examined in this process. The potential issues associated with these elements are discussed in this section, along with possible approaches for resolving these problems and ensuring the safe operation of the facility.

A. Intersection Control and Turning Movements

One of the major issues with arterial street HOV lanes is how to accommodate turning movements for general-purpose traffic. Problems with turning vehicles may arise with HOV facilities located on the right, left, and center of an arterial street. A variety of approaches can be used to address these conflicts and to ensure the safe operation of the HOV facility.

A first approach is to restrict turning movements during all or a portion of the day. This technique eliminates the potential for conflict between buses or HOVs and general-purpose traffic. It is not feasible to restrict turns at every intersection along an arterial street, however, and alternative or periodic turning locations must be provided. Another approach is to allow general-purpose traffic to enter the HOV lane to make either a right or left turn. This strategy may degrade the HOV lane if there are high volumes of general traffic. Another approach is to construct a separate turning lane for general-purpose traffic on the outside of the HOV lane and allow general-purpose traffic to cross the HOV lane to access the turn lane. Safety problems and conflicts may also arise between slowing or stopping buses and turning general-purpose traffic.

Allowing turning movements from the general-purpose lane across the HOV lane represents still another approach. Although this technique accommodates general-purpose traffic, it may degrade the HOV lane. Safety concerns may also arise with vehicles turning in the path of an oncoming bus.

B. On-Street Parking and Delivery Vehicles

Using a curb lane for a bus-only or HOV lane will require the removal of on-street parking and waiting areas for delivery vehicles during all or a portion of the day. The loss of on-street parking is often a major concern for merchants and businesses located along the street. The loss of service delivery space may also be a problem if alternative access points are limited or do not exist.

A number of approaches can be used to address potential conflicts between competing curb use functions. First, the HOV-only restriction may be in effect only during the peak hours or peak-periods when bus or HOV volumes warrant. This strategy accommodates the on-street functions during the non-HOV operating periods and may provide a compromise that satisfies all groups. A potential problem with this approach is vehicles parking during the HOV-operation period. Visible and continuous enforcement may need to be provided with this shared-use strategy.

Providing alternative parking and service delivery spaces is a second alternative that may be appropriate for 24-hour HOV lanes. On-street parking may be relocated to a cross street or a parking lot or garage may be developed as part of a project. Service delivery access may be accommodated through a side street, alley, or other approach.

C. Driveway and Land Use Access

Another common issue with arterial street HOV facilities is providing access to driveways and land uses along the roadway. Since a primary function of the arterial roadway network is to provide access to adjacent developments and land uses, consideration should be given how these movements will be accommodated.

Driveways are important to provide customers with easy and convenient access to businesses, schools, hospitals, and other land uses. In many suburban areas, developments have been designed so that the buildings are off-set from the road by a private or shared parking lot, while in other areas multiple driveways may access an arterial. In downtown areas, mid-block access to parking garages or service alleys may be needed.

From an arterial street HOV operating perspective, driveway access and egress movements may hinder the flow of buses and HOVs. Automobiles entering a driveway will slow down to make a turn, and vehicles exiting a driveway onto an arterial street will slow vehicles in the HOV lane. Thus, on many arterials, the right lane tends to be a slower lane than the adjacent lanes.

There are several options available to minimize the impacts to a right side HOV lane, while maintaining access to local businesses and land uses. Access management in the form of driveway consolidation may be an option in some locations, especially where businesses are closely spaced and parking lots are shared. In areas where cross-streets are frequent, it may be possible to use the side streets for parking lot egress and limit the driveways on the main roadway.

D. Pedestrian Considerations

Pedestrian safety, comfort, and access to businesses and bus stops are important components of arterial street HOV operations. Providing buffers between traffic lanes and sidewalks, such as plantings, trees, and curbside parking may enhance both safety and comfort of pedestrians, especially along busy arterials. Minimizing vehicle and pedestrian conflict by reducing the number and width of driveways and minimizing cross-walk distances also contributes to a pedestrian friendly arterial. Transit stops locations should be determined with pedestrian needs and safety in mind.

Some arterial HOV treatments, such as HOV lanes, signal queue jumps, and HOV left turn lanes may require that the overall roadway cross-section be widened. These changes may result in longer crossing distances for pedestrians, which may reduce pedestrian safety and convenience. As a result, consideration should be given to ways to enhance pedestrian safety if these approaches are being implemented. Bus bulbs may be used to reduce the intersection width or pedestrian safety zones at mid-way points at a busy intersection may be provided.

E. Bicycle Considerations

Bicyclists are allowed to use arterial street HOV facilities in some areas. In other areas, bicycle lanes have been incorporated into the overall design of the HOV facility. Additional design and operational considerations should be given to facilities that will be shared by HOVs and bicyclists to ensure the safety of both user groups. Design features to enhance bicyclist safety and reduce potential conflicts are described in Chapter 8. Elements to consider in assessing the potential for shared use include the volume and speed of vehicles in the HOV lane, turning movements and driveway access, alternative bicycle paths or routes, and other safety considerations.

IX. ONGOING MAINTENANCE OF ARTERIAL STREET HOV FACILITIES

Ensuring that arterial street HOV facilities are well maintained is important from an operations perspective, as well as from the point of view of users, businesses, and neighborhood groups. The type of roadway and HOV facility, the area, and utilization levels will all influence maintenance requirements.

In general, the agency with jurisdiction over the roadway will also have responsibility for ongoing maintenance of the HOV facility. Routine maintenance may include sweeping and picking up debris, repairing potholes and signals, snow removal, and other regularly scheduled activities. Periodic maintenance may include resurfacing and other more significant repairs.

Maintenance of HOV facilities usually becomes part of the ongoing street maintenance program in the specific area, although special attention may need to be given with some types of arterial street applications. In most cases, regular activities such as street cleaning and snow removal are conducted as normal.

The ongoing maintenance of arterial street HOV facilities should also be coordinated among the various agencies, as well as adjacent businesses and neighborhood areas. For example, although the agency with jurisdiction over the roadway is usually responsible for the HOV lane, in most cases, the transit agency is responsible for bus stops, passenger shelters, and other curbside amenities. Most transit agencies have ongoing maintenance programs to ensure that stops and shelters are kept clean, free of grafitti, and in good operation. In addition, some transit agencies have *Adopt a Shelter* programs where individuals, businesses, or neighborhood groups agree to clean and maintain a specific shelter. Further, a few transit agencies provide funding for street and roadway projects to enhance transit operations. These programs may help finance major maintenance or repair on an arterial street HOV facility.

X. ADDITIONAL RESEARCH NEEDS

The research conducted for this chapter reinforces the lack of available information on operating and enforcing arterial street HOV facilities. The characteristics of the arterial street environment are different from those on freeways or in separate rights-of-way. As a result, much of the experience gained over the years in operating and enforcing HOV facilities on freeways and in separate rights-of-way is not directly transferrable to arterial street projects. A comprehensive research program, which includes the following projects, is needed to address the operation and enforcement of HOV facilities on arterial streets.

Assessment of Operating Arterial Street HOV Treatments. Additional research is needed to fully explore the operation of existing arterial street HOV lanes. This study would start with a comprehensive documentation of the current use of different treatments. It would also explore utilization rates for buses, as well as carpools and vanpools. Potential issues associated with different techniques would be highlighted, along with approaches for addressing these. Operational concerns and strategies appropriate with bus-only lanes, HOV lanes, bicycle and HOV lanes, and other unique situations would be explored. Although many of these issues were examined briefly in this chapter, a detailed assessment was outside the scope of this research. Additional studies are needed to explore the operation of existing and planned arterial street applications.

Priority Treatments for HOVs at Signalized Intersections. Much of the delay experienced by HOVs on arterial streets is caused by traffic signals at intersections. More research is needed to fully document the current practices to give HOVs priority at signalized intersections. This project would also examine the issues associated with providing priority through different techniques and the potential use of ITS and other advanced technologies to overcome these concerns.

Enforcement of Arterial Street HOV Treatments. Enforcing HOV facilities on arterial streets is different from policing those on freeways and in separate rights-of-way. Additional research is needed to assess the use of different enforcement strategies and techniques, to identify those that appear to be most effective, and to examine new approaches using ITS and other advanced technologies.

Development of Evaluation Procedures and Data-Collection Techniques for Arterial Street HOV Treatments. Suggested procedures for monitoring and evaluating freeway HOV facilities have been developed as part of a multi-year FTA funded research project (4). Similar procedures have not been developed for arterial street HOV facilities. This research would start with a review of before-and-after studies, evaluation programs, and data collection techniques with the different types of arterial street HOV facilities. The results of this assessment would be used to develop suggested objectives, measures of effectiveness, data collection techniques, and comprehensive ongoing monitoring and evaluation programs for use with different priority measures for HOVs on arterial streets.

Coordinating Land Use and Arterial Street HOV Facilities. Arterial street HOV facilities may impact adjacent land uses in a number of ways. These include limiting access at driveways or intersections, removing or restricting on-street parking and delivery vehicles, and other impacts. Additional research is needed to obtain a better understanding of the effects arterial street HOV lanes may have on land uses and developments, to identify techniques to overcome potential negative impacts, and to identify approaches to better integrate land use and site design planning with planning and operating arterial HOV facilities.

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CHAPTER 8—DESIGN OF ARTERIAL STREET HOV FACILITIES

LIST OF FIGURES

LIST OF TABLES

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I. INTRODUCTION

This chapter discusses the design elements associated with HOV facilities on arterial streets. It includes information on steps in the design process, the groups that are usually included in this process, vehicle design criteria, and design features of various types of arterial street HOV facilities. Examples of cross-sections, signing and pavement markings, and other design elements are presented. The chapter is divided into the following five sections.

- **Design Process for Arterial Street HOV Facilities**. This section provides an overview of the design process commonly used with arterial street HOV projects. The agencies and groups usually involved in designing an arterial street HOV facility are identified and the steps in the design process are summarized. An overview of arterial street HOV facility design considerations is also presented.

- **Vehicle Design Criteria**. This section presents information on the characteristics and design requirements for vehicles that may use an arterial street HOV facility. These include different types of buses, as well as vanpools and carpools.

- **Arterial Street HOV Lane Design Guidelines**. This section discusses the design elements of various types of arterial street HOV facilities. Typical layouts and cross sections are presented for the different arterial street HOV applications. Alternative designs for transition areas, bus stop treatments, design element associated with signal priority projects, safety and enforcement design considerations, and other unique design issues are also discussed.

- **Regulatory Signing and Marking**. This section examines the signing and pavement marking used with arterial street HOV facilities. Issues such as visibility, clarity of message, placement, and spacing are discussed. Examples of current approaches and general guidelines are provided.

- **Additional Research Needs**. The chapter concludes with a discussion of further research needs related to the design of arterial street HOV facilities.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information on the design of arterial street HOV facilities.

II. DESIGN PROCESS FOR ARTERIAL STREET HOV FACILITIES

A. Groups Involved in Designing Arterial Street HOV Facilities

Similar to the planning phase for an arterial street HOV facility, numerous agencies and groups will be involved in designing a project. The participation of the appropriate agencies and individuals is key to ensuring that all groups are involved in discussing the different design elements, that potential issues are identified and resolved prior to implementation, and that all groups have a common understanding of the project.

If a multi-agency team or a multi-department team within an agency was formed during the planning phase of a project, this group may continue through the design process. A special subgroup or committee, comprised of the design personnel from various agencies, may be organized to address the specific design issues with arterial street HOV facilities. In addition, consideration should be given to other groups that may need to be involved or consulted, such as neighborhood and business organizations and the agency personnel responsible for operating and enforcing a project.

Table 8-1 identifies the various agencies and groups that should be considered for inclusion in the design of an arterial street HOV project. The roles and responsibilities of each group are highlighted in the table and described in more detail below. Practitioners can use the information in Table 8-1 as a guide to help ensure that consideration has been given to including the various groups in the development of the recommended design for an arterial street HOV facility. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

Local Municipalities. City or county departments often have the lead responsibility on arterial street HOV facilities. As the lead agency, the city or county may be responsible for all aspects of a project including planning, designing, implementing, operating, and maintaining an arterial street HOV facility. In these cases, the local municipalities would also head the multi-agency team and would take the lead in designing the project. In other cases, a transit agency may have overall responsibility for an arterial street project, or the state department of transportation may be the lead if the project is on a state-owned roadway. City or county personnel still usually play a major role even in these cases, however, as they have authority over the local street and traffic signal systems. The engineering and planning departments most frequently are responsible for these activities, although staff from other departments may also be involved.

Transit Agency. A transit agency may have the lead responsibility with HOV facilities on arterial streets or may be a co-sponsor of a project. In either case, the transit agency usually works closely with the local municipality or the state agency with jurisdiction over the street and traffic signal systems. If the transit agency has the overall responsibility for the project, they will also have the lead role in designing the facility. If the transit agency is playing more of a supporting role, key responsibilities may focus on assisting with the design to ensure safe and efficient bus operations, enforcement, and overall project coordination.

State Department of Transportation. The state department of transportation or the state highway department may play a supporting role with arterial HOV facilities on city or county roadways, especially if the project provides a link from a freeway HOV lane. The state will be the lead agency on HOV facilities located on state-owned roads. Representatives from the state may participate in or head the multi-agency team designing an arterial street HOV project.

Table 8-1. Agencies and Groups Involved in Designing Arterial Street HOV Facilities

Agency or Group	Potential Roles and Responsibility
Local Municipalities	• Overall project management responsibilities. • Major supporting role if transit agency or state is lead. • Design facility or assist with design. • Staffing multi-agency team or participating on team.
Transit Agency	• Overall project management or supporting role. • Design facility or assist with design. • Staffing multi-agency team or participating on team.
State Department of Transportation	• Assist with design of city or county facility. • Design facility on state-owned road. • Coordinate with freeway HOV facilities. • Participate on multi-agency team or staff team.
State and Local Police	• Assist with design, especially any enforcement elements. • Participate on multi-agency team.
Rideshare Agency	• Assist with design if carpools and vanpools allowed. • Participate on multi-agency team.
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multi-agency coordination. • Ensure that projects are included in necessary planning and programming documents. • May have policies relating to HOV facilities.
Federal Agencies—FHWA and FTA	• Funding support. • Technical assistance. • Possible approval of various steps. • Participate on multi-agency team.
Other Groups	• EMS, fire, and other emergency personnel. • Tow truck operations. • Businesses. • Neighborhood groups. • Judicial system—local courts.

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities was stressed earlier in this Manual. Representatives from the state, city, or county police department should be involved in the design of an arterial street HOV facility. These agencies are usually responsible for enforcing arterial street HOV projects. Their participation in the design process can help ensure that an arterial street HOV facility can be adequately enforced.

Rideshare Agency. The rideshare agency in an area may be involved in the design of an arterial street HOV project if the facility will be open to carpools and vanpools. In these cases, the rideshare agency should be included as a member of the multi-agency team and should be involved in the development of the operation and enforcement plan.

Metropolitan Planning Organization (MPO). Representatives from the MPO may participate on the multi-agency team and may provide assistance with the design of arterial street HOV projects. The involvement of MPO staff may depend on the nature and scope of a project and the link to metropolitan-wide facilities.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least to monitor the development of arterial street HOV facilities, including the design process. Personnel from these agencies may provide technical assistance on specific issues or suggestions on how certain elements have been addressed in other areas. Representatives from FHWA and FTA often participate on the multi-agency team.

Other Groups. Consideration should be given to including representatives from other groups or obtaining their input during the design process for an arterial street HOV facility. These may include representatives from the local judicial system who will be responsible for enforcing fines and citations; EMS, fire, and other emergency personnel who have to respond to incidents and accidents on the facility; tow truck operators who may be responsible for removing disabled vehicles; businesses; and neighborhood groups. Involving representatives from businesses and neighborhood groups may be especially important if the project will impact on-street parking or other elements.

B. Steps in Designing Arterial Street HOV Facilities

The design process for an arterial street HOV project will normally involve a number of steps. These include reviewing the results and recommendations from the planning process, considering operational issues and opportunities, obtaining input from the public and local organizations, assessing the specific characteristics of the roadway, developing a preliminary design, reviewing the preliminary design with the public and local organizations, and finalizing the design plans. The steps in the design process are highlighted in Figure 8-1 and summarized next. The public involvement process started during the planning process should continue through the design, implementation, and operation phases. Design concept workshops, focus groups, design charettes, and other techniques can be used to involve the public and stakeholder groups throughout the design process.

Review Recommendations from Planning Process

↓

Consider Operational Issues and Opportunities

↓

Obtain Input from the Public and Local Organizations

↓

Assess Specific Characteristics of Roadway

↓

Develop Preliminary Design

↓

Review Preliminary Design with the Public and Local Organizations

↓

Finalize Design

Figure 8-1. Steps in Designing Arterial Street HOV Facilities

Review Recommendations from Planning Process. The first step in the design process usually involves reviewing the results or recommendations from the planning process. The major elements included in planning arterial street HOV facilities are discussed in Chapter 4. The outcome of the planning process will usually be a recommended alternative or a limited number of alternatives. These recommendations will form the basis for the start of the design process.

Consider Operational Issues and Opportunities. The operating characteristics associated with the recommended arterial street HOV application should be considered early in the design process. Reviewing the operational issues and the opportunities related to the selected HOV alternative can assist in identifying critical elements that may need to be addressed in the project design. Approaches to address these concerns can then be incorporated into the facility design.

Obtain Input from the Public and Local Organizations. The public involvement process started in the planning phase of a project should continue through the design process. Providing the public, business and neighborhood groups, and other organizations with the opportunity to participate early in the design process will help identify any issues and concerns that will need to be addressed. As discussed in Chapter 10, a variety of techniques can be used to involve the public at this point in the process. These may include meetings, design concept workshops, focus groups, surveys, design charettes, and individual interviews. The results of these activities can provide valuable information on the perceptions, concerns, and needs of businesses and land uses along the street, neighborhood groups, and other organizations. will have been examined in the planning stage, a more detailed analysis is usually needed in the design process.

Assess Specific Characteristics of Roadway. The characteristics of the arterial street, the intersection, or other facility being considered for the HOV project are examined in this step. Possible activities include detailed assessments of on-street parking and delivery vehicle spaces, driveways, turn volumes at intersections, bus passenger boardings by stop, and other information. Although many of these items will have been examined in the planning stage, a more detailed analysis is usually needed in the design process.

Develop Preliminary Design. This step includes the development of the preliminary design for the specific arterial street HOV project. Although the complexity and level of detail will vary depending on the type of treatment, the design should be completed to a stage that allows all groups to understand the key components of the facility, to develop realistic cost estimates, and to outline an implementation schedule.

Review Preliminary Design with the Public and Local Organizations. The preliminary design should be reviewed by the public, business and neighborhood groups, and other organizations along the roadway. As discussed in Chapter 10, techniques for public involvement at this stage may include hearings, workshops, outreach efforts, newsletters, and other approaches.

Final Design. The comments received through the public involvement process should be reviewed and any needed modification should be made to the design plans. The design can then be finalized and used to develop the plans and specifications for the project. The actual construction and implementation process can then be initiated.

C. Overview of Arterial Street Environment and HOV Facility Design Considerations

As noted in the previous chapter, arterial streets serve a number of different functions. These include linking neighborhood streets with highways and freeways, providing access to adjacent land uses, accommodating on-street parking and service delivery vehicles, and other functions. These sometimes competing functions must be taken into account in the design and operation of arterial street HOV facilities.

Also as noted in the previous chapter, arterial streets are found within a wide range of settings and environments in an urban area. These include the downtown or central business district, suburban activity centers, neighborhood commercial areas, strip development corridors, and major commuter travel corridors. These areas all have different characteristics, which need to be considered in designing arterial street HOV facilities.

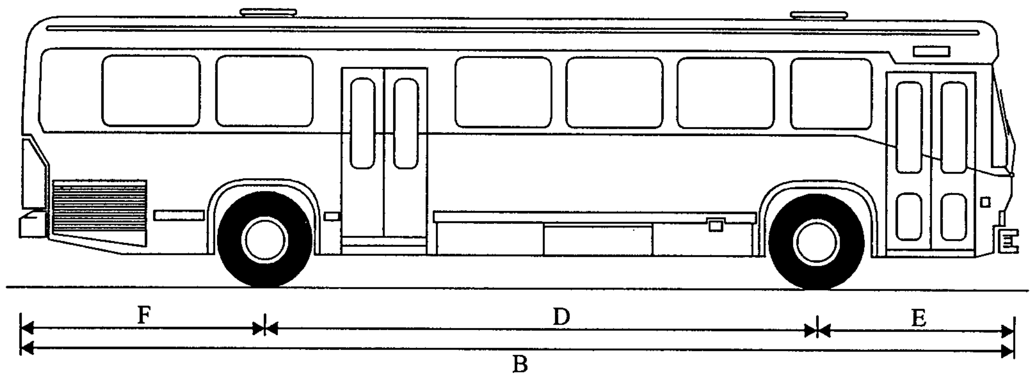
In most cases, arterial HOV treatments will be incorporated into an existing roadway in a heavily developed area. As a result, there may be little flexibility in design approaches. Further, many arterial street HOV applications require only minimum design modifications from the existing roadway cross section. Other factors that may influence design treatments include the part-time use of many facilities, the generally slower operating speeds on arterial streets, and pedestrian and bicycle issues. All of these elements should be considered during the design phase.

As a result, arterial street HOV facilities need to be coordinated with the other functions and elements of the roadway system. These include driveway access to businesses, schools, hospitals, and other land uses; signalized intersections; left and right turns for non-HOV traffic; on-street parking; delivery vehicles; pedestrians and bicyclists; and buses stopping to drop off and pick up passengers.

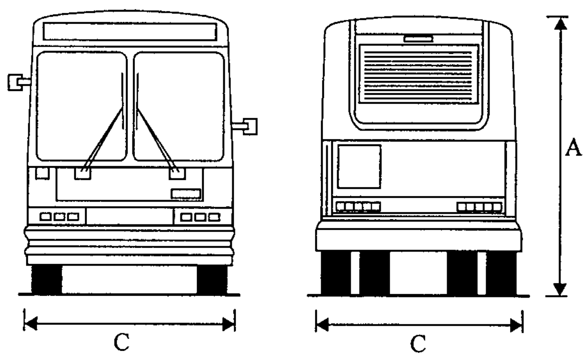
All types of arterial street HOV facilities will require some modification in the existing roadway. Restriping, signage, and pavement markings will usually be needed. Additional design elements may be required for various facilities. For example, physically separating the HOV lane from the general-purpose lanes may require additional right-of-way, and modifications to the placement of traffic signals will be required with contraflow facilities. Further, in some cases, the cross section may be altered by narrowing and restriping existing lanes to accommodate the HOV facility.

III. VEHICLE DESIGN CRITERIA

The physical and operating characteristics of the vehicles that will use the facility will influence the design of an arterial street HOV project. Buses are the primary vehicles allowed to use most arterial street HOV facilities. Standard buses, articulated buses, and mini-buses may all be part of the transit fleet operating on arterial street HOV facilities. The dimensions and turning radii for a 12.1 meter (40 foot) bus, a 13.7 meter (45 foot) bus, and an articulated bus are shown in Figures 8-2 through 8-6. As noted in Figure 8-6, the turning radii for articulated buses is being reexamined by AASHTO. These dimensions, which will also accommodate vanpools and carpools, can be used by practitioners to assist with the design of arterial street HOV projects.



ITEM		
A	Overall Height	3.0 m (9.9 ft) - 3.4 m (11.1 ft) *
B	Overall Length	12.1 m (40 ft)
C	Overall Width	2.5 m (8.2 ft) - 2.6 m (8.5 ft) *
D	Wheel Base	7.2 m (23.7 ft) - 7.6 m (24.9 ft) *
E	Front Axle to Bumper	2.1 m (7.2 ft)
F	Rear Axle to Bumper	2.4 m (9.3 ft)



NET/GROSS VEHICLE WEIGHT * *	
Front Axle	3,370/5,440 kg (7,420/11,980 lbs)
Rear Axle	8,200/11,200 kg (18,060/24,660 lbs)
Seating Capacity	46 - 51*
Standing Capacity	20 - 25*

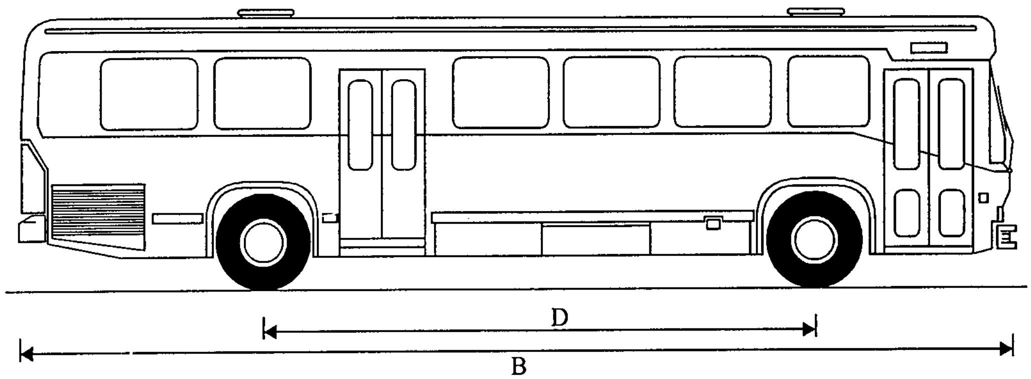
NOTES

* Varies for different types of 12.1 m (40 ft) buses

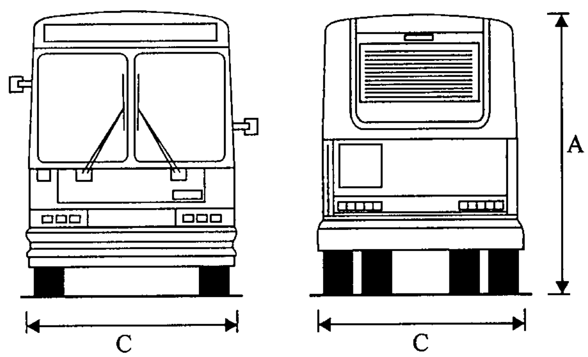
* * Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 8-2. Typical Dimensions of a 12.1 meter (40 foot) Bus

Source: (1,2)



ITEM		
A	Overall Height	3.7m (12.2ft)
B	Overall Length	13.7m (45ft)
C	Overall Width	2.6m (8.5ft)
D	Wheel Base	6.9m (22.9ft)



NET/GROSS VEHICLE WEIGHT **

17,326/22,777 kg (38,150/50,150 lbs)

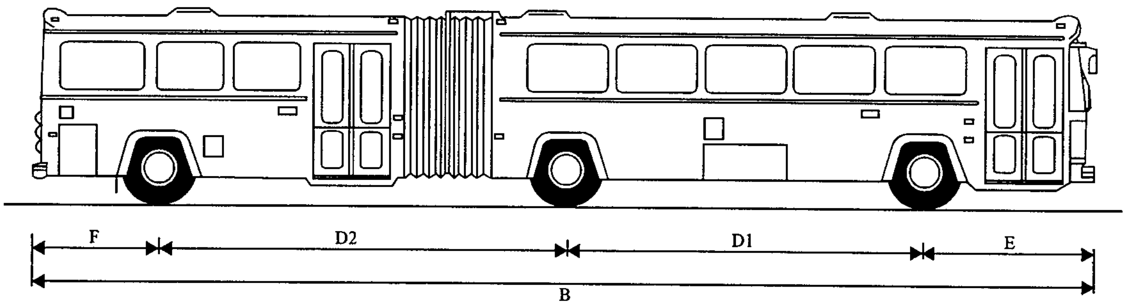
Seating Capacity	50 *
Standing Capacity	28 *

NOTES

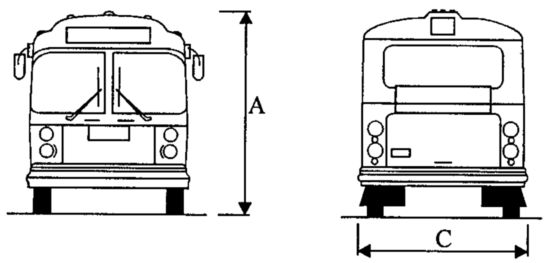
* Varies for different types of 13.7m (45ft) buses
** Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 8-3. Typical Dimensions of a 13.7 meter (45 foot) Bus

Source: (2)



ITEM		
A	Overall Height	3.2 m (10.2 ft)
B	Overall Length	18.3 m (60 ft)
C	Overall Width	2.6 m (8.5 ft)
D1	Wheel Base - Front	5.3 m (17.5 ft) - 5.7 m (18.6 ft)*
D2	Wheel Base - Rear	7.1 m (23.3 ft) - 7.4 m (24.2 ft)*
E	Front Axle to Bumper	2.6 m (8.5 ft)
F	Rear Axle to Bumper	2.9 m (8.7 ft)



NET/GROSS VEHICLE WEIGHT **	
Front Axle	5,360/7,450 kg (11,800/16,420 lbs)
Rear Axle	5,510/7,420 kg (12,130/16,420 lbs)
Center Axle	6,800/11,010 kg (14,970/24,250 lbs)

MAXIMUM BEND ANGLE	
Horizontal	± 36 deg
Vertical	± 11 deg

Seating Capacity	70 - 76*
Standing Capacity	38*

NOTES

* Varies for different types of articulated buses
** Net Weight is "Road Ready" Without Passengers
Gross Includes Passengers

Figure 8-4. Typical Dimensions of an Articulated Bus

Source: (1,2)

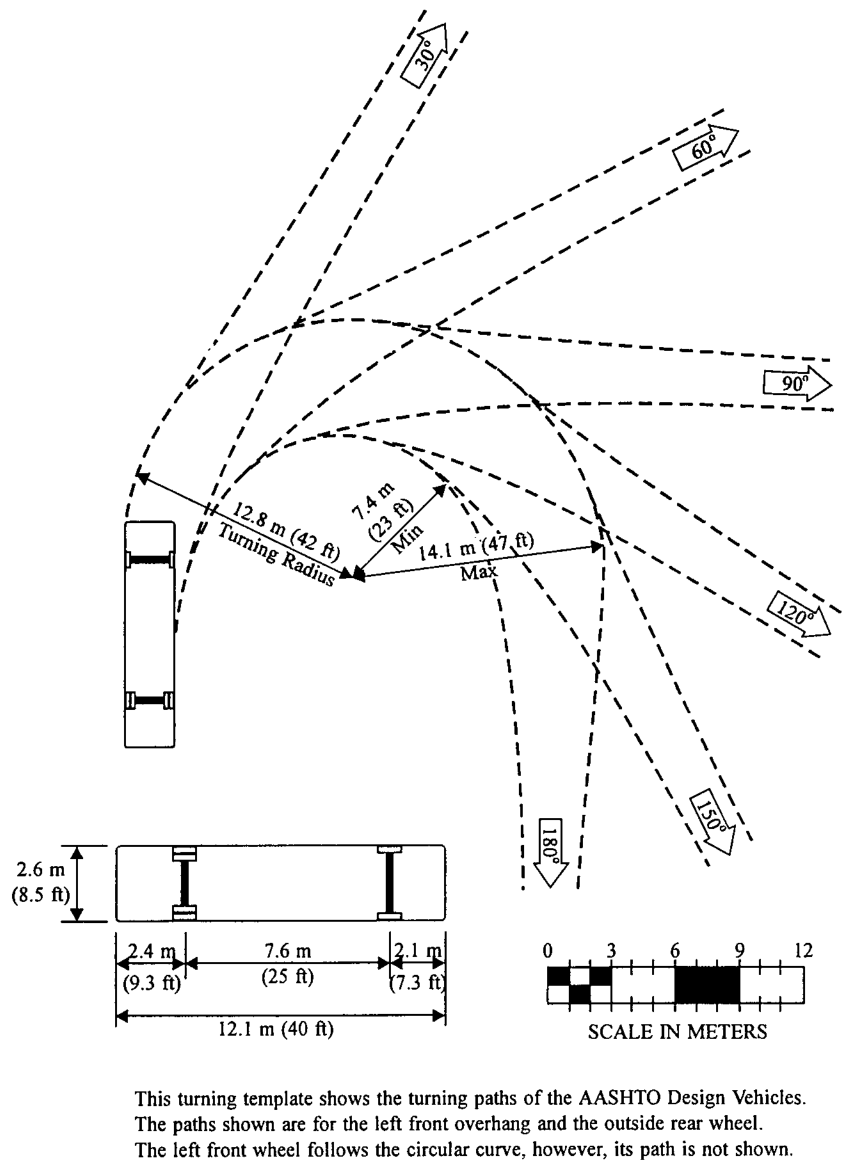
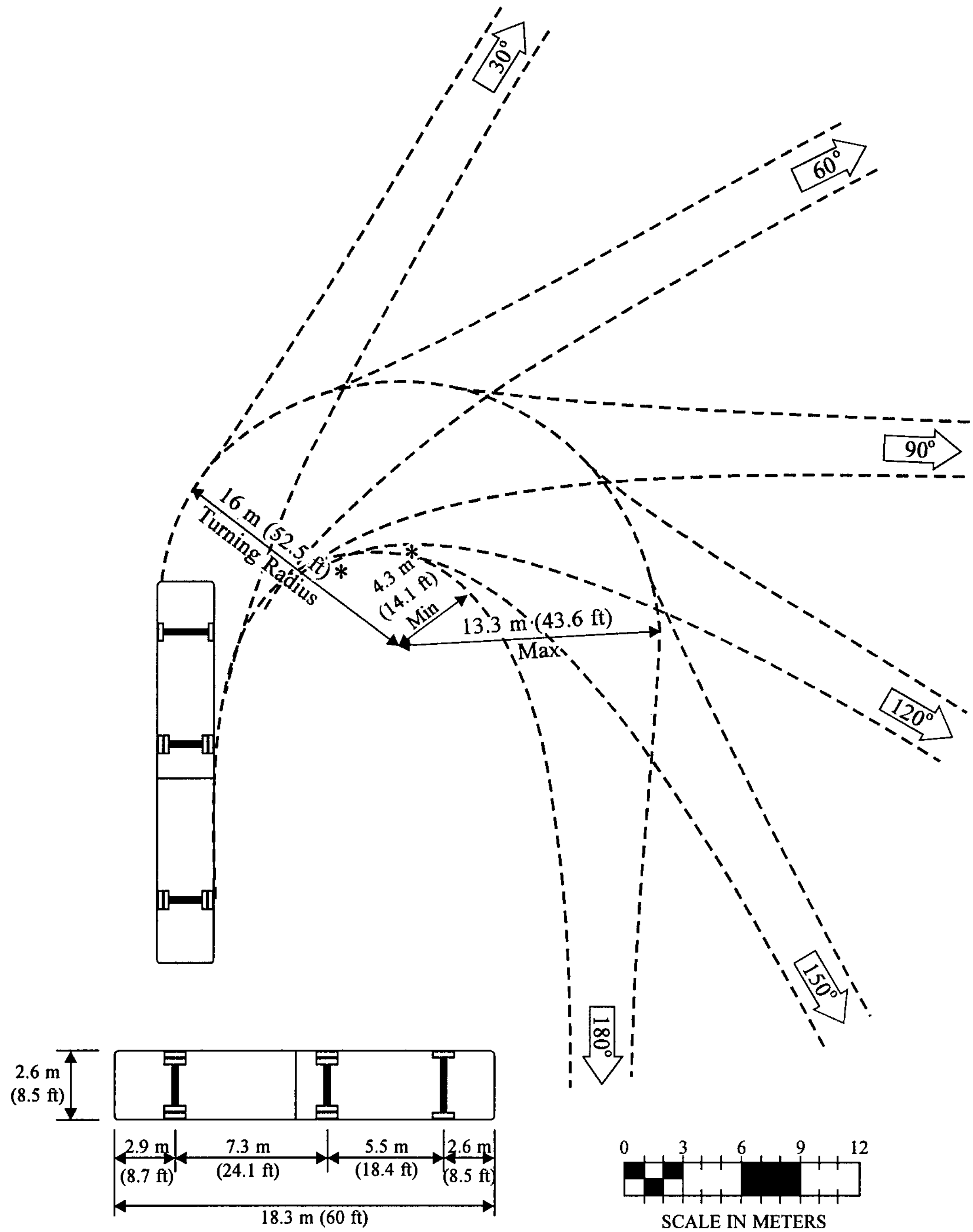


Figure 8-5. Design Turning Template for 12.1 meter (40 foot) Bus

Source: (3)



This turning template shows the turning paths of the AASHTO Design Vehicles. The paths shown are for the left front overhang and the outside rear wheel. The left front wheel follows the circular curve, however, its path is not shown.

* Note: These values are being reexamined by AASHTO.

Figure 8-6. Design Turning Template for an Articulated Bus

Source: (3)

These templates can be used in determining lane and shoulder widths, lateral and vertical clearances, bus stops, and other elements. In addition, the path of the vehicle overhang beyond the outside turning radius must be considered so there is little possibility of encroachment on adjacent traffic lanes. The standard bus can also be used as the controlling vehicle for arterial street HOV design speed transition needs. The nominal rate for acceleration is 3.2 kilometers/hour/second (2.0 mph/second) and for deceleration is 4 kilometers/hour/second (2.5 mph/second). These values assume standing passenger loads. Double-deck buses, which may operate in some areas, have essentially the same characteristics as a standard bus except for vehicle height.

IV. ARTERIAL STREET HOV LANE DESIGN GUIDELINES

A. Typical Cross Sections and Layouts

Typical examples of cross sections and layouts for the various types of arterial street HOV treatments are presented in this section. These examples are provided as guidelines for practitioners to use in designing specific projects. The characteristics of a specific street and area will influence the ultimate design of a facility.

1. **Bus Malls**. The design characteristics of a transit mall are usually very site specific. In general, bus malls will have 3.6 meter (12 foot) travel lanes in each direction. A variety of design treatments, including bus pull-ins, bus bulbs, center medians, special sidewalk space, connections to skywalk systems, and bus passenger and pedestrian amenities may also be provided. The design features of a transit mall will reflect the goals and objectives of the project and the characteristics of the area. A bus mall may be part of a larger project focusing on enhancing a downtown area or a major activity center.

   Figures 8-7 and 8-8 provide examples of the layouts for the transit malls in Denver and Minneapolis. As illustrated in these layouts, the approaches taken in Denver and Minneapolis are quite different. The 16th Street Mall in Denver has 3.6 meter (12-foot) travel lanes in each direction. A wide center median that includes trees, seating areas, and other amenities separates the travel lanes. The Nicollet Mall in Minneapolis provides 3.6 meter (12-foot) travel lanes. Originally designed in a serpentine route, the Mall was redone in the early 1990s to follow more of a crescent pattern.

2. **Right Side Bus-Only and HOV Lanes**. The same general design characteristics are found with the four treatments commonly associated with HOV lanes located on the right side of a roadway. These are curb lane bus-only facilities, curb lane HOV facilities, bus-only facilities using the second travel lane, and HOV facilities using the second travel lane. These approaches usually use the existing curb or travel lanes, with little or no modifications in design. In some cases, the existing cross section may be modified to narrow the general-purpose lanes and restripe the roadway or other changes may be made to accommodate the HOV facility.

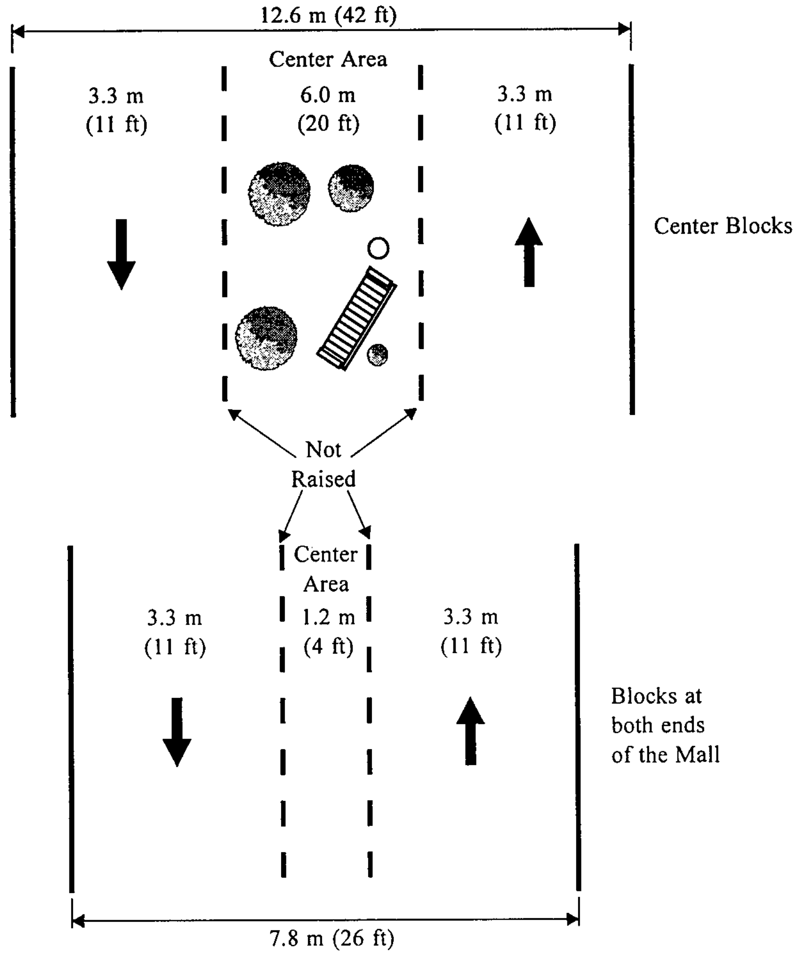


Figure 8-7. Layout for 16th Street Mall, Denver

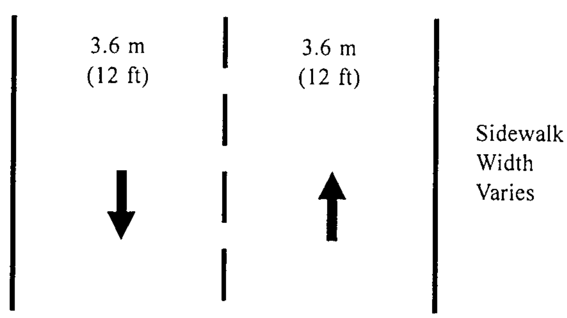


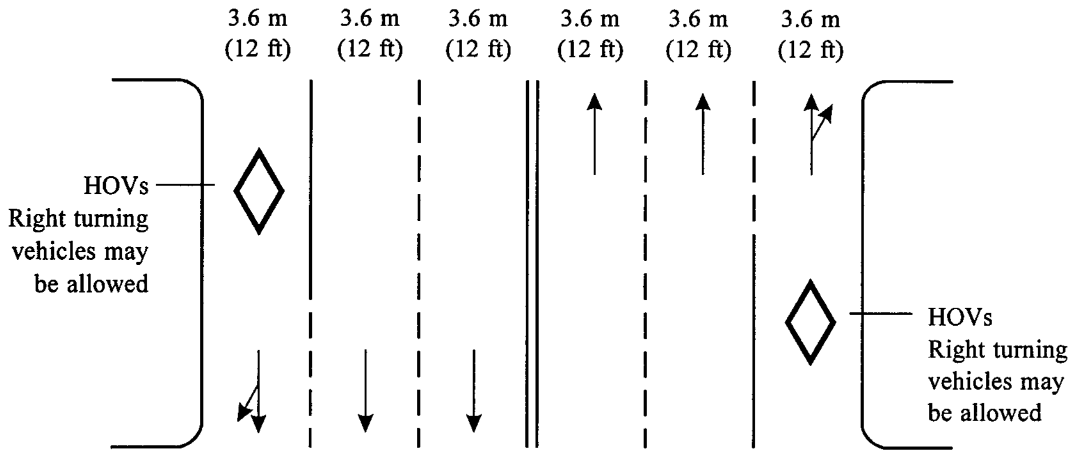
Figure 8-8. Layout for Nicollet Mall, Minneapolis

As shown in Figures 8-9 through 8-11, the cross section for these types of facilities usually include standard 3.6 meter (12-foot) curb and traffic lanes. In some cases, the travel lanes may be reduced to 3.3 meter or 3.0 meters (11 feet or 10 feet). Figure 8-9 illustrates a typical layout for a curb-lane HOV facility. As illustrated, general traffic may or may not be allowed to make right turns at intersections using the HOV lane. Figure 8-10 provides an example of a project using the second lane. With this approach, consideration will need to be given if general-purpose traffic should be allowed to merge through the HOV lane to make right or left turns. Figure 8-12 highlights a curb HOV lane on a one-way street. Modifications on these basic approaches may be used. Design features associated with bus stop treatments that may be used in conjunction with these types of HOV lanes are discussed later in this section.

3. **Left Side Bus-Only and HOV Lanes**. Although there are only a few examples of left-side bus-only and HOV lanes currently in operation, a number of design treatments may be used with these facilities. A relatively simple approach, illustrated in Figure 8-12, reserves the 3.6 meter (12-foot) left lane for buses or HOVs. This technique may be used in cases where there are high volumes of HOVs in one direction of travel or to provide access to an HOV-only left turn lane. Another design, shown in Figure 8-13, includes a barrier separation and a transit stop. Still another approach, shown in Figure 8-14, uses the left curb lane on a one-way street for an HOV facility.

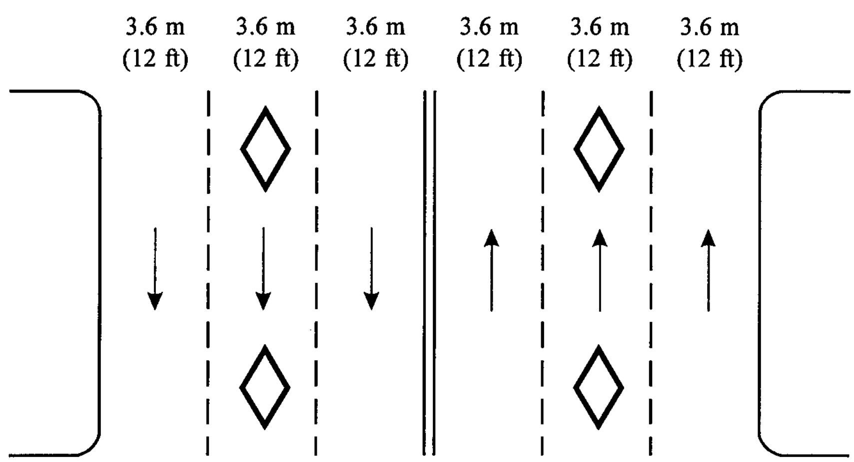
4. **Center Bus-Only and HOV Lanes**. HOV facilities located in the center of a roadway may include a single reversible lane or HOV lanes in both directions of travel. These facilities may be physically separated from the general-purpose travel lanes or paint striping can be used to delineate the lanes. Figure 8-15 provides an example of a barrier separated reversible center HOV lane. For safety reasons, consideration should be given to using some type of barrier or buffer separation with a reversible facility. Figure 8-16 illustrates an example of a non-separated two-directional facility, and Figure 8-17 shows barrier-separated lanes. In all cases, the HOV travel lanes are 3.6 meters (12 feet) wide. The barrier separation may add 0.6 meters to 1.2 meters (2 feet to 4 feet) to the cross section depending on the type of treatment used.

   Center located bus stops may also be used with these type of facilities. In most cases, stops will be positioned on either the near-side or the far-side of an intersection to allow easy passenger access. If the facility is shared by buses and carpools, consideration should be given to providing passing lanes or bus pull-ins at stops. Although these treatments allow carpools to bypass buses picking-up or dropping-off passengers, they also require additional right-of-way and will increase the capital cost of a project.



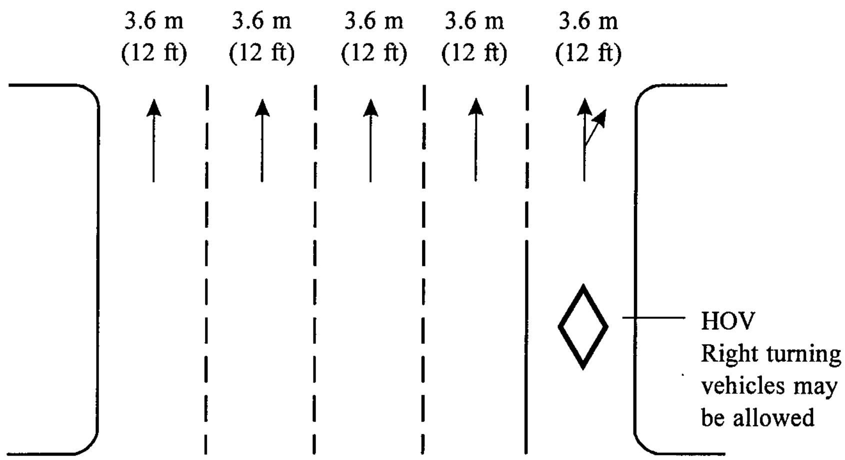
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-9. Layout for Curb-Lane HOV Facility on Two-Way Street



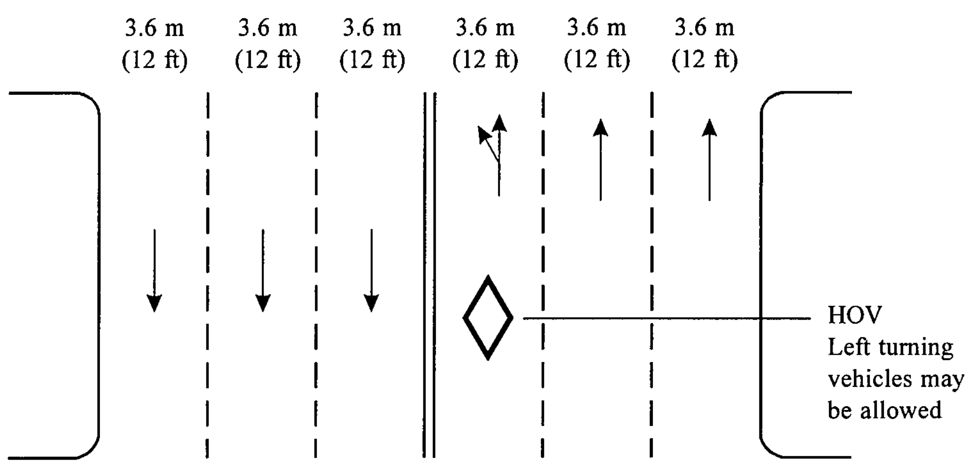
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-10. Layout for Second-Lane HOV Facility on Two-Way Street



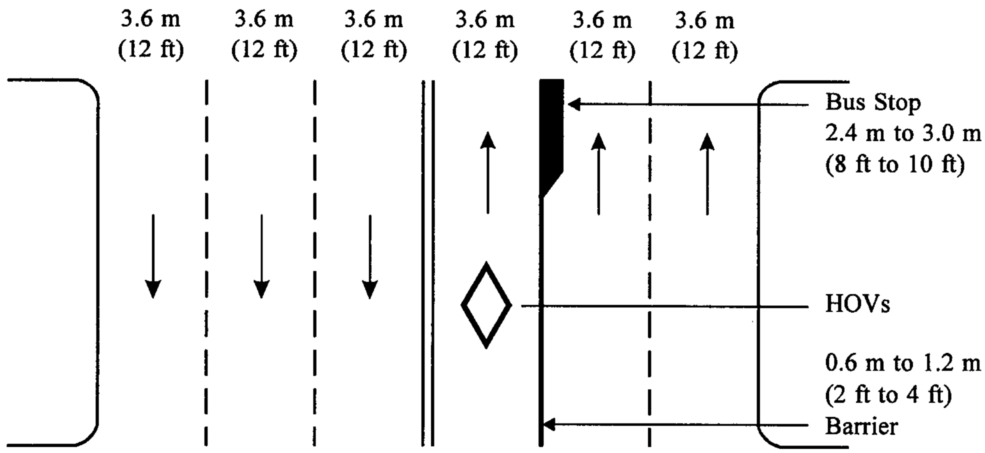
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-11. Layout for Curb-Lane HOV Facility on One-Way Street



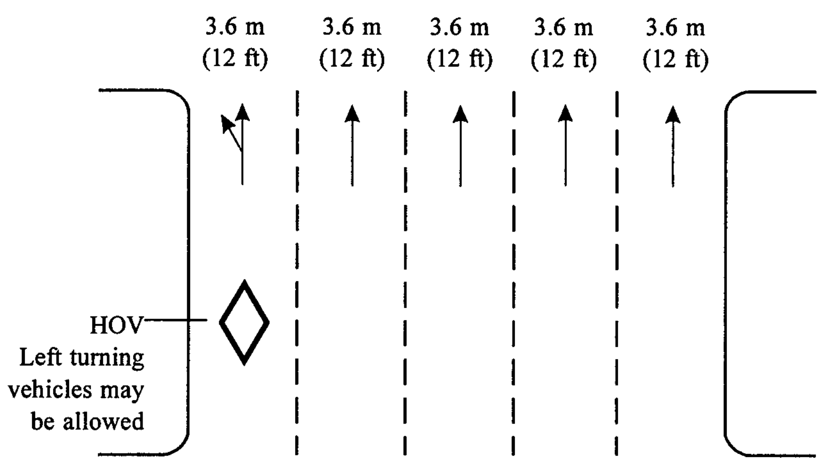
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-12. Layout for Left-Side HOV Facility on Two-Way Street



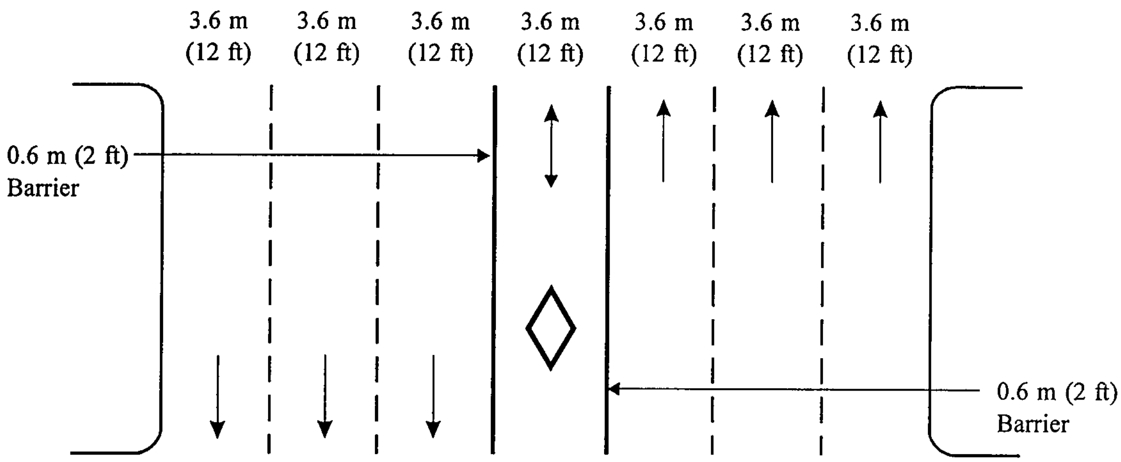
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-13. Layout for Left-Side Barrier Separated HOV Lane on Two-Way Street



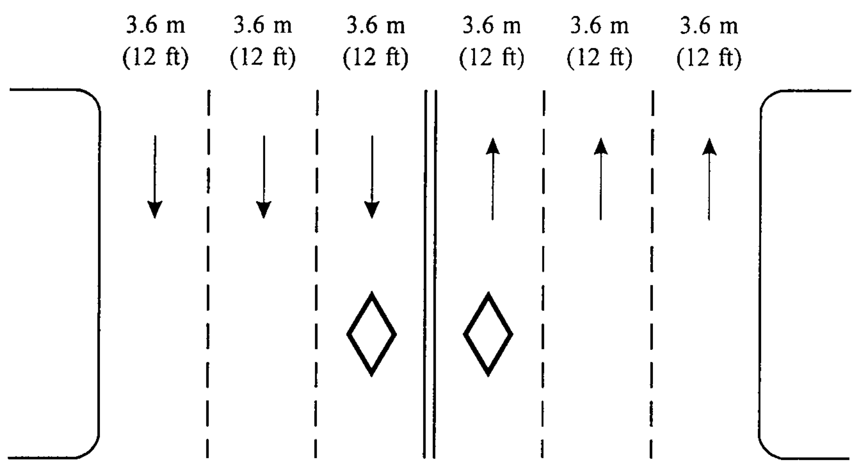
Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-14. Layout for Left-Side HOV Lane on One-Way Street



Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-15. Layout for Barrier Separated Reversible Center HOV Lane



Note: In some cases consideration may be given to narrowing the travel lanes to 3.3 meters to 3.0 meters (11 feet to 10 feet)

Figure 8-16. Layout for Non-Barrier Separated Two-Direction Center HOV Lanes

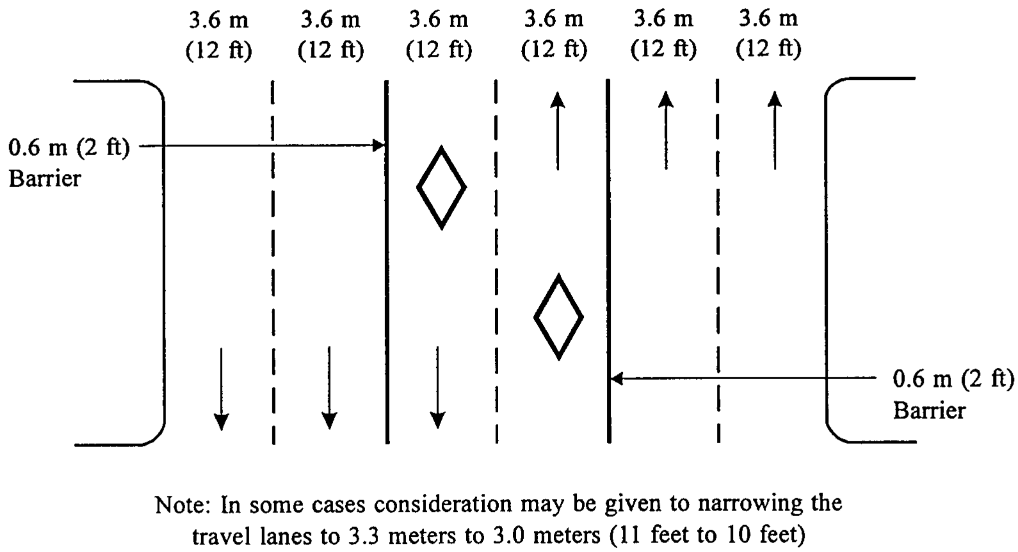


Figure 8-17. Layout for Barrier Separated Two-Direction Center HOV Lane

5. **Contraflow Bus-Only and HOV Lanes on One-Way Arterial Streets.** Examples of layouts for contraflow HOV lanes are illustrated in Figures 8-18 and 8-19. The design treatment used on Marquette, Second and Hennepin Avenues in downtown Minneapolis is shown in Figure 8-18, and the approach used on Spring Street in downtown Los Angeles is illustrated in Figure 8-19. Both facilities are reserved for buses only.

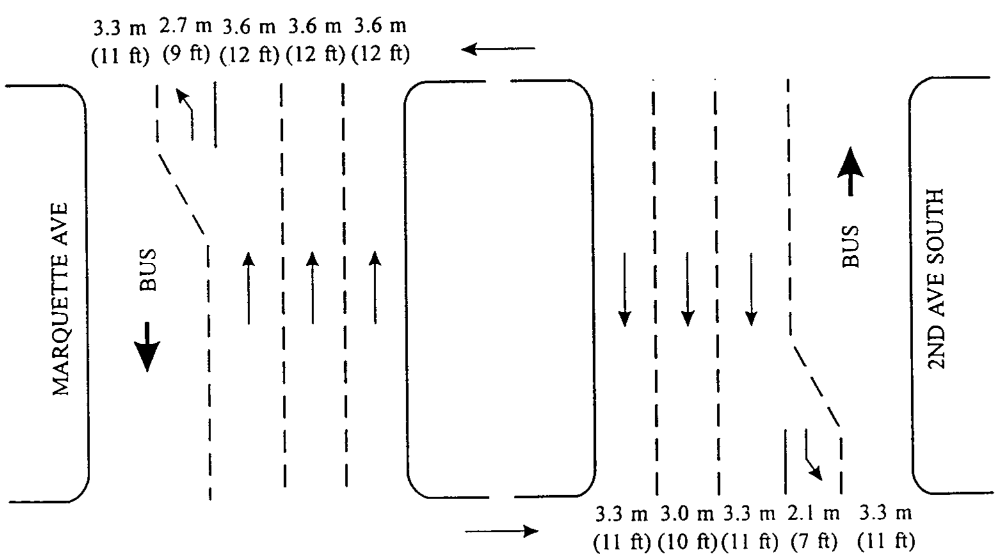


Figure 8-18. Layout for Contraflow HOV Lanes on Marquette and Second Avenues in Downtown Minneapolis

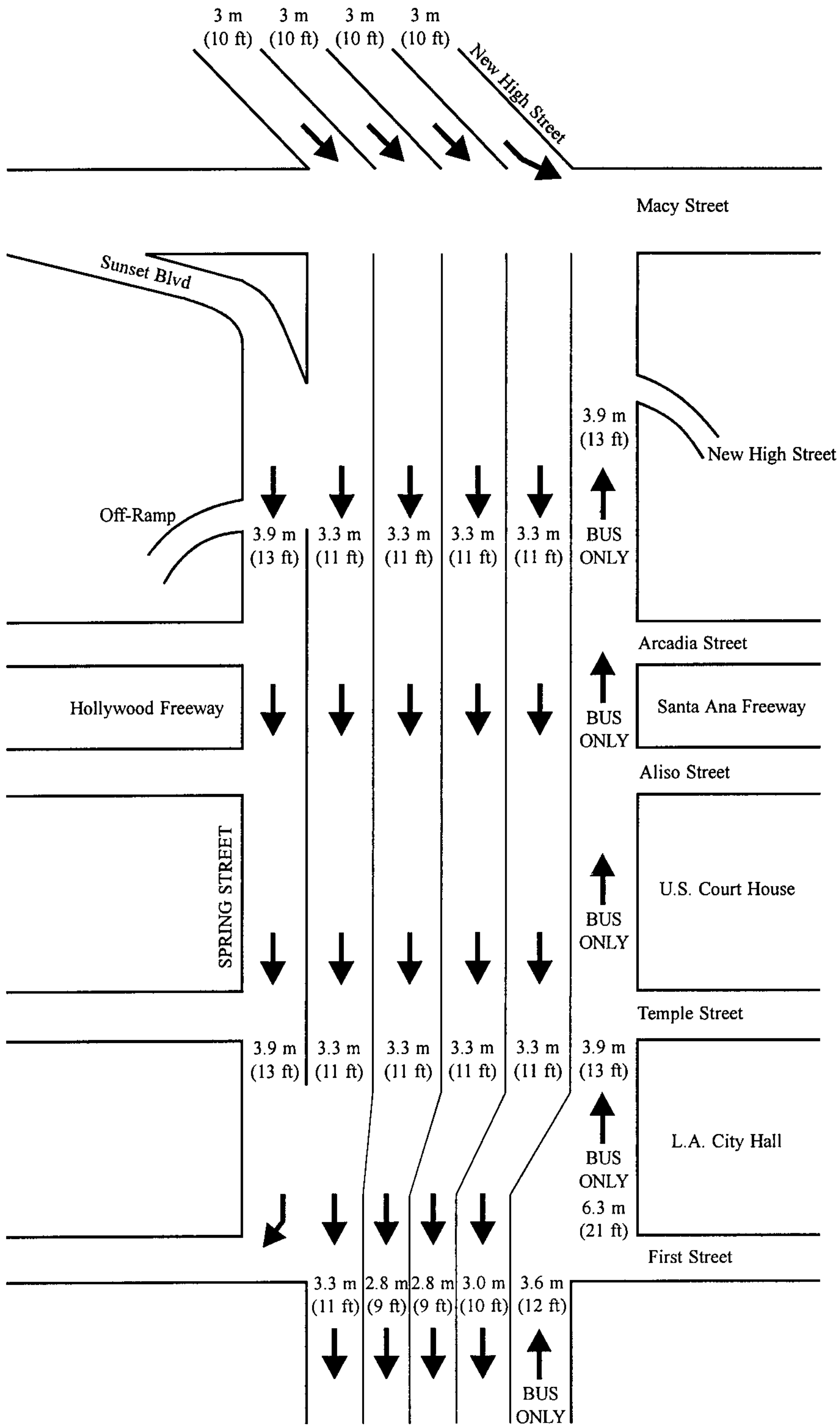


Figure 8-19. Layout for Contraflow HOV Lane on Spring Street in Downtown Los Angeles

The cross-sections on the three streets in downtown Minneapolis include 3.3 meters (11-foot) bus lanes and three general-purpose lanes ranging from 3.0 meters to 3.6 meters (10 feet to 12 feet) in width. A general purpose turn lane is also provided. A small curb separates the bus lane from the general-purpose lanes.

The Spring Street facility initially included a 3.9 meter (13-foot) bus lane. The general-purpose lanes were narrowed to 3.3 meters or 3.6 meters (11 foot or 12-foot) lanes. Paint striping is used to separate the contraflow bus lane. Changes were made in the design of the facility in response to operational issues. The 3.9 meter (13-foot) bus lane was widened to widths ranging from 6.3 meters to 7.8 meters (21 feet to 26 feet) to allow buses to pass those stopped to pick-up and drop-off passengers. This modification was accomplished by reducing the width of the general-purpose lanes slightly and converting the number one lane to a left turn pocket at intersections.

Contraflow lanes will also require modification to the placement of the traffic signal head. Figure 8-20 provides one example of relocating the signal head with a contraflow HOV lane. In addition, as discussed in Chapter 7, modifications may also be needed in the signal timing plan to accommodate HOV traffic in the contraflow lane.

6. **Spot HOV Treatments**. The design of spot HOV treatments will depend on the type of project being implemented and the conditions in the specific area. A special turn lane for bus or HOV access only will usually be of standard design. An example of layout for a special access turn lane is provided in Figure 8-21. The design of an HOV-only portion of a dual turn lane is illustrated in Figure 8-22. In both cases, it is important that consideration be given to ensuring that adequate storage length is provided approaching the turn lane to accommodate both HOVs and general-purpose traffic.

7. **Signal Queue Priority Treatments**. As discussed in Chapter 7, two potential lane treatments to provide buses or HOVs with priority at signalized intersections are queue jump lanes and bus advance areas or gating. Examples of these two techniques are illustrated in Figures 8-23 and 8-24. The major elements that need to be considered in the design of these facilities are the ingress, holding area, and egress. The placement of the signal head and the modifications to the operation of the signal system will also need to be considered in the design phase.

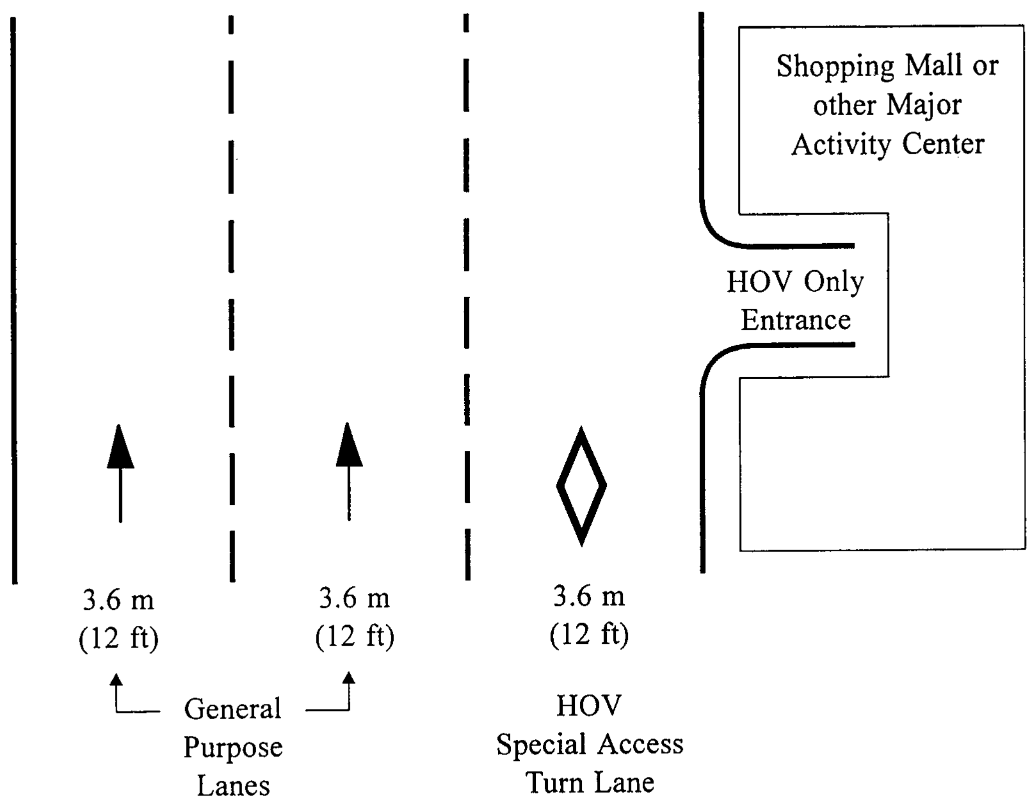


Figure 8-20. Example of Special Access Turn Lane

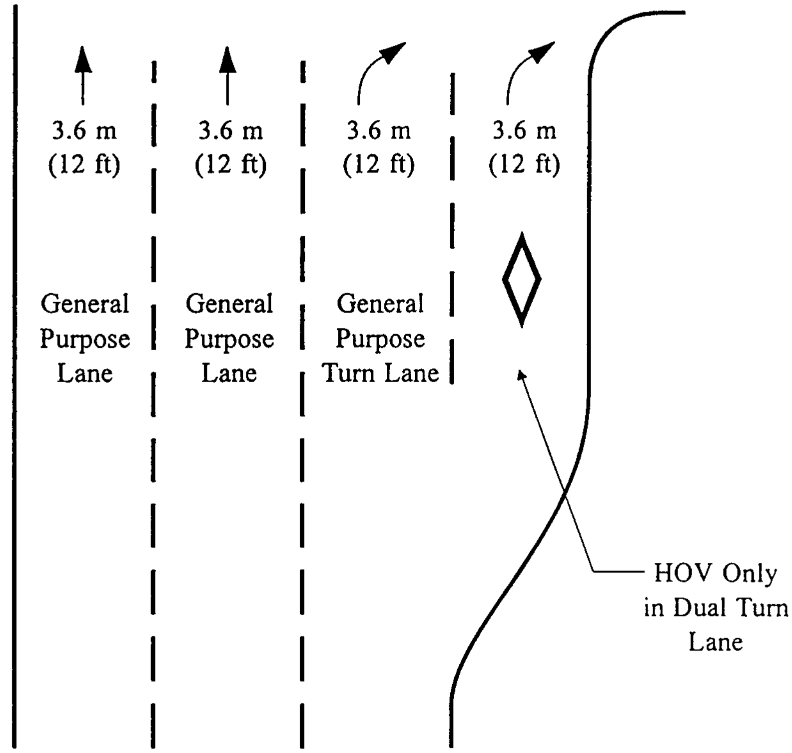
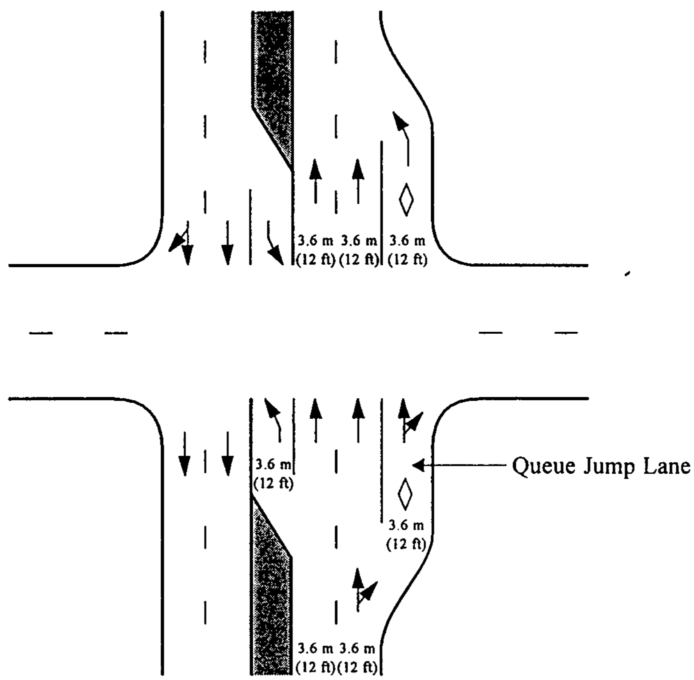


Figure 8-21. Example of HOV-Only Lane with Dual Turn Lanes



Right-Side Queue Jump Lane

Figure 8-22. Example of HOV Queue Jump Lane

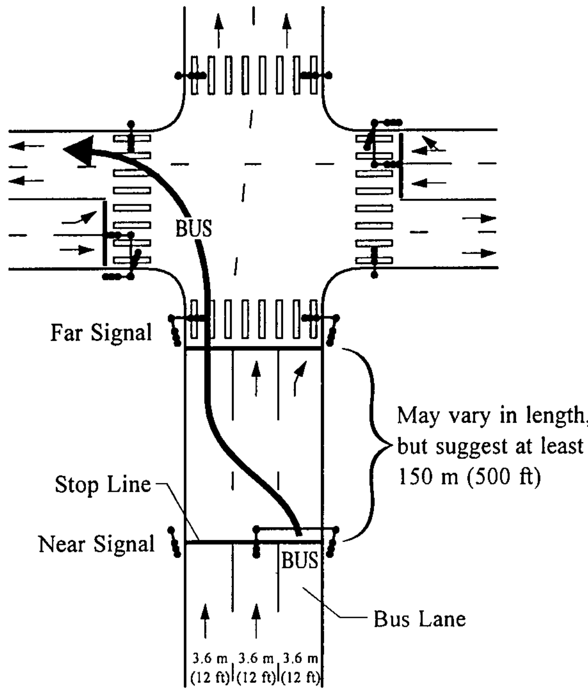
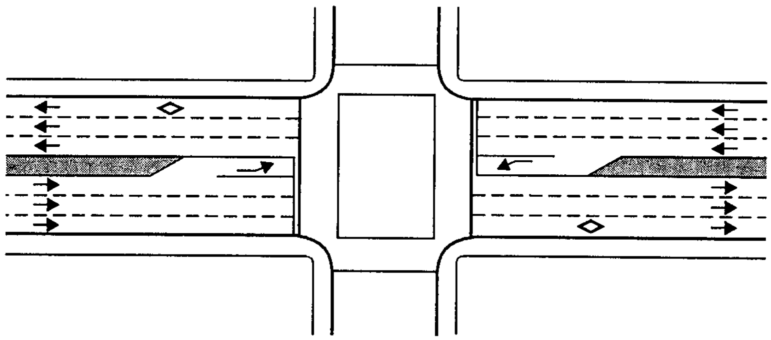
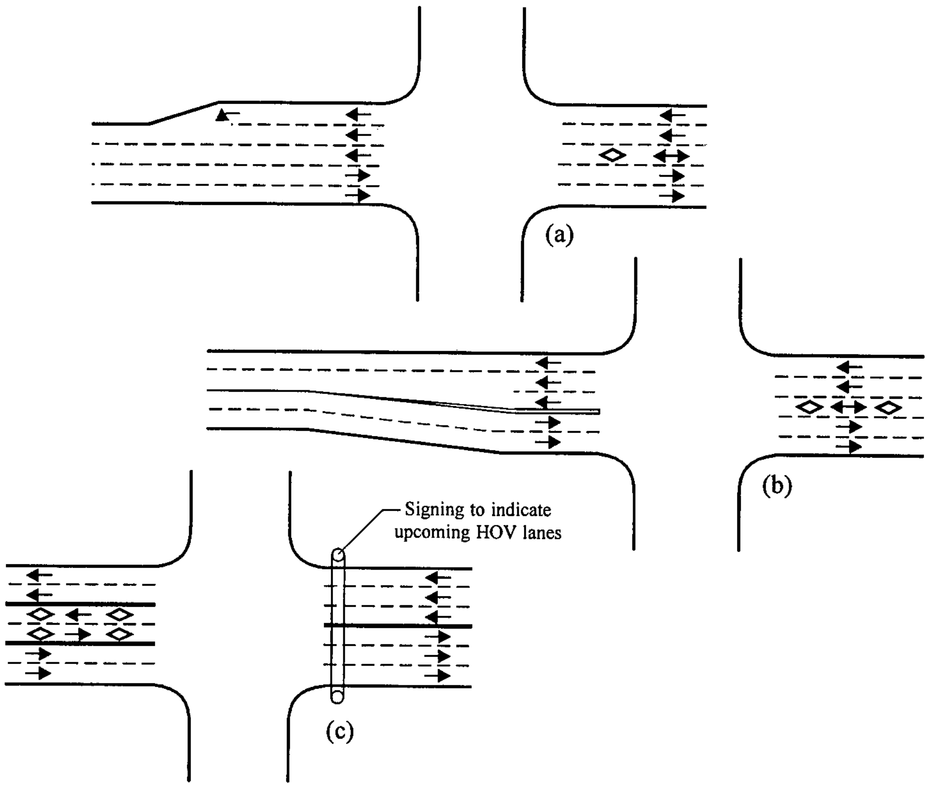


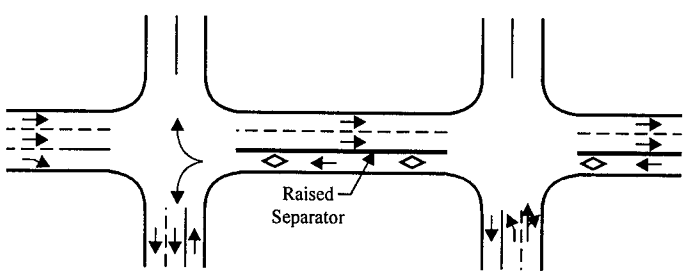
Figure 8-23. Example of Bus Advance Area or Gating



Example of Transition with Curb Lane HOV Facility Treatment



Examples of Transition Treatments with Center HOV Lanes (a,b,c)



Example of Transition Treatment with Contraflow Lane on One-Way Street (5)

Figure 8-24. Examples of Transition Treatments with Different Types of Arterial Street HOV Lanes

8. **Signal Priority Treatments**. The use of signal priority treatments may not involve any design changes to the roadway or may be incorporated with the designs discussed with the previous types of arterial street HOV applications described previously. The signal control strategies that may be appropriate to consider to provide buses or HOVs with priority at intersections were presented in Chapter 7.

B. Transition Treatments

Transitions at the beginning and the end of an arterial street HOV lane will need to be addressed in the design process. These areas should be designed to allow for the safe and smooth transition to and from the HOV facility. Transitions may be provided at intersections or at mid-block locations. The treatment used will depend on a number of factors. These include the type of arterial street HOV lane being considered, the types of arterial street, the nature of the area, traffic volumes and speeds, and other local characteristics. Examples of the treatments and issues that should be considered with the various types of arterial street HOV lanes are highlighted in this section and illustrated in Figure 8-24.

Bus Malls. Since general-purpose vehicles are not allowed to use bus malls, these vehicles must be directed to other streets at the beginning of a mall. The most common technique is to provide right and left turns at the intersection or intersections before the start of the mall. Adequate signing should be provided to alert motorists to the bus mall and the need to turn. Buses, and other allowed vehicles, usually access the mall directly from the approaching roadway. In some cases, such as the 16th Street Mall in Denver, buses may access the mall from bus stations or centers.

Right Side Bus-Only and HOV Lanes. In most cases, no special transition is provided with right side bus-only or HOV lanes on arterial streets. Signing should be provided in advance and at the start of the lane to notify motorists of the HOV restrictions. Consideration should be given to the starting and ending point for a facility. In many cases, right side HOV lanes are started and ended at intersections. Buses and HOVs can access the lane at the beginning or end and, depending upon the design, at any point along the facility.

Left Side Bus-Only and HOV Lanes. The transition alternatives for left side facilities should be matched to the specific type of lane being considered. Like right side lanes, transition areas for left side lanes are usually at intersections, and signing should be provided in advance and at the start of the facility.

Center Bus-Only and HOV Lanes. Transition techniques for these types of lanes will depend on the exact design of the facility. Figure 8-24 illustrates approaches that may be considered with non-barrier separated, barrier-separated, two-way, and reversible HOV lanes. Factors to consider in the design of center HOV lane transitions include the number of HOV lanes, the type of separation, the operating—one-way, two-way, or reversible—characteristics, and the traffic volumes and travel speeds in the general-purpose lanes. A separate traffic signal phase may be provided to allow protected access for HOVs to and from the lane.

Contraflow Bus-Only and HOV Lanes on One-Way Arterial Streets. Contraflow HOV lanes on one-way streets usually begin and end at intersections. Buses and HOVs enter the lane by turning from a cross street. In a similar fashion, HOVs exit the lane by turning onto a cross street. Conventional signing prohibiting turns by non-authorized vehicles should be used to alert motorists that they should not enter the lane.

C. Bus Stop Design Treatments

The TCRP report, *Guidelines for the Location and Design of Bus Stops*, provides numerous examples of the design elements associated with the various types of bus stop treatments and amenities at stops. A few examples are included in this section. Figure 8-25 provides the dimensions commonly associated with curb-side bus stops. Figure 8-26 illustrates the dimensions of a typical bus bay. Figure 8-27 provides a layout for a partially open bus bay, and Figure 8-28 highlights the dimensions of a bus bulb.

The exact design of a bus stop treatment will depend on a number of factors. First, bus stop treatments should consider the needs of transit patrons. Factors such as bus shelters that match anticipated passenger volumes, ADA compliant wheelchair access, curb ramps, marked crosswalks, and median or refuge islands should all be considered. For example, whether the wheelchair lift is located at the front door or rear door of a bus will influence the design and layout of the stop and the passenger waiting area. Second, the characteristics of the street, the limitations and opportunities in a specific area, and the bus operating strategy should be considered. The length of a bus stop and the deceleration and acceleration segments will depend on the number of buses using the facility, travel speeds, and other characteristics of the roadway.

D. Bicycle and Pedestrian Considerations

1. **Bicycle Considerations**. As discussed in Chapter 7, some arterial street HOV facilities allow bicyclists to use the lane. In other cases, a bike lane may be incorporated into the overall design envelope. The potential operational issues with mixing bicycles with buses and HOVs should be considered in the planning process. The addition of on-street parking, delivery vehicles, and other curb lane uses often found on arterial streets may further influence the potential for bicycle use of an HOV project. The design elements that should be examined if the decision is made to allow bicycles in the bus or HOV lane are described in this section.

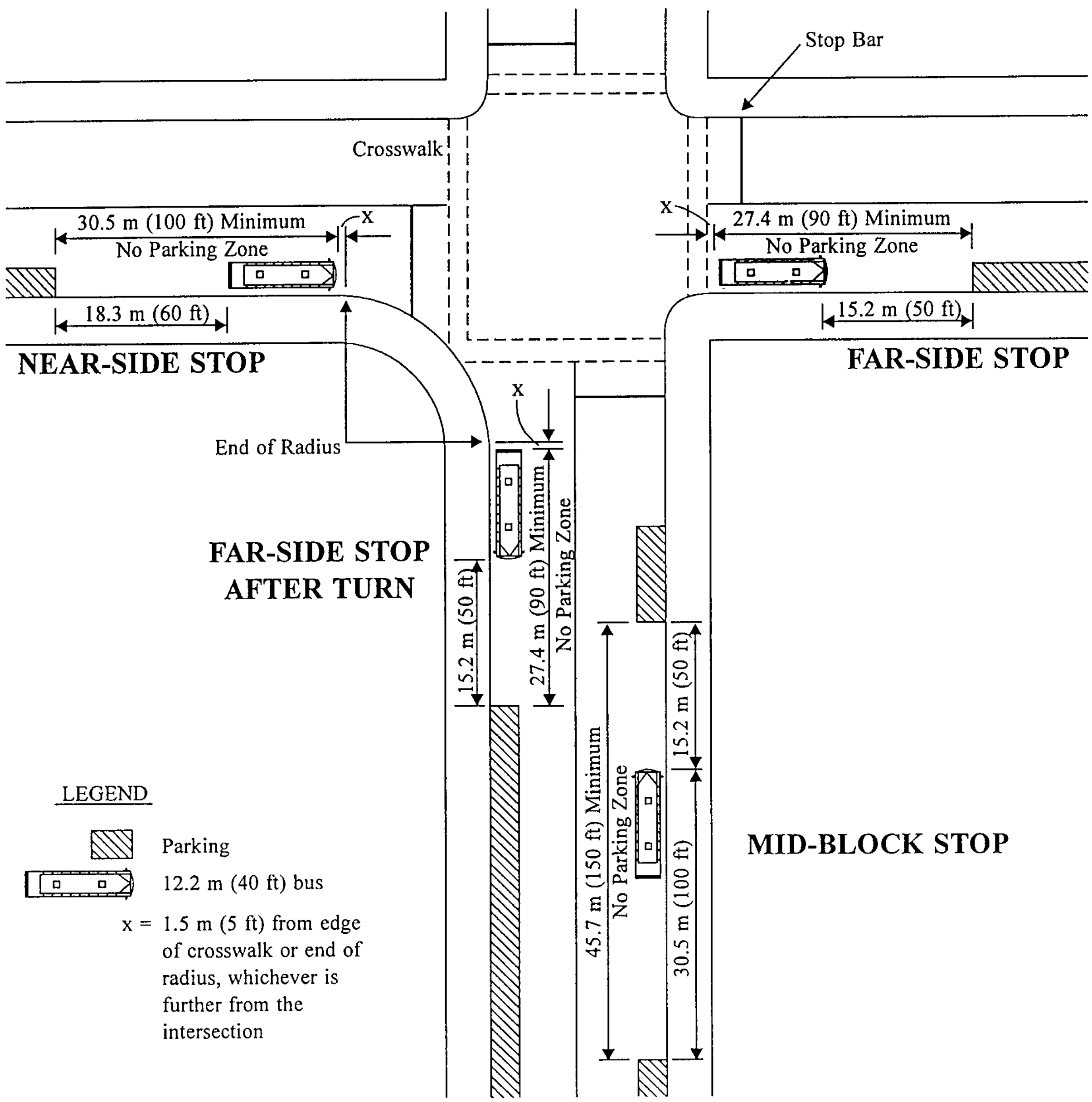


Figure 8-25. Curb-Side Bus Stop Dimensions

Source: (1)

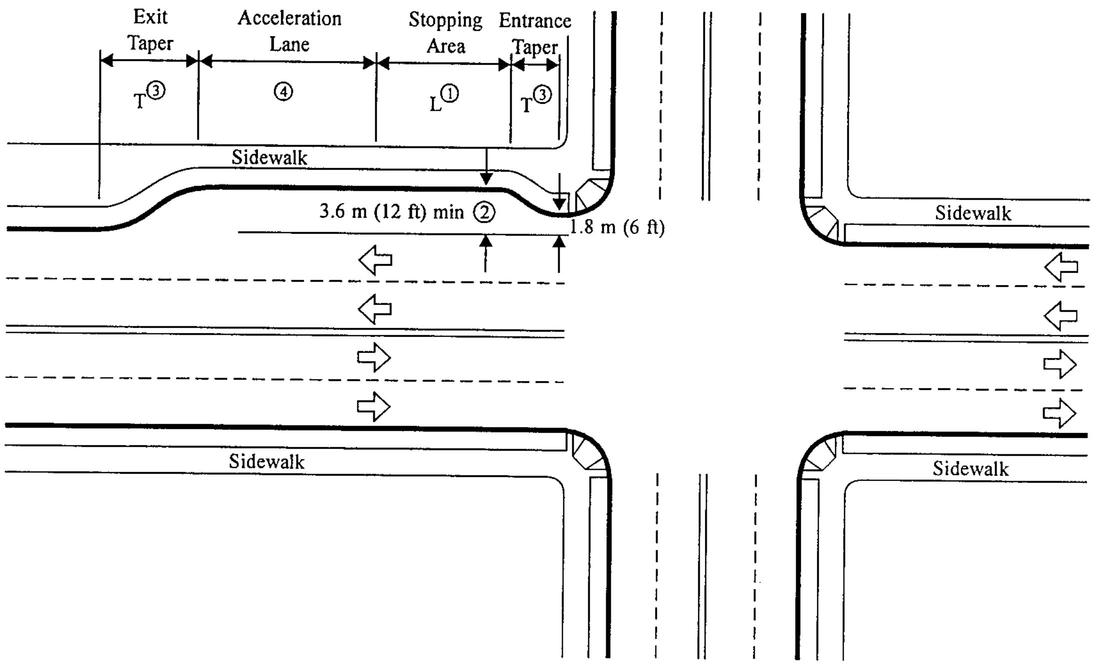


Figure 8-26. Example of Bus Bay Dimensions

Source: (1)

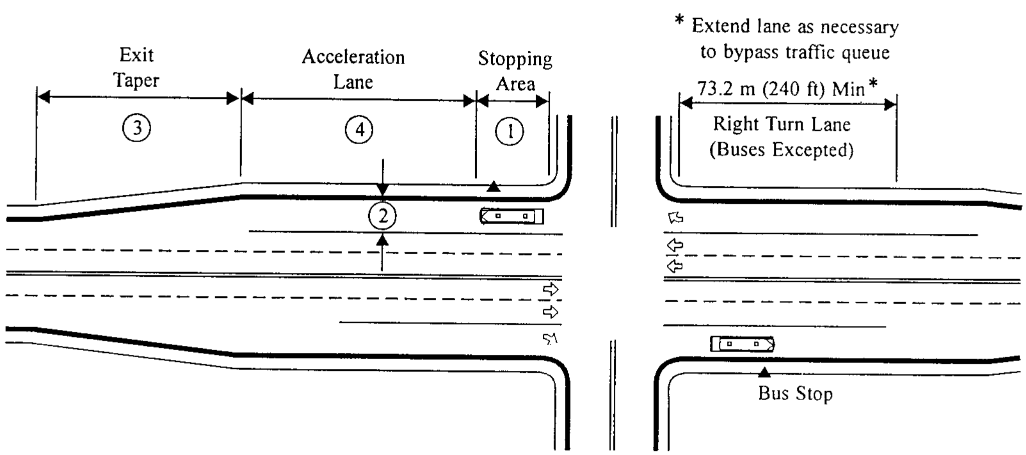


Figure 8-27. Example of Partially Open Bus Bay

Source: (1)

Notes for Figures 8-26 and 8-27.

