



U.S. Department of Transportation  
Federal Highway Administration

# *A Guide for* **HOT LANE DEVELOPMENT**



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BY



WITH



IN PARTNERSHIP WITH



U.S. Department of Transportation  
Federal Highway Administration

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# Table of Contents

<b>Chapter 1</b>	<b>Hot Lane Concept And Rationale</b> .....	2
1.1	HOT lanes Defined .....	2
1.2	Existing HOT Lane Facilities.....	5
1.3	The Benefits of HOT lanes.....	5
<b>Chapter 2</b>	<b>The Hot Lane Planning And Implementation Process</b> .....	7
2.1	Origination .....	7
2.2	Implementation Process.....	7
2.3	Unique Concerns Associated with HOT lanes.....	8
2.4	Milestones in the HOT Lane Implementation Process .....	9
<b>Chapter 3</b>	<b>Organizational Frameworks For Hot Lane Projects</b> .....	12
3.1	HOT Lane Roles and Responsibilities .....	12
3.2	Identifying a Project Sponsor.....	12
3.3	Private Sector Involvement .....	15
3.4	Determining Legal Authorities and Requirements .....	16
3.5	Operational Arrangements .....	18
3.6	Federal Assistance Programs.....	19
<b>Chapter 4</b>	<b>Achieving Public Acceptance</b> .....	21
4.1	Outreach for HOT lanes.....	21
4.2	Project Champions and Their Role .....	23
4.3	Public Acceptance of HOT lanes: The Issues.....	24
4.4	Building Political Consensus .....	32
4.5	Marketing and Refining the Concept.....	33
4.6	Towards Consensus.....	35
<b>Chapter 5</b>	<b>Technical Issues</b> .....	37
5.1	Design .....	37
5.2	Technology .....	48
5.3	Travel Demand Forecasting, Pricing, and Financing .....	51
5.4	Other Technical Analyses and Approvals.....	60
<b>Chapter 6</b>	<b>Operational Issues</b> .....	64
6.1	Lane Management .....	64
6.2	Toll Collection and Registry Procedures.....	66
6.3	Enforcement .....	68
6.4	Incident Management.....	70
6.5	Maintenance .....	71
<b>Chapter 7</b>	<b>Current Hot Lane Experience</b> .....	73
7.1	Houston’s QuickRide System: .....	73
7.2	SR 91 Express Lanes.....	80
7.3	San Diego I-15 Corridor .....	87
7.4	US Route 101 Corridor—Marin and Sonoma Counties.....	90
7.5	The Denver Value Express Lane Feasibility Study .....	94
<b>Chapter 8</b>	<b>A Guide To Hot Lane Development—Lessons Learned</b> .....	100
8.1	Rationale.....	100
8.2	Requisites.....	100
8.3	Benefits.....	100
8.4	Lessons Learned .....	101
<b>Glossary</b> .....		103
<b>Index</b> .....		106

## List of Tables

Table 1	Primary HOT Lane Roles and Responsibilities .....	13
Table 2	Identifying Potential HOT Lane Champions.....	25
Table 3	HOT Lane Cross-section Standards.....	37
Table 4	HOT Lane Demand Factors.....	53
Table 5	Sample HOT Demand Levels.....	54
Table 6	Financial Details of the SR 91 and I-15 .....	57
Table 7	91 Express Lanes-Westbound Toll Schedule—November 2001.....	84
Table 8	91 Express Lanes-Eastbound Toll Schedule—November 2001.....	85

## List of Figures

Figure 1	HOT Lane Implementation Process .....	7
Figure 2	HOT Lane Implementation Work Flows .....	8
Figure 3	HOT Lane Planning and Implementation Milestones .....	10
Figure 4	I-15 Brochures.....	35
Figure 5	SR 91 Website .....	35
Figure 6	Median-Based One-Lane Reversible Flow HOT Cross-sections .....	38
Figure 7	Median-Based Two-Lane Reversible Flow HOT Cross-sections .....	38
Figure 8	Median-Based Concurrent Flow HOT Cross-sections .....	39
Figure 9	Alternative HOT Lane Slip Ramp Configurations .....	41
Figure 10	HOT Lane Access, Electronic Toll Collection, and Enforcement Areas.....	42
Figure 11	Tubular Markers on SR 91 .....	43
Figure 12	Concrete Barrier on I-394 Reversible Lanes, Minneapolis .....	44
Figure 13	I-15 HOV Lanes with Slip Ramp, Orange County, California.....	45
Figure 14	I-405 slip ramp and at-grade access, Orange County, California.....	45
Figure 15	Elevated HOV Drop Ramp .....	46
Figure 16	Grade Separated HOV to Highway Flyover Ramps .....	46
Figure 17	SR 91 Signage .....	47
Figure 18	Buffer Location Signing.....	47
Figure 19	I-15 Variable Message Sign .....	48
Figure 20	I-15 Police Car .....	48
Figure 21	HOT Revenue Estimate: Sketch Planning Process.....	56
Figure 22	The I-15 FasTrak Customer Service Center.....	67
Figure 23	Violation Detection Camera .....	69
Figure 24	Katy Freeway Location Map .....	74
Figure 25	SR 91 Express Lanes Location Map.....	81
Figure 26	I-15 FasTrak Location Map .....	87
Figure 27	Sonoma County Route 101 Location Map.....	91
Figure 28	Proposed I-25/U.S. 36 HOT Lane Corridor Location Map.....	95

# Preface

This guide is intended to be a comprehensive source of collective experience gained from the nation's current and implemented high occupancy toll (HOT) lane projects. The guide presents a wide range of information on HOT lanes and is intended to assist transportation professionals contemplating specific projects, as well as others who wish to become more informed on the topic. While most transportation officials are familiar with the HOT lane concept, relatively few have had first hand experience with actual HOT facilities. Therefore, the need to learn from current experience is particularly important.

The guide addresses a wide range of policy and technical issues associated with HOT lanes, focusing on how these activities are likely to differ from those associated with more traditional highway improvements. In addition to these technical discussions, the guide includes case studies of the four existing HOT lane facilities, as well as two recent HOT lane studies that are indicative of current trends.

Conducted as a two-year collaborative effort between the Federal Highway Administration and Parsons Brinckerhoff, the guide has benefited from inputs from a wide range of transportation professionals who have first hand involvement with functioning HOT lane projects and recent studies. It has also undergone a thoughtful peer review by respected

industry professionals. Its intent is to educate and foster informed decision making.

## **Organization of this Document**

The guide is organized into the following chapters:

1. HOT Lane Concept and Rationale
2. HOT Lane Planning and Implementation Process
3. Organizational Frameworks for HOT lane Projects
4. Achieving Public Acceptance
5. Technical Issues
6. Operational Issues
7. Current HOT Lane Experience
8. Benefits and Lessons Learned

Readers are encouraged to refer to individual chapters, sub-sections, or case studies if they desire information on a specific topic. Useful information can be obtained without reading the document from cover to cover. An index is also provided in order to assist readers interested in locating topics of interest. The index is particularly helpful in directing readers to areas in the case studies that discuss actual experience with issues addressed elsewhere.

# Chapter 1

## HOT Lane Concept and Rationale

In the face of growing urban congestion, the range of strategies to maintain and improve highway service is also increasing. The traditional approach has been the addition of general-purpose lanes. However, because of the high costs and impacts of creating new capacity, increasing attention is also being given to strategies that make the maximum use of existing highway capacity.

These strategies focus on both highway supply and demand. The most basic supply-side measure is the provision of additional roadway capacity. Given the environmental concerns and cost of adding new capacity, Departments of Transportation (DOTs) are also making increased use of Intelligent Transportation Systems (ITS) technologies to support improved operational efficiency on existing facilities by focusing on operational control and the provision of real time user information.

At the same time, transportation officials are using a range of demand management strategies to influence user demand and provide preferential services to certain vehicle types. One such strategy, High Occupancy Vehicles (HOV) lanes, reserves existing or new highway lanes for the exclusive use of car pools and transit vehicles. In some areas, DOTs are expanding HOV lanes into metropolitan area-wide networks. An additional management strategy uses variable prices on tolled facilities to attract motorists to lower priced off-peak times, thereby maintaining higher service level volumes during peak periods.

One of the most recent management concepts—High Occupancy Toll (HOT) lanes—combines HOV and pricing strategies by allowing single occupancy vehicles to gain access to

HOV lanes by paying a toll. The lanes are “managed” through pricing to maintain free flow conditions even during the height of rush hours. The appeal of this concept is tri-fold:

- It expands mobility options in congested urban areas by providing an opportunity for reliable travel times to users prepared to pay a significant premium for this service;
- It generates a new source of revenue which can be used to pay for transportation improvements, including enhanced transit service; and
- It improves the efficiency of HOV facilities, which is especially important given the recent decline in HOV mode share in 36 of the 40 largest metro areas.<sup>1</sup>

The combined ability of HOT operations to introduce additional traffic to existing HOV facilities, while using price and other management techniques to control the number of additional motorists and maintain high service levels, renders the HOT lane concept a promising means of reducing congestion and improving service on the existing highway system.

With only four HOT lane facilities operating in the United States in 2002, decision makers may not have the familiarity necessary to recognize the potential of the concept and consider it in situations where it could be appropriate. This guide is intended to encourage further consideration of the concept by providing transportation professionals with information and insight gained from the nation’s initial experiments with HOT lanes.

### 1.1 HOT lanes Defined

HOT lanes are limited-access, normally barrier-separated highway lanes that provide free or reduced cost access to qualifying HOVs, and

<sup>1</sup> U.S. Census Bureau, 2000 Journey-to-Work Survey.

also provide access to other paying vehicles not meeting passenger occupancy requirements.

By using price and occupancy restrictions to manage the number of vehicles traveling on them, HOT lanes maintain volumes consistent with uncongested levels of service even during peak travel periods.

Most HOT lanes are created within existing general-purpose highway facilities and offer potential users the choice of using general-purpose lanes or paying for premium conditions on the HOT lanes.

HOT lanes utilize sophisticated electronic toll collection and traffic information systems that also make variable, real-time toll pricing of non-HOV vehicles possible. Information on price levels and travel conditions is normally communicated to motorists via variable message signs, providing potential users with the facts they need in order to decide whether or not to utilize the HOT lanes or the parallel general-purpose lanes that may be congested during peak periods.

HOT lanes may be created through new capacity construction or conversion of existing lanes. Conversion of existing HOV lanes to HOT operation is the most common approach.

### Origins

As described above, the HOT lane concept combines two of the most effective highway management tools: value pricing and lane management. These techniques are defined as follows:

### Value Pricing

The use of pricing to moderate demand during peak periods is common in sectors such as power and air travel. Similarly, the concept of value pricing within the highway sector involves the introduction of road user charges that vary with the level of congestion and/or time of day, providing incentives for motorists

to shift some trips to off-peak times, less-congested routes, or alternative modes. Higher prices may also encourage motorists to combine lower-valued trips with other journeys or eliminate them entirely. When peak period volumes are high, a shift in a relatively small proportion of trips can lead to substantial reductions in overall congestion levels and more reliable travel times.

### Lane Management

Lane management involves restricting access to designated highway lanes based on occupancy, vehicle type, or other objectives. Preferential service is provided by limiting the number of vehicles on designated lanes to levels where a desirable level of traffic service can be maintained. Managed lanes are separated from general-purpose lanes either with pavement striping or physical barriers, with entry limited to designated vehicles only. The rationale for lane management is to maintain a superior level of service and attract use by eligible vehicles that would otherwise travel in the parallel general-purpose lanes during peak travel periods.

Lane management can encourage a range of vehicle-related policies including:

- Car pools and transit vehicles—to encourage higher occupancy;
- Trucks—to improve goods movement;
- Low emission vehicles (LEV)—to improve air quality
- Vehicles equipped for electronic toll collection—to improve operational efficiency; and
- Vehicles with other special designations.

### HOT Lane Management Strategies

Several mechanisms may be used to manage traffic flows on HOT lanes:

- **Occupancy Requirements:** Qualifying HOVs are allowed to use HOT lane facilities at no cost or at a reduced toll. HOVs are usually defined as vehicles carrying 2+ or 3+ persons.



- **Pricing Systems:** In order to maintain superior traffic service conditions, toll levels are set to limit the number of users by willingness to pay. The fee structure may be fixed, varying by time of day, or dynamic, varying in response to real-time traffic conditions. In either case, higher tolls are charged during peak demand periods. Information on toll levels is conveyed to motorists through variable message signs located near entry points.
- **Toll Collection Procedures:** In order to avoid the delays associated with manual toll collection, HOT lanes rely on electronic payment systems or paid monthly passes during test pilot periods. Therefore, only those vehicles equipped with a transponder tag or valid permit may use the lanes.
- **Vehicle Type:** A range of management policies may be implemented related to vehicle type. Depending on local transportation goals, low-emission vehicles, motorcycles, emergency vehicles, transit vehicles, taxis, and/or trucks may be allowed to use a HOT lane, either at no cost or for a reduced fee.
- **Access Points:** HOT lane facilities are normally separated from general-purpose travel lanes by physical barriers or lane markings. Access to the lane may be provided at intermittent points, but in many cases there may be only single entry and exit points. Barrier separation and the limited number of access points are important tools for managing traffic flows on HOT lanes.

### Similarities

The history of HOT lanes appears to have led to some standardization regarding physical configuration and operation of these facilities.

- They are each physically separated from the parallel general-purpose lanes by continuous concrete barriers or a fence of collapsible pylons;

- While some have relied on a monthly permit payment system initially, they each utilize fully automated electronic toll collection with access restricted to HOVs and non-qualified, paying vehicles equipped with transponder tags; and
- All systems have developed an “information system” of fixed and variable signs to provide users with information about access, occupancy requirements, hours, prices and enforcement.

As experience with HOT lanes expands, there may be additional convergence, with new standards emerging for certain design and operational features.

### Differences

It should also be noted that the physical configuration and operational policies of these facilities are markedly different.

- The facilities range from one lane to four—with or without reversibility.
- On the I-15 FasTrak in San Diego, HOV vehicles ride free, while all SOVs pay a toll. On the SR 91 Express Lanes in Orange County, CA, HOVs pay reduced tolls, and in Houston, HOV 3 vehicles have free access to the Katy Freeway and Northwest Freeway QuickRide, while HOV 2 vehicles pay for use.
- Pricing policies include fixed differences by vehicle type and variations by time of day or level of demand
- Ownership and operating structures may also vary widely and involving organizations ranging from for-profit, private sector developers to local planning organizations, transit agencies, and state departments of transportation (DOTs).

Transport officials considering the use of HOT lanes should take note of these differences and recognize that a great deal of flexibility is avail-

able to them as they study different options and formulate plans.

## 1.2 Existing HOT Lane Facilities

While an increasing number of state DOTs are studying the HOT lane concept as a strategy to improve urban highway service, there are only four HOT lane facilities currently operating in the United States.

- **State Route 91 (SR 91) Express Lanes—Orange County, California:** The SR 91 Express Lanes are a 10-mile, four lane, HOT facility in the median of an existing highway. Toll rates on the Express Lanes vary from \$0.75 to \$4.75 by time of day and day of the week. Customers must have a prepaid account and transponder to use the Express Lanes. Tolls for HOV2+ vehicles are reduced by 50 percent. The SR 91 Express Lanes concession was awarded to a private consortium, which financed, built, and operated the new lanes, using project revenues to repay its debt and derive profit. In April 2002 plans were put into place to sell the facility to the Orange County Transportation Authority (OCTA).
- **I-15 FasTrak—San Diego, California:** The I-15 FasTrak involved the conversion of an underutilized preexisting, eight-mile, 2-lane HOV facility to a peak-period reversible HOT operation. The I-15 FasTrak program allows single occupancy vehicles to pay a toll ranging from \$0.50 to \$4.00 to use the HOT lanes, which are otherwise reserved for HOV2+ vehicles. Customers must have a FasTrak account and transponder to use the HOT lanes. HOV2+ vehicles may use the facility at no cost. The project is sponsored by the San Diego Association of Governments (SANDAG), the local metropolitan planning organization (MPO), which has earmarked a significant portion of the revenues derived from the HOT lane to fund expanded express bus service in the I-15 corridor.

- **Katy Freeway QuickRide—Harris County, Texas:** The Katy Freeway is an existing highway with a 13-mile, 6-lane freeway with a 1-lane reversible HOV lane in the median which initially operated at HOV 2. The facility was heavily utilized and eventually converted to HOV 3 operation in order to reduce congestion. However, this change resulted in excess capacity on the facility during the peak periods. As a result, the QuickRide program was introduced, allowing HOV 2 vehicles to pay \$2.00 per trip to use the facility during peak periods, while HOV 3+ vehicles continued to use the facility at no cost. Customers must have a QuickRide account, transponder, and windshield tag to use the facility.
- **Northwest Freeway (U.S. 290) QuickRide—Harris County, Texas:** The Northwest Freeway connects the northwest suburbs of Houston with downtown, and has had a one-lane, barrier-separated, 15.5 mile, reversible HOV facility in its median since 1988. In November 2000 the Northwest Freeway HOV lane was converted to HOT use, and is operated in a manner similar to the Katy Freeway. The Northwest QuickRide allows paying two-plus carpools to use the lane only in the morning peak when three-plus occupancy requirements are in effect. From 6:45AM to 8:00AM, when the facility serves inbound traffic, three-plus occupant vehicle may use the lane for free, but two-plus vehicles must pay \$2.00 to use the lane. HOV3+ vehicles may use the facility at no cost, while single-occupant vehicles are never allowed on the QuickRide lane.

## 1.3 The Benefits of HOT lanes

HOT lanes have the potential to afford a variety of benefits to both motorists and transit users. While no strategy can be expected to substantially eliminate congestion, HOT lanes provide an important management tool with

the potential to improve travel conditions for a meaningful segment of the driving public with a range of potential benefits:

- **Trip Time Reliability:** Traffic volumes on HOT lanes are managed to ensure superior, consistent, and reliable travel times, particularly during peak travel periods.
- **Travel Time Savings:** HOT lanes allow HOV and paying non-HOV motorists to travel at higher speeds than vehicles on congested general-purpose lanes.
- **Reduced Vehicle Hours Traveled (VHT):** The addition of HOT options to an existing HOV facility may provide traffic service improvements on congested general-purpose highway lanes. These improvements also have the potential to draw vehicles off of other parallel routes and improve overall flows and speed levels in the corridor.
- **Revenue Generation:** HOT lanes can provide an additional source of revenue to support transportation improvements such as the construction and operation of the lanes themselves, or to address corridor transit needs or other local demand management strategies. In areas with funding constraints, certain improvements might not be possible without the additional revenue provided by HOT lanes.
- **Transit Improvements:** HOT lane revenues may be used to support transit improvements, and new HOT lane facilities provide faster highway trips for transit vehicles.
- **Enhanced Corridor Mobility:** Improved trip time reliability, higher speeds, travel time savings, and possible transit improvements all lead to greater mobility at the corridor level.
- **Environmental Advantages:** Compared to general-purpose lanes, HOT lanes may provide environmental advantages by eliminating greenhouse gases caused by stop-and-go traffic, and by encouraging people to use carpools and mass transit, thereby reducing the number of cars on the road.
- **Trip Options:** In congested corridors with HOV facilities and transit service, HOT lanes provide SOV motorists with an additional travel choice: the option of paying for a congestion-free, dependable and faster trip.
- **Utilization of Excess Capacity:** HOT lanes may provide an opportunity to improve the efficiency of existing or newly built HOV lanes by filling “excess capacity” which would not otherwise be used.
- **New Interest in Managed Lanes:** By increasing the traffic carrying capability of HOV lanes, HOT lanes may make managed lane applications attractive in regions that would not otherwise consider them.
- **Remedy for Under-Performing HOV Lanes:** In some areas there has been increasing pressure to convert under performing HOV lanes to general purpose use. HOT lane applications have the potential to increase the number of vehicles traveling on underutilized facilities and possibly reduce pressure to convert them to general-purpose use.
- **New Interest in Value Pricing:** HOT facilities demonstrate the benefits of value pricing in transportation that may be transferable to a broader array of services.

# Chapter 2

## The HOT Lane Planning and Implementation Process

The planning implementation process associated with HOT lanes is deceptively similar to that of other highway improvements. However, there are a number of issues that are likely to arise that may require special attention and have the potential to introduce the unexpected. This chapter reviews the implementation process and identifies key elements that are likely to be encountered along the way.

### 2.1 Origination

The initial decision to consider HOT lanes is one of the most important milestones in the implementation process. The decision to pursue a highway improvement is usually the result of a search for a solution to a specific transportation need. Therefore, it is helpful to recognize that there are a number of discernable conditions where HOT lanes can be particularly effective. They include the following:

#### Lack of Free-Flowing Parallel Routes

HOT lanes work best in larger metropolitan areas on high density corridors where there are limited travel options. The lack of free-flowing parallel routes, together with limited transit options, makes HOT lanes more attractive. Although there is some commuter rail service, the SR 91 in Orange County is located in a canyon with no parallel arterial or nearby parallel highway. I-15 in San Diego runs through Miramar Naval Air Station, which limits the possibility of parallel access routes. When there are limited travel options other than the highway corridor itself, HOT lanes offer motorists and transit users another choice.

#### Congested HOV Facilities

HOT lanes can also be effective in situations where HOV lane demand exceeds the capacity

of a single lane, but cannot by itself justify the expansion of the facility by adding a second HOV lane. Under HOT operation, additional paying vehicles would be allowed on to the lanes, making optimal use of the facility, while freeing some capacity on the existing general purpose lanes. As with the Katy Freeway in Houston, the HOT lane approach can also be effective when implemented in conjunction with an increase in occupancy requirements from HOV-2 to HOV-3 on congested facilities where the addition of a new managed lane is not contemplated.

#### Underutilized HOV Facilities

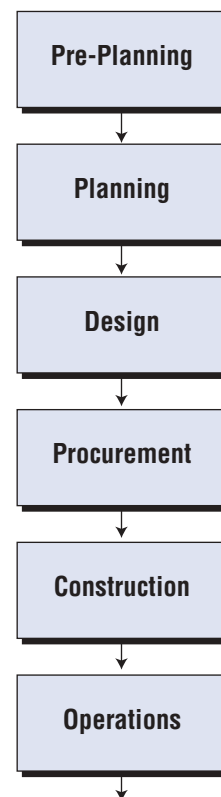
HOT lanes are appropriate in locations where demand for an existing HOV lane is below its operational capacity and where there is congestion during peak periods on the parallel general-purpose lanes. In such cases, additional paying SOV motorists may be allowed to use the facility, with tolls set at levels that maintain desired traffic service standards.

### 2.2 Implementation Process

The overall planning and implementation process for HOT lanes should be familiar to most transportation professionals. As shown in Figure 1, the steps involved are similar to those associated with any highway improvement. The process can be described as follows:

#### Pre-Planning

Once the need for an improvement is identified, the responsible Department of Transportation (DOT) identifies and reviews conceptual, operational and physical solutions for their effectiveness, anticipated cost, ease of implementation, and acceptability to the public. The improvement is then weighed against the other needs facing the jurisdiction, and then a decision is made whether or not to proceed with the project.



**Figure 1.**  
HOT Lane  
Implementation  
Process

**Planning**

If a decision is made to proceed, the conceptual improvements are narrowed and refined. The ability of a shortlist of more promising alternatives to meet a variety of desired goals is then assessed. The process culminates with the identification of a preferred alternative, which would then be integrated into a region’s federally mandated transportation improvement plans.

**Design and Procurement**

If a decision is made to proceed, the DOT completes detailed engineering and design studies for the preferred alternative. When this process is completed, the project is put out to bid, and a contractor is selected on a competitive basis.

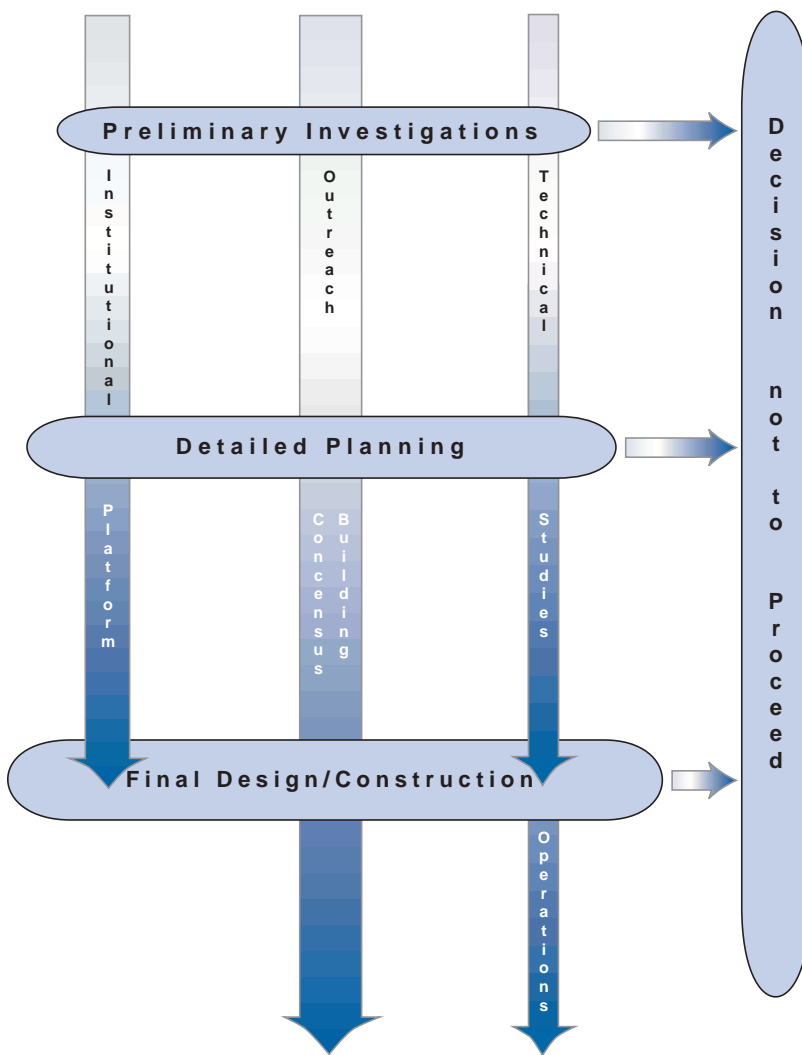
**Construction**

During the construction phase, the contractor completes the required work according to the design and implementation schedule established in the construction contract. The DOT supervises the construction and continues to operate existing facilities while the improvements are under way.

**Operation**

Once the construction has been completed to the satisfaction of the DOT, the new facilities are put into operation. The DOT normally assumes responsibility for the physical maintenance of the assets, and coordinates enforcement and incident management with the appropriate officials.

**Figure 2.  
HOT Lane  
Implementation  
Work Flows**



**2.3  
Unique Concerns Associated with  
HOT lanes**

The development of HOT lanes often requires modification to existing highways where space is constrained and the use of sophisticated traffic management and automated toll collection technologies, providing the opportunity for some DOTs to utilize new types of equipment.