1) Stopping area length consists of approximately 15.2 meters (50 feet) for each 12.2 meter (40 foot) bus and 21.3 meters (70 feet) for each articulated bus expected to be at the stop simultaneously.
2) Bus bay width is desirably 3.6 meters (12 feet). For traffic speeds under 48 km/h (30 mph), a 3.0 meter (10-foot) minimum bay width is acceptable. These dimensions do not include gutter width.
3) Suggested taper lengths are listed in table below. Desirable taper length is equal to the major road through speed multiplied by the width of the turnout bay. A taper of 5:1 is a desirable minimum for an entrance taper to an arterial street bus bay while the merging or re-entry taper should not be sharper than 3:1.
4) Minimum design for a busy bay does not include acceleration or deceleration lanes. Recommended acceleration and deceleration lengths are listed in the table below.

Through Speed	Entering Speed[a]	Length of Acceleration Lane	Length of Deceleration Lane[b]	Length of Taper
56 km/h (35 mph)	40 km/h (25 mph)	76 m (250 ft)	56 m (184 ft)	52 m (170 ft)
64 km/h (40 mph)	48 km/h (30 mph)	122 m (400 ft)	81 m (265 ft)	58 m (190 ft)
72 km/h (45 mph)	56 km/h (35 mph)	213 m (700 ft)	110 m (360 ft)	64 m (210 ft)
80 km/h (50 mph)	64 km/h (40 mph)	297 m (975 ft)	143 m (470 ft)	70 m (230 ft)
88 km/h (55 mph)	72 km/h (45 mph)	427 m (1400 ft)	181 m (595 ft)	76 m (250 ft)
97 km/h (60 mph)	80 km/h (50 mph)	580 m (1900 ft)	224 m (735 ft)	82 m (270 ft)

[a]Bus speed at end of taper, desirable for buses to be within 16 km/h (10 mph) of travel lane vehicle speed at the end of the taper.
[b]Based on 4 km/h/sec (2.5 mph/sec) deceleration rate.

Source: (1)

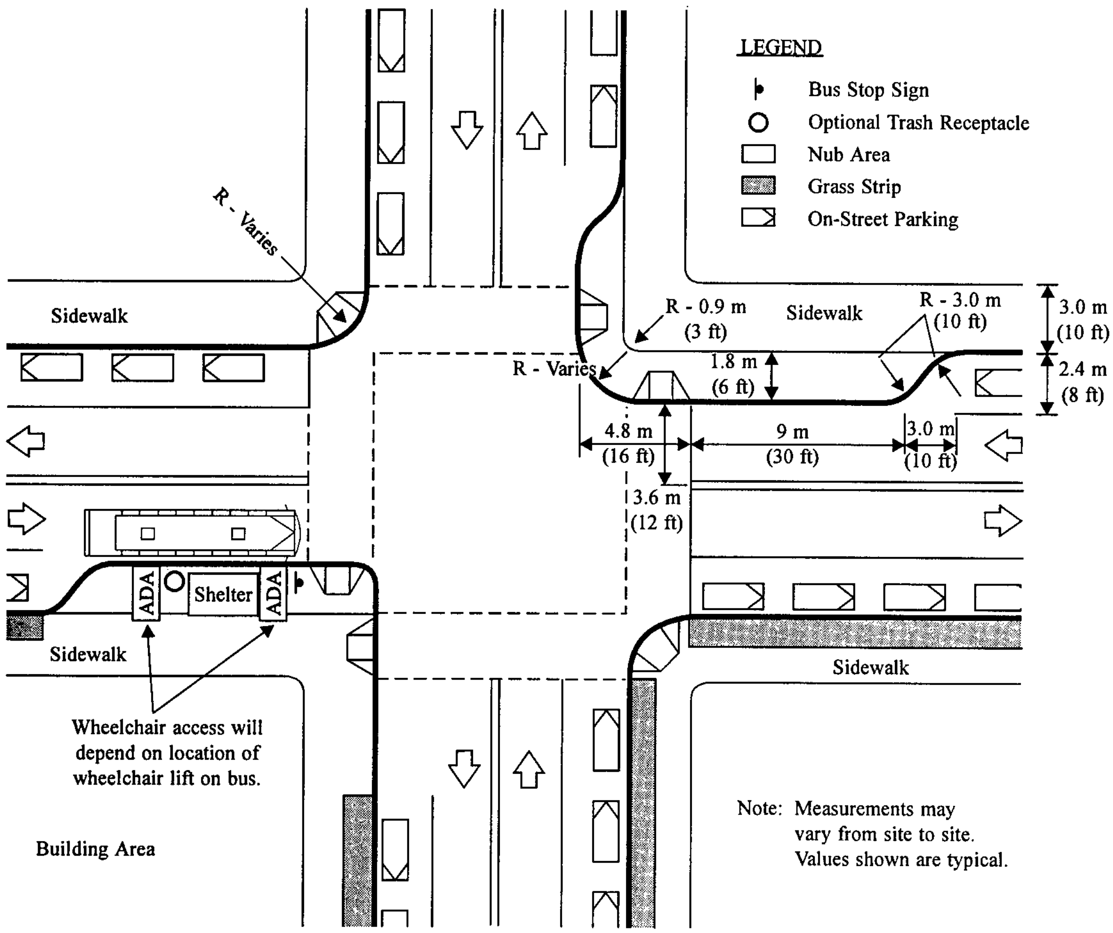


Figure 8-28. Example of Bus Bulb or Nub at Stop

Source: (1)

The general design elements that should be considered with bicycle use of an arterial street HOV lane are lane width, intersection treatments, pavement quality, drainage grates, and other roadside features. Possible design approaches to address these issues are highlighted below.

Bicycle Lane Width. A minimum width of 1.2 meters to 1.6 meters (4 feet to 5 feet should be considered for an arterial street bicycle lane. If bicycles are allowed to use an arterial street HOV lane, consideration should be given to either widening the lane or adding a special bicycle-only lane next to the HOV facility. Both of these approaches can help reduce the potential of conflicts between buses or HOVs and bicycles.

Figures 8-29 and 8-30 provide examples of these treatments. The HOV lane in Figure 8-29 has been widened to 4.2 meters to 4.8 meters (14 feet to 16 feet) to accommodate bicycles. No special striping or other delineation is used to separate the bicycle and HOV lanes with this approach. Another possible design, shown in Figure 8-30, provides a separate bicycle lane between the HOV lane and the curb. Another alternative is to provide a separate bicycle lane between the HOV lane and the general-purpose lane. This design minimizes potential conflicts between bicyclists and buses.

Intersection Treatment. Special design considerations may be needed at intersections if bicycles are allowed to use an arterial street HOV lane. Bicycles may further complicate the already conflicting situation involving buses, HOVs, bus stops, and turning general-purpose vehicles at intersections. Special lanes, signing, or other treatments may be needed to accommodate bicycles at intersections to reduce potential conflicts with other vehicles and to maintain a safe operating environment for bicyclists.

Pavement Quality. Irregularities in the pavement surface, potholes, and poor pavement quality can cause both an unpleasant ride for bicyclists and safety concerns. For example, uneven pavement may increase the chances of conflicts between bicycle and other vehicles. Ensuring that the bicycle portion of the facility has a smooth surface and uses the same pavement standards as the HOV lane is important to ensure the safe operation for all user groups. The surface for bicycles should be smooth and free of potholes or ruts. Consideration should also be given to providing a uniform edge treatment and replacing, modifying, relocating or clearly marking drainage grates, manhole covers, and other on-street hazards.

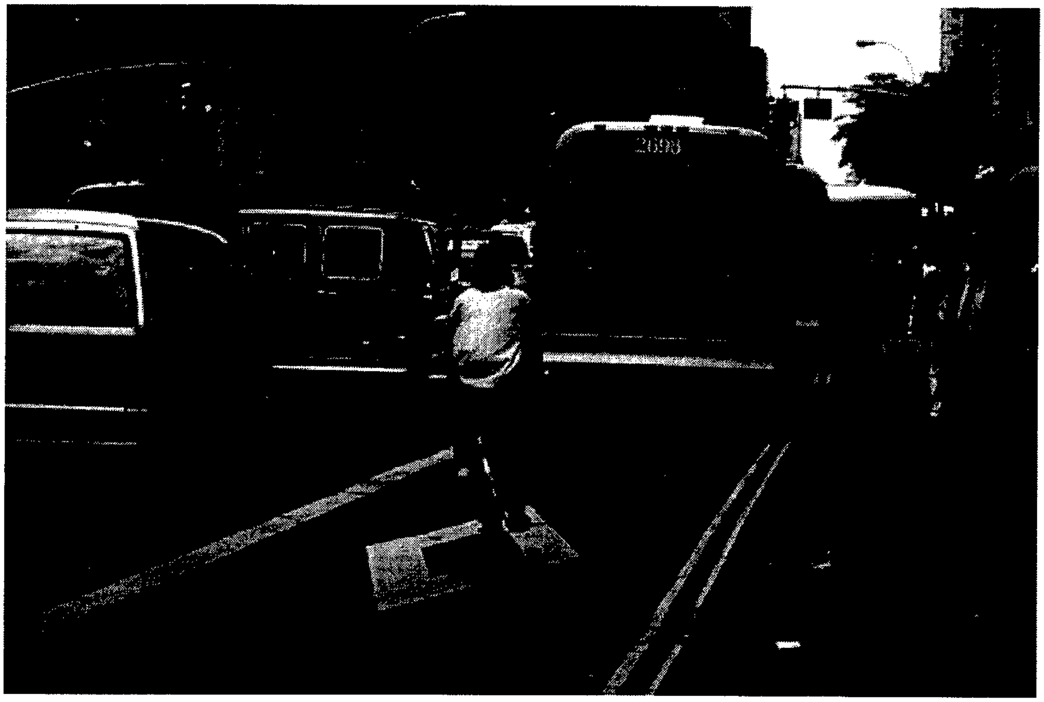


Figure 8-29. Bicycle Use Incorporated into Arterial Street HOV Lane

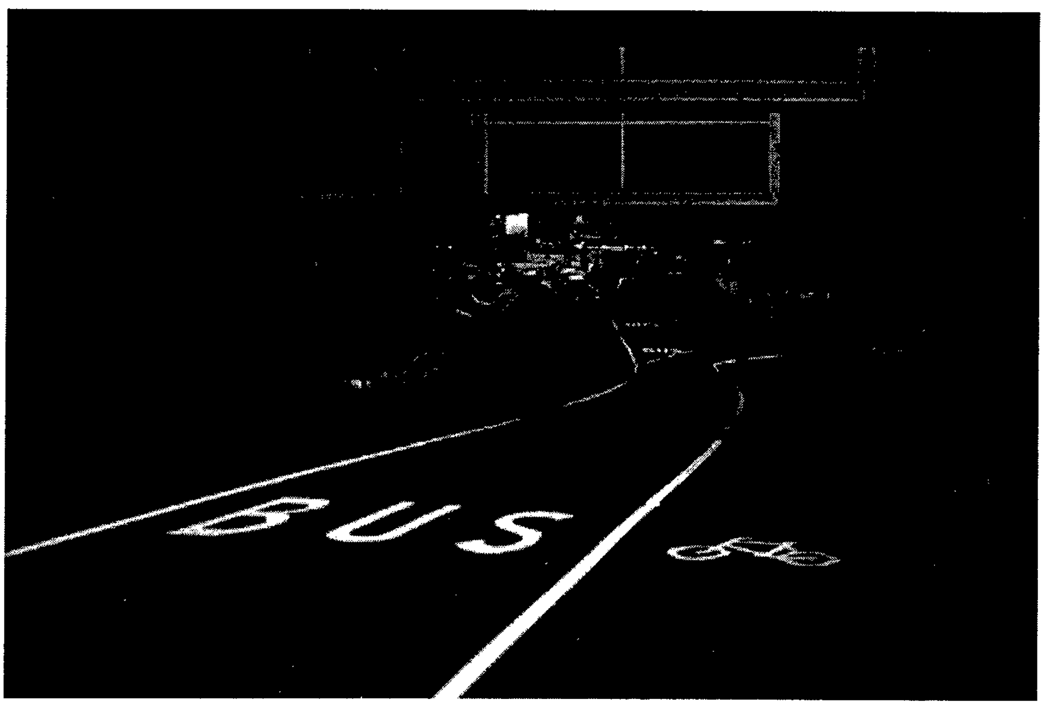


Figure 8-30. Separate Bicycle Lane Adjacent to Arterial Street HOV Lane

2. **Pedestrian Considerations**. The development and operation of an arterial street HOV facility may adversely affect pedestrians. For example, widening a roadway to add an HOV lane may lengthen the distance and walk time at an intersection. A center HOV lane with bus stops in the middle of the street may also increase the potential for pedestrian and HOV conflicts.

   The needs of pedestrians and reducing possible safety concerns should be addressed in the design process. Elements to be considered include crosswalks and signal timing, mid-street refuge islands, adequate sidewalk space and passenger waiting areas, sidewalk connectivity, links to pedestrian skywalks or tunnels, and other separation treatments to delineate pedestrian areas.

E. Safety Design Considerations

Additional consideration may need to be given in the design phase to ensuring the safe operation of an arterial street HOV facility. A project should be designed to minimize the potential for conflicts among buses, HOVs, general traffic, pedestrians, on-street parking, delivery vehicles, bicyclists, and other users of the arterial street system. Many of the elements that should be considered to address possible safety concerns have been discussed previously. These include turning movements at intersections and driveways, treatments to separate the HOV and general-purpose lanes, considering the needs of pedestrian and bicyclist, and other issues.

The potential safety concerns and specific techniques used to address them will depend on the characteristics of the roadway, the vehicle volumes, the type of HOV treatment, and other site-specific elements. Table 8-2 identifies some of the safety concerns that may arise in the design of arterial street HOV lanes and possible approaches to address these. The table can also be used as a checklist by practitioners to ensure that all potential issues have been considered.

F. Enforcement Design Considerations

Arterial street HOV facility enforcement strategies and techniques were discussed in Chapter 7. Due to the arterial street environment, there is usually fewer opportunities to design and develop special enforcement areas or treatments. In most cases, enforcement personnel will simply use available roadway, curb, or driveway space. The type, level, and design needs of enforcement activities should be matched to the specific HOV facility, eligible users, and opportunities within the corridor. For example, providing enforcement pockets may be appropriate to consider with a longer distance HOV lane, while the use of an alley, side street, or bus stop may be logical with a short downtown bus-only lane.

G. Other Unique Design Issues

The arterial street environment may present other special issues and opportunities for consideration during the design process. Many of these have been discussed previously in this chapter. The need to accommodate other functions and user groups, such as motorists, pedestrians, bicyclists, on-street parking, enforcement personnel, and service delivery vehicles should all be considered in the design process. Providing a safe environment and operation for all groups is the goal of the design phase.

Table 8-2. Potential Safety Concerns with Arterial Street HOV Lanes and Checklist

Potential Safety Concerns	Techniques to Address	Issue	Addressed
Turning movements at intersections	• Restrict turns by general-purpose vehicles during HOV operating hours. • Allow turns by general-purpose vehicles at selected intersections only.		
Turning movements at driveways	• Restrict turns by general-purpose vehicles during HOV operating hours. • Limit access points to adjacent land uses during HOV operating hours. • Provide alternative access points for general-purpose vehicles.		
On-street parking	• Restrict on-street parking during HOV operating hours. • Provide alternate parking spaces.		
On-street delivery vehicles	• Restrict on-street delivery vehicles during HOV operating hours. • Provide alternate locations for delivery vehicles and allow access during non-operating hours.		
Pedestrian conflicts	• Provide well marked crosswalks at intersections. • Set signal timing to provide adequate pedestrian crossing time. • Provide center median waiting area if needed. • Take special measures, such as reducing speeds, in school, hospital, and other special zones.		
Bicycle conflicts	• Provide bicycle lane in areas with high bicycle volumes.		

Design issues associated with service delivery vehicles and trucks may deserve special attention if there are high volumes of these vehicles on the roadway. In these cases, consideration should be given to any special design elements needed to accommodate these vehicles. Factors that may need to be examined include intersection turning radii, signal timing to accommodate truck acceleration and deceleration characteristics, and other considerations.

V. REGULATORY SIGNING AND MARKING

Providing a standard set of symbols, signs, and pavement markings for HOV facilities is important to building public awareness, understanding, and acceptance. Adequate signage is critical for both users and non-users of the HOV facility and plays a key role in public education and enforcement strategies. Ideally, a uniform approach should be used with all HOV facilities in a metropolitan area, including freeway and arterial projects.

The *Manual of Urban Traffic Control Devices* (MUTCD) (4) should be used in the design of signs and pavement marking for arterial street HOV facilities. Bus-only and HOV lanes should be clearly demarcated and signed. The primary approaches used to denote arterial street HOV facilities in most metropolitan areas are pavement markings, overhead signs, and side-mounted signs.

As illustrated in Figure 8-31, the diamond symbol is commonly applied to the pavement on arterial HOV lanes in many areas. Additional wording, such as *buses-only*, *HOVs-only*, *restricted lane*, or other messages are often included. Signs should use terms that will be easily understood in the local area.

The diamond symbol and other pavement marking should be placed at intervals of approximately 90 meters (300 feet). Pavement markings should be painted to ensure ongoing visibility. Repainting may be needed periodically, especially in areas where snow plowing, high vehicle volumes, and other conditions may limit the durability of the markings. Other approaches that have been used in some areas to give greater visibility to the HOV lane or to provide a unique identity to the lanes include larger and bolder markings and using a distinctive pavement color or payment type on the facility.

Overhead or roadside signs should also be used with arterial street HOV projects. As illustrated in Figures 8-32 and 8-33, signs may contain information on eligible users, hours of operation, penalties for misuse such as fines or loss of points on a driver's license, and other regulations. Symbols, such as a bus, a carpool, a bicycle, or a diamond, may also be used. In addition, active signage, such as the use of flashing lights, changeable lane assignment arrows, or changeable message signs may be appropriate for consideration in some circumstances.

VI. ADDITIONAL RESEARCH NEEDS

The examination of available information on design elements associated with arterial street HOV facilities identified a number of areas where further research is needed. The following research statements provide an indication of the major areas for further research associated with designing arterial street HOV projects.

Figure 8-31. Example of Diamond Pavement Marking
with Arterial Street HOV Lane

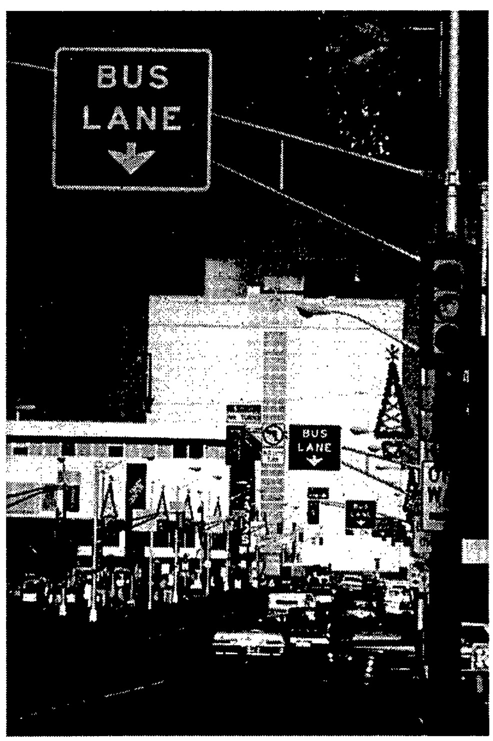


Figure 8-32. Example of Overhead Sign
with Arterial Street HOV Lane

Figure 8-33. Examples of Roadside Signs with Arterial Street HOV Lanes

Assessment of Design Issues with Arterial Street HOV Facilities. More research is needed to examine the design issues associated with various types of arterial street HOV treatments. The detailed examination of these issues was outside the scope of this research study. Topics which should be explored in more detail include design treatments to accommodate turning vehicles at intersections and at driveways, issues associated with on-street parking and delivery vehicles, and accommodating bicyclists and other user groups. The results of this study would be a more comprehensive design guide for all types of arterial street HOV facilities.

Assessment of Safety and Enforcement Design Treatments with Arterial Street HOV Facilities. The design of an arterial street HOV facility may impact the safety of users and non-users, as well as the ability to enforce the lane. Additional research is needed to examine the safety and enforcement issues associated with different design treatments. This study would explore current design features of arterial street HOV projects, potential safety and enforcement concerns, and potential enhancements to address these concerns.

Assessment of Design Issues with Arterial Street Signal Priority Projects. As discussed in this Manual, providing priority for buses and other HOVs at signalized intersections is not widespread. A number of design and operating issues have limited the use of this approach in many areas. Additional research is needed on the design of signal priority projects. This research project will examine the design issues associated with the intersection, the signal timing and signal algorithms, and other issues commonly associated with this technique. The results of the study would provide more detailed guidelines for designing signal priority projects.

Assessment of Standardizing Arterial Street HOV Facility Signing and Pavement Markings. This research project, which would examine the potential to standardize signing and pavement markings for HOV facilities on arterial streets, could be coordinated with the freeway project discussed previously. A more detailed assessment would be made of currently used signs and pavement markings, and the potential to implement a uniform approach.

VII. REFERENCES

1. Texas Transportation Institute. TCRP Report 19, *Guidelines for the Location and Design of Bus Stops*. Washington, D.C.: TRB, National Research Council, 1996.

2. Metropolitan Transit Authority of Harris County. *Final Draft—Design Criteria for METRO Park-and-Ride and Transit Center Facilities*. Houston, Texas: Metropolitan Transit Authority of Harris County, April 1995.

3. American Association of State Highway and Transportation Officials. *A Policy on Geometric Design of Highways and Streets*. Washington, D.C.: American Association of State Highway and Transportation Officials, 1994.

4. Federal Highway Administration. *Manual on Uniform Traffic Control Devices*. Washington, D.C.: Federal Highway Administration, 1988.

5. American Association of State Highway and Transportation Officials. *Guide for the Design of High Occupancy Vehicle Facilities*. Washington, D.C.: American Assocaition of State Highway and Transportation Officials, 1992.

VIII. ADDITIONAL INFORMATION SOURCES

Arterial Street HOV Design

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McCormick Rankin. *High-Occupancy Vehicle Opportunities, Incentives, and Examples*. Toronto, Ontario: Ministry of Transportation of Ontario, 1993.

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Bicycle Facility Design

American Association of State Highway and Transportation Officials. *Guide for the Development of Bicycle Facilities.* Washington, D.C.: American Association of State Highway and Transportation Officials, 1991.

North Carolina Department of Transportation. *North Carolina Bicycle Facilities Planning and Design Guidelines.* Raleigh, North Carolina: North Carolina Department of Transportation, 1994.

North Central Texas Council of Governments. *Bicycle and Pedestrian Facilities Planning and Design Manual.* Arlington, Texas: North Central Texas Council of Governments, 1995.

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CHAPTER 9—TRANSIT AND SUPPORT SERVICES AND FACILITIES

Page

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

Transit services and facilities are critical components of many successful HOV projects. This chapter presents the various transit service strategies and fixed facilities that may be used with different types of HOV projects. The chapter is divided into the following major sections.

- **Benefits to Transit Services from HOV Facilities**. This section highlights the benefits transit services may realize from HOV facilities. Benefits related to travel time savings and travel time reliability, improved schedule adherence, deadheading savings, improved vehicle and labor productivity, and ridership increases are all discussed. Case study examples are provided of benefits realized by transit operators from HOV facilities.

- **Groups Involved in Planning and Operating Transit Services with HOV Facilities**. This section highlights the agencies and groups usually responsible for planning and operating transit services associated with HOV facilities. The typical roles and responsibilities of the various organizations are described.

- **Transit Services**. An overview of alternative service strategies is presented first in this section, along with a discussion of planning guidelines, funding sources, and operating guidelines for transit. Case study examples are provided of approaches currently in use throughout North America.

- **Transit Support Facilities**. This section discusses the types of transit facilities commonly associated with HOV projects, including park-and-ride lots, park-and-pool lots, transit stations, and intermodal facilities. Guidelines for planning, designing, funding, and operating these facilities are presented. Case study examples are provided of existing transit support facilities in use with HOV lanes.

- **Integrating HOV and Rail Transit Systems**. This section examines techniques for integrating and coordinating HOV facilities and rail transit systems. Aspects relating to design, shared use of facilities, and service coordination are presented. Case study examples are presented to highlight specific approaches.

- **Joint Development with HOV Facilities**. This section provides an overview of the joint development concept and presents general guidelines for planning joint development projects with HOV facilities. Case studies of joint development activities with HOV facilities are discussed.

- **Additional Research Needs**. The chapter concludes with a discussion of additional research needs related to transit services and support facilities with HOV systems.

The references used in the chapter are also provided, along with a listing of additional sources of information related to transit services and HOV facilities.

II. BENEFITS TO TRANSIT SERVICES FROM HOV FACILITIES

HOV facilities offer a number of advantages to transit operators which can enhance service effectiveness and efficiency. Bus travel times, schedule adherence, and vehicle and labor productivity may all improve. HOV lanes also offer safer operating environments for buses. All of these factors may help streamline bus operations, improve transit effectiveness and efficiency, and attract new transit riders. Not all of these benefits have been well documented. This section summarizes some of the available experience with enhancing transit operations due to HOV facilities.

A. Travel Time Savings and Travel Time Reliability

HOV facilities provide higher operating speeds for transit vehicles. As a result, travel times savings have been realized by many transit operators. For example, in Houston peak-hour bus operating speeds doubled, increasing from 41 kph to 82 kph (26 mph to 51 mph). This increase in operating speeds resulted in a reduction in schedule times of as much as 20 to 30 minutes on some routes (1). Bus travel time savings have been documented with the opening of I-25 Express lanes in Denver. During good weather buses are averaging 7 minute savings during the peak-period, with 10 to 20 minute savings reported during bad weather (2).

Similar increases in bus operating speeds and corresponding reductions in schedule times have been realized by transit agencies in other areas with HOV facilities. For example, travel time savings of approximately 15 to 20 minutes have been achieved during the peak period with the opening of the Harbor Transitway in the South Bay section of Los Angeles. The opening of the bus lane on the approach to the Lincoln Tunnel in New York City reduced bus travel times by nearly 30 minutes. The HOV lanes in the Seattle area have resulted in significant travel time savings for buses, vanpools, and carpools. For example, travelers in the SR 520 HOV lanes regularly save between six and 20 minutes during the morning peak hour.

B. Schedule Adherence and On-Time Performance

As a result of the higher travel speeds and the improved travel time reliability provided by HOV facilities, schedule adherence and on-time performance for transit services also improve. Since buses are less likely to be delayed by incidents or accidents in the general purpose lanes, passengers can be more assured of arriving at their destination on time.

The travel time reliability provided by HOV facilities also enhances bus operations. Surveys conducted of transit riders in Dallas and Houston indicate that the travel time reliability provided by the HOV lanes is an important factor in their decision to use transit (1,3).

C. Deadheading of Transit Vehicles

Deadheading is a term used to describe the movement of a transit vehicle without revenue passengers. For example, a bus may deadhead out of the garage in the morning to the start of a route or an express bus may deadhead back out to the start of a route in the suburbs after making one trip to the downtown area. A vehicle is usually not in revenue service during these times, so deadheading represents non-productive time. Transit agencies attempt to keep deadheading time and miles to a minimum.

HOV facilities may help reduce deadhead time for transit vehicles. For example, busways and two-way direction HOV lanes may provide travel time saving for buses traveling in the off-peak direction, resulting in slight gains in service efficiencies and associated savings in operating costs. In these cases, the driver may be the only person on the bus.

D. Vehicle and Labor Productivity

The increased travel speeds, the travel time savings, and the improved travel time reliability offered by HOV facilities can improve vehicle and labor productivity for transit operators. For example, Houston METRO has documented savings in bus operating costs from specific HOV lane improvements and from the overall HOV facility system (1).

E. Increased Ridership

Many areas have seen increases in transit ridership with the implementation of HOV facilities. The increases in travel speeds, the travel time savings, and the improved travel time reliability offered by HOV lanes all appear to be factors in attracting new riders to transit and in retaining current passengers.

In Houston, the HOV lanes have been a significant factor in attracting new bus riders. METRO has seen increases in ridership in all corridors where HOV lanes have been implemented. In most cases, METRO has added new service as part of the development the HOV and park-and-ride facilities (1). As noted previously, survey results indicate that the HOV lanes are a major factor for commuters deciding to use the bus.

Ridership increases have been documented with HOV lanes in other metropolitan areas. Community Transit has experienced ridership increases on service to downtown Seattle and the University of Washington with the I-5 HOV lanes (4). Ridership on RTD service in Denver has also increased on routes using the I-25 Express lanes. Ridership on three routes, which were modified or expanded, increased by 48 to 74 percent after the HOV lanes were opened (2).

III. GROUPS INVOLVED IN PLANNING AND OPERATING TRANSIT SERVICES WITH HOV FACILITIES

As discussed throughout this Manual, numerous agencies and groups should be involved in all aspects of planning, designing, implementing, marketing, operating, enforcing, and evaluating HOV facilities. Transit agencies and bus operators are among the groups that should be actively involved in all phases of HOV facility development and operation.

Transit agencies will have the lead role in planning and operating bus services, bus facilities, and other related elements associated with HOV lanes. Other agencies and groups should also be involved in these efforts. The transit components of a facility should be part of the multi-agency team approach on a project. The roles and responsibilities of the various organizations in planning and operating transit services with HOV facilities are highlighted in Table 9-1 and summarized in this section.

Transit Agency. The regional or local transit agency will have the overall responsibility for planning, financing, implementing, marketing, and operating bus services associated with HOV lanes. In some cases, a transit agency may also be responsible for enforcement of an HOV facility. The transit agency may also have a lead role or major supporting role in planning, designing, and operating transit stations, park-and-ride lots, and other support facilities. Representatives from transit organizations should be members of a multi-agency project management team and may have the lead responsibility for projects on separate rights-of-way and arterial streets. The planning for transit services with an HOV facility should be coordinated through these teams. Further, transit personnel may head a subcommittee or other group to assist in developing new or expanded bus service with an HOV facility. The other agencies noted in this section should also be involved in these efforts.

Private Bus Companies or Operators. In some areas, private bus companies may provide service in a corridor with a new or existing HOV lane. Representatives from these operators should be involved in planning new or revised transit services and facilities.

Rideshare Agencies. In many metropolitan areas the transit agency operates not only the bus service, but also provides ridematching, vanpool, and other rideshare programs. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, representative from the rideshare agency should participate in the multi-agency team and should be involved in planning the transit and related services and facilities.

State Department of Transportation. As noted in previous chapters, the state department of transportation usually has overall responsibilities for HOV facilities on freeways and state-owned arterial roads. Further, the state may play a supporting role with HOV facilities in separate rights-of-way and those on local roads. Representatives from the state department of transportation may head the multi-agency management team or actively participate on a team. Staff from the state department of transportation should be involved in planning transit services on new or existing HOV facilities, as well as providing ongoing assistance and coordination with the operation of these services.

Table 9-1. Agencies and Groups Involved in Planning and Operating Transit Services with HOV Facilities

Agency or Group	Potential Roles and Responsibility
Transit Agency	• Overall responsibility for planning and operating transit services. • Lead or assist with multi-agency project management team. • Lead multi-agency sub group. • Public input and hearings on routes. • Implement, operate, and monitor service. • May have enforcement responsibilities. • Public information, marketing, public relations
Private Bus Companies or Operators	• Participate in planning new or expanded services. • May operate service using HOV lanes.
Rideshare Agency	• Rideshare promotional activities and coordination with transit services. • Public information, marketing, public relations.
State Department of Transportation	• Lead on projects on freeways and state-owned arterial streets. • Assist with planning and operating transit services. • Assist with overall coordination of transit operations. • Assist with and coordinate public information, marketing, public relations.
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multi-agency coordination. • May have policies and plans relating to transit services in the corridor. • May provide technical assistance. • May be responsible for MIS or other studies. • Ensure that projects are included in necessary planning and programming documents.
Transportation Management Organizations, Transportation Management Associations, Downtown Councils	• Assist with planning activities, such as surveys of employees. • Employer support activities. • Promotion of bus use and ridesharing. • May help fund special services. • Specialized information and marketing.
Special-User Groups—Taxis, Airport Limousines, School Buses	• Assist with planning activities. • Operate services on facility.

Table 9-1. Agencies and Groups Involved in Planning and Operating Transit Services with HOV Facilities, continued

Agency or Group	Potential Roles and Responsibility
Local Municipalities	• Authority over design and operation of local streets. • Provide technical assistance in planning transit services and facilities. • Coordination with other city departments and other agencies. • Assist with public information, marketing, public relations.
State and Local Police	• Usually responsible for enforcement of HOV facility. • Coordinate planning and operations activities.
Federal Agencies—FTA and FHWA	• Funding support. • May provide technical assistance. • Overall approval of various steps.
Elected and Appointed Officials	• Provide input and suggestions. • Participate in openings and meetings.
Commuters and Public Groups	• Provide input into transit planning process.

Metropolitan Planning Organization (MPO). Staff from the MPO may assist with transit planning and operating activities in a number of ways. First, the MPO may have policies and plans relating to the provision of transit services in the corridor or area where the HOV facility is located. Second, MPO staff should be part of the multi-agency project management team, and may take the lead in helping to facilitate meetings and other activities. Third, an MPO may have responsibility for a Major Investment Study (MIS) or other regional corridor study that includes an HOV facility as an alternative. MPO staff may also be able to provide technical assistance and support with the transit planning activities. Finally, the use of federal funds for transit capital and operation needs must be included in an MPO Transportation Improvement Program (TIP).

Transportation Management Organizations (TMOs), Transportation Management Associations (MPAs), and Downtown Councils. These organizations, which are usually composed of major employers in an area, may assist with planning and operating transit services associated with a new or an existing HOV facility. These organizations may help plan new or revised services by coordinating surveys of employers and employees, facilitating meetings, and providing other information. They may also help fund special bus services or facilities, and promote the use of transit and ridesharing among employers and employees. Representatives from these groups may be part of the multi-agency project management team and should be involved in the transit planning activities.

Special-User Groups—Taxis, Airport Limousine Services, and School Buses. Involving representatives from these groups in the transit planing process should be considered if it is likely they may operate service on the HOV facility. Inviting these groups to participate in the planning stage can help identify any special needs and assist in coordinating the services provided by various operators.

Local Municipalities. Cities and counties may have the lead role in arterial street HOV projects and may be actively involved in other types of facilities. These jurisdictions will also have authority over the design and operation of bus facilities along local roads. As a result, representatives from local units of government should be involved in planning and operating transit services associated with the various types of HOV facilities. Staff from these agencies may be able to provide technical assistance during the planning process. For example, some cities have extensive Geographic Information Systems (GIS) that may be of help in planning transit routes and facilities.

State and Local Police. These groups usually have responsibility for enforcing HOV facilities on freeways and arterial roadways. As a result, they should be involved throughout all phases of planning, designing, implementing, and operating an HOV facility, including activities related to the transit components.

Federal Agencies. Representatives from FTA and FHWA may participate on multi-agency project management teams for an HOV facility, MIS, or on other special studies. The FTA will be responsible for approving specific requests for federal transit funding. Staff from both agencies may also provide technical assistance during the planning process and may share information on the experience with other HOV facilities throughout the country.

Elected and Appointed Officials. The need to communicate with elected and appointed officials during all phases of an HOV project has been stressed throughout this Manual. Ensuring that these individuals are appraised of the transit planning activities, soliciting their ideas and suggestions, and notifying them of meetings with their constituents should all be considered in planning and operating transit services with HOV facilities.

Commuters and Public Groups. Obtaining input from the individuals who will be using the transit services associated with an HOV facility is an important element of the planning process. The techniques that can be used to solicit comments and participation from the public are described in Chapter 12. These include surveys, focus groups, meetings, workshops, hearings, and other methods to obtain input and feedback from commuters and the general public. Information from these groups is critical in developing transit routes and services that meet the needs of travelers.

IV. TRANSIT SERVICES

A. Transit Service Orientation

A variety of bus services and bus operating strategies can be used with HOV facilities. The wide range of operating scenarios indicates the flexibility in service orientation and service levels offered by HOV facilities. For example, bus services can be tailored to the specific travel patterns and travel needs of residents and the unique characteristics of an area. In addition, modifications to route structures and service levels can easily be made in response to changing conditions. The six bus operating strategies most often found with HOV facilities in separate rights-of-way and on freeways are described next and illustrated in Figure 9-1. In addition, paratransit or demand responsive services may use HOV facilities. Information on these types of services is also included in this section.

All of these transit services may use arterial street HOV facilities, including those in a downtown area, a major activity center, or in a major travel corridor. More detailed information on arterial street HOV applications is provided in Chapter 7.

1. Dedicated Services

Dedicated bus service operates only on a busway or an HOV lane. The route is dedicated to the HOV facility and does not deviate off of the lane. Routes of this nature provide service similar to an LRT or a heavy rail line. Passengers generally access dedicated routes by walking to a station, using a connecting route, driving to a station or park-and-ride facility, or being dropped off at a station. Operating speeds are usually in the range of 56 to 69 kph (35 to 40 mph), but may reach 80 to 89 kph (50 to 55 mph) on longer segments. Service is offered on these routes throughout the day, with frequent buses operating during the peak hours. As noted below, dedicated services are usually found with bus-only facilities.

Ottawa Transitway—Route 95. This route operates exclusively on the Transitway providing dedicated service along the 24-kilometer length of the facility. High-frequency service, often using articulated buses, is provided on Route 95. Service hours are from 4:00 A.M. to midnight on weekdays, 4:30 A.M. to 1:00 A.M. on Saturdays, and 5:00 A.M. to midnight on Sundays. Peak hour service operates on 2 to 3 minute headways. Off-peak and weekend headways average between 7 and 15 minutes. Route 95 buses stop at the park-and-ride lots and stations located along the Transitway and at bus stops in the downtown area. Figure 9-2 illustrates the express bus service on the Ottawa Transitway.

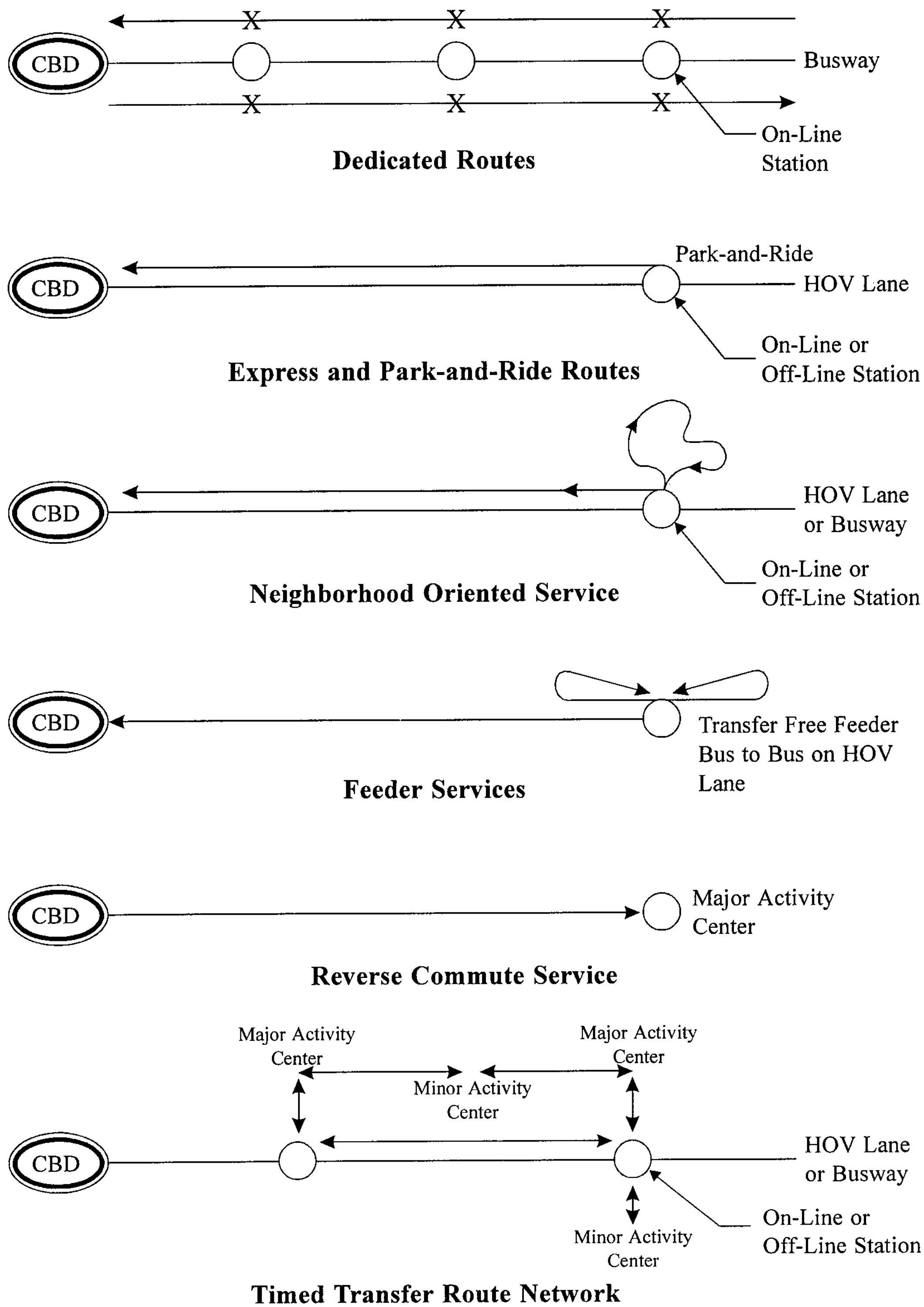


Figure 9-1. Bus Operating Strategies Frequently Used with HOV Facilities

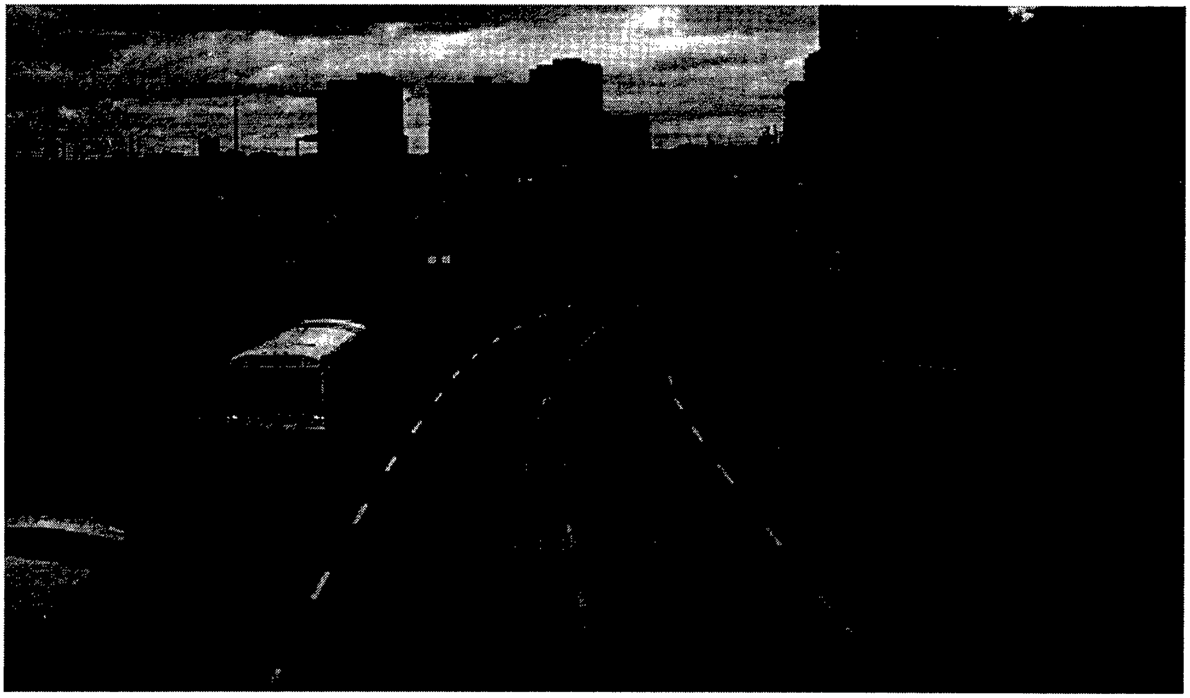


Figure 9-2. Express Bus Service on the Ottawa Transitway

Pittsburgh East Busway—All Stops Route. The East Busway All Stops (EBA) route provides dedicated service along the 11-kilometer (4-mile) East PatWay. Weekday peak hour headways average 4 minutes, with off-peak headways of 15 minutes. Extensive weekday service is provided, and buses operate on weekends.

University of Minnesota Busway. The University of Minnesota operates dedicated service on the 5-kilometer (3-mile) busway between the St. Paul and Minneapolis campuses. Buses operate on headways of 5 to 10 minutes during the morning and afternoon peak hours. Midday and evening service is provided every 10 to 20 minutes. Schedules are oriented around class periods at the University to accommodate students, faculty, and staff traveling between the two campuses.

2. Express and Park-and-Ride Services

Express services—or park-and-ride routes as they are called in some areas—are routes that initiate from park-and-ride lots or other areas close to the HOV lane and then operate as express or "closed door" service to major activity centers. This type of route provides high-speed service using the HOV lane. Most express or park-and-ride service is oriented toward downtown areas, although examples exist of service to other major activity centers. Speeds for the line-haul portion of the trip on the HOV lane usually average 80 to 89 kph (50 to 55 mph).

These services are also usually oriented toward peak-period commuters. Thus, many areas provide express or park-and-ride services only during the peak-periods, with little or no off-peak service. Express transit service is found with all types of HOV lanes.

Houston HOV Lanes—Park-and-Ride Service. Houston METRO operates an extensive system of park-and-ride bus routes oriented toward the HOV lanes. Premium express bus service is provided from most of the 16 major park-and-ride lots located adjacent to the 5 operating HOV lanes. Service is operated only on weekdays. Bus headways average under 5 minutes for most of the lots during the morning and afternoon peak hours. Service is oriented primarily toward the peak periods with little or no service provided during the midday. Service to most lots ends by 7:00 P.M. Over-the-road coaches and articulated buses are used on many of these routes. Most buses are able to access the HOV lanes directly from the park-and-ride lots by fly over ramps. Service is oriented primarily to downtown Houston, although some routes provide service to other major activity centers. After accessing the HOV lane, most buses travel directly to downtown Houston or other major activity centers although some routes stop at interim transit centers to allow passengers to transfer and to pick up additional riders. Figure 9-3 illustrates a METRO park-and-ride lot and a METRO bus operating in the HOV lane.

Seattle I-5 HOV Lanes—Express Service. Both Community Transit and King County Metro operate express bus services on the HOV lanes on I-5 in Seattle. Community Transit provides express service from park-and-ride lots in Snohomish County to downtown Seattle, the University of Washington, and North Seattle Community College. King County Metro also operates express services from park-and-ride lots in the corridor to downtown Seattle. Services are oriented toward the weekday peak periods, although Saturday and Sunday service is provided as well. Buses access the HOV lanes from the local street system.

Los Angeles San Bernardino Freeway Transitway—Express Service. Frequent express service is provided along the San Bernardino Freeway Transitway in Los Angeles. Routes operated from the San Gabriel Valley and the El Monte park-and-ride lot are oriented to downtown Los Angeles, with intermediate stops at the California State University at Los Angeles station and the University of California Los Angeles Medical Center Station. Service is oriented primarily to weekday peak-periods, but midday and weekend service is provided along the Busway. Figure 9-4 highlights the El Monte transit station and park-and-ride lot and buses on the San Bernardino Freeway Busway.

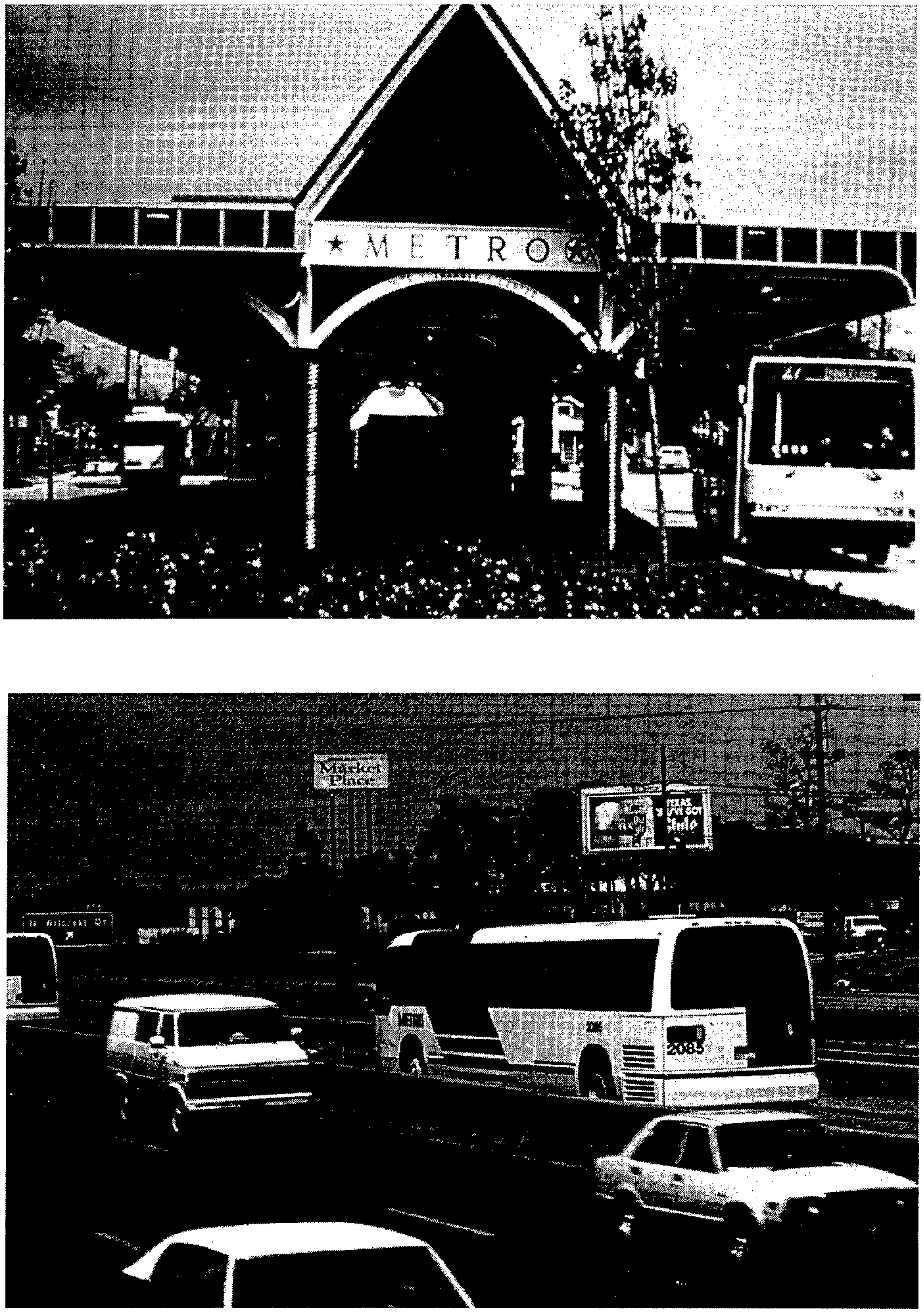


Figure 9-3. Houston METRO Park-and-Ride Service Using HOV Lane

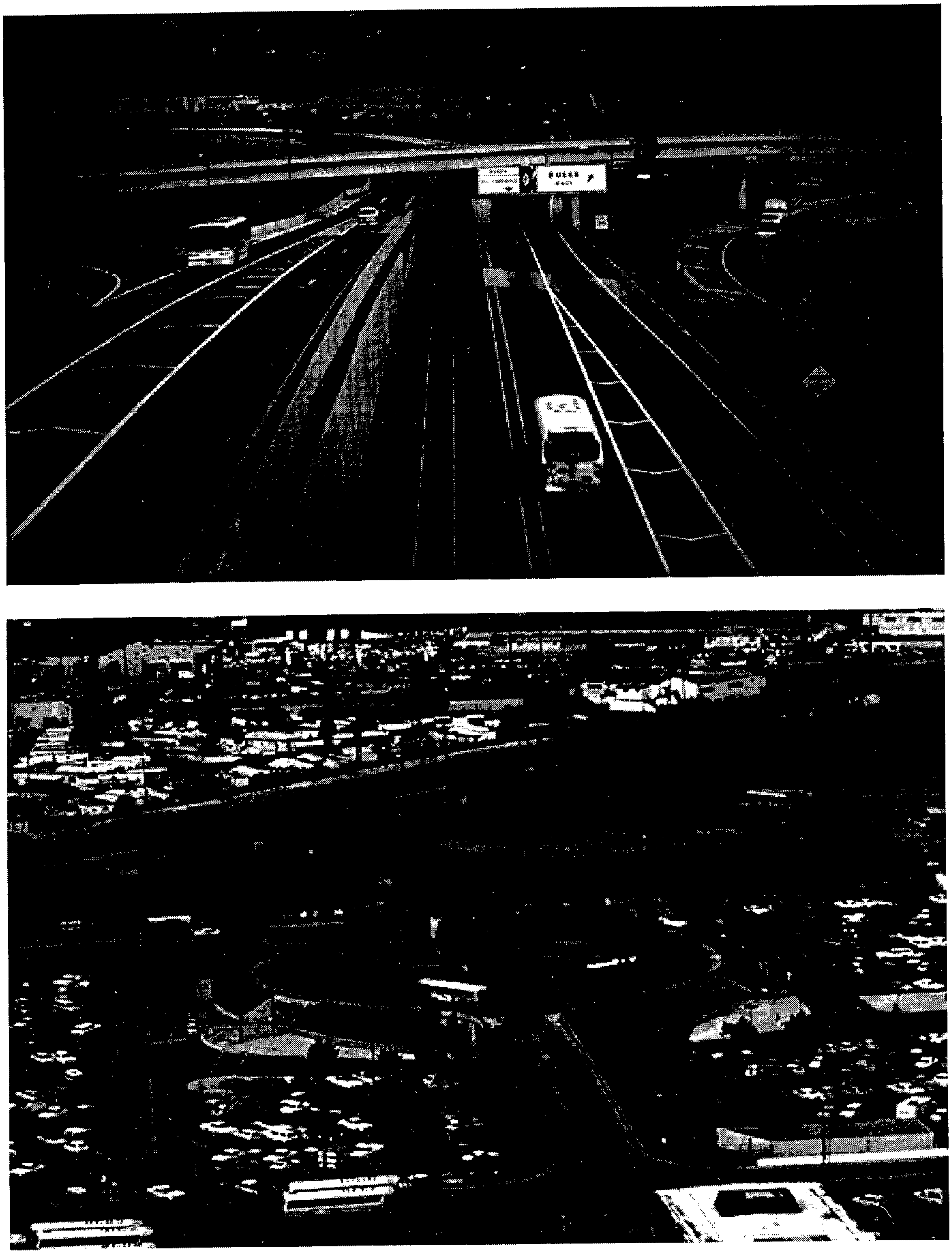


Figure 9-4. Los Angeles San Bernardino Freeway Bus Services

Denver North I-25 Express Lanes—Regional Service. The Regional Transportation District (RTD) operates regional express and neighborhood express bus routes on the two lane reversible North I-25 Bus/HOV facility. Regional express service is provided from Boulder, Longmont, and selected park-and-ride lots in the corridor to downtown Denver and a few other activity centers. For example, all day service is provided from Boulder to downtown Denver on the B Route. Peak hour headways on this route average approximately 10 minutes, off-peak service operates every half hour, and there is limited Saturday and Sunday service. The W Route provides three morning and three afternoon trips from two park-and-ride lots in the I-25 corridor to the Denver Technology Center south of the downtown area.

Minneapolis I-394 HOV Lanes—Express Service. Express service from the major park-and-ride lots and transit centers in the corridor use the I-394 HOV lanes. One example is Route 73, which provides weekday peak-period express service from the County Road 73 Park-and-Ride lot to downtown Minneapolis. Nine inbound and nine outbound trips are provided daily. Similar service is provided on other routes in the corridor.

Washington D.C./Northern Virginia Shirley Highway (I-395) HOV Lanes—Express Service. The Washington Metropolitan Area Transit Authority (WMATA), Fairfax County, and Prince William County operate express bus services from park-and-ride lots in the I-395 corridor. Services are oriented toward the morning and afternoon peak-periods, providing high levels of service. All WMATA and Fairfax County buses, and most Prince William County buses, terminate at either the Franconia/Springfield Metro Rail Station or the Pentagon Intermodal Station. The termination of buses at these stations reflect the policy that bus service should not be provided parallel to the Metro rail line.

New Jersey Route 495—Express Service. Public transit agencies and private bus companies operate extensive express bus services utilizing the contraflow bus lane on Route 495 on the approach to the Lincoln Tunnel. Peak-period express buses operate from park-and-ride lots and suburban neighborhoods into New York City.

3. Neighborhood Oriented Routes

These routes offer local service in neighborhood areas and then access the HOV lane for the trip to the downtown area or to another major activity center. Operating speeds in the neighborhood areas tend to be in the range of 8 to 16 kph (5 to 10 mph), while speeds on the HOV segment average between 72 to 89 kph (45 and 55 mph). Neighborhood routes provide commuters with the advantage of not having to drive to a park-and-ride lot or to transfer from a local feeder route. Further, neighborhood oriented routes may serve areas with concentrations of transit dependents. Neighborhood routes may operate only during the peak-periods, or they may operate throughout the day.

Ottawa Transitway—Local Service. In addition to Route 95, which provides dedicated service along the Transitway, other bus routes in Ottawa circulate in local neighborhoods and then access the Transitway for a major portion of the trip. Some routes operate only during the peak-periods, while others provide all day service or feeder service to Route 95.

Denver North I-25 Express Lanes—Neighborhood Express. In addition to the regional service described previously, the RTD operates a number of neighborhood express routes on the North I-25 HOV lanes. These routes operate in neighborhood areas and may stop at a park-and-ride lot before accessing the I-25 freeway and the HOV lanes for a major portion of the trip to downtown Denver. Most routes are oriented only toward peak-period commuters, providing three morning trips and three afternoon trips.

Minneapolis I-394 HOV Lanes—Neighborhood Express. In addition to the express routes from the park-and-ride lots, neighborhood services also use the I-394 HOV lanes. These routes provide service to neighborhoods in the western suburbs of Minneapolis and then access the I-394 HOV lanes for the trip to downtown Minneapolis. Most routes stop at the I-394 Transit Centers, allowing passengers to transfer to other routes as part of the timed-transfer system described later in this section. Weekday and weekend service is provided on most of these routes.

4. **Feeder Services**
These routes provide linking service from a neighborhood area or major activity center to a transit station or park-and-ride facility where riders transfer to dedicated, park-and-ride, or express routes for the major portion of their trip. Although feeder services are more commonly found with LRT or heavy rail systems, feeder routes are being used successfully with some HOV facilities.

Ottawa Transitway—Feeder Bus Service. A number of routes in Ottawa operate in neighborhood areas and terminate at stations along the Transitway. These routes, which operate on weekdays and on weekends, allow passengers to transfer to Route 95 and other services on the Transitway.

5. **Reverse Commute Routes**
The transit routes described previously focus primarily on serving trips oriented toward the downtown or to other activity centers. This network structures reflects the traditional orientation of transit services, which has historically provided service from suburban areas to central cities and downtown areas. Less service has been focused on providing residents of central cities with access to

suburban areas. Reverse commute services have been implemented in some areas to meet these travel needs. Reverse commute routes provide central city residents with access to jobs, shopping, and other opportunities in suburban areas. A few examples exist of reverse commute services with HOV facilities.

I-394—Plymouth METROLINK and Metropolitan Council Transit Operations (MTCO). A reverse commute service is offered in the I-394 corridor through the coordinated efforts of the MTCO and Plymouth METROLINK. This service provides residents of central city neighborhoods in Minneapolis and in first ring suburban communities with access to jobs in Plymouth, a suburb in the western part of the Twin Cities Metropolitan area. An individual can take an MTCO route to the Plymouth Road Transit Center and transfer to the van service operated by Plymouth METROLINK. The vans operate on a circular route, bringing Plymouth residents to the station to connect with MTCO service to downtown Minneapolis and other areas, and picking up passengers transferring from MTCO service destined to jobs in Plymouth. The vans operate on half hour headways during the morning and afternoon peak-periods.

I-5 San Diego Freeway North in the San Fernando Valley. Several suburb-to-suburb commute routes are found in the northern and central parts of the San Fernando Valley. Those routes tend to be run as point-to-point services with a minimal level-of-service (from one to two trips in each peak period); still they offer dedicated connections between remote suburbs. Santa Clarita Transit has three of those routes serving respectively the Warner Center, Chatsworth, and the Van Nuys areas. The Antelope Valley Transit Authority contracts out for one route to the Warner Center.

6. **Timed-Transfer Services**

Timed transfer systems are oriented around a system of transit routes designed to facilitate fast and convenient transferring between different routes. Timed transfer networks are set up so that routes and buses are linked at major interchange points which are usually major transit centers. Buses on all routes serving the transfer points operate on the same headways or service frequencies. Buses are scheduled to arrive at the interchange point at the same time. Following a layover period that allows passengers to change buses, the vehicles all leave at the same time. The advantage of this system is that passengers do not have to go downtown to transfer, as in a traditional radial system, allowing riders to reach more destinations quicker and more conveniently.

Minneapolis—I-394 Timed Transfer System. A timed transfer operating strategy was implemented as part of the I-394 HOV lane system. The timed transfer system focuses bus service on the two major transit stations built as part of I-394, downtown Minneapolis, and the smaller transit centers and park-and-ride lots in the area. New crosstown service was added in some areas and existing routes were modified to feed into the transit stations and to provide connections to routes operating along I-394. The timed transfer system provides improved service to multiple destinations in the corridor. Although the route structure and schedules have been modified as experience has been gained with the new system, the basic system is still in operation.

Houston Regional Bus Plan. Houston METRO is moving toward more of a timed transfer system as part of its Regional Bus Plan, which includes the addition of crosstown and neighborhood routes linking the major transit centers. Some buses operating on the HOV lanes divert into the centers to drop-off and pick-up passengers. The system will provide riders with access to multiple destinations without having to go downtown to transfer.

7. Paratransit and Demand Responsive Services

The previous types of transit services are oriented toward fixed routes and fixed schedules. Paratransit and demand responsive services represent a different type of operation. Rather than operating on a fixed route and on a fixed schedule, these types of services operate on demand. Thus, service is provided only in response to a specific request, and the routes and schedules are flexible.

Paratransit services are found in many areas. These services may be oriented primarily toward individuals with special needs, or they may be available to the general public. The Americans with Disabilities Act (ADA) of 1990 requires that all transit systems providing fixed route services also provide paratransit or other services to individuals with special needs. The paratransit service must be comparable to the fixed route system in terms of coverage, hours of operation, fares, and other factors. In addition, paratransit options are used in some areas in place of fixed route services for evening, weekend, and other off-peak periods.

Paratransit services are usually provided using wheelchair lift-equipped minibuses or vans. Taxicabs or other types of vehicles are also used in some areas. The use of HOV facilities by paratransit services has not been documented on a widespread basis. Since operators have control over selecting routes to pick-up and drop-off paratransit passengers, however, HOV facilities may be used in some cases.

B. Transit Vehicles

A variety of transit vehicles are found with HOV facilities. The ability to use different types and sizes of buses adds further flexibility to the services operated on HOV lanes. The appropriate vehicle can be matched to specific markets and services. The primary types of buses currently in use with HOV facilities are summarized next. These vehicles meet the accessibility requirements of the American with Disabilities Act (ADA) of 1991. Figure 9-5 illustrates the transit vehicles commonly operated with HOV facilities.

Figure 9-5. Examples of Transit Vehicles Commonly Operated with HOV Facilities

1. **Standard Buses**
The most commonly operated transit vehicle on HOV lanes is the standard bus. Standard-sized buses are usually 12.1 meters (40 feet) in length. Depending on the exact seating arrangements, these buses usually accommodate 40 to 51 seated passengers. Seats on standard buses are typically hard plastic or durable fabric, although some transit vehicles have more comfortable seating.

2. **Over-the-Road Coaches**
These vehicles are generally 13.7 meters (45 feet) in length and have a capacity of 50 seated passengers. Coaches provide a more comfortable ride through better vehicle suspension, individual cushioned reclining seating, reading lights, and overhead storage areas. In addition, some transit systems are testing television monitors on over-the-road coaches on routes that serve long distance trips. Over-the-road coaches are found on HOV facilities in Houston, Los Angeles, New York and New Jersey, and other areas.

3. **Articulated Buses**
The articulated bus is typically 18.3 meters (60 feet) long and accommodates between 66 and 76 seated passengers. Articulated buses have three sets of wheels, rather than two for standard buses. The bend — or articulation — located behind the second set of wheels allows the vehicle to turn and maneuver in and out of stops and around corners. Most articulated buses have three extra-wide doors for faster loading and unloading. Articulated buses are operated by many transit systems on high volume routes, including those using HOV lanes.

4. **Mini-buses**
Mini-buses are smaller vehicles, which accommodate between 16 to 18 seated passengers. Mini-buses are often used in low density areas and with paratransit services. Mini-buses are found with some HOV facilities, however. For example, Houston METRO operates mini-buses on a few routes using the Houston HOV lanes. Mini-buses are used on a suburb-to-suburb route in the I-10 West corridor. This route starts at a major park-and-ride lot and utilizes the I-10 West HOV lane for the major part of the trip to the Post Oak/Galleria area. METRO also uses mini-buses for limited off-peak service to some of the major park-and-ride lots located along the HOV lanes.

5. **Other Buses**
A few other types of transit vehicles are currently in use on HOV facilities in North America and throughout the rest of the world. The Orange County Transit Authority (OCTA) operates SuperBuses from Fullerton to downtown Los Angeles. This route does not currently use an HOV facility. The SuperBus is a vehicle that looks similar to a truck, in that the cab section is separated from the passenger trailer. The trailer accommodates 45 seated passengers. The floor of the trailer is lower than a standard transit vehicle, but the front rows of seats, which are located over the front wheels, are raised.

Two other types of buses are found in operation on HOV lanes in other parts of the world. Bi-articulated buses are currently being used on busways in Curitiba, Brazil. These buses have 5 doors and no steps. The buses are longer than an articulated bus and have a capacity of 220 seated and standing passengers. The routes these vehicles operated on have enclosed stations which provide raised, enclosed platform waiting areas for passengers. Each door on the bus has a ramp that extends from the bus onto the station platform, allowing for fast loading and unloading. The bi-articulated buses pull up to these platforms and passengers load and unload via the bus ramps. In addition, some busway systems in South America and Asia utilize buses with passenger trailer units. A variety of trailer types and sizes are used, increasing the passenger carrying capacity of the system without adding vehicles or drivers.

C. Planning Guidelines

Examining current transit routes and planning future bus services should be an integral part of the overall HOV facility planning process discussed in Chapter 4. Consideration of an HOV lane should compliment and enhance existing and future transit services in a corridor. A more detailed level of transit service planning is usually necessary, however, once a decision is made to proceed with an HOV facility. The normal planning process used to plan and evaluate routes and services in an area should be followed at this stage. The level of detail associated with the transit planning activities should be matched to the type of HOV facility being considered and the characteristics of the area. For example, a bus-only facility will involve a more detailed level of transit planning than will a circumferential concurrent flow HOV lane designed to serve mostly carpools.

Personnel from the local transit agencies and service providers usually take the lead in the planning process or should be actively involved. Most transit agencies have goals, policies, and criteria relating to new services, route structures, headways, and cost recovery ratios. All of these elements, as well as any transit-related goals and policies adopted by the MPO, state, or local government, should be considered. Further, the availability of funding for both capital and operating costs is often an important consideration in the planning process. The following elements should be considered in planning new, expanded, and restructured transit services associated with HOV lanes.

Examine Existing Services in the Corridor. The first step in the planning process is to review current transit services in the corridor or area. The route structures, headways, number of buses, passenger levels, running times, and other characteristics of existing services should all be examined. This information, which should have been included as part of the planning process for the HOV facility, provides the starting point for the development of a transit service plan.

Examine Transit Agency, State, MPO, and Local Goals and Policies. The goals, policies and criteria of the transit agency and other groups should be identified and reviewed. These should be used to help establish the parameters for the types and levels of services to be considered. This information can also help identify the realistic funding levels for capital and operating costs that the agencies can support.

Examine Origins-Destinations and Major Travel Patterns. The major travel markets, trip patterns, origin-destination pairs, and trip distances in the corridor or area should be analyzed. This information will provide an indication of the markets, and the size of those markets, that may be appropriate to serve with transit. For example, high levels of travel demand to the downtown area or major activity center provides an indication of a potential market for transit. On the other hand, dispersed origins and dispersed destinations indicate less potential for regular route transit services.

Surveys and Additional Market Analysis. Additional methods, such as surveys of drivers and current bus riders, surveys at major activity centers, focus groups, telephone interviews with residents in the corridor, neighborhood meetings, and other market research activities can be conducted to obtain further information on the interest of potential customers to different types and levels of transit information.

Fixed Facilities. Consideration should also be given by the planning process to the development of fixed facilities such as transit stations and park-and-ride lots, and the impact of these elements on the service plan and operating strategy.

Development and Analysis of Service Alternatives. The information obtained from all of the previous steps should be used to develop one or more transit alternatives. These alternatives should include the type and level of services, route structures, headways, vehicle types, fares, fixed facilities, and other elements. Bus operating speeds and travel times will need to be estimated and the capital and operating costs for each alternative will need to be developed and analyzed. A recommendation on the approach that best meets the goals and objectives of the HOV project and is financially viable should be developed.

Select Appropriate Service Strategies and Service Levels. The transit policy board is usually the group that must act to approve the transit service component of an HOV facility plan.

Implement, Monitor, and Evaluate Service. Implementing new, expanded, and restructured transit service should include a significant marketing effort and public information campaign. An ongoing monitoring and evaluation program should also be developed and implemented to ensure that the service meets the goals and objectives. Changes in routes and service levels may be needed on an ongoing basis.

D. Funding Sources

Funding for operating bus services and for purchasing vehicles, including those using HOV facilities, comes from four major sources. These are federal, state, and local programs, and revenues generated by passenger fares. Each of these sources is briefly summarized next along with other innovative funding techniques.

1. **Federal Funding**

Federal funding for operating support to public transportation systems is administered through the Federal Transit Administration (FTA). This agency is responsible for grant administration and other activities associated with the federal program. The Transportation Equity Act for the 21st Century (TEA-21) provides the funding authorization for public transit operating support and program requirements for the six-year period from 1998 through 2003. On an annual basis, Congress appropriates the specific funding levels for the various programs.

The major source of federal funding for transit capital and operating assistance in metropolitan areas is through Section 9. The Section 9 grant program provides funding to all urbanized areas of the country on the basis of a statutory formula. Section 9 funds can be used for capital and operating assistance in urbanized areas with populations of 50,000 or more. Large urban areas with populations over 200,000 receive direct allocations from FTA. Funding for urbanized areas with populations between 50,000 and 200,000 is allocated to the states and apportioned by the governor. For urbanized areas under 200,000 in population, the statutory formula is based on population and population density. For areas with over 200,000 in population, the formula considers population, population density, and transportation data (5,6).

Section 3 is the discretionary and formula capital grant program for new rail projects, rail and fixed guideway modernization, and bus and other capital projects. The ISTEA changed the allocation of Section 3 rail and fixed guideway modernization funds to a formula, rather than discretionary, basis. The funding share for Section 3 projects is 80 percent federal and 20 percent local, except for projects involving vehicle-related equipment to meet the requirements of the Americans with Disabilities Act or the Clean Air Act Amendments. In these cases, the federal share is 90 percent of the incremental capital costs to meet these requirements.

TEA-21 contains the provision of the ISTEA providing flexibility among the various federal surface transportation programs, including the ability to transfer funds between highway and transit programs. As a result, additional federal programs, such as the Surface Transportation Program (STP) and the Congestion Mitigation and Air Quality Improvement Program (CMAQ), may be used in special cases to support transit services. Additional information about the flexible funding opportunities for transit can be found in an FTA publication on the topic (7).

2. **State Funding**
Most states provide some financial support for public transit operating expenses. This funding may be used along with local sources to match federal funds, or it may be used to support other types of services. A wide variety of sources are currently being used by states to fund public transportation services.

According to recent surveys conducted by the American Association of State Highways and Transportation Officials (AASHTO), approximately 24 states use general fund allocations to support public transit, while six states have specific transportation funds which include transit. Other funding sources used by states include sale taxes, fuel taxes, motor vehicle taxes, lottery proceeds, and other mechanisms (8).

3. **Local Funding**
A wide range of funding programs are also used at the local level to support the operations of public transit services. These include local sales taxes, local property taxes, general revenues and other sources. Specific examples of local funding sources in areas with buses operating on HOV facilities include local sales taxes in Houston and Dallas, and property taxes in the Minneapolis-St. Paul area.

4. **Fare Revenues**
Most transit systems charge a fare for use of the service. The revenues generated through passenger fares help pay a portion of the cost to operate the service. The portion or percentage of the operating cost paid by fares, which is usually called the fare box recovery ratio, varies greatly among different systems as well as among routes and services offered by the same operator.

Available information indicates that HOV facilities can improve the fare box recovery ratio for bus services. For example, in Houston the fare box recovery ratio is higher for METRO park-and-ride routes utilizing the HOV lanes than for local and non-HOV express service (1).

5. **Other Funding Sources**
In addition to the traditional funding sources discussed in the previous four sections, many transit agencies receive income from sources such as advertising on the sides of buses and interest on reserve accounts or investments. Further, some transit agencies are exploring and utilizing innovative approaches to financing transit operations. These may include private business subsidizing services oriented specifically to their employees and other non-traditional techniques. In addition, privately funded services, such as private bus lines, intercity buses, and tour coaches may all use HOV facilities.

E. Operating Considerations

Once the general operating strategies have been determined, more detailed operational level route and schedule planning will be needed. In addition, the fares for services using the HOV facility must be established and other operating elements addressed. Although operating bus service on an HOV lane is not much different than operating service on freeways or local roadways, there are some additional issues that may need to be addressed. This section briefly highlights the elements that should be considered in the more detailed operational planning conducted by a transit agency.

Route and Schedule Planning. The general types of services that may be operated with HOV facilities and elements to be considered in the overall planning processes were discussed in previous sections. Once the service strategies have been determined, the next steps will be to complete the detail route and schedule planning. These activities will be the responsibility of the service planners and schedulers within the transit agency or operator. Most large transit agencies use some type of computer scheduling package to assist in this process. The outcomes of this step will be the route networks, the schedules, vehicle assignments, run-cutting, driver booking, and public information program. Each of these elements require a significant amount of effort on the part of transit agency staff.

Establishing Fares. Consideration will also need to be given to establishing the fare levels for services using the HOV facilities. The fares should fit within the overall structure used in a metropolitan area, which may include zone or distance-based fares, peak-period surcharges, and premium fares for express services or over-the-road coaches. In addition, the fare payment method will need to be established. Depending on the methods used in an area, these may include cash, tokens, tickets, passes, or smart cards.

Operating Personnel Training. Bus operators, on-street supervisors, maintenance personnel, and other transit support staff should be provided with training on the use of the HOV lanes and other facilities. These activities should follow the normal procedures used by the transit agencies and should be part of the implementation process discussed in Chapter 11.

Operating and Monitoring Services. Operating services from HOV facilities should follow the same procedures as other services provided by the transit agency. Personnel involved in the actual operation of the various services will usually include the bus drivers, on-street supervisors, transit police, maintenance personnel, dispatchers, and other support personnel. Elements frequently included in assessing the performance of transit services include monitoring on-time performance, passenger levels, fare revenues, and other operating statistics. Chapter 13 provides more detailed information on monitoring and evaluating HOV facilities, including transit services.

V. TRANSIT SUPPORT FACILITIES

A. Types of Transit Support Facilities

Four general types of transit facilities are used with HOV facilities on freeways and in separate rights-of-way. These are park-and-ride and park-and-pool lots, transit stations, intermodal facilities, and bus stops and shelters. Supporting facilities associated with arterial street HOV applications include bus stops and shelters, transit stations, and intermodal facilities. A general description of these facilities is provided in this section, along with case study examples. Techniques for planning, designing, funding, and operating support facilities are outlined in the following sections.

1. Park-and-Ride Facilities

Park-and-ride and park-and-pool lots are integral parts of most HOV facilities in North America. Although the size, location, and design of park-and-ride facilities vary among different HOV projects, all share a common purpose. Park-and-ride and park-and-pool lots provide users with the opportunity to change between low and high occupancy vehicles, affording an effective combination of access by automobile, bicycle, and walking with bus, vanpool, and carpool use.

Park-and-ride lots are usually oriented toward commuters changing from an automobile to a bus or a rail system, while park-and-pool facilities are oriented toward the formation of carpools and vanpools. Access to the lots may also be accomplished by walking or bicycling, and some park-and-ride facilities provide bicycle storage lockers or bicycle racks. In addition, some travelers may be dropped off and picked up, rather than leaving their vehicle in the lot all day. Short-term parking areas, called kiss-and-ride facilities, are often provided at lots to accommodate these travelers. A variety of amenities may be considered at park-and-ride lots. These include shelters and benches, enclosed waiting areas, newspaper machines, vending machines, and other services.

Park-and-ride facilities are often categorized by the location, the level of transit service provided, and the exclusive nature of the operation. Three general locations—remote, local, and peripheral—are used to describe park-and-ride lots. These facilities are located at different distances from the major activity center, serve different segments of the travel journey, and are characterized by different levels of transit services. Figure 9-6 provides an illustration of the three general locations for park-and-ride facilities. The characteristics associated with each type of facility are described next.

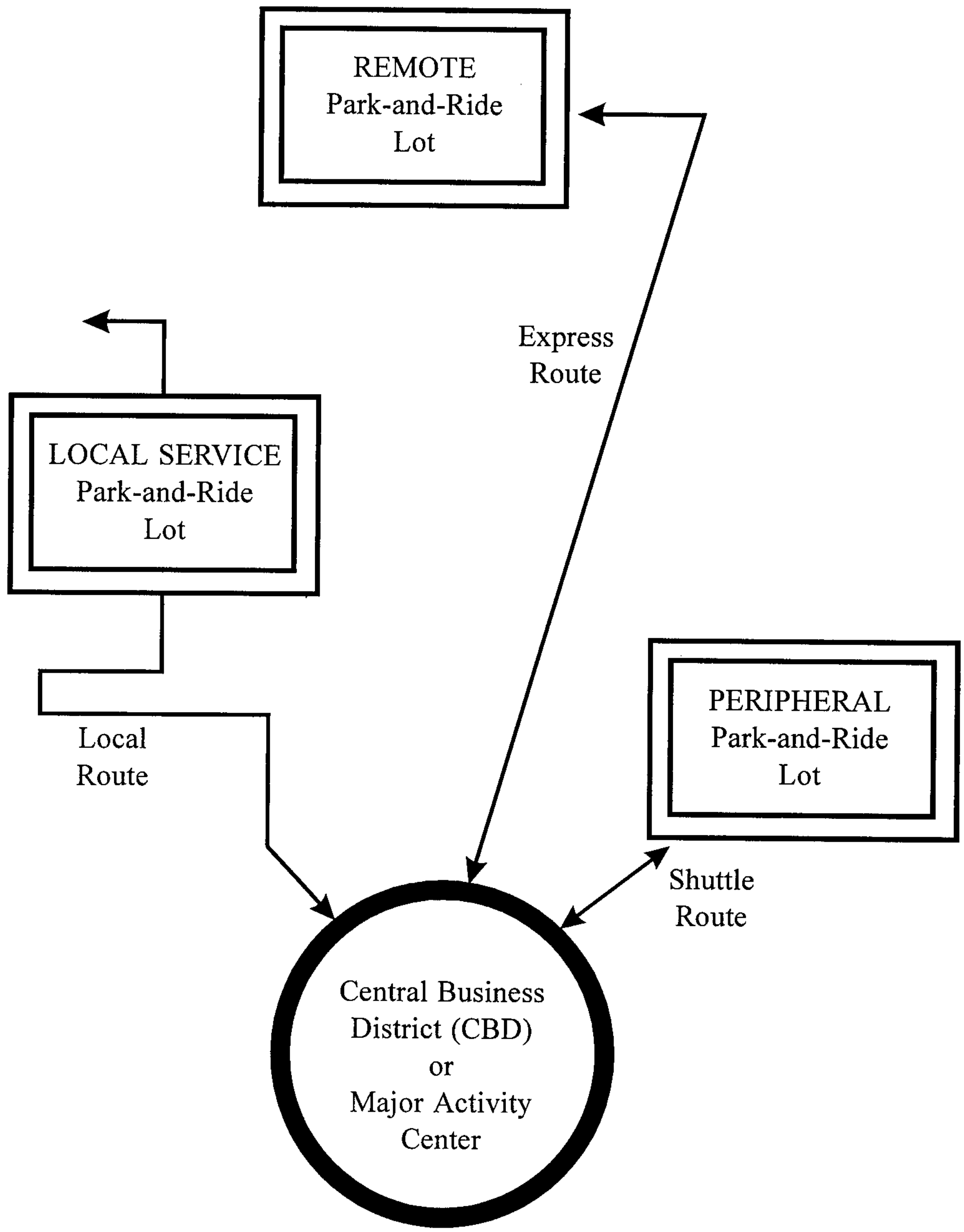


Figure 9-6. Types of Park-and-Ride Lots

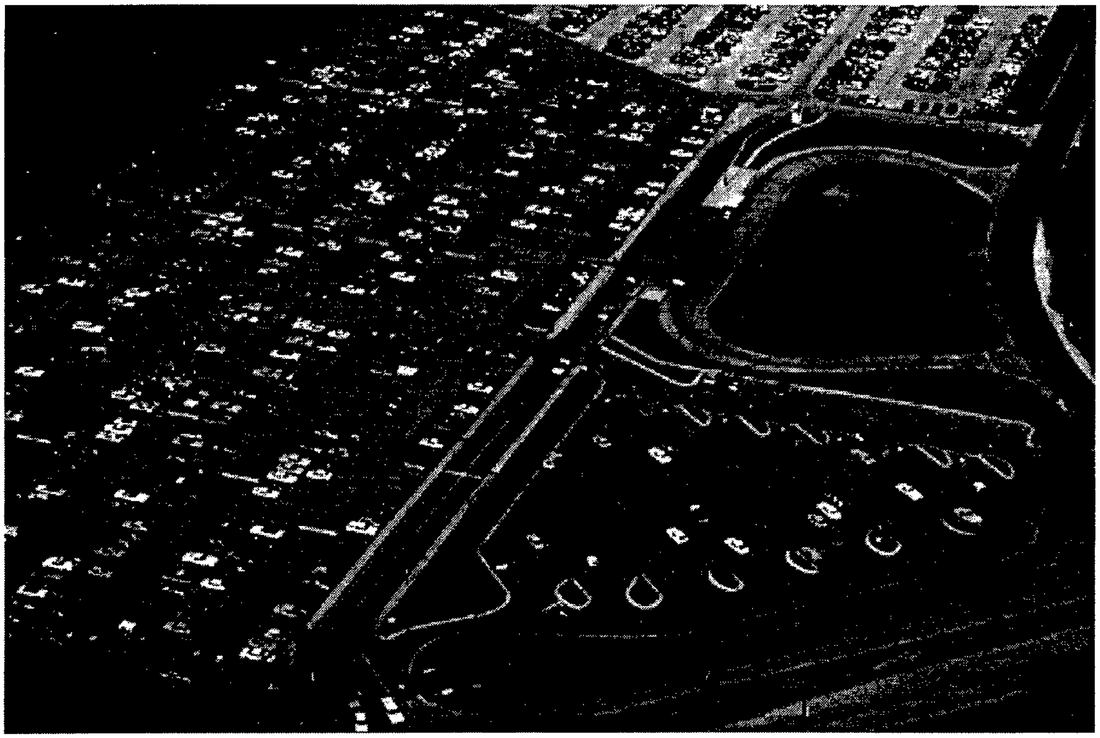
Remote Park-and-Ride Facilities. Remote park-and-ride lots are located relatively far from the major activity center or the final destination of users. Most remote park-and-ride facilities are oriented toward providing a change of mode for residents of suburban areas or satellite communities, with transit services oriented toward the downtown or other major employment center. The exact distance of remote facilities from the activity center varies between communities, with lots in large metropolitan areas located at relatively long distances from the final destination. Figure 9-7 provides examples of remote park-and-ride lots associated with the Houston HOV lanes.

Remote lots function to intercept automobiles close to the residential end of the trip. To accomplish this, they are often situated adjacent to or relatively close to freeways or major roadways in heavily traveled corridors. Commuters usually arrive by single-occupant vehicle, although local bus routes, walking, bicycling, or carpooling may also be used.

The size and level of transit service at remote lots will depend on the corridor demand. Many remote park-and-ride facilities, especially those located in major metropolitan areas, contain a large number of parking spaces and have high levels of express or high speed transit service. These types of lots are usually associated with HOV lanes, as well as with commuter rail, heavy rail, light rail transit (LRT), and express bus systems.

Another type of remote park-and-ride lot is a smaller facility located in an area without regular route transit service. Referred to as park-and-pool lots, these facilities are oriented toward the formation of carpools and vanpools, and are often located in rural areas. Few, if any, amenities are provided at these facilities. Park-and-pool lots are found with many HOV lanes, with the facility often located beyond the end of the HOV lane.

Local Service Park-and-Ride Facilities. Local service and park-and-ride lots are located along or at the end of a local bus route. Usually these lots are situated closer to the downtown area or activity center than remote lots and serve residential neighborhoods along the route. Local service lots tend to be smaller than remote facilities and are usually oriented toward bus service. Local service lots may be either exclusive or shared-use facilities. Local service park-and-ride lots are found with HOV facilities in some areas, although they are not as common as remote facilities. Figure 9-8 provides examples of local service park-and-ride lots.



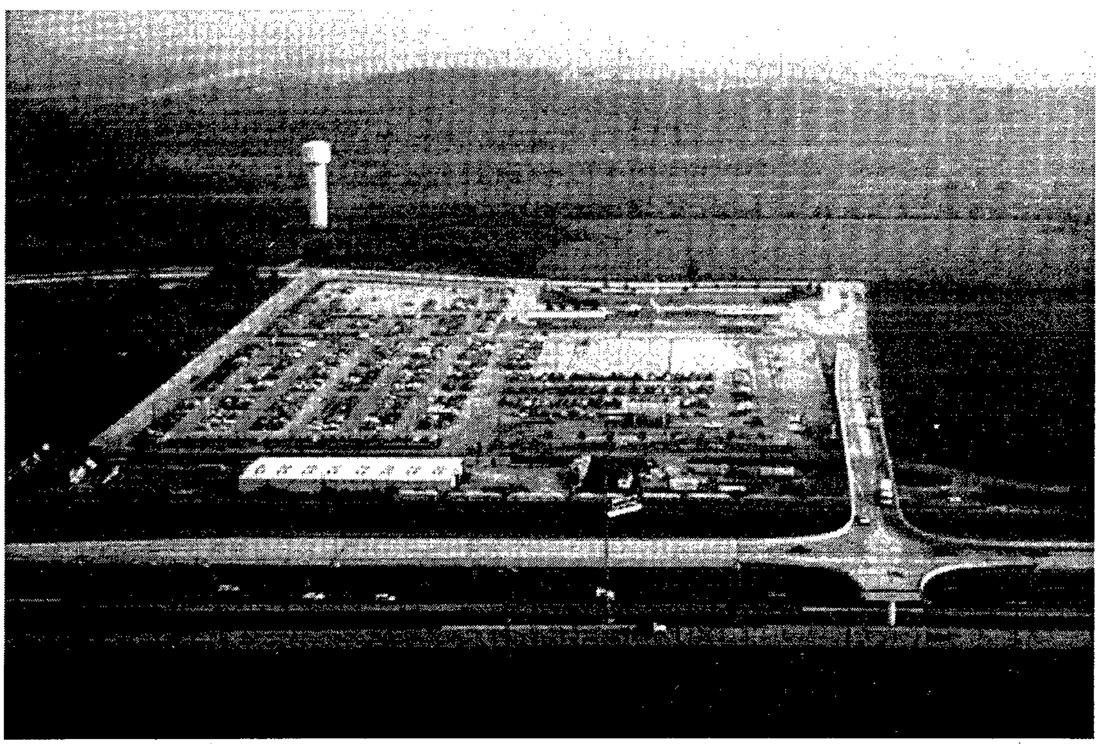


Figure 9-7. Examples of Remote Park-and-Ride Lots with the Houston HOV Lanes

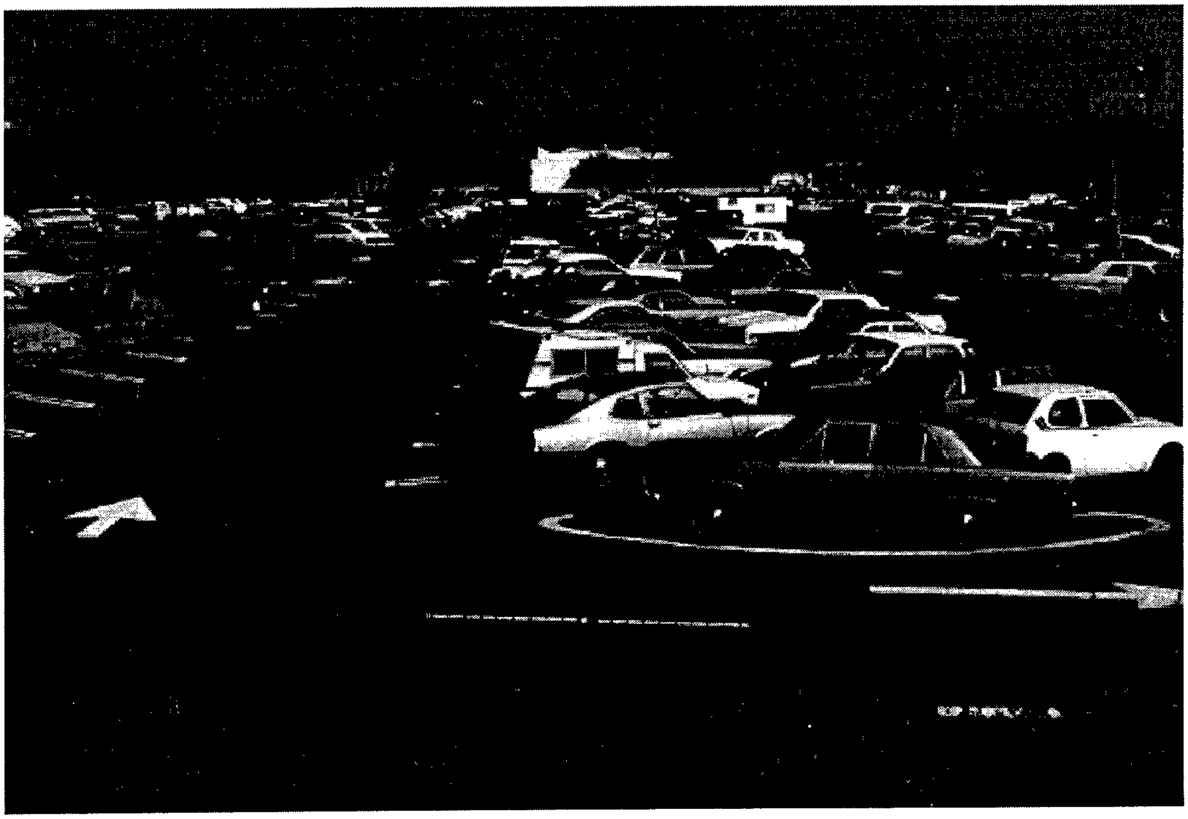


Figure 9-8. Example of Local Service Park-and-Ride Lots

Peripheral Park-and-Ride Facilities. Peripheral park-and-ride lots are located on the edge of a downtown area or other major activity center. These lots expand the amount of available parking in the area and help intercept automobiles before they enter a congested area. Parking in these lots may be free or reduced fees may be charged to vanpools and carpools. Commuters make the major portion of the trip by automobile, using transit for the last short segment. Peripheral lots may be served by shuttle routes or local service. They may be used in combination with a reduced fare or a free-fare zone. Peripheral lots may also be used to encourage ridesharing by providing reduced or free parking rates for carpool and vanpools. Some peripheral park-and-ride facilities are found with HOV lanes. One such example, illustrated in Figure 9-9, is the parking garages built on the edge of downtown Minneapolis as part of the I-394 HOV system.

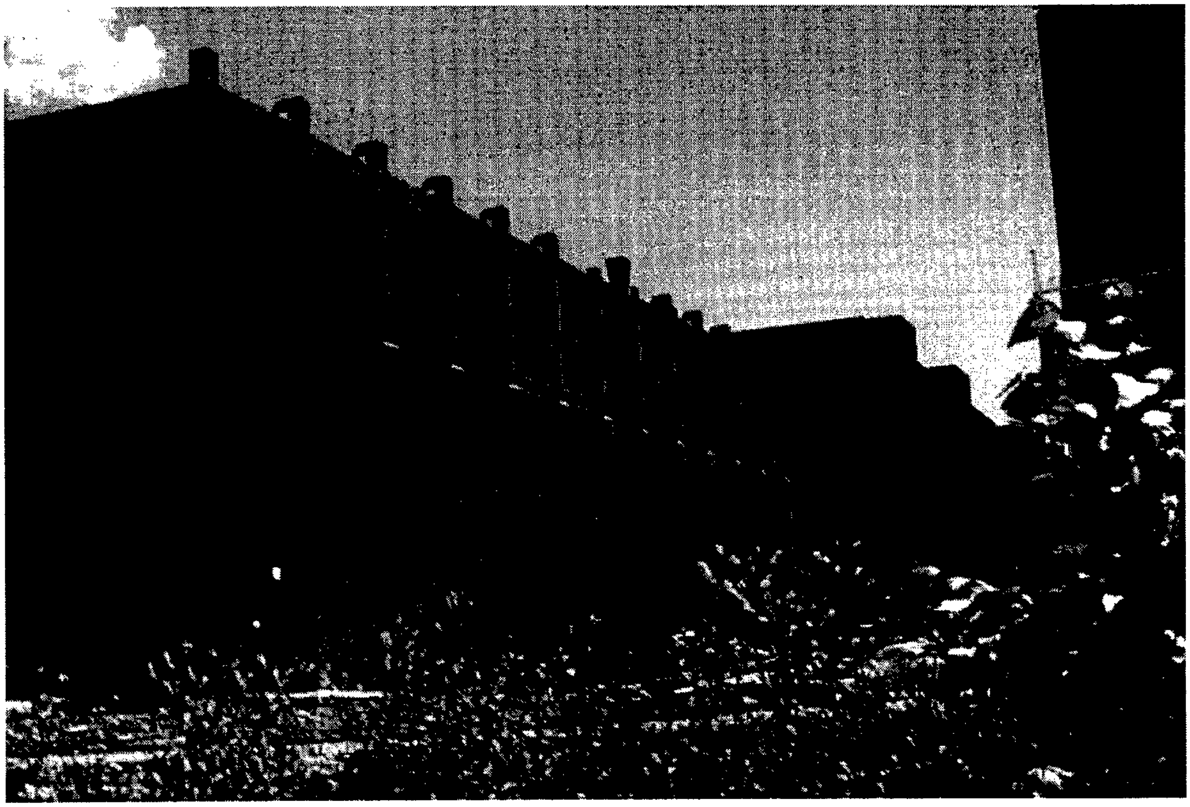


Figure 9-9. Downtown Minneapolis Parking Garages Connected to the I-394 HOV Lanes

Exclusive Use Park-and-Ride Facilities. Exclusive use facilities are planned, designed, constructed, and operated specifically to serve as park-and-ride lots. The remote park-and-ride lots associated with HOV lanes are usually exclusive facilities. These lots tend to be of medium to large size, are served by frequent peak-period transit service, and often include passenger amenities. Exclusive use lots offer advantages related to adequate automobile parking and bus space to meet anticipated demands, efficient lay-outs to maximize operations, and the ability to minimize potential automobile and pedestrian conflicts. Exclusive lots do require a significant capital investment and development time.

Shared-Use Park-and-Ride Facilities. Shared-use lots serve multiple functions by using all or a portion of an existing lot for transit related parking. Shopping center, church, school, and other activity center parking lots are common shared-use facilities. Shared-use lots are usually located along existing bus routes in urban areas and are smaller than exclusive lots, often ranging from 15 to 100 spaces. Shared-use lots are used with some HOV lanes, but are not as common as exclusive facilities due to their small size and focus on local service.

In general, exclusive remote park-and-ride lots are most frequently associated with HOV lanes. Further, extensive systems of both large and small park-and-ride lots are found with all types of HOV facilities. The following examples highlight the use of park-and-ride lots with the various types of HOV facilities (9).

HOV Lanes, Houston. Currently, 16 major park-and-ride lots are in operation adjacent to the 5 Houston HOV lanes. These facilities provide approximately 15,000 parking spaces in the five corridors. Additional lots, often smaller park-and-pool facilities, are located beyond the end of the HOV lanes. Fourteen of the park-and-ride lots contain spaces for between 950 to 2,246 automobiles. The park-and-pool lots normally contain between 35 and 100 spaces. The largest facility—the Kuykendahl park-and-ride along the I-45 North Freeway—contains 2,246 parking spaces. The number of parking spaces at lots in each corridor ranges from slightly over 3,000 to approximately 7,500. Direct access to the HOV lanes is provided at the major lots. Development and operation of the lots represents the coordinated efforts of Houston METRO and TxDOT. Utilization levels for the various facilities range between 50 to 100 percent (1,9). Examples of these facilities were illustrated previously in Figure 9-7.

Shirley Highway HOV Lanes, Washington, D.C. Three initial park-and-ride lots were developed as part of the Shirley Highway Express-Bus-On-Freeway Demonstration Project in the early 1970s. The park-and-ride system has expanded over the years and approximately 60 park-and-ride lots are now located along the 16-mile Shirley Highway corridor covering both the I-395 and I-95 HOV lanes. These facilities account for a total of some 10,000 parking spaces. The lots are owned and operated by a variety of different groups, including the Virginia Department of Transportation (VDOT), Fairfax County, Prince William County, and shopping centers and churches. The lots range in size from 50 spaces in some of the smaller joint use lots to almost 600 spaces in some of the VDOT lots (9).

San Bernardino Transitway, Los Angeles. A total of 20 park-and-ride lots are in operation in the I-10 or San Bernardino Freeway corridor. In addition to the Bernardino Transitway, the METROLINK rail system also operates in the corridor. Five of the park-and-ride facilities serve the METROLINK rail system, although some of these are used by vanpools which access the San Bernardino Busway. The remaining 15 lots, which are oriented toward the Busway, provide a total of some 5,100 parking spaces. The largest of these lots, the El Monte Station park-and-ride lot, contains 2,100 spaces (9). This facility was highlighted previously in Figure 9-4.

I-394 HOV Lanes, Minneapolis. Seven park-and-ride lots are located in the I-394 corridor. All of these lots are located along the concurrent flow HOV lane section, or at the end of the facility, and direct access to the HOV lanes is not provided. A total of some 840 parking spaces are located at these lots, which range in size from 60 to 285 spaces. The potential for developing new lots is being considered. Current utilization levels range from a low of 33% to a high of 100% at the different facilities (9).

I-5 North HOV Lanes, Seattle. Both Seattle Metro and Community Transit in Snohomish County operate bus service from park-and-ride lots in the I-5 North Freeway corridor which utilize the HOV lanes. Approximately 25 public and leased park-and-ride facilities are currently in use. Community Transit, which operates service in the concurrent flow HOV lanes north of the University of Washington, utilizes 13 park-and-ride lots located in Snohomish County. These lots range in size from approximately 50 to 900 parking spaces. Utilization of most of these facilities—5 of which are major lots and 8 of which are minor lots—is close to 100% (9).

2. **Transit Stations**

Transit stations or transit centers are used with many HOV lanes. Transit stations provide convenient, safe, and sheltered locations for passengers to wait for buses and to transfer between different routes or services. Most transit centers include enclosed waiting areas for passengers and multiple bus bays. Route and schedule information is usually provided and some facilities include amenities such as bus pass sales outlets, newspaper racks, small convenience stores, and other services. Many transit stations—although not all—associated with HOV facilities are incorporated into park-and-ride lots. In addition to long-term parking, kiss-and-ride or short-term parking areas, transit information, shelters, and other amenities are usually provided.

The type and design of a transit station is related to the nature of the HOV facility and the bus operating concept to be served. For example, the operating strategy will help determine if on-line or off-line stations are more appropriate. On-line stations are located directly along an HOV lane. Off-line stations may be located adjacent to the freeway or at a point further away from the HOV facility. Examples of the more extensive use of transit stations with HOV projects are summarized next.

Ottawa Transitway—On-Line Stations. Service on the Ottawa Transitway is oriented around a series of on-line stations. A few of the larger stations are tied into surrounding developments, including a hospital and a regional shopping center, while smaller stations have simple shelters and bus pull-ins. Station sizes and platform lengths are based on expected passenger demands and bus stopping volumes. Although each station is different, a common design treatment, using red steel pipes and glass structures, provides a unifying theme for the stations. Figure 9-10 shows examples of on-line stations on the Ottawa Transitway.

Pittsburgh East Busway—On-Line Stations. Transit service on the East Busway in Pittsburgh is oriented around six on-line stations. The stations include passenger waiting areas, bus pull-in spaces, and other amenities. Kiss-and-ride areas and connections to local buses are also provided. The stations were designed to fit into existing developments and neighborhood areas, with citizens' groups assisting with some of the station configurations. Figure 9-11 illustrates examples of on-line stations along the Pittsburgh Busways.

Los Angeles San Bernardino Busway—On-Line Stations. Three major stations are located along the San Bernardino Busway. The El Monte bus station at the eastern terminus of the facility was designed as a transfer point between local bus routes and the busway routes. As illustrated previously in Figure 9-4, the circular designed station includes a passenger waiting area, a transit information booth, and a large park-and-ride lot containing parking spaces for 2,100 automobiles. The two other on-line stations along the busway—the California State University at Los Angeles station and the University of Southern California Hospital station—are smaller facilities.

Houston HOV Lanes—Off-Line Centers. Off-line transit centers are located at most of the major park-and-ride lots associated with the Houston HOV lanes. These facilities, which were highlighted previously in Figures 9-3 and 9-7, include passenger waiting areas and multiple bus bays. In addition to these stations, Houston METRO is developing a series of transit centers as part of the Regional Bus Plan. These centers are being located to enhance the future route structure that will include more crosstown routes and services to multiple activity centers. Although some of these stations include small park-and-ride lots, many provide only bus transfer areas. The Houston transit centers have been individually designed and each represents a unique approach. Many of the stations have won local and national design awards.

Figure 9-10. On-line Stations on the Ottawa Transitway

Figure 9-11. On-line Station on the Pittsburgh Busways

Minneapolis I-394—Off-Line Centers. Two major transit centers are located along the I-394 HOV facility. As illustrated in Figure 9-12, these off-line centers, which are located at Plymouth Road and at Louisiana Avenue, include enclosed passenger waiting areas, small park-and-ride lots, kiss-and-ride areas, and multiple bus bays. The locations for the centers were selected based on the timed transfer system described previously. A common design is used at the two stations and is carried through in the smaller shelters and the park-and-ride lots located on the corridor. The transit centers located in the Third Avenue Distributor Garages (TAD) in downtown Minneapolis are also an integral part of the total HOV system.

3. **Intermodal Facilities**

Intermodal facilities serve multiple modes, providing travelers with the opportunity to change from one transportation service to another. Intermodal facilities enhance the connectivity of all mode and make it easier for individuals to transfer between different services. Intermodal facilities are usually relatively large, providing amenities such as waiting areas, ticket sales and passenger information, convenience services, and other activities. A few examples of intermodal facilities associated with HOV lanes are highlighted next.

Downtown Los Angeles Union Station and Gateway Transit Plaza—Intermodal Station. The intermodal passenger facility at Union Station in downtown Los Angeles is served by express buses operating on the San Bernardino Freeway Busway. A direct ramp from the freeway allows buses to easily access the facility. The historic Union Station occupies the south end of the intermodal facility and connection can be made to the Metrorail Subway Amtrak, Metrolink commuter rail buses, and local shuttles. The Gateway Transit Plaza, located at the north end of the facility, provides connections to local bus services. An underground pedestrian tunnel links both facilities.

Los Angeles Harbor Transitway—Glen Anderson Freeway Station. The Harbor Transitway includes intermodal facilities providing connections to the light rail Green Line. The new station, located at the south end of the Harbor Transitway, allows connections among buses on Transitway. The Green Line, which operates in the median of the Century Freeway, is served primarily with local feeder buses.

Pentagon Metro Station. The Metro Rail Station in Northern Virginia provides another example of an intermodal facility. In addition to the Metro rail station, the facility also includes bus bays and passenger waiting areas, formal carpooling facilities, and locations where informal or casual carpooling occurs. Many of the buses and carpools use the Shirley Highway HOV lanes. All of these services are linked to the Pentagon, which represents a major employment location in the Washington, D.C. area.

Figure 9-12. Off-line Centers on the I-394 HOV Lanes

4. **Bus Stops and Shelters**

Bus stops are the basic point of access for passengers. Transit stops are thus integral parts of HOV facilities, especially those located along arterial streets. Even HOV lanes on freeways and in separate rights-of-way are served by buses that operate on local streets in downtown areas, major activity centers, and neighborhoods. Ensuring that bus stops are located appropriate, are well situated and designed, are adequately maintained, provide information on routes and schedules, and include shelters, benches, and other amenities as needed, are important factors in the development of a comprehensive HOV system. Chapters

8 and 9 contain more detailed information on the operation and design of bus stops and other street-side transit facilities.

B. Planning Support Facilities

This section describes the general approaches and techniques that can be used in planning the support facilities found with HOV lanes. Although the overall planning process is similar, different planning approaches and techniques are needed with the various supporting facilities. For example, the planning approaches used for a major park-and-ride lot are different from those for locating transit stops and shelters.

It is important to note that planning for support facilities usually occurs as part of the overall HOV facility planning process and the local transit facilities development process. As stressed throughout this Manual, close cooperation and collaboration among all groups is critical to a successful facility development process. Thus, many of the activities described in this section should be just one part of the coordinated and integrated planning process described in Chapter 4. There may be cases, however, where an additional park-and-ride lot, transit center, or other support facility is being considered as part of an existing HOV lane. The planning techniques described in this section can be used in both situations.

1. Park-and-Ride Facilities

Planning and locating park-and-ride and park-and-pool facilities is not an exact process. The term park-and-ride is used in this section to cover both types of facilities. A number of factors may influence the need for and the location of a park-and-ride lot. Traffic congestion, travel patterns, the level and orientation of transit services, as well as the variability of individual travel behavior and factors related to the cost and availability of gasoline and the general economy of an area, may all influence the use of park-and-ride facilities. Factors which appear to contribute to the successful implementation and operation of park-and-ride facilities have been identified based on the experience with different projects, however, and procedures and techniques are available for estimating the potential demand for park-and-ride services and for sizing different types of park-and-ride lots. In most cases, use of park-and-ride and park-and-pool facilities will grow over time. The six general steps commonly used in planning and designing a park-and-ride facility are illustrated in Figure 9-13. The first five steps are discussed in this section and step 6 on design is described in Section C.

Examine General Need for Facility

↓

Define Study or Market Area

↓

Estimate Demand for Facility

↓

Site Evaluation and Selection

↓

Determine Needed Size of Facility

↓

Design Facility

Figure 9-13. General Steps in Planning and Designing Park-and-Ride Facilities

General Considerations in Locating Park-and-Ride Facilities
Based on the experience documented in several studies of park-and-ride facilities, a number of general factors have been identified as important considerations in the planning process (8,11,12,13,14,15,16,17). Many of these factors, such as congested travel corridors, are similar to those considered in planning an HOV lane. The following factors identify elements that should be considered when planning a park-and-ride lot with an HOV facility. Table 9-2 provides a preliminary checklist for use in identifying if these conditions exist in the corridor or area being considered for a park-and-ride facility.

- **Locate park-and-ride facilities in congested travel corridors**. Park-and-ride services are more successful when located in major travel corridors that experience severe levels of traffic congestion.
- **Locate park-and-ride facilities prior to areas experiencing major traffic congestion**. Providing commuters with the opportunity to access a park-and-ride lot before they reach a congested area increases the attractiveness of a facility.
- **Locate park-and-ride lots in areas with high levels of travel demand to the major activity center or centers served by the facility**. Locating lots in areas with significant residential densities and high travel demand to the destinations served by the park-and-ride services enhances the chance of success.

Table 9-2. Considerations in Locating Park-and-Ride Facilities—Preliminary Checklist

Corridor or Area:

Consideration	Does Condition Exist		Comments
	Yes*	No	
1. High Volumes of Existing or Planned Transit Services			
2. Congested Travel Corridor			
3. Travel Demand to Activity Centers Served by Facility			
4. Direct or Preferential Access to HOV Facility			
5. Good Access for Commuters			
6. Good Access for Buses from Neighborhoods			
7. Good Visibility			
8. Appropriate Spacing			
9. Safe and Secure Areas			
10. Expansion Potential			

*A rating system can also be used to provide more detail (i.e., 1—very heavy congestion, 2—heavy congestion, etc.).

- **Locate park-and-ride facilities so that HOVs have good access to the HOV lane**. Providing buses, carpool, and vanpools with safe, convenient, and direct access to the HOV lane is important. Direct access ramps, ramp meter bypasses, and other techniques can be used to provide this access. Park-and-ride lots are often located on the inbound side of a freeway interchange to enhance accessibility and visibility.
- **Locate park-and-ride facilities so that commuters do not have to backtrack to reach the lot**. Providing commuters with a direct route to the lot and with direct service to their ultimate destination enhances the potential success of the facility.
- **Orient park-and-ride facilities to ensure good visibility**. Lots should be highly visible to potential users to increase their awareness of the facility.
- **Locate park-and-ride facilities at appropriate distances**. Separating park-and-ride lots by appropriate distances will help ensure that services and facilities are not duplicated. The distance between lots will depend partially on the level of transit service provided and the characteristics of an area, including residential densities. Lots with frequent transit services may draw from a larger market area than facilities with only limited services.
- **Locate park-and-ride facilities where transit services are available or can be provided**. High levels of bus service are needed to support major park-and-ride lots. Ensuring that these services are currently available or can be provided is an important consideration in the planning process.
- **Cooperation among agencies is important in developing and operating park-and-ride facilities**. Like all aspects of planning, implementing, and operating HOV facilities, close cooperation is needed among transit agencies, the state department of transportation, local communities, and other groups to help ensure the effective and efficient development and operation of park-and-ride facilities.
- **Located park-and-ride facilities in safe and secure areas or provide needed security**. Providing a safe and secure area for travelers to leave their car or bicycle, or get dropped, is an important element. Safety and security factors should be considered in locating park-and-ride facilities.
- **Locate park-and-ride lot in area where expansion is feasible**. Consideration should be given to future expansion needs in the location of a facility.

Demand Estimation Procedures

A number of different techniques for estimating the demand at park-and-ride facilities are available for use in the planning process. This section reviews the various techniques and briefly explains how each can be used. Some are relatively easy to use, while others are more complex. Further, some techniques are more appropriate for estimating the potential demand at a specific site, while others focus more on a regional approach.

Consideration should be given to using more than one demand estimation technique in the planning process, with the results from each forming a range to be considered. The technique used, and the time and resources required to conduct the analysis, should be matched to the scale, scope, and complexity of the project. Given that park-and-ride facilities associated with HOV lanes usually represent significant capital and operating investments, the more rigorous approaches may be appropriate.

Caution should be raised with the use of any of these techniques, however, as all have advantages and disadvantages. Estimating the demand for park-and-ride facilities has been suggested to be more of an art than a science. Factors such as the type and level of service being offered, the potential time and cost savings over alternative modes, and other aspects unique to the local situation will all influence the actual demand for a facility. Thus, the characteristics of the corridor and the local area should be given strong consideration whatever demand estimation procedure is used.

Definition of Study or Market Area. A first step in assessing the potential demand for a park-and-ride facility is to examine the market area. This area, which may also be referred to by the terms study, service, catchment, or commuter-shed, represents the geographic area from which users are likely to originate. The size of a market area depends on the type of facility being considered, as well as the nature, orientation, level, and frequency of the transit services provided.

Experience with existing park-and-ride lots indicates that the most common market areas reflect either parabolic, semicircular, or circular shapes (8,11,12,13,14,15,16). Figures 9-14 through 9-16 illustrate these three market area configurations. The demand estimation techniques described next will provide a better indication of the nature of the market area for park-and-ride facilities based on the unique characteristics of each area.

Demand Observation. This technique represents the simplest approach for estimating the potential demand for park-and-ride facilities. Actual field observations and surveys are used to estimate the potential demand for a lot. Data from different sources including field observations, current ridership levels, aerial photographs, census information, land use maps, traffic counts, and special surveys are used to identify the potential demand for a facility. It may be appropriate to use this approach as a first step in the demand estimation process or in combination with another technique. Each of these elements is briefly described next.

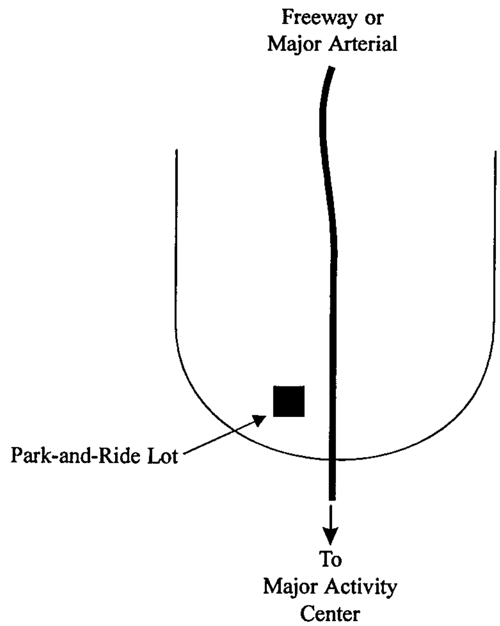


Figure 9-14. Parabolic Market Area for a Park-and-Ride Lot

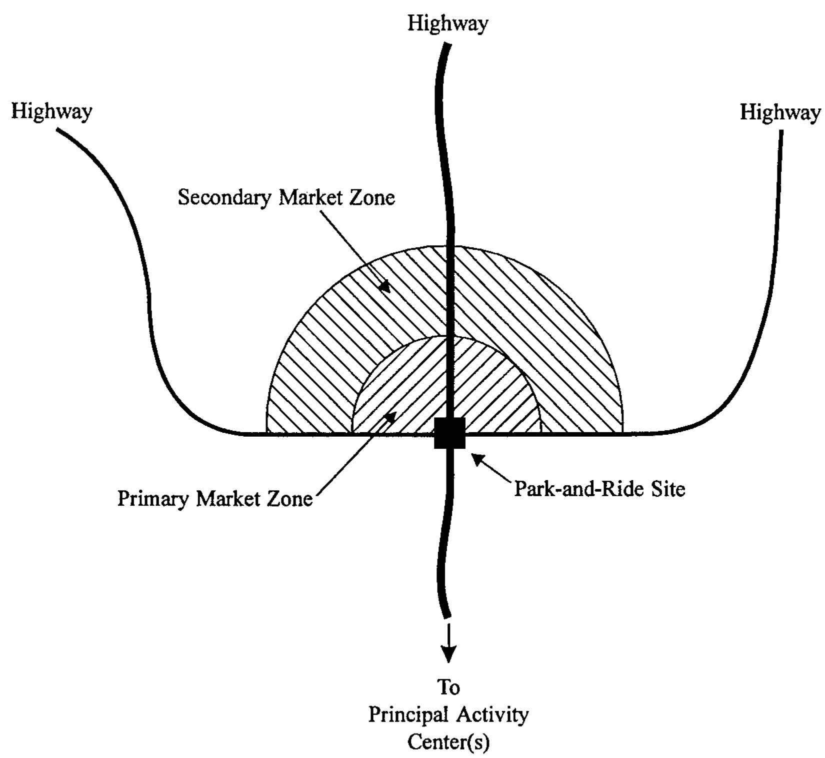


Figure 9-15. Semicircular Market Area for a Park-and-Ride Lot

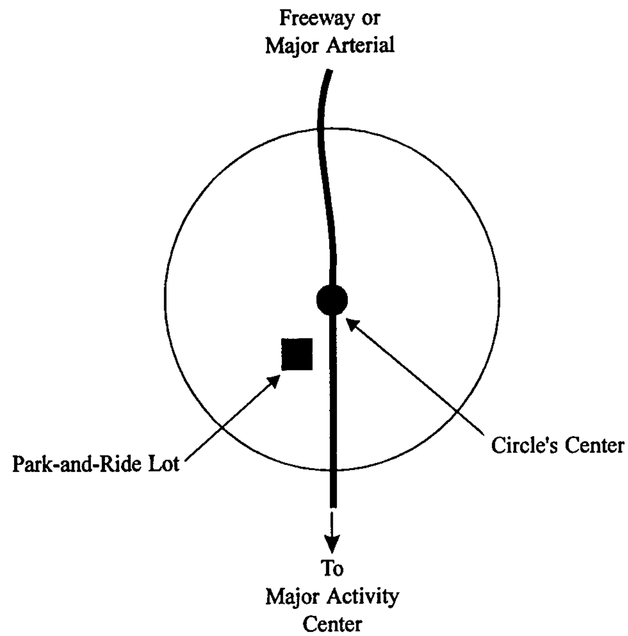


Figure 9-16. Circular Market Area for a Park-and-Ride Lot

- *Field Observation.* Field reconnaissance of the major travel corridors and neighborhoods in the area is used to obtain information on current traffic conditions and major congestion points, informal park-and-ride arrangements, unsafe or illegal parking activities, major access points, and potential park-and-ride sites. Field observation is usually used with all the techniques to assist in identifying the best location for a site. Including it as a step early in the process provides firsthand knowledge of the area.
- *Current Transit Routes and Ridership Levels.* Examining the current route structure and ridership levels provides a good indication of the potential for a park-and-ride facility. Frequent bus service and high ridership levels may indicate a need for park-and-ride lots.
- *Aerial Photographs.* Aerial photographs can be used to define the size and nature of residential neighborhoods and commercial areas in the corridor to help in identifying the potential market areas. Aerial photographs can also help identify access locations and vacant land and existing parking lots that may be candidates for the location of park-and-ride facilities.
- *Census Data.* Census data provides an indication of the number of individuals residing in the market area, as well as information on income levels, automobile ownership, and travel characteristics. This information is of use in determining the potential for park-and-ride services.

- *Land Use Maps.* Along with aerial photographs, land use maps provide an indication of both existing and future land use patterns and densities in an area. This information can be used to help identify current and future demands. Reviewing land use maps, comprehensive plans, and zoning maps provides a further indication of anticipated growth areas and community goals.
- *Traffic Counts.* Examining traffic counts and other traffic data can be useful in identifying congested corridors and specific bottleneck problems. This can assist in pinpointing logical locations for park-and-ride facilities and other transit priority treatments.
- *Special Surveys.* A variety of special surveys may be used to help estimate the demand for potential park-and-ride facilities. Surveys of transit riders, commuters in the corridor, employees and shoppers at major activity centers, and residents could all be conducted. On-board, mail, telephone, and direct interview techniques may all be used to conduct these surveys, which may be done for the specific purpose of obtaining information on the potential for a park-and-ride facility or which may be part of a larger study. For example, origin-destination or other surveys done as part of the analysis of an HOV lane can be used in planning park-and-ride lots and transit services.

Market Area Population. This technique examines the population in the proposed park-and-ride lot service area to obtain an estimate of the potential use of the facility. The percentage of users from existing park-and-ride facilities in the area is estimated and this percentage is applied to estimate the demand for a new facility.

The market area population demand estimation technique provides a relatively simple approach, which may be most appropriate for use in developing an initial estimate or in combination with another technique. It is also appropriate for use in estimating the demand for shared-use and small exclusive lots. The market area population methodology assumes that demand is equal for all activity centers being served. Estimating the demand for multiple activity centers requires the use of the modal split model described next.

Modal Split. This methodology takes the market area approach one step further by examining the portion of the market area population traveling to the various activity centers to be served by the facility. Thus, it attempts to account for the fact that different parts of the potential service area have different attraction rates to the various activity centers. This procedure requires that the percentage of the market area population working in each activity center be identified and analyzed to estimate the potential demand for the park-and-ride facility. Obtaining this information may be difficult, which makes this methodology more cumbersome and time consuming.

The results should provide a more accurate estimate of the potential demand for a given facility, however.

Institute of Transportation Engineers Model. The Institute of Transportation Engineers (ITE) model (18) is based on the assumption that park-and-ride demand is a direct function of peak-period traffic on adjacent travel facilities. A further assumption is made that commuters will not make major changes from their normal travel routes to reach a park-and-ride lot, but will divert from adjacent streets. As a result, potential users will be commuters who were already passing the park-and-ride location in their normal travel routes. Demand is therefore estimated as a percentage peak-period trips on adjacent streets that will divert into the lot. The formula used for the ITE model is:

$$\text{Demand} = a(\text{Peak}) + b(\text{Prime})$$

Where:

Peak = total peak-period traffic on adjacent facilities (including the prime facility);
Prime = peak-period traffic on the prime facility; and
a, b = diversion factors for total traffic and prime facility traffic, respectively.

The prime facilities are identified as the major arterial streets or freeways used by commuters as part of their normal travel route adjacent to the park-and-ride lot location being considered. There may be more than one prime facility, such as a potential site located at the intersection of two major roadways. The adjacent facilities represent the other roadways in the area but not directly next to the proposed site.

Diversion factors of one percent for total area traffic and an additional three percent for traffic on the prime facility have been recommended for use with this model. In general, the ITE technique is easy to use, requiring only peak-period traffic volumes on the major travel facilities. The approach has limitations however, in that no attempt is made to distinguish between commuting and non-commuting trips or among trips to different destinations.

King County Metro. A procedure for estimating park-and-ride demand for the King County-Metro service area has been developed. Five model equations were developed after studying the demand characteristics at thirty-one park and ride lots in the service area. The model utilizes the following site descriptive variables that are combined differently to estimate the demand.

- service area population
- ratio of auto to transit costs
- distance from the park and ride lot to a major employment center;
- number of buses in the morning peak period;
- optimal travel time between the lot and the central business district;
- proximity to the freeway system;
- distance to other park and ride facilities; and,
- availability of midday service.

These variables were evaluated for their dependence-independence characteristics so that a correlation coefficient matrix could be developed.

Five demand model equations were developed in order to provide estimation methods for sites that might not have all of the data items needed for future evaluations. The equations are as follows:

Equation 1

$D = -45.66 + 52.69 \times \sqrt{AMCBDBUS} + 0.60 \times CBDDIST^2 + 129.90 \times FREEWAY$

Equation 2

$D = -129.49 + 118.47 \times ATRANCOST + 37.97 \times \sqrt{AMCBDBUS} + 152.68 \times FREEWAY$

Equation 3

$D = -359.66 + 73.24 \times \sqrt{AMCBDBUS} + 13.22 \times TRANSPD + 145.39 \times FREEWAY$

Equation 4

$D = (-16.98 + 43.28 \times FREEWAY + 40.94 \times MIDDAY + 2.51 \times CBDDIST) \times (TOTPOP / 10{,}000)$

Equation 5

$D = (-49.85 + 36.71 \times FREEWAY + 51.24 \times MIDDAY + 3.35 \times CBDDIST + 10.07 \times NUMLOTS) \times (TOTPOP / 10{,}000)$

Where:
D = demand for park and ride facilities
AMCBDBUS = number of AM peak buses destined to central business district
CBDDIST = straight-line distance between park and ride lot and central business district
FREEWAY = proximity to freeway variable
ATRANCOST = ratio of auto to transit cost
MIDDAY = availability of midday service to and from park and ride lot variable
TOTPOP = population within market area served by park and ride lot
NUMLOTS = number of park and ride lots within market area of lot being examined

TRANSPD = fastest transit travel time between park and ride lot and central business district divided by straight-line distance between the two

These equations were developed for a specific area that has unique commuting and congestion patterns. Therefore, they cannot be applied to other areas or regions without making modifications to them. The model can be adapted by either estimating new coefficients or by validating the King County model. The estimation approach involves manually calibrating the variable coefficients based on data obtained from the area in question. This method is more reliable than validation, but it is more demanding in regards to the amount of time, effort, and data needed to implement the model. The validation approach involves applying the King County method to the new area and then estimating correction factors. The correction factors compensate for the differences in the two areas by comparing the demand estimates for the King County area with the observed demand levels in the area being studied. This method is less demanding on resources and is easier to utilize in areas with fewer park and ride lots, but it is less reliable than the estimation approach.

Other Demand Estimation Techniques. Other techniques and models are also available for estimating the demand for park-and-ride facilities. These include regression analysis techniques, as well as models developed by the Georgia Department of Transportation and others. Further, microcomputer modeling packages are used in some areas to analyze the potential demand for park-and-ride facilities. The content and use of these approaches are discussed more extensively in other sources (12,15,16). In addition, regional park-and-ride plans have been developed in some areas based on the use of sketch planning techniques.

Sizing Park-and-Ride Facilities

After the potential demand for a park-and-ride facility has been identified, the next step is to determine the lot size needed to serve this demand. Key considerations in determining the appropriate size of a park-and-ride facility include daily fluctuations in demand, pedestrian walking distances, type and level of transit services, access, supporting facilities, and land availability. Each of these factors is summarized next.

- *Daily Demand Fluctuations*. The demand estimation process should provide a projected average daily demand for a proposed park-and-ride facility. Experience indicates that individuals using park-and-ride facilities do so routinely for trips to and from work and little daily fluctuation in this demand should be expected, except on days with severe weather. Designing a facility to accommodate slightly more vehicles than the demand estimates indicate may be appropriate. A 10 percent increase has been suggested as a realistic approach to ensure that adequate parking spaces are available (12,16). Additional space may be desired, however, to ensure flexibility for future lot expansion.

- *Maximum Walking Distance*. In sizing park-and-ride lots, consideration should be given to the walking distance to and from vehicles. As a result, the size of a lot may be constrained to some extent by walking distances. The acceptable walking distance for commuters—from their parked vehicle to the transit loading area—has been identified as between 120 to 300 meters (400 to 1,000 feet) (12,16), although distances of 120 to 195 meters (400 to 650 feet) appears to be best. Experience indicates that walking distances of greater than 195 meters (650 feet) may be viewed as too long by users, resulting in illegal parking closer to the transit area or non-use of the facility. Walking distances of over 300 meters (1,000 feet) may be necessary in some facilities serving major congested travel corridors, however. Factors influencing walking distances may include sheltered walkways, moving sidewalks, and the frequency of transit services. Considering these factors and walking distances is important in both sizing and designing a park-and-ride facility.

- *Transit Services*. The type, capacity, and frequency of the transit service will also influence the size of a park-and-ride lot. The type of transit mode will impact the size and layout of the platform and waiting area, as well as the parking area. For example, rail and bus systems will have different requirements for right-of-way, platforms, stations, shelters, and waiting areas. The frequency of bus services and the types of vehicles used will influence the size of bus oriented park-and-ride lots. As discussed previously, bus headways of five to 10 minutes are common from larger lots associated with HOV lanes, with headways of as low as three minutes currently in use in Houston. Using three minute headways, 20 buses an hour could serve a facility. Assuming that 40 foot buses are used, approximately 900 to 1,000 passengers could be accommodated during the peak hour. Shared-use lots are more likely to be sized based on available parking and negotiated agreements with the owners.

- *Ridesharing Use*. Walking distance in park-and-pool lots is less of a concern than with bus facilities, since carpoolers and vanpoolers will usually meet at a pre-arranged location, rather than walking to a central platform or waiting area. The sizing of park-and-pool lots will depend on the demand projections, available space, and design constraints. If warranted, consideration should be given to the potential for future transit services, however. Many bus systems allow carpools and vanpools to use park-and-ride facilities as staging areas, as long as the facilities are not at capacity. As a result, consideration should be given to carpool and vanpool formations in the lot sizing process.

- *Access.* The capacity of roadways and intersections adjacent to the park-and-ride lot will also influence the size of the facility. Good access is needed to ensure that the facility does not overload the existing roadway system, causing delays to both users and non-users. To address potential concerns, a site specific traffic impact analysis should be conducted as part of the lot selection and lot sizing process. This analysis should include a review of existing capacity and levels-of-service, as well as an estimate of the impact of the park-and-ride lot. This analysis will help identify if improvements are needed to the roadway system to accommodate the projected demand.

- *Land Availability.* A key consideration in the sizing of a park-and-ride facility will be the amount of land that is available, the purchase or lease costs, and development costs. All of these factors will need to be considered in the locating, sizing, and designing a park-and-ride facility. Ensuring that land is available for not only the initial facility but also potential expansion, has proved to be important in many areas.

Park-and-Ride Site Selection

Once the decision has been made that an adequate demand exists for a park-and-ride facility, the next step is to identify, evaluate, and select a site. A number of factors have been noted as important in the site selection process for park-and-ride facilities. These factors, which are briefly described next, should be considered in the examination of alternative locations for potential park-and-ride facilities. A number of transit agencies have some type of site selection rating form or checklist as a part of the site selection process. The techniques currently being used range from formal criteria with numerical ratings to more informal guidelines.

Transit System, State, MPO, or Community Goals and Policies Related to Facility Development. The site selection process usually begins with a review of the appropriate agency or community goals and policies relating to the development of fixed facilities. These policies, which may be adopted by the transit system, state department of transportation, MPO, or community, will help determine the importance placed on different types of facilities and can be used to help guide the site selection process.

Availability. Identifying the availability of possible sites is a critical step. This may include checking ownership records and zoning requirements for vacant and developed sites. In the case of parking lots being considered for shared-use facilities, this will mean determining the long-term viability of a joint-parking arrangement.

Site Accessibility. Examining potential sites for their accessibility to both commuters and transit vehicles is important. Selecting sites that have convenient access from major roadways can reduce development costs and increase ease of use. Multiple access points—or at least access from two streets—are often preferred.

Site Visibility. Checking the visibility of potential sites from major roadways is important to ensure that passing motorists will be aware of the facilities. Visibility can also act as a deterrent to possible vandalism and enhance the safety and security of a lot.

Adequate Space. Potential park-and-ride sites should be large enough to accommodate the projected demand. Sites that are not large enough to provide the necessary parking spaces and transit areas are often avoided, as problems may result with parking in neighborhood areas or other unauthorized locations. Consideration may be given to both the immediate and long-term demand, with space reserved for future expansion.

Transit Service Operations. Examining potential sites for their proximity to existing transit routes and services is also important. Selecting sites that maximize operating efficiencies is often considered by a transit system to help ensure operating savings and to encourage ridership.

Development Costs. The cost of developing a park-and-ride facility is often a prime factor in the site selection process. Factors influencing the cost of a site may include the purchase or lease price, grading and leveling, environmental factors, and construction of the different supporting elements.

Proximity of User Amenities. Consideration may also be given to the availability of user amenities in the general area. These may include services such as gas stations, grocery stores, dry cleaners, and daycare facilities. Locating park-and-ride lots in areas with other businesses may encourage use by providing riders with easy access to desired services and may help deter vandalism. On the other hand, sites in developed areas are prone to be more expensive than those in undeveloped areas.

Joint Development Opportunities. The potential for joint development projects or activities may be examined in the site selection process. Logical projects may include convenience stores, daycare centers, or other services, as well as shared use by other providers.

Environmental Considerations. Park-and-ride lots may have environmental impacts on the areas adjacent to the facilities. Giving early consideration to potential noise, air quality, and other environmental issues can help ensure that any possible impacts are identified and adequately addressed.

2. **Transit Stations**

The planning process for transit stations associated with HOV facilities is very similar to the process just described for planning park-and-ride lots. In many cases, planning for the two types of facilities are combined, as transit centers are often located at park-and-ride lots. Not all transit stations are associated with park-and-ride facilities, however. Some stations may be designed to facilitate passengers transferring between different routes, while others may provide access for pedestrians and feeder buses. Transit centers are usually classified as on-line—located directly along the HOV lane—or off-line—located adjacent to the freeway or at some distance from the facility. The planning process for both type of facilities is similar, although the specific elements to be considered will be slightly different.

General Considerations in Locating Transit Stations

Based on the experience with existing transit stations, a number of factors appear to be important considerations in the planning process. Many of these factors are similar to those identified previously with HOV lanes and park-and-ride facilities. Table 9-3 provides a preliminary checklist for use in considering the need for a transit station.

- **Locate transit stations in areas with high volumes of existing or planned transit services**. High levels of bus services are needed to support major transit stations. The current and planned bus routes and schedule frequency should be a major consideration in determining if a station is needed.
- **Locate transit station in congested travel corridors**. The need for transit stations is higher in more congested travel corridors.
- **Locate transit stations in areas with high levels of travel demand to major activity center or centers served by the station**. Transit stations and bus services should be located in areas and corridors with high demand to the destinations served by the routes.
- **Locate station so that commuters do not have to backtrack to reach the facility**. Providing commuters with a direct route to the station enhances the potential success of the facility. All types of access—including walking, bicycling, driving, and being dropped off—should be considered.
- **Locate transit stations so that easy access can be provided to neighborhood areas and to feeder services**. Ensuring convenient and easy access by buses from local routes and neighborhood areas is also important to the success of a transit station.

Table 9-3. Considerations in Locating Transit Stations or Centers—Preliminary Checklist

Consideration	Does Condition Exist		Comments
	Yes*	No	
1. High Volumes of Existing or Planned Transit Services			
2. Congested Travel Corridor			
3. Travel Demand to Activity Centers Served by Facility			
4. Good Access for Commuters, Do Not Have to Backtrack			
5. Good Access for Buses from Neighborhoods and Feeder Services			
6. Direct or Preferential Access to HOV Facility for Buses			
7. Good Visibility			
8. Appropriate Spacing			
9. Safe and Secure Area			

*A rating system can also be used to provide more detail (i.e., 1—very heavy congestion, 2—heavy congestion, etc.).

- **Locate transit stations so that buses have good access to the HOV lane.** Providing buses with safe, convenient, and direct access to the HOV lane is important. Often the travel time savings from direct connections may be as much as those gained from the HOV lane. Direct access ramps, ramp meter bypasses, and other techniques can be used to provide this access.
- **Orient stations to ensure good visibility**. Transit stations should be visible to riders and potential passengers to help promote use.
- **Locate stations at appropriate distances**. Transit centers should be separated by appropriate distances. The nature of the service, route structure, and site availability will all influence the exact spacing and location of stations.
- **Locate stations in safe and secure areas**. Ensuring that transit stations are located in areas that are safe and secure for passengers and operators is important.

Sizing Transit Stations

The size of a transit center will depend on a number of factors. These include the number of transit routes and buses anticipated to use the facility, service frequency, operating philosophy, type and size of the transit vehicles, type and layout of bus bays, pedestrian access, feeder bus access, coordination with park-and-ride lots, access to the HOV lane and local streets, supporting facilities, and land availability. Each of these factors is summarized next.

- **Number of Routes and Buses**. The number of routes and the number of buses anticipated to serve the transit station will have a direct bearing on the size of the station. The size and layout of the platform and passenger waiting area, the number of bus bays, and passenger amenities will all depend on the number of routes and buses serving the facility.
- **Service Frequency**. The frequency of transit services will also influence the size of a station. Facilities with high frequency service, usually calculated by the number of buses per hour, may need more space or different layouts than stations served by only a few vehicles an hour.
- **Operating Philosophy**. The operating philosophy of the transit agency may also impact the size and design of a transit station. For example, one agency may have an operating philosophy focusing on providing a high level of service throughout the day, while another agency may focus only on peak-period service. Further, the operating philosophy may cover the types of amenities that will be provided at stations. These elements, which may include shelters, enclosed waiting areas, transit information kiosks, vending machines, and other items will all influence the size and design of a station.
- **Type and Size of Transit Vehicles**. The type and size of transit vehicles anticipated to serve the facility will need to be considered in sizing a transit station. The size of bus bays and platform areas will be influenced by the

use of minibuses, standard coaches, and articulated buses. The bus fleet mix will also impact the turning radius and other design elements.

- **Type and Layout of Bus Bays**. Both the type and the layout of bus bays will influence the design of a transit station. Alternative bus bay designs include sawtooth, parallel, linear, and head-in.
- **Pedestrian Access**. In sizing a transit station, consideration should be given to the walking distances from local neighborhood areas, as well as internal to the station. The same walking distance guidelines identified with park-and-ride lots—of between 120 to 300 meters (400 to 1,000 feet)—are also appropriate guides for stations.
- **Feeder Bus Access**. A station served by feeder buses will require more space than one without feeder bus service. Consideration of existing and potential future feeder bus service should be considered in the design of a station.
- **Park-and-Ride Facilities**. The demand for park-and-ride and kiss-and-ride facilities at a transit station should be considered in sizing the facility. The total area needed for a facility will obviously be larger if it includes a park-and-ride lot.
- **Access to HOV Lane and Local Streets**. The capacity of roadways and intersections adjacent to the transit station may influence the size of the facility. A site specific traffic impact analysis may be needed depending on the number of vehicles anticipated using the station. Good access is needed to ensure that the facility does not overload the existing roadway system, although the number of vehicles will be less if a park-and-ride lot is not included.
- **Support Facilities**. The type and nature of support facilities and amenities provided will impact the size of a station. The provision of shelters, heated or cooled waiting areas, on site transit information and pass sales, newspaper racks and vending machines, and other services should be considered in the station sizing process.
- **Land Availability**. A major consideration in the sizing of a transit station will be finding available land to purchase or lease. Finding an adequate parcel of land can be challenging in most environments.

Transit Station Site Location

A number of factors should be considered in the final site selection process for a transit station. These factors, which are briefly described next, should be examined as part of the final site selection process.

- **HOV Facility Plan**. The site selection process should be coordinated with the plan for the HOV facility or the existing HOV lanes. If a new HOV facility is being planned, the transit station site selection should be a part of the overall planning and design process. Consideration of a new transit center with an existing HOV lane, should start with a review of any sites identified in the planning effort.

- **Transit Service Operations**. The proximity of potential sites to existing transit routes and services should be considered. Selecting sites which maximize operating efficiencies is important for transit systems to help ensure operating savings and to encourage ridership.
- **Transit System, State, MPO, and Community Goals and Policies**. Regardless of whether a transit station is being considered for a new or an existing HOV lane, a review of the appropriate agency or community goals and policies relating to the development of fixed transit facilities should be an early step in the process. These policies can be used to help guide the site selection process.
- **Land Availability**. The availability of potential sites is an often critical factor locating a transit station, and one of the first steps should be to identify possible sites. Vacant land parcels should be identified, and ownership records and zoning requirements should be checked.
- **Site Accessibility**. The accessibility of potential sites to transit vehicles and commuters should be considered early in the process. Access for buses into and out of the HOV lane and to adjacent streets is especially critical. Selecting sites that have convenient access from major roadways will help reduce development costs and increase ease of use.
- **Site Visibility**. Ensuring that potential sites are visible from the adjacent freeways and roadways is important to ensure that passing motorists will be aware of the facilities and to help deter possible vandalism and enhance the safety and security of transit riders.
- **Adequate Space**. Ensuring that potential sites are large enough to accommodate all of the anticipated services and desired functions is important. Consideration should be given to both the immediate and the long-term demand, with space reserved for future expansion.
- **Development Costs**. The costs associated with developing different sites often is an important factor in the site selection process. Factors influencing the cost of a site may include the purchase or lease price, connection to HOV lanes, grading and leveling, environmental factors, and construction of the different supporting elements. Sites that are level, have good access, and are free of environmental problems will offer cost savings over sites with many or all of these problems.
- **Additional Transit Priority Treatments**. Sites which provide other priorities to HOVs such as signal priority treatments, arterial street HOV lanes, and other elements should be considered in the selection process.
- **Proximity of User Groups**. Consideration should also be given to the availability of user amenities in the general area. These may include services such as gas stations, grocery stores, dry cleaners, and day care facilities. Locating transit stations in areas with other businesses may encourage use by providing riders with easy access to desired services. The activity and visibility generated by these businesses may also help deter vandalism. On the other hand, sites in developed areas are likely to be more expensive than those in undeveloped areas.

- **Joint Development Opportunities**. The potential for joint development projects or activities may be examined in the site selection process. Logical projects may include convenience stores, day care centers or other services, as well as shared-used by other transit operators. Exploring joint development opportunities can result in additional revenues to the transit agencies through leases or other arrangements and increased ridership. Joint development opportunities with HOV facilities are discussed in more detail in Section V.

3. Intermodal Facilities

As noted previously, intermodal facilities serve multiple modes, providing travelers with the opportunity to change from one transportation service to another. Intermodal facilities enhance the options available to travelers, as well as enhancing the operating efficiencies of the various modes. Only a few intermodal facilities are currently associated with HOV systems.

A specialized planning process is required for intermodal facilities due to their unique characteristics. Since intermodal facilities are oriented toward places where multiple modes currently meet or are planned to meet, the planning process tends to be site specific from the start. Further, the high volumes of traffic generated by intermodal facilities require special considerations for mitigating potential negative impacts on adjacent land uses and the surrounding area. In some cases, opportunities may emerge to expand an existing facility serving one mode into an intermodal center. Often these may be historic structures, such as Union Station in Los Angeles which was expanded to include buses from the San Bernardino Freeway Busway, intercity buses, the Metrorail subway, and the Metrolink commuter trains, or major employment centers such as the Pentagon Metro Rail Station in the Washington, D.C., area.

Although planning for an intermodal facility will need to be tailored to the individual project, a number of elements can be identified for consideration in the planning process. These are briefly summarized next.

Consider intermodal facilities where multiple modes converge. An intermodal facility should only be considered if there are multiple modes operating in a corridor or area, or if additional modes are being planned.

Consider intermodal facilities where opportunities exist to enhance the connectivity among modes. Intermodal facilities may be appropriate for consideration when opportunities exist to link modes that are not currently connected.

Consider intermodal facilities where opportunities exist to use existing facilities, including historic buildings. The renovation, expansion, and enhancement of existing buildings, such as historic railroad depots, may provide opportunities for the development of intermodal facilities.

Consider opportunities for joint development. Intermodal facilities often include more than just the transportation functions. Examples of services found in intermodal terminals include food services, convenience stores, and other uses. Joint development opportunities may exist with these and other types of services and may be used to help finance an intermodal facility.

Consider neighborhood or area design issues and impacts. Planning for intermodal facilities should consider the traffic, visual, air, and noise impacts on the adjacent area. Ensuring that potential issues are identified early in the planning process is important so that measures can be developed to mitigate any concerns. Adjacent landowners and neighborhood groups should also be involved in the planning and design process to help ensure a project that meets both the transportation needs of the area and contributes to the economic health and vitality of the area.

4. Bus Stops and Shelters

Bus stops represent the major access point for most transit patrons, especially on arterial and local roadways. Bus stops and related amenities such as benches and shelters should be located, designed, and operated with the needs of both transit patrons and transit operators in mind. Bus stops should be convenient, safe, and accessible for passengers. They should also allow for the safe and efficient operation of bus service in the area.

Elements to be considered in planning, designing, and operating alternative types of bus stops are discussed extensively in Chapters 7 and 8. Section 7.III.I. outlines the advantage and disadvantages frequently associated with near-side, far-side, and mid-block bus stop locations. Alternative bus stop treatments, including curbside stops, bus bays, open bus bays, and bus bulbs are also discussed. The design elements associated with bus stop treatments are presented in Section 8.IV.C.

C. Designing Support Facilities

Design Considerations

Experience has identified a number of factors which may influence the design of park-and-ride lots, transit centers, intermodal facilities, and bus stops. These include local zoning and land use regulations, interface with the roadway system, internal lot layout, sizing, public acceptance, and environmental issues. A variety of issues associated with each of these elements should be considered in designing all types of transit facilities.

A number of design guidelines are available for park-and-ride lots, transit centers, intermodal facilities, and bus stops and shelters. These are identified in the additional references at the end of this chapter.

This section reviews some of the key issues and factors that are often considered in designing park-and-ride lots, transit centers, intermodal facilities, and bus stops associated with HOV lanes. The section highlights the major elements to be addressed in the design stage, and provides examples of designs for all types of support facilities. More extensive descriptions of the design process and specific examples are available in the reports noted previously and listed on the additional reference list at the end of this chapter.

The design process for supporting facilities should continue to involve representatives from all appropriate agencies, as well as the public. Participation from neighborhood groups, environmental groups, adjacent businesses, and other groups who may be affected by the facility is important to ensuring that all potential concerns are addressed. Multi-agency planning and design teams can be used to ensure the involvement of all groups.

Primary considerations in the design process for all types of support facilities focus on providing safe and efficient traffic flow within the site and on access roads and ensuring that adequate parking spaces, pedestrian walking and waiting areas, and shelters or stations are provided. Facilities to accommodate disabled individuals and other special user groups will also need to be considered in the design process. In addition, supporting facilities should be designed to fit into the surrounding neighborhood and adequate consideration should be given to safety and security concerns. Chapter 12 presents techniques that can be used to involve neighborhood groups and the public in the design process. Specific steps to be considered in the design process are described next.

Zoning and Land Use Regulations. The design process usually starts with a review of the local zoning ordinance and land use regulations, along with any other local requirements that may influence the development of a supporting facility. Ensuring that the specific type of support facility is an allowable use or requesting a rezoning or other change, should be done as part of the site selection process. Once this has been accomplished, the zoning ordinance and other regulations should be reviewed to ensure that all appropriate requirements are addressed. These may include elements such as setbacks, building designs, buffer areas, landscaping, environmental requirements, and access considerations. Establishing a good working relationship with representatives from the planning and engineering departments from the jurisdiction the facility is located in is important in the design process.

Involving neighborhood groups and adjacent businesses is also critical. This step will help ensure that any concerns are addressed early in the process. The public participation process described in Chapter 12 should include these activities. Involving these groups early in the process may help overcome potential concerns, which often relate to perceptions that local street traffic, noise levels and vandalism will increase. Further, any state or federal policies or regulations concerning design issues should be identified and addressed. These may include ensuring that the needs of disabled commuters and other user groups are accommodated in the design process.

Interface With the Roadway System. A number of design issues will need to be examined associated with the interface between the supporting facility and the local roadway system. These include automobile access and egress considerations, transit vehicle access and egress, access points to the facility, access roadways, and traffic signals and traffic control devices. The main elements that should be considered in each of these areas are summarized next.

- *Transit Vehicle Ingress and Egress*. The design of a supporting facility will need to provide ingress and egress for buses serving the facility to and from both the HOV lane and the adjacent street network. Direct access ramps and special bus only entrances and exits may be used to expedite the movement of transit vehicles.
- *Automobile Ingress and Egress*. The design of a park-and-ride lot and some transit stations and intermodal facilities will need to provide ingress and egress for automobiles entering and leaving the facility. Ensuring that the design provides for safe access and easy maneuverability for vehicles, as well as minimizing the impact on adjacent roadways, is important. Factors that may influence access include topography, location and type of adjacent roadway, traffic levels, and traffic control devices.
- *Access Points*. Based on the general consideration of automobile and transit ingress and egress considerations, a more detailed examination should be conducted to determine the best access points for the support facility. A traffic impact assessment should be conducted to identify potential problems and appropriate solutions. For example, park-and-ride lots, especially large exclusive facilities will have significant impacts on the local roadway system. Addressing possible issues in the design stage will help ensure the safe and efficient operation of the facility.
- *Access Roadways*. The design of the roadways accessing the support facility is important. The traffic impact assessment can be used to determine the existing roadway capacity, current traffic volumes, and projected volumes for a park-and-ride lot, transit station, or intermodal facility. Appropriate improvements can then be identified. The analysis may also consider the impact of any potential growth in commercial and business development and activities in the areas that may result from the location of the transit facility, as well as normal growth.
- *Traffic Signals and Traffic Control Devices*. Examination of the need for new traffic signals, modifications to existing signals, and other traffic

control devices should be included in the traffic impact assessment. Changes in timing at existing traffic signals or new signals may be needed at heavily used access and egress points to ensure the safe and efficient movement of vehicles using the park-and-ride facility and those on the local roadway. The *Manual on Uniform Traffic Control Devices* (MUTCD)(20) provides guidance in evaluating and justifying any new signals. The operation of existing signals can be analyzed using signal optimization and capacity software such as PASSER, TRANSYT, and Highway Capacity Software. Information or guide signs are also needed to provide commuters with directions to the facilities. Ensuring that these signs are easily visible to passing motorists is important.

Internal Facility Layout. Transit support facilities, especially park-and-ride lots, provide a combination of transit and parking related areas. As such, many facilities will encompass design elements of bus stations, passenger waiting areas, and parking lots. A number of factors will need to be considered and addressed in the design of these different areas. As described next, these include factors related to the different functional areas, internal circulation, amenities, pavement and drainage, landscaping, lighting, and safety and security.

- *Functional Area Designs*. The design of support facilities will need to accommodate the functional requirements of different user groups and transit services. For example, different types of access modes may be used, resulting in the design of bus and feeder bus areas, long-term parking areas, drop-off or kiss-and-ride areas, parking areas for disabled individuals, bicycle racks or lockers, and pedestrian walkways. The design requirements, as well as the locations, of these access modes may differ. Ideally, the design of different types of support facilities should provide for a hierarchy of uses. In a park-and-ride lot or transit station, parking for disabled individuals, bicycle storage, other amenities, and connecting transit services are usually located closest to a transit waiting area. Drop-off and pick-up areas, or kiss-and-ride areas, are also located close to the transit access point. In a park-and-ride lot, all-day parking areas are usually the farthest removed from the transit loading area. Transit stations, shelters, and waiting areas represent important considerations in the design phase, along with bus bays or bus pull-in areas. The flow of pedestrians to and from parking areas and between different transit modes is also very important. Transit loading areas are often located to equalize walking distance from the long term parking areas and to minimize potential conflicts between vehicles and pedestrians. The Americans with Disabilities Act (ADA) of 1990 and the subsequent regulations issued by the FTA and the Architectural and Transportation Barriers Compliance Board provide additional guidance for ensuring that a facility is accessible to handicapped individuals.

- *Internal Circulation.* Related to the design of the different functional areas is the internal circulation system. This is a critical element to ensure that conflicts do not arise between the different user groups. The internal circulation should allow for the safe and efficient movement of the various groups anticipated to use the facility. These may include buses, pedestrians, automobiles, vanpools, carpools, motorcycles, and bicycles. The circulation system will further need to consider both the peak and off-peak requirements of the facility.
- *Amenities.* Passenger amenities represent another design consideration for the various types of support facilities. These will depend on the type of facility, the anticipated patronage levels, local policies, and available funding. Amenities that are often incorporated into different types of supporting facilities include public telephones, trash receptacles, newspaper vending machines, other vending services, transit information displays, and transit shelters. Transit stations and intermodal facilities include heated or cooled waiting areas, staffed transit information booths, rest rooms, and small convenience stores.
- *Pavement and Drainage.* Consideration will need to be given to the pavement requirements of the different functional areas within a park-and-ride lot during the design phase. The American Association of State Highway and Transportation Officials (AASHTO) design standards, as well as local and state pavement specifications and agency guidelines, can be used to determine the appropriate pavement designs for the load-carrying demands of the different functional areas. Ensuring supporting facilities are designed for proper drainage is also important. In addition, local, state, and federal requirements associated with storm water runoff and other environmental issues need to be considered.
- *Landscaping.* Design of support facilities should consider landscaping needs and treatments. A well-landscaped station or park-and-ride lot can enhance the appearance of a facility, improve public and neighborhood acceptance, and add to the feeling of passenger security. Landscaping should be compatible with the type of facility, the surrounding area, and should not interfere with sight distance, the safe operation of the lot, or the ability of different user groups to access the lot. Landscaping treatments should also use plants and other elements appropriate to the area. Maintenance needs and costs should be considered in landscaping the facility to ensure that upkeep will be affordable. Involving neighborhood groups and local governments can further ensure that the landscaping addresses the needs of both the facility and the local area. Guidance on landscaping is available in *A Guide for Transportation Landscape and Environmental Design* (25), and *Transit Planting: A Manual* (22).
- *Lighting.* Providing adequate lighting at support facilities is important from a safety and security standpoint. Well lit areas may help deter vandalism and other potential problems. In designing lighting for support facilities, consideration should be given to the type, mounting height, and spacing of

luminaries to achieve the desired intensity and maintenance requirements. The AASHTO guidelines (23) provide recommendations on the type, intensity, and location of lighting for park-and-ride facilities.

- *Security*. Consideration of safety and security features is an important part of the design process. Security is critical so that commuters and operators feel they can safely use the facility. Security relates to personal safety and to protection of personal automobiles left in park-and-ride lots all day. Security concerns can be addressed in the design stage through a number of different approaches. These include lighting, fencing and gates, security monitoring booths, cameras and surveillance equipment, signing, and ensuring adequate visibility from all parts of the facility. Identifying the boundaries of a transit system or park-and-ride lot—through the use of fencing, hedges, or other techniques—can help control unauthorized use and reduce the potential for vandalism. For example, Houston METRO utilize a program *Crime Prevention Through Environmental Design* developed at the University of Florida to enhance safety and security features at its facilities. This program provides information on how environmental design can be used to improve safety and security at all types of buildings and facilities. Examples of design treatments currently include the use of lighting, maintaining clear views from all parts of a facility, eliminating any dark spots or dead end areas, and the use of plants and shrubs. Further, joint use facilities may have an added benefit in addressing potential security concerns due to increased activities in the area.

Signs. Providing adequate information to users and potential users is critical to the success of support facilities. Thus, informational signs—both external and internal—are important elements of any system. Sign needs are best addressed early in the design process and are usually coordinated with overall HOV signing and with other information signs used by the local agencies. Common signs, logos, and information are used in many areas. Basic elements for consideration in designing external and internal signs are described next.

- *External Signs*. External guide signs, or trail blazer signs, are critical to communicate information on the location and use of a park-and-ride lot, transit station, or intermodal facility to commuters. Ideally, guide signs should be placed to intercept potential users on their normal travel paths and to direct them to the facility. Thus, multiple guide signs are often used to ensure that commuters reach a facility. Transit and park-and-ride signs should be designed in accordance with the MUTCD, as well as state and local policies and regulations. Messages on signs should be short and concise but should convey key information about the types of services provided.
- *Internal Signs*. Internal signs are also critical to help ensure the proper use of support facilities. For example, signs at the entrance to a park-and-ride lot should direct commuters to the proper areas—transit platforms, daily

parking, kiss-and-ride locations, and handicapped parking spaces—and provide information on the hours of operation and allowable uses of the facility. Each of these functional areas should also be properly signed. Further, areas for transit vehicles-only, pedestrian walkways, and bicycle storage should be well marked. In addition, transit information—including information on routes, schedules, and fares—should be readily available. Internal traffic control and parking can further be enhanced through the use of proper pavement markings or plastic pylons. On paved lots, these may include lines demarcating parking stalls, restricted areas, and stops.

Environmental Considerations. The design of support facilities should consider and address any environmental issues associated with the site or area, as well as any potential environmental impacts of the development and operation of the facility. Possible environmental concerns may include ground water runoff and water quality, wildlife habitat, wetlands, noise, visual impacts, traffic impacts, and air quality issues. Landscaping, access designs, and other treatments can all be used to address potential environmental concerns.

The elements described previously should be considered in the design of various support facilities. The actual design of park-and-ride lots, transit station, intermodal facilities, and bus stops will depend on a number of factors. These include the goals and policies of the transit agency and other organizations, the surrounding area, local site conditions, available funding, input from neighborhood and business groups, and other local issues.

As a result, there is no one best design for the various types of support facilities. Figures 9-17 through 9-19 illustrate examples of layouts for park-and-ride lots. The design of transit stations, centers, and intermodal facilities will be even more diverse based on local characteristics and policies. For example, as illustrated in Chapter 5, Ottawa uses a common design for the stations along the transitway. Houston has taken a different approach, utilizing unique designs for each transit center. Finally, examples of bus stop designs were provided in Chapter 8.

D. Funding Support Facilities

A variety of funding sources are available for constructing, operating, and maintaining the support facilities described in this section. These include federal, state, and local funding sources, as well as private sector assistance and other innovative funding techniques. The major funding sources and programs available to support the construction and operation of park-and-ride lots, transit centers, intermodal facilities, bus stops, and shelters are summarized next. In most cases, a variety of funding sources appear to be used in designing, developing, implementing, and operating park-and-ride facilities.

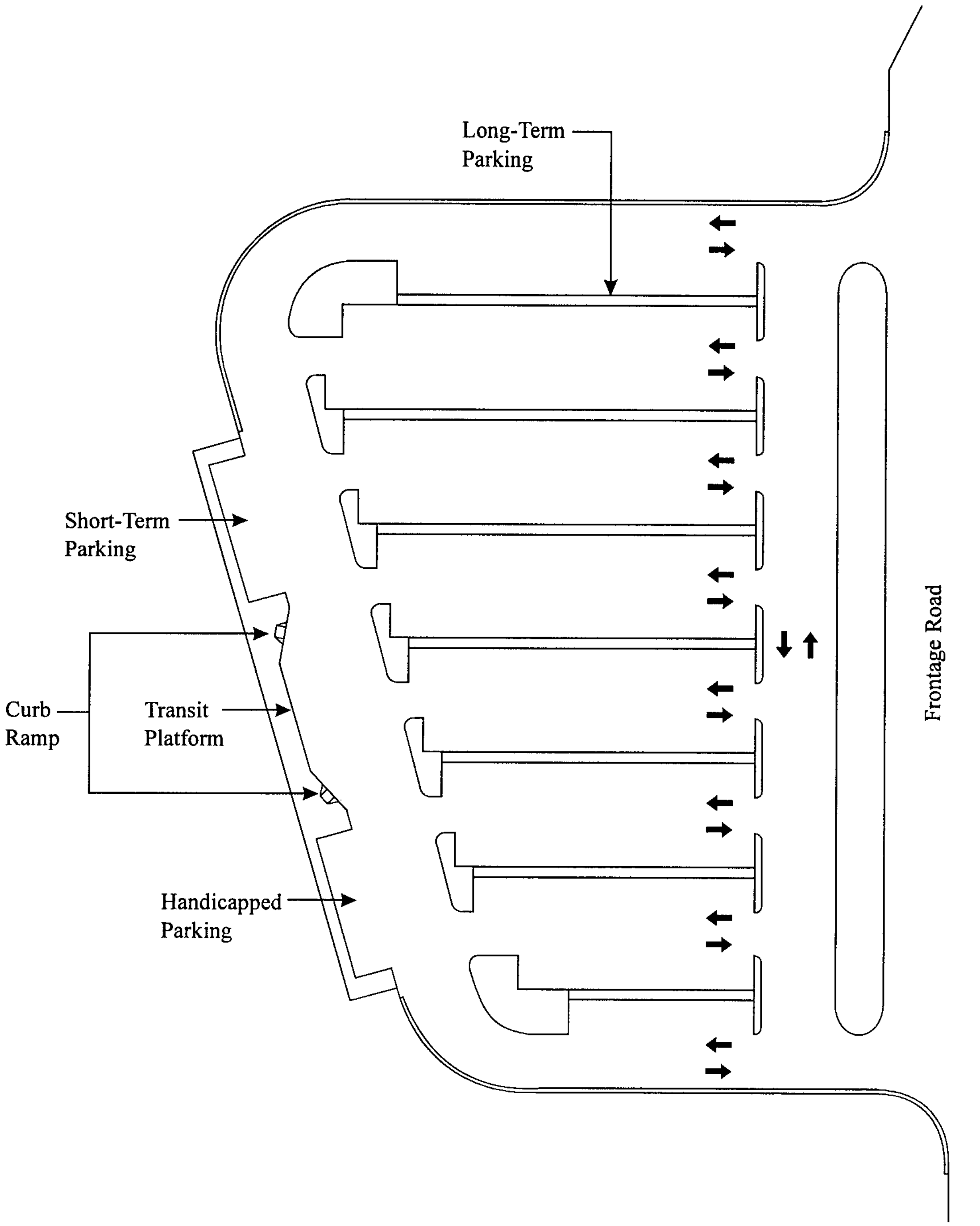


Figure 9-17. Example of Layout for Large Park-and-Ride Lot

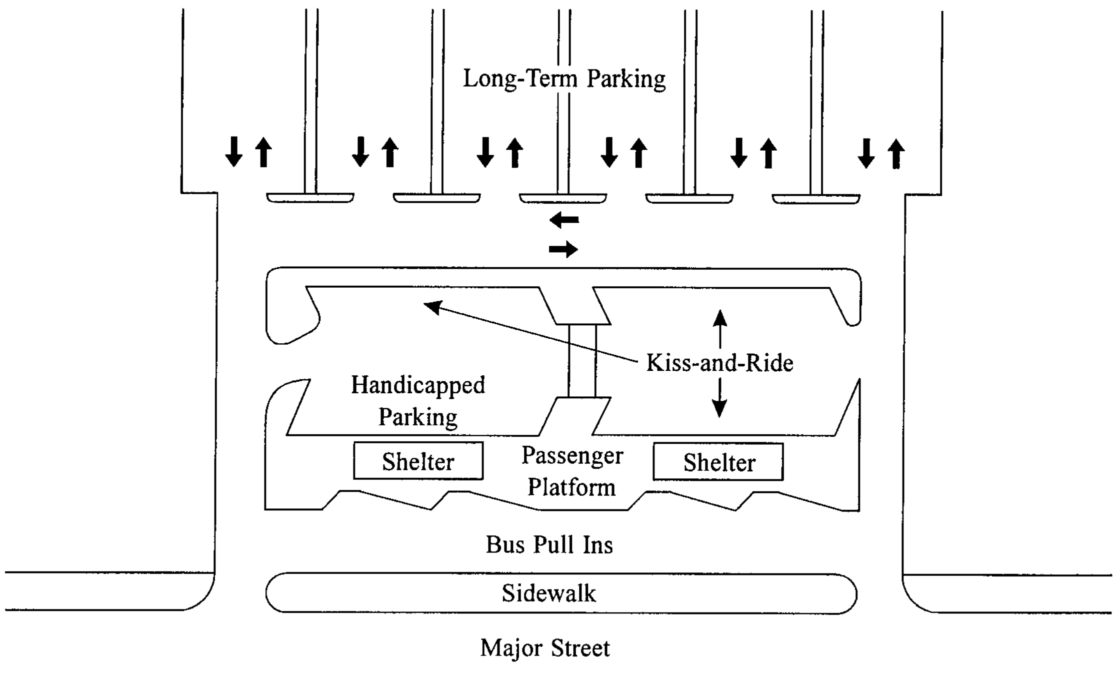


Figure 9-18. Example of Layout for Large Mid-Size Park-and-Ride

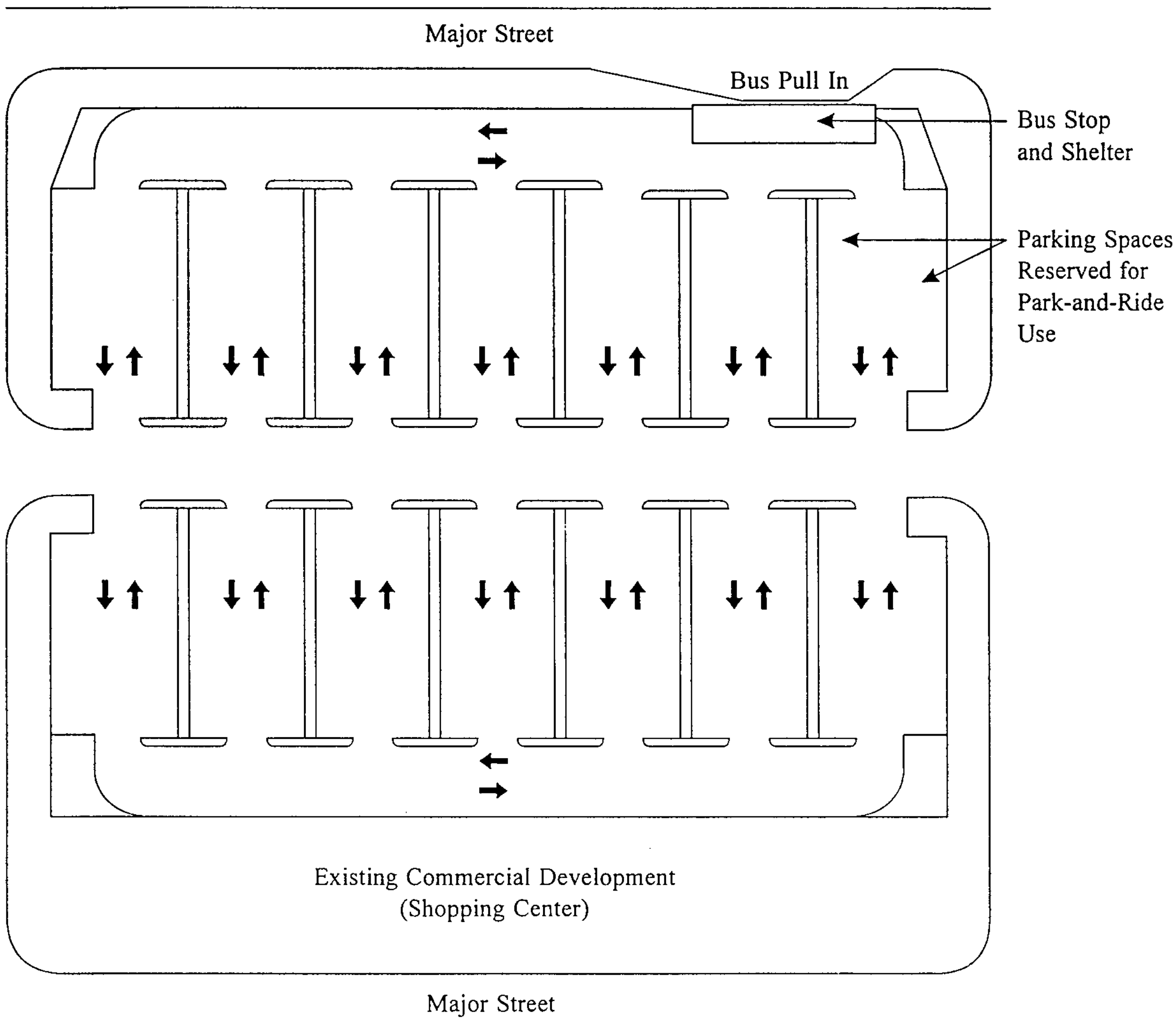


Figure 9-19. Example of Layout for Shared Use Park-and-Ride Lot

1. **Federal Funding**
Federal funding is available through both FHWA and FTA for different elements associated with park-and-ride lots, transit stations, intermodal facilities, and bus stops and shelters. Park-and-ride, transit and intermodal facilities associated with the Federal-Aid highway programs administered by FHWA are eligible for funding. In addition, funding from FTA Sections 3, 9, and 18 can be used for transit facilities related to HOV lanes. As noted in the transit operating sections, the provisions of TEA-21 provide greater flexibility in the use of funds from different programs, including the Congestion Mitigation and Air Quality Improvement Program (CMAQ), which is targeted at projects to help meet air quality goals, primarily in non-attainment areas. The exact level of available funding and the local match requirements vary among the different federal programs. The availability of funding from the different federal programs should be examined early in the planning process to identify those most appropriate to the scope and nature of the facilities being considered.

2. **State Funding**
A variety of state funding sources have been and are being used to support the capital and operating costs associated with supporting facilities. State funds are most often being used in combination with local funds to provide the required match for federal programs. Sources of state funds include general revenues, sales taxes, gas taxes, lotteries, and public works programs.

3. **Local Funding**
Local funds are often used either alone or in combination with state funds to match federal dollars. Sources of local funding include local sales taxes, fare box revenues, parking fees, general funds, property taxes, revenues from joint development projects, and other transit agency income.

4. **Other Funding Sources**
Other innovative financing techniques may also be used to support facilities. Examples include joint development activities and private sector support, innovative lease arrangements, and other techniques. Joint development opportunities are discussed in more detail in Section V.

E. Constructing and Operating Support Facilities

The ongoing administration and operation of support facilities is key to accomplishing the goals of the HOV system. This section summarizes the major elements to be considered in implementing, administering, and operating support facilities. Elements to be considered in the ongoing operation of park-and-ride lots, transit stations, and intermodal facilities include liability issues, leasing arrangements, construction approaches, marketing, managing demand, maintenance, and security.

1. **Liability**
The development and operation of support facilities place additional responsibilities on transit agencies, state departments of transportation, local communities, and other groups. The potential for additional tort liability accompanies these added responsibilities. A variety of approaches are being used to respond to the potential of increased liability. In some cases, park-and-ride lot, transit stations, and intermodal facilities are included as one component in self insurance programs. For example, support facilities that are considered part of the highway system may be covered by a state's self insurance program. In other cases, special insurance may be purchased by a state, transit agency, or local community to cover a shared-use facility. California provides an example of the use of special liability insurance to cover installation, maintenance, and use of leased park-and-ride lots. Liability issues are usually addressed in the lease agreements used with most shared-use facilities. The potential for tort liability is an issue which should be considered prior to implementing a project, however, and adequate insurance coverage should be in place before operations are initiated.

2. **Lease Agreements**
A variety of different lease agreements may be used with park-and-ride facilities or other types of supporting facilities. As noted previously, park-and-ride lots may be developed in a number of different ways. For example, state owned highway rights-of-way may be used or a state or transit agency may purchase property for development of a facility. In other cases, land may be leased from the current property owner or a shared-use agreement may be entered into for use of an existing parking lot.

Different types of lease agreements are used by transit agencies, state departments of transportation, and local communities. Although differences exist among the various approaches, the following common elements have been identified for consideration in any park-and-ride facility lease or agreement.

- *Identification of Parties.* Identification of the parties and their legal standing.
- *Purpose.* Identification of the intended purpose and use for the facility.
- *Premises.* Identification of the area to be used. A separate diagram or map may be included to highlight the specific area.
- *Access.* Identification of access to and from the designated area.
- *Terms and Conditions.* Identification of the duration of the agreement, cancellation provisions, and responsibilities of each party for maintenance and other elements.
- *Improvements.* Identification of the improvements or changes that will be made and the responsibility for these. For example, with shared-use lots, a transit agency may agree to improve the pavement in bus waiting areas and access roads.

- *Maintenance.* Identification of specific maintenance functions and responsibilities. For example, with shared-use lots, transit agencies may agree to clean the area or provide free snow plowing in return for use of the lot.
- *Liability Insurance.* As noted previously, the responsible groups and insurance coverages should be identified.
- *Use of Premise (non discrimination).* This clause may stipulate that the lot must be open to all users, without discrimination by the lot owner.
- *Examination of Property.* This section indicates that the property has been examined and has been found to be appropriate for the intended use.
- *Licensing.* This section may be necessary if only a license is granted by the lot owner. This section would indicate that no legal title or leasehold interest has been created.
- *Government Charges.* This section identifies that the agreement does not impose any responsibility on the government agency or unit for the property taxes of the private owner.

3. Construction Approaches

A variety of techniques, approaches, and institutional arrangements are being used to construct park-and-ride lots, transit centers, intermodal facilities, and bus shelters. In some cases, the transit agency is the lead group in constructing the supporting facilities. In other cases, the state department of transportation or other agency has taken the lead. Examples exist of these agencies working separately and jointly to develop support facilities. The techniques used to develop and construct park-and-ride facilities have also varied. In some cases, the state DOT or transit agency have simply followed traditional approaches to land acquisition and facility development. In other cases, innovative and non-traditional approaches have been employed. A few examples of the approaches being used to construct support facilities associated with HOV lanes are highlighted next.

Houston, Texas. Houston provides one of the best examples of multi-agency park-and-ride projects. In some cases, the Metropolitan Transit Authority of Harris County (METRO) took the lead on developing a park-and-ride facility, while in other cases the Texas Department of Transportation (TxDOT) was the lead agency. Federal funding, either through FTA or FHWA, was also utilized with these projects. Interagency agreements were used to identify the roles and responsibilities of the agencies in different projects. In addition, Houston METRO utilized a turnkey process to develop some of its initial park-and-ride lots. This process involved soliciting proposals for improved real estate and entering into earnest money contracts for the selected alternatives. Upon completion of construction, METRO bought the finished lot using local funds. These facilities were ready for immediate occupancy and operation. The process included issuing a request for proposal (RFP), holding a pre-proposal conference, evaluating proposals, awarding earnest money contracts, inspecting the constructed facility, and closing on the project. A total of 6,350 parking spaces were constructed through the use of the turnkey process. METRO estimated that it saved time and money through the use of this technique.

4. **Marketing**
Marketing activities related to the support facilities should be considered during the development of the overall marketing program for the HOV facility. More detailed information on developing and implementing a coordinated and comprehensive marketing plan is provided in Chapter 12. A few elements related to supporting facilities that should be included in the marketing effort are highlighted here.

Marketing for park-and-ride lots, transit centers, and intermodal facilities should focus on the use of promotional techniques to inform motorists about the facilities and available transit services. The marketing program should address both the introduction of new facilities and the ongoing promotion. Two important aspects for developing a marketing program are identifying the target audience and determining the most effective mechanisms for communicating the desired information. A variety of techniques can be used to identify the target audiences, including focus groups, telephone surveys, mail-out surveys, and employer based surveys. The results of the market research effort should be a target marketing program focusing on travelers most likely to use the support facilities. Actual marketing and communication techniques may include direct mail; radio, television, and newspaper advertisements; outdoor billboards; roadside signs; location maps, transit maps, and transit schedules; employer focused efforts; and other methods. The marketing effort should match the nature and scope of the project and should address all services provided at a facility. Experience also indicates that ongoing marketing efforts are needed to continually reinforce the message and to introduce new travelers to the facility.