While these particular issues are not unique HOT lane initiatives, others are when compared to typical highway or HOV projects. HOT lanes utilize traffic management techniques—pricing and occupancy requirements—in new ways, and in many jurisdictions HOT lanes may involve the introduction of tolls for the first time. These facts may require DOTs to establish new legal and institutional structures and operational capabilities before HOT lane projects can actually be implemented. They may also introduce unfamiliar project financing and operational approaches. Most importantly, they introduce public relations challenges that have the potential to bring HOT lane initiatives to an abrupt halt at nearly any stage of their development.

Figure 2 depicts the dynamics associated with the HOT lane implementation process. As shown, three primary streams of work are involved in the implementation process:

- Technical;
- Institutional; and
- Consensus building.

Technical tasks are relatively straightforward. During the formative stages of project development they involve design, environmental review, systems technologies, travel demand forecasting, financial planning, and operations management. Once a project is operational, they expand to include monitoring and evaluation, enforcement, and physical maintenance.

Institutional tasks involve creating the legal and organizational frameworks within which the project will take place. Some of these are likely to be new, particularly when DOTs are embarking on first-time HOT lane endeavors. As shown in Figure 2, most institutional and organizational arrangements will need to be finalized by the time project construction begins. Institutional issues are discussed in further detail in Chapter 3.

As reflected in Figure 2, outreach and consensus building activities are critical components of HOT lane implementation from the time preliminary investigations begin through the operational period. While the benefits of combining occupancy requirements, access, and price to manage demand bring clear transportation benefits, the concept is often difficult to embrace both for political decision makers and the public at large. Equity is also a key concern, as some constituencies are likely to argue that it is inequitable to provide premium service to those who appear more likely to afford it. This important issue is addressed in greater detail in Chapter 4 of this manual.

### How are HOT lanes different from traditional highway and HOV projects?

- HOT lanes use market price and other management tools to provide dependable and superior travel conditions, particularly during highly congested peak travel periods.
- HOT lanes provide a new and desirable transportation option for motorists and transit users in congested travel corridors.
- HOT lanes generate revenues that can be used to pay for their implementation or to help underwrite other transportation improvements.
- HOT lanes require considerable attention to roadway management, including monitoring traffic operation and responding to incidents.
- HOT lanes offer new ways to apply traffic management and toll collection technologies.
- HOT lanes require ongoing marketing and public awareness outreach efforts.
- HOT lanes are likely to require interagency cooperation.

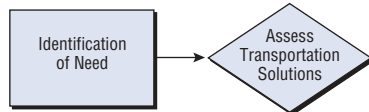
## 2.4 Milestones in the HOT Lane Implementation Process

As shown in Figure 3, there are a number of milestones that can be anticipated to occur in the different phases of the development of a HOT lane project identified in Section 2.1. These events range from policy decisions to the resolution of technical issues, the award of contracts, and facility implementation. As shown in Figure 3, the decision not to proceed is also a potential milestone that remains present throughout the development of any project.

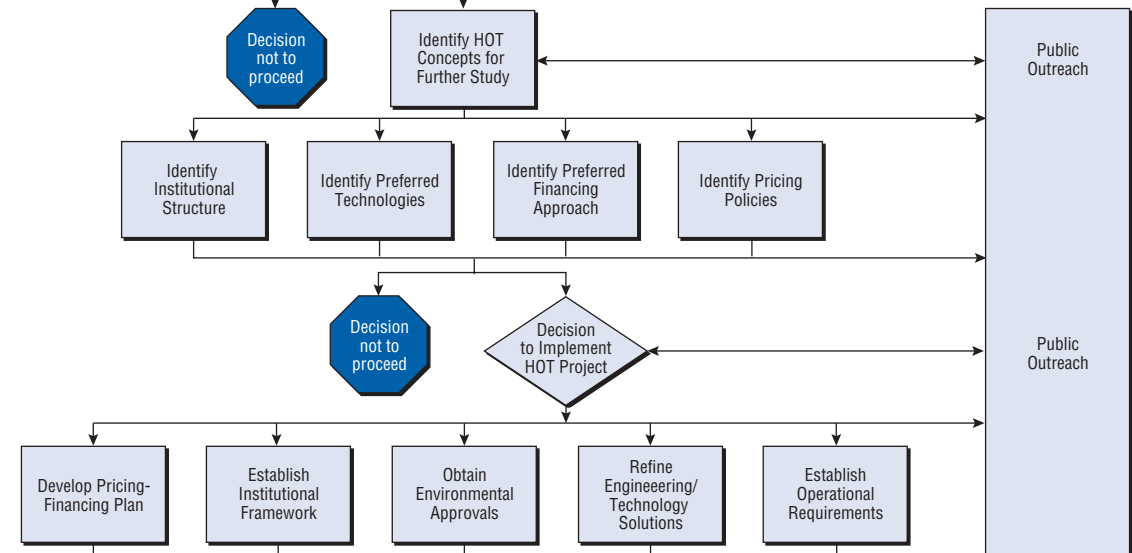
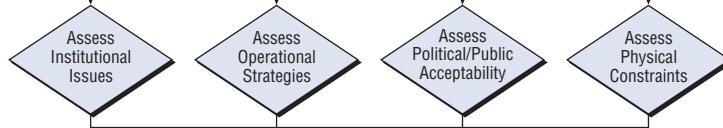
### 2.4.1 Establishing Operational Objectives

As they define potential HOT lane projects, transportation officials will need to establish the overall operating objectives that will govern them. This involves determining the combination of management techniques—occupancy requirements, access, and price—that allow specific goals to be met. This is especially important for HOT lanes that involve real-time

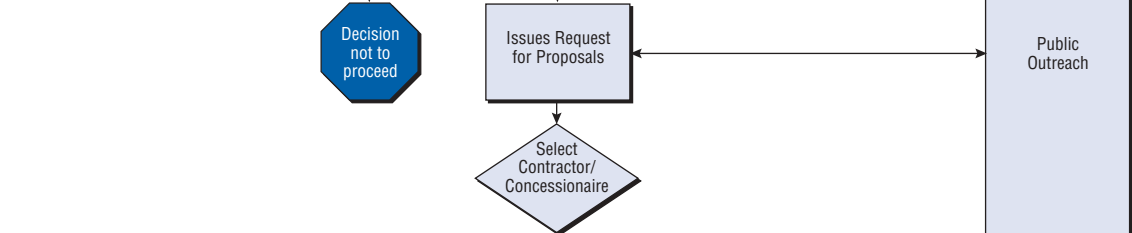
Pre-Planning Phase



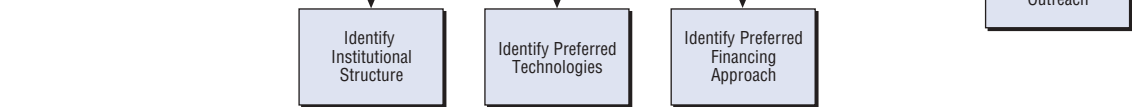
Planning Phase



Procurement Phase



Construction Phase



Operational Phase

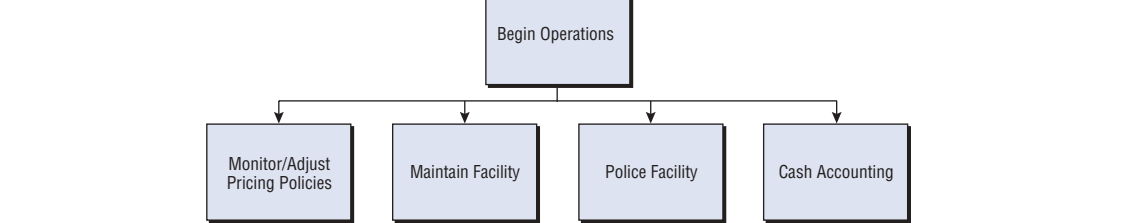


Figure 3. HOT Lane Planning and Implementation Milestones

variably-priced tolls. Possible objectives include one or more of the following:

- Maximum overall time savings (may include effects on both the HOT lane route and the alternative “free” facility);
- Maximum vehicle throughput subject to traffic level of service or minimum speed constraints;
- Maximum person throughput subject to traffic level-of-service or minimum speed constraints; and
- Profit maximization.

Certain of these issues may depend on the nature of the facility’s owner and operator. In cases where the private sector is responsible for developing and financing HOT lanes, their main objective may be to maximize revenue levels. Public agencies implementing HOT facilities may also be more focused on maximizing operational efficiencies such as throughput and travel time savings. However, it should be understood that profit maximization should generally coincide with the maximization of operational efficiencies, such as throughput and travel time savings.

## 2.4.2

### Other HOT Lane Decisions

Several other important choices face transportation officials and policy makers as HOT lane projects become more clearly defined. These decisions can have repercussions on design, as well as equity issues and are likely to include:

1. *Eligibility of vehicles.* What size and type of vehicles should be eligible to use the HOT lane? If demand exceeds supply, how should users be selected?
2. *Toll collection.* How should the toll collection program be administered? Government agency (if so, which one?) or a private contractor under government contract?
3. *Toll collection technology.* Should the project use electronic toll collection or a permit decal system?
4. *Intermediate access.* What frequency of access for buy-in vehicles should be permitted?
5. *Lane separation treatment.* Should the HOV lanes be separated by a physical barrier, solid lines on the pavement, or no visible treatment?



# Chapter 3

## Organizational Frameworks for HOT Lane Projects

In order to launch a HOT lane project, there are several organizational issues that need to be resolved. These involve identifying a logical project sponsor, arranging funding, working out operational protocols, and determining what legal ramifications may be involved. Answers to these issues may not always be obvious. This chapter identifies the wide array of organizational issues that transportation professionals must address as they consider the implementation of HOT lane projects.

### 3.1 HOT Lane Roles and Responsibilities

While there is no single fixed approach for implementing HOT projects, as shown in Table 1, there is a limited number of primary capacities in which transportation agencies can be involved in HOT lane projects.

There is no set formula or norm for the institutional arrangements supporting HOT lane projects. Institutional structures will depend on a variety of factors and are likely to vary from project to project. In some cases, a single agency, such as a state DOT, may fulfill all three functions. In others, individual functions may be performed by individual agencies, private companies, or partnerships among them.

### 3.2 Identifying a Project Sponsor

One of the first and most important issues to resolve is the identification of a project sponsor. This is the agency that will implement the project, execute planning studies, submit applications and environmental documentation, and oversee the construction and possibly the ultimate operation of the facility. The implementing agency will need to be vested with, or

obtain the legal authority to collect tolls and it will need to function as a champion for the project in order to garner the critical public and political support needed to bring the HOT project to fruition.

When HOT lane projects involve the conversion of existing HOV facilities, existing organizational arrangements are most likely to govern the operation of new HOT projects. Given that 95 percent of HOV lane-miles in the United States are managed by DOTs, responsibility for most HOV conversions is likely to rest with the state DOT. Other corridors suitable for HOT lane applications are likely to include highly constrained state or county highways.

In either case, a long legacy of institutional relationships has already been established. Therefore, it is important to understand these relationships, and then determine if any preexisting political or institutional issues should be addressed. As demonstrated by the nation's first crop of HOT lane projects, a variety of sponsoring and operating agencies may be involved. No single approach is preferable, and decisions regarding sponsorship will ultimately reflect local conditions.

#### 3.2.1 State Departments of Transportation

As the primary providers of highway service and owner/operators of a majority of the nation's HOV lane projects, DOTs are logical sponsors of new HOT facilities. They have extensive experience in planning, designing, constructing, operating, and maintaining limited access highways. They have the financial depth to contemplate building new highway capacity and to obtain the expensive toll collection and traffic monitoring systems that most HOT facilities require. DOTs also have the power of eminent domain and many DOTs are already operating HOV networks with extensive electronic traffic monitoring capabilities.

While state DOTs have a wealth of highway experience, they may not necessarily have the legal authority to levy tolls (see Section 3.4). Most have limited familiarity with the operation of tolled facilities and the sophisticated electronic toll collection traffic monitoring systems that HOT lane projects typically require, and in certain cases they may have limited legal authority to privatize these operations. Toll road operation also involves “back room” activities including auditing, credit card billing, and customer service, all of which may be new activities for many DOTs.

**3.2.2 Other Project Sponsors**

In addition to state DOTs, there are a number of other agencies that may play important roles in the implementation of HOT lane projects, including:

- Turnpike and toll road authorities;
- Local transportation agencies;
- Transit agencies; and
- Private sector concession companies.

The ramifications of involvement of these types of organizations are discussed below.

**Turnpike and Toll Road Authorities**

As a precursor to the interstate highway program, many states developed turnpike and toll authorities with specific legislative charters to finance, build and operate limited access, high-speed highways. While construction of the Interstate Highway System by state highway agencies eclipsed the need for these authorities, most still serve their original roles. In addition to these turnpike authorities, fiscal constraints in the 1980s and 1990s led to a revival of toll authorities, especially in fast growing areas such as California, Texas, Colorado, and Florida. Some of these authorities are state or county agencies, while others are joint entities formed by multiple jurisdictions.

In certain cases, the involvement of turnpike and toll authorities may facilitate the imple-

Role	Primary Responsibilities
<b>Owner</b>	The agency that owns the facility to which the HOT lane will be added, and in whose name applications and other official documents are submitted.
<b>Sponsor</b>	The organization charged with overall project implementation. Specific tasks include: <ul style="list-style-type: none"> <li>• Completing technical studies</li> <li>• Submitting FHWA Value Pricing Pilot Program Application</li> <li>• Education and public outreach</li> <li>• Gaining project approvals from FHWA, environmental agencies, and others</li> <li>• Awarding and overseeing design and construction contracts</li> <li>• Arranging for HOT lane enforcement</li> <li>• Operating the HOT facility</li> <li>• Completing follow-up activities mandated by FHWA or the Congestion Pricing Pilot Program</li> </ul>
<b>Operator</b>	The organization responsible for the day-to-day operation of the HOT lane. Specific tasks include: <ul style="list-style-type: none"> <li>• Toll collection and billing</li> <li>• Roadway and equipment maintenance</li> <li>• Monitoring and evaluation</li> <li>• Marketing</li> </ul>

mentation of a HOT lane project. In addition to engineering and construction experience, they are already vested with the legal authority to operate tolled highway facilities, thereby obviating the need to seek special authorizing legislation. Turnpike and toll authorities have the staff and systems in place to conduct all of the back room revenue handling and accounting activities. In addition, many operate the advanced electronic toll collection and traffic monitoring systems that HOT lane networks require.

While turnpike and toll road authorities offer natural advantages, they are not common in all areas across the country. In addition, if HOT lanes were introduced along untolled highway segments, they would not involve roads already under the control of such authorities. Nonetheless, given that motorists are accustomed to paying tolls to turnpike and toll road authorities, their involvement in the operation of HOT lane projects could help in gaining the public’s understanding and acceptance of these potential projects.

**Table 1. Primary HOT Lane Roles and Responsibilities**

### Local Transportation Agencies and Authorities

Based upon Section 450 of Title 23 of the United States Code, in order to receive Federal funding for transportation projects all urbanized areas in the United States are required to maintain an MPO. MPO status is designated by the United States Department of Transportation and is usually given to regional Councils of Government or other joint powers' authorities. These groups are generally governed by a board of elected officials representing municipal governments within their jurisdictions, as well as county officials, and local transit agencies. State DOTs are often represented on MPO boards by a non-voting member. The organizational structure of MPOs varies around the country and in certain cases MPO status is given to county or municipal governments.

In some areas local authorities have been created to assist MPOs in securing funding and implementing projects identified through the MPO. These transportation or funding authorities, created at the county or regional level under varying conditions, can help in studying the merits of HOT lanes, securing funding for their implementation and assist in disbursement of net revenues collected.

Given their regional mandate and their planning function, MPOs and local transportation authorities may be logical sponsors of HOT lane initiatives. They have commissioned several of the HOT studies that have been carried out in California. Their active and consistent support is also essential if a new HOT facility is to be built, and local transportation authorities often play a primary role in the initial planning studies investigating the feasibility of HOT lane projects. Although most MPOs are likely to lack operating experience or tradition, some might play a further role in overseeing the implementation and operation of a HOT facility, such as with the I-15 FasTrak HOT lane project in San Diego, where SANDAG is the project sponsor.

### Public Transit Agencies

In Houston the Harris County Metropolitan Transit Authority (Houston Metro) partnered with the Texas DOT in the Katy Freeway reversible HOT lane project. Public transit agencies present interesting opportunities for participating in HOT lane projects. Several transit agencies operate bus rapid transit or HOV facilities, which have excess capacity that could be sold to carpoolers, vanpoolers or single occupant vehicles. Utilizing additional roadway capacity for other vehicles can help win political and public support and may limit the need to add additional roadway capacity. In the same vein, the participation of transit agencies in HOT lane projects sponsored by other agencies highlights the potential for HOT lane projects to provide opportunities for promoting reliable mass transit improvements. Finally, transit agency involvement in the development of HOT lanes may also help to introduce new sources of capital funds and in return, as with the I-15 in San Diego, HOT lane revenues can provide important new revenues to support improved transit service.

It is important to note, however, that transit agencies would need to obtain the backing of FTA before being able to launch a HOT lane project on their own. To date, FTA has not allowed new start funds for facilities that would also be open to SOV vehicles. The issue of transit funding limitations has also arisen when investigating the possible conversion of existing HOV lanes built with transit funding to HOT use. For instance when considering the possible conversion of HOV lanes on the I-25 north of Denver in 2001, FTA found that allowing general traffic on an HOV facility would constitute a breach of its original agreements providing funding for the lane. At that time the agency took the position that the conversion could not take place without the full reimbursement of its original \$71 million contribution.

Recent collaboration among FTA, FHWA, and Congress has led to an important policy

change on the part of FTA supporting the agency's broader efforts to promote transit usage and encourage congestion management. Effective in Fiscal Year 2003 FTA will no longer withhold formula funds for fixed guideway transit facilities that provide access to paying SOV motorists under the following conditions: the facility must be able to control SOV use so that it does not impede the free flow and high speed of transit and HOV vehicles; and the toll revenues collected must be used for transit purposes.<sup>2</sup> This important policy change demonstrates growing support for the HOT lane concept within the transit sector that may lead to new opportunities for the joint development of new HOT lane projects. Transit agencies remain logical partners in the development of HOT lane facilities, as they can help to pool resources and help to garner public support for HOT lane initiatives.

Early consultation with FHWA or FTA is strongly recommended as an essential component of any HOT initiative or study to determine whether or not further federal review or analysis would be required. The nature of interest from FHWA or FTA will depend on the source of original funds used to implement the HOV lane. It is also possible that an HOV conversion could involve facilities that were constructed using FTA funds. If this is the case, similar issues could be raised with FTA and should be discussed early in the planning process.

<sup>2</sup> Prior to this change the FTA viewed the definition of "fixed guideway" contained in 49 USC Chapter 53, as well as in the National Transit Database Reporting Manual as prohibiting any use by SOVs. This interpretation was applied to the case of the I-15 FasTrak in San Diego, resulting in the loss of formula funds for that facility following its conversion to HOT use, which allowed SOVs use the facility for a fee. This policy is documented in FTA Administrator Jennifer Dorn's June 10, 2002 letter to Congressman Randy "Duke" Cunningham of California.

Colorado Senate Bill 99-088, passed in June 1999 is of particular interest, as it requires the state DOT to pursue the development of a HOT lane project in conjunction with a private investor-operator. The legislation states in part:

"The department shall issue a request for proposals to private entities for the purpose of entering into a contract for the conversion of an existing high occupancy vehicle lane...to a high occupancy toll lane by a private entity; the department may convert or operate the high occupancy toll lane, or both, in the event that no proposal by a private entity for such conversion or operation is acceptable."

In response, the Colorado DOT has evaluated the conversion of portions of the Boulder to Denver I-25 HOV lanes, to a HOT lane operation. It has also received a non-solicited offer to add HOT lanes to the I-70 between Downtown Denver and Denver International Airport.

### 3.3 Private Sector Involvement

The fact that HOT projects generate toll revenues also introduces the possibility that under the right conditions they could be financially independent or even profitable ventures of potential interest to private investors.<sup>3</sup> The conversion of existing HOV lanes to HOT use has the greatest potential to be attractive to private investors, as the associated costs are likely to be significantly less than building new lanes. A HOT lane conversion project involves the installation of electronic toll collection equip-

<sup>3</sup> Although privately financed motorways are common in countries around the world, they have not generally been favored in the United States. The following privately financed toll roads operating in the United States—the Dulles Greenway in Loudoun County Virginia, the Camino Colombia in Webb County, Texas, the Foley Beach Expressway in Baldwin County Alabama, and the SR 91 Express Lanes (a HOT lane facility) in Orange County California. An additional project, the SR 125 connecting south eastern San Diego with the Mexican border is also likely to be built. The Southern Connector in Greenville, South Carolina and the Pocahontas Parkway in the greater Richmond area in Virginia have also been financed on a limited recourse basis through public benefit 63-20 corporations.

### Potential Trade-offs

Inviting private investment in a HOT facility may also involve a sponsor's relinquishing its own authority to intervene in the same corridor. For example, the contract governing the private financing and construction of median toll lanes on the SR 91 in Southern California, required California Department of Transportation (Caltrans) to agree to non-compete provisions limiting its authority to make improvements or add capacity in the SR 91 corridor. Publicly funded improvements in the congested corridor would harm the private owner's ability to recoup investment in the HOT lanes. When Caltrans moved in 1999 to add general-purpose lanes in strategic locations on SR 91 to improve on and off ramp movements, the private owner sued to stop the plans. Caltrans ultimately withdrew its plans, but the non-compete agreement proved contentious. Interestingly, the planned sale of the SR 91 to the Orange County Tollroad Authority would render the non-compete provisions null and void.

ment, road sensors, signage, and perhaps changes to ramp and barrier configurations; yet, given the right conditions such a facility could generate significant revenue. One key issue facing decision makers is whether to forgo using that revenue to support transit or other publicly provided transportation enhancements or to offer it instead to a private concessionaire who would finance and operate the HOT lane.

Private sector investment in HOT lane projects involving significant new construction is likely to prove more challenging. The feasibility of attracting private participation depends on the balance between the cost of financing, building, and operating the facility and the revenues it would generate.

Private sector involvement can be an attractive option for transportation agencies, as it provides access to additional sources of capital. This allows DOTs to reserve their own funds for other needs and often accelerate the implementation of partnership projects. Private operators are motivated to maximize efficiency in order to maximize profits, and their services—both capital construction and roadway operating—often bring good value for money.

Private operators often offer an advantage in their attentiveness to quality of service as well as marketing activities, as witnessed by the customer services offered by the SR 91 Express Lanes. On the down side, financing terms for private investors may not always be as attractive as those available to the public sector, and have the potential to offset other efficiencies.

### 3.4 Determining Legal Authorities and Requirements

The implementation of a HOT facility is likely to require legislative action to clarify a wide range of management and operational issues. Several issues may be involved.

#### Tolling Authority

One of the first issues that will need to be investigated is whether or not the authority exists to implement tolls. Title 23 of the U.S. Federal Code prohibits the implementation of new tolls on the Interstate Highway System where user fees are not currently charged.<sup>4</sup> However, TEA-21 introduced two pilot programs which allow the implementation of tolls on the Interstate system on a trial basis: the FHWA Value Pricing Pilot Program, which allows real-time, variable pricing, and the Interstate Toll Pilot Program, which permits flat-rate tolls to raise needed revenue, but not necessarily to reduce congestion. These programs remain in force through mid-2004, after which a new multi-year authorization act will dictate transportation policy.<sup>5</sup> During the TEA-21 period, if HOT lanes are considered on any portion of the Interstate Highway System they must be implemented through the Value Pricing Pilot Program. Following reauthorization, any future HOT lane projects implemented on the Interstate Highway System will need to conform to the tolling policies established in the new authorization act. Existing HOT Lane

<sup>4</sup> Title 23 grandfathers the collection of tolls on those portions of the Interstate system operated by preexisting turnpike and toll road authorities.

projects implemented through the FHWA Value Pricing Pilot Program on the are considered to retain their authority to toll unless there is a specific legislative change that removes that authority.

HOT lane projects must also comply with state and local laws on toll collection. In many states the authority to collect tolls on state highways and other roads does not exist, and when such authority does exist, it is likely to be limited to roads operated by a designated turnpike or toll road authority. If a proposed HOT lane project is not located along an existing facility operated by one of these agencies, legislative provisions will have to be made to allow for the collection of tolls on the new facility.

#### **Variable Pricing Authority**

Trust agreements governing the operation of most toll roads only allow flat point-to-point toll rates (i.e., a consistently applied toll rate from point A to point B). If a HOT lane project involves variably priced tolls, legislation may need to be drafted that establishes how and when toll rates can be changed and establishes the minimum acceptable traffic service levels in the HOT lane.

These issues should be addressed in the enabling legislation that will establish the legal

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<sup>5</sup> Authorizing legislation for highways began with the Federal-Aid Road Act of 1916 and the Federal Highway Act of 1921. These acts provided the foundation for the FAHP as it exists today. The FAHP has been continued or renewed through the passage of multi-year authorization acts ever since then, which has altered the program as well as supplied funding. In addition, since 1978, Congress has passed highway legislation as part of larger, more comprehensive, multi-year surface transportation acts, such as TEA-21, which was enacted on June 9, 1998, and covers the six-year period through mid-2004, or the Intermodal Surface Transportation Efficiency Act, (ISTEA) which was enacted in 1991 and then extended for an additional one-year period in 1997.

and regulatory framework for the HOT facility. Because HOT lane operations require a high degree of interagency cooperation and shared responsibility, enabling legislation should designate the operating agency or agencies and outline their specific responsibilities in such areas as construction, maintenance, toll collection accounting, and enforcement. If the HOT facility were to be operated by a bi-state organization, approvals would be required from the United States Congress, as well as both state legislatures. Similarly, parallel legislation is required to establish an authority operating toll facilities connecting two countries.

#### **Privatization Authority**

Use of private financing mechanisms for transportation facilities can occur only when the necessary legal authority exists and governing legal principles and restrictions are observed. Local governments not only must have the legal power through constitutional or statutory provisions to finance transportation facilities, but they must also use this power within the legal restraints established by legislatures and courts. The methods of granting power and the limitations on that power vary widely among local governments.

Several states now have special public-private partnership (PPP) legislation designed to authorize state DOTs and other subdivisions of the state to enter into new forms of legal agreements with private entities in support of revenue-generating projects which are consistent with each state's overall transportation objectives. Most of this legislation has been oriented towards enabling states to capitalize on the provisions within ISTEA authorizing states to make loans or grants of Federal-aid to public or private entities for the purposes of toll road or HOT lane development. This type of legislation must be in place before a HOT lane concession can be awarded to a private investor.