5. **Managing Demand**
Managing demand at park-and-ride lots and at other supporting facilities may be a problem. For example, existing park-and-ride lots associated with some HOV facilities are at or over capacity. In some cases, this results in unauthorized parking on streets adjacent to the facility or in surrounding neighborhoods. In other cases, it results in a loss of riders and revenues because people cannot gain access to the facilities. Approaches and techniques identified to address this problem included purchasing excess right-of-way initially or later to expand existing lots, developing new lots close by, building parking garages, distributing lot passes through use of a lottery, charging for parking, and re-striping existing lots to gain more parking spaces. Another technique being considered in some areas is to give preferential treatment or lower parking rates to multi-occupant vehicles entering the park-and-ride lots.

6. **Maintenance**
Ensuring that park-and-ride lots, transit stations, intermodal facilities, and bus shelters are clean, attractive, and well maintained will have a positive impact on users. The type of facility, the nature and level of transit service, and the site location will all influence maintenance requirements. Ensuring that adequate funding is available for maintenance and that the facility is designed to allow for easy maintenance should be considered early in the planning and design stages. The agency or group responsible for maintenance should also be identified early in the planning process and then involved throughout all phases. Elements to be considered in developing a comprehensive maintenance program include the following:

- *Periodic Inspection.*
- *Pavement Repair.*
- *Shelter or Station Repair.*
- *Traffic Control Devices (signs and pavement markings).*
- *Lighting.*
- *Mowing.*
- *Sweeping and Cleaning.*
- *Trash Removal.*
- *Landscaping.*
- *Site Furnishings.*
- *Snow and Ice Maintenance.*
- *Security/Gates.*

A number of areas are exploring different approaches to maintaining support facilities. For example, the Orange County Transit District has an *Adopt a Park-and-Ride Lot* program to help with trash pick-up and other basic maintenance activities. This program is modeled after the successful *Adopt a Highway* programs in many states and *Adopt a Shelter* programs used by some transit agencies. In the *Adopt a Park-and-Ride Lot* program, individuals or groups agree to clean and maintain a specific park-and-ride lot.

7. **Security**
Concerns over safety and security of both individuals and parked vehicles have been raised with the use of park-and-ride lots and other support facilities in some areas. Approaches for addressing security issues in the design process were identified previously. A number of techniques can also be used to address these concerns in the operation of support facilities. The following techniques can be considered to enhance safety and security at support facilities.

- *On-site enforcement.* Some park-and-ride lots and transit centers have an attendant or other personnel on-site during all operating hours. In other cases, locked gates may be used to prevent access to and from park-and-ride lots during the midday or night. Access can be obtained during these hours by specific request. These approaches can act as deterrents to vandalism or other crimes.

- *Periodic Patrols.* In other cases, transit or enforcement personnel may check the support facility on a regular basis throughout the day.
- *Automated Monitoring and Enforcement.* The use of television cameras and other monitoring devices may be used to support on-site personnel or may partially reduce the need for on-site attendants. The use of these devices can extend the range of surveillance and can allow for all areas of a facility to be monitored on a continuous basis.
- *Coordinating with Adjacent Activities.* Coordinating enforcement with nearby businesses or activity centers may also be feasible. This may reduce costs and may provide for more uniform coverage of a facility.

VI. INTEGRATING HOV AND RAIL TRANSIT SYSTEMS

The operational and design elements to be considered in assessing the feasibility of converting an HOV facility to a fixed-guideway transit system—either heavy rail or LRT—were discussed previously in Chapters 5 and 6. The information provided in these chapters focused on the issues that should be considered in examining the potential for converting an existing HOV facility to a fixed guideway transit system. Different issues and opportunities arise when HOV facilities and rail transit services are operating in or are being planned for the same corridor or area.

A. Coordinating HOV and Rail Transit Services

This section discusses the approaches and techniques that can be used to integrate and coordinate buses, carpools, and vanpools operating on HOV facilities with rail service operating in the same corridor or area. Four different levels of possible coordination and integration are described. These are minimal coordination with services operating in the same area but serving different markets, service and schedule coordination, service and fare integration, and shared facilities. A next level of integration, which is discussed in Section B, is shared rights-of-way and mixed operation. Each of these approaches requires different degrees of coordination, cooperation, and integration. Table 9-4 summarizes the major characteristics of each approach and identifies key elements that should be considered in the planning process.

1. Minimal Coordination

At the lowest level of integration, an HOV facility and a rail transit system may operate in the same corridor or area with little coordination or overlap. The HOV facility and rail system may serve different markets and trip patterns, requiring minimal integration or coordination. For example, a light rail or heavy rail system may be oriented toward shorter trips from the first ring suburbs and the central city to the downtown area, while the HOV lane may serve long distance bus, carpool, and vanpool trips with diverse destinations. Due to the physical and service characteristics of the two systems, there may be few opportunities for coordination.

Table 9-4. Approaches for Coordinating and Integrating HOV and Rail Transit Services

Approach	Description	Key Planning Consideration
Coordinating 1. Minimal Coordination	HOV and rail transit systems operate in same corridor or area with little coordination or overlap. • Serve different markets and trip patterns. • Few opportunities for service coordination.	• Assess travel markets and trip patterns to ensure adequate demand for both HOV and rail, to ensure no service duplication, and to identify opportunities for future coordination.
2. Service and Schedule Coordination	Services and schedules of both systems are coordinated to provide links between the two systems.	• Assess travel markets and trip patterns in the corridor. • Assess the services offered or planned by both systems. • Identify potential transfer connections and linking services to maximize the coverage and operating effectiveness of both systems.
3. Service and Fare Integration	Fares are integrated along with services and schedules to provide easy transferring among modes.	• Coordinate among providers. • Establish common fare structure and reciprocal fare arrangements.
4. Shared Facilities	Facilities, such as park-and-ride lots and transit stations, are used by both HOV and rail transit services.	• Identify locations where services meet or could meet.
Integrating 1. Shared Right-of-way and Mixed Operation	HOVs and rail transit vehicles operate in the same right-of-way or in mixed operation.	• Identify corridors with high demand for both.

Planning for both HOV and rail in the same corridor or area should examine the travel patterns and markets to be served by the two systems. The travel sheds, origins and destinations, and trip patterns to be served by each system should be identified and analyzed. The demand for each service should be assessed to ensure that both systems are warranted and that compatible rather than competitive services are being offered.

2. **Service and Schedule Coordination**
The second level of integration involves coordinating services and schedules between the HOV facility and rail transit system. At this level, connections are provided between services operated on the HOV facility and the rail system. Providing links between the two systems can expand service coverage, providing more alternatives for commuters, and enhance the operating efficiencies of both systems. This approach might include providing transfer connections between express buses operating on an HOV lane and a rail system, using buses, carpools and vanpools on an HOV lane as feeders to a rail line, and extending the reach of a rail system with an HOV lane.

3. **Service and Fare Integration**
This level includes the integration of both services and fares between the HOV and rail modes. Travelers can use the same fare medium on all services operated on the HOV facility and the rail system, allowing for fast and convenient transfers between modes.

4. **Shared Facilities**
At this level of coordination, facilities are shared by services operating on both the HOV facility and the rail transit system. Examples of shared facilities include park-and-ride lots and transit stations that serve passengers on both the HOV lane and the rail transit system. Economies of scale and cost savings may be realized by sharing facilities, along with expanding the service coverage and enhancing the operating effectiveness of both modes. The following case study examples highlight current uses of shared facilities.

South Busway, Pittsburgh. Stations along two segments of the South Busway are used by both buses and the LRT system. In the first segment, which extends from the Mount Washington Tunnel to the Palm Garden Station, buses on the South Busway and trains on the Beechview-Mount Lebanon LRT line share two stations. The LRT system on the south end of the busway is currently being renovated. Upon completion, five stations will be served by both buses and LRT trains on the rebuilt line.

San Bernardino Busway, Los Angeles. Two stations initially developed as part of the San Bernardino Busway have been expanded to incorporate commuter rail services in the corridor. Buses on the HOV lane access the upper level platform at the California State University at Los Angeles station, while a commuter rail line stops at the lower level platform. Both buses and commuter rail services access the Union Station Intermodal facility in downtown Los Angeles. In addition, some park-and-ride lots in the corridor primarily serve the commuter rail lines, but also act as staging areas for vanpools using the busway.

B. Shared Right-of-Way and Mixed Operations

At the highest level of integration, HOVs and rail vehicles use a common right-of-way or operate in mixed service. In one scenario, the HOV facility and the rail system might be physically separated but located in the same right-of-way. In a second case, the two modes may share a common right-of-way, with mixed operations of both modes. As highlighted in the following example, these approaches are currently found with bus-only HOV facilities.

South Busway, Pittsburgh. Buses and an LRT line operate together on two segments of the South Busway. Currently, buses and Light Rail Vehicles (LRVs) operate in mixed fashion through the Mount Washington Tunnel and in the Palm Garden Station area. Approximately 23 trains and 42 buses operate on this section during the morning peak hour in the peak direction. Figure 9-20 illustrates the operation of both buses and LRT in the Mount Washington Tunnel.

VII. JOINT DEVELOPMENT WITH HOV FACILITIES

A. The Joint Development Concept and Strategies

Although the concept of joint development can be defined in different ways, a number of characteristics of transit and HOV related joint development projects can be identified. One characteristic that distinguishes joint development projects is that they involve the joint use or improvement of a piece of property. For example, transit facilities have been constructed on land owned by private developers, and private businesses have utilized property and facilities leased from public transit agencies or state departments of transportation. Another characteristic of the joint development process is the voluntary participation of all parties. Rather than having their involvement mandated through legal means, the participants in a joint development project are motivated by the existence, or perceived existence, of mutual benefits.

Although a number of joint development strategies may be appropriate for consideration with HOV facilities, four general categories or strategies appear to have the greatest potential for consideration with HOV projects. These are leasing development rights, leasing facilities, cost sharing and jointly developing, and negotiated land leases. The characteristics of each strategy are summarized in this section. Joint development strategies are more frequently found with heavy rail and LRT projects than with HOV facilities.

Figure 9-20. Bus and LRT Vehicle in Mount Washington Tunnel

1. **Leasing Development Rights**
One joint development strategy is the leasing of surplus development rights by a public agency to a private party. This approach is commonly used when a transit or transportation agency owns a parcel of real estate that is not being utilized completely. In that situation, the agency leases the right to develop the remainder of the property to another party. Typically the rights are leased to a private development company for the construction of development that is compatible with the HOV or transit facility, although another public entity could also be involved. The lease usually covers a very long term, ranging up to 99 years.

The leasing of excess development rights allows an agency to increase the yield from its real estate holdings and may have secondary benefits, such as increased ridership. In many cases the development rights are associated with real property that was acquired during the construction of the HOV, transit, or roadway facility, but is no longer needed by the agency. In areas where real estate values are relatively high, another source of surplus development rights is the development potential directly above or below a transit, HOV, or roadway facility. The development rights in the space immediately above a facility are frequently referred to as air rights.

Allowing additional development on the site of a HOV, transit, or other transportation facility is potentially beneficial to both the public agency and the developer. For the agency, the project could produce a steady, long-term stream of revenue, without an additional major public investment. In some cases, the revenue potential is increased by allowing the agency to share in the profits of the private development, in addition to regular lease payments. The private sector may be attracted to HOV related joint development projects by the potential savings from building on a prepared site or existing foundation, the project location, and the accessibility to HOV facilities and transit service for employees or customers.

2. **Leasing Facilities**

A second joint development strategy is leasing facilities. Leasing facilities is similar to the leasing of development rights in some respects, but it typically occurs on a smaller scale. As a result, this approach is found more frequently. Using this strategy, excess space within a transit facility is leased for other purposes. An assortment of uses, including intercity bus service, retail and restaurant sales, concessions, dry cleaning and other services have been implemented in space leased from transit agencies. Excess space in existing facilities may become available due to shifts in demand or the services provided, or public agencies may design and build new facilities with the intention of leasing space in them for other uses.

The leasing of HOV and transit facilities may have a variety of benefits. The exact nature and scope of these benefits will depend on the type and size of the facility, as well as the nature of the tenants. For example, leasing terminal or maintenance space to a private transportation provider or another public sector agency may generate revenue for the transit or transportation agency and economies of scale to all participants. Leasing space for some type of retail or concession activity may bring in modest income, provide valuable opportunities to small businesses, and result in services that passengers may find attractive and convenient. Although typical leasing arrangements may not generate enough revenue to cover the operating costs of the facility, they can be expected to improve the return on the public investment in the facility.

3. **Cost Sharing and Jointly Developing**

Cost sharing is a voluntary process in which multiple parties determine how the costs of a particular project are to be divided among the beneficiaries. In general, cost sharing for HOV and transit facilities refers to the involvement of the private sector in the financing of the capital or operating costs of a specific facility or service. The concept of cost sharing as a joint development strategy is based upon the theory that, in order to maintain long-term economic vitality, the private sector is often willing to contribute to the costs of transportation facilities that are essential to their businesses. A related approach is that a facility may be developed jointly by the public and private sectors.

The primary benefits of cost sharing or jointly developing for a public agency are reductions in the cost and time to develop necessary facilities, rather than generating long-term revenue. In addition, private contributions may be used as part of the local match for federal grant programs, further maximizing the amount of funding available to a local area. Private sector investments may speed the development process and may have potential returns for the community in the form of increased economic activity or a rise in property values. Benefits to the private sector may include maintaining and improving important elements of the local transportation system, which may enhance the economic health of the community.

4. Negotiated Land Leases

A negotiated land lease is a voluntary, mutually beneficial arrangement between a public agency and a private land owner. In a negotiated land lease, the land owner agrees to lease property to the agency at a nominal rate for construction of a specific facility such as a transit center, park-and-ride lot, or shelter. The terms of a typical negotiated land lease for the development of these types of facilities range from 20 to 99 years. Although the actual lease payments made by the public agency varies among projects, it often is only a token amount.

A number of benefits may be realized by both the public agency and the land owner in a negotiated land lease. For the agency, the arrangement can significantly reduce the costs of a new facility by eliminating the need to purchase or condemn the needed real estate. Private land owners may be attracted by the impact the new HOV facility will have on adjacent projects and property. Public land owners may have other motives for participating in a negotiated land lease. These may include stimulating other investment and development in the area, leading to general economic growth, or obtaining a facility that meets the needs of local citizens.

B. Planning Considerations

Joint development represents one strategy that may be appropriate for use with HOV lanes and supporting facilities. The following set of guidelines, which were developed in a previous research project (24), can be used to help identify opportunities for joint development. A series of steps or stages are presented to guide the initial consideration of joint development and the more detailed examination of the different joint development strategies. Each step in the process is intended to help focus the decision-making process on the key factors to be considered. The five general stages in the planning guidelines are illustrated in Figure 9-21 and described in the following sections.

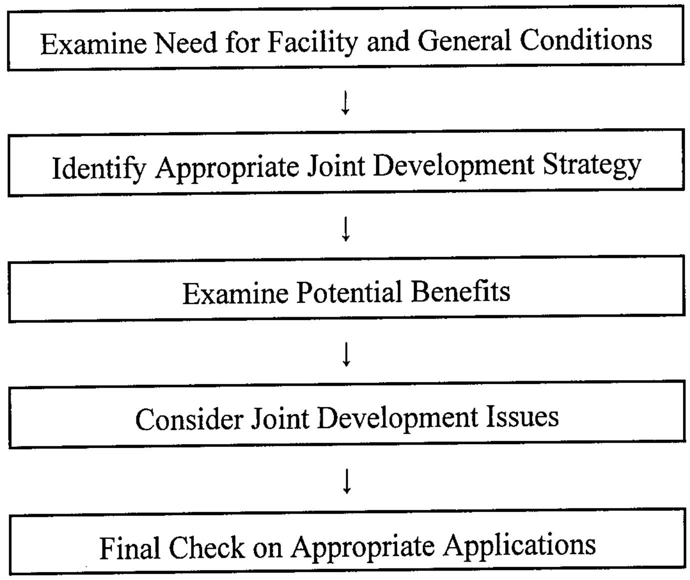


Figure 9-21. HOV-Related Joint Development Planning Guidelines

Source: (24)

Stage One—*Examine Need for Facility and General Conditions*. The joint development process is not an end or objective in and of itself. Rather, joint development represents one means of achieving an objective. In the case of an HOV facility, the objective is to assist in the development and ultimate operation of a capital project. Thus, the first step in the process should be to ensure that the facility being considered is a critical part of the overall HOV project. Joint development should be viewed as an opportunity to enhance and improve the implementation of a project, not to justify an unnecessary or unneeded one.

In addition, a number of other conditions or characteristics that should be present for joint development to be considered as a realistic option. Local characteristics that should be present to enhance the potential of joint development projects include a healthy economy, a cooperative working relationship between agencies, and an entrepreneurial or flexible perspective on the part of the implementing transit agency, state department of transportation, or other organization.

Stage Two—*Identify Appropriate Joint Development Strategy*. Once the need for the specific facility has been established and the local conditions have been examined, consideration can be given to the potential use of a joint development technique or strategy. Table 9-5 provides a summary of joint development strategies that have been used with different types of transit facilities and may be appropriate for consideration with HOV facilities. This table can be used to help identify those strategies that may be most appropriate for consideration with different types of HOV lanes and supporting facilities. Although each project will have unique features, Table 9-5 can assist in focusing the most appropriate strategies for various applications.

In examining possible joint development strategies for an HOV facility, consideration should also be given to the other participants. Table 9-6 identifies the types of groups commonly associated with the different joint development strategies, and Table 9-7 identifies potential partners for different types of HOV support facilities.

Table 9-6 and Table 9-7 can be used to help identify the typical participants that may be involved with the different joint development strategies being considered. The tables also provide an indication of the supporting features that may be appropriate to consider with different joint development techniques.

Stage Three—*Examine Potential Benefits*. A variety of potential benefits may be associated with different types of joint development projects. The specific objectives of a project, the type of joint development strategy employed, and the local conditions are just a few of the factors that may influence the nature and magnitude of the benefits realized from an HOV-related joint development project. Although a single project may yield multiple benefits, not all strategies should be expected to produce the full spectrum of benefits. A realistic assessment should be made of the potential benefits to be realized from a proposed project. This step is critical to help evaluate the viability of a project and to establish realistic expectations of the potential benefits.

Table 9-8 provides a summary of the benefits most often associated with the different types of joint development strategies. The relative magnitudes of the potential benefits are shown for each joint development strategy, based on the findings of joint development studies (24). The approximate magnitudes of the potential benefits are compared within each strategy, rather than across the different techniques. For example, if leasing development rights is being considered for a project, the lease revenue and the leveraging of private investments are expected to be the major benefits. Increased ridership and HOV use also may be a project objective for leasing development rights, but the relative magnitude of the benefit may not be as high.

Table 9-5. Joint Development Strategies Appropriate for HOV Facilities

Joint Development Strategy	Type of Transit Facility			
	Intermodal Station	Transit Bus Terminal	Transit Center	Park-and-Ride Lot
Lease development rights	♦	♦		
Lease facilities	♦	♦	♦	♦
Cost sharing	♦	♦	♦	♦
Negotiated land lease			♦	♦

♦ - indicates a typical strategy for an HOV facility.

Table 9-6. Typical Participants Involved with Joint Development Strategies

Joint Development Participant	Joint Development Strategy			
	Lease Development Rights	Lease Facilities	Cost Sharing	Negotiated Land Lease
Commercial developer	♦		♦	
Retail developer	♦		♦	♦
Public agency	♦	♦	♦	♦
Land developer			♦	♦
Intercity bus company		♦		
Retail business		♦		

♦ - indicates a typical participant in the joint development strategy

Source: (24)

Table 9-7. Potential Joint Development Participants for HOV Support Facilities.

Joint Development Participant	Type of Support Facility			
	Intermodal Station	Bus Station	Transit Center	Park-and-Ride Lot
Commercial developer	♦	♦		
Retail developer	♦	♦	♦	
Public agency	♦	♦	♦	♦
Land developer			♦	♦
Intercity bus company		♦	♦	♦
Retail business	♦	♦		

♦ - indicates potential participants.

Table 9-8. Potential Benefits Often Associated with Joint Development Strategies

Potential Benefit	Joint Development Strategy			
	Lease Development Rights	Lease Facilities	Cost Sharing	Negotiated Land Lease
Leverage private investment	●	○	●	○
Lease revenue	●	●		
Reduce property costs			○	●
Reduce construction costs			●	
Property tax revenue	○	○	○	
Increase ridership	○	○		○
Support local policies	○	○	○	○

● - indicates a major benefit associated with the strategy
○ - indicates a minor benefit associated with the strategy
- indicates a benefit that typically is not associated with the strategy

Source: (24)

The information in Table 9-8 is intended to serve only as a general guide—the local economy and other conditions will influence each case. It is also not intended to replace the detailed cost/benefit analysis that should be conducted for a proposed joint development project. The information can provide preliminary guidance in examining the potential benefits that may be expected from a particular type of project. If the anticipated project appears to offer the types of benefits desired, a more detailed cost/benefit analysis should be conducted to evaluate its feasibility.

Stage Four—*Consider Joint Development Issues*. Planning, constructing, and operating HOV-related joint development projects is not an easy process. Due to the often complex nature of joint development projects, problems and unresolved issues may emerge at many different points in the process. Recognizing that problems may arise—and maintaining the flexibility to respond with necessary changes—can be important factors in the joint development process.

This stage in the planning guidelines is intended to help identify potential problems or issues that may arise during the application of the different joint development strategies. It may be possible to avoid or minimize the impact of these problems by addressing them during the planning of the project. Issues related to legal, institutional, and economic concerns should be considered with the four different joint development strategies. Although many of the issues are common to all four joint development techniques, each has unique problems that may need to be addressed.

Table 9-9. Benefits, Issues, and Ideal Applications of Joint Development Strategies.

Strategy	Principal Benefits	Major Issues	Ideal Applications
Lease development rights	• Lease revenue • Leverage private investment • Support desired land use	• Inexperience • Requires high real estate values • Limited short-term benefits	• Commercial/office development at a fixed-guideway transit station
Lease Facilities	• Lease revenue • Passenger convenience	• May not produce positive cash flow • Potentially high vacancy or turnover in weak economy	• Leasing space at a transit terminal to an intercity bus company or other services utilized by passengers
Cost sharing	• Reduce construction costs • Leverage private investment	• Demonstrating the potential benefits to participants • Negotiating agreements with other participants	• Interagency funding for major projects • Private contributions for improvements to a facility
Negotiated land lease	• Reduce property acquisition costs • Use of preferred site	• Compatibility with neighboring land uses • Negotiating long-term agreements	• Bus transfer centers at shopping centers • Park-and-ride lots for bus or rail service

Source: (24)

Stage Five—*Final Check on Appropriate Applications*. The final stage is intended to summarize the previous steps and to provide a general indication of the most appropriate applications for the four joint development strategies. Although each project will have distinct characteristics and unique features, the experiences with transit-related joint development provide some typical indications of the benefits, issues, and appropriate applications associated with the different strategies. These features, which may also apply to HOV facilities, are summarized in Table 9-9.

The information in Table 9-9 is intended to serve as a final check in the general planning guidelines for agencies considering transit-related joint development projects. It provides a brief review of the principal benefits, issues, and appropriate applications for each joint development strategy. Once a particular joint development strategy has been identified, Table 9-9 can be used to verify that the principal benefits and issues have been considered, and that the intended application is appropriate. At that point, more detailed project analysis may be warranted.

VIII. ADDITIONAL RESEARCH NEEDS

The use of various types of HOV facilities by transit services was discussed in this Manual. The implementation of new or restructured express bus service is the most commonly found approach with HOV lanes. Although the benefits HOV facilities offer public transit services have been documented in some areas, there is still a need to better understand the impacts different design treatments and operating scenarios have on bus services. For example, a consensus does not currently exist on the impact of carpools and vanpools on bus operations. The following research studies have been identified through the literature review, the survey of practitioners, and the TRB HOV Systems Committee to help maximize the benefits of HOV facilities to transit operations. The results of these studies could be incorporated into the ongoing updates of this Manual.

Assessment of Transit Operations and Innovative Transit Services with HOV Facilities. Although case study examples of bus services with HOV facilities were included in this Manual, a detailed assessment of the impact on transit operations was beyond the scope of this project. A more detailed examination of the use of HOV facilities by transit operators, the impact of various design and operating scenarios on bus services, the implementation of new and innovative transit services, and the advantages and disadvantages of different design and operating approaches is still needed. This study would examine the impact of busways, freeway HOV facilities, and arterial street HOV applications on transit operations and services. It would also document the use of new services, such as reverse commute routes timed transfer networks, crosstown routes, suburb-to-suburb routes, and buspools. The results of this study would provide guidelines for use in planning, implementing, and operating innovative transit services with HOV facilities and maximizing the benefits of HOV facilities to transit operators.

Assessment of Innovative Transit Services with HOV Facilities. As discussed in this Manual, some transit agencies have implemented new and innovative services with HOV facilities. Additional research is needed to document these approaches and to explore other innovative transit services that could be implemented with HOV lanes. Potential strategies that would be examined in this study include

Assessment of Rail and HOV Coordination. As discussed in this Manual, a few examples exist of rail transit and HOV/bus operations in the same travel corridor. Additional research is needed to examine coordinating rail and HOV/bus operations in the same corridor, as well as coordinating services in different corridors in the same metropolitan area. This research study would document existing examples in more detail and would outline other techniques for enhancing intermodal and multimodal coordination.

Developing Improved Techniques for Estimating the Demand for Park-and-Ride Facilities. As discussed in this Manual, a number of techniques are currently available for estimating the demand for park-and-ride facilities, as well as locating and sizing these lots. These techniques have strengths and weaknesses. Additional research is needed to develop a better demand estimation model for different types of park-and-ride facilities. This research study would examine the existing techniques in more detail and would develop enhanced procedures for estimating the demand for park-and-ride lots associated with HOV facilities. It would also provide guidelines for locating and sizing these facilities.

Joint Development with HOV Facilities. A few examples of existing joint development projects with HOV facilities were described in this Manual. As noted, however, joint developments are more frequently found with rail transit systems than with HOV and bus systems. This research would examine the current HOV joint development projects in more detail and would identify techniques that could be used to encourage more joint development activities with HOV facilities.

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CHAPTER 10—SUPPORTING PROGRAMS AND POLICIES

LIST OF TABLES Page

I. INTRODUCTION

The development of an HOV facility does not automatically guarantee that it will be used. A number of supporting programs and policies have been identified as important to the successful operation of an HOV project. Some of these supporting elements, such as transit services and facilities, have been discussed in previous chapters. Another critical element, marketing and public information programs, is presented in Chapter 12. This chapter discusses other supporting programs and policies that may contribute to the overall success of HOV facilities. The chapter is divided into the following eight major sections.

- **Overview of Supporting Programs and Policies**. This section provides a summary of the different types of supporting programs and policies available to encourage greater use of transit, vanpooling, carpooling, and HOV facilities. The various approaches and techniques are discussed in more detail in the remaining sections.

- **Planning, Funding, Implementing, and Evaluating Supporting Programs and Policies**. This section provides an overview of the elements to be considered in planning, funding, implementing, and evaluating supporting programs and policies. Topics covered include institutional arrangements, planning approaches, potential funding sources, implementation strategies, and evaluation techniques. Examples of comprehensive approaches to supporting programs and policies are provided.

- **Regional Rideshare Programs**. Encouraging commuters to carpool or vanpool is a common approach used to support HOV facilities. This section discusses the more traditional approaches to ridesharing and ridematching services, as well as the innovative techniques being tested in some areas. Case study examples are provided to highlight various techniques.

- **Guaranteed Ride Home Programs**. This section describes Guaranteed Ride Home programs. The various approaches in use throughout the country are summarized, along with elements to be considered in developing and operating Guaranteed Ride Home programs. Examples of programs in areas with HOV facilities are highlighted.

- **Parking Management and Parking Pricing**. Preferential parking for HOVs, pricing strategies to encourage HOV use and to discourage driving alone, and other parking management strategies are discussed in this section. Examples of different approaches with HOV facilities are highlighted.

- **Employer-Based Programs**. This section discusses employer-based programs to encourage employees to use HOV commute modes. The different types of approaches, including the use of both incentives and disincentives, are presented. Case study examples are provided highlighting some of the techniques being used in areas with HOV facilities.

- **Growth Controls, Land Use Policies, and Zoning Ordinances**. This section summarizes techniques such as growth controls, land use policies, and zoning ordinances to encourage greater use of buses, carpools, and vanpools. An overview of various approaches is presented. These include growth management legislation, trip reduction ordinances, comprehensive plans, zoning ordinances, transit oriented development, and site design requirements.

- **Additional Research Needs**. The chapter concludes with a discussion of areas where further research is needed relating to supporting programs and policies.

The references used in the chapter are also provided, along with a listing of additional sources of information on supporting programs and policies.

II. OVERVIEW OF SUPPORTING PROGRAMS AND POLICIES—TRAVEL DEMAND MANAGEMENT (TDM)

A variety of programs and policies are being used throughout the country to encourage greater use of HOVs and alternative commute modes. Many of these strategies fall into the broad category of travel demand management. Travel demand management (TDM) includes a wide variety of techniques and actions aimed at managing the demand on transportation facilities by encouraging commuters to change from driving alone to using an HOV, shifting into less congested travel periods, or removing trips from the transportation system altogether. As a result, TDM programs may promote ridesharing and transit use, alternative work schedules, parking management and parking pricing, and peak-period travel spreading. Strategies may also focus on deterrents to driving alone and growth, land use, and zoning controls. The following general strategies are discussed in more detail in this Chapter. Table 10-1 highlights the techniques often used with each of these strategies.

- **Ridesharing**. Helping commuters form carpools and vanpools is the major focus of most ridesharing efforts. A wide range of marketing activities may be used to promote ridesharing. Further, ridematching services may be provided at the regional level, within a specific geographical area or by an individual employer. Ridematching arrangements may be formal and regular, or they may be informal and used on a periodic basis.

- **Guaranteed Ride Home Programs**. These programs provide commuters who take the bus or rideshare with a backup means of transportation in case of an emergency or a change in work schedule. A variety of approaches may be offered by a regional agency, a local group, or an individual employer.

- **Parking Management and Parking Pricing**. Approaches in this category include providing preferential parking for HOVs, pricing strategies to encourage HOV use or to discourage driving alone, parking cashout policies, and other strategies. Parking management and pricing strategies can be applied at a regional level, within a major activity center, and at a specific employment site.

Table 10-1. Supporting Programs and Policies

General Strategy	Techniques
Regional Rideshare Programs	• Ridematching services • Part-time, casual, and real-time carpooling • Vanpool programs • Employer outreach activities • Marketing and public information
Guaranteed Ride Home Programs	• Regional programs • Employer-based programs
Parking Management and Parking Pricing	• Preferential parking for HOVs • Pricing strategies • Parking cashout programs
Employer-Based Programs	• In-house transportation coordinators • Information dissemination • Company ridematching, vanpool, and guaranteed ride home programs • Subsidizing transit use • Subsidizing transit services • Transportation allowances • Preferential parking for HOVs • Parking pricing strategies • On-site amenities • Incentives for HOV use • Disincentives for driving alone
Growth Controls, Land Use Policies, Zoning Ordinances	• Growth management legislation and policies • Urban growth boundaries • Trip reduction ordinances • Adequate public facilities ordinance • Impact fees • Comprehensive plans and land use policies • Zoning ordinances and land use controls • Transit-oriented developments • Site design requirements

- **Employer Programs**. Many employers have implemented programs and policies to encourage their employees to use HOVs or other alternative commuter modes. These efforts may be undertaken in response to specific federal, state, and local regulations or they may be initiated to address a site specific issue. Employer programs may include approaches described previously, such as ridesharing and parking management activities, or they may involve financial incentives to encourage HOV use or monetary disincentives to discourage driving alone.

- **Trip Reduction Ordinances**. These ordinances are aimed at reducing or limiting the number of commute trips for new or existing developments. Encouraging greater use of HOVs is one approach that developers and employers may take to meet the requirements of these ordinances.

- **Growth Controls, Land Use Policies, and Zoning Ordinances**. A variety of growth controls, land use policies, and zoning techniques may be used to encourage the use of HOVs and HOV facilities. Growth controls and land use policies may be focused at the local, regional, or state levels. Local governments have the authority to approve and enforce zoning ordinances and site design requirements.

Many of these approaches are not new and many metropolitan areas where HOV facilities have been considered have also placed a greater emphasis on TDM strategies and other techniques. HOV facilities and TDM programs are closely linked. For example, HOV facilities are considered integral components of many TDM programs, and the use of HOV facilities can be further supported by the application of TDM strategies.

III. PLANNING, FUNDING, IMPLEMENTING, AND EVALUATING SUPPORTING PROGRAMS AND POLICIES

A number of factors should be considered in planning, funding, implementing, and evaluating various supporting programs and policies. Like other types of transportation improvements and strategies, the challenge to transportation professionals is to match the appropriate strategies to the needs, travel patterns, and characteristics of commuters in an area. Experience is still being gained with the use of many TDM techniques and related policies, as well as the effectiveness of packaging various approaches in different ways. The groups usually involved in TDM programs are discussed first in this section, followed by general guidelines for use in planning, funding, implementing, and evaluating TDM strategies and other supporting programs and policies.

A. Institutional Arrangements

A variety of public and private sector groups are usually involved in TDM programs and other supporting policies and strategies. Although many of these are the same agencies that are normally associated with planning and operating HOV facilities, others are not. For example, the involvement of private businesses and public/private organizations is critical to many TDM efforts. In addition, the authority for implementing land use and zoning requirements rests primarily with local governments.

The first step in developing TDM strategies and other supporting policies and programs is to identify the public and private sector groups that should be involved in the planning and implementation process. Table 10-2 identifies the public agencies and the private sector groups that should be considered for inclusion in the planning process. The potential roles and responsibilities of each group are highlighted in the table and discussed in this section.

Transit Agency. Many transit agencies are responsible for the provision of ridematching and rideshare services in addition to fixed-route, paratransit, and other transit operations. The services offered by transit agencies may include ridematching assistance, vanpool programs, guaranteed ride home programs, employer outreach activities, marketing, and other supporting components.

Rideshare Agency. In some metropolitan areas separate agencies have been established to promote ridesharing and to provide specific programs and services. These organizations usually offer the same types of programs provided by transit agencies in other areas. These services may include ridematching assistance, vanpool programs, guaranteed ride home programs, employer outreach activities, and marketing services.

Transportation Management Organizations and Associations (TMOs and TMAs). These are special organizations and associations that have been created to address transportation issues and other concerns in specific geographic areas—often rapidly growing suburban areas. TMOs and TMAs are usually comprised of representatives from businesses and developers in the area, local governments, and state and regional agencies. The unique aspect of most TMAs and TMOs is that they are organized and supported by the private sector. TMOs and TMAs provide the private sector with a more active role in the transportation planning and decision-making process. TMOs/TMAs are often responsible for the implementation of specific programs. For example, many TMOs and TMAs have become the focal point for the development, implementation, monitoring, and evaluation of TDM programs. Thus, TMOs and TMAs represent one way to establish closer working relationships among the pubic and private sectors and to coordinate a wide range of transportation programs.

Businesses and Public Agencies. Employers, including businesses and public agencies, may provide a number of programs to encourage employees to use HOV modes. These may range from simply promoting bus use and ridesharing among employees, to providing incentives for HOV use, to limiting driving alone. A wide range of approaches are currently used by public agencies and businesses to support HOV use by employees.

Table 10-2. Public and Private Groups Involved in Supporting Policies and Programs

Agency or Group	Possible Roles and Responsibilities
Transit Agency	• Rideshare program, including ridematching services and vanpool programs. • Employer Outreach programs. • Transit pass promotions. • Guaranteed Ride Home programs. • Subscription bus services. • Marketing and public education.
Rideshare Agency	• Rideshare program, including ridematching services and vanpool programs. • Employer Outreach program. • Guaranteed Ride Home program. • Marketing and public education.
Transportation Management Associations and Organizations (TMAs and TMOs)	• Coordinate private business and developer participation. • Promote ridesharing among employees. • Promote other transportation improvements. • Coordinate the delivery of ridesharing and transit services. • Provide or fund ridesharing programs, transit services, and guaranteed ride home programs. • Marketing and public education.
Businesses and Employers	• Promote rideshare and transit use among employees. • Provide incentives, such as bus pass subsidies, preferential parking, lower parking rates, guaranteed ride home program, to encourage employees to use HOVs. • Provide disincentives, such as higher parking charges, for SOV use. • Provide on-site transportation coordinator. • Provide on-site amenities.

Table 10-2 Public and Private Groups Involved in Supporting Policies and Programs, Continued

Agency or Group	Possible Roles and Responsibilities
Chamber of Commerce and Other Organizations	• Promote ridesharing and transit use. • Marketing and public education. • Coordinate employer participation.
State Legislature	• Approval of growth management and other legislation.
State Department of Transportation	• Administer funding for rideshare and TDM programs. • Provide rideshare and vanpool programs. • Provide technical assistance to local groups and employers. • Promote TDM programs among department and state employees.
Metropolitan Planning Organization	• Long-range planning and TIP development. • Administer funding for rideshare and TDM programs. • Provide technical assistance to TMAs/TMOs, local governments, and employers. • Help coordinate TDM activities. • Provide ridesharing and other TDM programs. • Help coordinate land use and transportation planning. • Specific growth management and other responsibilities based on state legislation.
Local Governments	• Authority to develop and administer land use controls. • Authority to develop and administer local transportation and growth management ordinances. • Participate in TMOs/TMAs. • Provide technical assistance to TMOs/TMAs and employers. • Help coordinate TDM programs and services. • Administer funding for TDM activities. • Promote TDM programs for employees.

Metropolitan Planning Organization (MPO). MPOs may be involved in TDM programs in a number of ways. First, as noted in Chapters 2 and 3, the MPO is responsible for developing the long-range transportation plan and the short-range Transportation Improvement Program (TIP) for an area. TDM and other supporting programs and policies will be incorporated into these documents. Second, an MPO may administer funding for rideshare programs and other TDM activities. Third, an MPO may provide technical assistance to TMAs/ TMOs, local governments, and employers in establishing and operating TDM programs. Further, MPOs may help coordinate TDM strategies and in some cases may provide specific services. Finally, MPOs play a role in helping coordinate land use and transportation planning, and in some areas have specific responsibilities for developing and implementing growth management programs based on state legislation.

Local Governments. Land use controls and zoning ordinances are the responsibility of local governments. Individual municipalities have the authority to develop and administer comprehensive plans, zoning ordinances, subdivision regulations, site design requirements, trip reduction regulations, and other land use controls. Local governments are often participating members of TMOs/TMAs. Local staff members may provide technical assistance to TMOs/TMAs and employers on TDM programs, may help coordinate TDM activities, and may administer funding. Finally, many local governments have developed TDM programs to encourage their employees to use HOVs or other alternative commute strategies.

B. Planning Supporting Programs and Policies

Assessing need for and use of TDM programs and other supporting policies and activities should be an integral part of the overall HOV facility planning process discussed in Chapter 4. Corridors that are congested enough to support consideration of an HOV lane may already have TDM programs underway. A more detailed level of planning for TDM strategies may be needed once the decision has been made to proceed with an HOV facility. At this point, consideration of TDM strategies should focus on the corridor the HOV facility is located in and specific activity and employment centers in the area. Planning for TDM techniques should also be coordinated with the transit planning activities discussed in Chapter 9.

The level of detail associated with planning TDM and other supporting policies should be matched to the type of HOV facility being implemented and the characteristics of the area. The following general guidelines can be used in planning TDM techniques and other supporting programs. More detailed planning tools and methods for estimating the potential impacts of different approaches are noted.

Examine Existing Services and Programs. The first step in the planning process should be to inventory and review existing TDM programs and services in the corridor or area. This assessment should cover current regional, area-specific, and employer-based ridematching services, vanpool programs, guaranteed ride home programs, parking management and pricing efforts, marketing and promotional activities, land use controls, and other activities. Available information on the nature of these programs, current utilization levels, and recent evaluations should be examined. This information can help identify the historical trends in the area, the extent and use of current programs, and the potential to develop new services.

Market Analysis. Assessing the market potential for different programs and strategies is the second step suggested in planning TDM programs. The market analysis should start with an examination of the major origins and destinations of commuters and travelers in the corridor or area. This step will help identify the location and the size of various markets so that specific strategies can be tailored to each market. This step is important since the characteristics of markets may vary, requiring different TDM strategies and implementation techniques.

A number of different methods may be used for identifying the travel markets in a corridor. Information generated and analyzed as part of the HOV facility planning effort can usually be used in the more detailed consideration of TDM strategies. Additional information can also be obtained from the regional forecasts available from the MPO or state, recent corridor studies or Major Investment Studies, census data, and other sources. The results of the market analysis should provide an indication of the major travel markets, traffic generators, and origin and destination patterns in the corridor.

Assessment of Alternative Strategies. Once the major travel markets have been identified, alternative TDM strategies can be identified and evaluated. The key consideration is to match the appropriate TDM techniques to the needs and characteristics of the various markets. Surveys, focus groups, and other methods can be used to obtain additional information on the potential use of different TDM programs and the reaction of commuters to various incentives and disincentives. Specific procedures, spreadsheet models, and computer programs can also be used to evaluate the impact of different services and programs (1,2,3).

Select Appropriate Strategies and Develop Implementation Plan. The results of the analysis conducted in the previous step can be used to select the most appropriate TDM strategies and other supporting programs for the corridor or area. An implementation plan can then be developed incorporating these approaches. The implementation plan should identify the specific strategies, the responsible groups, and funding and operating methods. It should also include a monitoring and evaluating component.

C. Funding Supporting Programs and Policies

A variety of sources can be used to fund TDM strategies and other supporting programs. Federal, state, and local funding may be available, as well as private sector resources. Funding the ongoing operation of these programs may be more difficult than funding capital projects. As noted previously, one of the unique characteristics of many TDM programs is the active involvement of businesses, major employers, and developers. The financial participation of these groups in supporting or providing TDM services is often part of this involvement. The various funding sources that may be appropriate for consideration with TDM programs are briefly summarized next.

Federal Funding. A variety of federal programs may be used to fund TDM efforts and other supporting activities. Most of the available federal funds are administered through FHWA and FTA. The Surface Transportation Program (STP), the Congestion Mitigation and Air Quality Improvement Program (CMAQ), and the Section 9 Program represent the FHWA and FTA programs most frequently used to fund TDM activities (4).

State Funding. States may provide funding for TDM programs through a variety of different mechanisms. These may include using state funds to match federal programs or to target specific initiatives. Like state funding for transit services described in Chapter 9, a variety of sources may be used to support TDM programs. Examples include general fund allocations, specific transportation funds, sales taxes, motor vehicles taxes, fuel taxes, property taxes, and lottery proceeds (5).

Local Funding. A wide range of funding sources are also used at the local level to support the operation of rideshare services, TDM programs, and other supporting elements. For example, funding from local sales and property taxes, general revenues, and other sources may be used to support the TDM services provided by a transit or rideshare agency. Local resources are also used to develop and manage land use regulations.

Private Funding. Businesses, employers, and developers may provide financial support for TDM programs and other related activities. Funding from the private sector may take many forms. For example, large employers may provide in-house transportation coordinators, rideshare matching services, and vanpool programs. Businesses and public agencies may also subsidize employee transit passes, bus services, or other programs. In addition, businesses and developers are often major funding sources for TMOs and TMAs (6). Further, developer mitigation or impact fees may be used to support these programs in some areas.

User Fees and Other Funding Sources. User fees, such as the monthly fares charged to vanpoolers, help pay a part of the cost of these and other TDM services. In most cases, user fees help support the operating cost of the services used by individuals but not the staff time or marketing and promotional activities associated with these programs. In addition, other financing techniques may be used to support these programs. These might include revenues from a priority pricing project which allows lower or single occupant vehicles to use an HOV lane for a fee.

D. Implementing Supporting Programs and Policies

A variety of approaches and techniques can be used to implement the TDM strategies and other supporting policies and programs recommended from the planning process. An implementation plan should be developed to help guide and manage this process. The plan should include the major program elements, the agency or group responsible for providing the service or implementing the strategy, and the funding sources. The specific steps needed to implement each element can also be identified. Table 10-3 identifies the items that should be considered in an implementation plan.

Additional information and resource guides are available to assist practitioners in designing and implementing specific TDM programs. These include how-to manuals and guidelines developed by federal agencies, regional and local organizations, and consulting firms. For example, more detailed guides are available on company vanpool programs (7) and guaranteed ride home programs (8), as well as comprehensive TDM programs (1).

E. Evaluating Supporting Programs and Policies

Chapter 13 provides a detailed discussion of developing and conducting an ongoing program for monitoring and evaluating HOV facilities. The evaluation of TDM efforts and other supporting programs and policies may be part of this overall process or a coordinated activity. Consideration should be given during the development and conduct of the evaluation to measuring the impacts of multiple TDM strategies implemented as a package. A few available reports (1,7,8) discuss techniques for assessing the impacts of TDM programs with multiple components. Key elements of the evaluation process are outlined next.

Establish Baseline or "Before" Information. The baseline or "before" characteristic should be established for each element in the TDM program. For example, if a company supported vanpool program is being implemented, the current number of vanpools and vanpool ridership should be established. This information could be collected through a survey of employees, monitoring vehicles entering and parking at the facility, and records for the regional rideshare agency.

Collect "After" Information. The procedures used to collect the baseline information should be used to collect the same data after the program has been implemented. With the vanpool example, the same methods used to collect the before information should be used to collect information after the program has been implemented, along with the records on company vanpools started. A number of different time frames are usually used to examine the impacts of TDM programs. These may include an initial evaluation after 6 months or a year, and then ongoing annual evaluations.

Analyze Before-and-After Data. In this step, the information from the two time periods is compared to identify the impact of the specific program element and to determine if the identified goals and objectives are being met.

Ongoing Monitoring and Evaluating of Supporting Programs. After the initial evaluation has been completed, it is suggested that an ongoing monitoring and evaluation process be continued. The appropriate frequency of these evaluations, the data collection needs, and the level of detail in the analysis will need to be determined for each project.

IV. REGIONAL RIDESHARE PROGRAMS

Ridesharing refers to the act of sharing vehicles for the trip to work or other destinations. Carpooling, which involves one or more persons riding with someone else, and vanpooling, which involves a more formal organization of people riding in a van, are the two basic types of ridesharing. A wide variety of approaches and techniques can be used to help individuals form and operate carpools and vanpools. This section summarizes the various approaches to ridesharing and provides examples of existing programs focusing on HOV facilities.

The first use of carpool matching assistance occurred during World War II, when ridesharing was promoted in response to gasoline and tire rationing. Carpooling and vanpooling was also promoted extensively during the energy crises and oil embargo in the mid-1970s and early 1980s. Today, rideshare programs throughout the Untied States provide a variety of services within the four broad categories of rideshare matching, vanpool support, marketing, and employer assistance and outreach. As described next, a number of different approaches and services may be offered within each of these general categories.

A. Rideshare Matching

Carpools are formed through a variety of methods and are comprised of different groups of people. The most common types of carpools are formed with family members, friends or neighbors, and co-workers. Experience from different metropolitan areas indicate that between 40 to 70 percent of carpools are family based, approximately 25 to 30 percent are organized with co-workers, and 7 to 14 percent are formed with neighbors and friends (9,10,11). Little or no outside help is needed to help individuals form carpools with family members and friends. Assistance from regional rideshare agencies and individual employers is often needed to help form carpools with co-workers and others.

During the 1970s, rideshare matching was usually done manually or with the use of early computer systems. Rideshare matching systems have increased in sophistication and capabilities since the 1970s and rideshare programs today use either commercially available software programs or specially designed systems to provide ridematching services. Most systems use some type of geographic base to record and track individual origins and destinations and to identify potential carpool matches.

An individual accesses a ridematching system by providing the necessary information over the telephone or by mailing in an application form. The computer system matches their origin, destination, and work schedule with others in the database, and the individual is provided with a match list of possible carpoolers either over the telephone or by mail. It is left up to the individual to make contact with other perspective carpoolers and to make arrangements for rides. Rideshare programs are currently in operation in most major metropolitan areas and many medium and small urban areas. The following examples highlight a few of the regional ridematching services offered in areas with HOV facilities.

Commuter Computer, Los Angeles. Commuter Computer provides a full range of services to encourage ridesharing in the Los Angeles area. Computerized ridematching, personalized trip planning, and marketing are just a few elements of the comprehensive services offered.

King County Metro. King County Metro and its predecessor agencies has provided computerized ridematching services in the Seattle area since 1975. A major focus of the promotional activities is on the HOV lane system in the Puget Sound area.

Minnesota Rideshare. Minnesota Rideshare, which is currently part of the Metropolitan Council Transit Operations, provides a comprehensive ridematching program in the Minneapolis-St. Paul metropolitan area. A major focus of the Minnesota Rideshare industry, including the computer ridematching system, has been to promote carpooling on the I-39 HOV facility.

Another ridesharing approach is fleetpooling, which involves the use of company or agency vehicles for carpooling and vanpooling. This technique allows fleet vehicles to be driven to and from work as employee carpools or vanpools. The vehicles are available during the day for company or agency travel needs. The employee or the employer may pay the costs associated with the commute trip, or the costs may be shared. This approach meets both commuting and business or agency needs. Fleetpooling is found in both Washington and California.

B. Part-Time, Casual, and Real-Time Carpooling

One of the factors often cited by commuters for not carpooling is lack of flexibility. Part-time, casual, and real-time carpooling are approaches being used in some areas to provide greater flexibility in the commute trip and to allow commuters to take advantage of the travel time savings offered by HOV and other preferential facilities whenever possible.

Part-time carpooling is defined as individuals who carpool less than five days a week. The intent of this approach is to provide flexibility for commuters based on the realization that individuals may need to drive alone some days to accommodate personal business and other activities. Employers may require that employees carpool at least two to three times a week to be classified as part-time rideshare participants (12).

The use of casual or instant carpooling has been identified in the Shirley Highway corridor in the northern Virginia/Washington D.C. area and on the Oakland Bay Bridge in the San Francisco area. In both areas, individuals are forming informal instant carpools on a daily basis to take advantage of the travel time savings afforded by the HOV facilities in the corridor. Activities in both areas were started by commuters and continue to operate without any formal planning or sanctions by agencies or organizations. Individuals wanting rides gather at park-and-ride lots and other locations and are picked up by drivers going to the same destination (12,13). The vehicle occupancy requirement on the Shirley Highway and the Bay Bridge HOV facilities is three or more individuals (3+).

Casual carpooling appears to be used more on the inbound trip in the morning than on the outbound trip in the afternoon on both HOV facilities. Commuters often use conventional transit service for the afternoon return trip. No major problems or incidents have been reported in either area. The impact of instant carpooling arrangements on these two facilities appears to be significant. Some 2,500 instant carpoolers have been estimated in the morning peak-period on the Shirley Highway, while approximately 8,000 commuters have been estimated to use casual carpools on the Bay Bridge in the San Francisco area (13,14).

The concept of real-time ridematching or carpooling attempts to formalize the casual carpooling phenomenon. A number of different approaches could be considered to provide real-time ridematching capabilities. One approach would allow commuters to call a ridematching service the night before, or in the morning of a trip, to either offer or request a ride. A second approach would provide commuters with the opportunity to request space in a vanpool on a real-time basis. A third concept would notify commuters traveling in a corridor of real-time rideshare opportunities at park-and-ride lots and other facilities. A fourth technique would use electronic mail (e-mail) or voice mail to help form carpools within a company or agency.

The Seattle Smart Traveler (SST) tested the provision of a real-time ridematching system using the World Wide Web at the University of Washington. The SST, which used both a home page and an e-mail system, was implemented in the Spring of 1996. Students, faculty, and staff at the University can access the system, complete a ridematching application, and request or offer rides. Although the test does not specifically focus on the HOV lanes in the Seattle area, carpools may use the HOV facilities, including those on I-5 near the University. As of the fall of 1996, approximately 300 individuals had registered to use the system (16).

C. Vanpool Programs

Vanpooling involves 8 to 15 individuals sharing a van for the commute trip. Usually, the driving is done by one individual, who travels for free, with the other passengers sharing the fixed and operating costs through monthly fees. Five general types of vanpooling arrangements are commonly found in use throughout the United States. These are employer-owned vanpools, employer/employee vanpools, owner-operator vanpools, transit or rideshare agency-owned vanpools, and third-party vanpools.

The major differences among these alternatives is the degree of employer involvement. Under the first option, the vans are owned, operated, and maintained by an individual company or business. Employees may be charged a monthly fee to cover all or a portion of these costs. The second alternative involves employers providing financial support to employees to purchase or lease vans and assisting with the organization of the vanpools. The owner-operator approach involves individual commuters acting as entrepreneurs to purchase a van and to develop a pool, without the support or involvement of an employer or a rideshare agency. In other cases, the transit or rideshare agency or state department of transportation owns the vans and provides them to commuters for a monthly fee. The last alternative involves leasing vans from a commercial company. This approach is often used by regional rideshare programs. Chrysler Corporation and other groups provide 3-party vanpool leasing programs.

Vanpool programs were in use in many areas during the 1970s and 1980s. Although vanpool programs have declined in some areas, vanpools are still found with HOV facilities in many areas. Information on establishing vanpool programs is available (17,18). The following examples highlight current vanpooling programs with HOV facilities in different areas.

METROVAN—Houston METRO. Houston METRO implemented a new vanpool program in 1994. Called METROVAN, the program offers employers three different options to help their employees form vanpools. First, METRO will match employer funding of a new vanpool up to $35 a month for the first four months of operation. Second, METRO will match monthly employer vanpool subsidies up to $35 per rider. Finally, METRO will subsidize up to $10 per rider for RideHome, METRO's guaranteed ride home program. As of mid-1996, 35 vans have been funded through this program, accommodating approximately 492 riders or some 15,885 monthly passenger trips. Approximately 30 different companies are participating in the programs. Many of the vanpools use the Houston HOV lanes.

Shirley Highway HOV Lanes. An extensive network of owner-operated and third-party vanpools operate in the Northern Virginia/Washington, D.C. area. For example, the Virginia Vanpool Association (VVPA) is the largest association of independent vanpool owners and operators in the country. The VVPA offers maintenance, safety, operational, and matching service to its members through newsletters and periodic meetings. Many of these vanpools utilize the Shirley Highway HOV lanes, as well as other HOV facilities in the area.

King County Metro Vanpool Program. King County Metro and its predecessor agencies has provided a vanpool program since the 1970s. Metro has experimented with the use of different sizes and types of vans, including mini-vans and luxury vans. This approach has been taken to better adapt to the demands of the marketplace and to match the product, or type of van, to the market.

D. Marketing and Public Information

Marketing and public information activities represent major components of most ridesharing programs. A wide range of techniques are used to promote carpooling and vanpooling. These may include permanent approaches, such as highway signs, to periodic marketing efforts using radio, television, and print advertising, billboards and bus signs, direct mail, and employer outreach activities. Public information activities often focus on explaining the need for ridesharing to address traffic congestion and air quality concerns. Marketing ridematching services, vanpool programs, and other services are usually major components of the promotional efforts undertaken with a new HOV facility. The ongoing advertising of rideshare services is also an important part of many successful HOV projects. The following case study examples highlight the use of rideshare marketing and public information programs with HOV facilities.

Southeast Expressway HOV Lane, Boston, Massachusetts. Part of the marketing program introducing this new contraflow HOV facility focused on promoting carpooling. A light tone, using the theme, "It's Your Choice," was used with the print advertisements. This approach stressed the advantages and benefits of carpooling and use of the lane, without criticizing driving alone.

HOV Lanes, Houston. A mix of public information and marketing materials have been used in association with the opening and ongoing operation of the HOV lanes in Houston. Kickoff ceremonies and target marketing have accompanied the opening of new segments of the HOV system. Radio advertising, newspaper advertisements, brochures, flyers, home pages on the Internet, and other outreach activities have all been used to promote carpooling, vanpooling, and riding the bus on the Houston HOV lanes.

I-394 HOV Lanes, Minneapolis, Minnesota. Extensive ridesharing promotions were undertaken to encourage ridesharing in interim and the final HOV lanes on I-394. The slogan "Get in the Sane Lane" was used when the interim HOV lanes were first introduced. Marketing activities promoting ridesharing included radio and newspaper advertising, direct mail marketing, billboards, bus signs, and other techniques.

HOV Lanes, Seattle. A wide range of marketing and public information programs have been used with the various HOV facilities in the Seattle area. These include brochures, newsletters, direct mail, newspaper advertisements, post-it notes, home pages on the Internet, and other techniques. Some marketing activities have been targeted toward specific projects or corridors, such as the opening I-5 South HOV lane, while other efforts are regional in scope.

Barnet-Hastings Express Lanes, Vancouver, British Columbia. A mix of promotional activities were used to introduce the freeway and arterial street HOV lanes in Vancouver. Slogans, including *Be a Roads Scholar*, *Travel Time Begins in September*, and *Group Savings Plan Starts in September*, were used with the various marketing materials. Promotional efforts included brochures and newsletters, which were distributed to businesses and mailed to households in the corridor, bus signs, a media kit, advertisements in suburban newspapers, public service announcements, work place displays, posters, and special events focusing on businesses along Hastings Street.

E. Employer Assistance and Outreach

Many rideshare programs offer a variety of employer assistance and outreach services. The types of services offered may include specialized ridematching services, agency or third-party vanpool assistance, and the development of multifaceted programs tailored to the needs of individual companies. Examples of employer assistance and outreach programs in areas with HOV facilities are highlighted next.

Commuter Services, Dallas. The Dallas Area Rapid Transit (DART) Commuter Services section provides a range of assistance to employers in the Dallas area. Many of these focus on encouraging greater use of the area's developing HOV lane system. Services include computerized ridematching, third-party vanpooling, and comprehensive transportation demand management assistance to employers. Commuter Services will prepare a specific TDM assessment to help determine employee transportation needs. They will also recommend alternatives and assist in implementing a mobility program for an individual employer. Assistance with parking management programs, business relocations, transit education, and training for employee transportation coordinators is also provided.

RideSponsor Program, Houston. The Metropolitan Transit Authority of Harris County (METRO) Corporate RideSponsor program provides a number of services to encourage employers to help support and promote bus use and ridesharing among employees. The program is open to public and private sector employers. To participate in the transit pass portion of the program, a company must agree to sell bus passes on-site and must have at least 25 regular bus riders. Employers are also encouraged to subsidize a portion of their employees' bus fares. METRO, in turn, provides a discount of 10 percent on all passes and ticket books. Currently, 104 public agencies and private businesses are participating in the program. In addition, METRO also provides employer outreach assistance with rideshare matching services, a subsidized vanpool program, and other supporting services.

Brentwood Area Transportation Management Association, Nashville. The Brentwood Area Transportation Management Association (TMA) provides a range of services to employers and employees in the corridor targeted toward encouraging use of the I-65 HOV lanes. These include ridematching services, a guaranteed ride home program, coordinating vanpool formations through the programs offered by the state or the Nashville Metropolitan Transit Authority, and other assistance.

V. GUARANTEED RIDE HOME PROGRAMS

Guaranteed ride-home programs provide commuters who take transit or rideshare with a back-up means of transportation in case of an emergency or a change in work schedule. These programs are designed to eliminate one of the reasons often noted by commuters for not using alternative commute modes—that is a fear not having a ride if they need it. Guaranteed ride home programs may be provided at the regional level by the transit or rideshare agency, at the local level by a TMO, or at the site-specific level by an individual employer. A variety of methods are used to provide this transportation, including taxis, company vehicles, leased vanpools, and private automobiles. The requirements for participation may also vary by program. Some programs require commuters to register and some place restrictions on the number of trips that can be made.

Experience to date indicates that although transit and rideshare users view guaranteed ride-home programs as important, actual use is relatively low (1). Thus, it appears that the programs are being used only in the case of an emergency or change in schedule and are not being abused.

The following guaranteed ride home programs are currently in use in metropolitan areas with HOV facilities. These examples provide practitioners with an indication of the various approaches that can be used with guaranteed ride home programs.

RideHome, Houston. METRO offers a guaranteed ride home program to employees of businesses and agencies participating in the Corporate RideSponsor Program. Employees of these businesses can access the RideHome program in case of an emergency or other change in schedule that requires a trip when regular METRO service is not available. The RideHome program is open to bus riders, vanpoolers, and carpoolers.

Brentwood Area Transportation Management Association (TMA), Nashville. The Brentwood Area TMA offers a guaranteed ride home program to individuals who take the bus, carpool, vanpool, bicycle, or walk to work. The program includes commuters using the I-65 HOV lanes in the Nashville area. The program provides free rides home using taxis for trips up to 25 miles in length and rental cars for longer trips to employees who use an alternative commute mode at least three times a week

Home Free Guarantee, Seattle. King County Metro provides a guaranteed ride home program, called Home Free Guarantee, for participating employers in the Seattle area. The program provides emergency taxi service for employees of participating businesses and agencies who use alternative commute modes. Metro provides vouchers for employees to use and contracts with local taxi companies for the actual service.

VI. PARKING MANAGEMENT AND PARKING PRICING

Numerous studies have verified that the availability, cost, and accessibility of parking has an influence on mode choice (19,20,21). If convenient, and reasonably priced parking is available, an individual is more likely to drive. If parking is expensive or located far from an employee's work site, transit and ridesharing may be more attractive. Further, many employees receive subsidized parking, and thus do not have to pay the true cost of parking. Recognition of the important role parking plays in determining travel behavior has led to the consideration and use of parking management strategies as one of the tools to encourage and support HOV facilities, transit, ridesharing, and other alternatives to single-occupant vehicle use.

Parking management and parking pricing encompasses a variety of techniques to influence mode choice. Parking supply and location programs may include favoring short-term over all-day parking; strictly enforcing municipal parking regulations; providing fringe and transportation corridor parking to facilitate transfers to transit and other high-occupancy vehicles; and limiting the available parking supply to carpools and vanpools, while providing only off-site parking for drive alone commuters. Strategies to regulate the price of parking include the elimination of subsidies and the institution of parking charges. Transportation allowances, which can be used to pay parking charges or can be cashed out each month if the commuter utilizes alternative transportation, provide additional financial incentive.

The supply, location, and pricing of parking has been identified as one of the critical factors influencing travel behavior and mode choice. A number of different approaches and techniques can be used to influence the management and pricing of parking. The three strategies highlighted in this section are providing preferential parking for HOVs, pricing techniques, and parking cashout programs.

A. Preferential Parking for HOVs

One approach is simply to provide preferential parking for carpools and vanpools. For example, rideshare vehicles may be given parking spaces close to the front entry of a building, in covered areas, or in parking garages. Strategies may be implemented at an individual work site and at public parking facilities in a downtown area or major activity center.

B. Pricing Strategies

Another approach is to charge higher parking rates for single-occupant vehicles. A number of parking pricing strategies can be used, including instituting parking charges, removing or reducing employer subsidies, eliminating discounts for long-term commuter parking, and reducing charges for carpools and vanpools. Studies indicate that increasing an already high parking charge will have more effect than increasing a relatively low price by the same percentage (19,20). The imposition of charges where parking had previously been free or the reduction or removal of the employer subsidy may also impact drive alone rates and transit use. The degree to which pricing strategies influence mode choice also depends on the availability and attractiveness of travel and parking alternatives.

I-394 Parking Garages, Minneapolis. The I-394 HOV lane and the downtown parking garages in Minneapolis provide one example of parking management and pricing strategies in use with an HOV facility. Three parking garages on the edge of downtown Minneapolis were constructed as part of the overall I-394 HOV facility. The garages, which contain bus and passenger waiting areas and approximately 6,000 parking spaces, provide greatly reduced parking rates for carpools and vanpools using the I-394 HOV lanes. For example, in 1996 the monthly rates for carpools and vanpools was $10.00, while rates for single-occupant vehicles was $90.00.

C. Parking Cashout Programs

Another approach, called *parking cashout*, allows or in some cases requires employers who offer subsidized parking to employees to also offer the choice of a cash allowance in lieu of parking. This type of system has been implemented in California and has been considered at the federal level. Parking pricing strategies and supply reduction techniques can be controversial and there are a number of issues that should be considered in developing programs using these techniques. These include tax implications of employer subsidized parking or transit use, employer concerns over maintaining a competitive advantage in attracting and retaining employees, and other issues.

VII. EMPLOYER-BASED PROGRAMS

Employers in a number of areas have developed and implemented internal programs to encourage employees to use HOV modes. A variety of programs and services may be provided to assist employees form carpools and vanpools, as well as offering incentives for using HOV modes and disincentives for driving alone. These programs have been initiated for a variety of reasons. In some areas, employers may be responding to specific federal, state, and local requirements and regulations. Programs in other areas may be focused on addressing site-specific traffic problems, environmental issues, or quality of life concerns, or employee benefits.

Experience seems to indicate that employer-based programs are more effective at influencing commute behavior than general regional strategies (1). This section summarizes the services and strategies that are often found with both public and private sector employer-based programs.

A. In-House Transportation Coordinators

The first approach used by many large businesses and public agencies is to appoint an employee to serve as the coordinator for the various activities and programs offered by the employer. The Clean Air Act Amendments of 1991 required employers with over 100 employees in severe and extreme air-quality non-attainment areas to designate an employee transportation coordinator (ETC). Many large businesses and agencies already had individuals responsible for transit and rideshare programs and many have maintained these positions even with the change in policy at the national level from mandatory to voluntary programs.

In-house transportation coordinators may provide a variety of services and functions. Although the exact responsibilities will vary by company size and geographical area, activities performed may include commute trip planning assistance, providing transit and rideshare information, and managing company rideshare, vanpool, guaranteed ride home, and transit pass programs. Further, the transportation coordinator often acts as the liaison with other groups, and may represent the business or agency in a TMO or TMA or other regional group.

B. Information Dissemination

A basic service that may be provided by an employer is simply the dissemination of information about available transit services, rideshare programs, and other commute operations. Information may be distributed through bulletin boards, flyers, newsletters, electronic mail, home pages, special events, and other mechanisms.

C. Company Ridematching Programs

As discussed in Section IV, regional rideshare programs provide ridematching services in most urban areas. In some cases, large employers may provide these same services for their employees. Company-based rideshare programs provide a number of advantages. First, individuals may be more comfortable ridesharing with co-workers than with complete strangers. Second, sharing a common work-site destination may make it easier to establish carpools. Finally, company-based ridematching services may be part of larger programs that include other incentives or disincentives for employees to share rides, further supporting the formation and continuation of carpools.

Table 10-3. Elements to Consider in Developing a TDM Program Implementation Plan

TDM Strategy	Responsible Agency	Funding Source	Action Steps	Schedule Dates	Actual Dates

Employer-based ridematching services may be provided in a number of ways. Like regional programs, employees fill out applications or match requests, providing information on work hours and home location. These applications may be processed by the company, using commercially available software, or by the regional rideshare agency. Employees are provided with a listing of potential carpool matches. Formation of a carpool is left up to the individual, but may be facilitated by the company transportation coordinator.

D. Company Vanpool Programs

Building on company sponsored rideshare services, some employers operate their own vanpool programs. Like regional vanpool programs, a number of options are available for employer-sponsored vanpool programs. These include employer-purchased vans, employer-leased vans, owner-operated vanpools, and third-party vanpools. The level of involvement and the financial commitment required vary for each of these alternatives. Companies may subsidize part of the cost of purchasing and operating vanpools, providing further financial incentives to employees.

Company-sponsored vanpool programs have been developed for a number of reasons, including limited parking, site-specific traffic impacts, energy conservation, providing access for transit dependent groups, and other factors. Employer-sponsored vanpools provide many of the same advantages noted with company rideshare matching services. These include enhanced employee comfort levels and coordination with other company policies and programs. These advantages help increase the likelihood for a successful vanpool program.

Fleetpooling. As noted in Section IV.A., fleetpooling represents another approach that may be used by employers to encourage carpooling and vanpooling. Fleetpooling involves the use of company or agency vehicles for carpooling and vanpooling. Employees are allowed to drive fleet vehicles to and from work as carpools or vanpools. The fleet vehicles are then used during the day for business trips. The employee or the employer may pay the costs associated with the work trip, or the costs may be shared. This technique meets both commuting and business needs and maximizes the use of fleet vehicles.

E. Guaranteed Ride Home Programs

As discussed previously in Section V, guaranteed ride home programs may be provided at the regional level, the local level, or at a company level. Guaranteed ride home services may be offered as one component of a comprehensive employer-based TDM program. The same types of mechanisms described in Section V can be used with company-sponsored guaranteed ride home programs. The cost-sharing arrangements between the individual and the agency or business may vary, but usually the employer pays a part of the cost of the service providing additional incentives to employees to use alternative commute modes.

F. Subsidizing Transit Use

Numerous public agencies and private businesses encourage employee use of transit by subsidizing all or a portion of the fares. In many cases, transit agencies provide monthly passes, transit checks, and tokens or tickets to employers at a discount if the employer also subsidizes part of the cost. Promoting these types of efforts represents an important part of most transit agencies marketing and information activities.

G. Subsidizing Transit Services

Alternative transit and ridesharing services must be available to commuters if they are expected to change from driving alone. As discussed in Chapter 9, large employers or groups of employers in some areas have subsidized special transit services to provide options for their employees. These may include buspools or specific routes serving an employment area, shuttles from transit centers and stations, reverse commute routes, and other service strategies.

H. Parking Management and Pricing Programs

As discussed previously in Section VI, parking management and parking pricing strategies may be applied at the regional, local, or site-specific levels. Parking management and pricing techniques may be part of a comprehensive employer-based TDM program. The easiest approach to implement is the provision of preferential parking for carpoolers and vanpoolers. This strategy provides reserved parking spaces for rideshare vehicles, close to building entrances, in covered areas, or in garages.

Another approach involves charging lower parking rates for carpools and vanpools. Discounts may be provided on a daily or monthly basis, and rates may vary by the number of occupants in a vehicle. Other techniques include charging solo drivers a premium rate, controlling the amount of parking available at a site, and parking cashout programs. All of these approaches can encourage greater use of HOVs.

I. Transportation Allowances

Transportation allowances represent one approach that employers can use to address the costs of various commute options, to provide additional alternatives for employees, and to encourage use of HOVs and alternative commute modes. Transportation allowances involve either a one-time or an ongoing payment to employees to cover the cost of commuting. Transportation allowances usually provide each employee with a set amount of money that can be used to pay for parking, transit fares, or other commute alternatives. An employee is allowed to keep the unspent funds. Thus, if an individual walks to and from work, they receive all of the transportation allowance. If an employee uses transit, they may also receive some of the allowance in cash, as programs are usually established based on the higher cost of parking. If an individual drives alone and parks, they usually will spend all of the allowance and in some cases may have to pay extra from their own resources.

J. Incentives and Disincentives

Many of the techniques and strategies described in this section include incentives for encouraging employees to use alternative commute modes or disincentives to discourage employees from driving alone. Subsidizing transit passes and vanpools, or charging lower parking fees for rideshare vehicles all represent financial incentives for using HOV modes. Higher parking rates for single-occupant vehicles provides a disincentive for driving alone.

Other incentives and disincentives may also be used to encourage employees to rideshare or take transit. Examples of approaches being utilized by some companies include extra vacation days or time off, free or discounted equipment and merchandise, drawings for prizes, vouchers for gas or vehicle maintenance, and other benefits. Offering these types of financial incentives may be part of a comprehensive employer-based TDM program.

K. On-Site Amenities

The provision of on-site amenities represents another approach that can enhance the use of HOVs and alternative commute modes. On-site amenities may focus on enhancing the ease of use and safety and security associated with transit and rideshare services. Components such as shelters, improved lighting, pathways, sidewalks, and covered walkways can all make transit a more attractive option for employees. Further, the provision of lunch facilities, as well as banking and other services on-site or in close proximity can enhance the use of alternative modes. These types of facilities and amenities are especially important in suburban areas where office complexes are often isolated from other services.

VIII. GROWTH CONTROLS, LAND USE POLICIES, AND ZONING

A variety of policies and programs focusing on land use, growth management, and land development can be utilized to encourage greater use of all HOV modes and HOV facilities. These approaches, which are described in this section, range from community or metropolitan area wide policies to specific techniques to encourage or require transit-friendly developments and land use patterns. As noted previously, local communities are responsible for administering land use policies, zoning ordinances, and other regulations. State governments in some areas have legislated growth management or placed other requirements on local governments. Further, policies at the MPO or regional level may provide further direction to cities on land use controls.

A. Growth Management

Growth management is usually defined as a comprehensive approach to regulating and directing the location, geographic pattern, density, quality, and rate of development in a specific area. Growth management focuses on using public policy to coordinate new development with the capacity of the existing and planned infrastructure and the desired level of service. Most growth management strategies focus on long term rather than short term impacts. The transportation system is a major focus of existing growth management programs, although infrastructure concerns relating to water, sewer, police, fire, housing, schools, open space, and economic development are often included.

The transportation components of growth management programs are usually based on the trip generation characteristics of various land uses. Controls are then placed on the type, location, density, and timing of development in a particular area to ensure that adequate capacity exists in the transportation infrastructure. Growth management may be focused on the local level such as Montgomery County, Maryland, at the regional level, such as the Minneapolis-St. Paul municipal urban service area, and at the state level, such as policies in Florida and the State of Washington.

B. Urban Growth Boundaries

In response to the pressures of increasing development, some states have established legislation requiring communities to establish urban growth boundaries. Urban growth boundaries allow communities to direct growth to areas having adequate public facilities and services. Growth boundaries can be used to help establish limits to sprawl and can encourage more compact development patterns that are conducive to HOV facilities. The limits of an urban growth boundary are typically established to accommodate 20 to 25 years of growth within an urbanized area. Land uses outside the boundary are usually designated for rural uses or resource preservation.

Oregon and Washington are two states that allow communities to develop well-defined urban growth boundaries and to strengthen the linkage between land use and HOV transit through state mandated legislation. Oregon's 1973 Senate Bill 100 gave communities the power to delineate boundaries to urban growth and to define urban and rural land uses. The Washington State Growth Management Act of 1990 provides municipalities with the initiative to create urban growth boundaries. Counties in Florida, without the backing of state legislation, have begun enacting urban service areas. For example, Dade County, one of Florida's largest counties, has established level of service standards for urban and rural roads to encourage infill development and higher densities within a defined urban service area.

C. Trip Reduction Ordinances

These are ordinances or other regulations aimed at reducing or limiting trips from new or existing developments. Trip reduction programs may be passed by a state or a local community. Similar to growth management programs, trip reduction ordinances are usually targeted at ensuring that the transportation infrastructure in an area is adequate to handle the current and anticipated demand. This type of ordinance may require a development or business to plan and implement programs to reduce single occupant commute trips. A variety of transit and ridesharing strategies, including HOV facilities, may be part of a trip reduction program. Examples of communities using trip reduction ordinances include Alexandria, Virginia; Silver Spring, Maryland; Sacramento, California; and Bellevue, Washington.

D. Adequate Public Facilities Ordinances

Adequate public facilities ordinances are growth management tools that allow new development to occur only where infrastructure and public services are adequate to support them. This approach may encourage more compact urban forms. Adequate public facilities ordinances are commonly enacted in areas undergoing rapid growth or by municipalities on the fringe of high growth areas, in an effort to control and direct development. These ordinances usually apply to roads, transit, water and sewer service, and schools.

Adequate public facilities ordinances may vary from one municipality to another in terms of level of specificity, rigor, and equity. Generally, under an adequate public facility ordinance, developments that will result in unacceptable level of service conditions on nearby roads and intersections are not allowed. The development must either be postponed until improvements have been made to the transportation infrastructure, or solutions must be found to address the issues. In some cases, developers may be able to negotiate transportation management agreements in order to facilitate project development. The actions that may be required of developers under negotiated agreements include financing private transit services and vanpool programs, providing transit subsidies to employees, and providing on-site employee transportation coordinators and ridematching assistance.

E. Impact Fees

Under a system of impact fees, a municipality charges developers for having to extend infrastructure and public services to outlying areas. Impact fees are generally implemented in areas of high growth or in areas where municipalities have limited budgets for improvements. Impact fees are designed to make developers pay a fair share of the costs generated by new development. Impact fees can only be used for mitigating the effects of the specific development from which the fee is collected. Funds from impact fees cannot be used to correct an existing problem. Impact fees can be used to direct development to desired areas, thus supporting HOV facilities and transit services. Although the intent of impact fees is to help control and manage growth, this technique may have an undesired affect of directing development to other areas which do not have similar ordinances or related measures.

F. Comprehensive Plans and Land Use Policies

Another approach being used in some areas involves establishing and implementing land use policies which promote transit use and ridesharing. These policies, which are intended to address existing congestion concerns as well as preventing future problems, are usually formalized through the comprehensive plan, zoning ordinance, subdivision ordinance, and other local plans and regulations. These ordinances are used to encourage the development of residential and employment areas at densities and with designs that will support and foster transit use and ridesharing. One of the strongest tools a city can use for encouraging transit and HOV sensitive development is its comprehensive plan. A comprehensive plan provides a statement of municipal policy and an expression of community intentions and aspirations. In general, a comprehensive plan performs the following functions.

- The plan is an expression of what a community wants–a statement of goals, a listing of objectives, and a future vision.
- The plan serves to help guide future decisions related to public and private investments.
- The plan may meet legal requirements.

Given that transit and HOV use tend be to most effective where there are high levels of activity, parking is limited, and access to the transit system is good, municipalities responsible for formulating land use policies, plans, and controls can use these techniques to encourage developments which support these approaches. Some of the major factors which may be considered in creating a land use plan supportive of transit and HOV use are population densities, the location of activity centers, site design criteria, and parking policies.

Further, a comprehensive plan may require that major activity centers, such as large office parks, medical facilities, universities, or regional shopping malls, be located in areas that are well served by transit. The zoning ordinance can then be can be used to focus desired development in transit corridors or nodes. Supported by the guidelines established in the comprehensive plan, zoning can foster an HOV-friendly mix of uses around activity centers. In addition, the comprehensive plan can establish the community's vision regarding the enhancement of transit services and the mix of land uses at existing activity centers.

G. Zoning and Land Use Controls

Once the overall goals and policies have been established in the comprehensive plan, land use policies that promote HOV and transit-friendly development can be implemented through the zoning ordinances and other land use controls. Possible tools discussed in this section include transit zoning districts, mixed use zoning, special commercial zones, transition zones, pedestrian priority zones, incentive zones, floating zones, transit easements, land banking, and transfer of development rights.

Transit Zoning Districts. Transit zoning districts may be used in areas immediately adjacent to transit centers or stations to encourage higher residential and office densities. Mixed land use may be encouraged through incentive zoning and other re-zoning techniques near the transit facilities. A major objective of this approach is to allow higher residential population and supporting land uses within walking distance of the transit facility. Residential and other land uses within the district may be interconnected with a comprehensive pedestrian circulation system. Currently, the use of transit zoning districts appear more common with LRT or heavy rail systems than with HOV facilities. Examples of these approaches are found in Gresham, Oregon and Atlanta, Georgia.

Mixed Use Zoning. Allowing for dissimilar but compatible land uses through mixed use zoning can create more diverse developments than traditional single use zoning. In single use zones, travel demand is often concentrated in peak periods. In contrast, activities and transit occur over extended periods in developments with diverse land uses.

Special Commercial Zones. These districts or zones are designed to encourage pedestrian access to commercial land uses from transit facilities by controlling the types of land uses allowed in the area. The zones are specially designed commercial centers typically located in downtown areas or an area adjacent to transit facilities. Single-occupant vehicles are often discouraged and ridesharing is encouraged through the implementation of parking regulations.

Transition Zoning. Transition zones may be used by municipalities to transition from higher density developments to lower density developments. High density land uses may be encouraged around transit stations or stops to generate the high ridership levels. Conflicts may arise, however, with nearby lower density neighborhoods. Transition zoning can be used to provide an area of medium density between the high-and low-density developments. The zone provides a gradual change between development densities and protects the quality of low-density single-family neighborhoods from high density developments adjacent to transit stations.

Pedestrian Priority Zones. A pedestrian priority zone is an area that establishes a network of pathways and pedestrian spaces connecting private and public spaces. These zones may be used to link building atriums, lobbies, plazas, and open spaces into a unifying system to increase access to HOV and transit facilities. Emphasis is on creating spaces and environments that are aesthetically pleasing, safe, and that provide a human scale of activities. A pedestrian priority zone is usually delineated by the distance a person is able to walk in five minutes, which is the assumed convenient maximum travel time for pedestrians.

Incentive Zoning. Incentive, or bonus, zoning includes provisions that allow builders to acquire expanded development rights. Upon meeting certain criteria, the developer is usually required to provide some public benefit as part of the project in exchange for increased densities, building heights, or floor area ratio bonuses. An increase in the density of a development may help support HOV and transit use in the area. In return, the municipality may require improvements from the developer to enhance HOV and transit facilities. For example, the developer may be asked to provide pedestrian amenities or to provide a direct link into a transit station or stop.

Floating Zones. A floating zone allows for certain uses, but is not fixed to any geographic location in the municipality. Floating zones are commonly used to establish planned unit developments (PUDs). Municipalities can use this zoning tool to encourage transit friendly developments. In exchange for approval of floating zones, HOV and transit related amenities may be required, such as bus shelters, walkways to transit facilities, or bus pull-outs.

Planned Unit Developments. Development plans are usually reviewed and approved on a lot-by-lot or subdivision basis. Planned unit developments (PUDs) are used in many areas to allow large tracts of land or entire developments to be approved at one time, with the intent of fostering better community design. In exchange, the developer of a PUD is required to dedicate various public amenities. A local government intent on promoting HOV and transit facilities and use may require land to be dedicated for these purposes as part of the PUD approval process.

HOV and Transit Easements. By definition, an easement is a right given by the legal owner of a property to another party, typically a governmental agency or public utility, to use the land for a particular purpose. The designated portion of land granted can be used only for that specific purpose. Examples of easements designated for HOV and transit might include providing land for transit stations and centers, bus stops and shelters, and direct access HOV lanes.

Land Banking. Land banking is a land use planning tool to shape and control the development of communities through the public acquisition of land for eventual use by the government or for resale to the private sector. Property held in land banks usually includes undeveloped or under-used public land and tax-delinquent properties. The government can influence both the character and the timing of growth by deciding when to sell land banked property and by placing restrictions upon future development of the property. Land banking can be used to hold land for future HOV transit facilities.

By imposing restrictions on the property sold from a land bank, the municipality can affect the density and quantity of growth and major types of development. In addition, use restrictions can limit the development options of a particular site or assure that new development has the attributes or quality level desired by the community. For example, a community which desires higher densities in order to increase transit efficiency can use land banking to create infill housing and to establish mixed-use developments.

In certain states, enabling legislation may be required in order to initiate a land banking program. Land banking has been applied successfully in several cities including St. Louis, Missouri and Cleveland, Ohio in the United States, and Edmonton, Alberta and Saskatoon, Saskatchewan in Canada.

Transfer of Development Rights. This land use technique is based on the premise that ownership of land includes several rights, which may be separated and transferred to another piece of property. The right to develop the property is one of these separable rights. Under a transfer of development rights program, an owner can sell or transfer the right to develop property to another person for use on a different parcel of land. The selling property is referred to as the donor site, and the purchaser's property is called the receiver site.

Property owners sell their development rights because they either do not want to develop them or because they are prohibited by some land use regulation. Transfer of development rights may serve as a means of preserving agricultural land, open space, historic landmarks, and ecologically sensitive areas. It may also be used to help direct growth in desired directions. For example, a local government may wish to safeguard land for agricultural uses or preserve an historically significant property, and prohibit development of these sites under its police powers. Thus, the owner is denied full use of the property. A transfer of development rights program offers the property owner fair compensation; the property owner's loss under the land use regulation is offset by the ability to sell or trade the development right.

H. Transit-Oriented Developments

Many communities are increasingly looking to maximize existing services and facilities in the face of continued urban expansion and increasing demands. Development that is oriented towards HOV and transit, and that emphasizes alternatives to the automobile, such as bicycling, walking, or transit, allows people of all ages and incomes to access jobs, public services, and shopping centers. The concept of transit-oriented development (TOD), represents an approach being used in some areas to encourage these types of land use patterns. TODs focus on creating mixed-use urban environments along transit lines that are easily accessible to pedestrians.

In contrast to the traditional pattern of suburban development, the TOD concept focuses on compact, higher density, and mixed land uses. The internal environment of a TOD is pedestrian-oriented and de-emphasizes the automobile. Public transportation is viewed as an integral element within the development to provide access and mobility to a wide variety of open spaces, retail centers, diverse residential styles, and office buildings. The Laguna West development in Sacramento, California represents one of the first uses of this concept.

I. Site Design Requirements

One of the barriers to HOV and transit use in many areas is site designs that limit transit access. This is especially true of suburban employment and commercial developments. The use of HOV-friendly site designs can help overcome this problem. Elements to consider in this approach include providing sidewalks, direct transit access to the front of a building, passenger shelters and other amenities, and mixed land uses. Pro-transit site design considerations can be built into zoning ordinances, subdivision ordinances, and other local regulations.

Site design strategies can be used to encourage and support transit and other alternative means of transportation by making developments more attractive, safe, and convenient for HOV users. This can be accomplished by providing adequate lighting, seating, and sidewalks, and by ensuring that the circulation pattern on a site is well defined and convenient for all users. Efforts to coordinate larger site design concepts, such as proximity and orientation toward transit, can also help to make public transportation an attractive alternative to the automobile.

A number of site design elements can be used by the public and private sectors to support and encourage HOV use. These include the orientation of buildings, the location and the amount of parking, and the provision of on-site transit facilities such as stops, shelters, information kiosks and ticket outlets. In addition, the design of a site's pedestrian and vehicular circulation system can be used.

IX. ADDITIONAL RESEARCH NEEDS

The important role supporting programs and policies play in the success of an HOV facility was described in this Chapter. The exact influence of many TDM strategies is still not well understood, however. Further research is needed to better document the impact various TDM techniques can have and to identify those strategies that may have the greatest impact on increasing the use of HOV facilities. The following research studies would address these needs.

Analysis of Factors Impacting the Effectiveness of HOV and TDM Strategies. TDM techniques are being used in many areas to enhance the effectiveness of HOV facilities. More research is needed to better understand the influence of TDM strategies with HOV projects. This study would provide a comprehensive review of HOV and TDM applications, with emphasis on instances involving simultaneous application for which HOV user trip and purposes are known. The characteristics associated with the successful and unsuccessful implementation of these strategies would also be examined.

Assessment of Innovative Techniques to Encourage Greater Use of Carpools, Vanpools, and Buses. This study would provide a new perspective on techniques that could be used to encourage greater use of alternative travel modes and HOV facilities for both work and non-work trips. The experience with existing strategies would be documented, and potential new approaches would be identified and analyzed. The intent of the project would be to take a fresh look at the factors influencing mode choice and travel behavior and to match service strategies, the use of ITS technologies, and other techniques to meet these needs.

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CHAPTER 11—IMPLEMENTING HOV FACILITIES

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I. INTRODUCTION

Implementing HOV facilities in a safe and efficient manner is critical to not only the success of the project but also to the operation of the roadway or corridor. A number of factors may contribute to help ensure that projects are implemented to minimize traffic disruption during construction, and to maximize the operating effectiveness of the HOV lane and the overall facility. This chapter discusses techniques and approaches to meet these objectives. Involving the appropriate groups, developing an implementation plan, project phasing and sequencing, project bidding and contracting, managing traffic during construction, training, pre-operational testing, and other considerations are presented. The chapter is divided into the following ten sections.

- **Implementation Planning**. Developing an overall plan or approach for opening the HOV facility to the public should be the first step in the implementation process. This section discusses the agencies and groups that should be involved in this process and the various steps that should be included in developing an implementation plan.

- **Project Phasing**. Ensuring that HOV facilities are opened in logical and operable sequences is important to the overall success of the project. This section discusses the various approaches that can be used to phase construction and implementation of HOV facilities. Case study examples are presented highlighting techniques that have been used in different metropolitan areas.

- **Bidding and Contracting HOV Facilities**. This section discusses the various bidding and contracting procedures that can be used with HOV facilities. Traditional approaches and innovative techniques are described. Case study examples of different procedures are presented.

- **Public Information, Outreach, and Marketing**. This section summarizes the marketing and public information activities that should be considered during the implementation phase of an HOV facility. The information presented highlights the key aspects of the marketing, advertising, and public information efforts discussed in more detail in Chapter 12.

- **Managing Traffic during Construction**. This section discusses the techniques that can be used to help manage traffic during the construction of an HOV facility. Case studies highlighting various strategies are presented.

- **Developing and Conducting Training for Operations and Enforcement Personnel**. Providing training for all personnel associated with operating and enforcing HOV facilities is an important part of the implementation process. The types of training needed for different personnel, the development of training materials, and the conduct of training sessions are discussed. Case study examples of training programs currently in use are provided. An outline of the elements to be considered in developing and teaching HOV operations and enforcement training sessions is included.

- **Pre-Operational Testing**. Ensuring that all components of the HOV facility are working properly before opening it to public use is also a critical element of the implementation process. Elements covered in this section include approaches for pre-testing variable message signs, automated or manual procedures for opening and closing HOV lanes, enforcement and incident response procedures, and other supporting facilities and services. Examples of the pre-operational testing strategies used in different areas are presented, and a checklist of elements to consider in this phase is provided for use by practitioners.

- **Special Considerations**. This section discusses other factors that should be considered in the implementation of special projects or facilities. These include general purpose lane conversion projects, priority pricing projects, and other less common HOV facilities. Items that may need to be considered with these types of projects are identified.

- **Monitoring and Evaluating the Implementation Process**. This section outlines the steps to consider in monitoring and evaluating the implementation process. These include documenting the specific activities conducted, the results of these actions, any problems or issues encountered, and other elements. The results of the evaluation can be used to address specific concerns related to the HOV facility and to modify implementation plans on future projects.

- **Additional Research Needs**. The chapter concludes with a discussion of further research needs related to the implementation of HOV facilities.

II. IMPLEMENTATION PLANNING

Implementing an HOV facility involves numerous activities, as well as a variety of agencies and groups. Taking a comprehensive and systematic approach to the implementation process will help ensure that the HOV facility is constructed, tested, and opened to the public in a safe and efficient manner. This section discusses the agencies and groups that should be involved in the implementation process and presents guidelines for developing and carrying out an implementation plan.

A. Groups Involved in Implementing HOV Facilities

Similar to the planning and designing phases of an HOV facility, numerous agencies and groups will be involved in implementing an HOV project. The participation of the appropriate agencies and individuals is key to ensuring that all groups have a common understanding of the implementation process and the operation of the facility, that all elements of the project are implemented in a coordinated manner, and that potential issues are addressed before they become major problems.

One approach used in many areas is to continue the multi-agency team formed during the planning and designing phases of a project through the implementation process. A special subgroup or committee, comprised of the operating personnel from the various agencies, may be formed to ensure that the individuals responsible for operating and enforcing the facility are involved in planning and carrying out the implementation plan. In addition, consideration should be given to other groups that may need to be involved or consulted during the implementation process. These may include members of the judicial system responsible for enforcing fines or penalties, special-user groups such as airport limousine or taxi operators, and local policy makers. In addition, the selected contractor or contractors may be asked to participate to help ensure that construction activities are coordinated with other elements of the project.

Table 11-1 identifies the various agencies and groups that should be considered for inclusion on an implementation team or consulted during the development of an implementation plan. The roles and responsibilities of each group are highlighted in the table and described in more detailed below. Practitioners can use the information in Table 11-1 as a guide to help ensure that consideration has been given to including the various groups in the implementation process. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

State Department of Transportation. The state department of transportation or the state highway department is usually the lead agency on HOV facilities on freeways. As a result, these agencies have overall responsibility for the project, including coordinating the implementation process. In many areas, state departments of transportation have been responsible for organizing, staffing, and chairing the multi-agency project management team associated with an HOV project. Consideration should be given to including representatives from a variety of departments including the planning, design, marketing or public information, construction, legal, operation, traffic management, and highway assistance.

Transit Agencies. Transit agencies often have the lead responsibilities with HOV facilities on separate rights-of-way. In other cases, the transit system may be a co-sponsor or a supporting agency. Depending upon the exact role, the transit agency may have overall or support responsibilities for project coordination, as well as the bidding and contracting process, training operating personnel, pre-operational testing, public information and marketing, and enforcement. If the transit agency is playing more of a supporting role, key responsibilities may focus on the bus operational aspects of the implementation process and overall project coordination.

Table 11-1. Agencies and Groups Involved in Implementing HOV Facilities

Agency or Group	Potential Roles and Responsibility
State Department of Transportation	• Overall project management • Bid preparation, bid letting, and contracting • Project phasing • Managing traffic during construction • Training operating personnel • Pre-operational testing • Public information, marketing, public relations
Transit Agency	• Overall project management • Bid preparation, bid letting, and contracting • Project phasing • Training bus operating personnel and field staff • Training bus support staff • Training transit police • Pre-operational testing • Public information, marketing, public relations
State Police	• Training enforcement personnel • Pre-operational testing of enforcement equipment • Coordination with judicial personnel
Local Police	• Training of enforcement personnel • Pre-operational testing of enforcement equipment • Coordination with judicial personnel
Judicial System—State and Local Courts	• Enforcement of fines and penalties for violation of vehicle occupancy requirements or other operating regulations
EMS, Fire, and Other Emergency Personnel	• Training personnel on response to incidents, accidents, special situations, and major emergencies • Pre-operational testing of emergency equipment and procedures
Tow Truck Operators	• Training personnel on procedures for providing assistance with disabled vehicles • Pre-operational testing of removing disabled vehicles
Local Municipalities	• Overall project management (especially with arterial street and traffic signal applications) • Bid preparation, bid letting, and contracting • Project phasing • Managing traffic during construction • Training operating personnel • Pre-operational testing • Coordination with other city departments and other agencies • Public information, marketing, public relations

Table 11-1. Agencies and Groups Involved in Implementing HOV Facilities, continued

Agency or Group	Potential Roles and Responsibility
Rideshare Agency	• Rideshare promotional activities • Public information, marketing, public relations
Metropolitan Planning Organization (MPO)	• Assist in facilitating meetings and multiagency coordination • Ensure that projects are included in necessary planning and programming documents
Transportation Management Organizations, Transportation Management Associations, Downtown Councils	• Employer support activities • Promotion of bus use and ridesharing • Specialized information and marketing
Special-User Groups—Taxi, Airport Limousine, School Buses	• Training of operating personnel
Federal Agencies—FHWA and FTA	• Funding support • Overall approval of various steps
Elected and Appointed Officials	• Approve necessary contracts and actions. • Participate in openings and meetings.
Commuters and Public Groups	• Provide input to implementation process.
Contractor	• Construction activities and schedules • Assisting with traffic management during construction • Assisting with project phasing

State and Local Police. The involvement of enforcement personnel throughout all aspects of planning, designing, constructing, implementing, and operating HOV facilities was stressed earlier in this Manual. Experience indicates that including state, local, and transit police, and other enforcement personnel in the implementation process is critical to the success of an HOV project. Ensuring that visible enforcement is provided from the start on an HOV facility helps establish a positive public perception and dissuade potential violators. Enforcement personnel should be involved in all aspects of the implementation process. They should take the lead in testing enforcement and incident management equipment and procedures, training field and office staff, coordinating with the state and local judicial systems, and other related activities.

Judicial System. Ensuring that fines and citations issued by enforcement personnel are handled appropriately in the local or state court system is an important aspect of the implementation process. Motorists may be more prone to violate the vehicle-occupancy requirements or other regulations associated with HOV facilities if they feel that the fines and penalties will be dismissed by the judicial system. Special information outreach activities with judges and other legal personnel should be considered during the implementation process. Techniques to consider include meetings and information brochures to explain the project and to stress the importance of judicial support for fines and penalties.

Emergency Medical Services (EMS), Fire Departments, and Other Emergency Personnel. These groups may be responsible for responding to incidents and accidents on the HOV facility and roadways in the corridor. Ensuring that representatives from these organizations are involved in the training, pre-operational testing, and other activities during the implementation process will help ensure timely and appropriate responses should accidents or other emergencies occur. The development of the implementation plan may be an appropriate time for these groups to review and revise local incident management plans, including hazardous material cleanup activities.

Tow Truck Operators. Tow truck operators and other wrecking services which will be responsible for removing disabled vehicles from the HOV facility should be involved in the implementation process. Representatives from these businesses or groups should be included in the training and pre-operational testing phases. Since these services may also be needed during construction of the facility, keeping these groups involved and informed throughout the implementation process should be considered.

Local Municipalities. City or County departments may have the lead responsibility on arterial street HOV applications and often have important supporting roles on HOV facilities on freeways and in separate rights-of-way. As the lead agency, a city or county may be responsible for overall project coordination, the bidding and contracting process, project phasing, managing traffic during construction, training, pre-operational testing, and public information and marketing programs. On projects headed by the state or transit agency, local jurisdictions are likely to play a supporting role in these activities.

Metropolitan Planning Organization (MPO). As discussed in Chapter 4, representatives from the MPO are usually members of the multiagency planning group associated with HOV facilities and may head the coordinating committees on Major Investment Studies. Although the role of the MPO is less during the implementation process, representatives from the MPO should still be included in the multiagency team. Staff from the MPO may help facilitate meetings or implementation strategies, assist with multiagency coordination, and disseminate information on construction and operational updates and revisions.

Rideshare Agency. In many metropolitan areas, the transit agency operates not only the bus service but also provides ridematching services, vanpool programs, and other ridesharing services. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, the rideshare agency should be included as a member of the project management team. The rideshare agency may play a major role in marketing and public information, ridematching promotions, and other activities.

Transportation Management Organizations (TMOs), Transportation Management Associations (TMAs), Downtown Councils, and Other Groups. These types of organizations, which are usually composed of major employers in a specific area, can help promote the use of the HOV facility among their employees. Involving representatives from these groups at appropriate points in the implementation process should be considered to build support for the facility among employers and employees and to help generate new bus riders, carpoolers, and vanpoolers.

Special-User Groups. Consideration should be given to involving public and private operators that may use the HOV facility in different phases of the implementation process. These may include taxi companies, private bus systems, school bus operators, airport shuttle and limousine services, and other special-user groups. Including representatives from these groups in training sessions and information meetings can help ensure the safe and proper use of the facility.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least to monitor the various activities conducted throughout the implementation process. Personnel from these agencies can often provide technical assistance on specific issues or suggestions on how certain issues have been addressed in other areas.

Elected and Appointed Officials. Elected and appointed officials may be involved in a number of different activities during the implementation of an HOV facility. First, various elements included in the implementation phase may come before these individuals for approval or other action. For example, requests for proposals, contract awards, and other actions usually have to be approved by the appropriate governing body such as the transit agency board, the state department of transportation commission, or a city council. Further, these groups frequently participate in groundbreaking ceremonies, ribbon cuttings, or other opening functions. They may also help facilitate meetings with various groups during the implementation of a project. Maintaining strong working relationships with elected and appointed officials throughout the implementation process can help contribute to the success of a project.

Commuters and Public Groups. Commuter, travelers, special interest groups, and the public should also be involved in the implementation process. The participation of these groups in planning, designing, and operating HOV facilities has been discussed in previous chapters. These groups should continue to be provided with opportunities to participate in and to provide comments on the implementation process.

Contractor. The contractor or contractors selected to construct the HOV facility should be involved in the implementation process. Ensuring that there is ongoing communication and coordination among all groups is critical to a successful implementation process. The contractor will play a critical role in project phasing, managing construction activities, and pre-operational testing.

B. Developing an Implementation Plan

The appropriate groups identified in the previous section should be involved in the development of an implementation plan for the HOV facility. The agencies and groups included in the implementation process will vary by the historic institutional arrangements in the metropolitan area. The extent of the planning and implementation process will relate to the regional experience with HOV facilities, as well as the type and scope of the project.

For example, the first major HOV facility in all areas will require a more detailed plan than a short HOV segment in an area with numerous existing facilities. A different approach may also be taken if an HOV system is being implemented. The nature, scope, and complexity of the implementation process will also be influenced by the type of HOV facility being constructed and the area. As discussed in this section, the same general approach can be used to develop an implementation plan for an HOV project for any type of HOV facility.

Figure 11-1 outlines the major steps that should be included in the development of an implementation plan for an HOV project. The extent of activities will vary from project to project, and some steps may be modified or deleted depending on the nature of the project and the characteristics of the area. Following these general steps will help ensure a carefully thought out implementation process, however. Each of the elements in the development of an implementation plan are briefly described in this section.

Identify Appropriate Agencies and Groups. The first step in developing an implementation plan is to identify all of the key agencies and groups that should be involved in the process. The information provided in Table 11-1 and discussed in the previous section can be used to identify the groups that should be included in the implementation process on a specific HOV project. As part of this step, the lead agency may also want to outline responsibilities of each organization during the implementation and operation phases of the project.

Identify Appropriate Agencies and Groups

↓

Organize Multiagency Implementation Team and Review Goals and Objectives

↓

Identify Key Stakeholders

↓

Develop Overall Approach and Schedule

↓

Construction and Project Phasing

↓

Public Information, Outreach, and Marketing

↓

Bidding and Contracting

↓

Managing Traffic During Construction

↓

Training Operating Personnel

↓

Pre-Operational Testing

↓

Special Consideration

↓

Monitoring and Evaluating the Implementation Process

Figure 11-1. Steps in Developing an Implementation Plan for an HOV Project

Identify Key Stakeholders. As discussed in the Marketing Chapter, an important element of the planning and implementation processes is the identification of key stakeholders. These may include local elected officials, state and federal legislators, neighborhood organizations, businesses in the corridor, and other groups. Once these groups have been identified, future steps can focus on identifying the appropriate methods for communicating with each and developing targeting information programs.

Develop Overall Approach and Schedule. This step should outline the general approach and schedule for implementing the project. The specific elements to be addressed in the implementation process should be identified, along with the anticipated schedule to accomplish each activity. The various elements that should be considered include project phasing, bidding and contracting, public education and outreach activities, managing traffic during construction, training, pre-operational testing, and other special features.

Construction and Project Phasing. The anticipated schedule for construction of the HOV facility should be outlined in this step. Consideration should be given to phasing the various elements of the project to ensure that logical and operable segments are open to the public and that needed support facilities and services come on-line at the same time.

Public Information, Outreach, and Marketing. As noted in Chapter 12, public information and marketing activities are important aspects of the implementation process. The activities identified during the marketing research and included in the development of the advertising and public information program should be incorporated into the implementation plan. Specific elements may include community and business outreach efforts, such as newsletters, television, newspaper, and radio advertisements, media coverage, direct mailings to residents, and other efforts. The implementation plan should identify the timing for each element and how these efforts will be coordinated with the construction activities to ensure a comprehensive approach to all aspects of the project.

Bidding and Contracting. The exact approach to be used in bidding and contracting for the HOV facility should be outlined and an anticipated schedule, which considers the time needed for each step, should be developed. The bidding and contracting process is usually governed by the requirements of the lead agency. Identifying the required steps will help ensure that the bidding and contracting process follows the proper procedures and avoids any legal challenges.

Managing Traffic During Construction. Depending on the type of HOV facility and the specific location, there may be a need to manage traffic during construction of the project. The implementation planning process should examine traffic flow during construction and specific strategies should be developed for managing traffic during each phase of construction. Consideration may be given to converting a general-purpose lane or providing an interim HOV lane during construction to help manage traffic.

Training Operating Personnel. Consideration should be given during the development of the implementation plan to the specific training needs of the personnel responsible for operating and enforcing the various aspects of the HOV facility. Developing and conducting specific training programs should be part of the implementation process.

Pre-Operational Testing. The specific features of the HOV facility that will need to be tested should be identified in the implementation plan, and a schedule should be established for each activity. The extent of the pre-operating tests and the specific features to be included will vary by the type of HOV facility. Components that may need to be tested include manual and electronic signs, manual and electronic gates and barriers, monitoring and surveillance systems, enforcement equipment and procedures, bus operations, emergency response equipment and procedures, and other features.

Special Considerations. The implementation plan should also address any unique features of the HOV facility that may require special consideration. These should be identified and the approaches to be used to address them should be outlined.

Monitoring and Evaluating the Implementation Process. The implementation process should be monitored and evaluated. This step can provide important benefits for the specific project, as well as future facilities. The monitoring process should document the specific activities conducted, the results of these actions, any problems or issues encountered, and other elements. The results of the evaluation can be used to address specific issues on the project, as well as to modify or update implementation plans on future projects.

III. PROJECT PHASING

Opening HOV lane segments and other project components in logical and operable sequences is important to the overall success of a project. For example, opening segments of HOV lanes that are not long enough to provide significant travel time savings or that require HOVs to merge back into congested areas, may have low levels of public support and use. A variety of techniques and approaches may be used to phase the construction and implementation of HOV facilities. As highlighted in this section, these include sequencing operable segments, coordinating support facilities, phasing support services, and work elements within the construction contract.

Sequencing Operable Segments. This approach focuses on phasing the construction activities to ensure that operable segments are opened to the public. In order to accomplish this objective, the implementation planning process should consider the major areas of traffic congestion and bottlenecks. Construction activities can then be phased to complete those segments first that will provide the greatest travel time benefits to HOVs, and to avoid opening sections that will create problems for both HOVs and for traffic in the general-purpose lanes.

Coordinating Support Facilities. The timing of construction of supporting facilities, such as park-and-ride lots and direct connections to the HOV lane, should also be considered in determining the project phasing. For example, ensuring that a park-and-ride facility is opened at the same time as an HOV lane will help ensure that buses, vanpools, and carpools have staging areas and that parking spaces are available for private automobiles.

Phase Support Services. Consideration should also be given to coordinating the introduction of new bus services, rideshare programs, and other services with the opening of appropriate HOV lane segments and support facilities. Opening a park-and-ride lot without needed bus service will lessen the chances for a successful facility.

Work Elements within the Construction Contract. The project phasing process should also consider the work items within the construction contract that must be completed before a facility can be open to the public. Signing, pavement markings, and other elements should all be considered. The phasing process and the contract language must reflect the time needed for these functions, as well as the proper sequencing.

IV. BIDDING AND CONTRACTING HOV FACILITIES

A. The Bidding Process

The implementation of an HOV facility usually follows the bidding and contracting requirements and procedures of the agency which has the overall responsibility for the project. In most cases, the lead agency on HOV projects on freeways or in separate rights-of-way is the state department of transportation or the transit agency. In the case of arterial street HOV applications, the city, county, or transit agency is usually responsible for the improvement.

Although the exact approach may vary by agency, the steps in the traditional bidding process are similar. The major steps in the normal bidding processes are illustrated in Figure 11-2 and summarized next.

Preparation of Bid Document

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Issue Bid Document and Request for Bids

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Pre-Bid Meeting

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Bid Opening

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Agency Review

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Bidder Selection

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Contract Execution and Pre-Construction Conference

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Notice to Proceed

Figure 11-2. Steps in Traditional Bidding and Contracting Process

Prepare Bid Document. In this step, agency staff develops the bid plans and specifications which comprise the bid document. The bid specifications contain the scope of the project, the anticipated schedule, the project limits, contract and construction specifications, and the design plans. The services requested of the contractor, the requirements of bid process, and any special terms and conditions associated with the project are also identified. Most agencies have specific requirements, formats, and standards for bid documents that will need to be followed in implementing an HOV project.

Issue Bid Document and Request for Bids. Once the bid document has been completed, and approved by the governing policy board if necessary, it is issued to prospective contractors. Most agencies have requirements and policies governing this process. These requirements may include how long the bid must be advertised and where it must be advertised, as well as procedures governing contacts between perspective bidders and agency staff members.

Pre-Bid Meeting and Response Period. The responsible agency often holds a pre-bid meeting soon after the bid document has been issued. The purpose of this meeting is to review the scope of the project and to provide perspective contractors with the opportunity to ask questions about the bid document. The lead agency may provide responses to all questions asked at the pre-bid meeting in writing. In addition, the agency may allow a time period for firms to submit written questions concerning the bid document, with the questions and answers provided to all prospective bidders. To help ensure equal competition among all proposers, the pre-bid meeting and the written questions are usually the only contact allowed with agency staff on the project.

Bid Opening. The bid document will include the time, date, and location for the submission of the bid proposal. To be considered, all proposals must be received by the required time. The actual bid opening may take place at that time or at a later date. At the opening, each proposing group is identified along with the bid price.

Agency Review. Once the bids have been opened and recorded, a period of time is provided for staff review of the documents to ensure that all the terms and conditions of the specifications have been met. A variety of groups are usually involved in the review process. These may include the legal, contract, design, and construction departments. Staff from other agencies may also assist with the review process or a multi-agency review team may be used.

Bidder Selection. This step involves the selection of the contractor and the authorization of the contract. The nature of the bid award may vary by project, by agency requirement, and by legislation. For example, many agencies are required by law to award the contract to the lowest cost qualifying bid. In other cases, agencies may have more flexibility in the selection process. The policy board of the agency is usually required to approve the selected contractor and to authorize staff to initiate the contracting process or to enter into a contract.

Contract Execution and Pre-Construction Conference. Once selection of the contractor has been approved by the policy board or administrative staff, staff can execute the actual contract. A pre-construction conference is usually held to discuss the contract management process, the procedures for resolving issues, and methods for ongoing coordination.

Notice to Proceed. Once the contract has been executed, a notice to proceed is issued by the responsible agency. This notice authorizes the selected contractor to begin work on the project.

The exact steps in the bid processes and the length of time needed for each element will vary by project and by agency. The preparation of the bid documents may take a year or more and the schedule to complete a typical bid process is generally from six to eight months. The exact timing will depend on the specific requirements of the lead agency and the nature of the project. The potential exists for delay in the award process if disputes arise from non-selected groups.

B. Contracting Approaches

The traditional approach to contracting for freeway, roadway, and HOV facility construction in many areas has been to negotiate a fixed-cost agreement with the lowest qualified bidder. Variations on the traditional bidding and contracting process may also be used to provide greater flexibility or to reduce costs. One example is a two-step process. In this approach, firms are pre-qualified in a first step. The qualified contractors are then invited to submit cost bids. As highlighted next, other examples of alternative approaches include design/build techniques, incentive contracting, turnkey contracting, public/private partnerships, and cost plus time bidding. Regardless of the approach used, regular progress review meetings should be held between the contracting agency and the contractor to ensure that the final product conforms to the design criteria, bid specifications, and guidelines of the contracting agency.

Design/Build. In this approach, the contracting agency develops and issues design guidelines to pre-qualified firms who are invited to submit proposals for final design and construction. The requested proposal may be for a fixed lump sum for the whole project or it may be for segments of the facility. This approach may shorten the implementation period by allowing some construction activities to start prior to completion of the entire design package. An advantage to the contracting agency is that the costs of the entire project are determined at an earlier stage than with traditional contracting techniques.

Incentive Contracting. Incentive contracts provide financial inducements for the contractor to complete the project ahead of schedule. The financial incentives may be on a daily basis or on some other schedule. In addition, financial penalties for late completion of various project elements may be imposed by the contracting agency.

Turnkey Contracting. This approach involves soliciting proposals for a specific project and then entering into a contract for the completed facility. Turnkey contracting was used by Houston METRO to develop some of the park-and-ride lots associated with the HOV lanes. METRO solicited proposals for the improved real estate and entered into earnest money contracts with the selected contractors. Upon completion of the facility, METRO purchased the lots using local funds. METRO estimated that this approach saved the agency both time and money.

Public/Private Partnerships. Another technique involves the innovative use of public/private partnerships by issuing requests for private firms or for public/private consortiums to propose and develop specific transportation projects. California, Washington, and Minnesota are all experimenting with various approaches. The 91 Express Lanes in Orange County, California represent a completed project that was developed using innovative public/private partnerships. In this case, a private company financed, constructed, and is operating a four lane express facility in the center median of State Route 91. This approach involves a private consortium assuming many of the roles and responsibilities which are traditionally handled by public agencies.

Cost Plus Time Bidding. Cost plus time bidding, which is sometimes referred to as A+B bidding, represents still another approach that may be considered. In this technique, the maximum time allowed for the construction of a project and the daily rate to be charged for the B portion is identified. The contract is awarded to the contractor with the lowest combined bid for both the project construction, which equals the A portion of the bid, and the daily rate multiplied by the contractor's completion time or the B portion of the bid. Experience with this approach indicates that it does not increase the overall cost of a project and that contractors complete projects early to achieve the maximum incentive.

V. PUBLIC INFORMATION, OUTREACH, AND MARKETING

Providing information on how to use the HOV facility and encouraging commuters to form carpools and vanpools or to take the bus is a critical part of the implementation process. As described in Chapter 12, the marketing and public information plan developed earlier should be implemented during this time. Activities that may be part of this effort include community outreach programs, newsletters, media advertisements, ribbon cutting or opening ceremonies, and special events. Table 11-2 provides a summary of the types of marketing and public information activities that may be used to build public awareness, support, and use of the HOV facility during the implementation phase. More detailed information on each of these techniques is provided in Chapter 12.

The advertising and marketing program for introducing a new HOV facility should be initiated approximately two to three months before the facility is opened to the public. A more concentrated effort should be undertaken in the weeks just prior to the opening. Significant advertising and promotional activities should also be continued through the first months of operation and on an ongoing basis. The marketing program should provide information on how to use the HOV facility, the benefits, and how to use rideshare and transit services. Chapter 12 provides a more detailed discussion of the duration and content of the different marketing phases.

Table 11-2. Examples of Marketing and Public Information Activities During Implementation of an HOV Facility

Marketing and Advertising	Content and Potential Use	Case Study Examples
Informational Brochures and Flyers	• Information and map about the project and how to use the facility, rideshare and transit information, telephone numbers.	• I-394, Minneapolis. • Houston HOV lanes. • Southeast Expressway, Boston. • San Francisco HOV lanes. • Route 44 and I-64, Norfolk. • Barnet-Hastings Express lanes, Vancouver.
Newsletters	• Use as handout at meetings and as part of direct mail. • Continuous information on construction activities and other project elements.	• I-394, Minneapolis. • I-5 South, Seattle.
Posters	• General information and map, how to use facility, transit and rideshare information and telephone numbers.	• Orange County HOV lanes. • I-5 South, Seattle. • Barnet-Hastings Express lanes, Vancouver.
Newspaper Advertisements	• Targeted information on use of the facility, ridesharing and transit.	• Houston HOV lanes. • I-394 Minneapolis. • Southeast Expressway, Boston. • I-65, Nashville. • Barnet-Hastings Express lanes, Vancouver. • Route 44 and I-64, Norfolk.
Radio Advertisements	• Short messages on projects, use, and where to get more information.	• I-394, Minneapolis. • Route 44 and I-64, Norfolk. • Long Island Expressway, New York.
Television Advertisements	• Short messages on projects, use, and where to get more information.	• I-495, New York.
Videos	• More detailed information on the project. • Use with Community Outreach slogans and short messages on project.	• Route 44 and I-64, Norfolk. • Houston HOV lanes. • I-495, New York.
World Wide Web Home Pages and Other Electronic Communication Techniques	• Information project schedules, how to use the facility, ridematching services, and bus schedules.	• Houston METRO. • King County, Seattle.

Table 11-2. Examples of Marketing and Public Information Activities During Implementation of an HOV Facility, continued

Marketing and Advertising	Content and Potential Use	Case Study Examples
Billboards and Roadside Signs	• Slogans and short messages.	• Dulles Toll Road, Northern Virginia. • I-394, Minneapolis. • Route 44 and I-64, Norfolk.
Bus Signs/Wrapped Buses	• Slogans and short messages.	• Bus signs—I-394, Minneapolis; Barnet-Hastings Express lanes, Vancouver; and I-5 South, Seattle. • Wrapped buses—Southeast Expressway, Boston.
Direct Mail	• Targeted information to commuters in corridor.	• I-394, Minneapolis. • Barnet-Hastings Express lanes, Vancouver.
Community Outreach	• Information brochures, flyers, posters, newsletters, videos, and speaker's bureau.	• Southeast Expressway, Boston. • I-394, Minneapolis.
Opening Ceremony	• Ribbon cutting or other ceremony to officially open the lane.	• I-35E, Dallas. • I-394, Minneapolis. • Southeast Expressway, Boston. • Houston HOV lanes. • East R. L. Thornton, Dallas.
Special Events	• Time trials of vehicles in general purpose lanes and HOV lanes. • Runs or walks on the HOV lanes.	• I-394, Minneapolis. • Southeast Expressway, Boston.
Other Techniques	• Changeable message signs. • Telephone hotline. • Cups/mugs. • Litter bags. • Pins. • Pens. • Post-it notes.	• I-394, Minneapolis. • I-5 South, Seattle. • Route 44 and I-64, Norfolk. • I-65, Nashville. • I-495, New York.

VI. MANAGING TRAFFIC DURING CONSTRUCTION

Another important consideration in the implementation process is minimizing disruption and mitigating negative effects on traffic on the freeway, roadway, and in the corridor. A number of approaches can be used to help manage traffic during construction. As summarized next, strategies that can be considered include interim HOV lanes, alternative routes, temporary facilities, special transit services, coordination with other construction activities, and nighttime and weekend construction.

Interim HOV Lanes. Temporary or interim HOV lanes can be used to both help manage traffic during construction and to introduce the HOV concept to commuters. By providing travel time savings to buses, vanpools, and carpools, an interim HOV lane can encourage commuters to use these modes to help alleviate possible traffic congestion during construction. This approach also provides a way to introduce the HOV concept to commuters in the corridor and to promote the desired mode change early in the development process. The interim HOV lane on the I-394 project in Minneapolis, called the "Sane Lane," provides one of the better examples of this approach. Interim facilities have also been used to help manage traffic during construction or reconstruction of HOV lanes in Washington D.C./Norther Virginia, Houston, Seattle, and Los Angeles/Orange County.

Alternative Routes. Another approach that can be used to help manage traffic during construction of an HOV facility is the use of alternative routes. Techniques that could be used include signing specific alternate routes or detours, or simply providing information on various alternative roadways. These alternatives may be open to all traffic or may provide preferential treatments to HOVs. Other enhancements may also be made to these routes to improve traffic flow during construction. For example, the phasing or timing of traffic signals on an alternative route may be adjusted to provide more green time to the diverted traffic.

Temporary Facilities. Temporary roadways, bridges, or other facilities may be constructed to assist with traffic management during construction. The cost of these facilities may limit the use of this approach, but it may be an appropriate alternative for a major construction project.

Special Transit Services. Another approach that may be appropriate for consideration in some situations is adding transit services in the corridor to encourage individuals to change from driving alone to taking the bus during construction. This technique would be most effective when used in conjunction with an interim HOV facility. Enhancing transit services by adding new routes and more buses to existing routes has been used in Minneapolis-St. Paul, Los Angeles/Orange County, and Houston.

Coordination with Other Construction Activities. It is critical that the construction of an HOV facility be coordinated with other roadway improvements. For example, projects should be phased to ensure that alternative routes are not under construction or reconstruction at the same time as the HOV facility. The Washington State Department of Transportation's Construction Coordination Office in Seattle provides an example of an approach being used by one agency to help coordination construction activities.

Nighttime and Weekend Construction. It my also be appropriate to consider scheduling construction for nighttime, weekends, or other non-peak travel periods. There may be cost and safety impacts associated with construction activities during these times, however, which will need to be considered before these approaches are used. Further, congestion may occur during these time periods due to normal non-work travel, special events, and other activities. All of these factors, as well as the impact on neighborhoods in the area, should be considered in the construction schedule.

VII. DEVELOPING AND CONDUCTING TRAINING FOR OPERATIONS AND ENFORCEMENT PERSONNEL

Providing training for all personnel associated with operating and enforcing an HOV facility is important to the safe and efficient operations of the project. The nature and extent of training will vary by the type of HOV facility, as well as the supporting components. Although the most extensive training will be needed for barrier-separated reversible and contraflow HOV facility, training of operating and enforcement personnel should be conducted in the implementation phase of all projects. Ongoing training and retraining of personnel should also be considered. This section provides an overview of the elements to be considered in the development of training programs, types of training that should be considered for operating and enforcement personnel, and techniques that can be used in actual training courses and on-street sessions. Consideration should be given to training individuals from different agencies together to enhance the coordination and cooperation needed to operate many HOV facilities.

Figure 11-3 presents a series of guidelines for developing and conducting training programs for a new or an existing HOV facility. The five steps include identifying the responsibilities of specific personnel and the training needed to carry out these responsibilities correctly, developing training courses and class materials, conducting classroom and field training, evaluating training efforts and monitoring changes in operations, and updating training courses and retraining personnel.

Identifying Responsibilities of Personnel and Training Needs. The first step in developing a comprehensive training program for an HOV facility is to identify the responsibilities of the various agencies and their personnel. The specific training needs associated with each responsibility can then be outlined. Table 11-3 identifies both the operating and enforcement personnel and the topics that should be considered for inclusion in a training program for a new or an existing HOV facility. Although the specific personnel in need of training and the topics to be addressed will vary by project, the listing provided in Table 11-3 and the information presented next can be used in the development of appropriate training courses and approaches.

Table 11-4 provides an example of a more detailed outline that can be prepared for an individual HOV project to identify the specific responsibilities and training needs of personnel from different groups. The example shown focuses on one responsibility of the state department of transportation.

Identify Responsibilities of Personnel and Training Needs

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Develop Training Courses, Materials, and Manuals

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Conduct Classroom and Field Training

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Evaluate Training and Monitor Changes in Operations and Responsibilities

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Update Training Courses and Retraining Personnel

Figure 11-3. Guidelines for Developing and Conducting a Training Program for an HOV Facility

Table 11-3. Operations and Enforcement Personnel Training Needs

Personnel	Training Needs
State Department of Transportation Operations Staff	• Procedures for opening and closing lanes and access points. • General operations, including operating hours, vehicle-occupancy requirements. • Enforcement techniques and provisions. • Incident and accident response procedures. • Emergency response procedures. • Snow removal and other special needs. • Measuring performance. • Reporting and presenting performance results to the public, decision makers, and media.
Transit Agency Operations Staff	• General operations, including operating hours and vehicle-occupancy requirements. • Procedures for opening and closing lanes and access points. • Operating buses on the lanes and support facilities. • Enforcement techniques and provisions. • Incident and accident response procedures. • Emergency response procedures. • Snow removal and other special needs. • Measuring performance. • Reporting and presenting performance results to the public, decision makers, and media.

Table 11-3. Operations and Enforcement Personnel Training Needs, continued

Personnel	Training Needs
State, Local, and Transit Police	• General operations, including operating hours, vehicle-occupancy requirements, procedures for opening and closing the facility. • Enforcement procedures and equipment. • Incident and accident response procedures and equipment. • Emergency response procedures.
EMS, Fire, and Other Emergency Services	• General operations. • Incident and accident response procedures. • Emergency response procedures.
Tow Truck Operators	• General operations. • Incident and accident response procedures. • Emergency response procedures.
Local Municipalities	• General operations. • Specific operating responsibilities on arterial street projects. • Incident and accident response procedure. • Snow removal and other special needs.
Special User Groups—Taxis, Airport Limousines, School Buses	• General operations. • Operating vehicles on the facility. • Incident, accident, and emergency response procedures.

Table 11-4. Identification of Responsibilities and Training Needs–
Example of State Department of Transportation Field Operations Personnel

Agency	Specific Responsibility	Responsible Staff	Training Needs
State Department of Transportation	Opening and closing lane.	Field operations	• Procedures for opening and closing lane and access points. • Procedures for incidents, accidents, and emergencies.

State Department of Transportation Operations Staff. If the state department of transportation is the lead agency on an HOV project, it is also likely that the department staff will be responsible for operating the facility. As a result, department personnel will need training on all aspects of operating and enforcing the HOV facility. More extensive training will be needed with barrier-separated reversible HOV lanes and contraflow HOV lanes than with concurrent flow HOV lanes. Training for department personnel should cover all aspects of operations and enforcement, with special emphasis on procedures for opening and closing the facility, incident and emergency response procedures, special needs such as snow removal, measuring performance, and presenting the results.

Transit Agency Operations Staff. Responsibilities, and training needs, for transit agency personnel will be greater with busways and HOV lanes on separate rights-of-way, than with facilities on freeway rights-of-way and arterial streets. For example, a transit agency may have overall operating responsibility for busways. In this case, training for agency personnel should cover all aspects of operating and enforcing that facility. In other cases, training may focus on bus operations on the HOV lanes, and park-and-ride lots, transit centers, and other supporting facilities.

State, Local, and Transit Police. Training for these groups should focus primarily on enforcement procedures, techniques, and equipment, as well as incident and emergency response procedures. In addition, enforcement personnel should be provided with a comprehensive overview of the operations of the HOV facility.

Tow Truck Operators. Training for truck and wrecking service personnel should focus on procedures for handling disabled vehicles and for responding to accidents and incidents. Like other groups, these individuals should also be provided with a comprehensive overview of the operating requirements and operating procedures for the HOV facility.

Local Municipalities. City or county staff may have the lead responsibilities for operating arterial street HOV facilities. In these cases, training should focus on all aspects of the project. Although local personnel may have fewer responsibilities with HOV facilities on separate rights-of-way and on freeways, they should still be provided with a comprehensive overview of the operations of the project.

Special User Groups—Taxis, Airport Limousines, and School Buses. Training for these groups should focus on the operating requirements and specific use of the facility.

Develop Training Courses, Materials, and Manuals. Once the training needs of each agency and group have been identified, the next step is to develop the specific training courses, manuals, and supporting materials. Approaches that may be considered include classroom training, manuals, notebooks, handouts, slide presentations, videos, CD ROMs, actual field training, and other techniques. The exact approaches should be matched to the specific responsibilities and the complexity of the HOV facility. Information on changes in operations can be included in updated manuals and materials.

Conduct Classroom and Field Training. The various training programs developed in the previous step should be conducted in the months prior to the opening of a new HOV facility. Both classroom and field training should be provided as appropriate. Documentation should be maintained of the training received by each employee. Table 11-5 provides an example of a log that can be kept to monitor and document the training provided to operations and enforcement personnel. Agencies may also wish to consider providing staff with a certificate or other document signifying successful completion of the training program.

Table 11-5. Example of Log to Document Training for Operations and Enforcement Personnel

Employee Name	Training Course of Field Test	Date	Topics Covered	Date for Next Retraining or Refresher Course

Evaluate Training Program and Monitor Changes in Operations and Responsibilities. The training program should be evaluated after it is offered for the first time and on an ongoing basis. Feedback from operations and enforcement personnel can be used to modify and enhance the training activities. In addition, the operations of the facility should be monitored, and a procedure should be established so that any changes in operating requirements or agency responsibilities triggers an update in the training program and retraining of personnel.

Updating Training Courses and Retraining Personnel. The training program should be updated to reflect any changes in operating requirements or agency responsibilities. Retraining should be provided in these cases. In addition, training for new personnel should be provided on an ongoing basis and regular refresher courses should be offered to existing staff.

VIII. PRE-OPERATIONAL TESTING

All elements of the HOV facility should be thoroughly tested before the project is opened to the general public. This section summarizes the major components of an HOV facility that should be tested during the pre-implementation phase. These include electronic signing, manual or electronic gates at ingress and egress points, monitoring and surveillance systems, enforcement equipment and techniques, emergency response features, bus operations, and special maintenance needs such as snow plowing. A two-week period may be adequate for testing the features associated with a concurrent flow HOV lane, while up to a six- to eight-week period may be considered for testing all of the features associated with a contraflow or a barrier-separated reversible HOV facility. Table 11-6 provides an example of a pre-operational testing checklist that can be used to ensure that all system components are thoroughly tested prior to opening a facility to the public.

Electronic Signing. Changeable message signs and other electronic signing on the HOV facility and in the corridor should be tested. Activities may include sending messages under different conditions and at various times of the day, checking the visibility of the messages and signing from all critical points along the facility, and testing backup power sources in the case of an electrical disruption.

Manual or Electronic Gates at Ingress and Egress Points. The gates, barriers, or other methods used to allow access into and out of the HOV facility should be thoroughly tested prior to opening the project to the general public. The physical and electronic components of the system should be tested under different conditions to ensure that they will function properly. The procedures to be used by the operating personnel should also be reviewed and a number of trial runs should be made to ensure that both personnel and equipment function properly. These activities are especially important on reversible HOV facilities. Extra tests should be conducted on these facilities to minimize the possibility of wrong way vehicle movements.

Monitoring and Surveillance Systems. Any monitoring and surveillance systems associated with the HOV facility should be checked during the pre-operation testing phase. These may include advanced transportation management systems (ATMS) that cover the full freeway or roadway system or closed circuit television cameras (CCTC) that monitor specific HOV facilities, park-and-ride lots, or transit centers. Activities may include testing the electronic components under various conditions, tracking a vehicle through all parts of the facility to ensure that no blind spots exist, and examining the responsibilities of the operating personnel.

Table 11-6. HOV Facilities Pre-Operational Testing Checklist

System Component	Test Date	Test Result	Comments
Electronic Signing			
Access Point Gates or Barriers			
Monitoring and Surveillance Systems			
Enforcement			
Emergency Response Features and Procedures			
Bus Operations			
Snow Plowing			
Other Features			

Enforcement. The techniques and equipment for enforcing the vehicle occupancy requirements and other regulations associated with the HOV facility should be examined and tested during this phase. Activities to be undertaken may include trial runs by enforcement personnel on the facility and testing of enforcement areas and any automated enforcement equipment. In addition, meetings should be held with judicial and other legal personnel responsible for the payment of fines or citations. Ensuring that these groups will support the citation issues and the fines assessed for violating operating requirements of an HOV facility is important to the success of the project.

Emergency Response Features and Procedures. The emergency response plan developed during the operations planning phase of the project should be tested. Specific features, such as moveable barriers or gates, should be tested under different conditions to ensure proper functioning. It is also suggested that a number of emergency simulations be run with operating personnel. Allowing operating staff to respond to a variety of potential emergency situations during the pre-test phase will help ensure that the correct actions will be taken in the event of an actual emergency. These activities should be undertaken in conjunction with ongoing incident and emergency response efforts.

Bus Operations. Training should be provided for bus operators, transit support personnel, and other operating staff who will be using the HOV facility. These individuals should be provided with both classroom instruction and with actual training on the facility. Elements to be addressed include normal operating procedures, emergency response actions, and special features associated with a project.

Other Features. Individual HOV facilities may have other features that should be included in the pre-operational testing phase. Examples of elements to include in this step are traffic signal systems associated with arterial street HOV applications, additional real-time bus or traffic information, and other features unique to individual projects. All elements associated with the HOV facility should be identified during the development of the implementation plan and pre-tested prior to opening the project to the public.

IX. SPECIAL CONSIDERATIONS

Additional items may need to be considered in the implementation phase of less common types of HOV facilities. Examples of projects which may require special attention include converting a general purpose lane to an HOV lane, priority pricing techniques, some arterial street applications, and other facilities. Additional elements that may need to be addressed during the implementation of these types of HOV facilities are briefly summarized in this section. Since there is little actual experience with many of these projects, only limited case study examples are provided.

Converting a General-Purpose Lane to an HOV Lane. Special attention should be given to the public information, marketing, and policy maker outreach activities with these types of HOV facilities. The limited experience with general-purpose lane conversion projects has been mixed. Some projects, such as those in Seattle and New Jersey, have been implemented successfully. The experience with the Santa Monica Diamond Lane in Los Angeles and the Dulles Toll Road in Northern Virginia point out the need for extensive public and policy maker information activities, as well as marketing and promotional campaigns. These efforts should focus on explaining the purpose of the HOV lane conversion project, encouraging bus use and ridesharing, and generating public support. In addition, extra training may be needed for police, as well as operations staff, to ensure that the lane is enforced and operated safety and effectively.

Priority Pricing Techniques. Extra attention may need to be given to public and policy maker information activities with priority pricing projects. The techniques used with the Route 91 Express Lanes in Orange County and the I-15 HOV lanes in San Diego provide some ideas on the approaches that can be used with these types of projects. The exact factors that need to be considered will vary by project and geographical area. For example, the concerns associated with a project like the Route 91 Express Lanes, which added capacity in the corridor, may be different than the I-15 project, which implemented priority pricing on an existing HOV lane.

Issues that are often raised in the discussion of priority pricing include equity concerns, the use of the revenues generated from the project, and charging for a previously free trip. Information and outreach programs for the public and policy makers may need to be developed to address these potential issues. In addition, marketing and public information will be needed during the implementation process to communicate how commuters can use the facility, where they can purchase toll tags or transponders, and what the fines or penalties are for violating the requirements. The pre-operational testing phase will need to include checking all of the technology associated with the project. Training activities will also need to be specialized for operations and information personnel.

Arterial Street HOV Applications. Special consideration often needs to be given with some arterial street HOV applications. For example, projects that remove parking spaces in the curb lane may raise concerns among business owners in the corridor. Special informational meetings and other communication techniques can be used to help address and overcome concerns related to loss of on-street parking. Public outreach and information programs are also important with priority signal projects and other types of arterial street HOV lanes. Further, pre-operational testing and training programs should be tailored to the specific features of these facilities.

Other HOV Facilities. Special considerations may be required with other types of HOV facilities. For example, the movable barrier machines used with the contraflow HOV lanes in Dallas and Boston require additional training for operating and enforcement personnel, extensive pre-testing of the equipment, and targeting marketing efforts. The unique features of all projects should be considered in the development of the implementation plan to allow for the appropriate approaches to be developed and implemented.

X. MONITORING AND EVALUATING THE IMPLEMENTATION PROCESS

Monitoring and evaluating the implementation process can provide benefits to the specific project and to future HOV facilities. As highlighted in this section, the monitoring and evaluation plan should document the specific activities conducted as part of the implementation process, the results of these actions, any problems or issues encountered, and other items that may emerge during the implementation phase. This information can be used to address specific concerns with the project and to update implementation plans for future HOV facilities.

Document Specific Activities. All of the activities conducted during the implementation phase should be documented. These should include the project phasing process, the bidding and contracting process, the public information and marketing activities, efforts associated with managing traffic during construction, developing and conducting training for operations and enforcement personnel, and any special considerations. The approach used and the outcome of each activity should be recorded.

Identify Issues or Problems. Any problems or issues encountered with the various activities during the implementation process should be identified. The nature of these issues and the approaches used to address them should be documented.

Evaluate the Implementation Process and Plan. The implementation process and the original plan can be evaluated based on the information obtained from the previous two steps. Special attention should be given to any problems encountered during the implementation process, the techniques used to address these issues, and approaches to avoid these issues in the future.

The results of the monitoring and evaluation effort can be used to address any issues on the specific project. They can also be incorporated into implementation plans for future HOV facilities. Thus, monitoring and evaluating the implementation process will benefit both the individual project, as well as future facilities and the HOV system as a whole.

XI. ADDITIONAL RESEARCH NEEDS

The development of the HOV Systems Handbook identified a number of areas where additional research is needed related to the implementation of HOV facilities. As discussed in this section, these include exploring techniques to manage traffic during construction, to enhance agency coordination during implementation, and to coordinate the opening of meaningful HOV segments. In addition, further research on innovative contracting techniques and special considerations with implementing general-purpose lane conversion projects and priority pricing projects are needed.

Techniques to Manage Traffic During Construction. This research study would examine techniques to manage traffic during the construction of HOV facilities. The use of temporary HOV lanes to assist with the management of traffic during the reconstruction of existing freeways and roadways would also be addressed. Although examples of current approaches were highlighted in this chapter, further research is needed to explore other innovative techniques. The results of this research would document existing case studies and would present new approaches for use with future projects.

Techniques to Enhance Agency Coordination During Implementation. The implementation of an HOV lane and supporting facilities and services requires extensive coordination and cooperation among agencies. Although staff from these agencies will usually have established good working relationships during the planning and designing phases, different personnel are often responsible for the implementation process. Additional research is needed to identify techniques that can be used to foster and promote greater coordination among agency personnel during the implementation phase. This research should explore approaches to ensure that the opening of facilities and the initiation of services are accomplished in a coordinated manner.

Implementation Phasing. Related to the previous topic, additional information is also needed on approaches to phase construction and implementation of HOV facilities. Experience indicates the importance of opening operable segments that provide significant travel time savings for HOVs. This research project would examine the approaches currently being used, present case studies, and outline enhanced techniques for phasing the implementation of HOV lanes, as well as supporting facilities and services.

Innovative Contracting Techniques. As highlighted in this chapter, many agencies are exploring and using innovative contracting techniques on a wide range of projects, including HOV facilities. Additional research is needed on the use of various techniques, the costs and benefits associated with these approaches, and the identification of other innovative strategies. The results of this study should include case study examples, guidelines for the use of different approaches, the benefits that can be anticipated from various mechanisms, and legal and policy issues that may need to be addressed with their use. The results, which could be incorporated into this Manual, would provide an easy to use guide for practitioners interested in using innovative contracting methods with HOV facilities.

Implementing General-Purpose Lane Conversion Projects. The implementation of projects which convert an existing general-purpose freeway or arterial street lane to an HOV lane requires special attention. There is only limited experience with the use of this approach, and little information is available on strategies to enhance the implementation of lane conversion projects. This research study would explore the experience with existing projects in more detail and would identify specific techniques that could be considered in the implementation process. The results of this research project could be incorporated into this Manual.

Implementing Priority Pricing Projects. The implementation of priority pricing projects on HOV lanes or projects which allow HOVs to use a toll facility for free may require special attention. There is only limited experience with these approaches; as a result, little information is available on strategies to enhance the implementation of these techniques. This research study would explore the experience with existing projects in more detail and would identify additional techniques that could be considered to enhance the implementation process. The results of this research project could be incorporated into this Manual.

CHAPTER 12—PUBLIC INVOLVEMENT AND MARKETING PROGRAMS

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I. INTRODUCTION

This chapter discusses the use of public involvement, market research, and promotional and informational campaigns with HOV facilities. It provides a comprehensive summary of the various elements to be considered in developing, implementing, and evaluating public involvement and marketing programs with HOV facilities. Topics covered include public participation, market research, using in-house and consultant resources, marketing campaigns, funding marketing efforts, evaluating marketing programs, and other issues. Case study examples of successful and innovative public involvement techniques and marketing programs are highlighted. The chapter is divided into the following seven sections.

- **Overview of Public Involvement and Marketing Programs**. This section provides an overview of the major components of public involvement and marketing programs. The basic elements of a comprehensive public participation and marketing program—public involvement, education, and promotion—are discussed. The use of these components in the planning, designing, implementing, and operating phases of an HOV project are described.

- **Developing a Public Involvement and Marketing Program**. This section outlines the elements that should be considered in planning and developing a public involvement and marketing program for an HOV project. It includes a discussion of the groups that should be involved in developing the plan, the roles and responsibilities of these groups, and potential funding sources.

- **Implementing a Public Involvement Program.** This section presents approaches that can be used to implement public involvement programs with HOV facilities. These include focus groups, charrettes, public meetings, public hearings, visioning sessions, brainstorming efforts, transportation fairs, collaborative task forces, newsletters, videos, and other approaches. Case study examples of different approaches and techniques are presented.

- **Implementing a Marketing Program**. This section presents the elements that should be considered in implementing a marketing program with an HOV project. Marketing techniques that are appropriate for use with various types of HOV facilities are outlined. Marketing strategies included are media alternatives, media relations, advertising, community relations, initial marketing efforts, and ongoing programs. Case study examples are presented highlighting the use of different techniques with HOV projects.

- **Evaluating Public Involvement and Marketing Programs**. This section discusses monitoring and evaluating public involvement and marketing programs with HOV facilities. An overview of the evaluation process is presented first, followed by a more detailed discussion of the individual steps involved in conducting an ongoing monitoring program. Evaluations of HOV public involvement and marketing activities are highlighted.

- **Case Studies and Special Situations**. This section presents case study examples of public involvement and marketing programs for HOV facilities in separate rights-of-way, on freeways, and on arterial streets. Available information on case studies examining priority pricing on HOV lanes and converting general purpose lanes into HOV lanes is also discussed.

- **Additional Research Needs**. The chapter concludes with a discussion of areas where further research is needed related to public involvement and marketing programs associated with HOV facilities.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information related to public involvement and marketing programs associated with HOV facilities, public participation techniques, and market research and survey methodologies.

An extensive *HOV Marketing Manual* (1) was prepared and published in 1994 under the sponsorship of FHWA. This manual provides a comprehensive discussion of all aspects relating to marketing of HOV facilities. This chapter is not intended to replace the *HOV Marketing Manual*. Rather, the information in the chapter provides an overview of the key elements practitioners should consider in planning, implementing, conducting, and evaluating public involvement and marketing programs with HOV facilities. Readers are encouraged to consult the *HOV Marketing Manual*, as well as the additional resources listed at the end of the chapter, for more detailed information and guidance on public participation techniques and marketing strategies.

II. OVERVIEW OF PUBLIC INVOLVEMENT AND MARKETING PROGRAMS

Public involvement and marketing programs are critical components of most successful HOV projects. Public involvement and marketing programs can help ensure that HOV facilities are developed with input from commuters, businesses, neighborhood organizations, and other interested groups. Further, these programs can enhance the understanding of the project by the public and policy-makers. Finally, and perhaps most importantly, these programs can help ensure that the facility is used by commuters and travelers. This section provides a general introduction to the basic elements usually contained in public involvement and marketing programs.

A. Defining Public Involvement and Marketing Programs

Public involvement is sometimes thought of as only public hearings or public meetings and marketing is often perceived to be nothing more than advertising a product or service. A comprehensive public involvement and marketing program is much more than just hearings, meetings, and advertising, however. As illustrated in Figure 12-1, a comprehensive program is based on a strong foundation of public involvement. An educational component is provided next. Only after these two elements have been accomplished, are the promotional and advertising activities undertaken. Each of these three elements is briefly discussed in this section.

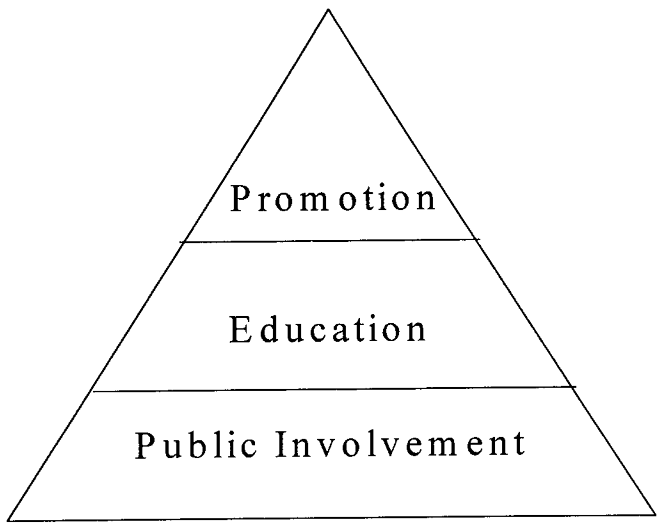

Figure 12-1. Elements of a Public Involvement and Marketing Program

Public Involvement. Public involvement forms the base of the pyramid because it represents the critical element in the development of a comprehensive public participation and marketing program for an HOV facility. As discussed in Chapter 4, the public, neighborhood and business organizations, elected officials, and other groups should be involved throughout all phases of planning, designing, implementing, and operating an HOV facility. Public participation should start early in the planning process and should be carried throughout all subsequent phases. The public involvement process seeks to ensure that all groups have the opportunity to provide input on the alternatives being considered, specific features of the selected alternative, implementation, and ongoing operation of the facility. To accomplish these objectives, the public participation components should focus on providing information on the project, listening to the public and other groups, and providing feedback on how their comments were addressed. A wide range of approaches can be used to encourage public participation. These include surveys, focus groups, charrettes, interviews, workshops, meetings, hearings, forums, visioning sessions, collaborative task forces, and other techniques.

Education. The educational level in the pyramid focuses on providing information about different aspects of the project. The educational component builds on the listening phase of the public involvement process. It provides accurate information on the selected alternatives and the construction and operation of the HOV facility. Techniques such as presentations, newsletters, videos and slide shows, displays, pamphlets, bulletins, and other approaches can be used in this phase to provide accurate and timely information on the various aspects of the HOV facility. The educational component is critical to ensuring that correct information is provided to individuals and groups on key elements of the project in a timely manner.

Promotion. Promotional activities are shown at the top of the pyramid because they build upon the two previous components. Advertising by itself is unlikely to be successful without a strong base of public involvement and education. Promotional activities provide the opportunity to deliver important information about the project and related facilities and services to a wider audience. Advertising also allows for targeting messages to specific user groups. Promotional techniques that may be appropriate for use with HOV facilities include radio, television, print advertising, special events, media relations, direct mail, and other methods.

B. The Use of Public Involvement and Marketing Programs with HOV Facilities

Public involvement and marketing programs serve multiple purposes and provide a variety of benefits. The major reasons for considering HOV public involvement and marketing programs are highlighted below and discussed in more detail in this section.

- Heighten awareness of issues.
- Obtain input on HOV alternatives during the planning and designing processes.
- Heighten public awareness of the selected HOV alternative.
- Build constituencies, partnerships, and support for the selected alternative.
- Increase public confidence in the HOV facility.
- Develop accurate expectations for use of the HOV facility.
- Promote and educate all groups on use of the HOV facility.
- Create awareness of support facilities and services.
- Enhance support for future HOV initiatives.
- Meet federal, state, and local requirements.

Heighten awareness of issues. The first objective of a public involvement and marketing plan is often to present accurate information on the conditions, issues, and potential solutions to traffic congestion in a specific corridor or area. For example, the public may not be fully aware of the issues or problems in a corridor where an HOV facility is being considered. One purpose of a public involvement and marketing program is to help ensure that all groups understand the problems being examined in an area, the roles and responsibilities of the various agencies, and the process being used to evaluate potential solutions and to select a preferred alternative.

Obtain input on HOV alternatives during the planning and designing phases. As noted in Chapter 4, the public, neighborhood organizations, policy makers, and other groups should be involved throughout the planning processes and subsequent phases of designing and implementing an HOV project. The participation of these groups is both desired and required. Obtaining public input and feedback on possible alternatives represents an important element in developing a facility that meets the needs of commuters, travelers, neighborhoods, and businesses in the corridor.

Heighten public awareness of the selected HOV alternative. Once a decision has been made on a recommended HOV facility, this information should be communicated to all groups in an accurate and timely manner. Providing information on the reasons for the selection of the alternative, the next steps in the process, and other related activities is important to the success of an HOV project.

Build constituencies, partnerships, and support for the selected alternative. Another reason for developing a public involvement and marketing program is to foster partnerships and support for the HOV facility among individuals, groups, and policy makers. Involving the public and key organizations and individuals early in the planning process can help develop a constituency to support the implementation and operation of the project.

Increase public confidence in the HOV facility. The public involvement and marketing program can increase awareness of and confidence in the HOV facility by providing information on successful HOV projects in the area or in other metropolitan areas. This step may be especially important if the project represents the first use of an HOV facility in an area.

Develop accurate expectations for use of the HOV facility. The public may have misperceptions about HOV facilities, as well as other transit and transportation projects. It is important to communicate realistic expectations for the use of the facility to build and maintain public confidence. Providing accurate information on the expected use of the HOV lane, the phasing of the project, and the scheduling of support services and facilities can all help develop realistic expectations for a facility.

Promote and educate all groups on the use of the HOV facility. A major focus of the marketing activities should be on educating all groups on the use of the facility and on promoting carpooling, vanpooling, and riding the bus. A major promotional effort should be undertaken when a new HOV facility is opened. Ongoing marketing is needed as well to maintain public awareness and to promote continued use of the facility.

Create awareness of support facilities and services. Marketing efforts should also focus on the supporting services and facilities associated with the HOV project. Rideshare matching services, new bus routes, additional bus services, park-and-ride facilities, guaranteed ride home programs, and employer transit pass subsidies represent just a few examples of the supporting elements that are often included in a marketing program with an HOV project.

Enhance support for future HOV initiatives. Public involvement and marketing programs may provide benefits in developing support not only for the current project, but also for future HOV initiatives. The old line of "success breeds success" is true with HOV facilities and other related projects. Future activities will be enhanced if the initial project is accepted by the public, is well used, and is viewed positively.

Meet federal, state, and local requirements. Public involvement and public participation programs are often required by federal, state, and local legislation and regulation. Although meeting these requirements should not be the sole reason for undertaking a public involvement and marketing program, such an effort can ensure that all appropriate requirements are met.

C. Constituency Groups for Public Involvement and Marketing Programs

Public involvement and marketing programs for an HOV facility have a number of audiences or constituency groups. These audiences include more than just the users of the facility. Potential constituency groups include the public, commuters, neighborhood groups and businesses in the corridor, elected officials, public agencies, local communities, and the media. Each of these groups will have different interest in the project, levels of understanding, and information needs. A challenge for the public involvement and marketing program is to identify the needs of each group, to provide the right information to meet these needs, and to use appropriate approaches to maximize involvement, participation, and input from each group. The general characteristics of these potential constituency groups are highlighted in this section.

The general public. The general public in the corridor and the metropolitan area represent important constituents for the public involvement and marketing program. Ensuring that all interested individuals and groups have the opportunity to participate in the planning process and subsequent phases, and that accurate and timely information is provided throughout the process, is important.

Commuters. Commuters in the corridor represent important constituents for a public involvement and marketing program. Commuters usually are interested in the options that are being considered in the planning process. Commuters may also live and work in the corridor and may have concerns related to impacts on neighborhoods. Once a decision has been made on a preferred alternative, information should also be communicated to this group on the use of the facility and alternative commute modes.

Neighborhood groups. Neighborhood groups and other organizations may be important constituencies if the project will influence or impact their areas. These groups should be involved early in the planning process and throughout subsequent phases. Obtaining input from neighborhood groups, listening to any potential concerns, and providing feedback on how their comments were considered are all important elements of a public involvement program.

Businesses and business organizations. Similar to neighborhood groups, individual businesses and business organizations should be involved early and throughout the planning process as well as the design and implementation phases. This involvement is especially critical if businesses will be impacted during construction or by the final design of a facility. In addition, employer support of transit and rideshare programs is critical to help encourage use of the HOV facility.

Elected and appointed officials. Elected and appointed officials at the local, regional, state, and national level represent important constituencies for the public involvement and marketing program. Providing these individuals with accurate and timely information concerning the project and opportunities to voice their ideas and concerns is critical to helping ensure their understanding of and support for the project.

Other Public agencies and local communities. Representatives from these groups are often involved in the development and implementation of the public involvement and marketing plan. Depending on the type of HOV project being considered, these agencies may have the lead responsibility or a supporting role in conducting various elements of the public involvement and marketing program. Regardless of the scope and type of HOV project, ensuring that public involvement and marketing activities are coordinated with other public agencies and local communities is important. Representatives from these groups may also be targeted to participate in specific elements of the programs.

The media. The broadcast and print media represent an important constituency group for HOV facilities. The media has a significant influence on public perceptions and opinions. Providing representatives from the media with accurate and timely information will help ensure that the correct information about the project is passed onto the public.

D. The Use of Public Involvement and Marketing Specialists

In developing and implementing public involvement and marketing programs, it may be appropriate to consider the use of professional firms specializing in market research, public relations, and advertising. The need for these services will depend on the internal staff expertise and resources available at the sponsoring agencies, the scope and nature of the HOV project, and available funding. There are advantages and disadvantages with the use of marketing consultants. Even if an outside firm is used, the public agency should have staff that are knowledgeable in these areas to direct the activities.

Professional firms can help ensure that the appropriate market research techniques and methodologies are employed. They can assist in defining the media and approaches that best match the target markets, in developing the advertising materials and creative approaches, and in making actual media placement. The only real disadvantage is the cost involved in contracting with these firms.

A state department of transportation or transit agency that has extensive in-house market research and advertising capabilities may not need to use an outside firm. Agencies without these capabilities may wish to consider the use of a marketing firm. Even agencies with strong internal capabilities often utilize market research, public relations, and advertising groups for specific tasks or projects.

If a decision is made to seek outside assistance, the next question becomes the type of firm needed and how they should be selected. The characteristics and the services offered by market research, public relations, and advertising agencies are described next. This summary is followed by a discussion of the approaches, including the request for proposal (RFP) process, that can be used to select a firm.

Market Research Firms. These firms specialize in identifying the appropriate market research techniques for use in analyzing specific issues or topics and conducting the actual research studies. Market research consultants may offer services related to designing, recruiting participants and conducting focus groups; developing survey instruments, drawing random samples, and conducting telephone or self-administered questionnaires; conducting executive interviews; and analyzing the results of all these techniques. Utilizing a consultant can help ensure that the most appropriate market research techniques are used, that the process and results are reliable and valid, and that adequate rigor is applied to the analysis process.

Public Relations Firms. These businesses focus on the development of a comprehensive approach for dealing with the public, obtaining media coverage, and generating public and policy maker support and acceptance for a project. Public relations firms can help develop a positive impact for a project. These groups may provide expertise in the development of slogans, logos, media relations, press kits, press releases, media training, special events, speech writing, newsletters, and other services.

Advertising Firms. These firms specialize in media creation and placement. Specific capabilities may include the development of logos, newsletters, radio spots, newspaper advertisements, television commercials, direct mail pieces, premiums, and other graphic design. These agencies also complete the media placement and may have established relationships with various media outlets.

Public agencies are usually required to follow a request for proposal (RFP) process to select consultants, including marketing firms. In developing an RFP, agency staff should be sure to outline the specific objectives on the project, as well as the tasks and services required of the consultant. It is also suggested that the selection process include interviews with the potential firms and reference checks. The same procedures can be used if a formal RFP process is not needed.

III. DEVELOPING A PUBLIC INVOLVEMENT AND MARKETING PROGRAM

This section outlines the steps and elements that should be considered in planning a public involvement and marketing program for an HOV facility. The guidelines can be used by practitioners to develop public involvement and marketing programs for specific projects. The groups usually involved in developing the plan are described first. The basic steps included in developing a public involvement and marketing program are discussed next, followed by the identification of potential goals and objectives for the public involvement and marketing effort, and the development of a funding and financing plan.

A. Groups to Involve in Developing a Public Involvement and Marketing Program

Like other phases of planning and implementing an HOV facility, numerous agencies and groups should be involved in the development and implementation of a public involvement and marketing program. The participation of the appropriate agencies and individuals is key to ensuring that all groups have the opportunity to provide ideas and suggestions on appropriate approaches and have a common understanding of the goals and objectives of the project, as well as the public involvement and marketing program. This approach can also help to maximize available resources, as well as to ensure that all elements are implemented in a coordinated manner, that the information obtained through the public involvement process is fed back into the planning phase, and that all appropriate federal, state, and local requirements for public participation are met.

One process used in many areas is to form a subgroup or a committee of the multi-agency team established during the planning phase of a project. This group should be comprised of the personnel responsible for public involvement and marketing programs at the various agencies. This approach can help ensure that the individuals responsible for conducting the public participation process and for marketing the HOV facility and support services are involved in planning and carrying out the plan. In addition, consideration should be given to other groups that may need to be involved or consulted during the development and implementation of the public involvement and marketing program. These may include marketing firms, advertising agencies, or other groups with specialized expertise.

Table 12-1 identifies the various agencies and groups that should be considered for inclusion in the development and implementation of a public involvement and marketing plan. The roles and responsibilities of each group are highlighted in the table and described in more detail below. Practitioners can use the information in Table 12-1 as a guide to help ensure that consideration has been given to including the appropriate groups in the development of a public involvement and marketing plan for a specific HOV project. The exact approach, as well as the agencies and individuals to involve, will vary by project and by area.

State Department of Transportation. The state department of transportation or the state highway department is usually the lead agency with HOV facilities on freeways. As a result, these agencies often have overall responsibility for the project, including developing and implementing the public involvement and marketing plan. As the lead agency, the department will also be responsible for ensuring that all requirements relating to public participation have been met. In many areas, state departments of transportation have been responsible for organizing, staffing, and chairing the multi-agency project management team associated with an HOV project. A subgroup of this team, comprised of staff from the various agencies responsible for public involvement and marketing, may be formed and given the responsibility for developing and implementing the public involvement and marketing program for the HOV facility.

Transit Agency. The local transit agency often has the lead responsibility with HOV facilities on separate rights-of-way or on arterial streets. In other cases, the transit system may be a co-sponsor or a supporting agency. Depending upon the exact role, the transit agency may have overall or support responsibilities for developing and implementing a public involvement and marketing program. In all cases, the transit agency will play a major role in developing and implementing the transit and rideshare marketing components of the plan.

Rideshare Agency. In many metropolitan areas, the transit agency operates not only the bus service but also provides ridematching services, vanpool programs, and other ridesharing services. In some areas, however, these activities are the responsibility of a separate agency or organization. In these cases, the rideshare agency should be included as a member of the project management team and the subgroup responsible for the public involvement and marketing activities. The rideshare agency will play a major role in marketing carpool and vanpool programs, ridematching services, and other related activities.

Table 12-1. Agencies and Groups Involved in Developing and Implementing HOV Public Involvement and Marketing Plans

Agency or Group	Potential Roles and Responsibility
State Department of Transportation	• Overall project management • Coordinate development and implementation of plan • Conduct public involvement process • Conduct or sponsor market research • Conduct public information, marketing, and public relations activities • Hire marketing and advertising assistance
Transit Agency	• Overall project management • Coordinate development and implementation of plan • Conduct public involvement process • Conduct or sponsor market research • Conduct marketing related to bus services and facilities • Hire marketing and advertising assistance • Provide assistance to employers
Rideshare Agency	• Participate in development and implementation of plan • Conduct rideshare promotional activities • Provide public information, marketing, and public relations assistance • Sponsor events and other activities • Provide assistance to employers
Metropolitan Planning Organization (MPO)	• Assist with public involvement and marketing activities • Ensure that public involvement requirements are met • Assist with market research and public information activities
Transportation Management Organizations, Transportation Management Associations, Downtown Councils	• Help solicit employer and employee participation in planning process • Promotion of bus use and ridesharing • Specialized information and marketing • Co-fund marketing activities
Local Municipalities	• Overall project management with arterial street and traffic signal applications • Coordinate development and implementation of plan or assist with plan • Conduct public involvement process • Conduct or sponsor market research • Conduct public information, marketing, and public relations activities
Federal Agencies—FHWA and FTA	• Funding support • Provide technical assistance • Ensure federal requirements are met
Marketing, Marketing Research, and Advertising Firms	• Provide technical expertise • Conduct specific tasks • Assist with media placement

Metropolitan Planning Organization (MPO). As discussed in Chapter 4, representatives from the MPO are usually members of the multi-agency planning group associated with HOV facilities and may head the coordinating committees on Major Investment Studies (MISs). The MPO may be active in ensuring that the public participation requirements for a project are met and may provide assistance with various public involvement strategies. Representatives from the MPO may also assist with other aspects related to public information and market research.

Transportation Management Organizations (TMOs), Transportation Management Associations (TMAs), Downtown Councils, and Other Groups. These types of organizations, which are usually composed of major employers in a specific area, are often involved in the development and implementation of public involvement and marketing plans. These groups can help ensure input from businesses and employees during the planning phase, help promote the use of the HOV facility among employees, and assist with funding specific marketing elements. Involving representatives from these groups in the development and implementation of the public involvement and marketing plan can help ensure their active involvement and support for the project.

Local Municipalities. City or county departments may have the lead responsibility on arterial street HOV applications and often have important supporting roles with HOV facilities on freeways and in separate rights-of-way. As the lead agency, a city or county may be responsible for all aspects of the public involvement and marketing process, including meeting all public participation requirements. In other cases, these agencies may play supporting roles in the development and implementation of public involvement and marketing programs.

Federal Agencies. Representatives from FHWA and FTA may wish to be involved or at least monitor the various public involvement and marketing activities. Personnel from these agencies can often provide technical assistance on specific issues or information on approaches used in other areas. These agencies may also provide funding for specific activities associated with the public involvement and marketing program and have the responsibility to ensure that all federal public participation requirements are met.

Marketing, Market Research, and Advertising Firms. These types of businesses may be used to conduct specific tasks or to provide advice on elements related to market research, media relations, or advertising. The use of these groups will likely depend on the capabilities, staff availability, and resources within the various agencies, as well as the type of HOV facility being implemented. The advantages and disadvantages of using these groups are discussed in more detail later in this chapter.

B. Steps in Developing a Public Involvement and Marketing Program

The appropriate groups identified in the previous section should be involved in the development of a public involvement and marketing plan for an HOV facility. The agencies and groups included in these activities will vary by the historic institutional arrangements in an area, as well as the nature, scope, and complexity of the HOV facility being considered or constructed. The steps usually included in developing a public involvement and marketing program are outlined in Figure 12-2 and briefly described next.

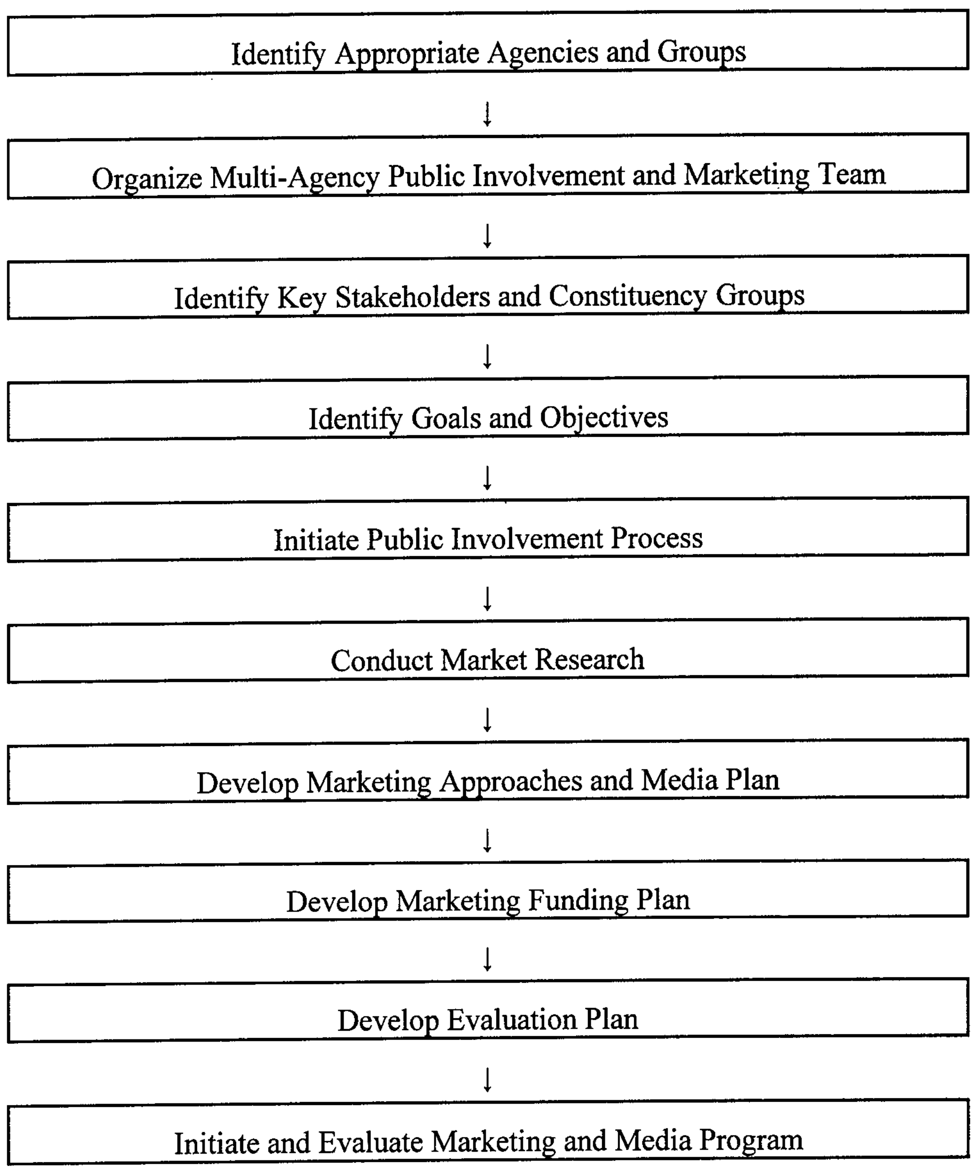

Figure 12-2. Steps in Developing a Public Involvement and Marketing Plan for an HOV Project

Identify Appropriate Agencies and Groups. The first step in developing a public involvement and marketing program is to identify all of the key agencies and groups that should be involved in the planning process. The information provided in Table 12-1 and discussed in the previous section can be used to identify the groups that should be included in the development and implementation of a public involvement and marketing plan for a specific HOV project. As part of this step, the lead agency may also want to outline the roles and responsibilities of each organization related to public participation, marketing, and promotional activities.

Organize Multi-Agency Public Involvement and Marketing Team. The second step involves organizing the multi-agency team or committee that will be responsible for developing and carrying out the public involvement and marketing program. The lead agency on the project is usually responsible for organizing the team, establishing a regular meeting schedule, and creating a method for ongoing communication and coordination. The team may be the same as the group involved in the planning process or it may be a subgroup comprised of individuals from the various agencies responsible for public involvement and marketing.

Identify Key Stakeholders and Constituency Groups. An important element in developing a public involvement and marketing plan is to identify the key stakeholders and constituency groups interested in the project. As described previously, these may include the public, neighborhood groups, local elected officials, state and federal officials, businesses in the corridor, commuters, the media and other groups. Once these individuals and groups have been identified, future steps can focus developing targeted information programs for each group and identifying the appropriate methods for communicating with the various markets.

Identify Goals and Objectives. Once the multi-agency team has been assembled and the key stakeholders and constituency groups have been identified, the next step is to outline the goals and objectives of the public involvement and marketing program. These goals and objectives will be used to guide the specific activities to ensure that there is public participation in all phases of the project and to market the facility once a decision has been made to implement a specific project. An initial set of goals and objectives focused on public involvement may be identified early in the planning process. These may be refined and revised to focus more on marketing activities once a decision has been made to implement a specific project.

Initiate Public Involvement Process. The public participation program should be initiated early in the planning process, and should be continued throughout the project selection, design, implementation, and operation phases of a project. A variety of approaches can be used to involve the public, key stakeholders, and other groups in the planning process. The purpose of these techniques, which are discussed in more detail in Section IV, is to provide accurate and timely information on the project to all interested parties, to obtain input and feedback from these groups, and to respond to specific issues and concerns raised by various groups.

Conduct Market Research. Depending on the nature, scope, and scale of an HOV project, market research may be conducted to obtain a better idea of the need for a specific type of facility, the current use of HOV modes, and reactions toward incentives and disincentives to encourage greater use of ridesharing and public transit. The various market research techniques that may be appropriate for use with an HOV project are discussed in Section V. The results from market research can provide valuable information for the planning process, as well as for developing specific promotional efforts once the decision has been made to implement a specific project.

Develop Marketing Approaches and Media Plan. Once the decision has been made to implement an HOV facility, a detailed marketing and media plan should be developed. The purpose of this plan is to identify the specific marketing and advertising techniques that will be used to inform the public about the facility and promote ridesharing and public transit. The plan should include the approaches and media that will be used, the anticipated schedule for each element, and the responsibilities of various agencies and groups. These elements are discussed in more detail in Section V.

Develop Marketing Funding Plan. Although funding for the public involvement and market research activities is usually considered early in the planning process, the funding plan for the marketing and media program is usually developed at this stage. In an ideal situation, the plan should be driven by the types of marketing and promotional activities outlined in the plan developed in the previous step. In reality, most areas have limited funding available for marketing, and the selection of specific media and promotional techniques are usually determined partially by available resources. The funding plan should identify the costs associated with the different marketing elements and the source of funds for each. The potential for cost sharing among agencies and with private sector groups can be explored and agreed upon at this point. Potential funding sources and innovative financing techniques are discussed in Section V.

Develop Evaluation Plan. This step involves developing the evaluation plan for the public involvement and marketing program. These activities, which focus on examining the exposure, reaction, and impact of the various activities and elements, should be coordinated with the overall project evaluation. The key elements to be included in developing and conducting the public involvement and marketing evaluation plan are discussed in Section VI and procedures for evaluating the overall HOV facility are presented in Chapter 13.

Initiate and Evaluate Market and Media Program. The last step is to implement and evaluate marketing programs. Activities in this step include placing newspaper advertisements, distributing newsletters, airing radio and television spots, and conducting other activities. How these elements fit into the overall implementation process are discussed in Chapter 11.

C. Identification of Goals and Objectives

The goals and objectives for the public involvement and marketing effort should be identified early in the planning process. The development of goals and objectives for a specific project should be linked to the overall goals and objectives of the specific project and those of the sponsoring agencies.

Goals and objectives for a public involvement program often focus on providing opportunities for all interested groups and individuals to participate in the planning process, as well as in subsequent phases of a project. Specific objectives may relate to identifying the techniques that will be used to accomplish the goal. An example of a goal and related objectives for a public involvement process with an HOV project is provided below. The FHWA Marketing Manual (2) contains examples of goals and objectives for specific case studies.

Goal: To provide all citizens and groups with the opportunity to voice their ideas, concerns, and suggestions on the transportation improvements being considered in the corridor.

Objective 1: Conduct five focus groups with commuters, residents, and business representatives to obtain input on the transportation issues in the corridor, potential solutions, and HOV alternatives.

Objective 2: Meet with representatives of major businesses and TMOs in the corridor to explain the project, and to obtain input on issues, potential solutions, and HOV alternatives.

Objective 3: Hold two transportation fairs in cooperation with neighborhood groups and organizations in the corridor to explain the project, and to obtain input on issues, potential solutions, and HOV alternatives.

Objective 4: Develop and utilize a speakers bureau comprised of representatives from the sponsoring agencies to talk at all types of groups and organizations to help disseminate information on the project.

Objective 5: Hold public meetings and public hearings at key milestones in the project planning, selection, and development process.

These examples are intended to provide a general idea of the types of goals and objectives that may be appropriate for consideration for a citizen participation program. The public involvement goals and objectives for a specific project should be more detailed than these examples. The objectives should be measurable, and should include target dates and responsibilities.

Goals and objectives should also be developed for the marketing program. These may include an overall goal of maximizing the use of the facility, and objectives related to the desired reach and market penetration of the marketing and advertising techniques used. The following provides an example of one goal and objectives for an HOV marketing program.

Goal: To ensure that the HOV lane attracts new carpools, vanpools, and bus riders, and meets the forecasted utilization levels.

Objective 1: Publish and mail a newsletter, rideshare, and transit information to all households in the corridor.

Objective 2: Hold a grand opening ceremony to introduce the facility to the public and to generate publicity for the project.

Objective 3: Develop a 30 second radio spot promoting use of the HOV facility and air it on two radio stations during the morning and afternoon drive time.

Like the public involvement process, the goals and objectives for a specific HOV facility marketing program should be more specific than these examples. Developing measurable objectives is important for determining if they have been accomplished.

D. Funding Sources for Public Involvement and Marketing Programs

A variety of sources may be appropriate to finance public involvement and marketing programs associated with HOV facilities. These include federal, state, and local funds, as well as private resources. The funding program for public involvement and marketing efforts associated with the construction of an HOV facility should be developed at the time the project is placed into the capital improvement program. The allowable uses of funds may vary among publicly funded programs, however. For example, public involvement efforts may be allowable expenses under some programs, while advertising is not. Potential funding sources for public involvement and marketing activities are highlighted next. These are provided as examples for use in determining the most appropriate financing approaches for a specific project.

Federal Programs. Funding public involvement programs and citizen participation activities are allowable expenses under most of the federal highway and transit programs. The ISTEA, TEA-21, and subsequent regulations, strengthen the federal requirements related to public involvement. These guidelines clearly indicate that the public should be involved early and throughout the planning and project selection process. Federal funds may also be used to inform and educate the public on the use of an HOV facility, construction activities, and project phasing.

State Funds. State funds may also be used to support public involvement and marketing programs associated with HOV facilities. State revenues may provide the needed match for federal funds, or they may be used in addition to federal programs. As noted previously, advertising and other marketing efforts may not be allowable expenses under some federal programs. As a result, state resources may be used to support these activities.

Local Funds. Like state revenues, local funds may be used to match federal programs or they may provided additional financial assistance for public involvement and marketing efforts. Local funds may be used more frequently with arterial HOV facilities and with transit marketing efforts than with freeway projects.

Private Funds. Private resources may also help support public involvement and marketing activities. In the public involvement phase, businesses may be willing to co-sponsor meetings, to support employee involvement in surveys and focus groups, to provide information in company newsletters, and to help fund specific activities. Businesses, major employers, and TMOs may also help fund specific marketing efforts. Developer mitigation fees may also be used to support these activities. Examples of joint public/private promotional efforts might include co-sponsorship of opening ceremonies or special events, cross-promotional advertising, and the use of company newsletters.

IV. IMPLEMENTING A PUBLIC INVOLVEMENT PROGRAM

Public involvement is a key element in planning, designing, implementing, and operating HOV facilities. The participation of the public and key stakeholders should start during the planning phase and should continue throughout the duration of the project. This involvement is required by federal legislation, as well as many state and local regulations. Although the traditional methods of public meetings and hearings are appropriate for use with HOV facilities, additional techniques are usually needed to ensure adequate involvement by all potentially affected groups.

Public involvement is not just public relations. Public relations strategies attempt to position an issue, project, or plan in the best possible light for decision makers and the public. Public involvement, on the other hand, involves the public in the shaping of policy and project decisions. As discussed in Chapter 4, public involvement should be initiated before project alternatives are developed and should continue through the selection of the recommended alternative and the implementation process.

A variety of techniques and approaches can be used to elicit public participation in transportation projects, including HOV facilities. These include the more traditional techniques of public meetings and hearings, and more innovative approaches such as charrettes, visioning sessions, and collaborative task forces. The various techniques that may be appropriate to consider with a specific HOV project are described in this section. In many cases more than one approach should be used to help ensure participation by all affected groups and individuals.

The challenge for transportation professionals is to match the appropriate approaches to the scope, scale, nature, and resources of a specific project. The following information, and the listing of additional references provided at the end of the chapter, can be used to identify logical public involvement techniques for a specific project.

A. Background Research

It may be appropriate as part of the public involvement process to start by probing for the opinions, attitudes, and reactions of individuals and groups in the corridor or area where the HOV facility is being considered. This information can be evaluated and used as input into the planning process and as a gauge of the extent to which public education is needed. The following approaches may be used in the public involvement process to assist with preliminary research. A more detailed discussion of these and other market research techniques is provided in Section V.

- ♦ Literature Searches. Information can be obtained through literature searches on the background of a project, public reaction to previous projects in the area, and the national experience with HOV facilities.

- ♦ Internet. Another good source of information on the experience with HOV facilities, including public information and market research approaches, is the Internet. Many state departments of transportation, transit agencies, and other groups have home pages that provide a wide variety of information on transportation facilities, supporting services and facilities, and other related elements in the specific area.

- ♦ Focus Groups. Focus groups can be conducted with commuters in a corridor or with residents of an area to obtain information on perceptions related to traffic congestion, alternative transportation improvements, HOV facilities, and using HOV modes.

- ♦ Surveys. A variety of surveys can be used to obtain more detailed information from different groups about issues, alternative strategies for addressing these concerns, and HOV facilities.

- ♦ Executive or Stakeholder Interviews. Interviews can be conducted with key policy makers and other stakeholders to obtain their thoughts, ideas, and concerns about issues in the corridor or area, alternative transportation improvements and HOV facilities.

B. Public and Stakeholder Meetings

A variety of meetings and forums can be used to provide additional information on the project and to gather and analyze more detailed information on public opinions, attitudes, and reactions relating to the HOV project or to other elements being considered as part of the facility. The following approaches represent some of the public meeting and workshop techniques that can be used to solicit and encourage input throughout the process of planning, designing, implementing, and operating an HOV facility.

Providing information on the project is an important component of the meetings, workshops, and other techniques discussed in this section. The term collateral refers to the printed educational and promotional materials commonly used at these meetings and in other marketing efforts. Collateral may include brochures, newsletters, information packets, fact sheets, posters, press kits, and other items. These elements are described in the next section.