### Toll Agency Legislation Checklist

The enabling legislation for any toll agency is unique, but there are many common provisions that are likely to be addressed, including the following:

- Creation of an authority or commission, including the legal name and nature of the newly created entity;
- Scope, purpose, and function of the new entity;
- Definition of terms;
- Delineation of district within which the entity operates;
- Details about the entity's governing board, including the number, composition, selection or appointment process, compensation, and term of members, voting/procedural rules for governing board action, and meeting requirements;
- The legal powers of the commission/authority, including the ability to establish rules and regulations, hire employees, sue and be sued, enter into contracts, construct facilities, acquire property, use the power of eminent domain, and impose fees;
- The authority to issue and refund bonds and use tolls and revenues in associated trust indentures,
- The authority to set and revise tolls and any applicable guidelines or formulas,
- The ability to invest bond proceeds;
- Administrative requirements, which may include periodic audits, competitive bidding, annual reports, public notice and/or hearing requirements;
- Any constraints or rules on the use of funds;
- The rights and remedies of bondholders;
- Tax-exempt status of authority property and bonds;
- The venue and jurisdiction of legal actions against the authority/commission;
- Police powers;
- Operating, maintenance, and repair obligations; and
- Relationship to other entities, e.g., for oversight, reporting, etc.

In addition to these typical provisions, an enabling act may have non-competition sections, which guarantee to the new entity that no new directly competing facility will be authorized by the state. Other legislation is likely to be required to cover issues such as:

- signing to the road from the rest of the network;
- advertising controls on the road;
- operational procedures (such as arrangements for emergency vehicles and information disclosure rules, which are particularly important where tolls are levied electronically);
- defining the enforcement regulations for non payment;
- the use of cameras to enforce occupancy requirements;
- provisions for land acquisition and clearance; and
- structure for involvement of the private sector in the provision of roads.

### 3.5 Operational Arrangements

Once the HOT lane is operational, a number of ongoing operational functions will be required. These involve routine roadway maintenance, as well as toll collection and enforcement. These functions, particularly the latter two, pose differences from normal highway operation and are discussed in further detail below. Operational functions may be performed directly by the public or private owner of a HOT lane facility, or contracted out to an outside vendor specializing in automated toll collection or facility management.

#### Toll Collection

By their definition, HOT lanes require the collection of tolls from motorists not meeting occupancy requirements. Moreover, in order to maintain the time savings and ease of use they are meant to afford, toll collection for HOT lanes must be fully automated. As discussed in further detail in Chapter 5, the operation of automated tolling systems requires sophisticated equipment and expertise. Although some toll collection agencies maintain this expertise in-house, the majority rely on the services of outside contractors to maintain their automated toll collection systems. If a HOT lane project is sponsored by a state DOT, it is also conceivable that the DOT could vest responsibility for toll collection with a local turnpike or toll road authority with the appropriate expertise.

Interoperability is also another critical toll collection issue. For toll roads, it is normally advantageous for automated toll collection systems to be interoperable from region to region.<sup>6</sup> This argument can also be made for HOT lanes. However, in certain cases, a HOT

<sup>6</sup> For example motorists can utilize the E-ZPass technology on toll facilities in New York, New Jersey, Pennsylvania, Maryland and Connecticut. E-ZPass holders can also use their transponders on the Massachusetts Turnpike, and Massachusetts FastLane tag holders also enjoy reciprocal privileges on all E-ZPass facilities.

lane operator may want to limit the availability of transponders as an additional means to manage overall access to the HOT lane.

It is advisable to consider possible operational arrangements for toll collection up front. The following questions should be answered:

- Does the region have a preferred automatic toll collection system?
- What agencies maintain those systems?
- Which agency/agencies will function as HOT lane sponsor, owner, and operator?
- Are there existing interoperability agreements in place?
- Is there an existing protocol for introducing automated toll collection on new facilities?
- Is interoperability advantageous?

#### **Enforcement**

Planning for a HOT lane should include early involvement of the appropriate police agencies. If the HOT lane will pass through several jurisdictions where each may take an active investigative and enforcement role, then planning should include early agreements to establish response and enforcement protocols. If the HOT lanes will be added to an existing facility, then the police agencies will have considerable experience on that roadway.

If the system will have a limited number of access and egress points, then agreements may be needed to consolidate enforcement responsibilities under a small number or one police agency. If only one police agency is involved, the transportation agency should request that a liaison be assigned to ensure continuity of input during the planning process. This early involvement can be invaluable for resolving design issues for enforcement locations, investigation sites, and enforceable signing. The police liaison can also be a significant help if law or procedure changes are needed before enforcement can be undertaken.

Additional information on enforcement issues is provided in Section 5.3

#### **Maintenance**

Responsibility for the physical maintenance of a HOT lane is most likely to rest with the agency that maintains the corridor in which the facility is located. In most cases this is the state DOT, but other agencies could also be involved. If multiple agencies are responsible for different operating aspects, agreements will need to be put into place identifying roles and responsibilities as well as reimbursement.

### **3.6 Federal Assistance**

#### **3.6.1 The FHWA Value Pricing Pilot Program**

Under Section 1216(a) of TEA-21, public agencies interested in implementing and evaluating HOT lane initiatives are eligible to apply for grants under the Value Pricing Pilot Program. The purpose of the program is to demonstrate and evaluate pricing concepts, such as HOT lanes, that have the potential to reduce highway congestion. The Value Pricing Program has dedicated funds available to support HOT lane studies, as well as the implementation of actual projects, and through it agencies may obtain the authorization to introduce new tolls on Interstate Highway System.

Information on the types of projects that are eligible for funding through the program as well as the application procedure are available in the Value Pricing Pilot Program's May 7, 2001 notice in the Federal Register. This information remains current until the next multi-year Transportation Authorization Act takes force in mid-2003, which will likely address pricing programs.

#### **3.6.2 Available Resources**

In addition to this guide, the following technical resources are available through FHWA:



- Comprehensive information on HOT lanes and other value pricing initiatives may be obtained from the value pricing homepage at <http://www.valuepricing.org>. This is operated by the University of Minnesota's State and Local Policy Program.
- Federal Register notice of May 7, 2001 [(Volume 66, Number 88), pages 23077-23081], provides a summary of the TEA-21 Value Pricing Pilot Program and establishes broad criteria for participation.
- The activities under the TEA-21 Value Pricing Pilot Program are summarized in the FHWA's Report to Congress, June 2000 and a similar report to be released in 2002.
- Pricing project planning guidelines are summarized in an FHWA report: Guidelines for Project Development, Revised Interim Report, FHWA, August 1996.

More general information about HOT lanes and the Value Pricing Pilot Program may be obtained from either of the following offices:

#### Policy Issues

Office of Transportation Policy Studies, HPTS  
Federal Highway Administration  
Washington, D.C. 20590  
Tel: (202) 366-4076

#### Operational Issues

Office of Travel Management, HOTM  
Federal Highway Administration  
Washington, D.C. 20590  
Tel: (202) 366-6726

# Chapter 4

## Achieving Public Acceptance

Effective outreach is an essential element of HOT lane planning and implementation. Basic public awareness of HOT lanes in general, as well as political and popular support for the particular proposal in question can facilitate efforts to implement HOT projects. Tolled high-occupancy facilities are a very new concept in transportation. Steps to familiarize the general public as well as local elected officials with HOT facilities and the specific rationale for proposing them may assist those outside transportation planning and engineering circles to evaluate a local HOT proposal. Without such outreach, the public may greet the introduction of a HOT facility with indifference or caution.

Carefully planned and executed public outreach can play a critical role in helping the public (1) to understand how a proposed HOT facility would work, (2) to evaluate the advantages it might offer, and (3) to accept the HOT facility as a new travel option.

### 4.1 Outreach for HOT lanes

While they will utilize many of the same techniques to exchange information, public outreach activities designed for HOT lane initiatives need to be *different* from those designed for more conventional transportation improvements.

#### Education

First, HOT lanes themselves are a new concept in most places, and public outreach for HOT proposals will necessarily involve a larger educational component than do traditional transportation projects. HOT lanes are unlike conventional road improvements—such as roadway resurfacing or reconfiguring an inter-

#### An Overview of Outreach

Public outreach has long functioned as an integral part of the transportation planning process in the United States. The process is well known among DOTs and metropolitan planning organizations. Following mandates initially established under the National Environmental Protection Act (NEPA) in the 1970's and strengthened under the Statewide and Metropolitan Joint Planning Regulations of October 1993, departments of transportation around the country must provide the public with information on transportation improvements under consideration in their jurisdictions. The feedback they receive from the public is used to refine their plans and ultimately implement more effective projects. Information and feedback are exchanged through a variety of ways, including public meetings, focus groups, newsletters, websites, and formal hearings. Both FHWA and FTA have performance measures to track the effectiveness of outreach efforts.

change—where the public may readily understand the future benefits. HOT lanes' market-oriented approach to allocating roadway space may be a new concept to the public, and education is needed to distinguish HOT facility user fees from ordinary tolls. Where the public knows that HOT facility tolls purchase premium traffic service, reliable trip times and time savings, support for HOT facilities may be greater. Therefore, effective public outreach efforts for HOT projects will communicate the critical function of user fees, how and by whom tolls will be collected, and how toll revenues will be spent.

#### Equity

Second, because HOT lanes provide paying drivers the opportunity to bypass congestion, some critics have asserted that HOT facilities favor higher income individuals. In spite of this concern, HOT lane usage data show that drivers in all income brackets use and support the facilities.

Local political support plays a key role in building consensus for HOT lane initiatives among the public. Where local constituents are concerned about equity, it is especially important to address in outreach efforts how the proposed HOT project may impact people in dif-

## Existing Public Outreach Resources

Many resources discussing public outreach for transportation projects are readily available, including an existing body of literature addressing public outreach for HOV facilities. Some of these materials include:

- ***Public Involvement Techniques for Transportation Decisionmaking (1996)***  
 It has long been a challenge to grab and hold people’s interest in a project or plan, convince them that active involvement is worthwhile, and provide the means for them to have direct and meaningful impact on its decisions. The FHWA and FTA published the guide *Public Involvement Techniques for Transportation Decisionmaking* in September, 1996 to provide agencies with access to a wide variety of tools to involve the public in developing specific plans, programs, or projects through their public involvement processes. It discusses a wide variety of subjects, including Civic Advisory Committees, Public Meetings/Hearings, Negotiation & Mediation, and Improving Meeting Attendance. This document is available electronically at <http://www.fhwa.dot.gov/reports/pittd/cover.htm>.
- ***High Occupancy Vehicle (HOV) Lane Marketing Manual—DOT-T-95-04 (FHWA), U.S. Department of Transportation, Federal Highway Administration (Sept. 1994)***  
 One of the most comprehensive resources addressing the marketing and outreach needs associated with managed lanes, this 250-page document was produced for FHWA by independent consultants in close cooperation of the Transportation Research Board Committee (TRB) Committee on High-Occupancy Vehicle Systems and other experts. It provides detailed information on all aspects of outreach campaigns, from constituency building, to goals formulation, marketing materials, and media and community relations. It also detailed case studies of both successful and unsuccessful marketing efforts, as well as suggestions for monitoring and evaluating marketing campaigns.
- ***The HOV Systems Manual, NCHRP Report 414***  
 This comprehensive manual is an essential resource for all transportation officials contemplating HOT lane projects. It provides direction to both transit and highway 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. The HOV Systems Manual reflects real-world experiences, addresses all current issues, and promotes consistency and effectiveness in future HOV applications. The manual covers all types of HOV facilities and includes, but is not limited to, the following: policy considerations, planning, design, operation and enforcement, support facilities and services, implementation considerations, marketing, and evaluation. It is available from the Transportation Research Board.
- ***Improving the Effectiveness of Public Meetings and Hearings, Publication No. FHWA-HI-91-006, U.S. Department of Transportation, Federal Highway Administration (January 1991)***  
 This guidebook focuses on the development and implementation of creative and realistic approaches to the preparation, conduct, and follow-up of public meetings and hearings. It introduces a variety of techniques and processes based on the practical community involvement experience and a review of public meeting and hearing materials developed by state highway and transportation departments. It discusses such basic meeting and hearing elements as appropriateness of notification procedures; format; exhibits; handouts; presentations; and meeting conductor or hearing officer.  
<http://ntl.bts.gov/DOCS/nhi.html>
- **Transportation Research Board's Committee on Public Involvement in Transportation**  
 The mission of TRB’s Committee on Public Involvement in Transportation is to enhance the understanding, acceptance and practice of public involvement as an art and science in transportation planning and project development activities by fostering research, identifying best practices, promoting use of new technologies, promulgating standards, and upgrading public involvement skills of transportation professionals. The committee’s website provides a library of technical papers and case studies providing best practices and guidance on public participation techniques and approaches.  
<http://trb-pi.lshassoc.com/>

ferent income ranges. Local officials and public figures who can defuse equity debates with usage data may be more successful project champions.

For example, in June 2001 Governor Parris Glendening of Maryland backed away from efforts to study or implement HOT facilities in Maryland, maintaining that it was “unfair to link an easier commute with a person’s ability to pay; our goal is to ease congestion for all.” The Governor’s decision demonstrates the vulnerability of HOT lane projects to political decision making and underscores the importance of communicating the facts about HOT lanes early and effectively to politicians and other stakeholders.

Section 4.3.6 discusses equity aspects in greater detail.

## 4.2 Project Champions and Their Role

A prominent project champion can be one of the most instrumental factors in garnering support for a HOT facility proposal or its implementation. A public champion may be an elected official, a community leader, or private sector leader who effectively communicates an individual or organizational rationale for supporting the project. Although local departments of transportation, transportation authorities, MPOs will likely serve as HOT lane sponsors, respected public figures who are not transportation professionals can play a critical role by supporting the project.

Public champions may guide the development of HOT lane projects during critical public outreach processes. In some cases, a project champion may also be influential in political processes if the HOT project requires legislative action or if it is debated in public elections. Project champions also act as effective coalition builders for a project, building consensus among different interest groups.

### Multiple Champions

Because HOT lanes often must receive approval at various stages and at various levels of government, it can be advantageous if several individuals champion the project. Some may be successful at building support for the initiative locally, and others may help to make a case for the project to governors, mayors, U.S. representatives and senators.

### Political Champions

Elected officials may emerge as important project champions, making the inclusion of elected officials in outreach efforts important for project planning. When formulating a position on the lane, politicians may consider the project from numerous angles, including its impact on constituents and its effect on local governance and finance. Outreach to elected officials should discuss an array of issues about the proposed initiative, including any impacts that local constituents may experience as a result of the project. Other issues that elected officials may consider when deciding whether to back the project include:

- the disposition of toll revenues;
- increased public spending;
- increased public revenues;
- alternative financing scenarios;
- competing transportation needs;
- competing transportation projects;
- their own political capital; and
- relationships with other officials and political jurisdictions.

### Early Champions

Early involvement by a project champion can be advantageous. A particular group or individual may step forward to express initial interest in and support of the proposal, or project sponsors may seek proactively to identify potential project champions early in the public involvement process. In some cases, champions may come from organizations and interest groups that are non-traditional supporters of roadway projects. For instance, if a HOT lane project promises to deliver environmental

### Road Pricing and Elected Officials

The Transportation Research Board's Variable Pricing Political Outreach Subcommittee has completed a comprehensive study of the relationship between road pricing and elected officials. In 2001, the subcommittee conducted interviews with transportation professionals involved with every road pricing study or implementation project in the United States. Elected officials were also contacted in order to gain an understanding of their reactions and opinions on the 16 pricing projects included in the survey, six of which involved HOT lanes. The following findings are excerpted from the Subcommittee's August 2001 report, "Road Pricing & Elected Officials."

- Political support is key to the successful implementation of variable pricing projects in the United States. All projects that have resulted in actual implementation to date can point to one or more elected individuals that championed the use of pricing as an effective method for addressing the growing gap between transportation demand and the available supply. Many of the projects that have not been successful can point to elected officials that actively blocked project implementation.
- The value pricing concept has gained more recognition and acceptance nationwide, although the understanding that a project works somewhere in the United States does not mean the constituents of a local community will readily accept the concept.
- The issues are similar in most projects, but vary in level of emotion in different locations.
- The importance of educating all stakeholders cannot be understated.... There appears to be a strong correlation between the knowledge of and support for variable pricing projects.
- It appears the best way to assist in the development of political champions and increase the likelihood of success is to communicate with the affected politicians early and often.... This enables officials to understand the concept and shape its application in their community before having to take a position for or against a specific pricing application.

benefits, groups like the Sierra Club or Environmental Defense may lend their support.

#### Identifying Potential Champions

Table 2 highlights some groups whose leaders may play the role of champion, depending on the circumstances of the project. When anticipating responses from different stakeholder groups, it is important to recognize that sup-

port for or opposition to a HOT project may depend on project circumstances. For example, a HOT operation proposed to regulate over- or under-utilization of an existing HOV lane may be received differently by different groups than a proposed new lane addition.<sup>7</sup>

### 4.3 Public Acceptance of HOT lanes: The Issues

During the public outreach process for a proposed HOT facility, certain issues not associated with conventional highway improvements may be of keen interest to the general public and particular stakeholder groups. It is advantageous for project planners to ascertain the concerns of various stakeholders in advance and address them proactively in the public outreach process. The following issues may arise:

- Project Travel Benefits
- Other Travel Impacts
- Project Funding Benefits
- User Fees
- Project Cost
- Social Equity
- Geopolitical Equity
- Disposition of Toll Revenues
- Technology
- Environmental Issues

HOT facility planners and sponsors who consider in advance the range of public concerns and questions that could arise will be better equipped to understand the public's concerns and to take the appropriate actions within the outreach process. The case studies found in Chapter 7 of this document explain the various issues and concerns that have arisen in response to the HOT lane projects and studies they describe.

In addition to the discussions provided in this

<sup>7</sup> The five case studies presented in later in Chapter 7 document the roles that various project champions have played in the development of the HOT lane initiatives described.

manual, HOT facility sponsors may also wish to confer with colleagues in other regions that have pursued HOT lane initiatives. These peer exchanges can provide valuable insight into the issues encountered, the public outreach approach followed, and what might have been done differently in hindsight. FHWA’s Office of Travel Management can help to identify useful contacts. <http://www.ops.fhwa.dot.gov/travel/>. The Hubert Humphrey Institute’s Value Pricing Website, <http://www.valuepricing.org>, also provides comprehensive information on projects utilizing the value pricing concept, including the nation’s four HOT lane facilities.

**4.3.1 Project Travel Benefits**

As with any investment of public funds, constituents and stakeholder groups have an immediate interest in the benefits that a HOT facility may bring. Project sponsors who can discuss the specific advantages anticipated from a HOT facility can more easily communicate the project’s rationale to a variety of public interests. Communicating the projected benefits plays an especially important role in regions where HOT concepts may not be widely known or understood due to their newness.

- **Time Savings:** Travel time savings for those who are willing to pay for it are a hallmark benefit of HOT facilities. Fees for the facility are structured in a way that preserves uncongested traffic service on the facility, ensuring that users will not lose time in traffic jams.
- **Trip Time Reliability:** Because the facility is operated to maintain a certain level of traffic service, users can count on predictable conditions and travel times. Users with personal or professional time constraints or those who simply prefer the peace of mind of a predictable journey will find the facility a great advantage.
- **Trip Choice:** A HOT facility creates a new travel option that a motorist may use or not use, depending on a highly individualized

Group	Why They May Support
Newspaper Editorial Boards Local Media	Media support may come where the project and rationale is well understood and where editorial boards believe the project benefits and deserves support of their readers.
Politicians	Politicians may support if they favor the HOT lanes’ market-oriented approach HOT facility benefits, if they want an innovative project in their district, or if their constituents support the proposal.
American Automobile Association (AAA)	HOT facilities may promise better mobility for their members.
Environmental Advocates	If a HOT project converts an existing general-purpose lane, it could make single-occupant auto travel less attractive.
Taxi Associations	Taxis that use a HOT lane may be able to generate more fares in less time during peak periods.
Transit Agencies; Transit Advocates	In corridors without preferential lane treatment for HOVs or transit, transit operators may support HOT lanes due to transit time savings.
Emergency Medical Service/ Police and Fire Departments	A HOT facility may enable emergency services to respond more quickly to incidents.
Rideshare Agencies, Transportation Management	For an over utilized HOV lane changing from 2+ to 3+ HOT operation, HOT lane tolling Associations may enable the facility to recapture operational benefits.
Employers; Business Groups	Employers and business may support HOT lanes for the potential to make transportation operations more efficient and to reduce delay time.
Developers	Developers may support HOT facilities that enhance access to office buildings, shopping centers, residences or other locations they own.
Neighborhood Associations	Area residents may support the HOT facility if it enhances their mobility and travel options.

decision at the time the trip is made. If under pressure to arrive punctually at the destination, a motorist may choose to use the facility. If time pressure does not influence the travel choice, the motorist may choose the general-purpose lanes. Even when drivers choose not to use the facility, many motorists value having this choice.

**Table 2. Identifying Potential HOT Lane Champions**

- **Enhanced Corridor Mobility:** HOT facilities enable more people to travel through a corridor in fewer vehicles and under better travel conditions. This advantage may interest transportation officials to a greater degree than the public at large, but some local constituents may also appreciate efficiency improvements in the transportation system.

### 4.3.2

#### Other Travel Impacts

In corridors with a HOT facility, drivers seldom choose to make all trips in that corridor on the HOT lane itself. Instead, they will decide to pay to use the facility when they wish to guarantee their trip time or avoid congestion. At other times they may risk congested conditions in lieu of paying the fee to use the HOT lane. Therefore, even regular HOT lane users are still likely to make many of their trips on the parallel free facility or general-purpose lanes.

Accordingly, project planners may use the public outreach process to address how the proposed HOT facility will affect travel conditions for non-users. The travel impacts on adjacent facilities will depend on the nature of the HOT facility itself.

- **New HOT Facility:** Where a HOT facility provides new traffic lanes in a corridor, the facility brings the benefits of any roadway capacity. Studies of the SR 91 corridor show that a diversion of some traffic from the general purpose lanes to the Express Lanes substantially improved peak period travel conditions in the general lanes. Additionally, the addition of the SR 91 HOT lanes also had the effect of shifting some traffic back to the state highway from parallel city streets.
- **HOT Facility Converted from Existing HOV-Lane:** Conversions of HOV lanes to HOT lanes may be contemplated when an existing HOV lane is underutilized. The

conversion can optimize utilization of the managed lane, eliminating motorist complaints about the underutilized HOV facility. The HOV conversion can also enhance travel conditions in the corridor at large.

The new capacity provided by the HOT facility will attract some vehicles formerly using the general-purpose lanes into the HOT lane. This may cause some vehicles to shift from local arterials to the general-purpose highway lanes. In some cases a modal shift from single-occupant vehicles (SOVs) to HOVs or transit may also result.<sup>8</sup> These shifts typically increase overall corridor person-throughput—a benefit that is attractive to transportation professionals and environmentalists alike.

In spite of additional usage, the HOT facility is managed with tolls to ensure that the HOT lane provides premium service for all users. Facility operators may also combine vehicle occupancy requirements with tolls to manage demand, rather than relying on tolls exclusively. This may be attractive when a highly utilized HOV facility is converted to HOT operations.

### 4.3.3

#### Project Funding Benefits

Some constituents and stakeholders will also have an interest in the financial dimensions of the project. One of the primary financial advantages of HOT lanes is their potential to generate revenue.

- **Revenue Generation.** Because HOT facilities impose a fee for use, they have the potential to generate revenue that usually does not exist with conventional roadway projects. Depending on how project sponsors propose to use the revenue, the generated funds can support the timely construction of the proposed facility, the construc-

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<sup>8</sup>A shift from SOVs to carpools or transit would occur if solo-drivers capitalized on reduced rate or free usage of the HOT lane, or if the travel time savings of transit vehicles in the HOV lane attracted solo-drivers to transit.

tion of other transportation improvements in the area, transit needs in the corridor, or other potentially beneficial local investments.

A comprehensive discussion of HOT facility benefits, including their financial benefits, is included in Chapter 1; however, public outreach efforts may begin by working with a shorter list than in Chapter 1. Stakeholders may be unmoved by a long list of alleged advantages if they do not understand how those benefits arise or their value to users.

#### 4.3.4 User Fees

In addition to the potential benefits of revenue generated by a proposed HOT facility, stakeholders will wish to know about the nature of the user fees themselves. Many questions are likely to arise.

**“How much will it cost?”** The public will perhaps have the greatest interest in knowing how much it will cost to use the proposed facility. Because HOT facility fees usually vary depending on the time of day and associated congestion levels, HOT facilities involve an additional dimension for public outreach efforts regarding tolls. Informational materials, public presentations, and news articles discussing the proposed facility can explain its innovative approach to tolls. Project sponsors will need to work not only with community groups, but also local elected officials and area newspapers to ensure that all understand the dynamics of the proposed tolling structure.

**“If the price changes by the time of day, how will I know how much it costs?”** When HOT tolls are based on real time travel conditions, additional public education is needed. Materials and presentations can explain that the current toll will be clearly posted on digital message boards at all entrances to the facility. It is important to communicate that motorists will always be informed of the current toll rate before having to choose to use the HOT facility.

When posted clearly prior to HOT facility entrances, this information allow drivers to decide whether or not to use the facility.

**“Can you tell us now what the tolls will be?”** Although potential users may inquire about the proposed toll amounts, fee schedules are often developed later in the HOT facility’s planning. In earlier planning stages, outreach efforts may discuss the potential range for fees, if appropriate. However, as described in Section 5.3.2, formulating an effective toll schedule often involves marketing surveys of potential users, and final toll levels may be undetermined in early phases. Moreover, once the facility opens, facility operators may have to adjust toll fees in order to control the level of traffic service on the facility. Where a facility uses real time dynamic prices, tolls are posted but no advance toll schedule is used. Project planners can use the public outreach process to describe how fees are established and, where appropriate, to discuss overall ranges for the potential fees.

**“Are drivers paying for premium service?”** The rationale for tolls on a HOT facility is different from that of traditional tolls. Historically, tolls have developed as a means to pay for the construction, operation and maintenance of the roads and bridges where they are collected. HOT facility tolls, however, have an added dimension. The fee paid by HOT lane users not only allows the driver to use the facility, but also ensures the driver will benefit from a high level of traffic service. Public outreach efforts can convey the message that drivers are paying for time savings and trip time reliability.

**“Will I have to wait in line at a toll booth?”** Finally, stakeholders may also raise the issue of toll collection. Manual toll collection is associated by many with long delays at toll plazas; however, high-speed electronic toll collection (ETC) is standard practice on all current HOT lane demonstrations. As a vital component of



### Pricing: A Familiar Concept

Although HOV lanes or toll roads may not exist in a given region, the concept of paying for premium service does. For example, air passengers are accustomed to paying higher fares during high travel seasons when there is much demand for flights. Or, telephone charges are often highest during the day, when there is most demand for placing calls. While drivers may perceive tolls as a cost, many would value travel time savings associated with HOT facility fees. If asked, “Would you pay two dollars to save 30 minutes consistently on your evening commute?” many motorists would answer, “Yes.”

HOT projects, ETC deserves elaboration in the public outreach process. Motorists have a great stake in ETC’s capacity for eliminating delays and making toll collection invisible and easy.

#### 4.3.5 Project Cost

The public may also be interested in the capital construction cost of the facility. They will want to know where the money to build the HOT lane is coming from and whether or not the project will be paid for from the toll proceeds. Project sponsors may wish to introduce a number of facts about the proposed project, including:

- range of cost estimates;
- potential funding sources;
- potential borrowing arrangements;
- anticipated toll revenue; and
- proposed disposition of toll revenue.

#### 4.3.6 Equity

Because HOT lanes create the opportunity for paying drivers to avoid congestion, some critics have charged that the facilities are elitist and serve primarily affluent users at the expense of middle- and low-income motorists. Evidence collected to date, however, suggests that such perceptions may not reflect actual experience. Outreach efforts that to listen to the public’s concerns, address equity questions directly, and communicate experiences from operating HOT

facilities can allay local concerns that HOT project benefits may be enjoyed unevenly.

#### Lexus Lanes?

Actual data on HOT lane use discredit the “Lexus Lane” critique. Studies of the SR 91 Express Lanes indicate a statistically significant correlation between income and frequency of toll lane use.<sup>9</sup> While the data indicate the proportions of commuters who choose the Express Lanes increase with income, commuters of all income levels use the lanes. High income individuals (those with annual incomes greater than \$100,000) utilize the toll lanes at greater rates than lower income individuals, but lower and moderate income individuals also make substantial use of the toll lanes. Although roughly one-quarter of the motorists in the toll lanes at any given time are in the top income bracket, data demonstrate that the majority are low and middle-income motorists. The benefits of the HOT lane are enjoyed widely at all income levels.

Lower income motorists may use the HOT lane periodically, when circumstances dictate that the reliability of their trip time is more important than under ordinary circumstances—for example, when critical appointments loom, or when day care facilities charge fees for late pick-up of children. The same applies to self-employed contractors and other small business people, who must make appointments on time or risk lost business.

#### Geopolitical Issues

Concerns may also arise if a proposed facility appears to favor one geographic region over another. For instance, the location of limited entry and exit points on the HOT facility may be contentious, as all communities may wish to have easy access to the facility. In this case, the

<sup>9</sup> State of California, Department of Transportation, Continuation Study to Evaluate the Impacts of the SR 91 Value-Priced Express Lanes: Final Report, December 2000.

### Public Support for the HOT Lane Concept

As in San Diego, public opinion research conducted around the country demonstrates that the public understands the value of pricing concepts and that a majority of motorists in many congested areas would be willing to pay for improved travel conditions. *These results demonstrate that the public may be more willing than its political leaders to support HOT lane projects.*

#### Minneapolis-St. Paul

In January 2002 a private Minneapolis-based agency completed a random sample of 1000 Twin city adults to investigate public reaction to proposals that would create new sources of revenue for transportation projects. *57 percent of the respondents support having an option to pay a fee to use an uncongested freeway lane when in a hurry.* 24 percent of the respondents strongly supported the concept. As a point of comparison, a well promoted gas tax increase received the support of 52 percent of the respondents, while a sales tax increase garnered a 53 percent support level. These results demonstrate that pricing user fees are a viable option to taxes. Survey organizers were particularly encouraged by the results because an earlier HOT lane proposal was dropped due to the perception that there was no public support for the concept.

#### Lee County, Florida

In Lee County, Florida—an area that has used value pricing as an effective tool in managing bridge traffic across its barrier islands—transportation officials are studying “Queue Jumps.” These facilities would involve elevated ramps or at-grade lanes that would allow paying motorists to bypass congestion for a fee. Tolls would vary by time-of-day or degree or in accordance with congestion levels and would be collected electronically using the county’s existing LeeWay system. Mail-back surveys investigating local residents’ opinion of the concept were distributed to drivers stopped at five intersections in Lee County in February 2002. Residents were also able to download the survey from the Internet. Of 1,739 surveys received, *59 percent of all respondents had a favorable opinion of the Queue Jump concept* (23.5 percent strongly approved). In an off-topic discussion initiated by participants in a follow-up focus group, 100 percent of the participants supported a new north-south tollroad in mid Lee County, which would provide premium service to those willing to pay for it.

#### Seattle

In Seattle both the I-5 and I-90 have auxiliary “Express Lanes” parallel to the mainline highways. These reversible facilities provide extra capacity in and out of Seattle during peak commute hours, and are partially reserved for HOVs. Transportation officials have investigated the possibility of expanding the Express Lane network and making the system available to HOV and paying SOV motorists. A statistically valid telephone survey of 1,161 Puget Sound Region residents in Washington State in May 2001 revealed that *41.4 percent of respondents were willing to pay tolls for faster trips*, with over one quarter of respondents (26.3 percent) indicating they would be willing to do so up to three times per week. Contrary to the notion that only the more affluent would be willing to pay a toll for a faster trip, *the Seattle survey found no statistically significant difference between income and willingness to pay tolls.* Additionally, 48 percent of the respondents supported varying toll rates by the time of day as a means to manage traffic flows.

### Fair Lanes: An Alternative Value Pricing Strategy

In response to equity concerns associated with HOT Lanes projects, transportation professionals in Maryland, Texas, Georgia, and Alameda County in California are studying the Fast and Intertwined Regular Lane (FAIR Lane) concept as an alternative way of implementing value pricing projects. The concept involves separating congested freeway lanes into two sections—Fast lanes and Regular lanes—using plastic pylons and striping. The FAIR Lane approach is different from HOT lanes in that it allows motorists traveling on the Regular lanes to earn credits toward use of the “priced” Fast lanes or transit.

The Fast lanes would provide premium travel conditions and would be electronically tolled, with tolls set in real time to maintain free-flowing conditions. Variable message signs would advise motorists of the toll rate changes. In the Regular lanes, where constricted flows would continue, drivers with electronic toll tags would earn credits that could be used toward future use of the Fast lanes or to fares when they opt to use improved transit service.

With FAIR lane operations, motorists could choose to pay for the premium Fast lane service, or they could choose to remain in congested traffic but earn credits toward the future use of the Fast lane or transit services operating on it.

While the FAIR lane concept has been discussed at seminars and professional meetings, it has not yet been implemented on a specific corridor.

public outreach process is the appropriate forum for community stakeholders, project planners, and politicians to address the issue. The collaborative nature of the public process can be used to identify measures to counter any geographic concerns.

#### San Diego I-15 Express Lane Survey

An 800-person telephone survey of I-15 Express Lane users completed in the summer and fall of 2001 demonstrates that motorists of all income levels recognize the benefits of HOT lanes. The following survey results show that the equity concerns are not shared by actual HOT lane users and other motorists in San Diego:

- 91 percent of those surveyed think that travel time savings options provided by the I-15 Express Lanes are a “good idea”;

- 66 percent of drivers who do not use them support the I-15 Express Lanes;
- 73 percent of non-HOT lane users agree that the HOT lane reduces congestion in the corridor;
- 89 percent of I-15 users support the extension of the Express Lanes;
- The extension of the Express Lanes was the top choice of both HOT lane users and non-users for reducing congestion in the corridor; and
- 80 percent of the lowest income motorists using the I-15 corridor agreed with the statement that, *“People who drive alone should be able to use the I-15 Express Lanes for a fee.”* Despite equity concerns that have been raised in locations without HOT lanes, low income users in San Diego were more likely to support the statement than the highest income users.

As demonstrated by surveys conducted in Washington, Minnesota and Florida, a majority of motorists in many congested areas would be willing to pay to avoid congestion, with no statistical correlation evident between income levels and willingness to pay.

#### 4.3.7

#### Disposition of Toll Revenues

Because HOT lanes produce revenues, a number of policy questions and administrative issues come to the fore. Depending on the locale, community stakeholders and elected officials may have a keen interest in how the toll revenues will be spent. Some communities may be more accepting of the facility if the generated revenues are used only for a dedicated purpose or a specific initiative, while other communities may support using the fees to support the general fund.

Some HOT lane projects have sought to use revenues first and foremost to pay for implementation and administration of the lane. The

disposition of surplus or net revenues then becomes a question for project sponsors.

In project applications to date, HOT toll revenues have been used to:

- back bonds issued to fund construction of the HOT lane facilities;
- pay for operation of a HOT lane facility; and
- fund transit services in the HOT corridor or the region.

#### 4.3.8 Technology Concerns

Electronic toll collection has grown increasingly common in the United States, known in different regions by names like E-Z Pass and FasTrak. Nonetheless, project planners should not assume that the public is familiar with this new technology. Public outreach efforts provide various opportunities to introduce the proposed toll collection technology to potential users. Project sponsors need to explain how the proposed ETC system will work, including the role of an electronic transponder, the function of HOT facility entry and exit gantries, the administration of pass-holder accounts, and the protection of individual privacy. Privacy is a key concern commonly associated with ETC systems. Outreach materials should address this issue and provide detailed information on the mechanisms used to protect the privacy of motorists' movements, as well as their financial and credit card information.

Additionally, once the HOT lane is unveiled, the initial performance of the ETC system will be of paramount importance. If toll collection snags occur during the project's launch, users may be unforgiving.

#### 4.3.9 Environmental Concerns

Finally, it should be recognized that HOT lanes are likely to provide environmental advantages by eliminating greenhouse gases caused by stop-and-go traffic, and by encour-

#### Project Spotlight: I-15, San Diego, California

The I-15 HOT facility in San Diego offers an example of an HOV lane conversion that included transit improvements. The original HOV lanes were funded partially with transit monies, and project sponsors sought to launch an express bus as part of the pricing program. Today, I-15 FasTrak revenue funds the Inland Breeze bus service in the HOT lane corridor. FasTrak revenue pays for roughly \$430,000 per year in operating costs and \$60,000 for facility enforcement provided by the California Highway Patrol. State law requires the remaining revenue to be spent improving transit service along the I-15 corridor. This innovative arrangement played a large role in the political acceptability of the project, and it is one way to address transit concerns when a HOT project involves an HOV-lane conversion and when the support of local transit authorities and other officials for the HOT lane is important. By dedicating all or a portion of HOT lane revenues to local transit services, a project may be perceived as more equitable and win greater approval.

#### Ensuring Personal Privacy

Although electronic toll collection has proven very popular among drivers, some perceive the electronic tracking of vehicles as an invasion of privacy. Tolling agencies have addressed this issue by linking the transponder with a generic, internal account number that does not reveal the driver's identity. Driver information is not disclosed to other organizations. Public outreach efforts can generate confidence in the technology by explaining to the public how their privacy is protected with these systems.

aging people to use carpools and mass transit, thereby reducing the number of cars on congested corridors. In addition, the conversion of existing HOV facilities to HOT operation involves limited amounts of new construction, limiting environmental concerns associated with the construction of additional lane capacity.

As with any transportation improvement, outreach activities should include clear information on the environmental effects associated with the HOT lane projects. Environmental advocates are likely to support HOT lane initiatives and, when given the right information, have the potential to become important project advocates garnering additional support for new HOT lane projects.

## 4.4 Building Political Consensus

Public outreach efforts establish meaningful processes for public participation in the planning and implementation of transportation projects and ensure that the different stakeholders have a voice in the planning process. This enables diverse interests involved to arrive at a transportation solution that is broadly accepted and beneficial.

As discussed earlier in Section 4.2, the backing of political champions is often an essential element in building political consensus. Greater involvement by local and regional officials and stakeholders, in early planning stages and onward, may increase the effectiveness of public outreach efforts for HOT lane facilities. Including a broad spectrum of stakeholders in the public outreach can be critical. In many cases, a single decision maker, such as a governor or mayor, may be in a position to derail or bolster the proposed HOT project. Greater involvement by local business leaders, community groups, and other public officials in project planning helps to ensure that key decision makers will consider the broad range of interests when they take a position on a proposed HOT project.

In using the public outreach process to build consensus, planners may attempt to anticipate the concerns of specific interest groups. An understanding of what aspects of HOT projects may be more or less attractive to different groups can be valuable to project sponsors. Certain stakeholders and interest groups with a defined agenda may support or oppose HOT lanes depending on their priorities, and some groups may feel differently from others about the proposal depending on how their town or county may be affected by the project. When sponsors understand constituents' concerns, the public outreach process can be tailored to ensure that those issues are addressed and to discuss how those concerns will or could be accommodated within the proposed project.

Existing experience suggests the following are key objectives for successful consensus building activities:

- Identifying and coordinating with affected jurisdictions and agencies;
- Cultivating project champions; and
- Employing stakeholder advisory committees.

### 4.4.1 Stakeholder Coordination

In reaching out to local communities; political groups and organizations; elected officials; and neighboring cities, town, and counties, project planners should include all potential stakeholders. No segment of a community likes to be left out or surprised, and early efforts at inclusiveness will help to establish channels of communication at the outset of a HOT project.

#### Potential Stakeholders

As a first step, project planners should identify the various stakeholders who will be impacted by or may have an interest in the project. Ensuring Personal Privacy. Although electronic toll collection has proven very popular among drivers, some perceive the electronic tracking of vehicles as an invasion of privacy. Tolling agencies have addressed this issue by linking the transponder with a generic, internal account number that does not reveal the driver's identity. Driver information is not disclosed to other organizations. Public outreach efforts can generate confidence in the technology by explaining to the public how their privacy is protected with these systems.

- local residents
- neighborhood groups and associations
- elected officials
- neighboring counties, municipalities, or towns
- associations of governments
- metropolitan planning organizations
- area businesses
- chambers of commerce
- tourism representatives

- developers
- local and state departments of transportation
- local and regional transportation providers
- local and regional transit providers (public and private)
- local and regional tolling authorities
- rideshare coordinators
- public agencies (for land use and air quality)
- emergency service providers
- environmental groups
- transit rider groups
- automobile clubs
- taxi associations
- labor interests
- trucking interests
- newspaper reporters
- newspaper editorial boards
- think tanks

### Sharing Information

Keeping the variety of stakeholders well informed during the initial project planning, review, implementation, and operation is important for consensus building. Project planners and spokespeople can use a variety of methods to keep stakeholders involved and informed. These may include:

- advance notice for public meetings;
- public meetings;
- brainstorming sessions/group problem solving;
- newsletters;
- e-mail lists;
- walk-in office/customer service center;
- telephone information/service line; and
- project websites.<sup>10</sup>

<sup>10</sup> See for example: <http://www.hou-metro.harris.tx.us/services/quickride.asp> (Katy Freeway); <http://argo.sandag.org/fastrak/> (I-15 FasTrak); <http://www.91expresslanes.com/> (SR-91 Express Lanes); and <http://www.valuelanes.com/-index2.html> (I-25 corridor in Denver).

Stakeholder coordination should continue throughout project implementation. Ensuring that technical work does not outpace constituency building is a prudent approach that keeps state, county and local politicians informed of project activities on a regular basis.

### 4.4.2 Citizens' Advisory Committee

One option for formalizing public participation is through a citizens' advisory committee. Such committees can be effective outreach tools and they may be particularly useful for HOT lane initiatives. Participants can be drawn from a variety of groups in the early planning stages, and the committee can help guide the public outreach process through later phases of planning and implementation. The group can be an important resource for identifying issues that outreach efforts should address and for connecting project sponsors with area community groups and other organized stakeholders. An advisory committee can also help to identify and recruit political champions.

## 4.5 Marketing and Refining the Concept

Ultimately, the success of a HOT facility will depend on drivers who are willing to pay to use it. In fact, some HOT facilities refer to users as subscribers, pass holders, or customers, indicating that the HOT facility has a clientele and that drivers generally must acquire an electronic tag for automated toll collection in order to use the facility.

Because HOT facilities are generally constructed within or parallel to existing roadways, drivers in the corridor may choose which facility to use: the general-purpose lanes or the HOT facility. HOT project planners thus face a challenge that is unique in highway facility planning: to cultivate users for the facility. Most highway or transportation officials traditionally have not had to advertise or market their facilities, but marketing is an important element of

### When to Market?

Although marketing is often perceived as advertising a final product, HOT facility marketing is not a one-time venture. Marketing efforts will be more productive if they are employed well in advance of the facility's opening and if they continue even once the facility begins operation. Early marketing studies provide important opportunities to gauge the HOT lane's potential for success, as well as to improve the project's chances of success. From the earliest planning phases, multiple marketing opportunities exist to gather information from the public about potential usage and to provide information to the public about the proposed facility. Marketing efforts in later project phases, even after operation has begun, can assess user satisfaction and attract additional users.

HOT projects. For this reason, some transportation agencies developing HOT lanes have sought the services of marketing professionals, including surveying and advertising firms.

The marketing aspect of HOT facility planning is directly related to project feasibility. Marketing efforts can address how and why drivers may opt to acquire a user tag and HOT facility account, and under what circumstances they will choose to use the HOT facility for a given trip. After the facility is operating, marketing techniques can be used to increase the number of users, address customer satisfaction issues, and to keep drivers well informed of any planned operational changes.

At various phases of the HOT lane implementation process, project marketing efforts may need to focus on different issues. Although the basic marketing objectives outlined below follow a general chronological evolution, the answer to later questions may draw heavily from what is learned during earlier marketing efforts.

#### Learning About the Public

Learning about project stakeholders will provide a foundation for the entire outreach process. Determining the level of awareness of and knowledge about HOT lanes by different groups will provide direction for HOT lane marketing initiatives and parallel public out-

reach efforts. For example, an initial survey of area households could gauge public knowledge of the HOT concept, public attitudes towards value pricing, and public preferences and behaviors. Such a survey could identify what and how much education is needed, and how current HOT educational efforts could be tailored to meet public needs.

#### Determining the Market

One of the most important issues that must be addressed in the early planning phases for HOT lane projects is determining the market and overall feasibility of a proposed project. What corridors and origin-destination pairs would be appropriate for the HOT lane facility? Who might use the HOT facility under consideration? What factors might make a driver more or less willing to pay to use the facility? Where should access points be located or how should toll collection be managed? When this market exploration is done properly, project planners are more likely to design a HOT facility that the public wants to use. These inquiries also supply technical experts with the information necessary (i.e., volume and revenue assumptions) to assess the fundamental feasibility of different project alternatives.

#### Publicizing the Facility

Once a facility has been approved and is under construction, project planners may turn their focus to publicizing the coming facility. Some project sponsors have relied on direct mailings to potential user households. Radio and other media advertisements have also been used. Press releases announcing the new facility may draw coverage in local and regional newspapers, and many HOT facility sponsors have also launched dedicated websites providing information and applications for using the facility.

#### Maintaining Customers and Attracting New Users

Once a HOT facility is operational, maintaining communication with the public must be a priority. Facility managers need to know

whether current customers are satisfied with the facility and related services, and communicate with users when any facility changes are anticipated. For example, within one year of opening, a facility may require adjustments to the toll schedule to manage current traffic levels. Established lines of communication with customers can be used to describe what changes are anticipated and why they may be necessary. Some facilities have relied on regular newsletters, and websites with customer updates are also popular. Continued marketing is also relevant in efforts to increase the number of facility users.

**Marketing Tools**

Marketing professionals offer a range of services and methods for reaching the public to meet the needs of HOT facility planning. The following list, while not exhaustive, provides various examples of marketing tools that may find application in HOT lane planning, implementation and operation:

- telephone and paper surveys;
- focus groups;
- direct mailings;
- project websites;
- project newsletters;
- radio and television ads; and
- newspaper coverage.

Figure 4 shows informational materials developed for the I-15 in San Diego, while Figure 5 provides screen capture of the SR 91 Express Lanes Homepage.

**Media Relations**

Although media outlets are not stakeholders in the conventional sense, they belong among the list of contacts that warrant inclusion in public outreach efforts. Establishing media relationships early on in a project can help to ensure the facts about the proposed project are publicized. A variety of media relation strategies are identified in the HOV Marketing Manual.

**Figure 4.**  
I-15 brochures



**Figure 5.**  
SR 91 website



## 4.6 Towards Consensus

Ultimately, the goal of a public involvement program in support of the HOT lane concept is to achieve consensus on a program of action. While one segment of the population may strongly favor HOT lanes, another segment may feel it derives little benefit from the pro-

posed facility. As with any proposed transportation improvement, HOT lanes may have documented potential for technical and operational success, but may not find unanimous approval among constituents in the corridor.

Stakeholders may possess a range of opinions about the HOT facility, but consensus on a course of action is more likely if the public has been engaged in all the issues and if stakeholders agree upon the following:

- A serious congestion problem exists and should be addressed. Conventional solutions like adding additional lanes, building transit facilities, or applying short-term or site-specific TSM strategies may not be sufficient.
- Travel time reliability in the corridor is desirable.
- Given the sponsoring agency’s mission, it is the right entity to address the situation.
- The sponsoring agency’s approach and proposed solution to the problem is reasonable, sensible, responsible, and fair.
- The sponsoring agency listens to and cares about local stakeholders.

### Achieving Consensus: Key Objectives for the Project Sponsor

Project sponsors that manage inclusive, responsive and effective outreach to stakeholders establish their own legitimacy and the legitimacy of the technical analyses, decision-making, and public processes that support project implementation.

Be Responsive	Be Effective
Get to know all the potentially affected interests	Nurture and protect credibility
Understand the project from their perspective	Have all communication received and understood by appropriate potentially affected interests
Identify all the relevant problems	Receive and review all the information needed to understand the potentially affected interests
Generate solutions	Search for common ground among polarized interests who have conflicting values
Articulate and clarify all key issues	Mediate between conflicting interests
Mediate between conflicting interests	

# Chapter 5

## Technical Issues

### 5.1 Design

When HOT lanes are implemented at the corridor level, design issues are driven by whether or not existing lanes (HOV or general-purpose) can be converted to HOT use or if new lanes must be constructed. The physical design and construction of the lanes is very similar to that of any highway improvement. As with general-purpose lanes, the construction of HOT lanes involves utility coordination and relocation, the installation of drainage systems, earthwork, paving, the construction of ramps, overpasses and bridges, and adding appropriate signage and striping. In some cases new lanes can be built within the median of the existing highway. In others, new right-of-way may be needed. In either case, modifications to existing structures, signs, and barriers are likely.

As expected, the conversion of an existing general-purpose or HOV lane to HOT lane use is less complicated. The pavement is already in place, and it is likely that little or no additional widening or right-of-way acquisition would be necessary. However, in order to maintain premium traffic service levels and discourage toll violations, HOT lanes generally require access control.

Current HOT lane projects have used traditional highway design standards and HOV guidelines maintained by AASHTO, state DOTs, and local governments. As shown in Table 3, the basic cross-section requirements of HOT lanes are similar to those of general-purpose and HOV lanes. As with HOV lanes, when adequate right-of-way is available HOT lanes are often placed in the median of an existing highway. The development of additional lane capacity within existing highway corridors inevitably requires extensive retrofitting and it is not likely to be possible to achieve desired standards in all circumstances. When this is the case, tradeoffs need to be assessed on an individual basis.

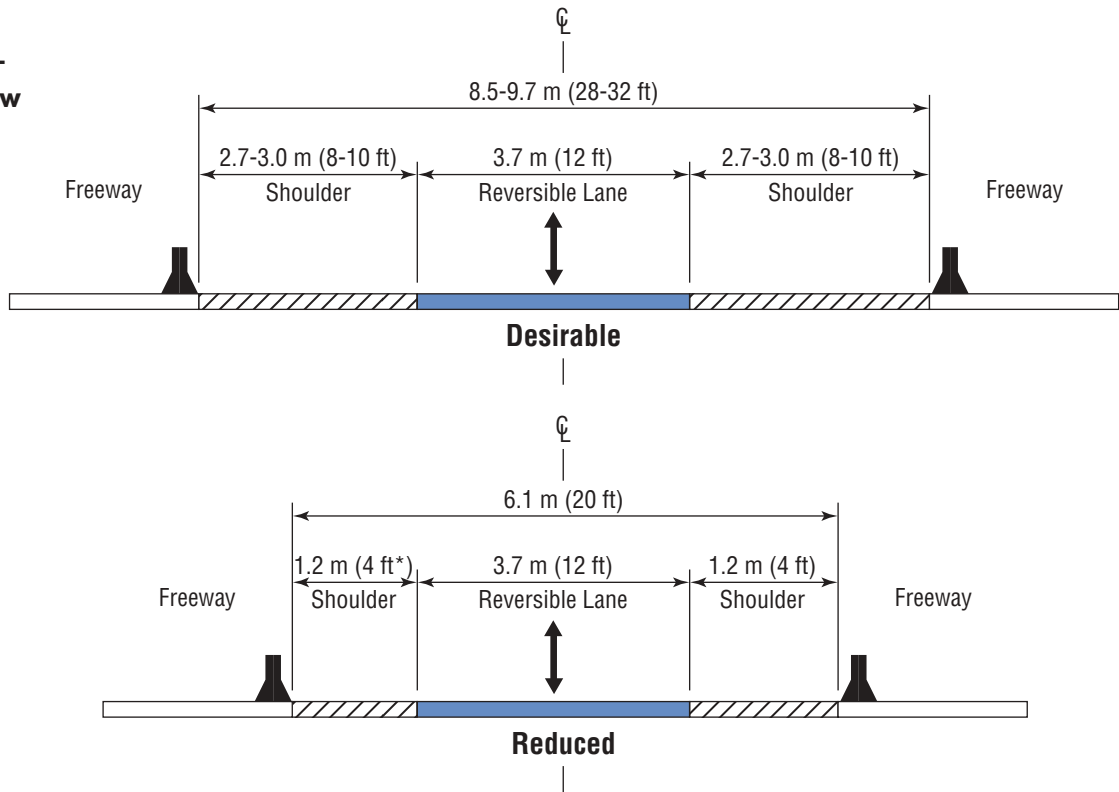
The physical configuration and operation of HOT lane installations varies greatly and is driven by travel demand and physical constraints. HOT lanes are generally located in the median of a new or existing highway. They may involve single or double lanes operated on a reversible-flow basis or one or two lanes providing continual service in each direction. Typical cross-sections for these typical configurations are provided in the figures below.