In developing and conducting the activities described in this section, it is important to consider the individuals attending these meetings and sessions to be both recipients of information and distributors of information on the project. The fact that an individual takes the time to attend a meeting, workshop, or other session indicates an interest in the project. Considering ways to capitalize on this interest and enlisting the assistance of these individuals in distributing information and spreading the word can be an important element of the overall marketing program.

Kick-Off Meetings. Kick-off meetings and briefings can be used to introduce an issue or a project to the public, neighborhood groups, businesses, policy makers, and other key stakeholders. The meetings can be used to initiate an ongoing process, to explain the problems in an area and the process that will be used to address these, and to generate an understanding of the goals, objectives, process, and timing of a project among all groups. Kick-off briefings are especially important when the project may be controversial or require a fast-track schedule. The briefing agenda should be designed to provide a forum in which all groups have an opportunity to voice their opinions and ask questions.

Community, Jurisdictional, Elected Official Briefings. Community, jurisdictional, and elected official briefings give the project team a mechanism for direct interaction with three important and powerful constituency groups. These briefings fulfill multiple purposes; they build constituencies, create partnerships, foster support, develop accurate expectations, and provide information which enhances future project planning activities. Briefings appear to be most successful when project staff are asking for input and reaction to specific ideas, concepts, or recommendations. Briefings should be scheduled so that input can be adequately considered and so that changes based on that input can be incorporated into the project.

Public Meetings and Hearings. Public meetings and hearings have been the traditional, and sometimes the only, mechanism used to secure public input on transportation projects. Public meetings provide an excellent opportunity to present information on a project. Formal presentations by project staff are appropriate to describe issues, possible alternatives, preferred approaches, the selection process, and ultimately the recommended alternative. These approaches have a number of limitations, however, which should be taken into account when considering the use of hearings and meetings. One problem is that public meetings are often sparsely attended due to lack of interest or a perception that it does not matter. Conversely, an issue may be so controversial that the public meeting disintegrates into heated, unprofitable debate.

Visioning Sessions. Visioning sessions represent one approach that can be used to help in the development of long-range plans. This technique usually involves a series of meetings where participants focus on identifying and defining their vision for the future of a neighborhood, community, transportation corridor, or other area. The desired outcome of these sessions is a collective or shared vision for the future. Information on current and projected characteristics of the area is usually provided to participants prior to the meetings, and alternative future development scenarios may also be prepared and presented. Visioning sessions can be used in the transportation planning process to assist in the development of alternative solutions and the identification of a preferred approach. Visioning sessions can be an effective approach for public and policy maker involvement in the transportation planning process. This technique provides the opportunity for all groups to discuss their ideas and concerns, and helps to develop a shared vision for the future.

Charrettes. Charrettes are a special type of meeting that usually focuses on addressing a specific problem or situation during a pre-specified time period, which might include multiple sessions. Charrettes may include the participation of outside experts, who are called upon to provide their ideas about potential solutions. A common format for a charrette may include defining the problems, analyzing the problems, identifying alternative solutions, analyzing the alternatives, presenting and discussing the advantages and disadvantages of the alternatives, and selecting a preferred approach. Charrettes provide the opportunity for all invited groups to be heard and to participate in the discussion and analysis of issues, and ultimately the recommended solution. Potential disadvantages of charrettes include the time and costs involved in organizing and conducting them. In addition, participation may need to be limited due to cost and space constraints.

Brainstorming Sessions. Brainstorming is a simple technique that allows participants to identify and voice their ideas about specific issues and solutions. Brainstorming may be an appropriate technique to use as part of a public or stakeholder meeting to identify issues and problems in a specific corridor, possible solutions, advantages and disadvantages of different improvements, and supporting components. These sessions may also provide information on the types of incentives or disincentives that would influence commuters to change from driving alone to using an HOV mode. Brainstorming sessions provide a good way to identify issues and potential solutions. The use of this technique needs to be managed correctly, however, so that it does not build unrealistic expectations among participants.

Transportation Fairs. Transportation fairs can be used to provide information on a specific project or multiple projects. This approach attempts to generate public interest and involvement by providing information in a more relaxed setting. Maps, displays, videos, models, and interactive methods may all be used to communicate information. Transportation fairs provide a good mechanism for disseminating information, but may be less effective than other techniques for obtaining input and helping to reach a consensus.

Workshops. Like a transportation fair, workshops provide another technique that can be used with projects that have distinct components or alternatives that should be closely reviewed by a community. Workshops provide the opportunity to discuss the details of a project. The public can provide input about specific features and react to design elements and other features of a project.

Collaborative Task Forces and Community Partnerships. Community partnerships, such as citizen steering committees, advisory committees, commissions, and collaborative task forces all offer the public a role in shaping decisions relating to a project. Neighborhood groups and communities that are represented on these types of groups learn firsthand about the goals and constraints of a project and have the opportunity to provide firsthand input to the project. As a result, citizens may be more likely to understand the parameters and rationale for decisions. These techniques provide a constructive means for interested parties to become involved in a project. Keys to successful community partnerships are clearly defining the roles and responsibilities of all participants, as well as regular communications about project progress and decisions.

Public Partnerships. As discussed previously, planning, designing, and operating HOV facilities often involve two or more public agencies. While these public partnerships can create additional management challenges, they also offer numerous advantages. The constituencies of various agencies may have different needs and desires. Ensuring that the constituents of all agencies are involved early in the planning process and throughout all phases can help develop support for the project.

C. Communication Techniques

A variety of methods and techniques can be used to communicate information about an HOV project to the public and other groups. Providing clear, accurate, and timely information throughout the planning process and subsequent phases is an important component of public involvement programs. The following communication methods represent some of the available techniques that can be used to explain the issues, project elements, alternatives, the recommended approach, and the implementation process.

Internet—Home Pages. Home pages on the Internet or World Wide Web provide a relatively new method of communicating information on projects to the public. Information can be provided on all aspects of the HOV project, maps and photographs can be used, and public meeting dates, times, and locations can be highlighted. The information provided on a home page can be updated and modified as a project moves from planning to design to construction and to operation. Links can also be provided to other home pages, such as the transit agency to allow users to access an even wider base of information. Including a link to electronic mail (e-mail) can also provide an interactive media for individuals to ask questions or request additional information on a specific topic.

Media Relations. Media comprise a very special stakeholder group, not only because of their functional role as the disseminator of information, but because of the inherent power of media to shape attitudes toward a project or issue. Targeted media activities should extend beyond the traditional news releases and press conferences to include editorial board briefings, media tours of the facilities, regular phone calls, and one-on-one meetings.

Newsletters. Newsletters are very efficient and effective communication tools. Newsletters can be used to address issues and questions raised concerning a project, provide timely information about different elements, and promote the use of various HOV commute modes. They can educate readers to an organization's mission and can be a mechanism to publicly recognize and compliment constituency groups. Finally, a newsletter is especially helpful in explaining the details of a project in an orderly and consistent fashion.

Standing Displays. Standing displays can be placed at any number of visible community locations to provide information on a project. Displays, which can be updated as the project progresses, provide the opportunity to communicate detailed project information with a minimum investment of staff time and resources. Displays can be designed to include comment cards and return boxes. These provide citizens with the opportunity to make suggestions on the project or to request additional information. Effective displays emphasize visual and graphic information, as well as printed information. They can be rotated through a variety of locations such as shopping centers, fairs, public libraries, civic centers, and government buildings.

Speakers Bureau. Public speaking engagements and participation in public forums are effective and timely methods for disseminating information about an HOV project. Presentations can be made at meetings of community and civic clubs, business organizations, city councils, state agencies, and other groups.

Speakers Kits. Speakers Bureaus are often supported by speakers kits. These kits are self-contained units that assist speakers with slides or other visual aids, presentation outlines, and additional information. Speakers kits help ensure that all agency representatives provide a consistent message about the project. A typical speakers kit might include the following items:

- A point paper or speech outline
- Overheads, slides or videos
- Handouts for the audience
- Feedback forms for audience input on key issues
- Address cards, so that members in the audience can be added to the project database or request additional information.

V. IMPLEMENTING A MARKETING PROGRAM

HOV marketing programs are typically characterized by partnerships among agencies, the media, and businesses. Consideration should be given to linking the various marketing activities and approaches together by a common theme or messages that effectively supports the project goals and objectives. Flexibility should be maintained in the marketing program, however, to respond to issues and opportunities that may arise during the implementation and operation of a facility. This section discusses market research techniques, media relations and media alternatives, advertising and promotional strategies, financing approaches, and initial market efforts and ongoing activities.

A. Market Research

The first step in conducting any market research is to identify the issues and questions to be addressed. Research provides important information for decision making, but only if the right questions are asked. In order to be useful, research questions need to be measurable. Market research for HOV facilities typically addresses the following issues:

How do people perceive the transportation problems in a corridor or area? Unless people perceive a transportation problem, no number of potential solutions will make sense to them. Market research can help identify the perception of commuters, travelers, and residents concerning specific issues in a corridor or area. It can also indicate if there is a consensus about the nature of these problems and how severe people feel these issues are. This information can be very useful in developing appropriate alternatives and in defining messages for promoting the use of buses, vanpools, and carpools.

What is the public awareness and attitude about HOV facilities? Understanding what people know and how people feel about HOV facilities can be useful in shaping public outreach strategies and communications methods. Responses to these questions can be used to determine whether a public information program should be geared toward explaining what an HOV facility is, how to form a carpool or vanpool, or the travel time savings commuters can realize through use of the facility.

Will people use the HOV facility? The ultimate test of success for an HOV facility is that people use it. Assessing the market potential for an HOV facility is an important part of the planning process. Examining if an HOV facility will be used and under what conditions it will be used are important questions to be examined in this phase. For example, information can be obtained on the travel time savings needed to induce a mode switch, pricing strategies that would encourage changing modes, and promotional appeals that might convince people to rideshare or use the bus.

Will the public support an investment in an HOV facility? Market research can help identify if there are special interest groups or elected officials with specific concerns about an HOV facility or strong opinions in favor of or against a project. For example, lane conversion and congestion pricing are often controversial in many areas. Survey research can be useful in providing a broader public opinion context for decisions about certain types of HOV facilities. It can also be helpful in identifying the conditions necessary to achieve public support and in developing a public information program that educates or addresses misperceptions about HOV facilities.

The results from market research can be used in the planning and decision making process related to an HOV facility. It is important to realize some of the limits with surveys and other market research techniques, however. For example, surveys reflect only what people say at the time they are being interviewed. Care should be taken in predicting the future even when longitudinal studies have been conducted that can help identify logical patterns. Public opinion can change markedly depending on the information available to people.

Research takes time and money, and it is critical that these resources be used wisely to provide information that will be of use to the project. Care should be taken in identifying the questions that need to be answered and the information that is important to the decision making process. The most appropriate market research techniques can then be used to obtain this information.

As discussed previously, it may be appropriate to consider using the services of a professional market researcher or firm to assist with market research activities. These professionals can help assure that the right techniques are used, and that they yield valid and reliable data. Inaccurate data or data incorrectly applied may be more harmful than no data at all. The use of these services require additional resources, however, and agency personnel will need to review available funding and the needs of a project.

A common mistake made by individuals without a background in market research is to decide on a research methodology before determining what information is needed and how it will be used. Different research methods have different applications, strengths and weaknesses, and costs. There is no "best approach" for obtaining data for marketing decisions. Trade-offs related to different approaches include cost, staff resources, statistical reliability, duration of data collection, and the generalizability of outcomes to the overall population.

Some research methods, such as surveys, can provide statistically reliable data, meaning the results from a sample of the population can be projected to the entire population. Other techniques, such as focus groups, are used primarily as exploratory or confirmatory research. Results from these approaches are used to help formulate other research objectives or to better understand the meaning of results from surveys with statistically reliable samples.

The key for market researches and transportation professionals is to match the appropriate research methodology to the issues being examined, the information desired, the scope of the project, and available resources. It may also be appropriate to consider the use of more than one technique. For example, focus groups may be used to conduct a preliminary investigation of commuters reactions to different HOV alternatives. A telephone survey may then be used to provide more quantitative information on commuter's behavior.

The four general types of market research techniques that may be appropriate for use with HOV facilities are summarized next. These are focus groups, telephone interviews, personal interviews, and self-administered questionnaires. More detailed information on the use of these and other market research techniques can be found in the additional references provided at the end of this chapter. Examples of the use of these techniques with HOV projects are provided.

Focus Groups. Focus groups are a qualitative technique used to obtain information about a variety of topics. This approach does not provide quantitative information because the number of participants is too small to be representative of the population. Focus groups can, however, provide insight into how people feel about a particular topic. Focus groups are often used to help formulate research objectives for a quantitative study or to clarify findings from a self-administered or telephone survey.

Focus groups usually consist of 8 to 12 people. An agency staff member or a market research professional acts as the facilitator. A discussion script is prepared and followed to help ensure that the key topics are covered and that the same approach is used with multiple groups. Interaction among group members is encouraged, and the facilitator may follow-up with further questions based upon the participants' initial responses.

Visual and audio aids may be used or participants may be asked to respond to slogans, messages, or radio or television promotions. Focus groups typically last one to two hours, and participants are often paid or given some incentive to participate. Focus groups are a relatively inexpensive and efficient approach to obtaining preliminary information and responses to topics and issues. A focus group can be conducted and findings reported in less than two weeks time.

> **HOV Lanes in Los Angeles**. The California Department of Transportation (Caltrans) has used focus groups on a number of different projects related to HOV facilities. For example, focus groups were conducted on research studies exploring public attitudes toward converting general purpose lanes to HOV lanes and enforcement issues associated with HOV facilities. The actual focus groups were conducted by universities and market research firms.

> **I-393 HOV Lanes, Minneapolis**. The Minnesota Department of Transportation (Mn/DOT) used focus groups in the development of the marketing and public information strategies on the I-394 HOV project. Focus groups, comprised of residents and commuters in the corridor, were used to test different marketing slogans, newspaper advertisements, and radio jingles for the interim HOV lane. The focus groups were conducted by a marketing firm under the direction of a multiagency team headed by Mn/DOT.

Telephone Interviews. Telephone interviews represent a relatively fast, and economical means of obtaining statistically reliable information provided the sample is randomly selected. Large numbers of telephone interviews can be conducted in relatively short periods of time. In general, telephone interviews should be limited to not more than 15 to 20 minutes in order to maintain participant interest.

The cost of telephone interviews is moderate compared to other forms of survey research. The actual costs will be dependent on the length of the interviews, the sample size, and the difficulty of contacting respondents. For example, if it is necessary to interview only the female head of a household between the ages of 18 to 24 who have driven on a specific roadway in the last week, the cost of the interview will be much higher than if any head of household qualifies for the interview.

Telephone interviews have been used as one component of market research programs with HOV projects in a number of areas. The following case studies represent a few of these examples.

I-394 HOV Lanes, Minneapolis. Telephone surveys were conducted of residents in the I-394 corridor at different points in the planning and implementation process. Information obtained through the surveys was used to help define and target the marketing effort, as well as to evaluate the program and the HOV project. The telephone surveys were conducted by a marketing firm under the direction of Mn/DOT and a multiagency team.

I-5 South HOV Lanes, Seattle. A telephone survey of some 800 residents in the I-5 South corridor was conducted as part of the market research study for the proposed HOV facility. Information was obtained from respondents on attitudes and opinions related to traffic congestion on the freeway, alternative HOV treatments, and converting a general purpose lane to an HOV lane. In addition, ongoing surveys are being conducted as part of the region-wide HOV evaluation. The surveys were conducted for the Washington State Department of Transportation (WSDOT) by a marketing firm.

Personal Interviews. Personal interviews are a good way to obtain information and to get reactions to visual aids, such as proposed HOV lane designs. Personal interviews may be more appropriate for use as part of the public involvement process rather than for market research due to cost considerations. Personal interviews are expensive, and it may be prohibitive to conduct enough interviews with a sample size that guarantees statistical reliability. Typically, a personal interviewer is paid more than a telephone interviewer and the interview is often longer and more complex. There may also be costs incurred getting the interviewer to and from the respondents home or place of business, and it may be necessary to offer an incentive to convince people to participate.

Personal interviews with key stakeholders have been conducted as part of the market research activities on some HOV projects. The following case study examples highlight the use of this market research technique.

Arterial HOV Lanes, Snohomish County, Washington. Interviews with key policy makers and community leaders were conducted as part of an arterial street HOV facility study in Snohomish County. The interviews were used to obtain information on potential HOV components, perceptions toward HOV facilities and issues associated with alternative approaches. Individuals were also asked about their interest in participating in further elements of the study. The interviews were conducted by a marketing firm as part of the consulting team on the study for Snohomish County.

I-5 South HOV Lanes, Seattle. Interviews were conducted with 22 key policy makers, business representatives, and neighborhood leaders as part of the market research phase of the I-5 South HOV lane study. The interviews provided information on perceptions related to traffic conditions on the facility, HOV alternatives, and specific issues and concerns. The interviews were also used to help identify potential interest in community and business partnerships and to establish a sound base for ongoing communication with these groups. The interviews were conducted for WSDOT by the consulting team on the I-5 South project.

Self-Administered Questionnaires. This technique involves individuals completing questionnaires that have been provided to them. A number of mechanisms can be used to distribute and collect the surveys. Commonly used methods are mail-out/mail-back, newspaper inserts, handouts at public meetings, or at locations commonly visited by the targeted group. In addition, surveys may be administered through electronic media such as e-mail, home pages on the Internet, and kiosks. Questionnaires are often kept short, and many use simple, multiple choice questions. The administration of surveys may take longer than other forms of survey research, however, due to the length of time needed for respondents to complete and return the survey.

One problem with self-administered surveys is that samples may be prone to "self-selection bias." This problem can affect the "randomness" of the sample and its generalizability to the population, since people who respond to self-administered surveys may differ greatly from those who do not. It is often necessary to achieve response rates of 50 percent or more to consider the results reflective of the population. Techniques to insure high response rates include utilizing telephone or postcard reminders and offering incentives of money or gifts.

The cost of self-administered surveys will depend on the length and complexity of the survey, the method of distribution, and the desired response rate. An elaborate mail survey may be more costly than a short personal interview, however. In general, surveys are considered in the middle of the cost spectrum of market research techniques.

Self-administered questionnaires have been used in market research studies on HOV facilities and as part of the ongoing monitoring and evaluation program for HOV projects. The following case study examples highlight the application of surveys with HOV facilities.

Houston HOV Lanes. A variety of self-administered questionnaires have been utilized with the HOV lanes in Houston. Mail-out/mail-back questionnaires were used to obtain information and reactions from carpoolers and vanpoolers in the HOV lanes and motorists in the general purpose lanes. On-board surveys of bus riders were also conducted at the same time. The surveys were conducted by a university research agency for the Texas Department of Transportation (TxDOT) and the Metropolitan Transit Authority of Harris County (METRO).

I-394, Minneapolis. Mail-out/mail-back surveys were used at different points in planning and implementing the I-394 interim and final HOV lanes. The questionnaires were designed to obtain information on commuters perceptions of the facility, use of the HOV lane, and their origins and destinations. The surveys were conducted by a marketing firm under the direction of Mn/DOT and a multiagency team.

I-405 Freeway, Orange County, California. A postcard survey was used on the I-405 Freeway to gather information on trip purpose, origins and destinations, frequency of travel, and vehicle occupancy levels of commuters. The survey was conducted by Caltrans.

University of Washington Real-Time Ridematching Services, Seattle. Electronic media were used with this project as both part of the ridematching system and the evaluation. This demonstration, which is one component of the Seattle Smart Traveler (SST), allowed students, faculty, and staff at the University to access a real-time ridematching system through e-mail. Rideshare applications were available on a home page, and individuals could request and offer rides through e-mail. Surveys conducted during the evaluation phase of the project were also available on the home page and through e-mail.

Once the research methodology has been selected, the next step is to determine the target group. For example, a focus group or survey may focus on commuters in a corridor, current bus riders, or households in the area. If survey data are to be statistically reliable, a random sample of the desired group of sufficient size is necessary.

Random simply means everyone in a given population has an equal chance of being included in the sample. Telephone directories are frequently used to draw samples for telephone surveys. While this approach will provide a random sample of people listed correctly in the telephone book, it is not an acceptable method for drawing a random sample of the general population. People without telephones, those with unlisted numbers, those with incorrectly listed numbers, and individuals new to an area do not have a chance of being selected.

A method called random digit dialing (RDD) is commonly used to draw random samples for a telephone survey. This approach can result in higher costs than simply using the telephone directory, because more time is spent dialing disconnected numbers or other numbers, such as calling businesses when residences are desired. It does help ensure a random sample, however, which is important for providing reliable data for the project.

Sample size is also important for obtaining reliable data. The appropriate sample size depends on many factors, including the size of the population, the variability of responses, and the desired degree of accuracy. As a rule of thumb for samples of the general population, findings from surveys using a random sample of 400 respondents will have a margin of error of plus or minus 5 percent with a 95 percent confidence interval. This means if 50 percent of the respondents are HOV users, then there is a 95 percent confidence that the percentage of HOV users in the true population is between 45 percent and 55 percent.

Responses from a random sample of 1,200 individuals will have a margin of error of plus or minus 3 percent, at the 95 percent confidence interval. After 1,200 individuals, sample sizes must increase dramatically to meaningfully reduce the margin of error. If information from sub-samples is desired, then each sub-sample must be large enough to be sufficiently representative. For instance, if a margin of error of plus or minus 3 percent is desired along with the ability to draw separate conclusions about the general population, about men, and about women, then a sample of 2,400 is necessary. This number would equate to a random sample of approximately 1,200 men and 1,200 women.

Additional information on research methods, selecting random samples, and drawing statistically valid conclusions can be obtained by consulting the references listing at the end of this chapter.

B. Media Relations

HOV facilities are usually publicly funded and support public purposes. Well placed and positive media stories represent a basic approach to getting key information to the public. This approach is often worth more than paid advertising. People read or watch the news more frequently and more closely than they do advertising, leading media experts to estimate the value of news stories at two or more times the value of equivalent advertising. Table 12-2 provides an overview of the general media relations and media alternative strategies and tactics that may be appropriate for use with HOV facilities.

A major focus of media relations should be on soliciting the media for help. Press releases and press conferences, editorial board and assignment editor briefings, and media tours can all be used to heighten awareness of a project and to increase visibility. Radio and television talk shows dealing with news, features, or special segments may also be appropriate communication mechanisms. Some areas have also had success working with the local traffic reporters. It is important to remember to always respond immediately to incorrect or misleading articles or broadcasts. No story is too small to correct, or too outrageous to affect public opinion.

Table 12-2. General Media Relations and Media Alternatives

Strategy	Tactics
Media Relations: Print Newspapers, trade journals, and targeted publications	• Editorial board briefings • Assignment editor briefings • News releases • Press conferences • Cold feature stories • Pre-arranged feature stories • Newsletter stories
Media Relations: Broadcast Radio and television	• Editorial board briefings • Assignment editor briefings • News releases • Press conferences • Talk shows -News -Features -Special segments • Meetings with radio traffic reporters • Briefings with selected reporters and editors
Special Events	• Opening Ceremonies and kick-off events • Award presentations • Photo opportunities • Displays at businesses, large employers, and community centers
Mailings and Distributions	• Mailings from sponsoring organizations • Mailings from interested outside organizations (bill stuffers, articles in newsletters) • Person-to-person distributions (street teams, desk-top distributions)
Public Presentations	• Presentations hosted by an outside group or organization, such as Kiwanis, employer associations, or community organizations • Presentations hosted by your agency, such as workshops, outside experts as speakers, in-house speakers bureau, videos, and slideshows.

A major component of a marketing plan for an HOV project may be a media relations program. The following activities may be appropriate to consider in a media relations program for an HOV facility.

- A media calendar that tracks key events and opportunities to raise the visibility of the HOV project through the media.
- A regularly updated media packet that includes camera-ready art, fact sheets, and suggested contacts for interviews and feature stories.
- Specialized media packets for reporters who cover specific beats, such as transportation, public transit, science and technology, real estate, or lifestyle reporting.
- Training for key project spokespersons that emphasizes the program message and major tips for dealing with the media.
- Media protocol outlining procedures, designated spokespersons, and lines of reporting authority on a project.
- Prepared responses for potentially controversial program elements or questions.
- Subscription to a clipping service.

C. Media Alternatives

A number of media alternatives are available for use in marketing an HOV facility. The various approaches that may be appropriate for consideration with a specific HOV project are summarized in this section.

Identify Cross-Promotion Opportunities. Marketing budgets are usually limited. In order to enhance and stretch available resources, consideration should be given to cross-promotional efforts. Fortunately, the HOV project promotional campaign is not the only game in town. There are probably a dozen or more opportunities to promote an HOV facility or service jointly with other businesses and community events. There may also be opportunities to coordinate targeted marketing with other promotion efforts or projects and service improvements within the sponsoring agencies.

Cross-promotional opportunities can be identified in a number of ways. These include talking to local businesses, obtaining lists of community events, and discussing their internal communication programs with employers. All of these approaches can help identify ways to establish partnerships for mutual benefit.

Advertising and Public Service Announcements. Advertising can serve many functions. Advertising messages may seek to stimulate behavior, to compliment or thank, or simply to heighten awareness of a certain issue or project. Advertising provides the advantage of targeting a specific message to a specific market segments.

There are a wide variety of advertising mechanisms. Primary mediums include radio, television, print, direct mail advertising, billboards, and transit advertising. The target market and desired outcome of the advertising will direct the type of media selected.

A certain sensitivity is required when undertaking advertising which is paid for by public agencies. The general public may not feel that advertising is an appropriate use of tax dollars or other public funds. Co-sponsorships and cooperative advertising may be a desirable means of spreading the cost among affected groups. Another technique is providing promotional material to other public agencies, community groups, and interested individuals to distribute on behalf of the lead agency or group.

Public service announcements (PSAs) are similar to paid advertising in many respects, but PSAs typically serve to simply notify the public of an event or change in public services. Creative development is usually limited with PSAs, and placement and frequency of the spots are not guaranteed by a station or newspaper. Paid advertisements take precedence over the airing of PSAs and frequently result in midnight and non-drive time airing of public service announcements. Viewed as a supplement to a marketing campaign, public service announcements are inexpensive and valuable in disseminating basic information over a period of time.

Special Events and Ceremonies. Ceremonies, kick-off events, award presentations, and photo opportunities are often used to commemorate significant events, such as the opening of an HOV facility. It is important to remember that an event needs to be significant to a broad section of the general public for it to warrant media coverage. Ceremonies and other special events have been used with the opening of HOV lanes and park-and-ride lots, as well as with the initiation of new bus services and other activities associated with HOV facilities.

Co-Sponsorships. Exploring opportunities for co-sponsorship of events and promotional activities is another strategy being used in many areas. Corporate groups may be willing to help participate in these events through financial and media support.

As traditional advertising has become more expensive and less effective, corporations are looking for new ways to present their products and services to target markets. Corporate sponsorships provide businesses with the opportunity to become associated with an event or project without having to compete with a lot of other advertisers. In exchange for financial support, in-kind services, or both, a corporation can sponsor an event that ensures its products are showcased and remembered.

Just like corporate sponsors, the media is also looking for ways to increase their customer base. Media sponsorships provide media groups the opportunity to be associated with an event in exchange for promoting an event free of charge on their station.

D. Advertising and Promoting an HOV Facility

Providing information on how to use an HOV facility and encouraging commuters to form carpools and vanpools or to take the bus is a critical part of an advertising and promotional campaign for an HOV project. As noted previously, a range of approaches can be used in this effort including community outreach programs, newsletters, media advertisements, ribbon cutting or opening ceremonies, and special events. Table 12-3 highlights the types of advertising and promotional efforts that may be used to build public awareness, support, and use of the HOV facility during the initial opening of the project and on an ongoing basis. The various approaches are summarized next, along with case study examples.

Informational Brochures. Brochures can be used to communicate a variety of information about an HOV facility or project. An attractive and easy to read brochure is an effective marketing tool that can be used with the public, neighborhood groups, commuters, businesses, policy makers, and other key groups. Brochures can be used to explain the project, illustrate the different features of the facility and access points, communicate the vehicle occupancy requirements, explain how to use the facility, and provide information on rideshare and transit services.

Brochures may come in a variety of shapes, sizes, and colors. The gate-fold or accordion-fold brochures are commonly used. Larger brochures have also been used effectively with HOV facilities. Brochures can be used at meetings and public hearings, mailed to residents and commuters, included in press kits, and provided at information racks located at agency offices and businesses. Brochures are often part of a comprehensive information dissemination process and may be combined with specific information on bus routes and schedules, rideshare matching services, and vanpool programs.

Brochures should be easy to read and pleasing to the eye. The content should be simple and straightforward. Because of the time and cost involved in developing brochures, the information should be general rather than time sensitive. More specific information on items such as construction schedules are usually more appropriate for flyers or newsletters. Figure 12-3 illustrates examples of brochures, flyers, and other promotional materials used with recent HOV projects, and Figure 12-4 highlights brochures from HOV facilities in Seattle, Houston, and Vancouver. Figures 12-5 and 12-6 provide examples of brochures used with HOV projects in Minnesota and California.

Table 12-3. Techniques for Advertising and Promoting an HOV Facility

Marketing and Advertising	Content and Potential Use	Case Study Examples
Informational Brochures and Flyers	• Information and map about the project and how to use the facility, rideshare and transit information, telephone numbers.	• I-394, Minneapolis. • Houston HOV lanes. • Southeast Expressway, Boston. • San Francisco HOV lanes. • Route 44 and I-64, Norfolk. • Barnet-Hastings Express lanes, Vancouver.
Newsletters	• Use as handout at meetings and as part of direct mail. • Continuous information on construction activities and other project elements.	• I-394, Minneapolis. • I-65, Nashville. • I-5 South, Seattle.
Posters	• General information and map, how to use facility, transit and rideshare information and telephone numbers.	• Orange County HOV lanes. • I-5 South, Seattle. • Barnet-Hastings Express lanes, Vancouver.
Newspaper Advertisements	• Targeted information on use of the facility, ridesharing and transit.	• Houston HOV lanes. • I-394 Minneapolis. • Southeast Expressway, Boston. • I-65, Nashville. • Barnet-Hastings Express lanes, Vancouver. • Route 44 and I-64, Norfolk.
Radio Advertisements	• Short messages on projects, use, and where to get more information.	• I-394, Minneapolis. • Route 44 and I-64, Norfolk. • Long Island Expressway, New York.
Television Advertisements	• Short messages on projects, use, and where to get more information.	• Long Island Expressway, New York.
Videos	• More detailed information on the project. • Use with Community Outreach slogans and short messages on project.	• Route 44 and I-64, Norfolk. • Houston HOV lanes.
World Wide Web Home Pages and Other Electronic Communication Techniques	• Information on project schedules, how to use the facility, ride matching, and bus schedules	• Houston METRO Home Page. • King County Riderlink, Seattle.

Table 12-3. Techniques for Advertising and Promoting an HOV Facility, continued

Marketing and Advertising	Content and Potential Use	Case Study Examples
Billboards and Roadside Signs	• Slogans and short messages.	• Dulles Toll Road, Northern Virginia. • I-394, Minneapolis. • Route 44 and I-64, Norfolk. • San Bernardino Busway, Los Angeles.
Bus Signs/Wrapped Buses	• Slogans and short messages.	• Bus signs—I-394, Minneapolis; Barnet-Hastings Express lanes, Vancouver; and I-5, South Seattle. • Wrapped buses—Southeast Expressway, Boston.
Direct Mail	• Targeted information to commuters in corridor.	• I-394, Minneapolis. • Barnet-Hastings Express lanes, Vancouver.
Community Outreach	• Information brochures, flyers, posters, newsletters, videos, and speaker's bureau.	• Southeast Expressway, Boston. • I-394, Minneapolis.
Opening Ceremony	• Ribbon cutting or other ceremony to officially open lane.	• I-35E, Dallas. • I-394, Minneapolis. • Southeast Expressway, Boston. • Houston HOV lanes. • East R. L. Thornton, Dallas.
Special Events	• Time trials of vehicles in general purpose lanes and HOV lanes. • Runs or walks on HOV lanes.	• I-394, Minneapolis. • Southeast Expressway, Boston.
Premiums and Other Techniques	• Telephone hotline. • Cups/mugs. • Litter bags. • Pins. • Pens. • Calendars • Post-it notes.	• I-394, Minneapolis. • I-5 South, Seattle. • Route 44 and I-64, Norfolk. • I-65, Nashville.

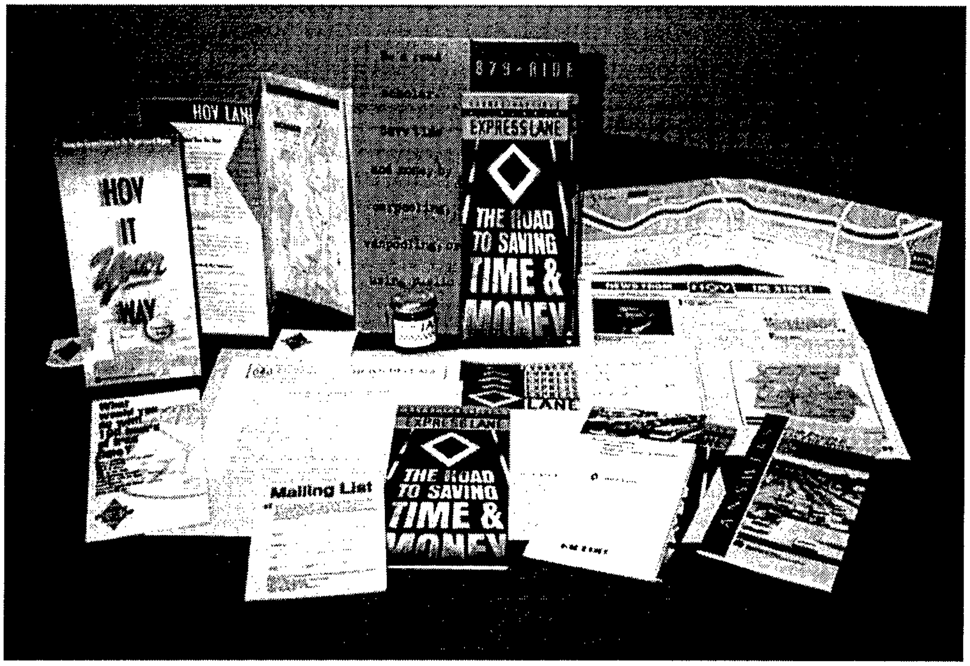

Figure 12-3. Examples of Brochures, Flyers, and Other Promotional Materials

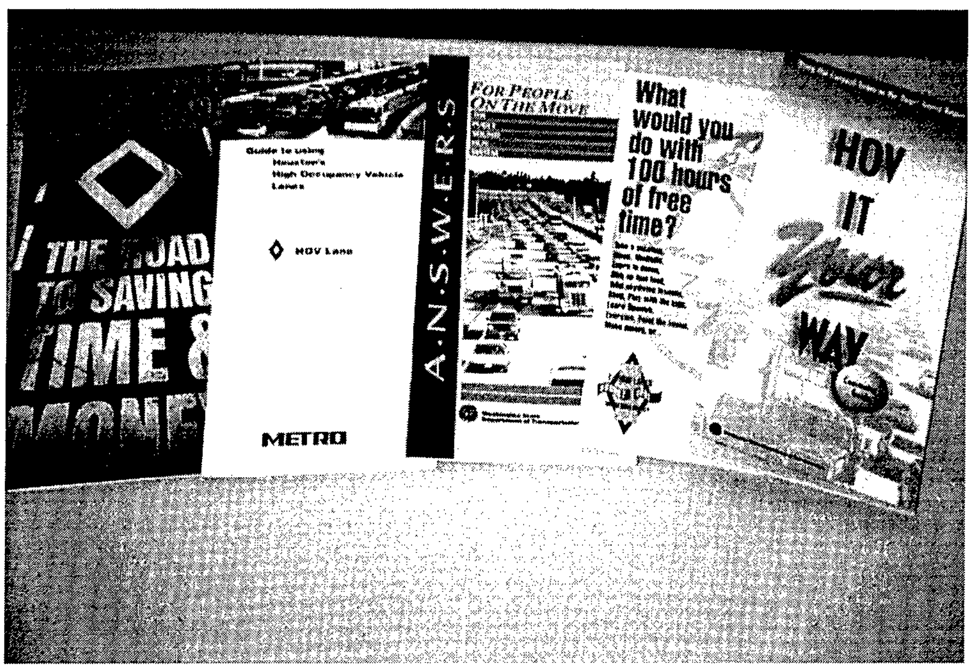

Figure 12-4. Examples of Brochures from Seattle, Houston, and Vancouver

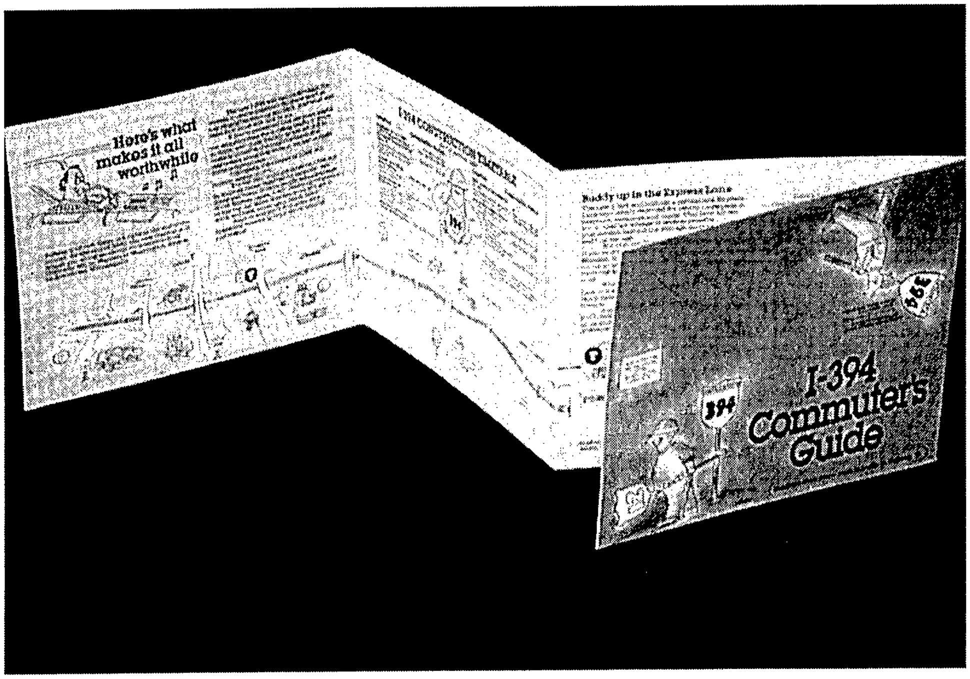

Figure 12-5. I-394 HOV Lane Brochure

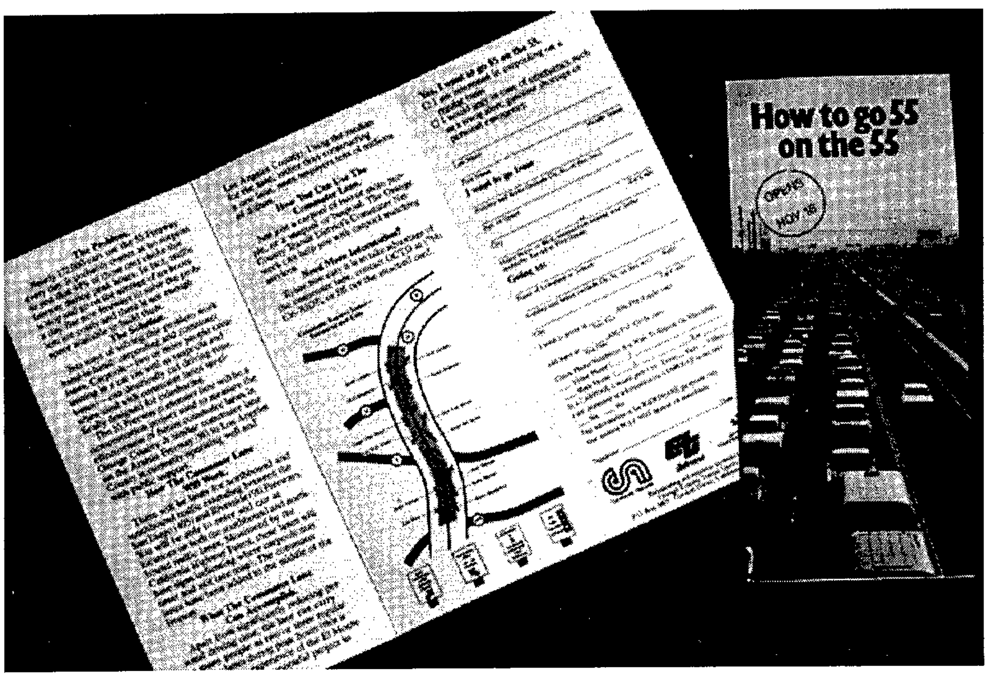

Figure 12-6. Route 55 HOV Lane Brochure

I-394 HOV Lanes, Minneapolis. The Minneapolis Department of Transportation produced a panel foldout, *Commuters Guide*, for the I-394 HOV facility. As shown in Figure 12-5, the *Guide* includes a large map of the facility which highlights the different features including the freeway, HOV lanes, park-and-ride lots, transit centers, and the downtown parking garages.

Route 44 and I-64 HOV Lanes, Norfolk. A brochure was used on the Route 44 and I-64 HOV lanes in Norfolk, Virginia. The brochure provided information on the project, how to use the HOV lanes, and answers to the most frequently asked questions concerning the facility.

Route 55 HOV Lanes, Orange County. A brochure, *How to go 55 on the 55*, was used to promote the opening of the HOV lanes on Route 55 in Orange County, California. As illustrated in Figure 12-6, the brochure included a map of the facility, information on use of the lanes, and a rideshare application. The brochure was developed by Caltrans, in cooperation with Commuter Network and the Orange County Transportation Commission.

The Puget Sound HOV System Brochure. The Washington State Department of Transportation (WSDOT) has a 22-page brochure called *Answers for People on the Move—The Puget Sound HOV System*. This brochure includes a general overview of the HOV system in the Puget Sound area and provides answers to the most frequently asked questions related to the HOV facilities.

I-5 South, Seattle. A brochure was used to promote the opening of the I-5 South HOV lanes in Seattle. The message, *What would you do with 100 hours of free time*?, was used to promote the benefits of the HOV lanes. The brochure, which was sponsored by WSDOT, included a map of the lanes, directions on use, and a form for requesting additional bus, carpool, and vanpool information.

Newsletters. Newsletters provide a regular method of communicating with residents, commuters, businesses, policy makers, and other groups about the status of an HOV facility. Newsletters are an effective mechanism for providing timely information about specific features of a facility or project and for the ongoing promotion of ridesharing and transit services. Newsletters may be oriented toward a specific HOV project, or information about an HOV facility may be included in a regular newsletter that covers a variety of topics.

Newsletters are often used with multi-year projects to help ensure ongoing communication throughout all phases. In these cases, early newsletters may explain the planning process, discuss the alternatives being considered, and provide information on the dates, times, and locations of public meetings and public hearings. In this respect, newsletters can be an integral part of the public involvement process. During later stages of a project, the content of the newsletter can change to providing updates on construction activities, the opening of HOV lane segments and supporting facilities, and information on use of the lane, bus services, and ridesharing programs.

I-394 HOV Lanes, Minneapolis. The Minneapolis Department of Transportation published a regular newsletter, *I-394 Expressions*, over the five-year construction period for the I-394 freeway and HOV facility. The newsletter was first used to acquaint residents, commuters, and businesses to the project. Over the course of the project, the newsletter provided information on the opening and use of the interim HOV lane, called the *Sane Lane*, the timing and phasing of construction activities, the opening of the completed facility, and the supporting components. Figure 12-7 provides example of two newsletters.

I-65, Nashville. A newsletter, *News from the Street*, was published and distributed during the development, implementation, and opening of the HOV lanes on I-65 in Nashville. The newsletter was developed jointly by the Tennessee Department of Transportation and the Regional Transportation Authority with funding from FHWA. The newsletter was used to highlight activities throughout the project. In addition, the Brentwood Area Transportation Management Association (BATMA) distributed newsletters, ridesharing applications, and other information to encourage use of the HOV lanes. Figure 12-8 provides examples of these materials.

I-5 South HOV Lanes, Seattle. A *Study Bulletin* was published quarterly on the I-5 South HOV project in Seattle. The newsletter was mailed to residents in the corridor, distributed at work sites, and handed out on buses. The bulletin provided background information on the project, and updates on the planning process, the alternatives being examined, the selected approach, and the implementation schedule.

Flyers. Flyers are usually single-sheets of paper that provide information about certain aspects of a project. Flyers are a quick and inexpensive technique to get timely information out to a wide range of individuals and groups. Flyers may be mailed directly to targeted groups, handed out at meetings, or distributed at offices and agencies.

Flyers can be used to provide specific and timely information on public meetings and hearings, construction schedules, temporary lane closings, facility opening ceremonies, new bus services, and other project elements. Flyers are thus effective techniques in both public involvement activities and in marketing campaigns.

Figure 12-7. I-394 HOV Lane Newsletters

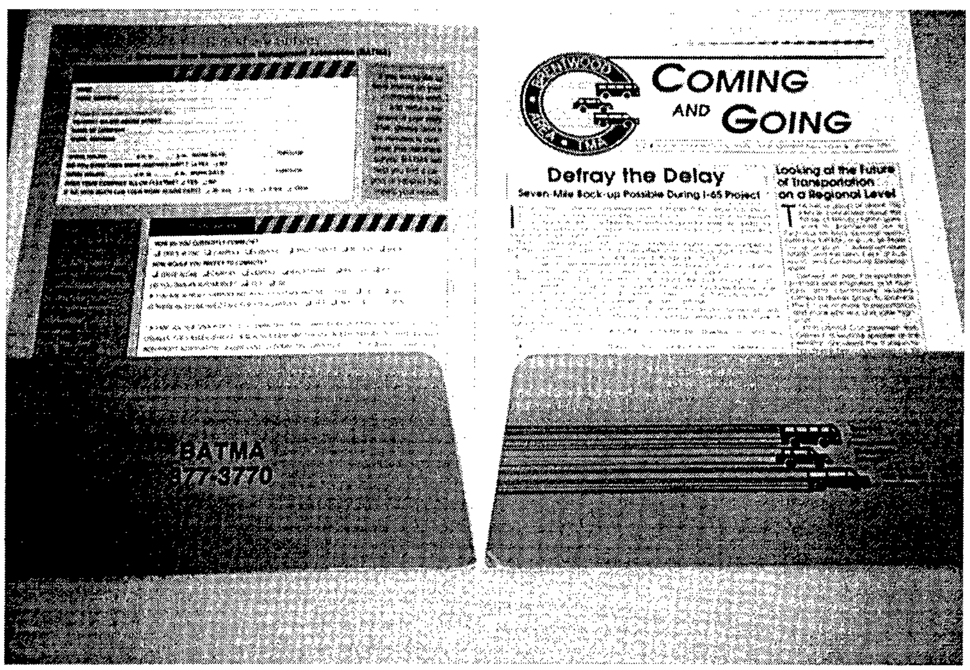

Figure 12-8. Brentwood Area Transportation Management Association Material Promoting I-65 HOV Lanes

I-394 HOV Lanes, Minneapolis. The Minneapolis Department of Transportation used flyers, called *I-394 Briefs*, to provide up-to-date information on specific elements associated with the construction and implementation of the I-394 freeway and HOV facilities. The flyers provided a quick, convenient, and inexpensive technique to communicate temporary detours, lane closings, and other information to area residents and businesses, as well as commuters in the corridor.

Posters. Posters are large signs or information boards that can be placed in key locations such as store windows, public offices, libraries, and community centers. Like flyers, posters are an inexpensive and quick method of providing timely information on key elements of a project. For example, posters can be used to communicate the date, time, and location of public meetings and hearings, update construction schedules and lane closings, and provide other information.

Barnet-Hastings Express Lanes, Vancouver. A poster highlighting *The Road to Saving Time and Money* message was used to promote the Barnet-Hastings Express Lanes in Vancouver, British Columbia. Both large and small posters were distributed to stores, businesses, and other offices along the corridor. The posters were displayed in store windows, on employee bulleting boards, and in other locations.

I-5 South HOV Lanes, Seattle. Large and small posters were part of the marketing package distributed to businesses, neighborhood groups, and other organizations along the I-5 South corridor in Seattle. The posters were partnered with other collateral including bus signs, brochures, and media and elected official information kits, to introduce the opening of the I-5 South HOV lanes.

Orange County HOV Lanes. Posters featuring a freeway crowded with single-occupant vehicles and the caption *in a crowd* were used as part of the print media campaign for the HOV lanes in Orange County, California. The same message was used in newspaper advertisements.

Newspaper Advertisements. Newspaper advertisements can be used to promote use of an HOV facility, announce public meetings and hearings, provide information about the status of construction and lane closings, and promote transit and ridesharing services. Advertisements may be placed in metropolitan papers, as well as community, neighborhood, and regional newspapers.

Newspaper advertising can be expensive, so care should be taken in the use of this approach. Targeting advertising to community and neighborhood newspapers or specific zone editions of metropolitan papers can help ensure that the messages reach the intended markets and can help reduce costs.

Houston HOV Lanes. An automobile dealership in Houston used an advertisement for Acura automobiles that also promotes the Houston HOV lanes.

I-394 HOV Lanes, Minneapolis. Newspaper advertisements were used at selected points during the construction of the I-394 Freeway and HOV lanes. These advertisements were placed in both zone additions of the *Minneapolis Tribune* and local newspapers in the corridor.

I-65 HOV Lanes, Nashville. Newspaper advertisements were used to promote the opening of the I-65 HOV lanes in Nashville. Focusing on the overall theme of *HOV—The Road to the Future*, the advertisements included messages such as *Middle Tennessee's New HOV Lanes will clean up a lot more than just the air*.

Route 44 and I-64 HOV Lanes, Norfolk. Newspaper advertisements were used as part of the media strategy for the opening of the HOV lanes on Route 44 and I-64 in Norfolk, Virginia. The advertisements featured information on how to use the lanes and supporting rideshare and transit services.

Barnet-Hastings Express Lanes, Vancouver. Advertisements in the weekly neighborhood newspapers in the Barnet-Hastings corridor was used to introduce the new HOV facilities. Small "teaser" advertisements were scattered throughout the papers, encouraging readers to look for the "major" advertisements in the same edition.

Radio Advertisements. Radio advertisements, or radio spots, as they are commonly referred to can be an effective part of the promotional mix on an HOV project. Radio spots aired during the morning and afternoon peak-periods, or drive time, can be a good way to reach the target market of commuters, especially those driving alone.

Developing and placing radio advertisements is not inexpensive, but is not overly expensive either. Radio spots are less expensive to produce and play than television commercials for example. The demographic profiles for radio station listeners can be used to help target specific market segments. Radio messages provide the opportunity to personalize and tailor messages to commuters driving alone on congested and slow moving freeways.

Typically, radio spots are developed in 60 second, 30 second, 20 second, or 10 second increments. These various lengths provide flexibility for the message and the costs involved. In addition, a standard jingle or advertisement can be developed with a blank space or "donut" that can be filled with a specific update or message. Another strategy used in some areas is to sponsor live or paid reads by traffic reporters to help promote an HOV project.

I-394 HOV Lanes, Minneapolis. Radio advertising was used to promote the opening of the I-394 interim HOV lane or *Sane Lane*. The jingle "get in the sane lane" was produced for the Minnesota Department of Transportation by a local advertising agency and aired on local radio stations.

Route 44 and I-64, Norfolk. The Virginia Department of Transportation and the Tidewater Regional Transit Commission sponsored live reads by radio traffic reporters during the morning and afternoon peak-periods. The reporters highlighted the conditions in the general-purpose and HOV lanes and noted the travel time savings provided to users of the HOV lanes.

Television Advertising. Television advertising is expensive to produce and to air. As a result, paid television advertising has not been used extensively with HOV projects. As noted below, television advertising has been employed in a few cases. In addition, public service announcements, participating in news or talk shows, and outreach videos can be effective approaches to maximize television exposure for an HOV project.

Videos. Videos represent another approach that can be used to inform the public and policy makers about an HOV facility and to promote carpooling, vanpooling, and riding the bus. The length and content of a video can be tailored to the specific message, the targeted audience, and the available budget and staff resources.

Videos represent a relatively modest cost approach, and many state departments of transportation or transit agencies have video production capabilities. A video can be used for multiple purposes and multiple audiences. For example, videos may be shown at neighborhood or business meetings, provided to commercial and public access television stations, and included in speaker kits.

California HOV Lanes. The California Department of Transportation prepared and disseminated five versions of a video, *Making Carpool Lanes Work for You*. Four of the videos were targeted for the Los Angeles, San Francisco, Sacramento, and San Diego regions. The fifth was focused at a statewide level. The videos were used for a number of different purposes, including local meetings, television, and outreach efforts.

I-394 HOV Lanes, Minneapolis. The Minnesota Department of Transportation prepared a video *I-394 Moving into the Future* to promote the HOV lane and the supporting elements of the facility. The video was used with neighborhood meetings and was shown on the cable television stations serving households in the corridor.

Ottawa Transitway System. The Regional Municipality of Ottawa-Carleton prepared a video on the Ottawa-Carleton Transitway. The video highlights the major elements of the system, the benefits to users of the transitway, and the long-range plans for expansion.

World Wide Web Home Pages and Other Electronic Communication Techniques. A number of electronic communication techniques can be used to promote HOV facilities, ridesharing, bus services, and other supporting components. Home pages on the World Wide Web (WWW) or the Internet, electronic mail (e-mail), and electronic message boards and talk groups represent just a few possible approaches. Although the use of these techniques and access to the Internet are becoming more commonplace, care should still be taken with these approaches as some groups may not have computers or links to the Internet. Although these approaches have not been used to date focusing solely on public involvement and marketing HOV projects, as described next there are a number of good examples of transit and rideshare home pages which emphasize HOV facilities.

Houston METRO Home Page. Houston METRO's Home Page provides information on bus routes, schedules, fares, HOV operating hours, carpool and vanpool programs, and other services. The routes and services operated on the HOV lanes, including those from the major park-and-ride lots are highlighted. The METRO Home Page also provides hot links or connections to other home pages including the Houston real-time traffic map.

King County Riderlink, Seattle. The Riderlink represents one of the first multimodal home pages implemented in the country. Developed through the joint efforts of King County Metro and the Overlake Transportation Management Association, Riderlink provides information on bus routes, schedules, and fares for King County Metro and Community Transit Services. Users can also access information on carpooling and vanpooling, on-line rideshare matching application forms, trip planning request forms, ferry schedules, Metro's Bike & Bus program, and the Washington State Department of Transportation's real-time traffic map.

University of Washington Real-Time Ride Matching Services, Seattle. An on-line ridematching system is being tested at the University of Washington in Seattle. The system, which is one component of the larger Seattle Smart Traveler (SST) project, allows students, faculty, and staff at the University to access a ridematching database through e-mail. A potential user accesses the web side by entering their student or staff identification number or user password. After completing an on-line application form, an individual can request matches for regular commute trips, additional regular trips, and occasional trips. The system generates potential matches and automatically sends an e-mail message with this information.

Washington State Department of Transportation HOV System Home Page. The Puget Sound HOV System Home Page is sponsored by the Washington State Department of Transportation (WSDOT). The home page includes a map of the HOV system in the Seattle area and information on HOV policies, the capital budget for the system, construction activities, and frequently asked questions (FAQs). Links are provided to the real-time freeway traffic condition map, Riderlink, and the HERO program. In addition, an e-mail address is included to allow people to raise questions or comments. The home page is updated on a regular basis. Figure 12-9 provides an example of the Puget Sound HOV System Home Page.

Billboards and Roadside Signs. Billboards and roadside signs provide a relatively inexpensive and effective method of reaching targeted populations for HOV facilities. Billboards and signs located along the freeway or travel corridor can communicate timely messages to motorists driving alone in the congested general purpose lanes. Some billboard companies may offer discounts to public agencies or reserve a portion of their signs for public messages. In addition to billboards, some agencies have used the *Burma Shave* approach to target messages about an HOV facility to commuters in the corridor. Another technique is to promote carpooling and ridesharing on highway signs. In all cases, messages on billboards and signs should be kept brief and to the point.

San Bernardino Busway, Los Angeles. Billboards were used to promote bus service on the San Bernardino or El Monte Busway in Los Angeles. The billboards were sponsored by the Regional Transit District (RTD), now the Los Angeles Metropolitan Transportation Commission. An example of one billboard is provided in Figure 12-10.

I-394 HOV Lanes, Minneapolis. Billboards were used to promote the interim HOV facility in the Highway 12/I-394 corridor. Messages such as *Get in the Sane Lane* and *Go for a Spin in the Sane Lane* were highlighted on billboards located along the corridor during the initial phases of the project. The use of billboards was discontinued in later phases of the project in response to suggestions from focus groups. Figure 12-11 provides an example of one billboard located in the I-394 corridor.

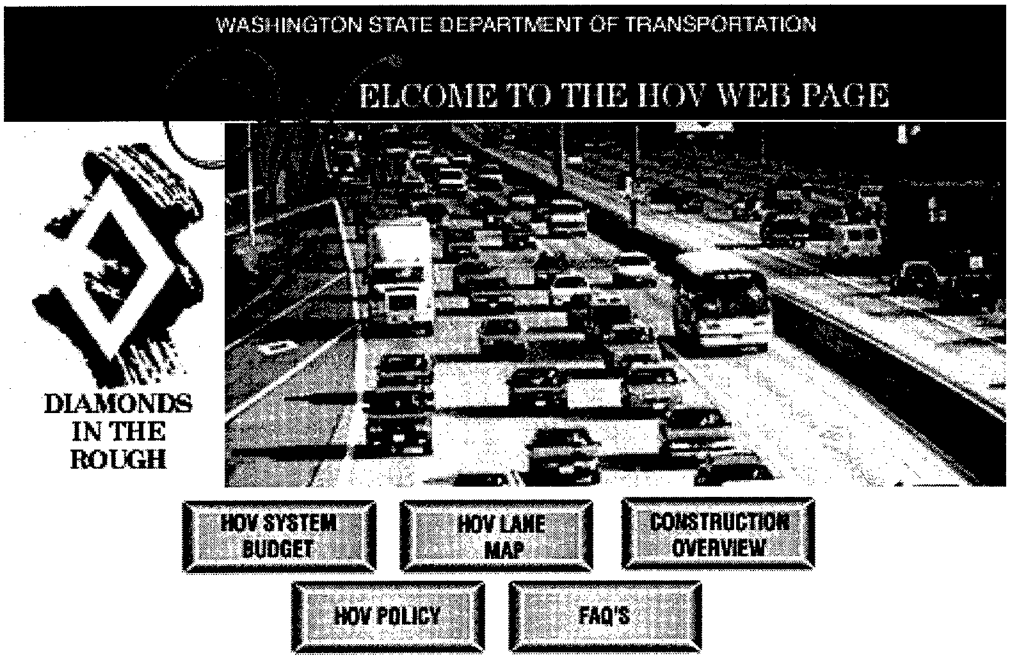

Figure 12-9. Puget Sound HOV System Home Page

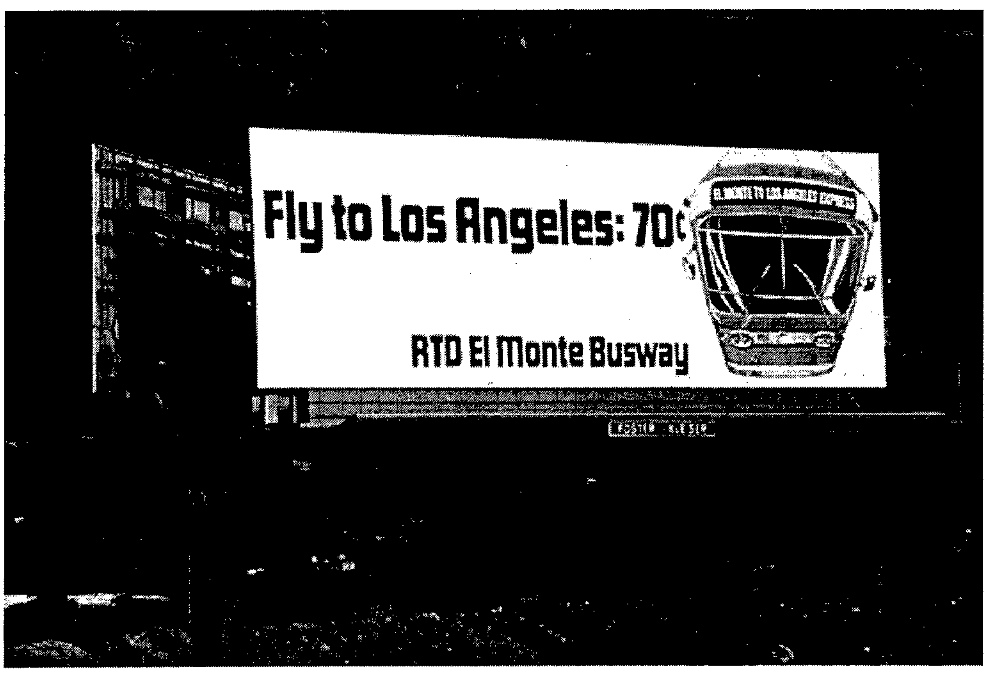

Figure 12-10. Billboard on the El Monte or San Bernardino Busway

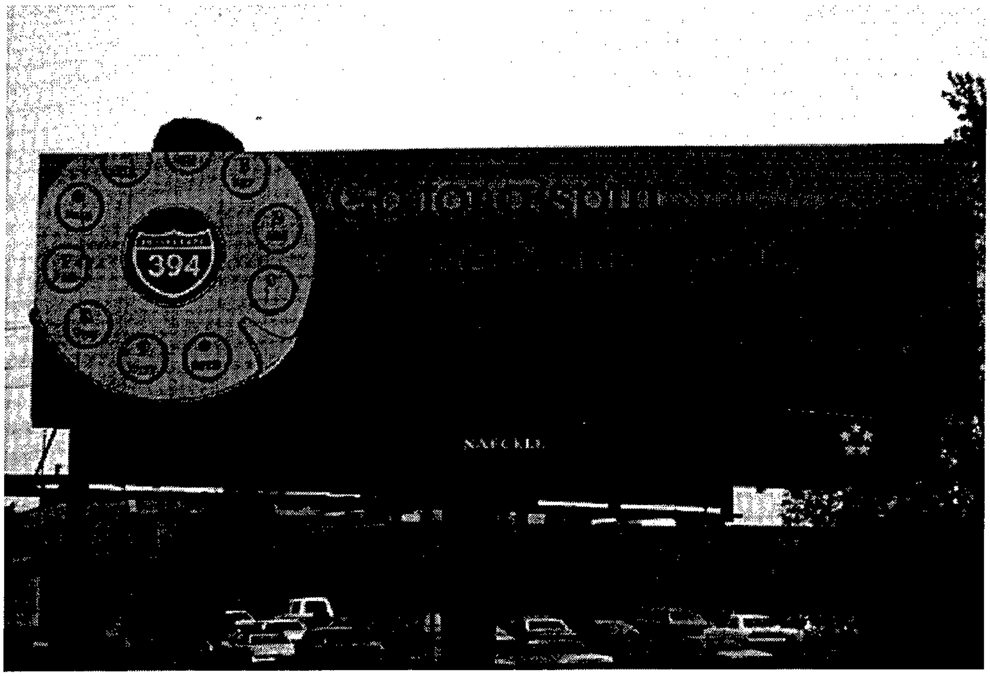

Figure 12-11. Billboard Promoting the I-394 HOV Lanes

Route 44 and I-64 HOV Lanes, Norfolk. Burma Shave signs or roadside jingles were used to promote the HOV lanes in the Norfolk area. The following jingles highlight examples of the signs.

Fewer Cars	Less Pollution	Be a Part of	The Solution
Bumper to Bumper	Set Yourself Free	Go the Distance	With HOV

Dulles Tollroad HOV Lanes, Northern Virginia. Burma Shave signs were also used on the Dulles Tollroad after the HOV requirement was removed. These signs, which included the following message, drew negative feedback from some commuters and policy makers, and were removed.

Those HOV Lanes	Took A Licking	But the Traffic Bomb	Keeps on Ticking

Bus Signs and Wrapped Buses. Some transit agencies allow advertising on the outside of their buses. Traditionally, advertising has been displayed on the side or back of buses. A more recent development is the use of wrapped or painted buses. In this approach, a bus is painted or wrapped with a specific message or advertising. This technique has been used to promote buses serving a special public facility, such as a zoo, while in other cases it has been used to advertise an event or product.

Southeast Expressway HOV Lane, Boston. A wrapped bus was used to promote the contraflow HOV lane on the Southeast Expressway in Boston. The bus operated on regular routes in the corridor and was used for press tours and other promotional activities.

I-394 HOV Lanes, Minneapolis. Bus signs were used to promote the I-394 interim and final HOV lanes. Most of the buses carrying the advertising operating in the corridor, but due to scheduling, some traveled in other parts of the metropolitan area. The bus signs were provided by the Metropolitan Transit Commission, as part of the multiagency marketing program.

I-5 South HOV Lanes, Seattle. Signs on both the sides and the back of buses represented one component of the marketing program for promoting the opening of the I-5 South HOV lanes in the Seattle area. A high volume of buses operate in the corridor, enhancing the use of this technique.

Barnet-Hastings Express Lanes, Vancouver. Signs on the exterior of buses operating in the Barnet-Hastings corridor were used to announce the opening of the HOV lanes. The bus signs were a key part of the overall marketing program for introducing the Express Lanes.

Direct Mail. Brochures, newsletters, flyers, bus schedules, rideshare registration forms, and other information related to an HOV facility can all be distributed directly to residents through the mail. Direct mail provides the opportunity to target specific markets and to provide personalized information. Direct mail is a relatively inexpensive way to distribute information on an HOV project. A disadvantage of this approach is that households receive large volumes of "junk mail" these days, and the HOV information may be lost among other advertising.

I-394 HOV Lanes, Minneapolis. Direct mail marketing was used at various points throughout the implementation of the interim and final HOV facilities on I-394. The I-394 brochure, I-394 newsletters, flyers, and other information were periodically mailed to some 65,000 households and businesses in the I-394 corridor.

Barnet-Hastings Express Lanes, Vancouver. A mailing to approximately 60,000 households in the Barnet-Hastings corridor was a major component of the marketing program introducing the new Express Lanes. The mailing, which included a brochure, a postage-paid card for requesting carpool information, and other material, was sent two weeks before the opening of the facility.

Community Outreach. In addition to conducting community outreach activities as part of the planning process, some areas have continued these efforts throughout the implementation phase to help introduce and promote use of the HOV facility. Meetings, fairs, workshops, and other activities can all be used to help explain the project, provide information on use of the facility, and distribute bus schedules and rideshare registration materials.

> **I-394 HOV Lanes, Minneapolis.** Meetings with businesses, neighborhood groups, and local officials in the corridor were held throughout the implementation process. These meetings provided updated information on construction activities, lane closings and rerouting, and bus and rideshare services.

Opening Ceremonies and Special Events. Almost all HOV projects have used an opening ceremony, ribbon cutting, or other special event to officially kick-off the operation of the HOV facility. These types of events draw attention to the project, provide the opportunity to recognize participating agencies and sponsors, and introduce the facility to the public. In addition to opening ceremonies, some areas have used events such as time trials of vehicles in the HOV lanes and general purpose lanes, parades, or other activities to help promote the facility.

Premiums and Other Techniques. A variety of other techniques and approaches can be used to market and promote HOV facilities and supporting services. Premiums are intended to maintain the visibility of a product, project, company, agency, or service. In the case of an HOV facility, premiums might promote the opening of a facility, ridematching assistance, and bus service in the corridor.

> **I-394 HOV Lanes, Minneapolis.** A number of premiums and other approaches were used to promote both the interim and the final HOV lanes on I-394. A telephone information service, HELP-394, was used during the implementation of the interim HOV lane to provide current information on the use of the facility, bus and rideshare services, construction updates, and lane closings. Litter bags, calendars, coffee mugs, and other items were also used to promote the facility.

> **I-65 HOV Lanes, Nashville.** A variety of premiums were used during the opening phases of the I-65 HOV lanes. These included t-shirts, coffee mugs, and other promotional items.

> **Route 44 and I-64, Norfolk.** Small jars of grape jam—called *Traffic Jam*— were used to highlight congestion problems in the Norfolk area. The jars were given to participants at a transportation workshop that focused on the development and implementation of the HOV lanes.

I-5 South HOV Lanes, Seattle. Post-it notes with the diamond logo for the I-5 South HOV lanes were used as promotional items during the implementation of the project. The post-it notes were distributed to downtown employees and to other groups in the corridor.

E. Initial Efforts and Ongoing Programs

The advertising and marketing program for introducing a new HOV facility should be initiated approximately two to three months before the facility is opened to the public. A more concentrated effort should be undertaken in the weeks just prior to the opening. Significant advertising and promotional activities should also be continued through the first months of operation and on an ongoing basis. The duration and content of the different marketing phases are summarized in this section.

Pre-Implementation Phase. The pre-implementation phase of a project is usually defined as the two to three months prior to the opening of a facility. This time period should be the start of the major advertising efforts on the project. During this time period, information should be made available on how to use the HOV facility, bus and rideshare services, and other supporting programs. The message should promote the benefits of the facility and changing to an HOV mode.

Implementation Phase. This phase includes the opening of the facility and the first few months of operation. An opening ceremony is often used to kick-off use of the HOV facility. Advertising and promotional activities are especially important during this phase to encourage use of the facility and to communicate realistic expectations to users, non-users, policy makers, and other key stakeholders.

Ongoing Phase. Marketing does not stop with the opening of a facility. Advertising and promotional activities should be continued throughout the life of a project, although lower levels may be appropriate. Ongoing efforts are needed to continue to encourage use of buses, vanpools, and carpools. Over time, new commuters will be traveling in the corridor, existing commuters will change work or home locations, and other factors will influence travel behavior. Messages which continue to reinforce the travel time savings, travel time reliability, and other benefits of the HOV facility are needed.

VI. EVALUATING A PUBLIC INVOLVEMENT AND MARKETING PROGRAM

Evaluating the public involvement and marketing activities conducted as part of an HOV project should be one component of an overall monitoring and evaluating program for a facility. Chapter 13 presents guidelines for developing and implementing a comprehensive evaluation program for an HOV facility. This section discusses some of the elements unique to evaluating the public involvement and marketing components of a project.

A. Purpose and Use of an Evaluation Plan

Evaluating the public involvement and marketing elements of an HOV project provides a number of benefits. First, an evaluation can help identify if the goals and objectives of the public participation and marketing programs have been realized. Second, an evaluation can help identify the impact and cost-effectiveness of the various techniques utilized in the program. Finally, the information generated through an evaluation can enhance future efforts on the project and on other facilities in the area.

The results of an evaluation will be of interest to a variety of groups. The transportation professionals responsible for the project will be interested in identifying the public involvement techniques and approaches that generate the greatest level of citizen participation. They will also be interested in determining the effectiveness of the marketing research techniques and promotional activities utilized with a project. Marketing professionals will use the results to identify the most cost-effective media for future efforts and other projects. Policy makers and the public will also be interested in ensuring that resources will be used wisely for marketing and that adequate opportunities are provided for public participation.

B. Components of a Marketing Evaluation Plan

Three levels are usually examined in evaluating marketing efforts. These are exposure, reaction, and impact. Each of these levels focuses on answering different questions. The ability to analyze each question becomes increasingly difficult. The nature of each level and the techniques that can be used to evaluate the marketing activities conducted in each are summarized next.

Exposure. This element focuses on who was reached by the campaign. The size, nature, and characteristics of the audience are examined. The extent to which the targeted market was reached by the advertising is assessed. Exposure is usually measured through the use of television and radio station logs and arbitron ratings, newspaper circulation figures, billboard viewer impressions based on average daily traffic, the distribution lists for newsletters, the number of "hits" on a home page, and the number of brochures and flyers distributed.

Reaction. The second level, that of measuring the public's reaction to a specific advertising technique and message, is more difficult. Measuring the public's awareness of the campaign, their understanding of the message, and any changes in their behavior are usually part of this element. Focus groups, telephone surveys, and self-administered questionnaires are often used to measure the public's reaction to marketing campaigns.

Impact. The third level attempts to assess the impact of the marketing activities on the goals and objectives of the HOV project. It attempts to examine if the marketing program actually led individuals to change from driving alone to carpooling, vanpooling, or taking the bus. This level ties directly into the overall evaluation of the HOV project discussed in more detail in Chapter 13. Changes in vehicle occupancy levels, new bus riders, and new carpools and vanpools all represent measures of effectiveness used at this level.

C. Data Collection and Analysis

As noted in Section B, the evaluation of a marketing program usually focuses on three elements. These are exposure, reaction, and impact. The data collection activities should focus on obtaining the necessary information to assess the impact of the marketing activities on these elements. Table 12-4 highlights the data collection efforts commonly incorporated into marketing evaluation programs.

The data obtained from the sources highlighted in Table 12-4 can be used to assess the impact of the marketing and public information program. The analysis should examine the success of the different marketing techniques at delivering the desired message and the extent to which people made changes in their commute behavior based on this information.

D. Initial Assessment and Ongoing Monitoring

An initial assessment is usually conducted of the marketing and public information program used to introduce a new HOV facility. This evaluation should examine the exposure or reach of the various techniques, the reaction to these, and changes in travel behavior. As noted previously, the data collection activities associated with the first element, exposure, are relatively easy to obtain from print, broadcast, and electronic media. Conducting focus groups and surveys to obtain information on reaction and impact is more time consuming and costly, but provides critical information on the effectiveness of the marketing efforts and the HOV facility.

The results from the initial assessment can be used to modify a marketing program or make other changes as needed. Further, the evaluation can assist with the development of future marketing efforts on the same facility or with the introduction of new HOV lanes in the area.

The ongoing monitoring of marketing and public information efforts should be included as part of the continuing evaluation program discussed in Chapter 13. These efforts should focus on the three elements described previously—the exposure, reaction, and impact—of the various techniques used to promote the opening and ongoing use of new HOV facilities.

VII. CASE STUDIES

This section presents case study examples of public involvement and marketing programs used with HOV facilities in separate rights-of-way, on freeways, and on arterial streets. The case studies included were selected to provide examples of more comprehensive approaches with various types of HOV projects. Examples are included of the techniques used with priority pricing and converting a general purpose lane to an HOV lane.

Table 12-4. Examples of Data Collection Techniques to Evaluate HOV Facility Marketing Programs

Evaluation Component	Possible Data Collection Techniques and Measurements
Exposure	• Television station log—size of audience. • Radio station log—size of audience. • Arbitron or other ratings—size of radio and television audience. • Newspaper circulation figures—number of households reached. • Average daily traffic on roadways with billboards—viewer impressions. • Distribution lists for newsletters—number of households reached. • Attendance lists at meetings and other sessions—number of individuals reached. • Number of "hits" on home page—number of individuals reached. • Number of brochures and flyers distributed—number of individuals reached.
Reaction	• Focus groups—awareness and understanding. • Telephone surveys—awareness and understanding. • Surveys on Home Page, e-mail, or Internet—awareness and understanding. • Mail surveys—awareness and understanding.
Impact	• Changes (increases) in transit ridership, carpools, and vanpools. • Increase in auto occupancy levels in corridor. • Surveys of bus riders, carpoolers, and vanpoolers.

A. Separate Right-of-Way HOV Facilities—Case Studies

A variety of public involvement and market research techniques have been used in planning the bus-only facilities in Pittsburgh, Ottawa, Minneapolis-St. Paul, and Miami. These include more traditional approaches, as well as innovative techniques. For example, business and neighborhood groups were actively involved in the design of the stations along the East Busway in Pittsburgh. As highlighted next and in Table 12-5, a variety of approaches are being used in planning and implementing the new Airport Busway/Wabash HOV facility in Pittsburgh.

Table 12-5. Airport Busway/Wabash HOV Facility Case Study

General Elements	Techniques
Planning and Public Involvement	• Multiagency team. • Newsletters. • Community Station Design Advisory Committees. • Meetings with businesses. • Public hearings.
Public Information and Marketing	• Newsletters. • Meetings with businesses and neighborhoods groups.
Responsible Agency	Port Authority of Allegheny County.

Airport Busway/Wabash HOV Facility, Pittsburgh. The Airport Busway/ Wabash HOV facility in Pittsburgh includes a number of components. The Wabash HOV portion will provide exclusive access to buses and HOVs through the Wabash Tunnel. The Airport Busway will connect with the tunnel at Station Square and will provide an exclusive roadway for buses to the airport. The project also includes a new bridge over the Monogahela River and other improvements. The Port Authority of Allegheny County (PAT) is using a variety of public involvement techniques over the five year construction schedule of the project. These include a regular project newsletter, community station design advisory committees, neighborhood meetings, updates to businesses and community groups, hearings, and other activities. A ground breaking ceremony was held and press coverage is being encouraged on other project milestones.

B. Freeway HOV Facilities—Case Studies

There a number of examples of comprehensive public involvement and marketing programs with HOV facilities on freeways. The projects summarized in this section highlight examples of approaches used with different types of freeway HOV lanes.

Southeast Expressway Contraflow HOV Lane, Boston. A six-mile contraflow HOV lane was opened on the Southeast Expressway in November 1995. The facility uses the movable barrier technology to convert a general-purpose lane in the off-peak direction of travel. The Massachusetts Highway Department (MassHighway) is responsible for the overall planning, implementation, and operation of the facility. Table 12-6 highlights the elements included in the Southeast Expressway public involvement and marketing program.

Table 12-6. Southeast Expressway Contraflow HOV Lane Case Study

General Elements	Techniques
Planning and Public Involvement	• Multiagency team. • Neighborhood meetings. • Public hearings.
Public Information and Marketing	• Public relations—media tours, time trial, meetings. • Newspaper advertising. • Radio advertising. • Wrapped bus. • Grand opening ceremony
Responsible Agency	• Massachusetts Highway Department (MassHighways).

Two previous HOV facilities had been implemented and discontinued on the freeway during the 1970s. These included a contraflow HOV lane in 1971 and a converted general-purpose lane in 1977. The contraflow HOV lane had public support and was well used, but was discontinued due to operational problems with setting up and removing the pylons for the facility. The conversion of a general-purpose lane to an HOV lane was terminated due to lack of public support.

In examining the potential for an HOV facility in the 1990s, MassHighway utilized a more active public involvement and marketing effort. First, the Department organized a multi-agency team to assist with the feasibility study. The team included representatives from other transportation and transit agencies, local communities, enforcement agencies, and neighborhood groups. The team was involved throughout the analysis of alternatives and the selection of the preferred option.

Once the decision was made to implement a contraflow HOV lane with a moveable barrier, a public information and marketing program was developed to introduce the facility and to promote its use. A budget of approximately $500,000 was allocated for this effort. The *HOV Lane Marketing Manual* and comments and questions received from local groups and the multiagency team were used to help guide the development and implementation of the marketing program.

The public and media seemed to focus on the machine used to create and take down the barrier. As a result, the *Zipper Machine*, as it is called, became the focal point for much of the marketing and public outreach activities. Approximately 20 percent of the marketing budget was used to fund a public relations program. A public relations agency and two advertising firms were hired to assist with this portion of the program. Activities conducted during this phase included media tours of the lane, the *Zipper Truck*, and the operations center. A time trial between a vehicle traveling in the HOV lane and the general-purpose lane was also staged to promote the travel time savings provided by the lane.

Advertising comprised approximately 70 percent of the available budget. Newspaper advertising, radio spots, and an illustrated bus represented the major focus of the advertising campaign. A light tone was taken with the promotional activities. One of the themes, *It's Your Choice*, stressed the advantages of using the HOV lane without criticizing driving alone.

I-394 HOV Lanes, Minneapolis. An extensive public involvement and marketing program was used in planning, implementing, and operating the I-394 HOV facility. The project represented the construction of the last segment of the interstate system in the Minneapolis-St. Paul area and was constructed on the right-of-way of an existing roadway, Highway 12. The approximately 17 kilometer (11-mile) project included the freeway, concurrent flow HOV lanes, barrier separated reversible HOV lanes, transit centers and park-and-ride lots, and three parking garages on the edge of downtown Minneapolis with direct connection to the HOV lanes. Table 12-7 highlights the market research, public involvement, and marketing activities associated with the I-394 project.

Due to the complexity of the project and the long and somewhat controversial history of the facility, the Minnesota Department of Transportation(Mn/DOT) used a comprehensive public involvement and marketing program to plan, implement, and operate the project. A multiagency team was formed to assist with all phases of the project. The team included representatives from the MPO, the transit operating agency, the transit planning agency, the state patrol, local communities, and other groups. Techniques used in the public involvement process included neighborhood meetings and outreach efforts, briefings with businesses, meetings with business organizations, hearings, newsletters, and other techniques.

An extensive market research program was conducted to help identify the needs of various user groups, to test possible slogans and marketing techniques, and to develop a baseline of information on commuter behavior. Focus groups of corridor commuters and residents, employer discussion groups, and telephone surveys of residents represented the primary market research techniques used on the project.

Table 12-7. I-394 HOV Lanes Case Study

General Elements	Techniques
Market Research	• Assessment of national experience with HOV lanes. • Focus groups of corridor commuters and residents. • Telephone survey of corridor commuters.
Planning and Public Involvement	• Multiagency teams. • Brochure. • Newsletters. • Neighborhood meetings. • Meetings with businesses. • Meetings with elected officials.
Public Information and Marketing	• Telephone information hotline. • Radio advertisements. • Newspaper advertisements. • Brochure. • Newsletter. • Flyers. • Posters. • Time trials. • Billboards. • Bus signs. • Grand opening ceremony.
Responsible Agency	• Minnesota Department of Transportation (Mn/DOT).

The market research results were used to develop a promotional campaign. The marketing effort focused on different phases of the project. These included the opening of the *Sane Lane* or interim HOV lane, the lengthy construction period, the opening of the completed HOV and freeway facility, and the ongoing operation. Since the *Sane Lane* represented the first use of an HOV lane in the area, extensive marketing and public outreach activities were utilized during the opening of this facility. Campaign elements included a brochure on the project, the *I-394 Expressions* newsletter, direct mail of these pieces and transit and ridesharing information to households in the corridor, a *Sane Lane* radio spot, a HELP-394 telephone information hotline, flyers with construction updates, billboards, newspaper advertisements, bus-side advertising, media relations, a grand opening event, and other special activities.

Many of these activities were continued throughout the multiyear construction period. For example, flyers and newsletters were used to keep businesses, residents, and commuters informed of construction activities, lane closings, and reroutings. Additional market research was also conducted during this phase to help evaluate commuters use of and reaction to the facility and the exposure, reaction, and impact of the various advertising techniques. A second major marketing effort was undertaken with the opening of the final facility. This effort included most of the media noted previously. A lower level of marketing, focusing primarily on the more traditional ridesharing and transit promotions, has been continued.

The initial market research activities and promotions for the opening of the *Sane Lane* was funded at approximately $1.5 million. Subsequent efforts averaged approximately $200,000 a year. Since the opening of the final facility the market budget has dropped off. Funding for the various activities came from a combination of federal, state, and local sources. Federal Interstate funds were used with a state match for much of the early activities. Interstate funds could be used for providing information on the use of the facility, but not direct advertising. Other federal and state programs, as well as local funding sources, were used for the transit and ridesharing promotions, as well as other program components.

I-5 South HOV Lane, Seattle. The I-5 South HOV lane case study provides an example of the involvement of a citizen's group in the planning process, which resulted in the opening of the temporary HOV facility earlier than initially scheduled. The Washington State Department of Transportation included market research and marketing components in the planning activities for the project. Market research elements included a telephone survey of corridor residents and executive interviews. Table 12-8 highlights the public involvement and marketing components included in the I-5 South project.

A major portion of public involvement effort focused on a citizen group called Southend High-Occupancy Vehicle Enthusiasts (SHOVE). This group, which favored the early implementation of the HOV lanes, used a number of techniques to promote its position. These included presenting the Department with a petition signed by some 2,000 commuters, testifying before the State Transportation Commission, and presenting their case through the press. These actions were effective in helping convince the Department to move up the implementation schedule for the HOV lanes.

Marketing and advertising techniques used with the project included a logo, bus tours, agency and jurisdictional kick-off briefings, media relations, newsletters, displays, special events, post-it notes, buttons, brochures, posters, and bus signs.

Table 12-8. I-5 South HOV Lanes Case Study

General Elements	Techniques
Market Research	• Telephone survey of corridor residents. • Executive interviews.
Planning and Public Involvement	• Multiagency teams. • Meetings with Southend High-Occupancy Vehicle Enthusiasts (SHOVE). • Neighborhood meetings. • Meetings with businesses. • Newsletters.
Public Information and Marketing	• Media relations—bus tours, media kit. • Agency and jurisdictional kickoff briefings. • Newsletters. • Brochure. • Posters. • Special events. • Bus signs. • Post-it notes. • Buttons.
Responsible Agency	• Washington State Department of Transportation.

C. Arterial Street HOV Facilities—Case Studies

Fewer examples exist of comprehensive public involvement and marketing programs with arterial street HOV facilities. Reasons for the lack of extensive citizen participation and marketing efforts with arterial streets include smaller and more targeted applications which may impact fewer people and groups, bus-only projects, and other unique features. As summarized next, there are a few examples of more extensive efforts. These examples are followed by suggestions for elements to be considered in public involvement and marketing programs with arterial street HOV applications.

The Barnet-Hastings People Moving Project, Vancouver, British Columbia. This 20 kilometer project includes a combination of HOV facilities on the Barnet Freeway and on Hastings Street in Vancouver. The Hastings Street portion of the project required the removal of approximately 130 on-street parking spaces, as well as new street lights, sidewalks, trees, benches, curbs, and gutters, five new signalized intersections, and bicycle facilities. As a result, it required additional public involvement and marketing efforts. The elements public information and marketing components associated with the project are highlighted in Table 12-9.

The British Columbia Ministry of Transportation and Highways had overall responsibility for the project.

Table 12-9. Barnet-Hastings Express Lanes Case Study

General Elements	Techniques
Planning and Public Involvement	• Multiagency teams. • Meetings with neighborhood groups, schools, and businesses.
Public Information and Marketing	• Brochure. • Newsletters. • Posters. • Media kit. • Bus signs. • Newspaper advertisements. • Radio public service announcements.
Responsible Agency	• British Columbia Ministry of Transportation and Highways.

Special outreach efforts were made to business owners along the corridor who were concerned about the removal of on-street parking. Meetings were held with merchants to discuss the project and alternative parking arrangements. Another concern was voiced by school administrators and parents who did not want the lane open when children would be crossing the street to go to school. After meetings with these groups, the operating period of 6:00 a.m. to 8:30 a.m. was established as a compromise to accommodate commuters, businesses, and the school.

A limited budget of approximately $130,000 Canadian was available for the project. These limited resources were maximized through the involvement of *Go Green*, which is a consortium of public agencies in the Vancouver area committed to encouraging environmentally friendly behaviors and activities. This group helped support the project and participated in a variety of marketing and public information activities.

Slogans, including *Be a Roads Scholar*, *Time Travel Begins in September*, and *Group Savings Plan Starts in September* were used with the various marketing materials. Promotional efforts included brochures and newsletters, which were distributed to businesses and mailed directly to households in the corridor, bus signs, a media kit, advertisements in suburban newspapers, public service announcements, work place displays, and special efforts focusing on businesses along Hastings Street.

D. Converting a General-Purpose Lane to an HOV Lane—Case Studies

Santa Monica Diamond Lanes, Los Angeles. The Santa Monica Diamond Lanes is the project usually referred to in the discussion of converting a general-purpose lane to an HOV lane. This project, which was in actual operation for approximately seven weeks in 1976, converted seven miles of a general-purpose lane on the Santa Monica Freeway in Los Angeles to an HOV lane. Although the lane worked from an operational standpoint, the public reaction was so negative that the project was discontinued. There were numerous reasons for the failure of this project, the lack of an adequate public involvement and marketing program may be partly to blame. The promotional program included radio, newspaper, and television advertisements, billboards, and brochures handed out on the freeway on ramps. These approaches were unable to overcome the large volume of negative publicity that was generated on the project, and it was discontinued after seven weeks of operation. Table 12-10 highlights the techniques used with the Santa Monica Diamond Lane project.