Figure 6, 7, and 8 provide representative cross-sections for concurrent-flow and reversible-flow HOT lanes. These dimensions are reflected in guidance found in NCHRP 414, HOV Systems Manual and correspond to current practice for many HOV lane treatments nationwide. Figure 6 shows cross-sections for a single

Cross Section Element	Standard
Lane Width	12 feet, 3.6 meters
Shoulder Width (Right and Left)	10 feet, 3.0 meters preferable 2 feet, 0.6 meters minimum (dependent on number of lanes, type of operation, sight distance)
Separation Width (for non-barrier separated operation)	4 feet, 1.2 meters
Sight Distance	Standard stopping sight distance for facility type
Safety considerations	Crash attenuation for exposed barrier ends Transition treatments with HOV or general purpose lanes Adequate access opening lengths

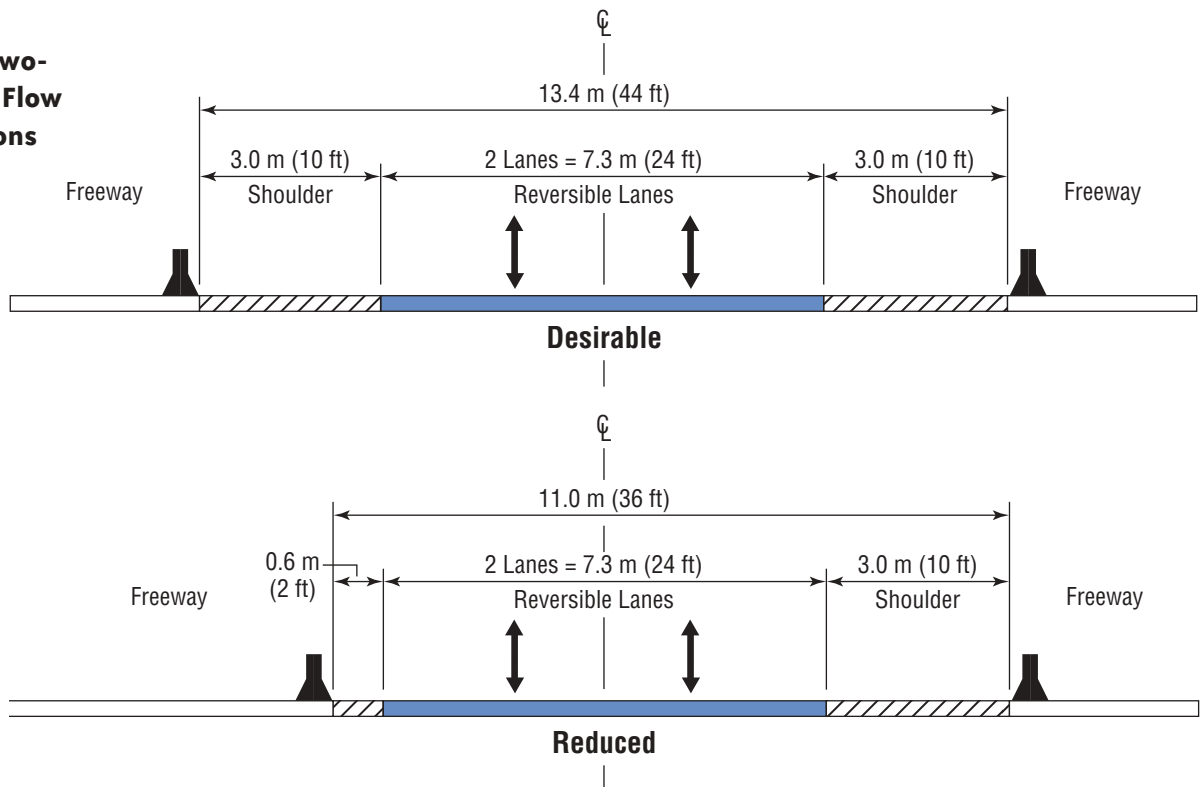
**Table 3.**  
**HOT Lane Cross-Section Standards**

**Figure 6.**  
**Median-Based One-**  
**Lane Reversible Flow**  
**HOT Cross-Sections**

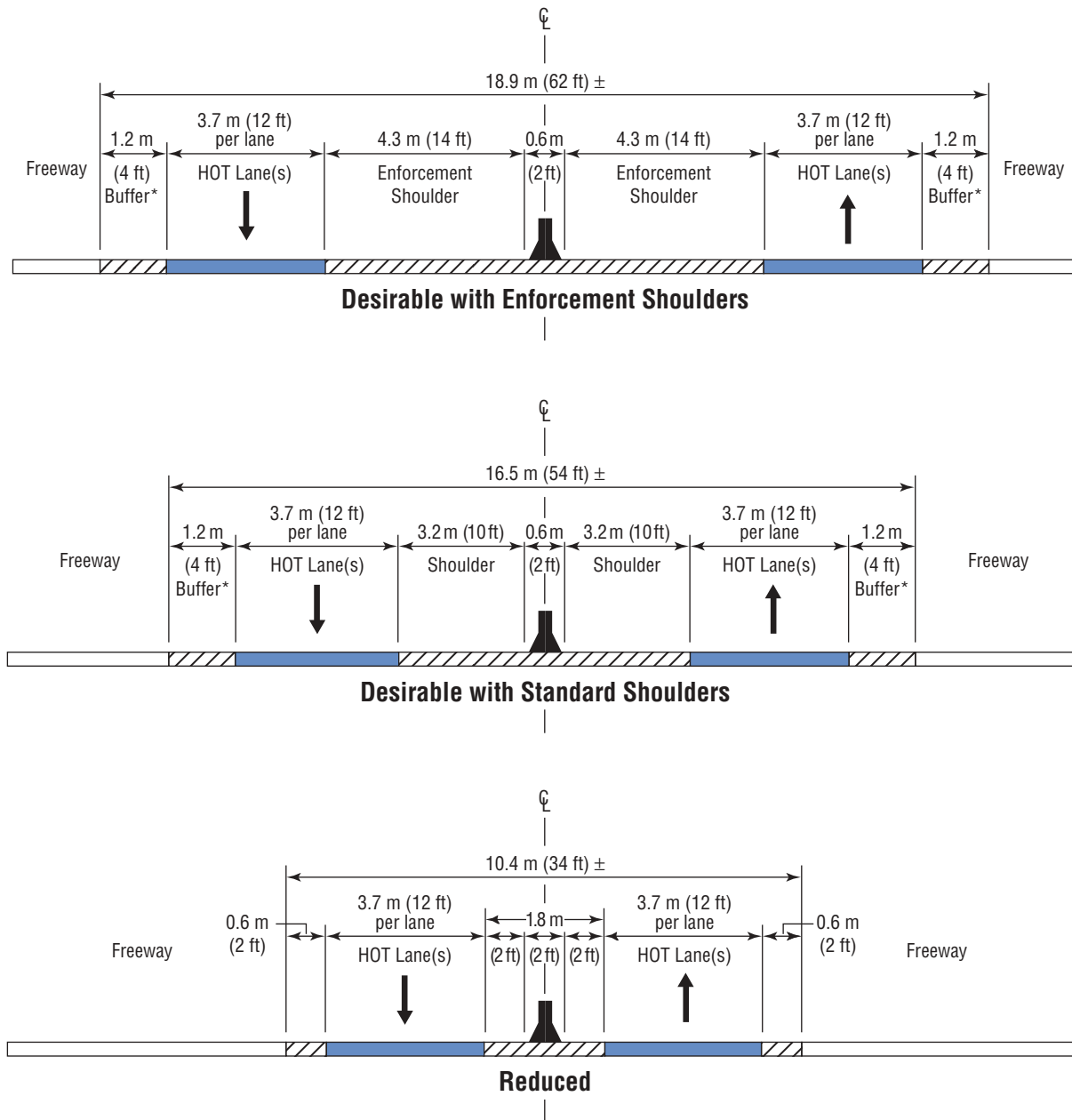


\* Lateral clearance may be combined to provide a dedicated 2.4 m (8 ft) shoulder on one side or the other, or a 7.3 m (24 ft) envelope may be striped with two 3.7 m (12 ft) travel ways with traffic always operated to the right of the center stripe

**Figure 7.**  
**Median-Based Two-**  
**Lane Reversible Flow**  
**HOT Cross-Sections**



**Figure 8.**  
**Median-Based**  
**Concurrent Flow HOT**  
**Cross-Sections**



\* Buffer area may include permanently placed pylons or traffic channelizers

lane reversible HOT facility located in the median of an existing highway, such as the existing Katy Freeway HOT lane in Houston. Figure 7 provides similar information for a two-lane, reversible flow, median HOT facility similar to that found on the I-15 in San Diego. Finally, Figure 8 shows typical cross-sections for a four-lane concurrent flow HOT facility similar to the SR 91 in Orange County, California. Regardless of the number of lanes being considered, lane widths are typically 3.6m (12 feet) wide. Shoulder widths range from a desired width of 3.0 meters (10 feet) to 1.2 meters (4 feet). Shoulders suitable for use by enforcement officials generally require a width of 4.3 meters, or 14 feet.

The design of most HOT lane projects is dominated by the issues of access to the HOT lane

and the physical separation of the HOT lane from general-purpose lanes. The HOT lane facilities currently in operation in the United States utilize either concrete barrier or pylon separation and have single entry and exit points. Tolls are collected electronically at the access point. However, studies have been undertaken identifying ways to provide additional access points in intermediate locations. As shown in Figure 9, this would be accomplished using slip ramps equipped with tag readers located on gantries downstream of the access points. A variety of different buffer and weaving lane configurations would be possible. Figure 10 illustrates how intermediate access can be provided for a concurrent-flow HOT lane with ability to provide occupancy enforcement in the vicinity of each electronic tag reader site.

The following sections focus on these aspects of HOT lane projects, as they present issues that are not likely to arise during the design on general-purpose highway lanes. Discussions of specialized signage and toll plaza requirements are also provided.

### 5.1.1 Separation

As discussed above, HOT lanes can be provided in a variety of configurations. However, in all cases they must be separated from the general-purpose lanes. As with HOV lanes, this can be accomplished by using a painted stripe or buffer zone, or a physical barrier. Physical barriers are preferred for permanent HOT lane installations as they provide better access control and are more effective at reducing violations and maintaining premium traffic service. Since there are often high speed differentials between the general-purpose lanes and HOT lanes, physical barriers also help maintain safety by preventing potential violators from crossing the buffer into the HOT lanes and disrupting the traffic flows.

### Useful HOV Resources

Given the extremely close overlap between the physical design of HOT and HOV lanes, those seeking detailed information on the physical design of HOT lanes are directed to take advantage of the wealth of existing information on HOV design.

There are several excellent resources providing detailed information on the design of managed lanes. Two of these are described below. Others are cited in Appendix X of this report.

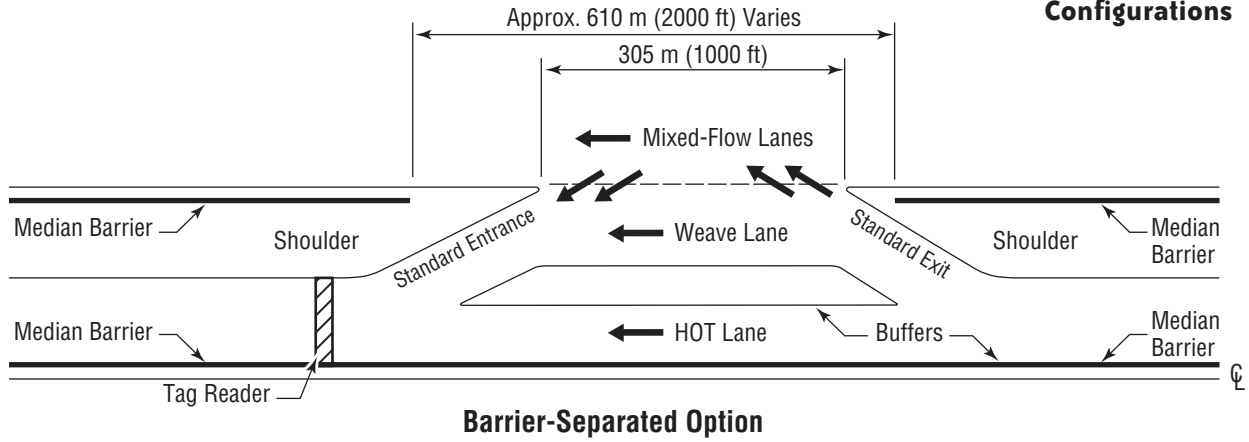
*HOV Systems Manual*, National Cooperative Highway Research Program (NCHRP) Report 414, Transportation Research Board, National Research Council, National Academy Press: Washington, D.C. 1998.

Chapter 6 of the NCHRP report addresses design issues for managed lanes built within existing highways and in separate rights of way. The manual discusses the design features of barrier separated, concurrent flow, and contraflow managed lanes, as well as multiple access treatment. Sample cross-sections, signing and pavements markings are presented.

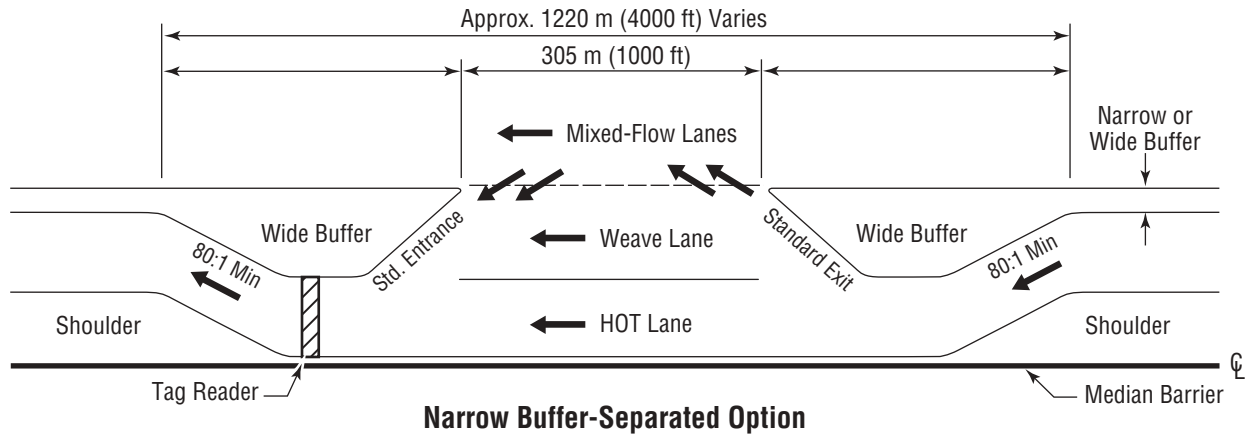
Fuhs, Charles A., *High Occupancy Vehicle Facilities: A planning, Design, and Operation Manual*, New York: Parsons Brinckerhoff, December 1990.

Also an industry standard, the Fuhs manual is organized in three main sections paralleling the decision making process for implementing managed lanes: planning, operation, and design. Among other areas, the design section provides comprehensive information on cross-section requirements for various configurations, enforcement, signing and pavement markings.

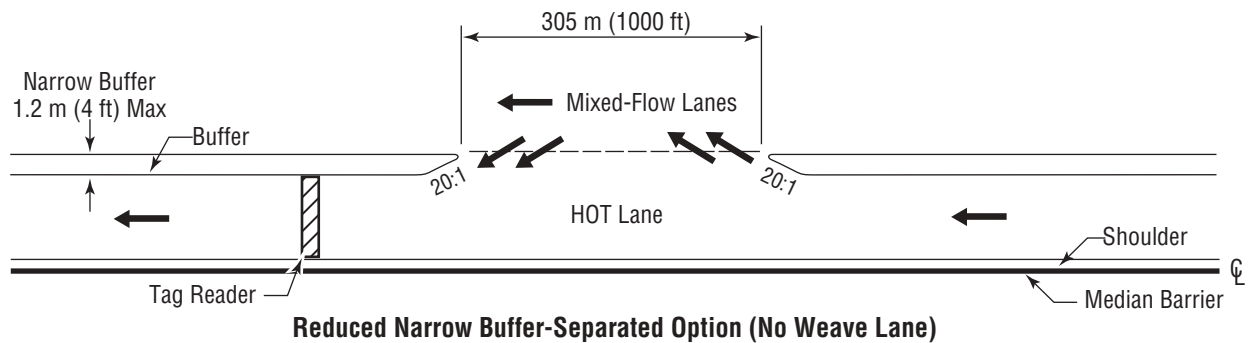
**Figure 9.  
Alternative HOT Lane  
Slip Ramp  
Configurations**



**Barrier-Separated Option**

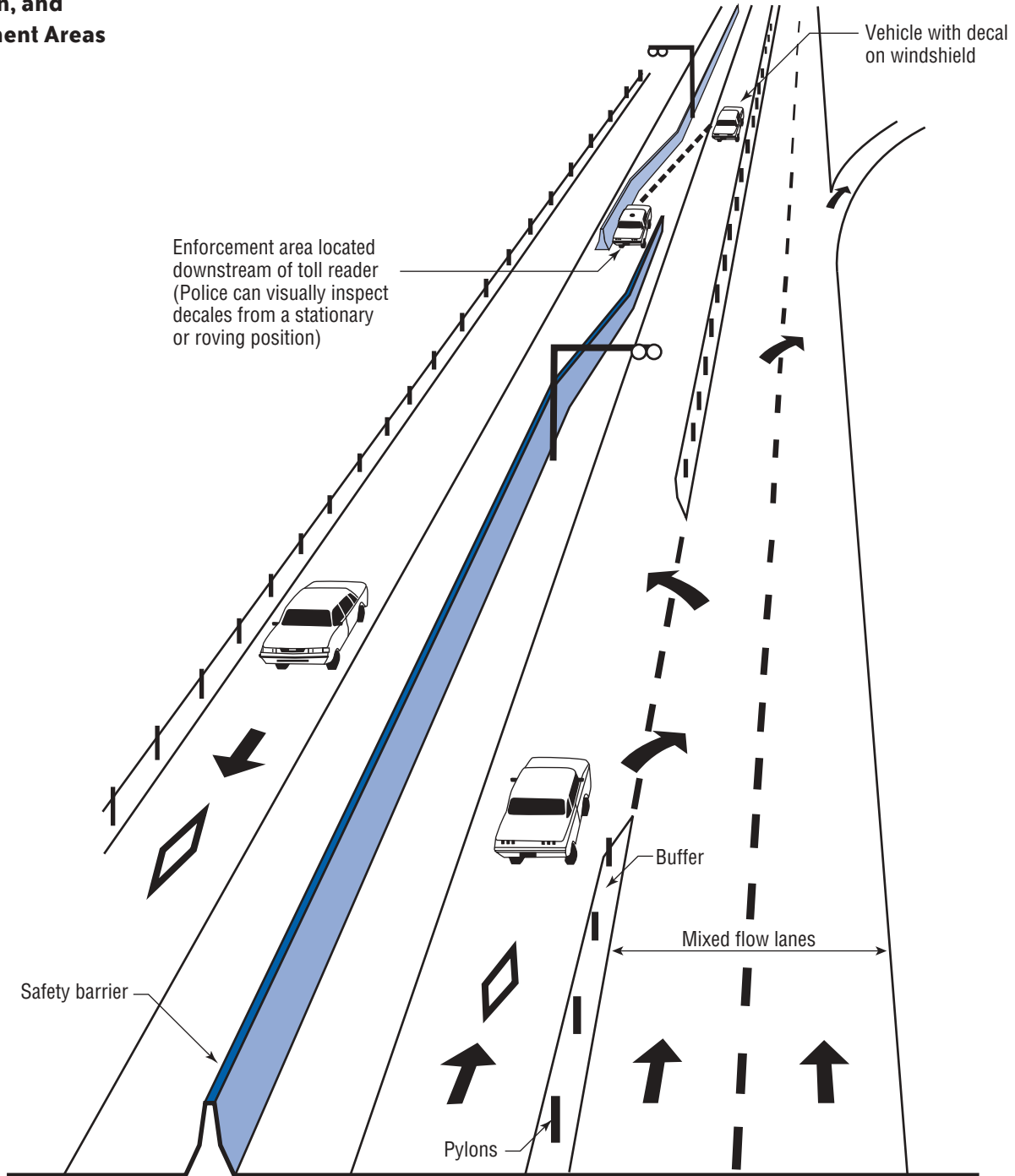


**Narrow Buffer-Separated Option**



**Reduced Narrow Buffer-Separated Option (No Weave Lane)**

**Figure 10.**  
**HOT Lane Access,**  
**Electronic Toll**  
**Collection, and**  
**Enforcement Areas**



### Tubular Markers

Tubular markers, pylons, or stanchions provide another separation option for HOT lanes.

They consist of a series of painted lightweight plastic tubes approximately three feet in height placed at regular intervals. Because they rise vertically out of the pavement, they perform a greater psychological function than striping alone, but do not provide the physical protection of a continuous barrier. One of their primary advantages is that they require a narrower swath of right-of-way than continuous barriers and, therefore, are less expensive to install.

Tubular markers do not entirely eliminate cross over traffic, but they reduce violations to an acceptable level. One primary advantage to the markers is that they do not add to right-of-way requirements. They also allow emergency and maintenance vehicles to drive over them to take advantage of the higher travel speeds in the HOT lane. However, the cost of regular (daily) maintenance must be weighted against those of other separation methods.

Based on the experience of HOV programs in California, 20-foot spacing between pylons is recommended.<sup>11</sup> In addition, it is also recommended that a minimum 18-inch striped buffer zone be provided on each side of the pylon. This approach has been used on the SR 91 Express Lanes, where a double yellow line separates the outer general-purpose lane from the pylons and inner yellow line and outer white line are used on the HOT lane side of the markers (Figure 11).<sup>12</sup>

There are three tubular marker systems currently used by DOTs around the United States:

<sup>11</sup> *High Occupancy Vehicle Facilities: A Planning, Operation, and Design Manual*, Parsons Brinckerhoff, 1990

<sup>12</sup> This is contrary to MUTCD striping requirements, which stipulate that yellow stripes should be used to separate flows in opposing directions and white stripes to separate those in the same direction.



**Figure 11.**  
Tubular markers on SR 91

- individual plastic pylons attached to the roadway with adhesive;
- pylons affixed to a mountable plastic raised curb; and
- electronically operated pylons that retract into the ground.

### Mountable Curb Markers

Mountable curb markers feature a 10- to 12-inch-wide, four-inch-high curb that supports vertical round or flat markers with reflective sheeting. The markers themselves are reboundable and bounce back into place if they have been hit. The markers do not damage vehicles crossing them, but do make a loud banging noise. The mountable curb markers are designed to enable emergency vehicle access and to stand up under winter conditions.

Although mountable curb markers are used by many highway departments to maintain traffic around construction sites, they have not been widely tested in high speed lane separation situations.

### Retractable Markers

In addition, automatically retractable marker systems are available, such as found on the I-5 in San Clemente, California and on the New York Thruway near Albany. The retractable pylons utilize flexible channelizing posts housed in self-contained cartridges recessed in the roadway and can be raised or lowered from a remote location as needed. One advantage of



the retractable technology is that the pylons could be lowered during snow removal operations or to provide access for emergency vehicles. However, at a cost of \$25,000 for eight units they are expensive. They also require minor excavation at each post and the installation of electrical wiring beneath the roadway.

#### Maintenance Issues

There are maintenance issues associated with all types of pylons. Experience shows that the displacement rate for traditional pylons is roughly 10 percent every 60 to 90 days, which means that all units would need to be replaced every year. Although generally durable, the adhesive-mounted plastic pylons can only be hit a certain number of times before they cease to bounce back up. They can also be hit with such force that the units dislodge from the pavement, pulling out pieces of asphalt with them. The New York Thruway Authority has used pre-drilled holes in the pavement to attach pylons in an effort to prevent pavement damage, but found the loss ratio to be the same as for the glued units.

Similarly, the mountable curb pylons are often damaged on impact, but their replacement rate is 10 to 15 percent per year, which is less than for adhesive-mounted pylons. Because the mountable curb pylons have a much better

success rate in this area, there would be fewer replacement and maintenance concerns. For both types, the plastic pylons tend to turn black in color from the tires of vehicles that strike them. The cost of the traditional pylons is approximately \$60 per unit. Therefore, depending on spacing and frequency of replacement, both the capital and maintenance costs are high for tubular barriers. Moreover, retractable pylons require considerable maintenance to remove debris and provide for their operability. As with other systems they require replacement after a number of hits at a slightly greater cost (due to their design).

Snow removal is also an issue in many locations and presents two problems when pylons are used. As the snow is plowed, it is pushed into the adjacent lane because of the lack of a physical barrier. This means that the adjacent lane is not properly cleared. Also, snow removal equipment often damages pylons, either by plowing snow onto the posts or by hitting them.

#### Continuous Barriers

Continuous concrete barriers, such as Jersey barriers or movable barrier systems, are a more permanent and durable type of barrier and have been used for separation on a number of managed lane facilities around the country (Figure 12). They are also preferable from enforcement and traffic service perspectives as they prevent unauthorized vehicles from entering the managed lanes. In addition, they provide enhanced safety and are essential if reversible flow operations are being contemplated.

On the negative side, the presence of continuous barriers is likely to increase response time for emergency vehicles and may hinder emergency response operations in the HOT lane. Concrete barriers can also complicate snow removal, unless sufficient storage reservoirs are provided in the shoulder. Exposed barrier ends at access points should also be buffered to protect motorists.

**Figure 12.**  
Concrete barrier on  
I-394 reversible lanes,  
Minneapolis



The installation of concrete barriers usually requires roadway modifications, as ample shoulders are needed. Based on AASHTO standards, a minimum four-foot shoulder is required between the HOT lane and the barrier, while a 10 foot shoulder is preferred between the general-purpose lane and the barrier.<sup>13</sup> Including the barrier itself, a total width of 18 feet (12' lane width + 4' shoulder + 2' barrier) is recommended between a barrier-separated HOT lane and the adjacent general-purpose lanes. Figure 12 shows the concrete barriers separating HOT lanes on I-394 in Minnesota, together with the associated striping and shoulders. Because of their right-of-way requirements, continuous concrete barriers are more costly to build than other separation options. However, maintenance costs are low in comparison.

### 5.1.2 Access

Access to a HOT lane facility, and the extent to which it is controlled, is a fundamental issue in designing and operating any HOT lane project. There are important cost, operational, safety and enforcement trade offs associated with the different levels of access control. As described below, there are two general approaches to providing access to managed lanes: restricted at-grade access, and grade-separated access.

#### Restricted At-grade Access

Restricted at-grade access to either striped or barrier separated HOT lanes is provided by slip ramps leading to openings in the barriers or stripes. The slip ramps provide acceleration and deceleration space for vehicles moving in or out of the HOT lanes which can be used together with barrier openings to provide acceleration/deceleration lanes in the merge area. Slip ramps, or some variation thereof, currently provide access to many HOV managed lane and general highway facilities around the



**Figure 13.**  
I-15 HOV lanes with slip ramp, Orange County, California

United States, such as the HOV lanes in Los Angeles and Orange County, California, shown in Figures 13 and 14. I-5 provides an HOV lane in each direction and restricts access across a four-foot buffer area. The I-405 provides one HOV lane in each direction and access is similarly limited to breaks in that buffer.

Acceleration/deceleration lanes are provided in the example in Figure 14. The locations of the barrier openings and slip ramps needs to be closely coordinated with highway entrance and exit ramps and allow adequate room for motorists to complete weaving movements when moving between the general-purpose and HOT lanes and an entrance or exit ramp.

Caltrans recommends a buffer/barrier opening of at least 1300 feet, and a weaving distance of at least 1,000 feet per lane between the upstream and downstream ramps and the opening.<sup>14</sup> For planning purposes a buffer opening of 1500 feet with a weaving distance



**Figure 14.**  
I-405 slip ramp and at-grade access, Orange County, California

<sup>13</sup> AASHTO's *A Policy on Geometric Design of Highways and Streets* (Chapter VIII, Freeways)

of 1000' per lane between the ramps and opening may be used. When determining the locations of slip ramps, local topography, lines of sight, and operating characteristics of adjacent lanes need to be taken into consideration.

**Figure 15.**  
Elevated HOV drop ramp



**Figure 16.**  
Grade separated HOV to  
highway flyover ramps

Restricted at-grade access to a striped or barrier-separated HOT lane is a cost effective approach to providing controlled access to the HOT lane facility. Together, slip ramps and barrier/stripping openings control access and egress to and from the managed lane, mini-

<sup>14</sup> HOV Guidelines for Planning, Design, and Operations, Caltrans, July 1991.

mize traffic service impacts in the managed lane, and control weaving movements on the parallel highway. While they limit the need for expensive ramp structures, slip ramps require additional pavement area, and can require modifications to existing bridges and sign structures. Because access is limited to certain locations upstream and downstream of interchange ramps, there is the potential for bottlenecks to form near access points. As a result, in areas of heavy weaving between the HOT lanes and interchange ramps, where multi-lane HOT treatments are envisioned, grade-separated access may be desirable based on traffic engineering analysis of the demand and roadway geometric.

### Grade-Separated Access

Conventional wisdom in highway engineering holds that the greatest efficiency, safety, and capacity are achieved when conflicting movements are grade separated. Grade-separated access for HOT lanes greatly reduces weaving and merging movements for vehicles entering or exiting a facility. In addition, the ramps provide acceleration and deceleration areas, which allow high-speed merges and diverges. Grade-separated options include median drop ramps from overpasses or direct freeway-to-freeway connections, such as those shown in Figures 15 and 16. Layouts for these examples and others can be found in the aforementioned HOV guides.

Access and egress to and from HOT lanes should be designed to minimize conflicts with mainline general-purpose traffic. As with other highway facilities, HOT access and egress ramps should meet AASHTO design standards.

### 5.1.3 Signage

Accurate, informative signs are essential in explaining operational procedures of HOT lane facilities and ensuring safe access and egress from the managed lanes. HOT lane signs should provide motorists with information on:

- access and egress locations;
- distances to ramps;
- occupancy requirements;
- operating hours;
- cost; and
- enforcement issues.

In addition, motorists need to be given adequate time to decide whether or not to use the HOT facility, and then be able to access the facility safely. This requires that the proper information be provided so that motorists are able to make informed, real-time decisions whether or not to use the facility.

General information, such as the address and telephone number of the customer service center and website should also be conveyed (Figure 17).

Signage for HOT lanes should generally adhere to the standards prescribed for HOV facilities in the Federal Manual on Uniform Traffic Control Devices (MUTCD) Section 2B-49 and 50.

**Access and Egress Signage**

Good signage is critical in directing motorists to access and egress locations on barrier-separated facilities. In order to access interchanges, the corresponding buffer opening must be placed several thousand feet upstream of the exit ramp. Drivers need to be directed to the buffer openings providing access to their desired interchange. Figure 18 illustrates the sequence of signs that lead a HOT lane driver from the facility to a general-purpose lane exit. In this particular case, the driver would merge on to the general-purpose lanes at an opening two miles upstream of the Montrose Road interchange. The driver would then merge towards the desired exit ramp, following signs on the general-purpose lane located approximately one mile north of the Montrose Road exit ramps. The locations of the appropriate buffer openings for each interchange must be communicated clearly to HOT lane users.

**Tolling Signage**

HOT lane signage systems must also provide motorists with information on toll levels. Good signage is particularly important when variable tolls are involved. These can involve either time-of-day tolls or a dynamic pricing system that changes price according to the level of congestion in the parallel general-purpose lanes and the availability of excess capacity on the managed lane(s).

When this is the case, variable message signs (VMS) are the best way to provide motorists

**Figure 17.**  
SR 91 signage



with accurate and current information. Variable message signs can also provide motorists with other information, such as general travel conditions, and enforcement policies.<sup>15</sup> When variable or dynamic pricing is used, at least one and preferably two, variable message signs should be placed before all entrance points to the HOT lane in order to provide drivers with the basic information they need in order to determine whether or not they will use the HOT lane. These signs operate in parallel and are usually controlled from an operations or



**Figure 18.**  
Buffer location signing

<sup>15</sup> HOT lane operators have contemplated displaying anticipated travel times savings together with toll levels in order to help motorists make the decision whether or not to use the HOT lane, but have generally decided against this, given that the actual time savings experienced by motorists could differ.



**Figure 19.**  
I-15 variable message sign



**Figure 20.**  
I-15 police car

traffic control center.

Variable message signs are currently used on the SR 91 Express Lanes and on the on I-15 in San Diego (Figure 19).

#### 5.1.4 Enforcement Areas

HOT facilities should also include locations from which enforcement agencies can monitor traffic and identify any unauthorized

vehicles. In order to see occupants properly during the hours of darkness or inclement weather, lighting is required at the observation points for officers. The enforcement areas should be large enough to accommodate the need to accelerate to the speed limit before entering traffic to stop a violator. They should be wide enough to accommodate safe enforcement action and may be located near tolling points, allowing officers to monitor traffic as it enters the facility and provide a visual deterrent to would be offenders (Figure 20). Barrier-separated facilities will require less enforcement presence than would be required for a roadway that is not physically separated.

The primary reason that facilities for on site enforcement are recommended near the access points is that current technologies—both video and thermal—cannot accurately discern the number of occupants in large numbers of vehicles traveling at highway speeds. Moreover, the presence of an officer is a useful deterrent for misuse by those who want to abuse the system. Enforcement issues are addressed in further detail in Section 6.3.

## 5.2 Technology

HOT lanes involve significant technology components that often far exceed those of general-purpose highway expansions. They require fully automated electronic toll collection (ETC) systems and some also include real-time traffic surveillance and variably priced electronic toll collection systems. These sophisticated systems allow tolls to be collected in an efficient matter, enable real-time toll pricing, maintain premium travel conditions on the HOT lanes, and communicate cost and travel information to motorists.

The following sections provide information on the various technical systems needed for HOT lane projects.

### 5.2.1 Electronic Toll Collection

Each of the three operating HOT lane facilities in the United States and over 250 other tolled facilities across the country utilize electronic toll collection (ETC). ETC enables motorists to pay tolls without cash transactions at a toll-booth and enter and exit toll facilities at normal highway speeds.

ETC systems rely on a number of individual components each of which are linked to a lane controller (a micro processor) that controls and coordinates their activities. The following components are needed.

### The Lane Controller

The lane controller coordinates the activities of all equipment in a single lane and generates the transactions assigned to individual customers. The lane controller also stores a list of valid tags so it can validate the information from the AVI. A larger plaza (local) computer collects transaction information from the lane controllers at each toll collection point and then communicates it to an Agency Central Host Computer. The latter collects and consolidates information from all toll collection points in the system, transmits the list of valid tags to each lane controller for AVI validation, and prepares audit reports from each tolling point.

Generally there is one lane controller for each travel lane. These, in turn, are linked with a central host computer. Depending on the data transmission requirements, linkages are generally provided by leased T-1 telephone lines or a fiber optic system. The lane controller is capable of receiving messages and control signals, transmitting messages and generating and sending appropriate control signals to effectively interface with a central computer and the lane subsystems.

The lane controller must contain sufficient memory to store the toll tables, staff ID information and all the AVI/ETC lists of valid and invalid transponders sent to the lane from the central computer. The lane controller also performs equipment status checks as part of the normal processing of transactions, with alarm failures reported to the operator.

In the event of a communications failure with the central computer, the lane controller should generally be capable of storing transaction data for a minimum of thirty days. The lane controller should also be able to operate in a stand-alone mode for the same period of time.

### Automatic Vehicle Identification Systems

Automatic Vehicle Identification (AVI) tech-

nology features a radio frequency device called a transponder, located in the vehicle that transmits a unique identity to an antenna located on a gantry above each lane to be tolled. The antenna is linked by coaxial cable to a reader located in an adjacent roadside cabinet. The reader interprets the information received from the transponder devices and sends it to the lane controller, which determines if the vehicle is carrying a valid transponder, verifies the vehicle classification, and generates the appropriate toll transaction.

### Automatic Vehicle Classification Systems

Automatic Vehicle Classification (AVC) sensors are located at the tolling point and verify the vehicle's classification so that the proper toll can be charged. Classification is typically based on the vehicle's profile and number of axles. If there is a discrepancy between the observed classification and that recorded on the transponder, then the matter is sorted out according to established protocols, or sent to a violations processing center for further action.

AVC systems can include any or all of the following components:

- **Detector loops and loop detector amplifiers** are imbedded in the pavement and used to detect and classify the type of vehicles passing over them. The loops are linked to the lane controller and can be used individually to count traffic, to trigger the violation enforcement cameras or in tandem to measure vehicle speeds.
- **Infrared light curtains** are installed in pairs to sense the separation between two vehicles passing through a lane, as well as height depending on the number of beams deployed. The information passed on to the lane controller is used in conjunction with the loop detectors to support the correct grouping of axles and to identify large trucks or vehicles pulling trailers. When used in conjunction with radar, a vehicle can be tracked through the toll transaction,

### Detection Equipment Options

Typically, the antennas are mounted overhead on a sign gantry, existing overpass (bridges), or on dedicated gantries. On some variable pricing facilities, such as the 407 in Toronto, SR 91 in Orange County, California, and I-15 in San Diego, overhead gantries support the AVI antennas at various intervals along the roadway.

Alternatively, side-mounted antennas are available but not commonly used for tolling purpose. One advantage to side mounted antennas is that they are easier to access for maintenance or repair than overhead or in-pavement detectors. The single biggest disadvantage is that side-mounted antennas are prone to cross reads i.e. reading tags in vehicles that may be in adjacent general-purpose lanes.

In-pavement detectors have been used in some areas, most commonly in warm climates. This approach is often problematic in that it can require comparatively long lane closures during installation and repair. In-pavement detectors also require that transponder tags be mounted below vehicles or on the front license plate. This type of installation is difficult for vehicle owners and could force them to seek professional assistance. This level of inconvenience is not prudent if market penetration is sought. In addition, with plate mounted transponders are more likely to be stolen or damaged, and they cannot be easily transferred from one vehicle to another.

Given these placement factors, it is recommended that detection equipment be placed overhead and, where feasible, be mounted on existing structures. However, the structure must be substantial enough to exhibit minimal movement under design wind loads. This requirement is due to the sensitivity of VES cameras, lighting and the AVI antenna. A typical installation for single lane HOT would require two (2) antennas (one over the 10-12' lane and another over the shoulder (if greater than 4' in width), and two (2) VES cameras and high intensity lights (a set)—with one set for rear plate capture and another for front plate coverage.

its speed registered and a profile developed in concert with an infrared curtain or overhead/sign scanner/separator.

- **Treadles** are pressure sensitive devices inserted in the pavement designed for directional counting of vehicle axles passing over them. Each treadle operates with a treadle interface board mounted inside the lane controller. The treadle consists of two pieces, a frame and a body with removable bars or stripes (sensors). These sensors are used as inputs to the lane controller via the

input board to provide information on axle count and vehicle direction of travel, depending on the order in which the stripes are hit.

- **Vehicle separators/profilers** can be located on a gantry or at the side of a lane. They perform functions similar to the light curtains. The class of vehicles is determined based on the profile of the passing vehicle.

### Video Enforcement Systems

Video enforcement systems are used to capture rear and/or front images of all vehicles that do not carry a valid transponder, as well as those with an observed discrepancy between the classification of tag and the vehicle in which it is located. Video enforcement equipment includes a controller computer, an interface to the lane controller, camera(s) mounted on the gantry above each lane, and high intensity lighting. High-resolution cameras with automatic aperture settings and field of view are used to capture images of the rear and/or front of the vehicle.

### ETC Issues

There are variations on typical ETC system configurations. In New York and New Jersey, for example, the recently implemented Regional Consortium system on the New Jersey Turnpike, utilizes a Type 2 Read/Write Tag that stores toll information. Upon entering the Turnpike, data on the point of entry and time is written to the tag. The system reads the tag upon exiting and computes and deducts the toll from the customer's account.

As electronic toll collection and other intelligent transportation technologies continue to emerge, new technologies may come to play a role in the enforcement of variable pricing in the future. However, until technologies such as thermal or video imaging are refined and can determine vehicle occupancies accurately, ETC will remain the most effective and accurate means of collecting tolls, and visual enforcement will be the most fool proof.

System integration is a complicated process. Most agencies hire specialists either to integrate the technology into their existing toll environment or develop a new toll system.

### 5.2.2

#### ITS Technology

Free flow travel and more reliable travel times are essential to the success of HOT lane projects. HOT lanes utilize ITS technologies to monitor travel conditions, and communicate information to motorists. In certain cases travel conditions are also used to establish real-time variably priced tolls. The following ITS components are likely to be needed for most HOT lane applications:

#### Variable Message Sign (VMS)

The VMS can be located on the gantry at the pay point to provide direction to patrons or upstream of the HOT lane access points to convey the variable toll rate, operating regulations, and information on travel conditions. The VMS includes the controller and associated equipment, sign attachment hardware and control cabling from the lane controller to the sign.

#### Lane Use Signal (LUS)

The LUS would become necessary on a facility if more than one lane is used for its operation thereby properly identifying the appropriate lane to use for various hours of the day or during peak periods. One LUS would be located above each lane attached to the gantry at the payment location. Each LUS has a one-way, one-section head. The signal is capable of displaying two messages, a red "X" and a green down arrow. The signal consists of a data interface to the lane controller.

#### Closed Circuit Television (CCTV) System

A CCTV video monitoring and security system can provide continuous monitoring of traffic operation along the length of a facility. In addition, it can be used to monitor areas where money and/or tags are handled, as well as

building entry doors and storage areas. Video and loop detectors placed along the roadway can be used to monitor corridor-wide operations, identify incidents, dispatch a response team, and monitor the incident through recovery.

#### Traffic Volume and Speed Monitoring Subsystem

This subsystem was discussed above as part of the use of loop, radar or video detectors in the Vehicle Classification System and/or CCTV sections.

Other ITS tools such as overhead and side firing radar/microwave, speed/volume detectors such as Remote Traffic Microwave Sensor and travel advisory radio can also play an important role in managing the operation of variably priced HOT facilities.

Since free flow travel and reliable travel times are essential to the success of HOT lane projects, ITS technologies allow HOT lane operators to quickly identify, respond and monitor incident recovery; providing variable messages on the road for changing conditions; and using advisory radio to inform drivers about changing conditions.

## 5.3

### Travel Demand Forecasting, Pricing, and Financing

In any feasibility assessment of a proposed HOT facility, travel demand forecasts, possible pricing structures, and financing strategies all play a role and are closely interrelated. This section discusses how these processes overlap and highlights those aspects that are unique to HOT lanes.

HOT lane initiatives share some aspects of both toll road and HOV lane initiatives. As managed lanes, they provide priority treatment for high-occupancy vehicles and, as tolled facilities, they provide premium service for paying motorists. One of the unique aspects of HOT lane planning is that demand levels for the



managed lanes must be forecasted for both HOV and SOV buy-in vehicles under a variety of pricing and occupancy requirement regimens. This exercise serves a dual purpose.

- First, it allows different pricing and vehicle occupancy structures to be tested in order to derive the combination of pricing and occupancy requirements that maximizes transportation benefits for all motorists traveling in the HOT lane corridor.
- Second, it involves translating the projected vehicle flows and toll levels into anticipated revenue streams that, in turn, facilitate the evaluation of various financing approaches.

While planning for other kinds of transportation improvements may use these technical analyses independently, in planning for and assessing HOT lane proposals, the relationship between the cost of access to the HOT facility

and its utilization levels is key. HOT lane user fees may vary in real time based on travel congestion in the parallel general-purpose lanes. Determining the elasticity of demand for the HOT lane involves analysis of:

- trip purpose;
- driver income;
- congestion levels;
- travel time savings; and
- the availability of alternative travel routes.

In most locations, there is limited empirical data that can be used to assess these relationships, forcing modelers to utilize behavioral and attitudinal surveys, as well as historic data from existing HOT lane facilities, such as the SR 91 and I-15.

### 5.3.1 Travel Demand Forecasting for HOT Lane Projects

Travel demand models are mathematical tools that are used to forecast roadway and transit travel based on projected population levels, land use trends and expected roadway and transit characteristics such as cost and travel time. Based on a traditional four-step model, the process involves the creation of travel demand or “trip tables” which identify the demand for mobility between different origin and destination pairs and then an assignment model which distributes those trips on to the travel network by mode based on the location, capacity and travel characteristics of its different components. Models vary in their size and complexity. Complex multi-modal models often involve a collection of sub-models each addressing specific modes or types of trips.

Travel demand models can be adapted to assess HOT lane projects with toll strategies that vary with the time of day and vehicle occupancy. Estimating traffic demand for a HOT lane facility must address both the general demand for mobility as well as the willingness of motorists to pay for improved travel conditions.

### Deciding to use a HOT lane

The decision whether or not to use a HOT lane is based largely on the value of time. The literature related to the value of travel time is extensive, and there are many “rules of thumb” that have evolved from this literature. The most common approach is to value travel time at some percentage of area-specific average wage rates. Work trips may be valued at close to the full rate, while off-peak non-work trips are valued at less.

The accuracy of this is difficult to validate. Moreover, the value of any individual’s time will vary by that person’s income (higher income individuals will “value” time more highly than low income travelers), and the average wage rate fails to reflect this. In addition, the value of time for specific individuals may change depending on the situation at hand — whether one is late for a commitment or making a discretionary trip. Similarly, some motorists may choose the HOT lane even if the time savings fall short of the out-of-pocket cost because the HOT travel time is predictable, while that associated with the free alternative is not. For example, experience on the SR 91 in Orange County has shown that lower income wage earners whose job security requires timely arrival at work may be likely to utilize the HOT lane rather than risk delays on the general-purpose lanes that could lead to tardiness affecting their job security.

The best approach for valuing HOT lane travel time savings is through stated preference surveys.

In addition, HOT lanes are often implemented in concert with, or in addition to, HOV facilities. If this is the case HOV behavior must also be considered when preparing HOT travel demand forecasts. Demand for an HOV facility—either involving the introduction of new lane(s) on an existing facility, or the conversion of an existing general-purpose lane(s)—is typically estimated based upon the time savings the facility would afford. There are a number of readily available sketch planning tools, such as FHWA’s HOV Demand Estimation Model, that are used to prepare conceptual estimates for HOV facilities. These models, discussed further in Section 5.4.2, can also be enhanced to assess the effects of the costs and travel time savings issues associated with potential HOT lane projects.

At a minimum, demand assessments must consider the HOT lane travel time differential to estimate the value of time savings afforded by the HOT lane, as it is likely that motorists will chose the HOT lane if the time savings value exceeds the out-of-pocket cost required to achieve the savings. The array of factors affecting travel demand for HOT lanes is provided below in Table 4.

**Behavioral Surveys**

Given the limited experience with HOT lanes in most locations, additional stated and/or revealed preference survey research may be required to refine model assumptions, particularly those related to value of time, toll elasticities of demand, and cost trade-off decisions—all of which affect mode and route choices.

When demand estimation methods at a “sketch planning” level are employed, it may still be advisable to conduct survey market research through mail-back surveys, intercept and interview techniques, focus groups, etc. to learn more about the travel patterns, demographics, willingness to pay, and other decision trade-off factors of travelers. “Stated preference” survey questions posing particular choices with various

Categories	Demand Factors
<b>Price of HOT lane service</b>	Toll or out-of-pocket cost Pricing structure as a function of time of day, vehicle occupancy, prevailing traffic levels on alternative facilities, etc.—affects usage decisions including mode choice / carpooling attractiveness HOT lane travel time cost (value of time _ travel time, summed across vehicle occupants) HOT lane route vehicle operating cost perceived by user “Membership cost”—the out of pocket, inconvenience, and/or opportunity cost of making the user eligible to use the facility (includes AVI tags for electronic tolling, account deposit, setup fees, etc.)
<b>Cost of Alternative “Free” Service</b>	Expected congestion time cost of using a parallel or alternate “free” route as perceived by the user (value of time _ travel time, summed across vehicle occupants) Additional time cost associated with the congestion-related uncertainty of using a parallel free facility (inconvenience and frustration arising from the variation between the expected travel time before use and the actual “true” travel time after use) Free route vehicle operating cost perceived by user
<b>Travel Characteristics</b>	Trip purpose—affects value of time, and thus willingness to pay out of pocket costs Vehicle occupancy—affects willingness to pay via the net time savings value for the vehicle, and may impact the HOT lane price for the vehicle Trip frequency—may affect willingness to buy into the HOT lane concept (obtain an account and AVI equipment or becoming a HOT lane “member”)
<b>User Characteristics</b>	Risk profile of users (risk averse / neutral / loving)—relates to willingness to pay for travel time reliability Disposable income and other demographic user characteristics—affects value of time and risk aversion in both predictable and unpredictable ways

out-of-pocket and time costs associated with them can help clarify the conditions for which various groups of travelers would choose to use the HOT lane facility, including estimating various toll elasticities of demand. Ultimately the objective is to determine the market share of existing and potential travel that could be captured under various HOT lane pricing schemes.

Regardless of whether sophisticated modeling methods or sketch planning techniques are used, it is not possible to model the full variation of behavior encountered among travelers, particularly with the many elements of uncertainty that exist, and incomplete information at

**Table 4.**  
**HOT Lane Demand Factors**

the time travel decisions are made. This suggests that any HOT lane demand forecasts should be presented as a range of volumes over a specified time interval (i.e., per peak hour, peak period, weekday, year) rather than absolute volumes.

**5.3.2  
HOT Lane Pricing and Travel Demand**

As with any user fee-based transportation system, toll rates have a direct effect on the demand for a HOT lane facility. The precise effect of pricing strategies differs from setting to setting and is governed by issues such as trip purpose, income levels, and congestion levels on parallel routes. An effective pricing strategy is used in concert with vehicle-occupancy requirements for HOVs to manage demand on the HOT lanes to ensure that adequate residual capacity is retained in order to maintain premium travel conditions on the managed lanes. This is achieved by charging a premium for utilizing the HOT lanes during peak demand periods—determined either by time-of-day, as with the SR 91, or, as with the I-15, on a real-time basis based on congestion levels on the parallel lanes.

Pricing hierarchies can be calibrated once facilities become operational in order to achieve the desired result. However, when projects are still in the planning stage these effects can only be modeled. The studies associated with the State Route 14 in Los Angeles County, California illustrate the dynamics involved in different pricing and operating scenarios.<sup>16</sup> The following pricing and operational strategies were considered:

- HOT2+ \$0.10/mile—restricting free access to HOV-2 vehicles and charging all others \$0.10 per mile to use the HOT lane;
- HOT3+ \$0.10/mile—restricting free access to HOV-3 vehicles and charging all others \$0.10 per mile to use the HOT lane; and
- HOT2+ \$0.20/mile—restricting free access to HOV-2 vehicles and charging all others \$0.20 per mile to use the HOT lane.

Table 5 shows how the different scenarios affected the demand in the peak direction at one particular location.

The SR 14 study showed that with a two-person HOV occupancy requirement there was a fairly even split between tolled vehicles and free vehicles on the HOT lanes. When the occupancy restriction was increased to HOV3, there was a drop in the overall demand for the HOT lane of about 10 percent, and a marked increase in the number of tolled vehicles using the facility, as fewer vehicles were eligible to use the HOT lane at no cost. When the occupancy restriction was kept at HOV2 and the SOV toll was increased to \$0.20, there was a 22 percent decrease in the overall demand for the HOT lane due to a marked decrease in the number of tolled vehicles, as the cost of the trip exceeded the expected benefit for many of the SOV drivers.

Although they differed somewhat, the results of the SR 14 model showed similar demand trends at other locations along the corridor. This level of variance suggests that at the planning stage forecasts should include sensitivity analysis to show the likely range in revenue and utilization figures in order for planners to make prudent assumptions, particularly when financing relies on projected revenues and the potential profitability of the HOT lanes.

**Table 5.  
Sample HOT Demand Levels**

Alternative	Vehicular Demand on SR-14 HOT Lanes in the AM Peak Period between Escondido Canyon Road and Crown Valley Road
HOT2+ \$0.10/mile	2233 (1179 toll, 1054 free)
HOT3+ \$0.10/mile	2101 (1730 toll, 372 free)
HOT2+ \$0.20/mile	1731 (520 toll, 1211 free)

<sup>16</sup> State Route 14 Corridor Improvement Alternatives Study, SCAG/Parsons Brinckerhoff, October 2000.

### 5.3.3 A Sketch Planning Methodology for Estimating HOT Lane Revenue

This section provides a sketch planning methodology which can be useful in preparing revenue forecasts that typically play a critical role in initial feasibility assessments of HOT lanes and other surface transportation investments. This approach is less rigorous than a full-fledged “investment-grade” revenue forecast but can still provide helpful information to decision makers. Figure 21 provides a conceptual sketch planning methodology to estimate HOT lane traffic and revenues which may be adapted by agencies or their consultants.

The sketch planning model incorporates various situations that may face the analyst, for example:

- A completely new HOT lane facility is to be constructed adjacent to existing general-purpose lanes;
- An existing HOV lane is to be converted to a HOT lane; and
- A new HOV lane is to be constructed, but with the intent of a possible conversion to HOT use at a later point if traffic conditions warrant.

The methodology presented in Figure 21 mirrors the actual operation of a HOT lane and the pricing regime that might be in place. First, peak traffic on the general-purpose lane is measured, and LOS determined. Utilizing this information, peak period congestion delays can be estimated, and the cost of those delays quantified based on hourly values of travel time. Then, based on the available capacity in the HOV lane (after “free” HOV vehicles are accounted for), SOV users are “shifted” to the HOT lane, just up to the point where free flow conditions can be maintained in the HOT lane. The HOT lane toll is modeled based on the degree of congestion in the general-purpose lane, and the cost of that congestion to SOV

users. HOT lane revenues are then estimated after accounting for market penetration of electronic toll collection accounts.

In a more complex, but perhaps more realistic version of this, HOT lane tolls are repeatedly set to reflect the income distribution of SOV drivers in the general-purpose lane. Those SOV users at the top of the income distribution—who place the highest value on time—are shifted first, and a test is made to determine whether there is any remaining capacity in the HOT lane. This iterative process is repeated, and tolls set progressively downward, until an equilibrium condition in the HOT lane is reached. This process determines an “optimal toll”—a process that mirrors a real world dynamic tolling process.

Although there are a number of cases of underestimates, experience around the country with toll roads and transit systems indicates that demand projections and revenue forecasts are more likely to err on the high side.