Table 12-10. Santa Monica Diamond Lanes Case Study

General Elements	Techniques
Public Information and Marketing	• Radio advertisements. • Newspaper advertisements. • Television. • Billboards. • Brochures.
Responsible Agency	• California Department of Transportation.

Dulles Toll Road HOV Lanes, Northern Virginia. The 12-mile Dulles Toll Road links Dulles International Airport to Tyson Corner. In 1992, the Virginia General Assembly approved legislation to add one lane in each direction to the facility and stipulated that these be reserved for HOVs during the morning and afternoon peak hours. A six-mile segment was completed in 1991, one year in advance of the completion date for the full 12-miles and the anticipated implementation of the peak-period HOV restrictions. The lanes were open to all traffic as the various segments were completed. When the HOV requirements were implemented there was a vocal negative response, which included the formation of the Citizens Against Dulles HOV (CAD HOV) group and support from the local Congressman. As a result, the Virginia Department of Transportation rescinded the HOV requirement. Table 12-11 highlights the public information and marketing components associated with the Dulles Toll Road HOV lanes.

The Virginia Department of Transportation conducted a survey of commuters in the corridor approximately a year before the opening of the HOV lanes. The survey results indicated that some 300 current carpools met the 3+ requirement and that 32 percent of the respondents felt the HOV lanes were a good idea. The low number of existing carpools and the minority of commuters favoring the lane may have sent early warning signs to the Department (1). A number of marketing approaches were used to inform the public of the opening of the HOV lanes and to promote the formation of carpools and vanpools. The included Burma Shave signs, bus-side advertisements, brochures, and an opening day ceremony. These elements were not enough to overcome the strong opposition to the HOV lanes from the public and a few politicians.

I-90 HOV Lanes, Seattle. In 1993 and 1994, general-purpose lanes in each direction of travel on an 11-kilometer (7 mile) section of I-90 between Issaquah and Bellevue in the Seattle area were converted to HOV lanes by the Washington State Department of Transportation (WSDOT). The HOV lanes connect to the HOV lanes on the Lake Washington Bridge, which were in operation when consideration of the lane conversion project was initiated. The project converted one of the four general-purpose lanes in each direction to an HOV lane.

Table 12-11. Dulles Toll Road HOV Lanes Case Study

General Elements	Techniques
Market Research	• Survey of commuters in corridor.
Public Information and Marketing	• Burma Shave type signs. • Bus signs. • Brochures. • Opening ceremony.
Responsible Agency	• Virginia Department of Transportation.

A number of elements contributed to the success of this project, including many related to the public involvement and marketing activities. As highlighted in Table 12-12, the first element was a reexamination of the WSDOT policy on when lane conversion projects would be considered. Initially, the WSDOT policies related to adding HOV lanes only as part of new construction. After a study examining the opportunities and issues associated with lane conversion projects, the Department revised these policies to include consideration of lane conversion to address capacity deficiencies.

Table 12-12. I-90 HOV Lanes Case Study

General Elements	Techniques
Policy Development	• WSDOT policies revised—converting a general-purpose lane to be considered with projects addressing capacity deficiencies.
Planning and Public Involvement	• Consensus building efforts. • Neighborhood and public meetings. • Agency coordination. • Outreach to elected officials.
Public Information and Marketing	• Newsletters. • Flyers. • Newspaper advertisements. • Media relations.
Responsible Agency	• Washington State Department of Transportation.

The Department undertook an extensive consensus building effort during the planning process for the project. Key elements at this stage included neighborhood and other outreach meetings, agency coordination, and obtaining support from elected officials. Once the decision had been made to proceed with the project, marketing activities included media relations, newsletters, flyers, and newspaper advertisements. The project was implemented successfully. The volumes in the HOV lanes have been good, and the level of service in the remaining three general-purpose lanes have remained satisfactory.

E. Priority Pricing on HOV Facilities—Case Studies

There is little experience with the actual use of priority congestion pricing with HOV facilities. One project, the SR 91 Express Lanes in Southern California, currently utilizes a pricing mechanism and priority pricing studies with HOV facilities in Houston and San Diego are underway.

Route 91 Express Lanes. The Route 91 Express Lanes were opened in December 1995. The Express Lanes are located in the median of Route 91 in Southern California and represent the first of four private toll road projects authorized by the California State Legislature in 1989. The Route 91 Express Lanes were financed and constructed, and are operated by a private consortium. The ten-mile facility includes 2 lanes in each direction and electronic toll collection using automatic vehicle identification (AVI) technology. Currently, vehicles with 3 or more riders can use the facility for free, but a transponder is still required on the vehicle. Tolls for other vehicles range from 25 cents to $2.50 during peak-hour. A variety of techniques have been used to promote use of the facility. These include newspaper advertisements, press releases, an opening ceremony, and other media. Table 12-13 highlights the techniques used with the Route 91 Express Lanes Case Study.

Table 12-13. Route 91 Express Lanes Case Study

General Elements	Techniques
Public Information and Marketing	• Newspaper advertisements. • Press releases. • Opening ceremony.
Responsible Agency	• California Transportation Company (private).

I-10 West HOV Lane Priority Pricing Study, Houston. A study examining the potential for a priority pricing demonstration on the I-10 West HOV lane in Houston was conducted in 1995 and 1996. The study was funded through the ISTEA priority pricing demonstration program and was sponsored by Houston METRO and TxDOT. The study examined the potential of allowing 2+ carpools to use the HOV lane for a fee during the morning and afternoon peak-periods, when a 3+ vehicle occupancy is required. In addition to the economic and technical analysis, the study included a market research component. This element included a literature review and focus groups of commuters in the corridor and residents throughout the Houston area. The results of these activities were used in developing the recommended approach for a demonstration project. It is anticipated that the demonstration called *QuickRide*, will be implemented in late 1997. Marketing and promotional efforts will be part of the demonstration. The market research conducted on this project, as well as the anticipated promotional activities, are highlighted in Table 12-14.

I-15 HOV Lanes Congestion Pricing Study, San Diego. A study is being conducted examining the feasibility of implementing congestion pricing on the I-15 HOV lanes in San Diego. The study is one of the federally funded ISTEA congestion pricing demonstration projects. The potential of allowing single-occupant vehicles to use the HOV lanes for a cost is being examined. The project is being conducted by the San Diego Council of Governments (SANDAG). A number of mechanisms are being used to obtain public involvement in the feasibility study. These include a community advisory committee, the distribution of project fact sheets, workshops, regular meetings of SANDAG committees, and other special outreach activities. It is anticipated that a decision on proceeding with an actual demonstration project will be made in 1997.

Table 12-14. QuickRide I-10 West Demonstration Case Study

General Elements	Techniques
Market Research	• Focus groups. • Review of national experience. • Assessment of pricing options and elasticity.
Planning and Public Involvement	• Multiagency teams. • Focus groups.
Public Information and Marketing Planner	• Brochures. • Flyers. • Newspaper advertising.
Responsible Agency	• Metro Transit Authority of Harris County (METRO) and Texas Department of Transportation (TxDOT)

VIII. ADDITIONAL RESEARCH NEEDS

The use of various public involvement and marketing techniques with HOV facilities was described in this Manual. In addition, the FHWA sponsored HOV Marketing Manual provides more detailed information on marketing and promotional activities. Even with these two documents, however, there is a need for further research related to public involvement and marketing programs with HOV facilities.

Assessment of Techniques to Build Public and Political Acceptance for HOV Facilities. Additional research is needed to assess the techniques that are currently being used to build public and political acceptance with HOV facilities around the country and to identify new approaches. Although many public agencies have undertaken enhanced public education and outreach efforts, additional guidance on the most effective techniques is still needed. This research study would explore the approaches currently being used, as well as the techniques used by agencies and private sector groups on other projects. New approaches for gaining public and political support would also be identified. The study would develop guidelines on the various strategies that can be used, the advantages and limitations of different techniques, and approaches to consider based on specific conditions or situations.

Assessment of Public Information and Marketing Strategies for Priority Pricing, Lane Conversion, Changing Vehicle-Occupancy Requirements, and Other Special Projects. As noted in this Manual, extra attention may need to be given to public information and marketing techniques if priority pricing, lane conversion, changing vehicle-occupancy requirements, or other unique projects are being considered. Additional research is needed to better identify the issues that may need to be addressed with these approaches and the approaches that can be used. This study would examine the experience with the few existing and past projects, assess other techniques that may be appropriate for consideration, and develop guidelines for public information and marketing programs for use with these types of HOV projects.

Assessment of Information and Marketing Techniques for Visitors, Tourists, and Part-Time HOV Lane Users. Public information and marketing efforts related to HOV facilities are usually oriented toward commuters who use the lanes on a daily or regular basis. Less emphasis has been placed on promoting HOV lanes with part-time or periodic users, although HOV facilities are located in areas with significant numbers of visitors and tourists. This research study would examine the special information needs of visitors and tourists, the potential use of HOV facilities by these groups, and the techniques that could be used to promote HOV lane use. The study would identify approaches and strategies that could be implemented in different areas, the cost and benefits of various techniques, and methods to assess the impact of these programs.

IX. REFERENCES

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X. ADDITIONAL INFORMATION SOURCES

Additional reports and articles on public involvement techniques, market research, survey methodology, and marketing are available. The following sources are provided for transportation professionals interested in further information on these topics.

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CHAPTER 13—MONITORING AND EVALUATING HOV FACILITIES

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I. INTRODUCTION

This chapter discusses the development and implementation of an ongoing program to monitor and evaluate HOV facilities. The benefits of a comprehensive evaluation program are highlighted and the elements to be included are described. The process of conducting an ongoing monitoring and evaluation program are presented and data collection techniques are discussed. Case study examples of evaluation programs with HOV facilities are also included. Much of the information presented in this chapter is from a research project sponsored by the FTA and documented in a previous report (1). This information has been updated, however, and new case studies are included. The chapter is divided into five sections covering the following topics.

- **Need for an Evaluation Program**. This section discusses the need for a comprehensive evaluation program for HOV facilities and the benefits that may be realized from such a program. The various reasons evaluations are conducted are described, and the uses of the information generated by these studies are summarized. The different audiences evaluations may be targeted toward are also discussed.

- **Development of an Evaluation Program**. This section outlines the major elements that should be included in an evaluation program for HOV facilities. A general set of guidelines or steps are presented for use in developing an evaluation program.

- **Conducting an Evaluation Program**. This section summarizes the major activities to be carried out in conducting an ongoing monitoring and evaluation program for HOV facilities. The various data collection techniques are described, and examples of different approaches are provided.

- **Overview of Evaluation Programs**. Case study examples of programs to monitor and evaluate HOV facilities in different metropolitan areas are presented in this section. The nature and general approaches used with the different evaluations are highlighted.

- **Additional Research Needs**. The chapter concludes with a discussion of further research needs related to monitoring and evaluating HOV facilities.

The references cited are provided at the end of the chapter, along with a listing of additional sources of information related to monitoring and evaluating HOV projects.

II. NEED FOR AN EVALUATION PROGRAM

A. Benefits of Evaluation Programs

Multiple benefits may be realized from comprehensive evaluations of HOV facilities. Evaluations provide the ability to determine if the goals and objectives of a project are being achieved. In addition, the information obtained from an evaluation has numerous secondary benefits. The reasons for conducting HOV project evaluations, and the potential benefits of these programs are summarized in this section.

It is important that the evaluation program cover all elements of the HOV facility. Depending on the specific project, these might include HOV lanes, direct access connections, park-and-ride and park-and-pool lots, transit stations, and new or enhanced transit services. In some instances it may be difficult to separate the impact of the various components. The evaluation program should be designed to examine the individual components and the full HOV system.

The main reasons for conducting an evaluation of an HOV facility are to identify the benefits accrued from the project and to determine if the goals and objectives are being met. Evaluations provide an opportunity to ascertain the degree to which the desired results are, in fact, occurring. Further, ongoing evaluation studies provide an official database for a project. This information can help ensure that all groups are utilizing the same data, assisting to clarify any possible disagreements over the impact of a project.

The results of evaluation studies are beneficial in future planning efforts within a metropolitan area. The information generated can be used to calibrate planning and simulation models for future use. Calibrating models with the results of local evaluations will ensure that they more accurately reflect actual experience, provide a valuable check on the modeling process, and improve the future capabilities of the models. In addition, the results from an evaluation, along with the experience gained from a project, can enhance the decision-making process on future projects.

The information collected as part of an 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 a facility. Monitoring these and other aspects of the HOV lane as part of the evaluation process will help identify problems that may need to be addressed. For example, changes in operating hours, vehicle occupancy requirements, bus service levels, and access points may be necessary. Longitudinal data on the use of a facility serves a critical operations function. This information can also be used to evaluate the marketing and public information programs associated with a facility, as well as helping to identify if additional marketing is needed.

Evaluations may also be needed to meet federal or state requirements. As discussed previously, a variety of funding sources are available to plan, design, construct, and operate various components of an HOV facility. Different funding sources and programs may require ongoing evaluations or other documentation of project results. Even when not a requirement, evaluations of HOV projects can be useful to help justify future funding for similar facilities in an area.

Finally, by providing information on 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 will assist transportation professionals and decision makers in keeping pace with critical issues. 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.

B. Audiences for Evaluation Program

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 state and federal agencies. The groups interested in HOV evaluations fall into two categories; those with a technical orientation and those with a more general focus.

The types of information presented, as well as the communication methods, should be tailored to the interests and levels of the various groups. For example, consideration should be given to the format and to the approach used to present the results of the evaluation process to various audiences. The scope, content, and level of detail used in different documents and presentations should be appropriate for the audiences being addressed.

III. DEVELOPMENT OF AN EVALUATION PROGRAM

A. Steps in Developing an Evaluation Program

The development of an evaluation program for an HOV facility should include the major activities that would normally be undertaken as part of any evaluation program. The four major steps in this process are illustrated in Figure 13-1 and briefly outlined next. A more detailed discussion of each step follows this summary. To ensure that a comprehensive, well-designed evaluation program is pursued, consideration should be given to each of these steps.

Step 1—Clear Articulation of Project Goals and Objectives

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Step 2—Identify Measures of Effectiveness

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Step 3—Identify Information Needs

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Step 4—Develop Study Design

Figure 13-1. Steps in Developing an Evaluation Program for an HOV Facility

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 an evaluation program. These goals and objectives should flow from, and be consistent with, those articulated during the policy development phase and the planning process. The development of HOV-related policies are discussed in Chapter 3, and the planning process is described in Chapter 4. This step is critical, as the remainder of the evaluation program will be designed to obtain and evaluate information that will 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.

The term objective is used here to indicate a goal or purpose an HOV facility is designed to meet. The objectives for an HOV project should be stated clearly and concisely. Each objective should represent a well-defined and measurable statement. 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.

Identify 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 are established. These measures and thresholds should relate to the key elements in the objective statements.

Identify Information Needs. This step identifies the information needed for the evaluation process. The data needs for each measure of effectiveness should be outlined. The appropriate methods to obtain and evaluate the information must also be identified. It is important that the same procedures and definitions are used throughout the evaluation to ensure comparability.

The basic information usually needed in an HOV evaluation include vehicle and occupancy counts, bus ridership data, travel time and speed information, safety and accident data, violation and enforcement data, and surveys on the perception of users, non-users, and the general public. This information is desirable for the HOV facility, adjacent freeway lanes, parallel routes, 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. Information should also be collected on any fixed-guideway transit system in the corridor to monitor and evaluate potential shifts in ridership between the fixed-guideway system and the HOV facility.

Develop Study Design. The previous three activities should all be brought together in the development of an evaluation study design. The study design should include a listing of the objectives, the measures of effectiveness and thresholds, the statistical study design, and data collection needs, locations, and procedures. As noted previously, the study design should include all of the project components to allow for the assessment of the individual elements as well as the full system. It should also identify the anticipated funding and staffing resources. 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.

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 all types of HOV facilities.

B. Examples of Objectives, Measures of Effectiveness, and Information Needs

The first step in the development of an evaluation program is to ensure that there is agreement on the project goals and objectives. It is important to ensure that the objectives are measurable, as the remainder of the evaluation program will focus on gathering and analyzing information to determine if the objectives have been met.

The identification of project goals and objectives usually occurs during the policy process described in Chapter 3 and the planning process discussed in Chapter 4. HOV facilities have been developed to achieve a number of goals and objectives. The following objectives represent some of those most commonly associated with new HOV projects that add a lane on freeways (1). Projects that convert an existing general-purpose lane or involve priority pricing on an HOV lane may have different objectives.

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

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

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

- The HOV facility should provide favorable impacts on air quality and energy consumption.

- The HOV facility should not unduly impact the operation of the freeway general-purpose mainlanes.

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

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

- The HOV facility should have public support.

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

These represent a few of the reasons most frequently cited for implementing HOV facilities that involve adding a lane. As noted, the objectives for lane conversion and priority pricing projects may be different. The objectives of a specific HOV project should be defined in more detail during this step. Each objective should be written as a clear statement identifying the desired end result, the action that will be taken to achieve this result, and the time frame within which the results will occur.

Once the objectives have been clearly defined, the next step is to identify the appropriate measures of effectiveness (MOEs) or evaluation criteria 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 collected and analyzed.

Commonly used measures of effectiveness associated with each of the previous objectives were identified in the FTA-sponsored study (1). These are listed in Tables 13-1 and 13-2 and described next along with possible threshold ranges and data needs. MOEs are presented for each of the general objectives. The threshold ranges are provided as very general guidelines. The appropriate thresholds should be developed for each for individual project. The thresholds provided here relate to projects which add an HOV lane on a freeway. The thresholds for lane conversion and priority pricing projects may be different.

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. This objective will be accomplished by increasing the average vehicle occupancy 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.

Table 13-1. 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-kilometer, operating cost per passenger, operating cost per passenger-kilometer). ◆ 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 in the growth of vehicle-kilometers of travel (VKT) 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 100 million vehicle-kilometers of travel. ◆ Accident rate per million passenger-kilometers 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.

Source: (1)

Table 13-2. Suggested Objectives, Data Collection Efforts, and Measures of Effectiveness for Evaluating HOV Facilities

Objective	Data Collection Efforts							Corresponding Measures of Effectiveness (MOEs)[3]
	Vehicle and Occupancy Counts		Travel Time Runs		Surveys[1]		Other	
	Freeway[2]	HOV Lane	Freeway[2]	HOV Lane	Freeway	HOV Lane		
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	*	*	*	*	**	**	**[7]	Reduction in emissions; reduction in energy consumption facility.
Per lane efficiency	*	*	*	*				Increase in peak-hour per lane efficiency of total freeway facility.
Freeway operations	*		*		**			Maintain or improve level of service on freeway mainlanes.
Safety	**	**					*[8]	Number and severity of accidents; accident rate per million vehicle kilometers of travel and per million passenger kilometers of travel.
Public support		**			*	*	**[9]	Percent of users, non-users, and general public who approve of HOV facility; violation rates.
Cost effective	**	*	*	*				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 use of surveys of HOV users (bus riders, carpoolers, and vanpoolers), non-HOV users in the general traffic lanes, and in some cases, the general public.
2 It is strongly suggested that these data be collected for both the freeway lanes adjacent to the HOV facility, parallel routes, and the control freeway.
3 Some, but not necessarily all, of the suggested MOEs associated with gauging the attainment of the objectives are shown.
4 Vehicle and occupancy counts on alternate arterial routes to identify any changes in throughput for the corridor, counts at park-and-ride lots, and vehicle and occupancy counts on a "control" freeway.
5 Before-and-after bus service levels, vehicle productivity, schedule adherence, number and severity of bus accidents, vehicle operating costs, and changes in labor, fuel, and other costs.
6 Monitoring bus on time performance and schedule adherence before-and-after implementation of the HOV lane(s).
7 Monitoring air quality levels along the corridor and use of simulation models to estimate impact.
8 Monitoring freeway accident rates and types before-and-after implementation of the HOV lane(s), as well as obtaining accident rates on the HOV facility.
9 Identifying violation rates for the HOV lane (i.e., those vehicles not meeting the minimum occupancy requirement). Monitor complaints, media, and policy actions.

Source: (1)

The following are some specific MOEs that may be appropriate for consideration with this objective. Specific criterion for anticipated change in the peak hour, peak period, and the daily total may be identified for each MOE.

- 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: Possible threshold ranges for these MOEs over the first year of operation might 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 for these MOEs include before-and-after vehicle and vehicle occupancy counts and bus ridership levels on the HOV facility, the adjacent freeway, and a control freeway. Secondary data needs include before-and-after vehicle and occupancy counts on parallel roadways, and surveys of bus riders, carpoolers, and vanpoolers in the HOV lane, and non-users 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 might be appropriate for use with this objective.

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

General Threshold Ranges: Improvements of 5 to 20 percent in vehicle productivity may be realized with the implementation of HOV facilities, resulting in similar reductions in operating cost per vehicle-kilometer, operating cost per passenger, and operating cost per passenger-kilometer. On-time schedule adherence can be expected to improve significantly, as can a reduction in the bus accident rate. Since bus travel speeds should increase with the implementation of an HOV lane, transit schedules may need to be modified to ensure that buses do not arrive at stops early, thereby missing passengers.

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. Monitoring the actual arrival times of buses before-and-after implementation of the HOV facility may be appropriate to provide the most accurate picture of changes in on-time performance. In addition, the perception of bus users 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 kilometer 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.

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. It is important that enough observations be conducted over an adequate number of days to ensure an accurate reflection of 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 facility 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 use of these models and other techniques are discussed in Chapter 4. The following MOEs are commonly used with this objective.

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

General Threshold Ranges: The HOV facility 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 usually 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 facility 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.

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 100 million vehicle-kilometers or million passenger-kilometers 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 threshold may not be realistic. As a result, this MOE and possible threshold ranges should be carefully examined for each project.

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, and a general perception should exist that the facility is adequately utilized. One MOE might focus on the perception of utilization of the HOV facility and another MOE might focus on the perception of whether it is a good transportation improvement. The violation rates and compliance with operating requirements on an HOV facility may also be appropriate MOEs for this objective.

General Threshold Ranges: Although it may be difficult to establish a specific threshold level for this objective, a desired level of public acceptance, user acceptance, and non-user acceptance can be identified and measured through the use of surveys.

In general, a majority of users and non-users should feel that 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.

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. As a basic guideline, 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. This approach is extremely conservative, 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, while other groups support the inclusion of additional benefits. The appropriate elements to include in a cost-benefit analysis should be determined for each area.

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.

C. Study Design and Data Collection Methods

The previous information and possible objectives, measures of effectiveness, general threshold levels, and data needs can be used to help develop a detailed evaluation program study design for an HOV facility or an HOV network. The study design should include the specific objectives for the project, the measures of effectiveness to be used with each objective, the threshold levels, and the information that will be used to measure the changes.

The study design should also outline the data collection and analysis methods and techniques. The use of sound and consistent data collection and analysis techniques is critical to help ensure the integrity of an evaluation program. Elements of successful data collection include maintaining similar procedures through the evaluation process, carefully conducting each data collection activity, and taking necessary safety precautions for field personnel.

The procedures and techniques commonly used to collect the data needed in evaluations of HOV projects are summarized in this section. Both manual data collection techniques and automated procedures are presented. Data collection methods are presented for vehicle and occupancy counts, travel time surveys, monitoring park-and-ride and park-and-pool facilities, on-board passenger surveys, carpool and vanpool surveys, general-purpose lane user surveys, safety and accident information, and violation rates. Information is also presented on data reduction and analysis techniques and the general costs associated with data collection activities.

1. **Vehicle and Occupancy Counts**. Vehicle and occupancy counts represent one of the basic data needs for evaluating the effectiveness of HOV facilities. These counts measure the number of vehicles and the number of passengers or occupants per vehicle, in both the freeway mainlanes and the HOV facility. Comparing changes in these two variables before construction begins on a project and after the HOV facility is open provides the information needed to evaluate the objectives related to increasing person movement efficiency, cost effectiveness, impacts on energy consumption and air quality, and freeway operations. In addition, vehicle and occupancy data are critical to evaluating potential changes in occupancy requirements that may be necessary in response to increased demands or legislative action.

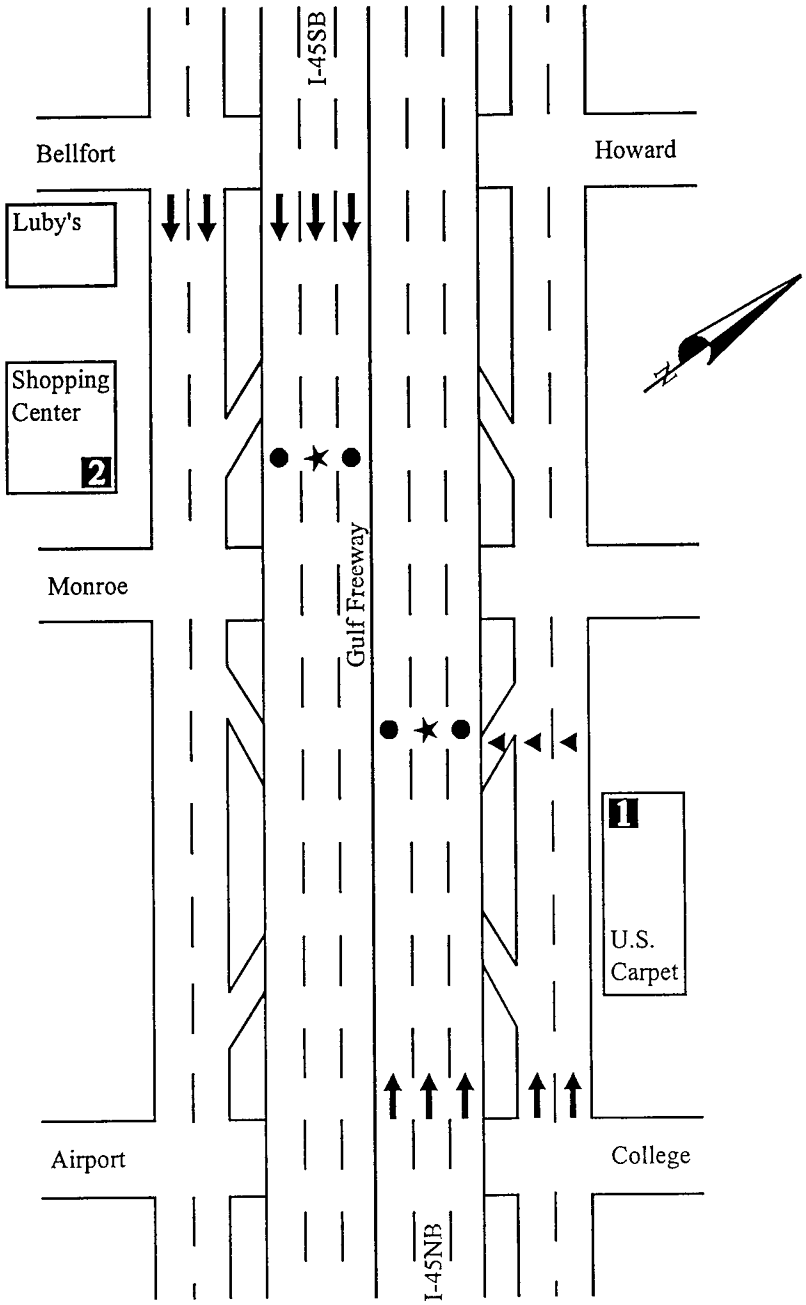
   Vehicle and occupancy counts should be taken on the HOV facility, the general-purpose freeway lanes, parallel routes, and a control freeway. Consideration should also be given to conducting counts on the freeway frontage roads, if they exist in the corridor. The number of count sites, and the exact count location, should be determined based on the length of an HOV facility and the number and location of access points. Further, the count sites should be selected based on the ability to clearly and accurately see vehicles and safety concerns.

   Manual Count Techniques. The manual count technique for conducting vehicle and occupancy counts relies on human observers in the field. Count locations for the HOV lanes, freeway lanes, and frontage roads should all be in the same general area, although safety and visibility concerns may influence the exact sites. At a minimum, at least one count location should be used to collect vehicle and occupancy information for both the HOV lane and the freeway mainlanes. This should be located at the highest HOV volume point if possible. More than one location should be considered if major access/egress points influence the volumes on either facility.

An example of the location of a freeway count station in Houston is provided in Figure 13-2, and an example of an HOV lane count station is shown in Figure 13-3. Data are collected in 15-minute intervals. On freeways, vehicle classification and occupancy counts are taken only on the middle or one of the middle lanes. Only vehicle counts and general classification (automobile or commercial) are taken in the other lanes. The occupancy data obtained for the middle lane, with the exception of buses and vanpools, have been shown to provide a reasonable representation of occupancy characteristics for vehicles utilizing the freeway mainlanes in the peak-direction of flow. This reduces the need to collect occupancy data for cars and commercial vehicles on the remaining freeway lanes. However, it is important to note that this methodology has been developed using historical data for the Houston freeway system. The variance of occupancy characteristics across freeway lanes in other urban areas may be different. Therefore, vehicle occupancy data should initially be gathered for each lane. If the trends across the lanes are similar, as they are in Houston, counting only one lane may be possible.

The vehicle and occupancy information from the middle lane is recorded on the data sheets shown in Figure 13-4, while the vehicle and classification information from the other lanes is recorded on the data sheets shown in Figure 13-5. The occupancy rates observed in the middle lane are then applied to the vehicles in the other lanes to produce the overall person volume estimates for the entire freeway in the peak-direction of flow.

In the Houston analysis, automobiles, pickup trucks, mini-vans, and motorcycles are classified as cars. Commercial vehicles include taxicabs, large emergency vehicles, delivery trucks, semi-trucks, and other large vehicles. Since buses and vanpools exhibit occupancy rates that are significantly higher in range and magnitude than those of cars or commercial vehicles, making inferences about the occupancy rates of the other lanes based on those observed in the middle lane could produce serious errors. To reduce this risk, the occupancy rates of buses and vanpools utilizing the other lanes are individually recorded on the data sheet shown in Figure 13-6.



LEGEND

- **1** A.M. Peak Period Count Location
- **2** P.M. Peak Period Count Location
- ● Main Lane Vehicle Classification and Occupancy Count
- ★ Main Lane Vehicle Count
- ▲ Frontage Road Vehicle Classification and Occupancy Count

Figure 13-2. Example of Gulf (I-45 South) Freeway Count Locations

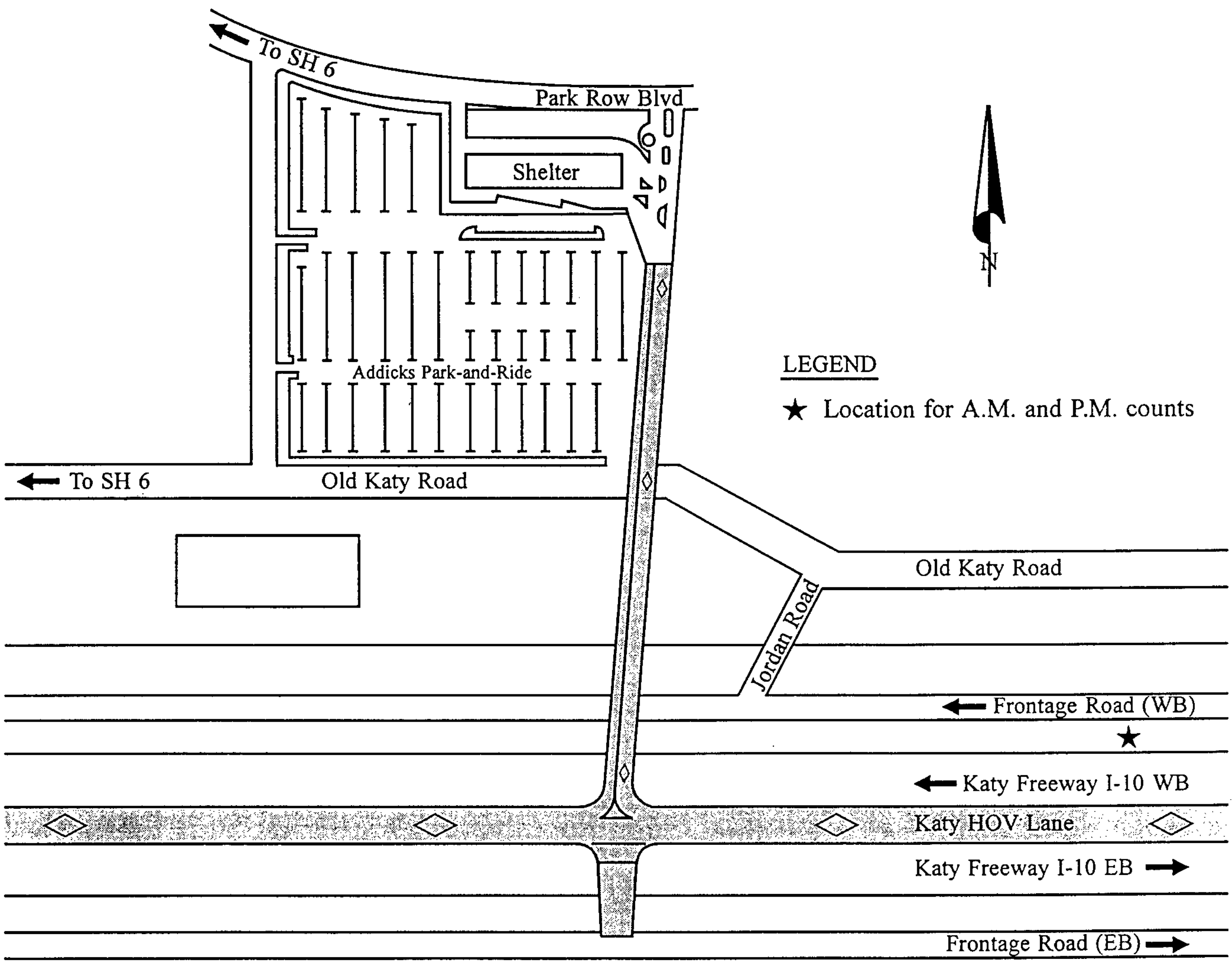


Figure 13-3. Example of Katy (I-10 West) HOV Lane Count Location

TTI VEHICLE OCCUPANCY DATA

Facility:____________ Weather:____________

Time:____________ Recorder:____________

Date:____________ Lane:____________

Vanpools

1-3	
4-6	
7-9	
10-12	
13+	

Buses

Empty	
1/4 Full	
1/2 Full	
3/4 Full	
Full	
Full+	

Pickups/Passenger Cars

1	
2	
3	
4+	

Commercial

1	
2	
3	
4+	

Motorcycles

Frontage Rd Volumes

Trucks 18-Wheelers

1	
2	
3	

Taxi Cabs

1	
2	
3	

Figure 13-4. Example of Freeway Mainlane Vehicle Occupancy Data Form Used in Houston

TTI BY LANE VEHICLE VOLUMES (Freeway)

Facility: ________________ Weather: ________________
Date: ________________ Recorder: ________________

Begin Time	Code Time	Lane: ______		Lane: ______		Lane: ______	
		Cars	Commercial	Cars	Commercial	Cars	Commercial
3:30	15						
3:45	16						
4:00	17						
4:15	18						
4:30	19						
4:45	20						
5:00	21						
5:15	22						
5:30	23						
5:45	24						
6:00	25						
6:15	26						
6:30	27						
6:45	28						

Figure 13-5. Example of Freeway Mainlane Vehicle Volume Data Form Used in Houston

HOV OCCUPANCY SUMMARY

Date: ____________________

Location: ______________________________

Observer: ____________________

Time	Buses						Vanpools					Carpools				
	E	1/4	1/2	3/4	F	F+	1-3	4-6	7-9	10-12	13+	1	2	3	4	5+
3:30 P.M.																
3:45 P.M.																
4:00 P.M.																
4:15 P.M.																

Figure 13-6. Example of HOV Lane Vehicle-Occupancy and Classification Data Form Used in Houston

In the Houston evaluation, the observed general bus passenger levels are translated into specific occupancy rates based on the utilization levels identified in Table 13-3. A person-carrying capacity of 50 persons is used for all regular buses, including standard buses, school buses, and charter buses. The capacity of articulated buses is estimated to be 70 persons. Since it is often difficult to observe passenger levels through the tinted bus windows, the accuracy of this procedure is checked periodically by physically counting the number of individuals boarding buses at selected locations. These detailed counts are compared to the survey results, and adjustments to the estimating process are made as needed.

Table 13-3. Bus Person Volume Estimates for Different Passenger Utilization Levels

Type of Bus	General Status of Bus Occupancy[1]	Estimated Number of Persons Aboard Bus[2]
Standard Size[3]	Empty	1
	1/4 Full	10
	1/2 Full	20
	3/4 Full	30
	Full	40
	Full +[4]	50
Articulated[5]	Empty	1
	1/4 Full	15
	1/2 Full	30
	3/4 Full	45
	Full	60
	Full +[4]	70

1 Estimated portion of bus that is occupied by passengers.
2 Corresponding estimate of the number of passengers based on a seating capacity of 40 persons for standard size buses and 60 persons for articulated buses.
3 Includes Metro buses, school buses, and charter buses.
4 Refers to the ultimate capacity of the bus; all seats full and passengers standing in the aisle.
5 Refers to Metro buses that are longer than standard size buses and that have a permanent hinge near the center which allows maneuverability.

Other techniques may be used to obtain information on bus ridership levels and vanpool passengers. A manual count can be taken of bus passengers by a checker riding the bus, stationed at a park-and-ride lot, or stationed at the first stop after the bus exits the HOV lane. Surveys of vanpooolers, like the ones conducted in the Washngton, D.C. area, can also be used to obtain information on the number of passengers in vanpools using an HOV facility.

In Houston, vehicle and occupancy counts are also collected at eight locations on alternate parallel routes. These counts are conducted to assist in identifying the potential impacts of the HOV lanes on parallel alternate routes. An example of a count station location for a parallel route is shown in Figure 13-7. The same data collection forms utilized for the middle freeway lane, as shown in Figure 13-6, are used on these facilities. The same general procedure used for the freeway counts are used on the alternate parallel routes.

Other techniques can also be used to obtain vehicle and occupancy data. For example, road tubes and loop detectors may be used to collect vehicle count data. In the Seattle urban area, inductance loop detectors are used to monitor the entire freeway system, including the HOV lanes. In the Washington, D.C. area, ongoing data collection activities include the Metro Core Cordon Counts and Beltway Cordon Counts, and screen line volume, mode, and occupancy counts. Data from these efforts are used to evaluate the Shirley Highway and the I-66 HOV lanes. Closed Circuit Television Cameras (CCTV) represent another possible approach. This technique is currently being used in the Minneapolis-St. Paul area. CCTV loop detectors are utilized on parts of the freeway system, including the HOV lanes on I-394. This technology will also be implemented in the near future on the freeways, HOV lanes, and parallel alternate routes in Orange County.

Although these technologies are being used successfully to obtain vehicle count and classification data, less positive results have been realized in attempts to obtain vehicle occupancy data through the use of CCTV or other video technologies. Both Orange County and Houston have experimented with the use of video technology to monitor vehicle occupancy rates. The results obtained through these efforts generally were not as accurate as those obtained through manual methods. The primary reasons for the lower degree of accuracy stems from the static limitations of the video technology and the reproductive limitations of the film or television. Thus, the use of these technologies for vehicle counts are often supplemented with manual vehicle occupancy counts.

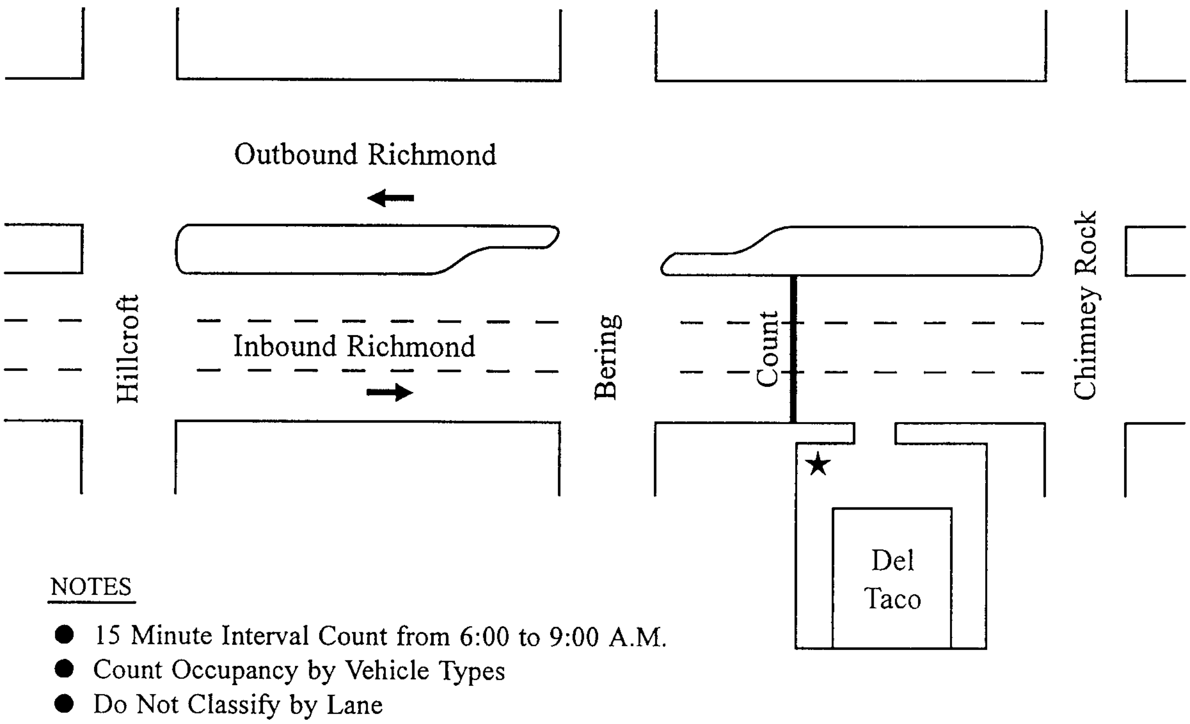


Figure 13-7. Example of an Alternate Route Count Location in Houston

2. **Travel Time Data**. Travel time data represent the second most common type of information needed to evaluate HOV facilities. Travel time data measure the time it takes a vehicle to travel a certain distance. Travel time data are usually collected for the freeway facility, parallel routes, and the control freeway prior to construction of the HOV facility. These same data are then collected for the HOV facility, the freeway mainlanes, parallel routes, and the control freeway after the HOV facility has been opened. The differences in travel times can then be compared for the before-and-after freeway conditions, the before freeway with HOV lane(s), and current freeway with HOV lane(s). In addition, as shown previously in Tables 13-1 and 13-2, the travel time data are used to help determine the benefit-cost ratio, energy consumption and air quality impacts, and freeway operational impacts.

   In the Houston evaluation, travel time data for the freeway and HOV facility can be obtained using a number of methods. The simplest, and most commonly used, is referred to by a variety of names including the "floating car" and "maximum car" techniques. All refer to the use of a test vehicle making a series of trips along a roadway or HOV lane section to obtain travel times. The techniques are based on the concept that the test vehicle should travel at the average speed of other traffic without exceeding the speed limit.

   Travel time runs are conducted during the morning and evening peak-periods in the peak-direction of travel, with the test vehicles dispatched at 30-minute intervals. Two people per vehicle are needed to conduct the travel time runs; one to drive and one to monitor the stopwatch and record the results. Ideally, travel time runs should be conducted at the same time on both the HOV facility and freeway lanes. To accomplish this in Houston, it is usually necessary to have between 2 to 4 vehicles making the travel time runs. The exact number of vehicles and corresponding personnel depends on the length of the HOV facility and travel speeds.

The methodology utilized in Houston to collect the freeway and HOV lane travel time information is the test vehicle method referred to as the "floating car" technique. Figure 13-8 provides an example of how this process works for both the freeway lanes and the HOV lanes. The specific procedure consists of the driver beginning at a designated starting point with the passenger setting a stopwatch at zero. The driver begins traversing the freeway using the floating car technique, while the observer notes the elapsed time at predetermined mile points on the form shown in Figure 13-9. If at any time, the traffic flow conditions on the freeway cause the driver to travel at a speed below 50 km/h (35 mph), which is considered to be the upper range of travel speed indicating traffic congestion on freeways, the passenger records the mile point, time at which the vehicle speed was reduced to less than 50 km/h (35 mph), and the apparent cause of the slow-down on the data sheet. Once the test vehicle regains a speed of 50 km/h (35 mph), the mile point and time are again noted. Thus, the length and nature of the traffic congestion problem is recorded. This procedure represents a modification of the process outlined in the *Transportation and Traffic Engineering Handbook* (2) but serves to collect the same basic data.

The same general approach is used for conducting the HOV lane travel time runs, with slight modifications. As shown in Figure 13-8, the floating car begins at the same designated starting point used in the freeway runs. This point is prior to the entrance to the HOV facility. The passenger starts the stopwatch at this point as the vehicle starts along the freeway. The vehicle progresses along the freeway, enters the HOV lane, progresses the length of the HOV lane, and reenters the freeway traffic lanes. Throughout the trip, the passenger records the time at various checkpoints on the data form shown in Figure 13-10. Since the HOV lanes are one lane, the driver cannot pass or be passed. The drivers are instructed to maintain the travel speed of other vehicles in the lane, but not to exceed the speed limit. As with freeway travel time runs, the passenger records both the duration and reasons for travel speeds falling below 50 km/h (35 mph).

In addition to recording decreases in travel speed below 50 km/h (35 mph), construction zones, weather, lighting and pavement conditions, and incidents are also noted, regardless of whether or not they cause a significant reduction in travel speed. It is important that when the test vehicle is used, the entrance and exit points of the HOV lane should be designated as checkpoints for recording the elapsed time. This will ensure that the travel time checkpoints will be the same for both the freeway and the HOV lanes, allowing comparability between results. For example, the travel times for the HOV lanes and freeway lanes, as shown in Figures 13-9 and 13-10, can be compared.

In addition, information on the travel times of buses using the HOV lanes is also obtained in conjunction with the on-board bus surveys. The personnel distributing the surveys, on the buses, also record the bus travel time information. These surveys are done on an approximately annual basis.

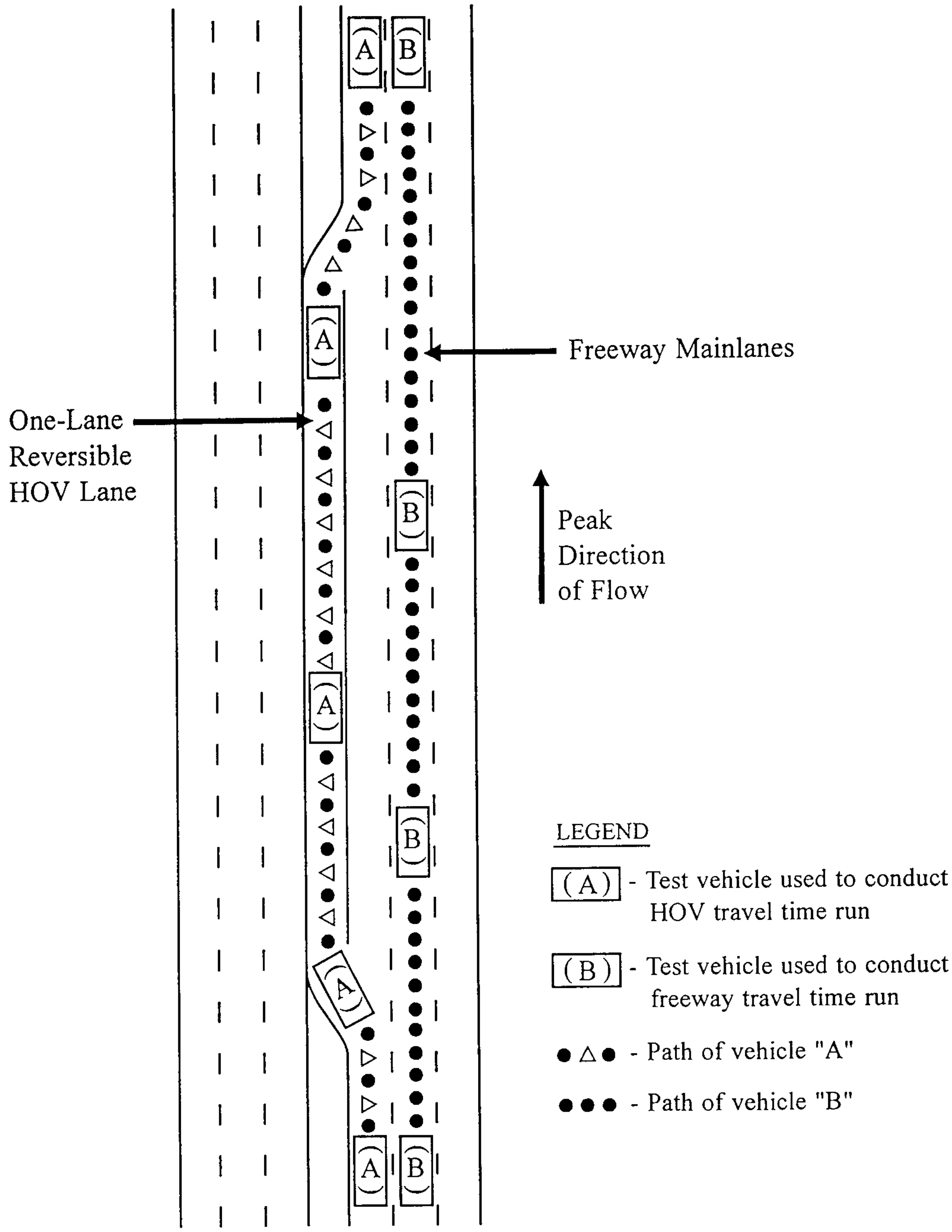


Figure 13-8. Example of Test Vehicles Conducting Travel Time Runs

Highway: Northwest (US 290)　　Run Date: 6/14/90　　Time Run Start: 7:30 a.m.

Direction: SB　　Mile Run Start: 946.9

Section Limits	Mile Point	Clock Time	Remarks				Queue		Construction	
			Weath	Light	Pave	Incid	Mile	Time	Type	Mile
Telge	-----	-----								
Huffmeister	1.60	1.40								
* FM 1960	0.95	2.38								
Eldridge	1.25	3.57								
Jones Rd.	1.42	5.24								
FM 529	1.20	6.26								
Senate	0.42	6.57								
W. Little York	1.00	8.07								
Gessner	0.45	10.06								
Fairbanks	1.15	12.45								
W. Tidwell	1.05	14.26								
Hollister	0.30	14.47								
Pinemont	1.00	16.05								
Bingle	0.30	17.26								
Antoine	1.35	20.33								
W. 34th	0.45	21.21								
Mangum	0.85	25.06								
** I-610 Overpass	0.75	28.17								
SPRR @ I-10	2.20	32.03								
Washington	0.92	32.95								
Shepherd	1.20	34.23								
Taylor	1.70	36.20								
Hogan St.	1.00	37.35								

(Bracket from Eldridge to I-610 Overpass:) Adjacent freeway travel time = 25 minutes and 39 seconds (25.65 minutes)

* Entrance point to HOV lane during morning operations
** Exit point of HOV lane during morning operations

Figure 13-9. Example of Freeway Travel Time Data Form Used in Houston

Highway: Northwest (US 290) Run Date: 6/14/90 Time Run Start: 7:30 a.m.

Direction: SB Mile Run Start: 85.7

Section Limits	Mile Point	Clock Time	Remarks				Queue		Construction	
			Weath	Light	Pave	Incid	Mile	Time	Type	Mile
Telge	-----	-----								
Huffmeister	1.60	1.37								
* FM 1960	0.95	2.29								
Eldridge	1.25	3.41								
Jones Rd.	1.42	4.11								
FM 529	1.20	5.06								
Senate	0.42	6.20								
W. Little York	1.00	6.47								
Gessner	0.45	7.53								
Fairbanks	1.15	8.23								
W. Tidwell	1.05	9.32	Transitway travel time = 13 minutes and 27 seconds (13.45 minutes)							
Hollister	0.30	10.37								
Pinemont	1.00	10.59								
Bingle	0.30	11.55								
Antoine	1.35	13.41								
W. 34th	0.45	14.08								
Mangum	0.85	15.02								
** I-610 Overpass	0.75	15.56								
SPRR @ I-10	2.20	18.21								
Washington	0.92	20.20								
Shepherd	1.20	22.36								
Taylor	1.70	24.12								
Hogan St.	1.00	25.24								

* Entrance point to HOV lane during morning operations
** Exit point of HOV lane during morning operations

Figure 13-10. Example of HOV Lane Travel Time Data Form Used in Houston

The floating car technique can be enhanced with the use of an electronic distance-measuring instrument (DMI). This approach involves attaching the sensor of the electronic DMI to the transmission of the test vehicle. The DMI, which operates like an odometer, receives consecutive pulses from the transmission while the vehicle is moving. The frequency of the pulses are directly related to the distance traveled. The electronic DMI translates the number of pulses to an equivalent distance. When calibrated appropriately, the DMI can provide speeds up to every 0.5 seconds. The data can be automatically downloaded to a portable computer. This technique is being used in Houston with the HOV evaluation program and for other travel time studies in Texas (3,4).

Advantages of the electronic DMI procedures include enhanced safety and accuracy, reduction in personnel needs, and faster data reduction capabilities. Potential disadvantages include equipment costs, ongoing maintenance needs, and added staff expertise.

Another technique for collecting travel time information involves recording license plate and time information at specific points along the freeway and HOV facility. This information can be recorded manually, or as is done in Seattle, recorded into lap-top microcomputers. An example of the use of this method is provided in Figure 13-11. Individuals stationed at locations "A" and "B" record the license plate data and time for passing vehicles. If lap-top computers are used, the time of the entry is recorded automatically. If the manual method is employed, both the time and the license plate information must be recorded. Depending on the method used, a series of computer programs are used to match the license plates and compute the travel times for vehicles between the two points.

The use of Automated Vehicle Identification (AVI) technologies represents still another technique for collecting travel time data. This methodology has been tested on the Houston HOV lanes (5). This procedure uses the data collected from the AVI system on the Houston freeways and HOV lanes to obtain travel times and other information on vehicles traveling on both facilities. The AVI traffic monitoring system was initiated in Houston in the early 1990s, and currently covers most of the freeway system in the area.

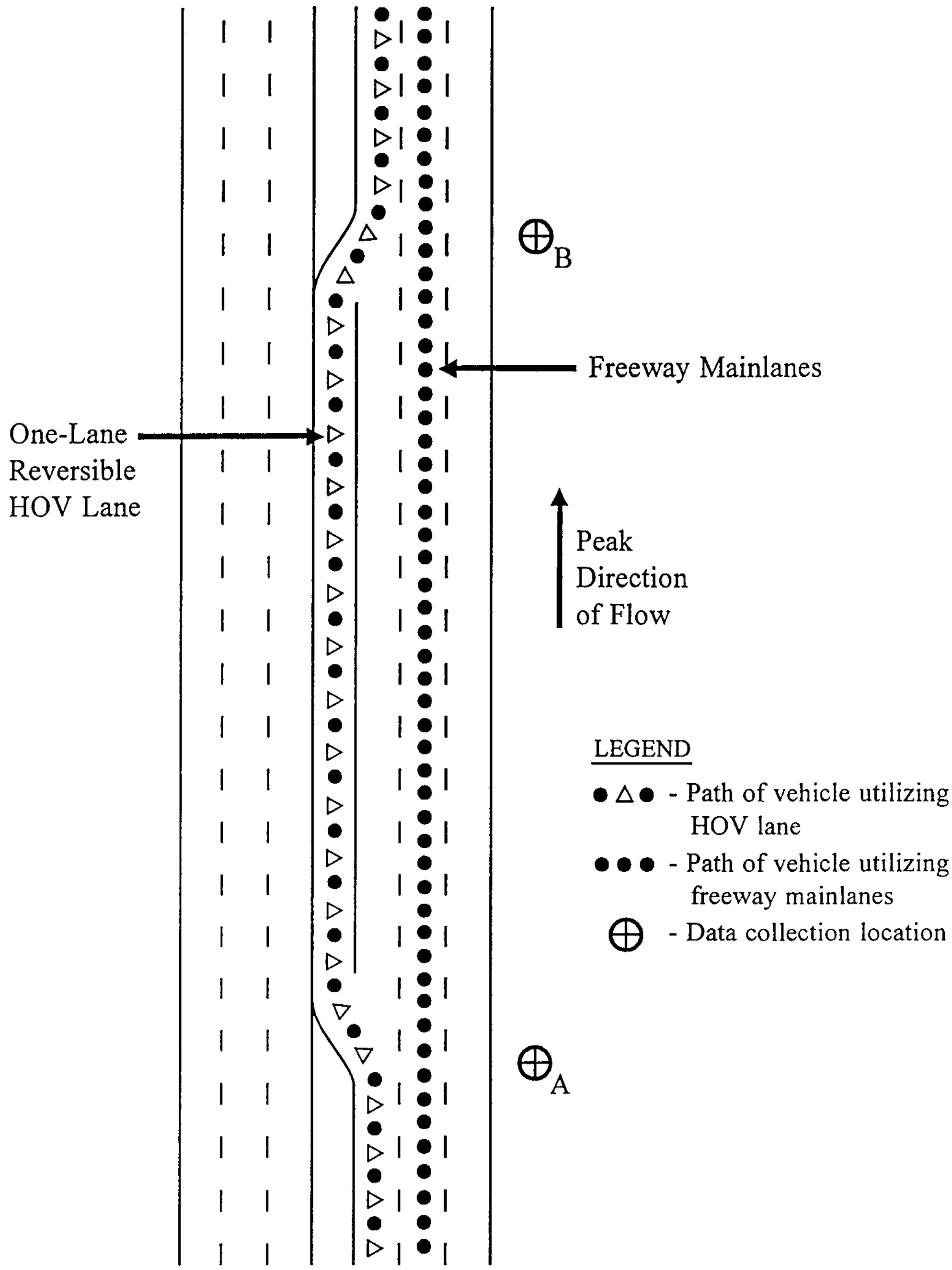


Figure 13-11. Example of Data Collection Locations for Lap-Top Computer Techniques

The AVI traffic monitoring system is comprised of four major elements. First, AVI reader antennas are located along the freeways and the HOV lanes at approximately 1.6 to 8 kilometers (1 to 5 miles). The second component is AVI tags placed on the front windshield of vehicles traveling on the freeway system. In Houston, toll tags were given away to commuters as part of the initial demonstration. In addition, vehicles with tags from the toll roads in Houston are picked up by the readers. Third, roadside reader cabinets relay the transponder identification numbers to TranStar, the transportation management center in Houston. Fourth, a software system has been developed to analyze the data and display it on a real-time traffic map.

The data collected through the system can also be used to examine travel time information for the HOV lanes and the general-purpose freeway lanes. A wealth of historical data are available from this system. To date, an initial test has been conducted analyzing the data files for an eight-month time period. Data and statistical variables examined included average speed, minimum speed, maximum speed, speed standard deviation, Shapiro-Wilk normality statistic, and skewness value (7).

3. **Monitoring Park-and-Ride and Park-and-Pool Facilities**. Information on the use of park-and-ride and park-and-pool facilities can be obtained through periodic manual counts. Usually, the number of vehicles parked at each facility is recorded during the middle of the day on weekdays. The data sheet shown in Figure 13-12 can be used to record this information.

4. **User and Non-User Surveys**. Surveys can be used to obtain information for bus riders, carpoolers and vanpoolers, motorists in the general purpose lanes, and the general public. The most commonly used surveys focus on users of the HOV facility, including specially designed questionnaires for carpoolers, vanpoolers, and bus riders, and non-users in the adjacent freeway lanes. In some cases, random surveys of residents in the corridor or metropolitan area, surveys of businesses in the corridor, and special marketing surveys, have also been conducted.

   The use of surveys appears to be one of the best ways to identifying the perceptions of users and non-users toward utilization of the HOV facility, changes in mode choice and the reasons for this change, and obtaining socio-economic, demographic, and general travel information on commuters in the corridor. A better understanding of these elements is important for evaluating many of the HOV project objectives, especially those relating to mode shift and public support.

Month:____________________

Project:____________________

Freeway Corridor	Name of Lot	Number of Parked Vehicles	Date
Katy (I-10W)	1. Kingland		
	2. Fry		
	3. Addicks		
	4. West Belt		
	5. Mason		
	6. Barker-Cypress		
North (I-45N)	1. N. Shepherd		
	2. Kuykendahl		
	3. Spring		
	4. Seton Lake		
	5. Woodlands		
Gulf (I-45S)	1. Edgebrook		
	2. Bay Area		
Southwest (US 59S)	1. Sharpstown		
	2. West Loop		
	3. Westwood		
	4. Alief-Boone		
	5. Missouri City		
Eastex (US 59N)	1. Kingwood		
	2. Eastex		
Northwest (US 290N)	1. NW Station		
	2. W. Little York		
	3. Pinemont		
I-10E	1. Maxey		

Figure 13-12. Example of Park-and-Ride Lot Data Collection Form Used in Houston

A copy of a survey that has been used with bus riders on the HOV lanes in Houston is provided in Figure 13-13. The survey form is designed to obtain information on trip purpose, origin-destination, previous mode of travel, reason for using the bus, the importance of the HOV lane in mode selection, perceived travel time savings from the HOV facility, perception of utilization rates on the HOV lane, and socio-economic characteristics. To maintain a one page format, the questionnaire is kept relatively simple, focusing only on key information needs. Since individuals will be completing the survey on the bus, maintaining a simple, easy to complete format is essential. Other survey forms with different questions have been used on occasion for different purposes.

In Houston, surveys and pencils are distributed by personnel to all passengers as they board the bus. The completed surveys are then collected by the same personnel as passengers exit the bus. Response rates on the on-board ridership surveys on the HOV lanes have averaged approximately 95% over the past few years. This basic approach is used in most areas, although sometimes slight modifications may be used, such as having the bus driver collect the completed surveys.

The questionnaire used to obtain information from carpoolers and vanpoolers using the HOV lanes in Houston is similar in scope to the bus rider survey. A copy of this survey is provided in Figure 13-14. However, the methodology used to distribute and collect the survey is different. A mail-out, mail-back format is used.

The procedure starts with personnel recording the license plate numbers of carpools and vanpools using the HOV lanes during the morning peak-period from 6:00 A.M. to 9:30 A.M. The attempt is made to record the numbers from all vehicles in the lane. The numbers are read into a tape recorder, as this has proven to the fastest and most reliable method. The numbers are then transcribed and sent to the Texas Department of Transportation, Division of Motor Vehicles. TxDOT provides a listing of addresses from the motor vehicle registration files. Corporate and leasing agency addresses are deleted by TTI, along with those outside the metropolitan area, and surveys are mailed to the remaining addresses with a postage-page return envelope.

The response rates to the carpool and vanpool surveys in Houston have been good. For example, a total of 2,200 license plates were recorded for the recent survey conducted on the Katy HOV lane. Of these, 1,500 met the above requirements and were sent surveys. The other 700 were either addresses of corporations, leasing agencies or residences well outside the Houston area. Of the 1,500 mailed surveys, 590 completed surveys were returned, accounting for a response rate of 39 percent.

NORTH HOV LANE TRANSIT USER SURVEY

This survey is being undertaken by the Texas Transportation Institute, the Texas Department of Transportation, and METRO in order to obtain information about your use of the North HOV Lane. Please take a few minutes to answer the questions below and return this form to the survey taker before leaving the bus.

1. What is the purpose of your bus trip this morning? ___ Work ___ School ___ Other

2. What is the Zip Code of the area where this trip began? (For example, if this trip began from your home this morning, you would list your home Zip Code.) ____________

3. What is your final destination on this trip? ___ Downtown ___Galleria/City Post Oak/Uptown
   ___ Texas Medical Center ___ Greenway Plaza ___ Other (specify Zip Code___________)

4. Have you ever carpooled or vanpooled on the HOV lane? ___ Yes, carpooled ___ Yes, vanpooled ___ No

5. How important was the opening of the North HOV lane in your decision to ride the bus?
   ___ Very Important ___ Somewhat Important ___ Not Important

6. If the North HOV lane had not opened, would you be riding a bus now?
   ___ Yes ___ No ___ Not sure

7. How many minutes, if any, do you believe this bus presently saves by using the North HOV lane instead of the regular traffic lanes? _____ Minutes in the Morning _____ Minutes in the Evening

8. How long have you been a regular bus rider on the North HOV lane?

9. Does your employer pay for any part of your bus pass? ___ Yes, all ___ Yes, part ___ No

10. Was a car (or other vehicle) available for this trip? (Check one) ________________________________
    ___ No, bus was only practical means
    ___ Yes, but with considerable inconvenience to others
    ___ Yes, but I prefer to take the bus

11. Before you began riding a bus on the North HOV lane how did you normally make this trip? (Check one)
    ___ Drove alone
    ___ Carpooled
    ___ Vanpooled
    ___ Rode a park-and-ride bus on the regular freeway lanes
    ___ Rode a regular route or express bus
    ___ Did not make this trip prior to using the North Transitway
    ___ Other (specify ________________________)

12. Do you feel that the North HOV lane is, at present, being sufficiently utilized to justify the project?
    ___ Yes ___ No ___ Not sure

13. What is your... Age? _____ Sex? _____ Occupation? ____________________________

14. What is the last level of school you have completed? ____________________________

Comments: ____

THANK YOU FOR YOUR COOPERATION

Figure 13-13. Example of HOV Lane Bus Rider Survey Form Used in Houston

NORTH HOV LANE CARPOOL/VANPOOL SURVEY

Undertaken by the Texas Transportation Institute, The Texas A&M University System in cooperation with the Texas Department Transportation, the Metropolitan Transit Authority of Harris County, and the U. S. Department of Transportation.

1. Is your vehicle a carpool or a vanpool? ___ Carpool ___ Vanpool
2. What is the primary purpose of your a.m. carpool/vanpool trip? ___ Work ___ School ___ Other
3. How many members are regularly in your carpool/vanpool (including yourself)? ___________
4. Who makes up your carpool/vanpool group? ___ Family Members ___ Neighborhood Friends ___ Co-Workers
5. Does your carpool/vanpool use a park-and-ride or park-and-pool lot as a staging area?
   ___ Yes (please specify which lot you typically use___________) ___ No
6. Does your carpool/vanpool use the Sam Houston Tollway? ___ Yes ___ No
7. How long have you been a regular use of the North HOV lane? ___________
8. Which HOV lane entrance to you normally use to access the North HOV lane in the morning?
   ___ North Belt mainlane entrance ramp ___ Aldine-Bender wishbone ramp ___ North Shepherd ramp
9. What time do you normally enter the HOV lane in the morning? ________ a.m.
10. What is your a.m. carpool/vanpool destination? ___ Downtown ___Galleria/City Post Oak/Uptown
    ___ Texas Medical Center ___ Greenway Plaza ___ Other (specify Zip Code ________)
11. When did you join your present carpool/vanpool? Month: ________ Year: ________
12. How important was the North HOV lane in your decision to carpool/vanpool?
    ___ Very Important ___ Somewhat Important ___ Not Important
13. If the North HOV lane had not opened to carpools/vanpools, would you be carpooling/vanpooling now?
    ___ Yes ___ No ___ Not sure
14. Prior to carpooling/vanpooling on the North HOV lane, how did you normally make this trip?
    ___ On the HOV lane
      ___ Bus ___ Vanpool ___ Carpool

    ___ On the North Freeway general-purpose lanes
      ___ Bus ___ Vanpool ___ Carpool ___ Drove Alone

    ___ On a parallel street or highway (Street Name ___________)
      ___ Bus ___ Vanpool ___ Carpool ___ Drove Alone

    ___ Did not make this trip
15. How many minutes, if any, do you believe your carpool/vanpool saves by using the North HOV lane instead of the regular traffic lanes? ______ Minutes in the morning ______ Minutes in the evening
16. Do you feel that the North HOV lane is, as present, sufficiently utilized to justify the project?
    ___ Yes ___ No ___ Not sure
17. What is your... Age? ____ Sex? ____ Occupation? ___________
18. What is the last level of school you have completed? ___________
19. What is your home Zip Code? ________

Figure 13-14. Example of HOV Lane Carpool and Vanpool Survey Form Used in Houston

Instead of recording license plate information and mailing surveys to vanpoolers and carpoolers, some areas have handed surveys directly to the drivers as they are entering or exiting the lanes. The completed surveys are then mailed back in the postage-paid envelope provided. Concerns about safety and disrupting the operation of the facility may arise with this approach, but it may be appropriate in some areas if the right set of conditions exist.

A copy of the questionnaire sent to drivers in the general purpose lanes in Houston is provided in Figure 13-15. The survey is similar in focus to the bus rider and vanpoolers and carpooler surveys. The procedure for administering the survey is similar to that used with the vanpool and carpool surveys. TTI personnel record license plate numbers of vehicles traveling in the mixed-traffic lanes. Surveys are mailed to the appropriate addresses provided by TxDOT with a postage-paid return envelope. In a recent survey conducted on the Katy Freeway mainlanes, a total of some 4,800 license plates were recorded. Out of this, approximately 3,100 surveys were mailed. A total of 1,050 completed surveys were returned, accounting for a 37 percent response rate (6).

Attachment 1 provides an example of a telephone survey of the general population used in the Seattle area. The telephone questionnaire was used to obtain information on perceptions about traffic congestion on the I-5 South Freeway and possible approaches for addressing these concerns.

5. **Safety and Accident Information**. Safety and accident information should be monitored on the HOV lanes, in the adjacent freeway general-purpose lanes, and on the control freeways. In most areas, accident information is obtained from the state department of transportation, the local department of public safety, and the state, local, or transit police.

Ensuring that similar techniques are used to collect and analyze accident data is important. For example, variations may exist in the methods used to record accidents by different agencies in the same corridor. Further, it is often difficult to determine the exact cause of an accident and the exact location. Establishing a methodology in the study design that all groups responsible for accident records agree to use and developing a good trend line before an HOV facility is opened are two important steps to ensuring accurate accident data.

NORTH HOV LANE MOTORIST SURVEY

Undertaken by the Texas Transportation Institute, The Texas A&M University System in cooperation with the Texas Department of Transportation, the Metropolitan Transit Authority of Harris County, and the U. S. Department of Transportation.

1. What was the purpose of your trip? _____ Work _____ School _____ Other

2. What are your reasons for driving your car on the freeway mainlanes rather than traveling in a high-occupancy vehicle on the HOV lane?
   _____ Need car for job
   _____ Car is more convenient and flexible
   _____ No convenient bus, vanpool, or carpool available
   _____ Work irregular hours
   _____ Other (Specify ____)

3. How many days per week do you normally make this trip? ____________

4. How do you usually make this trip?
   ______ Drive alone ___ Vanpool ________________ METRO regular route or express bus
   ______ Carpool _________ METRO park-and-ride bus ___ Other (specify ____________________)

5. How many people (including yourself) were in your vehicle for this trip? ____________

6. Which on-ramp did you use to enter the North Freeway for this trip? ______________________

7. What was the destination of your trip?
   ___ Downtown ___Galleria/City Post Oak/Uptown
   ___ Texas Medical Center ___ Greenway Plaza ___ Other (specify Zip Code __________)

8. Based on your observation of the number of vehicles currently using the North HOV lane, do you feel that it is being sufficiently utilized? ___ Yes ___ No ___ Not sure

9. Based on your perception of the number of persons currently being moved on the North HOV lane, do you feel that it is being sufficiently utilized? ___ Yes ___ No ___ Not sure

10. Do you feel that the North HOV lane is a good transportation improvement?
    ___ Yes ___ No ___ Not sure

11. Do you normally listen to traffic reports on the radio at home, at work, or in your car? ___ Yes ___ No

    If "yes," have you every changed your original travel plans (taken an alternate travel route, altered your travel time, or used a bus or carpool) because of information obtained from these reports? ___ Yes ___ No

12. Do you know the location of the park-and-ride lot nearest your home? ___ Yes ___ No ___ Not sure

13. Do you know enough about the park-and-ride service provide by METRO to confidently begin using it tomorrow?
    ___ Yes ___ No ___ Not sure

14. What is your... Age? _____ Sex? _____ Occupation? ___________________________

15. What is the last level of school you have completed? ____

16. What is your home Zip Code? ___________

Figure 13-15. Example of Motorist Survey Form Used in Houston

6. **Violation Rates**. The violation rates, which reflect the number of vehicles not meeting the minimum HOV lane occupancy requirements, can provide a general indication of the degree of public understanding and support for the facility and if the facility is being used for the intended purpose. In Houston, violation rates are monitored in two different ways. First, the METRO Transit Police, who are responsible for enforcement of the HOV lanes, maintain records on the number of citations issued. Second, the vehicle and occupancy counts also provide information on the number of vehicles, by time of day, not meeting the minimum occupancy requirements. The results from both of these sources are examined as part of the ongoing monitoring and evaluation process.

   These two approaches are commonly used with other HOV facilities, although some areas have experimented with the use of video cameras to monitor occupancy levels and violations of the occupancy requirements. Current technologies appear to have a number of limitations preventing their use at this time. As new technologies are developed, however, video cameras or other approaches may be appropriate for use in monitoring HOV lane violation rates and related enforcement activities.

7. **Data Reduction and Data Analysis**. Once the previously described activities have been completed, the collected data must be reduced and analyzed. In Houston, the data collected from the vehicle and occupancy counts, travel time runs, user and non-user survey, accident rates, and violation levels are analyzed by TTI staff. The computer program SAS (Statistical Analysis System) is used to manage and analyze the data. This program allows for the maintenance of large data files and the creation of sub-files for specific analysis activities. Quarterly summaries of the results of the ongoing monitoring and evaluation efforts are published and used by the operating agencies for various purposes. An annual report is also prepared documenting the results of all the data collection activities.

   The results of the data collection and ongoing monitoring activities can be presented in a variety of ways. A key to presenting the results of the evaluation and ongoing monitoring program is to focus on the major measures of effectiveness. These should be presented in a clear, concise, and readable manner, that allows individuals to easily identify the purpose of the data and the changes that have occurred. In addition, the narrative accompanying these tables and graphics should be concise and easily understood. A good data collection and evaluation effort can be wasted if the results are presented in a sloppy and unprofessional way. Thus, spending adequate time and resources on ensuring a clear, well done report is essential to the evaluation process. The results of the evaluation should be communicated and presented in a professional, accurate, and understandable way.

As noted in Section II, it is also important that consideration be given to the audience the information is directed at. The results of the evaluation and the ongoing monitoring activities will be of interest to transportation professionals and technical staff, decision makers, special interest groups and the general public. The presentation, level of detail, and analysis provided should be appropriate for the audience being addressed. For example, transportation professionals would be more interested in the detailed technical information, while decision makers and the general public may be more interested in general trends and utilization levels.

8. **Staffing and Resource Needs**. The staffing and resources needed to conduct the data collection activities will depend on the frequency and approach used. The current schedule for the data collection activities associated with the Houston evaluation program is shown in Table 13-4.

An example of the general level of effort and cost associated with conducting the annual vehicle and occupancy counts, travel time runs, and surveys associated with the Houston HOV lane monitoring and evaluation program are shown in Tables 13-5 and 13-6. The costs vary somewhat by HOV lane depending on the length, number of access/egress points, and number of support facilities. The Northwest HOV lane corridor, which represents the middle range in terms of effort and cost, has been used to show the average expenditures. Only the direct cost are shown, since the fringe and indirect rates used at different agencies may vary greatly. This will probably result in a total cost in the range of $95,000 to $120,000 per HOV lane corridor. Including the cost of monitoring a "control" freeway would add approximately $25,000 to this figure. These figures do not include the costs associated with the detailed analysis of the data or the preparation of the different reports. Depending on the scope, level of detail, and type of report, these costs could be expected to range from roughly $50,000 to $150,000; bringing the total budget to between $150,000 and $300,000.

Table 13-4. Frequency of Data Collection for the Houston HOV Lanes

Data Collected	Facilities	Frequency
Vehicle and Occupancy Counts	Freeways and alternate routes	Quarterly
Vehicle and Occupancy Counts	HOV lanes and park-and-ride lots	Monthly
Travel Time Runs	HOV lanes and freeways	Quarterly
Surveys	HOV lanes and freeways	Yearly[1]
Accident Information	HOV lanes and freeways	Ongoing
Violation Rates	HOV lane	Ongoing

[1] Surveys are generally conducted approximately once a year, but not necessarily always one year apart.

Source: (1)

Table 13-5. General Staffing Requirements for Data Collection Activities for the Northwest Corridor in Houston

Data Collection Activity	Staffing Requirement
Vehicle and Occupancy Counts	
Freeway mainlanes	3[1]
Freeway frontage road	1
HOV lane	2
Parallel alternate route	1[2]
Travel Time Runs	
Freeway mainlanes	4[3]
HOV lane	4[3]
Surveys	
On-board bus	8[4]
Carpool/vanpool	2[5]
Freeway mainlanes	1[5]

[1] One person is needed for each freeway mainlane. Thus, if it is a 4-lane facility, 4 people would be needed.
[2] One person is needed for each parallel route.
[3] A total of 4 people, 2 people per vehicle.
[4] Refers to personnel needed to hand out and collect surveys on the buses. This allows all surveys to be completed in one day.
[5] Refers to personnel needed to read license plates at specific locations on the facility. The staffing requirements depend on the number of recording locations.

Source: (1)

Table 13-6. General Annual Data Collection and Reduction Costs for the Northwest HOV Lane Corridor in Houston

Data Collection	Staff Hours		Staff Cost[1]	Direct Costs[2]	Total Cost[3]
	Staff	Technicians			
Vehicle and Occupancy Counts[4]	100	1,620	$15,000	$4,700	$19,700
Travel Time Runs[5]	320	360	$9,300	$2,700	$12,000
Surveys[6]	600	1,000	$20,000	$4,000	$24,000
TOTAL	1,020	2,980	$44,300	$11,400	$55,700

1 Based on an estimate of $8 an hour for technicians and $20 an hour for professional staff. Does not include fringe or indirect rates.
2 Includes mileage, computer time, etc.
3 Does not include fringe and indirect costs.
4 Includes vehicle and occupancy counts for the freeway, HOV lane one alternate parallel route, and park-and-ride lots.
5 Includes travel time runs on freeway and HOV lane.
6 Includes surveys of bus, carpool, and vanpool users on the HOV lane, and non-users in the adjacent general purpose freeway lanes.

Source: (1)

IV. CONDUCTING AN EVALUATION PROGRAM

Once the study design has been completed, the ongoing evaluation program can be initiated. The four basic steps in conducting an evaluation program of an HOV facility are illustrated in Figure 13-16 and briefly described next. These steps are collecting the base line information before a facility is opened, collecting the same information after the facility is in operation, analyzing the data from both time periods, and conducting the ongoing monitoring and evaluation efforts.

A. Conduct "Before" Data Collection

The first step in conducting the evaluation program is to collect the necessary information 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 data collection activities prior to the opening of the HOV facility 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.

Step 1—Conduct "Before" Data Collection

↓

Step 2—Conduct "After" Data Collection

↓

Step 3—Analyze "Before" and "After" Data

↓

Step 4—Conduct Ongoing Monitoring and Evaluation

Figure 13-16. Conducting an HOV Facility Evaluation Program

The evaluation study design will have identified the specific data collection methods and techniques. A number of factors should be considered in conducting the data collection activities to ensure a safe and accurate process. Regardless of the exact data collection procedures used in the evaluation, the following items should be considered in planning for and conducting the actual data collection activities.

Statistical Methods. Using correct statistical methods in the collection, tabulation, analyzation, and interpretation of the data in monitoring and evaluating HOV facilities critical to the credibility of the analysis. The use of appropriate statistical or scientific methods should be considered in developing the data collection activities, gathering the data, examining the significance of the data, and presenting the results. Some of the key issues that should be considered in developing statistically valid sampling and analysis techniques are highlighted in this section. This information is provided as an overview to identify some of the technical areas where statistical analysis needs to be considered; it is not intended as a detailed guide. It is recommended that references or expertise in statistics be consulted in the development of the specific data collection activities presented previously in this chapter.

Ensuring that the sampling techniques utilized with the different data collection activities are statistically valid is one of the more important issues associated with evaluations of HOV facilities. The purpose of many of the data collection activities is to identify characteristics or attributes of individuals of the group being investigated. Thus, as a first step, the population or universe being examined must be well defined. In the case of HOV project evaluations, the population usually consists of individuals traveling in the freeway general-purpose lanes, the HOV facility, parallel alternate routes, and the control freeway. In addition, the time frame for the evaluation must be selected. These include the hours days and months for which the sample is to be representative.

In an ideal situation, the data collection activities would encompass all of the defined population. However, depending on the size of the population involved, this may not be possible. Thus, sampling techniques must be used to select a subgroup of the population from which to obtain the data. To ensure the reliability of the data and subsequent analysis, the sample must be selected so that it accurately represents the population. Thus, a method must be used that will result in a random or unbiased sample. Simple random and stratified random sampling techniques represent the two most commonly used methods associated with HOV project evaluations.

The simple random sampling technique, which is based on the concept that everyone within the population has an equal chance of being included in the sample, represents the most basic sampling approach. The stratified random sampling technique selects random samples from specific subgroups of the population. Determining the appropriate sample size relates to the quantity of data needed to meet different statistical considerations. In most cases, the identification of the sample size corresponds to the maximum error that is acceptable for the analysis and the degree of certainty desired that this maximum error will not be exceeded.

The sample size for vehicle classification and occupancy data will need to be considered. In Houston, these data are collected in 15-minute intervals, and the vehicle classification and occupancy counts for the freeway general-purpose lanes are taken only for the middle lane, with vehicle and general classification counts taken on the other lanes. Thus, the universe of vehicles are counted for all lanes for the vehicle classification, with a sample of only the middle lane for the occupancy data. For this method to be statistically valid, the occupancy levels of the middle lane must be shown to be similar to the other lanes. This method was utilized in Houston only after it was established that the middle lane was in fact representative of all the general-purpose freeway lanes.

Consideration will also need to be given to the sample size for the travel time studies. A larger sample size may be possible if one of the automated techniques discussed previously is used. A smaller sample size would probably be used with the floating car technique.

Simple random samples and cluster samples appear to be the two most often utilized techniques with surveys of users and non-users of the HOV facility. However, in cases where only a few buses are operated on the HOV facility, the total population of bus riders may be surveyed. As a general guideline, the research effort will be better served by obtaining a high response rate from a statistically valid sample group rather than a low response rate from the full population. In the latter case, it is difficult to establish if the results are in fact representative of the full population due to the large number of non-respondents.

Scheduling. A schedule for data collection activities will need to be established. This schedule should include the hours of the day, the days of the week, and the months when data collection activities will be conducted. Historically, data collection activities have been conducted on days that represent normal weekday conditions. As a result, Monday and Friday are often avoided, as travel on these days tends to be different than Tuesday through Thursday. As a result, data collection activities in many areas tend to be scheduled on Tuesday through Thursday. Consideration should be given to including data collection on Monday and Friday with HOV facilities for a number of reasons. First, ignoring these days eliminates 40 percent of the work week. Second, HOV lanes may provide the most significant benefits on these days due to higher volumes in the general-purpose lanes. Third, individuals who may not use the lanes for their regular commute trips may do so on these days for recreational travel oriented toward long weekends.

The time of year is also important. Data collection during holiday periods and the summer should be avoided, unless they are conducted as part of a frequent, regularly scheduled data collection effort. The fall and spring represent the best times of the year for routine data collection. In addition, data collection activities should not be conducted during periods of inclement weather which may significantly impact normal traffic conditions. For example, data collection activities should be rescheduled if a major rain or snow storm occurs during the planned time period.

These general rules of thumb do not, of course, apply in the case of special data collection efforts focusing on a specific time period, such as the monitoring of weekend use, or if a system is in place through which data are continuously obtained. When possible, the data collection activities should be conducted on the same days for the HOV facility and freeway lanes. While it is beneficial to have information for both the morning and afternoon peak-periods, it may be appropriate in some instances to conduct more intensive efforts during the morning peak-period.

Training and Safety. Collecting traffic data in a congested urban environment can be extremely dangerous. Thus, safety should be the primary consideration in all decisions regarding the data collection activities. Adequate training should be provided to the personnel conducting the various data collection activities. These might include training sessions, slide presentations that address safety measures and data collection procedures, and taking new trainees out to the freeway and HOV lanes for practice runs before the actual data collection activities are initiated. All personnel involved in data collection activities should take all appropriate precautions.

B. Conduct "After" Data Collection

In this step, the "after" data are collected. The same procedures used to collect the data before the facility is open should be used in this step. 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 development of these time-series data is needed to accurately reflect the long-term impact of an HOV facility. This information can be used to address potential operating issues such as not enough demand or too high a demand.

C. Analyze Before-and-After Data

In this step, the information collection before the HOV facility was implemented is compared to the information collected after the facility has been in operation. 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.

The guidelines established in the study design should be followed to compare and analyze the data from the two time periods. The data reduction and data analysis techniques described previously provide examples of the approaches that may be appropriate in this step.

D. 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.

In determining the appropriate frequency of data collection activities, consideration should be given to the type of HOV facility, the maturity of the system, available resources, and changes or anticipated changes in the operating environment. The desired outcome is to best utilize the available resources to ensure a basic ongoing level of data collection to effectively monitor and evaluate the HOV facility. Each of these considerations will be touched on briefly.

Data collection activities should be tailored to the type of HOV facility and operating characteristics. Short contraflow or concurrent flow lanes that operate only during the peak periods may require lower levels of effort than extensive exclusive or concurrent flow lanes.

The maturity of the facility may also influence data collection efforts. New facilities should be evaluated more frequently than those that have reached a stable operating level. This is not to say that older facilities should not continue to be monitored, but the frequency of these activities may be slightly less. Data from current projects suggest that usage levels on successful HOV facilities will continue to increase for several years. Thus, it is important that data collection and monitoring activities be organized to accurately monitor these changes.

If changes have occurred or are anticipated in the operating environment, more frequent data collection may be appropriate. Examples of possible changes could include increasing or decreasing the minimum occupancy requirements, changing the hours of operation, and the opening of other competitive facilities. Anticipating these changes should allow for conducting the appropriate data collection activities to evaluate the impact of these changes.

Regardless of the type and maturity of the facility, it appears that a base level of data needs can be identified. Table 13-7 outlines a suggested desired level and a basic level of data collection. In terms of providing information needed to evaluate the HOV project objectives, the vehicle and occupancy counts and travel time runs for the HOV lane, freeway mainlanes, and a control freeway are the most important. Information from these are used in determining if the major objectives have been met. Thus, limited resources would best be used in obtaining accurate vehicle and occupancy counts and travel time data. However, the surveys provide valuable information on the perception of users and non-users, and surveys should be considered at a minimum shortly after implementation of an HOV facility, and at periodic times thereafter.

Table 13-7. Suggested Minimum Frequencies of Data Collection

Data Collected	Facilities	Frequency[1]	
		Desirable	Minimum
Vehicle and Occupancy Counts	HOV facility, freeway, alternate parallel routes, and park-and-ride lots	Quarterly/ Monthly for HOV lane	Annually[2]
Travel Time Runs	HOV facility and freeway	Quarterly	Annually[2]
Surveys	HOV facility and freeway	Annually	2-3 years
Accident Information	HOV facility and freeway	Quarterly	Annually[2]
Violation Rates	HOV facility	Monthly	Annually[2]

[1] It may be appropriate to focus these activities on the A.M. peak period if initial data collection activities indicate this is appropriate.

[2] HOV facilities that have reached a stable operating condition, it may be appropriate to collect this information every 18 to 24 months.

Source: (1)

The following is suggested as a basic level of data collection for a new HOV project to ensure that an adequate before-and-after evaluation can be completed. Prior to the start of any construction activity, vehicle and occupancy counts and travel time runs should be conducted on the freeway and along parallel alternate routes. At a minimum, these should be conducted during the A.M. peak-period. The results of the Houston evaluations strongly indicated the importance of trend data, rather than a single data point. Thus, establishing several "before" data points appears important. Historical information on safety and accident rates on the facility should also be collected.