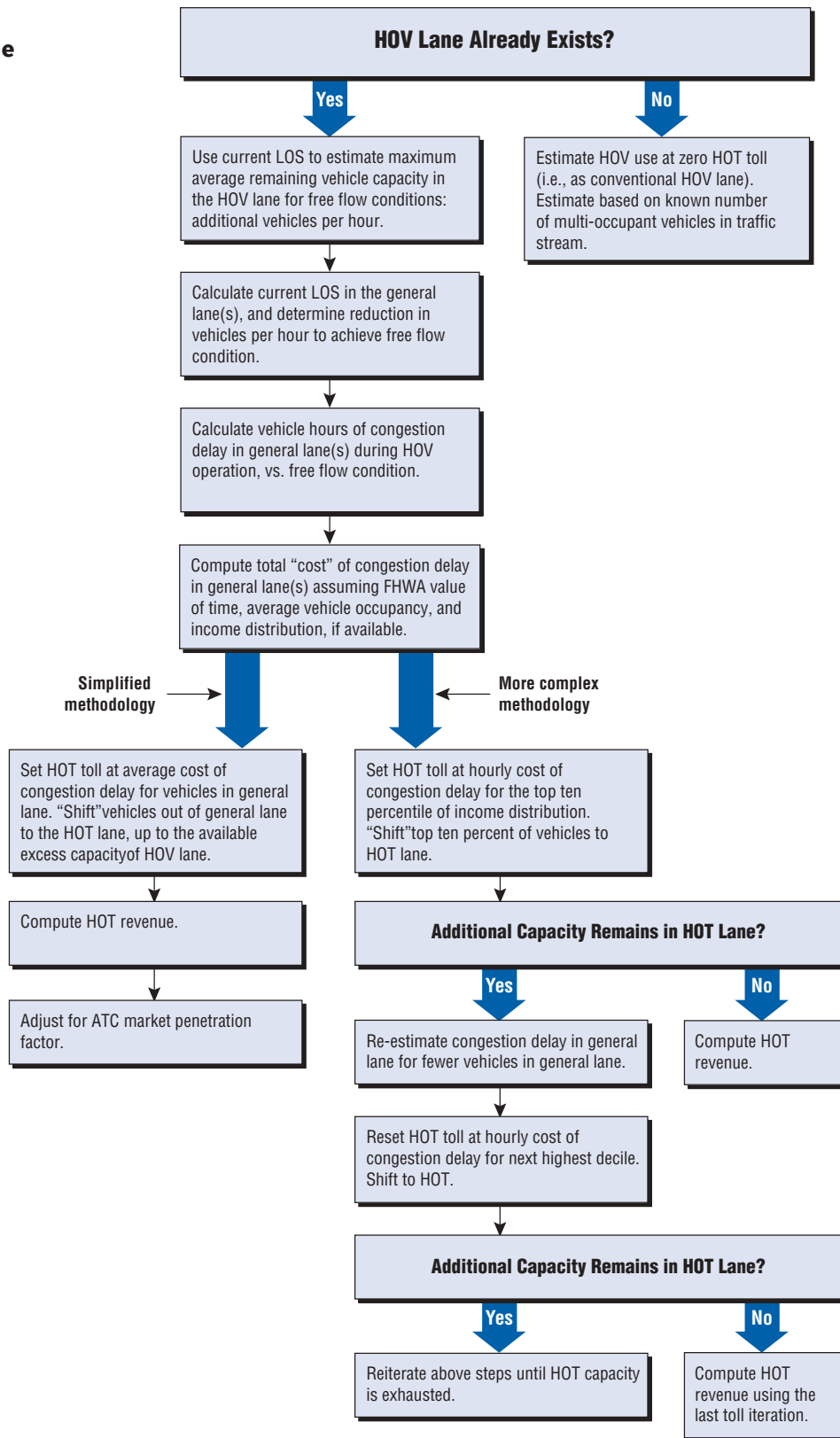
Overestimates of revenue potential can result in unexpected public expenditures or even project default. Therefore, it is preferable to build-in conservative assumptions regarding travel demand characteristics and the underlying economic conditions that drive travel demand forecasts. Such assumptions are questioned as a matter of course in the due diligence reviews that private lenders require when they finance infrastructure projects. Similarly rating agencies focus closely on forecasting assumptions when rating project bonds. However, there may be a particular risk of overestimating utilization and revenue levels when these types of financing mechanisms are not being used.

### 5.3.4 Financing HOT Lane Projects

#### Potential Sources of HOT Lane Financing

There are many different strategies that may be pursued to finance HOT lane projects. All projects are unique in this regard and there is no single approach that will be universally

**Figure 21.**  
HOT Lane Revenue  
Estimate: Sketch  
Planning Process



**Figure 21. HOT Lane Revenue Estimate: Sketch Planning Process**

appropriate. The SR 91 in California was financed on a limited recourse basis with a private developer borrowing the necessary funds from capital market sources and is repaying its debt from toll revenues. Sponsored by the local MPO, the I-15 in San Diego involved the conversion of an existing HOV facility. The HOV lanes had initially been constructed using transit monies and local transit providers supported the HOT conversion because the MPO agreed to dedicate the majority of the resulting toll revenues to support local transit improvements. Funding for the conversion of the facility was provided by the FHWA Value Pricing Pilot Program. Table 6 summarizes financial details associated with these two facilities. Additional information on the financing approaches for these particular projects, among others, is provided together with background and context information in Chapter 7.

The following discussion identifies a range of possible funding sources and techniques that could be pursued for other HOT lane projects.

**1. Federal Demonstration Funds**

The Transportation Equity Act for the 21st Century (TEA-21) permits the U.S. Department of Transportation’s FHWA to enter into cooperative agreements with up to 15 State or local governments or other public authorities to establish, maintain, and monitor value pricing projects of which HOT lanes are one category. Any value pricing project included under these local programs may involve the use of tolls on the Interstate System. A maximum of \$7 million was authorized for fiscal year (FY) 1999, and \$11 million for each of FYs 2000 through 2003 to be made available to carry out the requirements of the Value Pricing Pilot Program. The Federal matching share for local programs is 80 percent. Funds allocated by the Secretary to a State under this Section will remain available for obligation by the State for a period of 3 years after the last day of the fiscal year for which the funds are authorized.

SR 91	
<b>Location</b>	Orange County, California
<b>Description</b>	A four-lane, privately-owned and operated toll facility built in the median of a 16 km section of the 91 Riverside Freeway, a pre-existing CalTrans facility. Entry and exit are restricted to the facility’s two endpoints.
<b>Sponsor</b>	CalTrans Orange County Transportation Authority
<b>Cost</b> (facility construction and ETC equipment)	\$130 million
<b>Type of Finance</b>	\$65 million in 14-year variable rate bank loans \$35 million in longer term loans (24 years) \$20 million private equity \$ 9 million subordinated debt to OCTA to purchase previously-completed engineering and environmental work
<b>Tolling Structure</b>	As of January 2, 2001, tolls on the Express Lanes varied between \$0.75 and \$4.25, with HOVs receiving a 50 % reduction.
I-15	
<b>Location</b>	San Diego, California
<b>Description</b>	An eight-mile, two-lane facility located in the I-15 median. Lanes operate only during the peak in the direction of the commute: southbound in the morning and northbound in the evening. Entry and exit are restricted to the facility’s two end points. Carpools of two or more, buses, and motorcycles travel free, while SOVs must pay a fee. Toll revenues support transit service in the corridor.
<b>Sponsor/Partners</b>	SANDAG Caltrans (California Department of Transportation) California Highway Patrol (provides enforcement) Metropolitan Transit Development Board Federal Highway Administration Federal Transit Administration
<b>Cost</b> (ETC equipment)	\$130 million \$9.95 million
<b>Type of Finance</b>	\$7.96 million FHWA Value Pricing Pilot Program grant \$1.99 million local matching funds \$230,000 Federal Transit Administration
<b>Tolling Structure</b>	Dynamic tolling. Generally, the toll ranges between \$0.50 to \$4.00, depending on current traffic conditions, however tolls may be raised up to \$8.00 when traffic congestion is severe. Toll rates are adjusted every 12 minutes in response to real-time traffic volumes.

**Table 6.**  
**Financial details of the**  
**SR 91 and I-15**

## 2. State Funds

In locations where there are no prohibitions against using state monies to construct a toll facility, state transportation funds may be used to support construction of HOT lane facilities. State Infrastructure Banks (SIBs) are one of the most logical sources of state support for HOT lane projects. SIBs are revolving funds that function much like a private bank and can offer a range of loans and other credit assistance enhancements to public and private sponsors of highway or transit projects.<sup>17</sup> SIBs can provide loans—at or below-market rates—loan guarantees, standby lines of credit, letters of credit, certificates of participation, debt service reserve funds, bond insurance, and other forms of non-grant assistance.

SIB support may be used to attract private, local, and additional state financial resources, leveraging a small amount of SIB assistance into a larger dollar investment. Alternatively, SIB capital can be used as collateral to borrow in the bond market or to establish a guaranteed reserve fund. Loan demand, timing of needs, and debt financing considerations are factors to be considered by states in evaluating a leveraged SIB approach.

Most SIBs were established using Federal-aid grants and local match funds as seed money. As loans or other credit assistance are repaid, a SIB's initial capital is replenished and can be used to support new projects. Therefore the resources available to many SIBs are likely to be constrained. However, as of mid-2002 additional Federal funding for SIBs in California, Florida, Missouri, Rhode Island, and Texas provide significant new resources for SIB loans and credit enhancements in those states. Among other facilities, SIB funding has been

<sup>17</sup> One of the most comprehensive sources of information on the SIB program is the FHWA State Infrastructure Bank Review, which is available online at <http://www.fhwa.dot.gov/innovativefinance/sibreview/index.htm>

used to support the construction of the Pocahontas Parkway in Virginia and Butler Regional Highway in Ohio.

## 3. Local Sales Tax Initiatives

With shrinking federal and state budgets, local initiatives have been used successfully to fund transportation improvements. But a key to this type of funding mechanism is outlining what will be built with the money before the legislation goes to a vote so that citizens will know what they are getting. In the case of a HOT lane, the revenue allocation plan would also need to be spelled out before the initiative is taken to the voters so that the funds can be accounted for. People are less likely to vote to tax themselves if they feel that the money is going to go into a black hole of bureaucracy, so definition of the projects on which the money will be spent and strict accountability for the funds after they are collected is of paramount importance from the outset.

Sales taxes, while they have the potential for significant revenue generation, are also highly sensitive to economic cycles. Currently, many transportation agencies that rely extensively on this source are experiencing funding gaps, as the economy has slowed to near-recession conditions, and in response to the terrorist attacks.

Other sources of local transportation finance are also available and have been utilized; these include motor fuel taxes, motor vehicle registration taxes, commuter taxes, tax increment financing, and other forms of special assessment.

## 4. Bonds/Private Financing

Debt financing through the sale of bonds leveraging future toll revenues is a common approach for financing toll roads. Bond options include 1) taxable toll-revenue bonds, which are the only kind private sector sponsors can issue—private bonds were used to finance the SR 91 Express Lanes—and 2) tax-exempt toll revenue bonds issued by state toll agencies, public authorities, or special-purpose 63-20

public-benefit corporations. The fact that public agencies have access to tax-exempt financing lowers their borrowing costs as well as the revenues required to repay bond obligations.

Debt service costs for private issuers is generally higher than for public agencies and are likely to require proportionally larger revenue streams to cover debt payments. Shareholder equity is also an important component of private bond financings.

### 5. Innovative Financing Programs

Given that they generate dedicated and independent revenue streams, HOT lanes also lend themselves well to a number of innovative finance programs established by the US Department of Transportation. The following are particularly well suited to HOT lane projects.<sup>18</sup>

#### Section 129 Loans

Section 129 of Title 23 U.S.C. allows Federal participation in state loans to a public or private entity supporting the construction of toll highways and other non-tolled projects with other dedicated revenue sources, such as excise taxes, sales taxes, real property taxes, motor vehicle taxes, incremental property taxes, or other beneficiary fees.

There are no Federal requirements that apply to how a state selects a public or private entity. Rather, this selection process is governed by state law, and it is the state's responsibility to ensure that the recipient uses the loan for the specified purposes. Assuming that a project meets the test for eligibility, a loan can be made at any time. The Federal-aid loan may be

for any amount, provided the maximum Federal share (typically 80 percent) of the total eligible project costs is not exceeded.

States have the flexibility to negotiate interest rates and other terms of Section 129 loans and the loans can be combined with other flexible match and advanced construction programs. The President George Bush Turnpike, a toll road connecting Dallas with its expanding northern suburbs, was the first highway facility to be financed with Section 129 loans.

#### TIFIA

The Transportation Infrastructure Finance and Innovation Act (TIFIA) credit program offers three types of financial assistance that could be used to support HOT lanes:

- Direct flexible repayment loans to cover capital construction and financing costs;
- Loan guarantees that provide full-faith-and-credit guarantees by the Federal government to institutional investors making loans for projects; and
- Standby lines of credit providing secondary sources of funding in the form of contingent Federal loans. These loans may be drawn upon to supplement project revenues, if needed, during the first 10 years of project operations.

TIFIA project sponsors may be public or private entities, including state and local governments, special purpose authorities, transportation improvement districts, and private firms or consortia. However, the overall amount of Federal credit assistance may not exceed 33 percent of total project costs. TIFIA assistance involves a competitive Federal application process. Project must meet threshold criteria to qualify, and estimated eligible costs must be at least \$100 million or 50 percent of the state's annual Federal-aid highway apportionments, whichever is less, or at least \$30 million for Intelligent Transportation Systems (ITS) proj-

<sup>18</sup> Additional information on these innovative financing programs is available in the FHWA Innovative Finance Primer at <http://www.fhwa.dot.gov/innovativefinance/ifp/index.htm>; the NCHRP Innovative Finance Clearinghouse <http://www.innovativefinance.org/>, the FHWA Innovative Finance Website <http://www.fhwa.dot.gov/innovativefinance/>, and the TIFIA program Website <http://tifia.fhwa.dot.gov/>.



ects. Project must also be supported in whole or part by user charges or other non-Federal dedicated funding sources and included in the state's Transportation Plan. If individual HOT lane projects do not meet these minimum threshold criteria, they could still be eligible for TIFIA assistance if they were integrated with other larger regional improvements under a Record of Decision.

These financing and credit enhancement tools may also be combined or used in innovative ways with other more traditional funding sources.

## 5.4 Other Technical Analyses and Approvals

### 5.4.1 Preparing HOT Lane Cost Estimates

The estimation of HOT lane capital investment and ongoing operations and maintenance (O&M) costs during the planning stage is useful for several reasons. Reasonably accurate and detailed cost estimates are needed to complete cost effectiveness and benefit-cost (economic feasibility) analyses.

#### Operating Costs

HOT lane operating costs include the following areas, some of which are not typically associated with “free” or non-priced roadways, including:

- Toll processing, collection, account management and transponder distribution;
- Administrative functions including advertising and marketing;
- Physical facility operations, including traffic data collection and monitoring equipment, dynamic pricing, occupancy observation, and enforcement;
- Physical facility routine maintenance; and
- Periodic or extraordinary maintenance and rehabilitation.

#### Capital Costs

Capital investment costs include all of those applicable to a typical roadway facility plus those associated with toll collection, traffic monitoring and other technology applications. The cost of converting an existing HOV lane to HOT operation is mostly attached to the implementation of the technology and the space needed to provide that technology in the form of electronic toll collection equipment, manual and video enforcement, static and dynamic signage, CCTV cameras, etc.

If an HOV facility is being considered as an interim step toward future HOT lane implementation, there are really no throwaway costs in the initial construction. The HOT operation infrastructure can and should be planned for as part of the initial HOV construction and put in place so that the highway does not need to be reconstructed a second time a few years after the HOV lane is implemented. Toll facilities would not be constructed, but much of the management infrastructure (loop detectors, cameras, communications, and utilities) can be constructed early and at marginal incremental cost. These facilities can also be used to operate the HOV lanes prior to HOT conversion.

If a newly opened HOV facility is being considered for HOT lane conversion without the benefit of any earlier planning, then there can be some “throw-away costs.” Pavement may need to be reconstructed to allow conduit to be installed under the lanes or shoulder. Median barriers may need to be replaced to accept additional signage. Drainage facilities may need to be modified to address an additional barrier (if one is installed). All of these issues can be addressed ahead of time if conversion is considered from the beginning. Of course, an HOV lane that has been in operation for ten or more years has already supplied many years of use and any changes that would be made to convert it to HOT operation should not be considered “throw-away.”

At the planning stage for a HOT lane project, particularly if a detailed financial model has not yet been developed to evaluate the project, it may be necessary to annualize the constant-dollar capital cost estimates for various HOT lane and non-priced alternatives to facilitate various comparisons. This is typically done using capital recovery factors that take appropriate project financial life and discount rate assumptions into account. It is appropriate to combine annualized capital costs with annual O&M costs to arrive at a total annual cost factor. This may be useful input to assessing a business operating objective, modeling demand under such an objective involving profit or cost recovery criteria, conducting cost-effectiveness comparisons, or evaluating economic feasibility using benefit-cost analyses.

### 5.4.2

#### Economic Evaluation

Economic analyses of HOT lane initiatives generate important information that compares the benefits afforded by the projects with the cost of building and operating them. Economic assessments are used by decision makers to compare the benefits and overall efficacy of investment projects of all types and identify those that provide the greatest benefits. They are often required by Federal agencies before disbursing grants and are also often included in environmental impact statements and major investment studies. In that they quantify the benefits of HOT lane projects in different ways, the information generated through economic analyses is also essential to public outreach efforts and in garnering political support.

Economic analyses focus on the calculation of a number of important indicators.

#### Benefit-Cost Ratio

The benefit-cost ratio (BCR) gives the ratio of a project's present value benefits to its present value costs. In addition to being the most commonly recognized measure of economic

#### Evaluation Tools and Economic Feasibility Measures

Several available sketch planning and modeling tools may be tailored for evaluating HOT projects. The FHWA has developed several software packages, listed below, to help provide decision makers with useful information for comparing alternative transportation solutions. Regardless of the tool employed, reasonable results are dependent on using reasonable assumptions and relevant measures for quantifying and valuing benefits and costs. When using a software package, it is particularly important to understand and review the assumptions made within the software to ensure that they are appropriate for the project.

- Sketch Planning Analysis Spreadsheet Model (SPASM) is a corridor sketch planning tool that shows economic efficiency information for cross-modal and demand management strategies. See <http://www.fhwa.dot.gov/steam/spasm.htm>
- For more detailed corridor analysis and to facilitate systemwide analysis, the Surface Transportation Efficiency Analysis Model (STEAM) reports mobility and safety benefits by user-defined districts and an accessibility measure. The district reporting and accessibility features help to gauge the social impacts of transportation investments. <http://www.fhwa.dot.gov/steam/index.htm>
- FHWA's Spreadsheet Model for Induced Travel Estimation (SMITE) accounts for new travel that may be induced by highway expansion over and above that which is simply diverted from other regional highways. <http://www.fhwa.dot.gov/steam/smite.htm>
- IMPACTS is a series of spreadsheets for screening-level evaluation of multi-modal corridor alternatives. Inputs are travel demand estimates by mode for each alternative. The impacts estimated include costs of implementation, induced travel demand, benefits including trip time and out-of-pocket cost changes such as fares, parking fees and tolls, other highway user costs such as accident costs, revenue transfers due to tolls, fares or parking fees, changes in fuel consumption and changes in emissions. <http://www.fhwa.dot.gov/steam/impacts.htm>

feasibility, the BCR is useful for comparing projects of different scale or financial size since it assesses economic efficiency.

For consistency reasons, it is important to clarify which items will be classified as benefits, and which as costs, regardless of whether they are negative or positive dollar amounts, since this will affect the estimation of the benefit BCR, discussed further in the next section. Typically,

all direct, indirect, and mitigation costs of constructing and implementing the project, and providing for its ongoing operations and maintenance, are labeled as costs and put in the denominator of the BCR, even if they represent cost savings relative to the basis of comparison. These cost items may include:

- Capital investment, design and construction costs;
- Right-of-way costs;
- Mitigation costs;
- Routine and ongoing annual operations and maintenance costs; and
- Periodic rehabilitation or extraordinary maintenance costs.

Other factors, whether user benefits, cost savings, eliminated costs, or even disbenefits, are labeled as benefits and flow to the numerator of the BCR. Typical HOT lane benefits may include, but are not limited to:

- The value of user travel time savings;
- Adjacent road travel time savings or costs;
- Vehicle operating cost savings;
- Accident reduction savings;
- Incident/accident reduction congestion time savings; and
- Emission savings or costs.

#### **Net Present Value**

The net present value criterion (NPV) gives the net benefit of a project in absolute present dollar terms. HOT project ‘A’ could have a higher NPV and yet a lower BCR than project ‘B’ if project ‘A’ is a larger scale project; however, in this example, project ‘B’ would be more cost-effective, generating more benefit for each dollar of cost.

#### **Economic Rate of Return**

The economic rate of return (ERR) sometimes referred to as the internal rate of return, gives the effective discount rate for which the project’s benefits would just equal its costs, in present value terms. In other words, it is the

discount rate that yields a BCR of 1.0. An ERR significantly greater than the real discount rate indicates economic feasibility even with a modest margin of error in measurement of benefits and costs.

#### **5.4.3**

#### **Environmental Approvals**

Discretionary federal actions generally require review under the National Environmental Policy Act (NEPA). In completing these reviews, the lead agency evaluates the proposed action to determine whether it is included in a list of actions that have been predetermined not to result in significant environmental effects and may be categorically excluded from environmental review. Actions categorically excluded by FHWA are identified in 23 CFR Part 771.117. Part 771 specifically excludes “modernization of a highway by resurfacing, restoration, rehabilitation, reconstruction, adding shoulders, or adding auxiliary lanes (e.g., parking, weaving, turning, climbing)” from environmental review. Certain HOT lane projects could potentially fall under this exclusion, depending on the extent of new construction or other components of the proposed action.

Environmental reviews for HOT lane projects will include the same component analyses as other highway projects. However, unlike general-purpose highway improvements, HOT lane initiatives utilize occupancy requirements and user fees as tools to manage traffic flows. As such, they can be expected to have generally positive effects on the movement of traffic and traffic-driven environmental concerns, such as noise, air quality and energy consumption. In addition, given that HOT lane projects affect traffic conditions on managed and general-purpose lanes in different ways, the analysis of traffic-driven impacts will need to quantify the resulting impacts separately, and then assess the collective effects on the environment.

In the case of HOV conversions, different environmental scenarios can be envisioned. If occupancy requirements for free travel in the HOT lane facility remain the same as for the HOV lanes they replace, traffic service and travel speeds should improve on the HOT lane corridor. These changes would result in positive environmental affects and would not require detailed assessment. However, an increase in the occupancy requirement for free travel in the HOT lane could warrant environmental analysis, as it would have the potential to induce additional general-purpose lane trips, resulting in increased congestion and lower travel speeds.

Finally, it is important to recognize that prolonged environmental reviews have the potential to delay the implementation of highway projects, and increase their capital costs as a result of inflation during the ensuing period. Transportation officials should weigh the potential for such delays carefully, especially when considering developing HOT lane projects on a public-private partnership basis. Increased delay brings with it increased risk, thereby increasing financing costs. Together these factors can render an otherwise attractive investment opportunity unworkable for potential private sector partners.

### **Air Quality**

One of the expected benefits of HOT lanes involves having more vehicles in the corridor

moving at higher and more stable speeds. Generally speaking, this should result in a benefit (albeit small) in air quality, as faster moving vehicles generate less pollution. Slower, stop-and-go traffic—which would be expected with over-utilized general-purpose or HOV lanes—would produce more pollution. While air quality review may show an advantage for HOT lanes over general-purpose lanes (at least), that advantage is likely to be fairly small and may not provide a compelling argument on its own to justify the investment. However, in conjunction with other potential benefits, air quality improvements could be a factor in garnering support for HOT lane applications.

### **Noise**

Unlike air quality, traffic-induced noise levels increase with speed. Depending on the location of the HOT lane—whether it is in the median of an existing highway, a separate alignment adjacent to the highway, or a former rail alignment, for example—and its effect on speeds, the resulting noise levels could be reduced, increased, or remain about the same. Construction of new lanes to the outside of existing lanes also could result in increased noise levels at nearby sensitive land uses. The potential for noise impacts should be assessed during the planning stage to determine the differences in the various configurations under study.

# Chapter 6

## Operational Issues

As tolled facilities, HOT lanes have a number of operational needs—such as toll collection and enforcement—that are not normally associated with general-purpose or HOV highway facilities. This chapter provides information on the different operational aspects for which HOT lane operators are normally responsible, with the exception of public outreach, which is addressed in Chapter 4.

### 6.1 Lane Management

As with HOV lanes, HOT lane traffic levels need to be limited to volumes that ensure reliable speed advantages when adjacent general-purpose lanes are congested. Without this type of management the HOT lane facilities also risk becoming congested and losing their benefits. Two issues are critical in lane management:

- Quantifying how much additional lane capacity can be made available to paying vehicles before congestion occurs; and
- Developing an understanding of the types of strategies that can be applied to regulate demand.

These issues are discussed in the following sections.

#### Maximum Capacity Versus Managed Capacity

Various references provide an understanding of highway lane capacity. This capacity is based on the maximum flow that can be expected to occur under the prevailing conditions. As volume increases, speed gradually decreases until reaching a point of instability typically between 2000 and 2100 vehicles per lane per hour. When throughput degrades beyond maximum capacity, speeds decline to levels around 15 miles per hour and flows drop as low as 1300

vehicles per lane per hour. Analysis of speed-flow data on congested highways in greater Los Angeles using the Caltrans Performance Measurement System in September 2000 suggests that contrary to the Highway Capacity Manual range of 35-50 mph, 60 mph is the optimal rush hour speed facilitating the highest throughput levels.<sup>19</sup>

When lanes are managed to promote “free flow” conditions, as is the case for HOT lanes, throughput must be contained to a level below maximum capacity. This regulated threshold, or managed capacity, is simply a management benchmark that ensures premium traffic service for HOT lane users.

Much like the design and operational variables identified in the Highway Capacity Manual, managed capacity levels may vary from one HOT facility to another depending on the number of access points, vehicle mix, roadway slope and configuration, separation treatments, and number of travel lanes. A single HOT lane will have a lower managed capacity than multiple HOT lanes. For example, flows on the Houston I-10 Katy Freeway QuickRide—a one lane, reversible-flow facility are kept to 1500 vehicles/hour. However, the SR 91 Express Lanes—which provide two travel lanes in each direction—have been able to operate at acceptable conditions with flow rates of 1800 vehicles/hour/lane.

A safe range for establishing managed capacity for most project settings would be approximately 1700 hourly automobile equivalents per lane, with the understanding that road configuration, slopes and speed limits can drive this number up or down. This threshold is reflected in a number of HOV references and locally

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<sup>19</sup> Freeway Performance Measurement Project, University of California at Berkeley, Partners for Advanced Transit and Highways, Caltrans, September 2000.  
<http://pems.eecs.berkeley.edu/login.phtml>

adopted policies, and is also appropriate for HOT lanes. Local traffic studies can be used to identify more precise, site-specific capacity levels. This may also be accomplished by studying the effects of allowing small numbers of additional onto the managed lanes in order to identify an optimal managed capacity.

It is important to understand that for any HOT lane to be successful, the facility must be regulated at a managed level that is well below the maximum capacity cited in the Highway Capacity Manual. As described above, the operators of projects including I-15 FasTrak have taken steps to open the lanes gradually to more over time, in order to insure that the HOT lanes do not become congested. This conservative approach enabled the HOT concept to gain public credibility before attempting to maximize the number of users.

### Management Tools

While the role of lane management in preserving HOT lane benefits is evident, the actual application of management techniques can be complex and dynamic. Although much attention focused on the role that pricing can play in regulating lane demand, pricing is only one of a number of management policies that can be used with HOT lanes. The following three tools are used to maintain superior traffic service levels on HOT lane facilities:

- **Pricing:** imposing a user fee on the lanes that help regulate demand by time of day or day of week. The fee increases during periods of highest demand.
- **Occupancy:** limiting lane use to vehicles carrying a minimum number of passengers. Two (HOV 2) and three (HOV 3) minimums are typical occupancy constraints.
- **Eligibility:** limiting lane use to specific types of users, such as HOVs, motorcycles, low emission vehicles, or trucks. Most typically for HOT lane settings, such use would be limited to selected hours or specific access ramps.