After implementation of the HOV facility, vehicle and occupancy counts and travel time runs should be conducted on the HOV facility, freeway lanes, and alternate routes. It is recommended that these be conducted at least once during the first 3 to 6 months of operation, and again at 12 months. Safety, accident, and violation information should also be examined on the same schedule. A survey of users and non-users should be conducted at some point during the first year and on the same schedule. A regular schedule should be established for ongoing monitoring of all these elements.

V. OVERVIEW OF EVALUATION PROGRAMS

Evaluations of HOV facilities have been conducted in a number of areas. Some of these efforts have focused on initial assessments, while others represent more comprehensive ongoing programs. A few examples of the ongoing comprehensive monitoring and evaluation programs are provided next. More detailed information on these projects and related activities can be found in other reports (1,7).

Boston, Massachusetts. An evaluation was conducted on the first year of operation of the Southeast Expressway contraflow HOV lane and an ongoing monitoring program is in effect. The initial evaluation included before and after assessments of travel times in both the HOV lane and the general-purpose lanes, daily vehicle and occupancy counts for the HOV lane, and monitoring of any incidents or citations in the lane. The monitoring and evaluation program is being conducted by the Massachusetts Highway Department (MassHighways). The ongoing monitoring program includes daily vehicle and occupancy counts in the HOV lane, as well as documentation of incidents and violations.

Houston, Texas. The Houston HOV facility evaluation, which has evolved over the last 16 years, represents the most extensive and comprehensive ongoing monitoring and evaluation program being conducted of HOV facilities. The evaluation program started with the implementation of the I-45 North Freeway Contraflow Lane in 1979. The evaluation conducted of this demonstration project evolved into an ongoing monitoring and evaluation program for all of the HOV facilities in Houston. The program has been sponsored and funded by TxDOT and METRO, and conducted by TTI. The regularly scheduled data collection activities included in the evaluation are vehicle and occupancy counts, park-and-ride lot counts, travel time runs, user and non-user surveys, accident data, and violation rates. This information is presented in quarterly summaries and annual reports and is used by TxDOT and METRO personnel for operations planning and decision making.

Minneapolis, Minnesota. The Minnesota Department of Transportation (MnDOT) conducted an extensive before-and-after study of the I-394 HOV facility. The evaluation was initiated prior to the opening of the interim HOV lane in 1985 and continues today. In addition to the before data, the evaluation focused on three time periods—interim HOV lane, the start-up period for the complete facility, and the stable operating period. Elements examined in the evaluation include vehicle and occupancy counts on the HOV lanes, freeway and a parallel roadway, surveys of users and non-users, travel time data, park-and-ride lots counts, accident data, violation rates, and special surveys and focus groups.

Montgomery County, Maryland. The Maryland State Highway Administration is conducting an ongoing monitoring and evaluation program on the I-270 HOV facilities in Montgomery County. Data collection activities were initiated in 1993 prior to the opening of the first HOV element. An ongoing data collection and analysis effort has been conducted since that time. The evaluation program has focused primarily on travel times, vehicle volumes, vehicle classification, and vehicle occupancy levels for both the HOV lane and the general-purpose lanes and violation rates in the HOV lane.

Seattle, Washington. An evaluation was conducted as part of opening of the first HOV freeway lane in the Seattle area. The evaluation of the first segment of the I-5 HOV lanes occurred in 1983. Additional evaluations have been conducted on I-5 and other HOV facilities in the area. The ongoing monitoring of HOV facilities in the Seattle area is conducted by the Washington State Department of Transportation (WSDOT) as part of the FLOW evaluation process. Elements of this program include vehicle and occupancy counts, travel time runs, violation rates, safety data, and periodic surveys of users and non-users.

Suffolk County, New York. The New York State Department of Transportation (NYSDOT) conducted an evaluation of the Long Island Expressway (I-495) HOV lanes in Suffolk County. The evaluation focused primarily on traffic operations, HOV user and non-user characteristics, and safety and enforcement issues. Data on traffic volumes, vehicle classification, vehicle occupancy levels, and travel times were collected and analyzed before the HOV lane was implemented after the lane had been in operation. Surveys of HOV lane users and motorists in the general-purpose lanes were also conducted.

VI. ADDITIONAL RESEARCH NEEDS

This Manual provides a comprehensive guide to developing policies, planning, designing, funding, implementing, marketing, operating, and enforcing HOV facilities. Regular updating of the Manual will be needed to ensure that it continues to reflect current practices and that recent experiences with new projects and techniques are incorporated. The following research studies are needed to help maintain the Manual as a practical and useful guide.

Updating the HOV Systems Manual. This manual should be updated on a regular basis to ensure that it reflects current trends and information. The research needs outlined in this chapter should be incorporated into these updates. The use of the three ring binder format allows for new or revised sections to be added easily.

Maintaining and Updating HOV Project Database. In addition to updating the HOV Systems Manual, the listing of current and planned projects, case study examples, and other information will need to be updated periodically. Maintaining a current database that provides accurate information on all projects would provide a resource for practitioners, policy makers, and others throughout the country.

Ongoing Monitoring and Evaluation of Studies. Support is also needed for the ongoing monitoring and evaluation of HOV facilities throughout the country. Accurate and current information on the performance of HOV facilities is needed at the local, regional, state, and national levels. Ongoing research studies at the local levels, as well as coordinating these at the national level, is needed.

Development of Evaluation Procedures and Data-Collection Techniques for Arterial Street HOV Treatments. As discussed in this chapter and noted in Chapter 7, suggested procedures for monitoring and evaluating freeway HOV facilities were developed as part of a multi-year FTA funded research project (1). Similar procedures have not been developed for arterial street HOV facilities. This research would start with a review of before-and-after studies, evaluation programs, and data collection techniques with the different types of arterial street HOV facilities. The results of this assessment would be used to develop suggested objectives, measures of effectiveness, data collection techniques, and comprehensive ongoing monitoring and evaluation programs for use with different priority measures for HOVs on arterial streets. The results of this research could be incorporated into a future update of this Manual.

VII. REFERENCES

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5. Turner, Shawn M., Gary A. Carlin, and Russell H. Henk. *Quantifying the Benefits of High-Occupancy Vehicle Facilities Using Automatic Vehicle Identification Technology.* College Station, Texas: Southwest Region University Transportation Center, 1995.

6. Christiansen, D. L. and D. E. Morris. *An Evaluation of the Houston High-Occupancy Vehicle Lane System.* College Station, Texas: Texas Transportation Institute, 1991.

7. Turnbull, Katherine F. *An Assessment of High-Occupancy Vehicle Facilities in North America: Executive Report.* College Station, Texas: Texas Transportation Institute, 1992.

VIII. ADDITIONAL INFORMATION SOURCES

In addition to the references listed in the previous section, the following documents may be of use in developing and conducting ongoing monitoring and evaluation programs for HOV facilities.

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Neumann, Lance A. *Performance Measures: Promise and Pitfalls*, prepared for the Transportation System Performance Measure Conference on November 1 and 2, 1995. Washington, D.C., October 1995.

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ATTACHMENT 1

This is a survey about traffic in King and Pierce County. As you may be aware, the State Department of Transportation will construct permanent high occupancy vehicle lanes along I-5 between Seattle and Tacoma over the next ten years. To ease traffic congestion in the meantime, the State is considering some temporary measures. You are one of 800 persons, selected at random, to participate in this study to help figure out what kinds of temporary solutions make the most sense.

1. First, I'd like to ask in the average week, how many days to you drive I-5 to or from work

   1..1 2..2 3..3 4..4 5..5 6..6 7..7
   (IF ONE OR LESS, TERMINATE)

2. Please tell us where you usually enter and exit I-5 when you commute.
   Southbound— Enter I-5:______________________
   Exits I-5:______________________
   Northbound— Enter I-5:______________________
   Exits I-5:______________________

3. We are particularly interested in your thoughts about traffic on I-5 between Seattle and Tacoma. What are your perceptions of traffic conditions on I-5 between Seattle and Tacoma? Do you think those conditions are:
   1. Extremely congested most of the time
   2. Extremely congested during peak hours
   3. Congested only some of the time
   4. Hardly ever congested

4. In the last year would you say traffic conditions on I-5 between Seattle and Tacoma has
   1. Gotten worse 2. Stayed about the same 3. Improved 8. DK

5. Now I'd like to ask about how you personally feel about the I-5 traffic. On a scale of 1 to 5, with 5 being "most frustrated and 1 being " not frustrated at all, what "score" would you give your personal level of frustration with traffic along I-5?
   1 2 3 4 5
   Not frustrated Highly frustrated

People have had a number of ideas about how to address some of the traffic congestion on I-5 between Seattle and Tacoma. I'd like now to get your reaction to some of those ideas.

6. The first idea I'd like to discuss with you is "high occupancy vehicle" or diamond lanes. These are lanes designated on the freeways for buses, vanpools and carpools.

   a. How effective do you think these lanes are in addressing traffic congestion generally. Are they:
      1. Very effective 2. Fairly effective 3. Not very effective
      4. Not effective at all 8. DK

b. Have you used high occupancy vehicle lanes :
1. Frequently   2. Sometimes   3. Seldom   4. Never: GO TO "C"
5. Never had access

What mode of travel have you used?
1. Ride the bus
2. Carpool
3. Vanpool
4. Other:______________________________

c. How would you feel about constructing high occupancy vehicle lanes on I-5 between Seattle and Tacoma. Would you
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK
Why do you feel this way?

7. The next idea I'd like to discuss with you is reversible lanes. This would entail designating an existing lane that would switch directions during peak periods to accommodate traffic flow.

a. How effective you think these lanes would be in addressing traffic congestion, generally. Are they:
1. Very effective   2. Fairly effective   3. Not very effective
4. Not effective at all   8. DK

b. Have you used reversible lanes :
1. Frequently   2. Sometimes   3. Seldom   4. Never: GO TO "C"
5. Never had access

c. How would you feel about designating reversible lanes on I-5 between Seattle and Tacoma. Would you
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK
Why do you feel this way?

d. How would you feel about designating reversible lanes if they were designated for HOV only ?
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK

e. One of the concerns that has been raised about reversible lanes is traffic safety. Would you personally feel _____ using a reversible lane:
1. Very safe   2. Fairly safe   3. Unsafe   4. Very Unsafe   8. DK

f. Would you feel safer if the lane were separated by a barrier?
1. Yes 2. No 8. DK

8. Another idea being discussed is converting an existing freeway lane into a high occupancy vehicle lane.

a. How effective do you think this measure would be in addressing traffic congestion, generally. Would it be:
1. Very effective 2. Fairly effective 3. Not very effective
4. Not effective at all 8. DK

b. How would you feel about converting an existing freeway lane into a high occupancy vehicle lane for a limited distance on I-5 between Seattle and Tacoma. Would you
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK
Why do you feel this way?

c. How would you feel about a lane conversion to high occupancy if the lane were converted for peak hours only. Would you be:
1. More inclined to support peak only conversion
2. Less inclined to support peak only conversion
3. Would make no difference
8. DK

9. Another tool for addressing traffic congestion is "ramp meters". These are signals at on-ramps that regulate traffic flow onto the freeway to improve highway efficiency.

a. How effective do you think ramp meters are in addressing traffic congestion, generally. Are they:
1. Very effective 2. Fairly effective 3. Not very effective
4. Not effective at all 8. DK

b. Have you experienced ramp meters:
1. Frequently 2. Sometimes 3. Seldom 4. Never: GO TO "C"
5. Don't have access

c. How would you feel about constructing ramp meters on I-5 between Seattle and Tacoma. Would you
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK
Why do you feel this way?

10. Another idea is to ban truck traffic on I-5 during peak hours.

a. How effective do you think this measure would be in addressing traffic congestion. Would it be:
1. Very effective 2. Fairly effective 3. Not very effective
4. Not effective at all 8. DK

b. How would you feel about banning truck traffic on I-5 between Seattle and Tacoma during peak hours. Would you
1. Strongly support
2. Support somewhat
3. Neutral
4. Oppose somewhat
5. Oppose strongly
8. DK
Why do you feel this way?

11. Which of the following statements best describes your current travel behavior:
1. I commute daily to Downtown Seattle
2. I commute daily to an employment site east of Lake Washington
3. I commute daily to work in South King or North Pierce County
4. I do not commute (SKIP to Q 10)
5. Other ____________________________________

12. FOR COMMUTERS ONLY

A. How do you usually commute to work?
1. Drive alone (GO TO B)
2. Direct bus service   4. Vanpool
3. Park & ride to bus   5. Carpool

Is your public transportation subsidized in any way by your employer?
1. YES   2. NO   GO TO 12

B. Once HOV lanes are constructed, persons traveling by bus, carpool or vanpool will be able to save time on the freeway. How many minutes would you need to be able to save for buses, carpools or vanpools to become attractive to you? (DO NOT READ)
1. 5 minutes   3. 15 minutes   5. No option would work
2. 10 minutes   4. 20 minutes or more   8. Don't know

Another reason many people have for using carpools, vanpools and buses is that it saves them money. How much money would you need to be able to save for buses, carpools or vanpools to become attractive to you? (DO NOT READ)
1. $25/month   3. $100/month   5. No option would work
2. $50/month   4. $150 month or more   8. Don't know

Another reason many people start using carpools, vanpools and buses is when parking costs increase. How much would parking costs need to increase for buses, carpools or vanpools to become attractive to you? (DO NOT READ)
1. $10/month or less   3. $50/month   5. No option would work
2. $25/month   4. $100 month or more   8. Don't know

C. What is your level of interest in the following types of transportation information?

	----INTEREST-----			
	HI	MED	LOW	DK/NA
• Notices in the newspaper about upcoming traffic revisions				
• Notices on the radio about upcoming traffic revisions				
• Transportation information available at your worksite				
• Transportation information sent to your home				
• A monthly Commuter Newsletter sent free to your home				
• Radio traffic report information				

13. The following is a list of actions that some people have taken related to traffic congestion in their communities. Tell me how interested you are personally in each of the following activities:

	----INTEREST-----			
	HI	MED	LOW	DK/NA
•Reading articles about traffic congestion in newspaper & magazines				
•Taking the bus or using a carpool or vanpool				
•Distributing information to your co-workers or neighbors about public transportation options				
•Attending public meetings about public transportation options				
•Participating in public meetings about high occupancy vehicle projects				
•Encouraging school curricula to cover public transportation issues				

I have a few last questions to help us with our statistical analysis.

14. How long have you lived in this area?
    1. Less than 2 years
    2. 2-5 years
    3. 6-10 years
    4. 11 to 15 years
    5. Over 15 years

15. How old are you?

16. What is the last year of schooling you completed?
    1. Graduate, medical, law school (advanced degree)
    2. 2 or 4 year college
    3. High school
    4. Less than High School

17. Which of the following best describes your approximately family income, before taxes, for 1989:

    1. Less than $15,000
    2. $15,000 to $25,000
    3. $25,000 to $50,000
    4. $50,000 to $75,000
    5. $75,000 to $100,000
    6. Over $100,000

The State Department of Transportation is planning to conduct focus group research in the near future about traffic and transportation in your area. Would you be willing to be re-contacted regarding further research?

1. NO 2. YES: May I have your name and address, so that we can re-contact you?

____
name

____
street

____
city zip

17. BY OBSERVATION: 1. Male 2. Female

Thank you very much. You have been very helpful.

APPENDIX A—GLOSSARY OF TERMS

This glossary defines the terms most frequently associated with planning, designing, funding, implementing, marketing, operating, enforcing, and evaluating HOV facilities. A listing of glossaries on related topics is provided at the end of the appendix should the reader wish to consult additional sources. Also, Appendix B provides a listing of agencies, organizations, and legislation relating to HOV facilities.

Activity Center—A geographic area characterized by a significant amount of retail, commercial, business, industrial, or other land uses. Activity centers may be located in any area, but usually include the downtown or a suburban area.

Access—The ability to enter or approach a facility or to make use of a facility.

Accessibility—Measure of the ability or ease of individuals to travel among all origins and destinations in an area.

Access Mode—Mode or type of transportation used to reach the major mode of transportation used to reach a destination. Walking, bicycling, or driving to a park-and-ride lot are all examples of access modes.

Add-a-Lane—Term used to describe when an HOV facility is created by adding roadway capacity. The additional capacity may be accomplished by widening a freeway or arterial street, modifying a median or a shoulder, or by adding a new facility on a separate right-of-way.

Advanced Public Transportation Services (APTS)—A categorization of intelligent transportation systems (ITS) and other advanced technologies focusing on enhancing public transit management and service delivery. Technologies may include automatic vehicle location (AVL) systems, advanced customer information systems, and other elements.

Advanced Transportation Management Systems (ATMS)—A categorization of intelligent transportation systems (ITS) and other advanced technologies focusing on improving the overall management of the transportation system, including freeways, HOV facilities, arterial streets, and other elements. Technologies and approaches include transportation management centers, video cameras and other monitoring devices, weather monitoring, and incident detection systems.

Advanced Traveler Information Systems (ATIS)—A categorization of intelligent transportation systems (ITS) and other advanced technologies to provide real-time traffic, transit, weather, and other information to commuters, commercial operators, and travelers. Technologies and approaches include in-vehicle systems, changeable message signs, and computers in the home and office.

Advanced Vehicle Control Systems (AVCS)—A categorization of intelligent transportation systems (ITS) and other advanced technologies focused on enhancing vehicle control and operation, including elements such as intelligent cruise control, lateral and longitudinal control function, collision avoidance systems, and completed automated vehicles.

Air Rights—The ability to sell, lease, or otherwise use the air space over property owned by another source. This technique may be used for developments over or below transportation facilities.

Alignment—The horizontal and vertical ground plan of a roadway, HOV lane, transit route, rail system or other transportation facility as it appears in plan and profile.

Alternatives Analysis—A detailed study of alternative transportation improvements to address specific issues in a corridor. All feasible alternatives are investigated, and the best approach is selected for implementation. An Alternatives Analysis was required by the Federal Transit Administration (FTA) as the first step in the Environmental Impact Statement process before Major Investment Studies.

Alternative Transportation—Modes of transportation other than the single-passenger motor vehicle, including but not limited to carpools, vanpools, buspools, public transit, walking, and bicycling.

Alternative Work Schedule—Work policies and programs such as flexible and staggered work hours, variable work hours, flextime, and compressed work weeks that allow employees to avoid commuting during the most congested or peak travel periods in the morning and afternoon.

Ambient Air Quality—The concentration of chemicals and other elements in the air determined over a set time period.

Arterial Street or Roadway—A major thoroughfare serving higher speed through trips, with limited access to adjacent property.

Articulated Bus—An extra-long, high-capacity bus. The rear portion of the vehicle is connected to the forward portion by an articulated section. Articulated buses have passenger seating for 60 to 80 persons, with additional space for standees. Vehicle length is from 60 to 70 feet. The turning radius for an articulated bus is usually less than that of a standard urban or intercity bus.

Automated Highway System (AHS)—A categorization of intelligent transportation systems (ITS) focusing on a fully automated system of vehicles traveling on a roadway or freeway.

Automatic Vehicle Location (AVL) System—The use of advanced technologies to monitor the location and movement of vehicles, included buses.

Average Daily Traffic (ADT)—The average number of vehicle trips generated during a 24-hour period from a specific site or area. This term also applies to traffic volumes on a roadway over a 24-hour period.

Average Vehicle Occupancy (AVO)—The total number of persons in all vehicles divided by the number of vehicles traveling past a selected point during a predetermined time period. AVO is usually expressed to two or three significant decimal places, such as 1.2 or 1.26.

Average Vehicle Ridership (AVR)—The average number of employees who report to a work site divided by the average number of vehicles driven by these employees, calculated for an established time period. This calculation recognizes vehicle trip reductions from telecommuting, compressed work weeks, and non-motorized transportation.

Barrier-Separated HOV Facility—An HOV lane that is physically separated from the adjoining general-purpose lanes by some type of barrier. A concrete barrier is the most commonly used approach, but wide buffers, movable barriers, and pylons may be used. A barrier-separated HOV lane may be a one direction/reversible facility or a two lane bi-directional facility.

Benefit-Cost Ratio—Analysis tool used to estimate the anticipated benefits for a specific project. Estimated by dividing the dollars of discounted benefits achievable by the discounted costs.

Bicycle Lane or Bike Lane—A portion of a roadway reserved for preferential or exclusive use by bicycles through striping, signing, and pavement markings.

Bicycle Path or Bike Path—A path or trail reserved for exclusive use by bicycles and physically separated from motorized vehicle traffic by an open space or barrier. A bicycle path may be in a separate right-of-way, such as the use of an abandoned railroad line, or in a roadway right-of-way. Bicycle paths or trails may also be open to other user groups such as walkers, joggers, or in-line skaters.

Bicycle Route—A system of bicycle lanes or paths designated and signed by a jurisdiction.

Bicycle Facilities—Shelters, racks, storage facilities, and other elements for bicycles.

Bid and Bid Process—The process of a public agency requesting proposals for a specific project or scope of work and the response from an individual or firm to secure a contract.

Bi-Directional HOV Facility—An HOV facility accommodating two-way traffic.

Buffer-Separated HOV Facility—An HOV lane that is separated from the adjacent mixed-flow freeway lanes by a designated buffer. Different widths of buffers are currently in use with various HOV lanes.

Bus—A self-propelled, rubber-tired vehicle designed to carry a substantial number of passengers.

Bus Bay—A designated area at a bus stop or transit station for buses to pull into to pick up and drop off passengers.

Bus Bulb—A section of the sidewalk that has been extended through the parking lane on an arterial street.

Bus Lanes—HOV lanes on freeways, arterials, or in separate rights-of-way restricted to buses only.

Bus Mall or Transit Mall—An arterial street, usually in the downtown area, restricted to buses only.

Buspool—A form of bus service set up to serve one large employer or group of employers with limited origin and destination points. Buspools are often subsidized by the employer they serve, provide guaranteed seats for passengers, and have limited service.

Bus Priority Systems—Techniques and strategies to improve the movement of buses in heavily traveled corridors, usually on arterial streets, which may include priority at traffic signals, phasing and coordinating traffic signals, and other treatments.

Busway—A preferential roadway designed exclusively for use by buses. Busways are usually constructed in separate rights-of-way, but may be located within a freeway or roadway right-of-way.

Capacity—The maximum number of vehicles (vehicular capacity) or persons (person capacity) that can pass over a given section of roadway in one or both directions during a given period of time under a prevailing management strategy that assures an acceptable level of free-flow service, usually expressed as vehicles per hour or persons per hour.

Capital Cost—The costs associated with the purchase, development or construction of fixed assets such as land, roadways, guideways, stations, buildings, and vehicles.

Carbon Dioxide (CO_2)—A colorless gas that enters the atmosphere as a result of the combustion processes. CO_2 is a normal component of ambient air.

Carbon Monoxide (CO)—An invisible, odorless, tasteless and toxic gas, which is primarily generated by motor vehicles, but is found in trace quantities in the natural atmosphere.

Carpool or Carpooling—Any automobile or private vehicle containing two or more occupants including the driver.

Carpool Lane—Another term used to describe an HOV lane, especially in areas with lower levels of bus service and high numbers of carpools.

Casual Carpool—Term used to describe the formation of a carpool on a periodic basis, with no formal arrangement for regular riders, or where drivers pick up random passengers at predetermined locations. Often used interchangeably with informal and instant carpooling.

Central Business District (CBD)—The major concentration of business activity in a downtown area. Formally defined by the Census Bureau.

Central City—The major or largest city in a metropolitan area, usually containing the CBD. Formally defined by the Census Bureau.

Change of Mode—The transfer from one type of transportation vehicle to another. For example, changing from driving alone to taking a bus at a park-and-ride lot represents a change of mode.

Commute Trips—Trips that are made on a daily or regular basis to work, including those with intermediate stops to and from a work site.

Commute Alternatives—Alternatives to driving alone such as carpooling, vanpooling, transit, bicycling, and walking, or alternative work schedules that shift, commute trip to less congested periods, or remove work trips from the system altogether.

Commuter Assistance Programs—Programs which provide services to help commuters identify and use alternative modes, such as ridesharing and transit, and provide support facilities and services.

Commuter Rail and Commuter Rail Transit—Passenger rail service which is often operated on existing railroad rights-of-way or on trackage shared with freight railroads. Commuter rail is characterized by long distance trips, faster operating speeds, and limited service, with longer distances between stops.

Compliance Rate—The number of eligible vehicles using an HOV facility. Calculated as the number of vehicles in the HOV lane obeying the occupancy restrictions divided by the total vehicles in the lane and expressed as a percent.

Compressed Work Week—One alternative work schedule technique that consists of condensing the standard 5-day work week into a fewer number of longer workdays. Common schedules include 4-10 hour days with one day off a week, and 9-9 hour days, with one day off every two weeks.

Concurrent Flow HOV Lane—An HOV lane that is operated in the same direction as the adjacent mixed-flow lanes, and is designed for use by HOVs during all or a portion of the day. The lane is separated from the adjacent general-purpose freeway lanes by a standard lane stripe or a buffer. Concurrent flow HOV lanes are usually found on the inside lane, but may also be on the outside lane.

Congestion Pricing–The concept of charging for the use of a transportation facility, such as a roadway, based on the level of traffic congestion. The greater the level of congestion, which usually occurs during the morning and afternoon peak-periods, the higher the cost to use the facility.

Contraflow HOV Lane—An HOV lane operating in a direction opposite to the normal flow of traffic designated for peak direction travel during at least a portion of the day. Contraflow lanes are usually separated from the off-peak direction general-purpose lanes by plastic pylons or moveable barriers.

Corridor—A geographical area usually defined by a freeway, roadway, or other physical element and its immediate surrounding area, including collector routes, that has similar characteristics.

Cost-Benefit Analysis—An analytical technique that computes the costs and benefits, measured in monetary terms, of a proposed transportation improvement or policy action. Identified losses and gains experienced by society are included, and the net benefits created by an action are calculated. Alternative actions are compared to assist in the selection of those that yield the greatest net benefits or benefit-cost ratio.

Crosstown Transit Service or Routes—Transit service that does not serve a downtown area. Routes are laid out in a non-radial fashion.

Deadheading—The segment of a trip made by a transit vehicle when not in revenue service. A bus traveling from a garage to the start of a route in the morning is one common example of deadheading.

Delay—The increased travel time experienced by a person or a vehicle due to circumstances that impede the desirable movement of traffic. Delay is measured as the time difference between the experienced travel time and the travel time during free-flow conditions.

Demand—The quantity of a good or service, such as transportation, desired. The desire for a good or service may be different based on different costs or benefits.

Demand Estimation and Demand Forecasting—Procedures for determining the desire for travel by potential users of the transportation system, including the number of travelers, the time of day, and the travel routes.

Demand Modeling—The development and use of computer models to represent the relationships between land use and the transportation system to conduct demand estimation analyses.

Demand-Responsive Transit Services—A bus, van, or other vehicle that is dispatched and operated only in response to a specific request for a passenger.

Destination—The point, area, or zone in which a trip terminates.

Dial-A-Ride—Another term used for demand response services in which a bus, van, taxi, or other type of vehicle is dispatched in response to a passenger request.

Diamond Lane—A term sometimes used to refer to an HOV lane due to the diamond symbol on signing and pavement markings.

Diamond Symbol—The diamond symbol is commonly used on signing and pavement markings to designate an HOV lane or a restricted lane.

Directional Split—The distribution of traffic flows on a two-way facility, usually expressed as a percentage of the total two-way traffic.

Disincentive—Programs, policies, and techniques aimed at discouraging a specific type of behavior, such as driving alone.

Effectiveness—The extent to which the desired or stated goals and objectives are being met or the stated results are being achieved. The general idea of "doing the right things."

Efficiency—Providing the desired results with the minimum of resources or the ratio of output to input. The general idea of "doing things right."

Egress—The provision of access out of an HOV lane, freeway, or roadway. Providing access into the lanes is ingress.

Emergency Vehicle—Any vehicle used to respond to an incident or accident. Examples include police cars, fire engines, ambulances, tow trucks, and maintenance vehicles.

Eminent Domain—The power to take private property for a public use. Compensation must be provided to the property owner.

Employee Transportation Coordinator (ETC)—An individual designated by a company or a group of companies to develop, implement, and administer an employee transportation demand management program. Duties may include coordinating vanpool and carpool programs, providing information on commute options, promoting the use of public transit, monitoring employee participation, and other related activities.

Enforcement—The function of ensuring that the rules and regulations relating to the use of an HOV facility, such as vehicle occupancy levels, are abided by. The state police, transit police, or local police are usually responsible for enforcement activities.

Enforcement Area—An area for enforcement vehicles and personnel to monitor the HOV lane and to stop vehicles to issue citations. Enforcement areas may be delineated within an available shoulder or provided at specific locations such as entrances and exits.

Environment—The physical characteristics of an area including land, air, water, plants, animals, noise, historic structures, and other elements.

Environmental Assessment (EA)—A study to determine the potential impacts on the environment from a project as required by the National Environmental Policy Act of 1969.

Environmental Impact Statement (EIS)—A comprehensive study of all the potential impacts of a project funded with federal dollars as required by the National Environmental Policy Act of 1969.

Equity—A normative measure of the fairness of a transportation project or a strategy among all users.

Estimated Trip Reduction—The estimated percentage of vehicle trips to be reduced through implementation of various commute alterative strategies, usually at one worksite or a small area.

Express Bus Service—Bus service characterized by high speed travel with a limited number of stops. Express service may be oriented from a neighborhood or from a park-and-ride lot. Most bus service provided on freeway HOV lanes is express.

Fare—The payment required to ride public transit. A variety of payment methods or media may be used including cash, tokens, tickets, passes, and other techniques.

Farebox Recovery Ratio—The amount of the cost of operating a transit system paid for through fares, calculated as the ratio of fare revenue to operating expenses.

Far-Side Stop—A transit stop located beyond an intersection.

Feasibility Study—A study to determine the suitability of alternative projects or actions.

Fixed Guideway Transit System—Any transit system with vehicles that operate on a permanent or a fixed guideway. Examples include heavy rail, light rail, transit, monorail, and other related systems.

Fixed Route—Transit services that operate on a set route and a set schedule.

Fleet—Vehicles belonging to a transit system.

Flexible Work Hours and Flextime—One alternative work schedule technique that gives employees the option of varying their starting and stopping times each workday. The intent is to allow employees more flexibility to adjust their work hours to individual needs and to avoid congested travel periods. Most policies specify a core period in the middle of the workday, such as 10:00 A.M. to 3:00 P.M., when all employees are required to be present.

Forecasting—The planning process of estimating future conditions, such as population and employment levels, demographic characteristics, and demand for roadway and transit facilities.

Freeway—A divided highway with full access control and grade separation intended to serve through traffic and long distance trips.

Frequency of Service—The number of vehicles on a route traveling in the same direction often expressed as the number of vehicles that will pass a certain point in the route within an hour period.

Fringe Parking—A parking facility located adjacent to a downtown area or other major activity area. Fringe parking facilities are intended to expand the number of parking spaces in an area and are usually connected to the heart of the activity center by transit services and pedestrian facilities such as skywalks.

Frontage Road—A street located adjacent to a freeway or expressway that provides access to the local street system and property.

General-Purpose Lanes—The travel lanes on a freeway or roadway that are open to all motor vehicles.

Goals—General value or vision statements that reflect a desired end state.

Grade—A raise in elevation within a specific distance. A 1-percent grade is a 1 meter raise in elevation over 100 meters of horizontal distance.

Grade Separation—The vertical separation of an intersecting transportation facility to prevent conflicts.

Guaranteed Ride Home Program—Programs that provide commuters who rideshare, take transit, or use other alternative modes with a way to get home or to another location in the case of an emergency. A Guaranteed Ride Home program may be offered by an employer, a group of employers, a transit agency, or other groups, and a variety of techniques may be used to provide the service.

Guideway—An exclusive track or other facility that supports and guides transit vehicles.

Headway—The time interval between buses operating on a route or out of a transit facility.

High-Occupancy Toll (HOT) Lane—Concept of using congestion or priority pricing on a toll or HOV facility. An example would be charging variable toll rates depending on the number of people in a vehicle and the time of day.

High-Occupancy Vehicle (HOV)—Motor vehicles with at least two or more persons, including carpools, vanpools, and buses. Individual HOV facilities may require different vehicle occupancy levels, which are usually expressed as either two or more (2+), three or more (3+), or four or more (4+) passengers per vehicle.

High-Occupancy Vehicle (HOV) Facility—Term used to refer to any type of treatment that gives priority to buses, vanpools, and carpools, including HOV lanes, park-and-ride lots, and other elements.

High-Occupancy Vehicle (HOV) Lane—A lane designated for exclusive use by high-occupancy vehicles (HOVs) for all or a portion of the day. An HOV lane may be on a freeway, roadway, arterial street, or in a separate right-of-way.

High-Occupancy Vehicle (HOV) Network—Planning, designing, implementing, and operating HOV lanes, park-and-ride facilities, transit services and facilities, and other elements. Usually developed in an incremental, but coordinated, manner.

High-Occupancy Vehicle (HOV) System–The development and operation of a coordinated approach of physical improvements, such as HOV lanes and park-and-ride lots, and supporting services and policies.

Home-Based Trip—A trip where either the origin or the destination is the traveler's home.

Hydrocarbon (HC)—A chemical compound containing the elements hydrogen and carbon.

Inbound—A trip toward a downtown, CBD, or major activity center.

Incentive—Programs, policies, and techniques aimed at a specific type of behavior, such as taking the bus or carpooling.

Informal Carpool—The composition of the carpool passengers varies from one day to another and there is no formal arrangement for regular riders. Often used interchangeably with casual and instant carpooling.

Infrastructure–All fixed components of a transportation system including roadways and bridges, park-and-ride lots, fixed transit components, and other elements.

Ingress—The provision of access into an HOV lane, freeway, or roadway. Providing access out of a lane is egress.

Intelligent Transportation Systems (ITS)—The application of a wide range of advanced technologies to enhance the operation and management of the surface transportation system.

Interchange—The system of grade separated ramps connecting two or more freeways, toll roads, or other exclusive roadways, or connecting a roadway to an interstate.

Intermodal—The integration of multiple modes in a corridor or area.

Instant Carpool—A form of carpooling in which drivers pick up random passengers at predetermined locations along the route. The composition of the passengers typically varies from one day to another. Instant carpool passengers sometimes use this commute mode in one direction and take public transit in the other. Often used interchangeably with informal and casual carpooling.

Jitney—A privately owned vehicle operated on a fixed or semi-fixed schedule for a fare.

Joint Development—Projects that involve the joint use or improvement of a piece of property. Joint developments usually involve the public and private sectors working together on a project, but they may also include public/public partnerships.

Kiss-and-Ride Lot or Facility—Short term parking spaces and pick up/drop off areas for commuters who are driven to a transit station or park-and-ride lot and are then picked up on the return trip.

Lane—A portion of a street or highway, usually indicated by pavement markings, that is intended for one line of vehicles.

Lane Conversion—Term used to refer to the implementation of an HOV lane created by converting a general-purpose lane on a freeway or arterial street. Used interchangeably with take-a-lane.

Level of Service (LOS)—A qualitative measure that describes the operational conditions or a road or intersection, as defined by the Highway Capacity Manual. The various service levels are defined by a range from A to F, with A representing freeflow traffic conditions and F representing stop-and-go traffic.

Light Rail Transit (LRT)—A mode of transit that operates on steel rails and obtains its power from overhead electrical wires. LRT may operate in single or multiple cars on separate rights-of-way or in mixed traffic.

Line-Haul—That portion of a commute trip that is express or nonstop between two points. The term is usually used to define the express portion of a transit trip.

Local Bus Service or Local Routes—Bus routes and services characterized by frequent stops and relatively slow operating speeds that usually link neighborhood areas and downtowns or major activity centers using the local street system.

Main Lane—A mixed-flow freeway or general-purpose lane on a freeway that is open to all motor vehicles.

Main-Lane Metering—Regulating the flow of vehicles on a general-purpose or mixed-flow freeway lanes or freeway-to-freeway connection through the use of traffic signals that allow vehicles to proceed at a predetermined rate.

Market—Consumers—both actual and potential—for a type of transportation service or mode.

Market Analysis—A market research technique to identify the transportation needs and characteristic of specific groups.

Marketing—A comprehensive approach to identifying the need of various user groups, matching services to meet those needs, and promoting the use of specific services.

Market Research—Broad term used to describe a general approach to identifying markets and their characteristics and the marketing services to those markets. May include a variety of techniques and approaches.

Mass Transit and Mass Transportation—Transportation provided by public or private operators by bus, rail, ferry, or other mode that operates on a regular basis, and serves large numbers of riders.

Measures of Effectiveness (MOEs)—Criteria or measures that identify the threshold level of change or benefits anticipated from a transportation improvement or project. MOEs are used in evaluating the impact of an HOV facility or other project.

Median—The area of a divided freeway or roadway that separates the opposing directions of traffic.

Mid-Block Stop—A transit stop located in the middle of a block.

Mixed-Flow Lanes—Travel lanes on a freeway or arterial street open to all traffic and vehicles. Used interchangeably with general-purpose lanes.

Mobile Source—A source of pollutants generated by self-propelled transportation vehicles, such as over-the-road motor vehicles, boats, ships, locomotives, aircrafts, or off-road motor vehicles.

Mode—A particular form of travel conveyances, including buses, automobiles, carpools, vanpools, single occupant vehicles, walking, bicycling, rail, air, and water-borne vessels.

Mode Shift—The act of changing from one mode, such as driving alone, to another mode, such as taking the bus.

Mode Split—The proportion of total person-trips using the various modes of travel.

Multimodal—More than one mode operating in a corridor or area.

National Ambient Air Quality Standards (NAAQS)—The air quality standards established by the Environmental Protection Agency (EPA) for various air pollutants. Standards have been established for ozone, carbon monoxide, nitrogen dioxide, non-methane hydrocarbons, lead, and particulate matter.

Network—A system that comprises all transportation elements.

Near-Side Stop—A transit stop located on the approach to or before an intersection.

Non-Attainment Area—A geographic area that does not meet the National Ambient Air Quality Standards for one or more pollutants.

Non-Commute Trips—Vehicle-trips made for purposes other than work-related reasons. Examples of non-commute trip purposes include shopping, personal business, medical, school, day care, and recreation.

Objective—A measurable and attainable level of achievement. Used to establish a level, time period, and responsibilities to achieve a desired goal.

Off-Line Station—A mode transfer facility located off of an HOV lane, or other fixed guideway system, either adjacent to the facility or a short distance away.

Off-Peak Direction of Travel—The direction of travel in a corridor experiencing lower demand during a peak commuting period. In a radial corridor, the off-peak direction has traditionally been away from the central business district in the morning and toward the central business district in the evening. This situation is no longer the case in many metropolitan areas and in suburban areas, circumferential freeways often experience congestion in both directions.

Off-Peak Period—The period of time outside the peak commuting period, usually the midday, evening, night, and early morning.

On-Line Station—A mode transfer facility located along a HOV lane or a fixed guideway system.

On-Time Performance—The measure, usually a percentage, of times that a transit vehicle meets the published schedule arrival time within a policy window.

Operating Ratio—The ratio of operating expenses to operating revenue.

Operating Revenue—The total funds received by a transit operator from regular passenger fares, charters, and other sources.

Operating Cost—The ongoing costs associated with administering, operating, enforcing, and maintaining HOV facilities and related facilities and services.

Operation Plan—A comprehensive plan documenting the policies and procedures for administering, operating, enforcing, and maintaining an HOV facility and related facilities and services.

Operator—Driver of a transit vehicle or other transit mode.

Origin—The point or zone where a trip starts.

Origin-Destination Study—Analysis of the starting and ending points or zones of people or vehicles.

Outside Lane—The lane on a freeway or roadway closest to the shoulder or farthest from the median.

Oxides of Nitrogen (NO_x)—A collective term for chemical compounds containing nitrogen and oxygen. The two most common oxides of nitrogen found in the atmosphere are nitric oxide (NO) and nitrogen dioxide (NO_2).

Ozone—A highly reactive form of oxygen with a pungent odor that is formed in the atmosphere by a series of photochemical reactions involving oxides of nitrogen and reactive organic gases in the presence of sunlight. National Ambient Air Quality Standards have been established for ozone.

Paratransit—Transit services that are operated on demand, rather than on a fixed route and fixed schedule. Examples include dial-a-ride, jitney services, and shared-ride taxis.

Paratransit Vehicle—Usually smaller vehicles than conventional buses used on fixed route services. Examples include taxis, jitneys, vans, mini-vans, and small buses.

Park-and-Pool Lot and Park-and-Pool Facility—A facility where individuals can park their private vehicle and join a carpool or vanpool. The facility is not normally served by public transportation.

Park-and-Ride Lot and Park-and-Ride Facility—A facility where individuals can park their private vehicle for the day and access public transportation or rideshare for the major portion of their trip. Park-and-ride lots are found with HOV facilities, LRT, heavy rail, commuter rail systems, and ferry services.

Parking Management—Policies and programs aimed at managing both the supply of and the demand for parking at employment sites and major activity centers. May include strategies focusing on pricing, space availability and location, and priority treatments for carpools and vanpools. Measures that favor carpools and vanpools, including parking charges for drive-alone commuter parking, preferential parking for pool vehicles, and the elimination of free, low-cost, or on-street parking in employment areas.

Parking Pricing—Using pricing mechanisms to control the demand for parking and to encourage carpooling and vanpooling. Approaches include charging higher rates for driving alone, reducing or eliminating fees for carpools and vanpools, parking cash-out programs, and other approaches.

Parking Reduction Ordinances—Local government ordinances addressing parking managing policies and programs, including regulations allowing changes in zoning and other requirements for off-street parking, often in return for developer-sponsored transportation management efforts.

Peak Direction and Peak Direction of Travel—The direction of higher travel demand during a peak commuting period. In a radial corridor, the peak direction has traditionally been toward the central business district in the morning and away from the central business district in the evening.

This situation is no longer the case in many metropolitan areas and in suburban areas, circumferential freeways often experience congestion in both directions.

Peak Hour—The hour in the morning and in the afternoon when the maximum demand occurs on a given transportation facility or corridor.

Peak Period—The time period in the morning and in the afternoon when the heaviest demand occurs on a given transportation facility or corridor. Usually two or more hours.

Peripheral Parking—Parking lot or garage located adjacent to the downtown area or other major activity center.

Person Throughput—Term used to describe the number of persons, not vehicles, being carried on a facility. Usually measured at a specific point on the roadway facility for a predetermined period of time.

Pollutant Standard Index (PSI)—A number between 0 and 500 used to indicate the air quality at a given time and location relative to the National Ambient Air Quality Standards.

Preferential Parking—Parking lots, spaces, or other areas reserved for carpools and vanpools. Preferential parking is usually located closer to the destination, in a parking garage, or in some other area which is more desirable.

Preferential Treatment—Providing special privileges to a specific mode or modes of transportation, such as bus lanes or signal priority for buses at intersections.

Preliminary Engineering or Preliminary Design—Development of specific criteria and specifications at a detail to allow final design.

Priority Lane—Lane providing preferential treatment to buses, carpools, and vanpools.

Priority Lane Pricing—Concept of using congestion pricing or priority pricing on an HOV lane. Examples might include charging single-occupant vehicles for use of an HOV lane or charging 2+ carpools and allowing 3+ carpools to use the facility for free.

Priority Pricing—Term used to describe the same concept as congestion pricing; that is charging for use of a transportation facility by time of day, level of congestion, or distance traveled, as well as providing lower rates for HOVs.

Public Transit and Public Transportation—Passenger transportation service to the public on a regular basis using vehicles that transport more than one person for compensation, usually but not exclusively over a set route or routes from one fixed point to another. Routes or schedules of this service may be predetermined by the operator or may be determined through a cooperative arrangement.

Queue—A line of vehicles or persons.

Queue Bypass or HOV Bypass (HOV)–An HOV facility that provides a bypass around a queue of vehicles waiting at a ramp or at a mainline traffic meter, toll plaza or other bottleneck location.

Queue Jump—A short section of roadway reserved for buses, and sometimes carpools and vanpools, providing access around a major congestion point.

Rail Transit—General term used for all types of rail transit systems including light rail transit (LRT), heavy rail, and commuter rail.

Ramp—A roadway that allows vehicles to enter and exit a freeway or provides connections between freeways.

Ramp Meter Bypass—A form of preferential treatment at a ramp meter in which one or more bypass lanes are provided for the exclusive use of high-occupancy vehicles.

Ramp Metering—A system used to reduce congestion on a freeway facility by managing vehicle flow from local-access on-ramps. An on-ramp is equipped with a traffic signal that allows vehicles to enter the freeway at predetermined intervals.

Reactive Organic Compounds (ROC)—A group of organic compounds that undergo photochemical reactions. There are numerous schemes for classifying the reactivity of various species of organic gases for air pollution control purposes. Also commonly referred to as Reactive Organic Gases (ROG), Reactive Hydrocarbons (RHC), Hydrocarbons (HC), etc. ROC in combination with NO_x are the primary precursors to smog.

Revenue Service—The time a transit vehicle is operating service that is open to passengers.

Reverse Commute—Regular travel between home and work or school in the opposite direction of the peak direction of traffic. Travel from a central city area to a suburb is one example of a reverse commute trip.

Reversible HOV Facility—An HOV facility in which the direction of traffic flow can be changed at different times of day to match the peak direction of travel during periods of peak demand.

Ridesharing—The function of sharing a ride with other passengers in a common vehicle. The term is usually applied to carpools and vanpools.

Right-of-Way–The area or property reserved for a specific transportation function such as a roadway or transit guideway.

Route—The path a bus or other vehicle takes.

Satellite Office—An office used for employees who telecommute as a means of decentralizing part of a company's operations to a remote location, thereby reducing commute distances.

Schedule—A listing of trips and time points for buses or other transit vehicles for a given route.

Service Frequency—The number of buses or other transit vehicles on a given route, passing a specific point within a given time period.

Shared Ride—A trip other than by public transit where more than one person occupies the same vehicle.

Single Occupant Vehicle (SOV)—A motor vehicle occupied by only one person.

Smog–A general term used to describe the irritating haze produced by photochemical reactions in the atmosphere.

Staggered Work Hours—One alternative work scheduling technique that allows employees to begin and end work at times different than the normal 8:00 A.M. to 5:00 P.M. schedule. Work hours are usually staggered over a range from 15 minutes to two hours. Most staggered work hour programs require that employees maintain a set schedule, such as 7:30 A.M. to 4:30 P.M., on a regular basis.

Station—A major facility servicing one or more transit mode.

Subscription Bus Service—Pre-arranged use of a regularly scheduled bus service, for which passengers generally agree to pay a weekly or monthly fee. Often focused on a major employer or group of employers.

Support Facility—A physical improvement that enhances HOV operations, including park-and-ride lots, park-and-pool lots, transit centers and elements.

Support Program—Policies, programs, and services that enhance the public acceptance or usage of an HOV facility, including ridesharing programs, employer-sponsored incentives, public information, and marketing activities.

Surveillance Control and Communication (SC&C)—A remotely operated system for monitoring and managing operation of an HOV facility, freeway, or roadway facility to enhance the overall management and operation, better assure acceptable traffic operation, improve responsiveness to incidents, and improve communication with motorists.

Take-a-Lane—Term used to refer to the implementation of an HOV lane created by converting a general-purpose lane on a freeway or arterial street. Used interchangeably with lane conversion.

Taxi and Taxicab—A vehicle to be operated by a professional and licensed driver for hire for a fee.

Telecommunications—The conveyance of information by electronic means. Examples include the telephone, interactive cable facilities, computer networks, and video conference centers.

Telecommuting—A work arrangement program whereby employees work at a location other than the conventional office or central headquarters, usually from home or an office close to home. Telecommuting can remove commute trips from the roadway system or reduce the length of commute trips.

Throughput—The volume of vehicles or passengers passing a specific point during a predetermine period of time.

Timed Transfer System—Bus or transit system set up to provide quick and convenient transfers among routes. Schedules are designed so that vehicles on different routes arrive and depart from a station or transfer point at the same time.

Traffic Assignment—The planning and modeling process of allocating trips by different modes and to different origins and destinations and routes.

Traffic Assignment Zone or Traffic Analysis Zone (TAZ)—The division of a study area into subunits or zones allowing for a more detailed level of analysis.

Traffic Volume—The number of vehicles on a freeway, roadway, HOV lane, or other transportation facility.

Transfer—The act of changing from one vehicle or route to another. Also, the paper provided to a passenger by a transit operator upon paying a fare that allows the individual to board the second vehicle without paying another fare.

Transit—General term referring to all vehicles and systems that move more than one individual, includes carpools, vanpools, minibuses, buses, coaches, LRT, heavy rail, and commuter rail.

Transit Center or Transit Station—A facility serving transit buses and other modes such as automobiles and pedestrians. Centers and stations provide locations for individuals to access transit services and to transfer between buses or between buses and other modes.

Transit Dependent—An individual or group of individuals that are dependent on public transit to meet their private mobility needs because they are unable to drive, do not own a car, are not licensed to drive, or choose not to drive. Groups often considered transit dependents include the elderly, the young, low income individuals, and households without an automobile available.

Transitway—Term used to describe an HOV lane or facility. In some cases, it refers to bus-only facilities, but in other cases, it may be used on a facility open to all HOVs.

Transportation Control Measure (TCM)—A series of vehicle trip reduction measures focusing on reducing travel by single-occupant vehicles and increasing the use of buses, carpools, vanpools, and other alternative commute modes.

Transportation Demand Management and Travel Demand Management (TDM)—A variety of strategies and techniques aimed at increasing the use of buses, carpools, vanpools, and other alternative commute modes, reducing single-occupant vehicles, and spreading travel to less congested time periods. Strategies may include both incentives, such as employer subsidized bus passes, and disincentives, such as higher parking rates for single-occupant vehicles.

Transportation Management Association/Organization (TMA/TMO)—Organizations comprised of some combination of employers, developers, building owners, and local government representatives formed to help address local transportation problems and to encourage greater use of high-occupancy vehicles and other strategies.

Transportation System Management (TSM)—Improvements focused on enhancing the management of the transportation system, including various elements of the transportation system. Examples of TSM projects include ramp metering, HOV ramp meter bypasses, and signal improvements.

Travel Time—The length of time it takes to travel between two points.

Travel Time Reliability—Term referring to the lack of variability in travel time that can be expected using different facilities.

Travel Time Savings—The time saved by use of an HOV facility rather than driving alone. Calculated by the difference in travel times between two points using the HOV facility and the general-purpose lane.

Trip Generation Rates—The number of vehicular trips to and from a development, cited per unit of measure such as square foot, thousand square feet, housing unit, or acre. The trip rates published by the Institute of Transportation Engineers (ITE) or developed by local jurisdictions are used to identify the potential impacts of new projects and to develop approaches to mitigate negative impacts.

Trip Reduction Ordinances—Laws or policies enacted by local governments that require developers, property owners, and employers to manage the number of vehicle-trips from a work site or development and to assist in financing necessary for transportation improvements.

Unlinked Trip—Trip that goes directly from origin to destination and does not include any intermediate stops or waiting or walking time.

Validation—Process of testing a travel demand model, regression equations, computer simulation model, or other model with actual data from an area to ensure that it accurately reflects the conditions in the area.

Vanpool—A prearranged ridesharing function in which a number of people travel together on a regular basis in a van, usually designed to carry six or more persons.

Variable Work Hours—One alternative work schedule technique that allows employees to select work starting and ending times different than the normal 8:00 A.M. to 5:00 P.M. schedules. Most variable work hour programs require that employees maintain a set schedule, such as 7:30 A.M. to 4:30 P.M., on a regular basis.

Vehicle—Any motorcycle, car, truck, van, bus, or rail car designed to carry passengers or goods.

Vehicle Kilometers of Travel (VKT)—The total distance traveled in kilometers by all motor vehicles of a specific group in a given area at a given time.

Vehicle Miles of Travel (VMT)—The total distance traveled in miles by all motor vehicles of a specific group in a given area at a given time.

Vehicle Occupancy—The number of people in a car, truck, bus, or other vehicle.

Violation of HOV Facility Requirements—An infraction of the rules and regulations for use of an HOV facility or other transportation system. On an HOV facility, not having the required number of people in a vehicle is a violation.

Violation Rate—The number of vehicles that do not meet the minimum vehicle-occupancy level required to use an HOV facility. Usually expressed as a percentage of the total vehicles using the lane during a predetermined time period.

Volume to Capacity Ratio—The ratio of demand flow rate to capacity for a given type of transportation facility. The flow rate is typically given in terms of the number of vehicles passing a point for a given unit of time and the capacity is given in terms of vehicles for the same period of time.

Zoning—Land use regulations that divide a community into districts which have different allowable uses, development requirements, and regulations.

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APPENDIX B—GLOSSARY OF AGENCIES, ORGANIZATIONS AND LEGISLATION

This glossary defines the agencies, organizations, and federal legislation most commonly associated with different elements of the surface transportation system, including HOV facilities. It is provided as a separate appendix to accommodate easier updating to reflect new legislation or changes in organizations and agencies.

American Association of State Highway and Transportation Officials (AASHTO)—National organization of state departments of transportation and state highway agencies.

American Planning Association (APA)—National organization of local, state, and federal planning professionals and officials.

American Public Transit Association (APTA)—An international organization comprised of transit systems, organizations, and institutions related to the transit industry.

American Society of Civil Engineers (ASCE)—A national organization of civil engineers, including those in the transportation field.

Americans with Disabilities Act of 1990 (ADA)—Federal legislation designed to prohibit discrimination against individuals with physical or mental disabilities. The ADA covers areas relating to business, employment, mass transportation, and communications. The ADA, and subsequent regulations issued by the FTA and other federal agencies, place specific requirements on transit operators relating to vehicle and route accessibility, employment, alternate services, fares, and other related items.

Clean Air Act Amendments of 1990—Most recent federal legislation addressing air quality issues. The Act, and subsequent regulations promulgated by the Environmental Protection Agency (EPA) and other federal agencies, contain specific requirements relating to various elements of the transportation system and the classification of areas called non-attainment areas that do not meet the federal standards for different air pollutants.

Congestion Management System (CMS)—One of the six management systems contained in the Intermodal Surface Transportation Efficiency Act (ISTEA). CMSs are developed and implemented by states in cooperation with metropolitan planning organizations (MPOs), transit agencies, local communities, and other groups. CMS strategies may include transportation demand management measures, traffic operations improvements, measures to encourage the use of high-occupancy vehicles, and other actions. Currently, Congestion Management Systems are required in Transportation Management Areas and are optional in other urban areas.

Congestion Mitigation and Air Quality (CMAQ) Improvement Program—A federal funding program established by the ISTEA that directs funds to air quality non-attainment areas with the worst air quality problems. The program provides funds for projects that would reduce vehicle miles traveled, increase vehicle occupancy levels, and improve air quality.

Council of Governments (COG)—An organization comprised of local government representatives who meet on a regular basis to address transportation and other metropolitan issues. Similar to Metropolitan Planning Organization (MPO) in some areas.

Department of Energy (DOE)—A cabinet-level federal agency responsible for improving the energy efficiency of transportation.

Department of Health and Human Services–A cabinet-level federal agency that provides funds for many specialized transportation services in urbanized and rural areas as part of its social service programs.

Department of Housing and Urban Development (HUD)—A cabinet-level federal agency with responsibilities for community development programs, such as improved community facilities and services, assistance to nonprofit entities, and acquisition and rehabilitation of publicly owned real property.

Department of Labor (DOL)—A cabinet-level federal agency whose responsibilities include waivers of the labor protection provisions of Section 13(c) of the Urban Mass Transportation Act of 1964, as amended.

Department of Transportation (DOT)—A cabinet-level federal agency responsible for the planning, safety, and system and technology development of the national transportation system, including highways, mass transit, aircraft, rail, and ports.

Environmental Protection Agency (EPA)—An independent federal agency in the executive branch whose responsibilities include development and enforcement of national air quality emission standards and support of antipollution activities by state and local governments.

Federal Communications Commission (FCC)—An independent federal agency whose responsibilities include licensing and regulating radio communications, including those used in transportation facilities and vehicles.

Federal Highway Administration (FHWA)—An agency within the U.S. Department of Transportation, with responsibilities related to funding and administering the national road and highway transportation system, intelligent transportation systems (ITS), and other related programs.

Federal Railroad Administration (FRA)—An agency within the U.S. Department of Transportation responsible for funding and administering programs related to the railroad industry.

Federal Transit Administration (FTA)—An agency within the U.S. Department of Transportation responsible for funding and administering the federal transit capital and operation assistance programs.

Institute of Transportation Engineers (ITE)—An international organization of transportation professionals.

Intermodal Planning Group (IPG)—A regional organization of federal agencies, set up to oversee transportation planning activities in the states of a specific region. It may include representatives of the Federal Highway Administration, Coast Guard, Federal Aviation Administration, Federal Railroad Administration, Federal Transit Administration, Department of Housing and Urban Development, Environmental Protection Agency, and other federal agencies.

Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991—Federal legislation that provides funding authorization and program direction for federal highway, highway safety, and public transportation programs for the six-year period from 1992 through 1997. The ISTEA modified existing programs and created new programs, altered policies and agency responsibilities, and provided greater flexibility in the use of funds.

International Taxicab Association (ITA)—A national organization of fleet taxicab owners.

Intelligent Transportation Society of America (ITS America)—A non-profit educational and scientific association formed to plan, promote, and coordinate the development and deployment of ITS. Formally designated as a utilized Federal Advisory Committee to the U.S. Department of Transportation.

Long-Range Plan—A plan developed by an MPO, in conjunction with the state and local units of government, that includes the long range (usually a 10 to 20 year time period) goals, policies, objectives, and components of the surface transportation system in an area.

Major Investment Study (MIS)—A Major Investment Study (MIS) is conducted when significant transportation improvements are being considered in a corridor or area within a metropolitan area. An MIS must include the analysis of realistic concept, involve all affected federal, state, and local agencies, and provide for public involvement. A recommended concept should result from the process.

Metropolitan Planning Organization (MPO)—An organization designated by the governor and local elected officials as responsible, together with the state, for transportation planning in an urbanized area as required by federal legislation. It serves as the forum for the cooperative, coordinated, and continuous (3 "C") transportation planning process.

National Association of Counties (NACo)—National organization of elected and appointed county governing officials and other county officials and their deputies at management or policy levels.

National Association of Regional Councils (NARC)—A national organization comprised of regional councils of governments and government agencies, libraries, organizations, and others interested in regionalism.

National Highway System (NHS)—A 170,000-mile network of interstates and major state and federal highways. The designation of the NHS was required by the ISTEA, which also authorized $21 billion for improvements and reconstruction of the system.

National League of Cities (NLC)—A national organization comprised of state leagues and cities that promote the interest of municipalities.

National Environmental Policy Act (NEPA) of 1969—Federal legislation establishing national policy to prevent or eliminate damage to the environment. The Act requires federal agencies to use a systematic interdisciplinary approach to planning and decision making on environmental issues. NEPA requires the preparation of an Environmental Impact Statement (EIS) for all legislation and major federal actions that would significantly affect the environment.

Regional Planning Agency—A nonprofit, quasi-public organization whose policy board is composed of member municipal government representatives to help plan and coordinate transportation, land use, development, and other issues within a region.

State Transportation Improvement Program (STIP)—As required by federal regulations, the list of transportation projects drawn up by a state to be carried out within a three-year period. The projects are to be consistent with the long-range transportation plan and must have identified sources of funds. The program is to be developed in cooperation with MPOs in metropolitan areas and is to be reviewed every two years.

Surface Transportation Program (STP)—A program created by the ISTEA that provides funds for the construction, reconstruction, and operational improvements for highways and bridges, including projects to accommodate other transportation modes and mitigation of damage to ecosystems. Transit projects, carpool projects, safety improvements, and a variety of other activities are eligible for funding. STP is the largest funding program in ISTEA, authorized at nearly $24 billion for a six-year period.

Transportation Equity Act for the 21st Century (TEA-21)—Federal legislation that provides funding authorization and direction for federal highway, highway safety, and public transportation programs for the six-year period from 1998 to 2003.

Transportation Enhancement Program—A category of projects in the Surface Transportation Program (STP) that includes provisions for pedestrians and bicycles, the development of trails along abandoned railroad corridors, and other actions. Ten percent of the STP funds apportioned to each state are to be used for enhancements.

Transportation Improvement Program (TIP)—As required by federal regulations, a one-to-three-year work plan developed and adopted by an MPO that identifies projects from the long-range plan and the funding necessary to implement them. The TIP is usually revised annually. ISTEA requires that projects only appear in the TIP if funding is already secured for the work.

Transportation Research Board (TRB)—A unit of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academy of Sciences and the National Academy of Engineering. The purpose of TRB is to advance knowledge concerning the nature and performance of transportation systems by stimulating research and disseminating the information derived therefrom. Its affiliates and participants include transportation professionals in government, academia, and industry.

APPENDIX C—CHARACTERISTICS OF SELECTED HOV FACILITIES AND PROPOSED PROJECTS IN SEPARATE RIGHTS-OF-WAY AND ON FREEWAYS

OPERATIONAL CHARACTERISTICS OF SELECTED FREEWAY/EXPRESSWAY HOV FACILITIES AS OF JANUARY 1997

HOV Facility	Number of Lanes	Project Length km/h (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules Since Opening
Busway					
Ottawa, Ontario, Canada					
Southeast Transitway	1 each direction	5.1 (3.0)	24 hours	Buses only	No
West Transitway	1 each direction	11.0 (6.5)	24 hours	Buses only	No
Southwest Transitway	1 each direction	4.2 (2.5)	24 hours	Buses only	No
Pittsburgh, PA					
East Patway	1 each direction	9.9 (6.2)	24 hours	Buses only	No
West Patway	1 each direction	6.6 (4.1)	24 hours	Buses only	No
Minneapolis, MN					
U of M Intercampus Busway	1 each direction	1.8 (1.1)	24 hours	Buses only	No
Dallas, TX					
Southwest Texas Medical Center busway	1 each direction	1 (0.6)	24 hours	Buses only	No
Barrier-Separated: Two-Way					
Los Angeles, CA					
I-10 (El Monte) San Bernardino Fwy.	1 each direction	6.4 (4)	24 hours	3+ HOVs	Changed from buses only in 1978
I-105/I-110 fwy/fwy connectors	1 each direction	1.6 (1)	24 hours	2+ HOVs	No
Denver, CO I-25 opposing flow not separated	1 each direction	12 (7.5)	6 am to 10 pm	Buses only	No
Orange County, CA I-5	1-2 each direction	7.2 (4.5)	24 hours	2+ HOVs	No
Houston, TX I-610/US 290 elevated, opposing flow not separated	1 each direction	2.4 (1.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
Seattle, WA I-90	1 each direction	2.4 (1.5)	24 hours	2+ HOVs	No
Barrier-Separated: Reversible-Flow					
Northern Virginia					
I-395 (Shirley Hwy.)	2 reversible	24 (15)			
Houston, TX					
I-10 (Katy Freeway)	1 reversible	21 (13)	5 am-12 noon, 2-9 pm, 5 am-5 pm WB Sat., 5 am-9 pm Sun.	3+ peak hours, 2+ other times	Opened for authorized buses and vanpools, lowered and raised since
I-45 (Gulf Freeway)	1 reversible	19.4 (12.1)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
US 290 (Northwest Freeway)	1 reversible	21.6 (13.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
I-45 (North Freeway)	1 reversible	21.6 (13.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	Started with buses and vanpools only, changed operation periods
US 59 (Southwest Freeway)	1 reversible	18.4 (11.5)	5 am to 12 noon, 2-9 pm	2+ HOVs	No
San Diego, CA I-15	2 reversible	12.8 (8)	6-9 am, 3-6:30 pm	2+ HOVs	No
Minneapolis, MN I-394	2 reversible	8 (5)	6-10 am, 2-7 pm	2+ HOVs	No

HOV Facility	Number of Lanes	Project Length km/h (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules Since Opening
Pittsburgh, PA I-279/579	1-2 reversible	6.6 (4.1)	5-9 am, noon-8 pm	2+ HOVs, all traffic NB after 8 pm during sports games	Changed from 3+ and operating periods, all traffic allowed to use lanes during sports games downtown
Norfork, VA I-64	2 reversible	12.8 (8)	5-8:30 am WB, 3-6 pm EB, mixed flow other times	2+ HOVs	No
Seattle, WA					
I-5 North (Express Lanes)	2-3 reversible	SB 4.2 (2.6) NB 2.6 (1.6)	5-8:30 am SB, 12 noon-4 am NB	2+ HOVs	Changed from 3+ NB
I-90	2 reversible	9.9 (6.2)	24 hours	2+ HOVs	No
Concurrent-flow: Buffer-Separated/ Non-Separated					
Phoenix, AZ					
I-10	1 each direction	33.6 (21)	24 hours	2+ HOVs	Changed from 3+
SR 202	1 each direction	12.8 (8)	24 hours	2+ HOVs	No
I-17	1 each direction	9.6 (6)	24 hours	2+ HOVs	No
Vancouver, BC, Canada					
H-99	1 each direction	SB 6.4 (4) NB 1.6 (1)	24 hours	3+ HOVs	Changed from buses only
Los Angeles County, CA					
I-10 (El Monte) San Bernardino Fwy.-(wide buffer separation)	1 each direction	12.8 (8)	24 hours	3+ HOVs	Changed from buses only in 1978
I-105	1 each direction	25.6 (16)	24 hours	2+ HOVs	No
I-110	2 each direction	24.3 (15.2)	24 hours	2+ HOVs	No
I-210	1 each direction	29.6 (18.5)	24 hours	2+ HOVs	No
I-405	1 each direction	31 (19.4)	24 hours	2+ HOVs	No
I-605	1 each direction	11.2 (7)	24 hours	2+ HOVs	No
SR 91	1 each direction	22.9 (14.3)	24 hours	2+ HOVs	Changed from peak periods only
SR 118	1 each direction	18.2 (11.4)	24 hours	2+ HOVs	No
SR 134	1 each direction	21.3 (13.3)	24 hours	2+ HOVs	No
SR 170	1 each direction	9.8 (6.1)	24 hours	2+ HOVs	No
Orange County, CA					
I-5	1-2 each direction	54.4 (34)	24 hours	2+ HOVs	No
SR 55	1 each direction	19.7 (12.3)	24 hours	2+ HOVs	No
I-405	1 each direction	38.4 (24)	24 hours	2+ HOVs	No
SR 57	1 each direction	19.2 (12)	24 hours	2+ HOVs	No
SR 91	1 each direction	4.2 (2.6)	24 hours	2+ HOVs	No
SR 91 toll/HOV lanes[2]	2 each direction	16.2 (10.1)	24 hours	3+ HOVs free	No
Riverside County, CA SR 91	1 each direction	27.2 (17)	24 hours	2+ HOVs	No

HOV Facility	Number of Lanes	Project Length km/h (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules Since Opening
San Bernardino County, CA					
SR 60	1 each direction	16 (10)	24 hours	2+ HOVs	No
SR 71	1 each direction	3.7 (2.3)	24 hours	2+ HOVs	No
Santa Clara/San Mateo Counties, CA					
US 101	1 each direction	40 (25)	5-9 am, 3-7 pm	2+ HOVs	No
SR 237	1 each direction	9.6 (6)	5-9 am, 3-7 pm	2+ HOVs	No
SR 85	1 each direction	35.2 (22)	5-9 am, 3-7 pm	2+ HOVs	No
I-280	1 each direction	17.6 (11)	5-9 am, 3-7 pm	2+ HOVs	No
San Tomas Expy.(shoulders)	1 each direction	12.8 (8)	6-9 am, 3-7 pm	2+ HOVs	No
Montague Expy. (shoulders)	1 each direction	9.6 (6)	5-9 am, 3-7 pm	2+ HOVs	No
Alameda County, CA					
I-80	1 each direction	3.8 (2.4)	5-9 am, 3-7 pm	2+ HOVs	
I-880	1 each direction	8 (5)	5-9 am, 3-7 pm	2+ HOVs	
Contra Costa County, CA					
I-80	1 each direction	21.9 (13.7)	5-9 am, 3-7 pm	2+ HOVs	No
I-680	1 each direction	23 (14.4)	5-9 am, 3-7 pm	2+ HOVs	No
I-580	1 each direction	9.8 (6.1)	7-8 am, 5-6 pm	2+ HOVs	No
Marin County, CA US 101 (2 projects)	1 each direction	21 (13)	6:30-8:30 am, 4:30 -7 pm	2+ HOVs	Changed from 3+
Sacramento, CA SR 99	1 each direction	6.2 (3.9)	24 hours	2+ HOVs	No
Denver, CO, US 36 Boulder Turnpike	1 EB only	6.6 (4.1)	6-9 am	Buses only	No
Hartford, CT					
I-84 (wide buffer separation)	1 each direction	16 (10)	24 hours	2+ HOVs	Changed from 3+
I-91 (wide buffer separation)	1 each direction	14.4 (9)	24 hours	2+ HOVs	No
Ft. Lauderdale, FL I-95	1 each direction	43.2 (27)	7-9 am, 4-6 pm	2+ HOVs	No
Miami, FL I-95	1 each direction	19.2 (12)	7-9 am SB, 4-6 pm NB	2+ HOVs	No
Orlando, FL I-4	1 each direction	48 (30)	7-9 am SB 4-6 pm NB	2+ HOVs	No
Atlanta, GA					
I-20	1 each direction	15 (9.4)	6:30-9:30 am WB, 4:30-7 pm EB	2+ HOVs	No
I-75	1 each direction	64 (40)	24 hours	2+ HOVs	No
I-85	1 each direction	32 (20)	24 hours	2+ HOVs	No
Honolulu, HI					
Moanaloa Fwy.	1 each direction	3.8 (2.4)	6-8 am, 3:30-6 pm	2+ HOVs	No
Kalanianaole Hwy.	1 (WB only)	3.2 (2.0)	5-8:30 am	2+ HOVs	No
H-1	1 each direction	12.8 (8)	6-8 am, 3:30-6 pm	2+ HOVs	No
H-2	1 each direction	13.1 (8.2)	6-8 am, 3:30-6 pm	2+ HOVs	No
Montgomery County, MD					
US 29 (shoulders)	1 each direction	4.8 (3)	Peak periods only	Buses only	No
I-270 (eastern connection)	1 each direction	4 (2.5)	Peak periods only	2+ HOVs	No
Boston, MA I-93 North	1 (SB only)	1.8 (1.1)	6:30-9:30 am	2+ HOVs	Changed from 3+

HOV Facility	Number of Lanes	Project Length km/h (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules Since Opening
Minneapolis, MN					
I-35W	1 each direction	8 (5)	6-9 am NB, 4-7 pm SB	2+ HOVs	No
I-394	1 each direction	11.2 (7)	6-9 am EB, 4-7 pm WB	2+ HOVs	No
Morris County, NJ					
I-80	1 each direction	17.6 (11)	Peak periods only	2+ HOVs	No
I-287	1 each direction	XXXX	Peak periods only	2+ HOVs	No
Suffolk County, NY I-495	1 each direction	19.2 (12)	6 am-8 pm	2+ HOVs	No
Ottawa, Ontario, Canada Hwy. 17 (shoulder)	1 (WB only)	4.8 (3)	7-9 am	Buses only	No
Nashville, TN I-65	1 each direction	11.5 (7.2)	7-9 am NB, 4-6 pm SB	2+ HOVs	No
Northern Virginia					
I-66 (outside Capital Beltway)	1 each direction	11.2 (7)	6-9 am, 3:30-6 pm	2+ HOVs	No
I-66 (inside Capital Beltway)	2-3 each direction	15.4 (9.6)	6:30-9 am EB, 4-6:30 WB	2+ HOVs	Changed operating periods and from 3+
Norfolk/Virginia Beach, VA					
SR 44 (shoulder)	1 each direction	6.4 (4)	5-8:30 am WB, 3-6 pm EB	2+ HOVs	No
I-64	1 each direction	8 (5)	Peak periods only	2+ HOVs	No
I-564	1 EB only	3.2 (2)	3:30-6 EB	2+ HOVs	No
Seattle, WA					
I-5 North	1 each direction	SB 22 (13.6), NB 18 (11.3)	24 hours	2+ HOVs	Changed from 3+
I-5 South	1 each direction	SB 13.4 (8.4) NB 26 (16.1)	24 hours	2+ HOVs	No
I-90	1 each direction	11.7 (7.3)	24 hours	2+ HOVs	General purpose lane conversion
I-405 (median and shoulders)	1 each direction	SB 36 (22.5), NB 35 (21.7)	24 hours	2+ HOVs	No
SR 167	1 each direction	6.7 (4.2)	24 hours	2+ HOVs	No
SR 520 (shoulder)	1 WB only	3.7 (2.3)	24 hours	3+ HOVs	Changed from bus only in AM peak period
Contraflow					
Honolulu, HI					
Kalanianaole Hwy.	1	WB 7 (4.4) EB 1.6 (1)	5-8:30 am, 4-6:30 pm	2+ HOVs	Changed from 3+
Kahekili Hwy.	1	1.8 (1.1)	5:30-8:30 am, 3:30-7 pm	2+ HOVs	No
New Jersey, Rte. 495 (to Lincoln Tunnel)	1 EB only	4 (2.5)	6-10 am	Buses only	No
New York City, NY I-495 Long Island Expy.	1	6.4 (4)	7-10 am	Buses, vanpools taxis	No

HOV Facility	Number of Lanes	Project Length km/h (miles)	HOV Operation Period	General Eligibility Requirements	Changes in Rules Since Opening
Dallas, TX I-30 East	1 each peak direction	WB 8.3 (5.2), EB 5.3 (3.3)	6-9 am, 4-7 pm	2+ HOVs	No
Boston, MA I-93 Southeast Expy.	1 each peak direction	9.6 (6)	6-10 am, 3-7 pm	3+ HOVs	Additional hour added in AM period
Montreal, Quebec, Canada Rte. 10/15/20 Champlain Bridge	1	6.9 (4.3)	6:30-9:30 am NB, 3:30-7 pm SB	Buses only	Speed limit reduced
<u>Queue Bypasses</u>					
Bay Area, CA					
S.F./Oakland Bay Bridge toll plaza, I-80	3	1.4 (0.9)	6-9 am, 3-6 pm	3+ HOVs	Number and location of lanes reoriented
Dumbarton Bridge toll plaza, SR 84	1	3.2 (2)	Peak periods	2+ HOVs	Changed from 3+
San Mateo Bridge toll plaza, SR 92	1	1.6 (1)	Peak periods	3+ HOVs	No
SR 4	1	0.8 (0.5)	Peak periods	3+ HOVs	No
Various freeway entrance ramps	1	0.2 (0.1)	When demand warrants	2+ HOVs	No
Los Angeles and Orange Counties, CA					
Over 250 entrance ramps	1	0.2 (0.1)	When demand warrants	2+ HOVs	No
San Diego, CA					
Various entrance ramps			When demand warrants	2+ HOVs	No
Coronado Bridge toll plaza	1 (WB only)	0.2 (.1)	24 hours	2+ HOVs	No
A Street entrance ramp to I-5 freeway	1	0.6 (0.4)	24 hours	Buses only	No
I-5/Mexico port of entry	4 gates	0.2 (0.1)	24 hours M-F	4+ HOVs	No
Honolulu, HI, H-2	1 (SB only)	1.3 (0.8)	6-8 am, 3:30-6 pm	2+ HOVs	No
Illinois, Chicago, I-90 toll plaza	1 (EB only)	0.8 (0.5)	Peak periods	Buses only	No
Minneapolis, MN, Various entrance ramps	1	0.6 (0.2)	Peak periods	2+ HOVs	No
New Jersey					
Ft. Lee, I-95 (to George Washington Br.)	1 (EB only)	1.6 (1)	7-9 am	3+ HOVs	No
Union, Rte. 495 (Lincoln Tunnel toll plaza)	1 (WB only)	0.5 (0.3)	6-10 am	Buses only	No
Seattle, WA					
SR 509 shoulder	1 (NB only)	1.3 (0.8)	24 hours	2+ HOVs	Changed from 3+
SR 526	1	0.8 (0.5)	24 hours	Buses only	No
Freeway entrance ramps (69)[3]	1	0.2 (0.1)	24 hours	2+ HOVs	No
Ferry terminal dock, downtown	1-2	0.2 (0.1)	24 hours	Registered carpools/ vanpools only	No

Footnotes
1. 7-day week; all others are 5-day week.
2. This project is a privatized toll road with congestion pricing. Registered 3+ HOVs can travel free.
3. Included are 39 metered ramps and 30 non-metered ramps.

6/95 corrections and insertions to <u>both tables</u> included from Boston, Seattle, California (1995 update), Phoenix, Florida and New Hampshire

LISTING OF PROPOSED MAJOR FREEWAY/EXPRESSWAY HOV FACILITIES
AS OF JANUARY 1997 (Listed by State/Province)

Project	Project Length: Route-kilometers (miles)	Project Length: Lane-kilometers (miles)	Status or Anticipated Opening
Arizona, Phoenix			
Route Loop 202 (East Papago Freeway) I-10 to SR 101 concurrent-flow lanes	1.6 (1)	3.2 (2)	1997
I-10 (91st to Chandler Rd.) concurrent-flow lanes	8 (5)	16 (10)	1997
I-17(SunCap/University-Berkeley) concurrent-flow lanes	1.6 (1)	1.6 (1)	1997
British Columbia, Vancouver, Canada			
H-7 Barnet Hastings Highway, concurrent-flow lanes	9.6 (6)	19 (12)	1996
Trans Canada Highway, concurrent flow-lanes	12.8 (8)	25 (16)	Late 1990s
California, Bay Area			
I-580 concurrent-flow lanes	(NA)	(NA)	Late 1990s
I-80 (Contra Costa County) concurrent-flow lanes	56 (35.2)	112 (70)	Staged through 1998
US 101 (Marin County) concurrent-flow lanes	4.8 (3)	9.6 (6)	Late 1990s
I-80/580/880 (Alameda County) concurrent-flow lanes	27 (17)	52 (32.3)	Staged through late 1990s
I-680 (Contra Costa County) concurrent-flow lanes	9.6 (6)	18 (11.2)	Staged through 1999
I-880 (Santa Clara County) concurrent-flow lanes	9.6 (6)	17 (10.8)	Late 1990s
SR 237 (Santa Clara County) concurrent-flow lanes	24 (15)	48 (30)	Late 1990s
SR 85 (Santa Clara County) concurrent-flow lanes	3.2 (2)	6.4 (4)	1999
SR 101 (Marin County) concurrent-flow lanes	8 (5)	14.4 (9)	Late 1990s
SR 101 (Santa Rosa) concurrent-flow lanes	8 (5)	16.6 (10.4)	Late 1990s
California, Los Angeles County[1]			
I-10- (San Bernardino Fwy.) concurrent-flow lanes	33 (20.3)	66 (41)	2001-2003
I-10 (Santa Monica Fwy.) concurrent-flow lanes	15 (9.3)	30 (18.6)	2020
I-110 (Harbor Fwy.) transitway extension and ramps	3.2 (2)	12.8 (8)	1998, 2011
I-405 concurrent-flow lanes	64 (40)	128 (80)	1996-2002
I-605 concurrent-flow lanes	17 (12)	38 (24)	Late 1990s
I-710, concurrent-flow lanes	13 (8)	26 (16)	Beyond 2015
I-5 concurrent-flow lanes	58 (36)	115 (72)	2000-2013
SR 14 concurrent-flow lanes	58 (36)	115 (72)	1997-2020
SR 30 concurrent-flow lanes	13 (8.3)	27 (16.6)	1997-99
SR 57 concurrent-flow lanes	7.2 (4.5)	14 (9)	1997
SR 60 concurrent-flow lanes	30 (19)	61 (38)	1997-2002
SR 71 concurrent-flow lanes	6.4 (4)	12.5 (7.8)	2006
California, Ventura County			
SR 118 concurrent-flow lanes	24 (15)	48 (30.2)	Beyond 2000
California, Orange County			
I-5 concurrent-flow lanes	19 (12)	38 (24)	2002-2004
SR 91, concurrent-flow lanes	14 (9)	30 (18.8)	Funding study pending
SR 55/405, 57/91 interchanges, HOV ramps	9.6 (6)	21 (13)	2000-2005
SR 73 concurrent-flow lanes	4.8 (3)	7 (4.4)	Planning studies pending
I-605 concurrent-flow lanes	4.8 (3)	9.6 (6)	Planning studies
SR 22 concurrent-flow lanes	19 (12)	38 (24)	Planning studies pending
California, San Bernardino County			
I-10 concurrent-flow lanes	16 (10)	32 (20)	1999
SR 60, concurrent-flow lanes	19 (12)	38 (23.6)	Beyond 2000
SR 30 concurrent-flow lanes	32 (20)	64 (40)	Beyond 2000
SR 71, concurrent-flow lanes	5 (3.1)	10 (6.2)	Late 1990s
I-215, concurrent-flow lanes	8 (5)	16 (10)	1999

Project	Project Length: Route-kilometers (miles)	Project Length: Lane-kilometers (miles)	Status or Anticipated Opening
California, Riverside County			
SR 60, concurrent-flow lanes	32 (20)	62 (39)	1996-99
SR 71, concurrent-flow lanes	9.6 (6)	19 (12)	Planning studies
I-215, concurrent-flow lanes	11.2 (7)	22 (14)	Planning studies
California, Sacramento			
I-5, concurrent-flow lanes	27 (17)	52 (32.4)	Late 1990s
SR 99, concurrent-flow lanes	9.6 (6)	18 (11.4)	Late 1990s
California, San Diego County			
I-5, concurrent-flow lanes	37 (23)	73 (45.6)	Staged through 2010
I-15, concurrent-flow lanes or transitway	14 (9)	27 (16.8)	Beyond 2000
I-15, congestion pricing demonstration on reversible lanes	12.8 (8)	26 (16)	1996
Colorado, Denver			
I-25, barrier-separated reversible lanes ramps	6.4 (4)	12.8 (8)	Late 1990s
Connecticut, Hartford			
I-84 WB concurrent-flow lane	2.4 (1.5)	2.4 (1.5)	1996-98
Florida, Orlando-Tampa			
I-4 concurrent-flow lanes	64 (40)	141 (88)	Beyond 2000
I-4 interim reversible lane (Orlando)	9.6 (6)	9.6 (6)	Late 1990s
Florida, Ft. Lauderdale			
I-95 concurrent-flow lanes	46 (29)	93 (58)	Beyond 2000
Maryland			
I-270 concurrent-flow lanes	19 (12)	33 (24)	1996-98
SR 141 concurrent-flow lanes	(NA)	(NA)	Late 1990s
I-95/495 Capital Beltway concept to be determined	(NA)	(NA)	Planning studies
Massachusetts, Boston			
I-93, north contraflow lanes	12.8 (8)	26 (16)	2004
SR 3 south concurrent-flow lanes	18 (11)	36 (22)	Planning studies
I-93 Southeast Expy. reversible flow lane	12.8 (8)	12.8 (8)	2004
I-93 Central Artery concurrent-flow lanes	6.4 (4)	12.8 (8)	2004
Route 128 (I-95) concurrent-flow lanes	22 (13.7)	44 (27.4)	2004
Route 3 North (concept to be determined)	35 (22)	70 (44)	Late 1990s
I-90 Massachusetts Turnpike queue bypasses	1.6 (1)	1.6 (1)	Late 1990s
Minnesota, Minneapolis			
I-35W, concurrent flow lanes	19 (12)	38 (25)	1996
I-94, concurrent-flow lanes	56 (35)	116 (70)	Late 1990s
New Hampshire			
I-93 concurrent-flow lanes	32 (20)	64 (40)	Planning studies
New Jersey, Morris and Somerset Counties			
I-287 concurrent-flow lanes	12.8 (8)	26 (16)	Late 1990s
I-95 New Jersey Turnpike concurrent-flow lanes	16 (10)	32 (20)	1996
New York, New York			
I-495 Long Island Expy. concurrent-flow lanes	48 (30)	96 (60)	Staged through 2010
I-287 Cross Westchester Expy. (concept to be determined)	8 (5)	16 (10)	Late 1990s
Gowanus Expy., concurrent-flow lanes	8 (5)	16 (10)	Late 1990s
North Carolina, Charlotte			
US 74, reversible lane and ramps	6.9 (4.3)	6.9 (4.3)	1997-2001

Project	Project Length: Route-kilometers (miles)	Project Length: Lane-kilometers (miles)	Status or Anticipated Opening
Ontario, Toronto area, Canada			
H-403 (Hwy. 407 and 401) concurrent-flow lanes	8 (5)	16 (10)	Late 1990s
H-404 (Hwy. 401 to Maj. Mackenzie Drive) concurrent-flow lanes	(NA)	(NA)	Beyond 2000
H-427 (Hwy. 401 to 7) concurrent-flow lanes	(NA)	(NA)	Planning studies
H-400 (Hwy. 401 to 407) concurrent-flow lanes	(NA)	(NA)	Planning studies
Ontario, Ottawa, Canada			
Extensions to busway system	8 (5)	16 (10)	Staged through 2000
Concurrent-flow freeway bus lanes	(NA)	(NA)	Late 1990s
Pennsylvania, Pittsburgh			
Airport Busway	8 (5)	16 (10)	Late 1990s
Wabash Tunnel reversible HOV lane	1.6 (1)	1. 6 (1)	Late 1990s
East Busway extension	(NA)	(NA)	Beyond 2000
Texas, Dallas			
I-635 LBJ Fwy. interim concurrent-flow lanes	11.7 (7.3)	21 (13)	1997
I-35 East Stemmons Fwy. concurrent-flow lanes	12.5 (7.8)	24 (15)	Late 1990s
I-35 East/US 67 R.L.Thornton concurrent-flow lanes	12.8 (8)	19 (12)	Late 1990s
I-30 concurrent-flow lanes	4.8 (3)	9.6 (6)	Late 1990s
US 75 (Plano) reversible lane	8 (5)	8 (5)	NA
Texas, Houston			
US 59 (Southwest Fwy.) reversible-flow lane extension	1. 6 (1)	1.6 (1)	1997
US 59 (Eastex Fwy.) reversible-flow lane	32 (20)	32 (20)	1998-2000
I-45 (North Fwy.) reversible-flow lane extension	10 (6.2)	10 (6.2)	Late 1990s
I-45 (Gulf Fwy.) reversible-flow lane extension	6.4 (4)	6.4 (4)	Late 1990s
I-10 (Katy Fwy.) reversible-flow downtown extension	4.8 (3)	4.8 (3)	1998
I-10 (Katy Fwy.) long range plan concept to be determined	NA	NA	Planning studies
I-610 (North and West Loop) concept to be determined	NA	NA	Planning studies
Texas, San Antonio			
I-35 North Pan Am Fwy. concept to be determined	NA	NA	Planning studies
I-410 North Loop concept to be determined	NA	NA	Planning studies
Utah, Salt Lake City			
I-15 concurrent-flow lanes	32 (10)	64 (20)	2000-2005
Virginia, Norfolk/Virginia Beach			
I-264, concurrent-flow lanes	6.4 (4)	12.8 (8)	1996
Route 44, concurrent-flow lanes	32 (10)	64 (20)	Late 1990s
Virginia, Washington D.C. Area			
I-66, concurrent-flow lanes	12 (7.5)	24 (15)	Mid-late 1990s
I-95/495 Capital Beltway concept to be determined	32 (20)	64 (40)	To be determined
Washington, Seattle/Tacoma/Everett			
I-405 extensions to concurrent-flow lanes (median)	12.8 (8)	26 (16)	Staged through 2000
I-5 South, extensions to concurrent-flow lanes	35 (22)	64 (40)	Staged through 2000
I-5 North, extensions to concurrent-flow lanes	8 (5)	16 (10)	Staged through 2000
SR 520 concurrent-flow lanes	6.4 (4)	12.8 (8)	Staged through 2000
SR 525 concurrent-flow lanes	4.8 (3)	9.6 (6)	Staged through 2000
SR 167 extensions to concurrent-flow lanes	9.6 (6)	19 (12)	Staged through 2000
SR 16 concurrent-flow lanes	9.6 (6)	16 (10)	Staged through 2000
SR 526 queue bypass	1.6 (1)	1.6 (1)	NA

NA Not available

[1] Programmed list of future Los Angeles County projects is currently being reassessed as part of a long range plan update.