### Traffic Models Validate the Operational Benefits of HOT lanes

A recent UCLA Ph.D. dissertation by Eugene Kim provides new and important quantitative analysis of HOT lanes. The study, HOT lanes: A Comparative Evaluation of Costs, Benefits, and Performance uses a logit travel-demand model to compare changes in travel times associated with the conversion of an existing HOV lane in a congested corridor to:

- a general purpose lane;
- a HOT lane; or,
- a toll lane.

Kim's research finds that in almost all cases, HOT lanes or toll lanes provide greater fiscal and mobility benefits. Conversion to general purpose lanes is only defensible when HOV use is less than 7 percent of all corridor trips and when there are fewer than 700 vehicles per hour in an HOV lane. Otherwise, the implementation of tolls on HOV lanes produces greater benefits because tolling preserves free-flow conditions on the managed facility, even if congestion worsens on the general purpose lanes. Kim's modeling work also demonstrated that either tolling option would produce large delay reduction benefits regardless of whether the conversion results in a significant increase or decrease in the proportion of HOVs. Similarly, Kim's research finds that in terms of air quality the HOV base case would produce greater output of toxins such as NO<sub>x</sub> and CO than conversion to either general purpose or toll lanes. However, toll lanes would produce the largest reduction in emissions because they eliminate vehicle trips and reduce congestion more effectively compared with general purpose lanes.

Kim's research corroborates speed flow analyses and other traffic performance and air quality studies conducted around the country.

*This description of Kim's findings is based on a summary appearing in "Reason Surface Transportation Innovations Newsletter #4," Reason Institute, August 6, 2002.*

- **Access:** limiting or metering ingress to the lane or spacing access so that demand cannot overwhelm HOT lane capacity.

Applied in combination, these tools give the operating agency a wide range of opportunities to flexibly adjust demand conditions to meet available lane capacity. Traffic service conditions need to be monitored on an on-going basis to determine whether pricing structures are meeting the performance goals (e.g., traffic service, customer satisfaction) established for the facility.

### Management Measures on Two Existing HOT Facilities

On the I-15 reversible lanes in San Diego, pricing, access and eligibility all play roles in lane management. Access is limited to a single set of ingress and egress ramps with the project functioning as a pipeline. No intermediate access is provided, so mainline demand cannot be overwhelmed by too many entering vehicles. HOVs with two or more persons are given a free trip to encourage carpool formation and transit use, and others are priced. Pricing varies significantly between peak and off-peak conditions to help regulate demand. Collectively, these strategies ensure that the I-15 project provides a high-speed, reliable trip to users.

On the I-10 Katy Freeway in Houston, a single reversible lane with more limited capacity than I-15 contains about five ingress and egress locations along a 12-mile distance. The potential to overload the lane exists with this many access points. The Katy HOV lane exceeded capacity during peak hours with 2+ occupant carpools and transit, so eligibility rules were raised during these isolated peak periods to 3+. The residual capacity left by removing many of the carpools was ultimately provided to 2-occupant carpools for a price that is fixed per trip. With a very limited lane capacity the potential for dynamic pricing is not critical to managing demand on this facility, but restricting use to a smaller potential priced market was. This approach successfully ensures that as many vehicles as possible can still travel in the lane during periods of greatest demand.

#### The Conversion of HOV Facilities to HOT Operations

At present, approximately 70 percent of the nation's HOV lane miles operate with peak hour volumes of between 900 and 1500 vehicles/hour. Ten to 15 percent are operating with over 1500 peak hour vehicles, and the remaining 10 to 15 percent below 900 vehicles in peak hours. This suggests that there is some available capacity to allow other user groups on certain HOV facilities. However, residual capacity is quite limited and additional traffic levels would need to be managed closely.

Changes in occupancy regulations on HOV facilities can alter utilization levels and result in additional capacity becoming available for possible use by non-HOV vehicles. Occupancy requirements are set at 2+ on approximately 95 percent of all lane miles operated in the United States. An increase to HOV 3+ operation can be expected to lower traffic levels dramatically,

making an HOV 2 or SOV possible, as was the case with the Katy Freeway in Houston.

Access to HOV lanes is either continuous or at designated locations. About half the nation's lane miles restrict access to designated locations. An access designation threshold is typically not less than every 2-3 miles. Few of these sites with restricted access have changed access yet to make lanes more restrictive when volumes reach capacity. This is one tool that may be used more in the future.

#### An Ongoing Process

The role of operations management is critical to successful HOT lane performance. The role relies on a fundamental understanding of the facility's available vehicle carrying capacity under varying conditions, and an understanding of how various management tools can be employed in combination to achieve reliable "free flow" conditions while optimizing utilization. This balancing process can be extremely dynamic, changing when incidents occur and as demand builds and falls in each successive peak period. The ability to manage a HOT lane requires an ongoing monitoring presence and ability to aggressively react to conditions that adversely affect roadway performance. Without this complement of operations presence, a HOT lane is unlikely to meet its objectives in commute periods when it is most needed and justified.

## 6.2 Toll Collection and Registry Procedures

### 6.2.1 Pilot Period Monthly Permits

During pilot test periods, monthly permits may be issued to a select group of motorists. While this approach does present certain enforcement challenges, the permit system is low in cost and easy to implement. In both Houston and San Diego, HOT lane operations were first implemented on test basis in order to determine

whether they would achieve the desired effects on traffic operations and also win the acceptance of the public. As such, it was important to minimize the upfront costs, so rather than relying on expensive electronic toll collection equipment, HOT lane users were issued monthly permits that they displayed on their vehicles. The permits are generally hang-tags or stickers that can be mailed to participating motorists who then display them on their windshields when using the HOT lane. The hang-tags or stickers need to be visible for enforcement purposes, but should not obstruct the driver's view.<sup>20</sup>

Although test programs relying on monthly passes are relatively simple to implement, they have a downside in that they involve selling a month of unlimited trips and cannot sell single trips in the same way that that ETC technologies can. When equipped with an ETC transponder, motorists are able to make discriminating decisions about when to pay for the premium travel conditions the HOT lanes provide.

### 6.2.2 Automated Variable Priced Toll Collection

If HOT lane operations are maintained on a permanent basis, it is best to automate toll collection. The equipment requirements and technical functions of automated toll collection systems are described earlier in Section 4.2.

A protocol for distributing transponders to customers needs to be established, together with a financial/accounting system to reconcile

<sup>20</sup> A similar approach was followed on the now defunct Connecticut Turnpike in the 1950's and 60's. Instead of a tag, a license plate was affixed to the front of the vehicle. Similarly the Delaware River Port Authority (DRPA), which for years used a monthly "Bar Coded" system enabling holders to pay a much lower toll in automated lanes if they used the DRPA bridges more often in a given month.



**Figure 22.**  
**I-15 FasTrak Service Center**

patron accounts as well as toll payments attributed to other agencies where reciprocity has been established for toll payments. These functions, whether facilitated by public or private agency, could be performed by that agency or potentially outsourced.

#### Issuing Transponders

Generally motorists order transponders by telephone or over the Internet. In certain cases they are also available at a customer service center (Figure 22). Payment policies also need to be established, and operating agencies may find it to their advantage to require users to pay via credit or debit cards rather than cash. Similarly, HOT lane operators will also need to determine whether or not motorists should be required to pay a fee to obtain the transponder itself.

In certain cases, HOT lane operators may use a region-wide automated toll collection system. If this is the case, the agency will need to adhere to the distribution policies and window placement guidelines established by the regional consortium of tolling agencies that use the technology.

#### Registry Procedures

Given that all tolls are collected electronically and involve no cash transactions, internal



accounting procedures for HOT lanes are simpler than those required by traditional toll facilities. The computer systems and software running the ETC equipment are also capable of instigating credit card transactions, generating bills, and generating detailed reports allowing agency officials to track all financial activity.

If the HOT lane operator is participating in a region-wide automated toll collection system, the facility will be assigned a use code that will be included in all transactions in order to distinguish it from other tolled facilities.

This is the case in Orange County in particular, as well as Houston, both of which operate a HOT lane facility in addition to regional tollroads. Both types of facilities share the same transponder technology, same accounting database, and same outlets for purchasing and subscribing to the various programs (although there are some unique exceptions to this at each locale). Recent experience shows that use of HOT lanes is made more convenient if the transponders for a project are the same as for other toll facilities in a given locale or region.

### 6.3 Enforcement

Enforcement procedures need to be established for HOT lane facilities to ensure that motorists comply with both occupancy and toll policies.<sup>21</sup> Given that toll collection on HOT facilities is electronic, some violations may be unintentional as unfamiliar motorists might expect to be able to make a cash payment at a manned toll booth and then be unable to exit due to the presence of barrier systems. Equipment malfunctions could result in nonpayment by regular users who have every intention of paying

<sup>21</sup> With the proper systems in place, the enforcement of HOT lane facilities should be no more difficult than that of HOV facilities. Given that HOT facilities provide SOV motorists with a legal option for obtaining faster trips, HOT lanes may actually reduce the temptation to violate.

the prescribed toll. Nonetheless, drivers can also avoid payment intentionally, such as using tags reserved for vehicles paying lower tolls (i.e., HOVs), shielding the transponder, or using the HOT lane without a tag.

Consistent signage and police presence should convey the message to motorists that the likelihood of being cited for violations is high. It is especially important to educate motorists during the first days of operation and then to continue reinforcing the message.<sup>22</sup> One of the most effective techniques is to install signage that explains the use of video enforcement techniques. Visible and consistent police presence near tolling points further reduces the likelihood of violations and deters motorists from fraudulent activity, the use of the wrong tag, or the opportunity to “evade the toll”. Violators are also less likely to enter a HOT facility if there are limited opportunities to escape and if the perception of being caught is high.

At the operational level, enforcement can be implemented using several different surveillance and detection procedures. The methods chosen depend on several factors including the nature of violations police are trying to address and the physical characteristics of the corridor. Enforcement personnel should provide input during the planning and design of HOT lane facilities in order to optimize their ability to patrol them once they become operational.

#### 6.3.1 Enforcement Techniques and Procedures

##### Toll Collection

Given their strong dependence on automated toll collection systems, the enforcement of toll infractions on HOT lanes also relies heavily on those same systems. The general trend in

<sup>22</sup> Seattle routinely uses a special motorcycle enforcement squad for the first six months of any HOV project operation.

enforcing toll collection on HOT lanes and other facilities using ETC technologies is video surveillance. This approach involves the use of in-lane toll violation cameras at tolling points, which are integrated with other ETC systems and triggered when incomplete or anomalous transactions occur. This is a highly effective, cost-efficient, and non-intrusive method (Figure 23).<sup>23</sup> Repeat offenders are generally subject to legal action, as are those who shun payment. Special state legislation is normally required before automated video surveillance enforcement methods can be put in place. Legislation is also likely to be needed to provide access to Department of Motor Vehicle records.

### Occupancy Requirements

Given the limitations of automated technologies and the difficulties of verifying the number of occupants in a vehicle, the enforcement of occupancy requirements requires routine visual inspection. Several challenges are involved including vehicle design, tinted windows, inclement weather, limited lighting, lack of enforcement locations, and small occupants such as children and infants who may not be clearly visible to outside observers. Enforcement officers generally park adjacent to the lanes and stand outside their vehicles to have a better view of the approaching vehicles. This approach can be effective, but can increase congestion especially if more than one patrol vehicle is involved. A physical inspection of suspected occupancy violators has proven an effective enforcement technique on the I-15 in San Diego.

Given the difficulty and associated delays of stopping violating vehicles while they are traveling on barrier-separated facilities, traffic cita-

<sup>23</sup> Legislation may be required in order to use cameras for law enforcement purposes in certain locations. Fixed, single-frame toll violation cameras should not be confused with video surveillance systems that use steerable moving picture cameras to survey larger areas in order to monitor traffic conditions and detect incidents.

### Automated Violations Processing

When video enforcement is used on facilities such as the E-470 EXPRESS Lanes in Denver Colorado or the Port Authority of New York and New Jersey's bridge and tunnel crossings, a Violation Processing Center (VPC) is established to process transactions. An investigation into a potential violation is triggered by when the violation of a business rule is detected. This could involve a mismatch between tag class and AVC class; a vehicle entering with no tag; a vehicle using a lost, stolen or otherwise invalid tag. In such a case, the ETC systems communicate in real time with in-lane toll violation cameras that capture an image of the license plate of the suspect vehicle. The image and other information related to the anomalous transaction are then transmitted digitally over a secure fiber optic backbone from the lane to a local computer, and then on to a violation host computer at the VPC which receives similar information from all tolling points. Here each image linked to a transaction is viewed for clarity and checked against a list of a registered program subscribers before an invoice for the toll and administrative fee is mailed to the violator. Department of Motor Vehicle records are used to verify the name and addresses of the registered owners of the violating vehicles, and reciprocity agreements are often put into places among state using compatible ETC systems to obtain information on out-of-state vehicles. Violations processing is covered by legislative action which generally is based on tort offense (as opposed to a motor vehicle violation) and is linked to a person's ability to renew his or her license registration if the violation is not paid. It also allows court intervention. Violators generally receive a warning/fine (toll + administrative fee) through the mail containing the picture with the date, time and location of the violation.

tions are generally sent by mail to owners of violating vehicles. This practice generally requires specific state legislation and has been an effective tool in addressing HOV violations.<sup>24</sup>

### Pilot Programs

There are different enforcement issues when considering pilot projects involving monthly permits. In such cases enforcement relies only on visual identification, with officers searching for a decal or placard on the vehicles using the

<sup>24</sup> In Virginia, where citations are sent by mail if an enforcement officer visually documents an HOV occupancy violation, there has been a ten-fold increase in the number of citations issued and a corresponding reduction in violations.



**Figure 23.**  
Camera

HOT lane and determining the vehicle occupancy of those not displaying passes. This complicates the split-second decision-making process confronting enforcement officers and allows only for random challenges much like looking for out of date motor vehicle tag registrations.

### 6.3.2 Penalties

Penalties for violations must be adequate to discourage the willful violator such that reliance on dedicated enforcement officers can be minimized. Penalties on HOT/HOV projects in the United States vary from \$40 to over \$310 (\$100 plus court costs) for the first offense. In California, HOV penalties become rather steep after the third offense, rising to over \$1000 inclusive of court costs.

Signs should be posted indicating fines for violations and that police are enforcing the facility. Empirical evidence suggests that when fines are sufficiently high, observed violations for such offenses may be reduced significantly.

### Performance and Monitoring

A systematic monitoring program is required to determine compliance levels and provide a basis for fine-tuning HOT operations and enforcement requirements. Funding to support enforcement activities should include a contractual arrangement for reporting requirements from the enforcement agencies. The data in these reports would be of great benefit for future planning and for identifying resource requirements for ongoing enforcement and future HOT projects.

Helpful performance monitoring information includes:

- The method of enforcement (officer, officer with video, etc.);
- The time the enforcement commenced/ended;
- The location where enforcement took place (direction and location);
- The number of police personnel on duty (members supplied, person hours used);
- A summary of violations (warnings issued, violation tickets issued, etc.);
- General notes regarding typical response by motoring public and challenges faced in carrying out this type of enforcement; and
- The results from any court actions regarding dispute of HOT/HOV violations.

This information can be used to correlate the level of police efforts with compliance in a corridor and provides information that can be used to fine-tune enforcement activities.

## 6.4 Incident Management

Incident management is critical on HOT lanes. The need for effective management is two-fold:

First, it is essential to maintain premium travel service conditions on HOT lane facilities, and this requires quick response and rapid clearance when incidents occur.

Secondly, given that HOT lanes are likely to be separated by physical barriers, vehicles may not be able to navigate around disabled vehicles, introducing the risk that all traffic traveling on the facility comes to a standstill.

Because of these realities, real-time traffic sensing and surveillance equipment should be used to monitor travel conditions on the HOT lane facility at all times, with the proper authorities notified whenever there is a severe deterioration in speeds or traffic service. Incidents should be reported to response agencies within minutes of their occurrence. In addition to the right technology, quick detection also depends upon observant staff.

### Access

The major difference on a HOT lane when an incident occurs is normally the limited access points. The site, depending on the incident (fire, injuries), can often be reached from other lanes more easily than from the actual HOT lane. Protocols for responding to different types of incidents should be established in advance, with appropriate training provided to all response personnel. On-scene traffic control is also critical in maintaining traffic flows on other lanes and allowing tow truck and rescue vehicles to access the actual incident location if necessary. Tow trucks and rescue vehicles are typically brought in from the opposite direction of traffic if the lanes are completely blocked. Attempts should be made to keep at least part of the facility open to allow inbound response agencies to reach the incident depending on the magnitude, type and location of an incident as well as the physical constraints of the facility.

### Plans and Procedures

Response training should include the criteria for use, procedures for getting messages posted, and the process for activating and deactivating messages. Incident Response Plans and Emergency Procedures including drills must be prepared in concert with all response agencies to cover various types of incidents including accidents, breakdowns, snow/ice control, other routine maintenance, and major occurrences, such as an evacuation or special event. Plans also need to be developed to close HOT facilities to traffic in the event of certain incidents.

## 6.5 Maintenance

HOT lane operations require the maintenance of the roadway, including the pylons or barriers, signing and markings, and electronic toll devices and infrastructure. Maintenance activities are also likely to include repair, rehabilitation and replacement of equipment, pavement, shoulders, signs, barriers, pylons and markings. Each component requires an assessment of

### Typical Incident Response Plan Issues

- Maximizing response to blocking incidents
- Establishing emergency vehicle alternate access routes when lanes are altered or closed
- Providing advanced incident response training for all responders
- Conducting at least one training exercise to test the incident response plan
- Providing the briefing to the media and seek their support for more frequent traffic reports
- Maintaining a liaison role with the key response agencies throughout all phases of construction
- Developing and maintaining a comprehensive list of all key project personnel including emergency numbers
- Identifying alternative routes
- Providing public notifications thru the National Transportation Safety Board's (NTSB) Highway Accident Report (HAR); news media; agency; project or traffic websites

### Additional Construction Period Incident Response Issues

- Implementing 24 hour stationary or roving service patrols in the construction zone
- Creating temporary collision investigation/enforcement sites within the construction zone
- Establishing the construction zone as an immediate tow area
- Developing agreements with the construction companies to use their heavy equipment to assist in clearance of debris from truck accidents
- Identifying landing locations for medical response helicopters near the construction zone
- Offering presentations to key stakeholders such as the trucking industry, major employers and automobile clubs before construction starts
- Installing surveillance throughout the construction area to detect an incident and monitor traffic flows

how often maintenance should be performed and when major replacements or rehabilitation are required so that funding may be reserved.

It is also important to consider the initial capital costs for equipment, signage and ETC equipment, as well as equipment for snow and ice removal in colder climates.

If the facility is to be privately owned and operated, then a maintenance fleet may need to be assembled, housed and maintained separate

from the state DOT, specifically for the HOT lane. Alternatively, a private owner may contract with a state DOT or public tollroad operator for maintenance, in which case the agency may need to augment its maintenance fleet for that facility. Even if it is state owned and operated, there is always the potential need for additional maintenance vehicles and personnel.

# Chapter 7

## Current HOT Lane Experience

This chapter provides descriptive case studies of the four HOT lane facilities currently operating in the United States, as well as two recent HOT lane initiatives. Presented in a parallel format, the cases illustrate the variety that abounds in the nation's HOT experience, as well as many common themes.

The cases have been assembled through review of project documentation and interviews with associated state, county and local officials, as well as with consultants and private concession companies. While they present different points of view and offer observations on how and why various occurrences came to pass, the cases are intended to be journalistic and non-judgmental. Most importantly, they offer real-life illustrations of the different policy and technical issues addressed in the earlier chapters of this document.

### 7.1 Houston's QuickRide System: IH-10 West Corridor "Katy Freeway" and US 290 "Northwest Freeway"

#### Background

Houston's IH 10 Corridor, known commonly as the Katy Freeway, extends 40 miles from the Central Business District of Houston west to the Brazos River (Figure 24). It was constructed from 1960 to 1968 to replace the old Katy Road, when Houston was a much smaller city. Since its construction, explosive growth in private residences, corporate offices, and retail centers along the route have made the IH-10 corridor a central artery of western Houston.

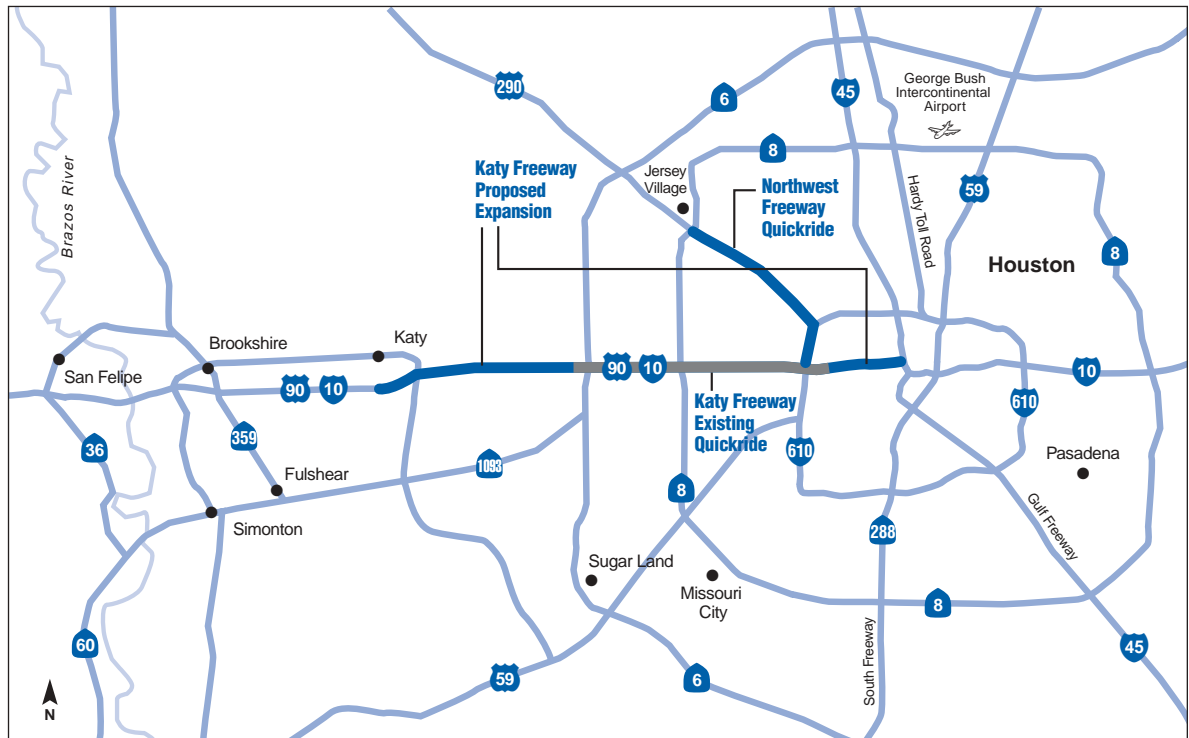
Designed to carry 79,200 vehicles per day, the Katy Freeway now carries over 207,000 vehicles per day, and it is considered one of the

most congested stretches of freeway in Texas. The Katy also has the highest daily truck volumes of any roadway in the state. Traffic generated from six radial highways, nine employment centers, the Port of Houston, and through truck traffic are all compressed into three lanes in each direction. Congestion may be present for 11 hours or more each day, extending well beyond conventional peak hours, and there is even congestion for long periods during the weekends. Some estimates place the cost of the Katy's traffic delays to commuters, residents and businesses at \$85 million a year.

As currently configured, the Katy Freeway has three main lanes (or general purpose lanes) and two frontage-road lanes for most of its length in each direction. Situated in the center of the freeway is a barrier-separated high-occupancy vehicle/toll (HOT) lane for carpools and buses, making for a total of 11 through lanes. A single reversible lane, the HOT facility handles inbound traffic in the morning and outbound traffic in the evening. The HOT lane, which runs for 13 miles from west of State Highway 6 to west of Washington Avenue, has been in operation since 1998, when it was converted from the freeway's original high occupancy vehicle lane dating from 1988. Although the Texas Department of Transportation (TxDOT) owns and operates the Katy Freeway, the center QuickRide lane is operated by the Harris County Metropolitan Transit Authority (Houston Metro), which operates all HOV lanes in the region. This arrangement adds some institutional complexity to the HOT facility.

For a number of reasons, the Katy Freeway makes for a rich study of HOT lane implementation. First, the QuickRide system offers an example of a regular HOV lane converted to a tolled high-occupancy facility, as well as of HOT lane operation. Additionally, current planning by TxDOT and other Houston transportation agencies for a major reconstruction

**Figure 24.**  
**Katy Freeway and**  
**Northwest Freeway**  
**Location Map**



of the Katy Freeway may bring a dramatic expansion of the center HOT lane. The various agencies involved in the Katy and the alternatives under consideration for its expansion provide a window into some complex dimensions of HOT lane planning. Finally, the success of the Katy HOT lanes encouraged Houston Metro to expand the QuickRide system in November 2000 to another well traveled corridor in the region, the Northwest Freeway or US 290.

### 7.1.1 The Katy QuickRide HOV Beginnings and Conversion

Since the 1980s, escalating travel demand on the I-10 West in Houston has pushed transportation planners and engineers continually to find new solutions to accommodate growing traffic. In 1984, TxDOT and Houston Metro opened an HOV lane on the Katy Freeway. As a joint project of Houston Metro and the State Department of Highways and Public Transportation, the Katy HOV lane was constructed with support from Federal Transit Administration (FTA) funds. Its operation was

initially dedicated for transit. Although it now operates as a high occupancy toll lane under Houston Metro's QuickRide, the lane's physical form has not changed. Today, two plus-occupant vehicles may pay to use the reversible one-lane facility during hours when three-plus requirements are in effect. Concrete barriers separate the 13-mile QuickRide lane from three outer general purpose lanes in each direction, and there are three intermediate access points.

When the Katy HOV lane first began operating, eligibility requirements were at their most restrictive. Initially, only buses and authorized vanpools were allowed to use the lane. The resultant under-utilization gradually encouraged a loosening of the HOV entry rules, and slowly, registered carpools of four or more, then three or more, then two or more were allowed into the lane. As restrictions were relaxed, traffic on the facility grew, and more restrictive carpool rules were eventually reinstated at certain hours of the commute to reduce traffic on the facility. When congestion in the lane under two-plus HOV operation

began to defeat the lane's travel time advantage, the three-plus carpool restriction was reinstated.

With two-person carpools no longer allowed, the number of persons moved by the lane during the peak hour declined 30 percent. Attempting to increase the number of people moved by the HOV lane while also preserving the facility's time advantage, Houston Metro and TxDOT launched a value pricing pilot on the existing 13-mile HOV-lane in January of 1998.

The QuickRide program, initially funded as an FHWA Priority Corridor Program and designated as a value pricing pilot, converted the Katy Freeway HOV-lane to a high-occupancy toll lane that uses price and occupancy requirements to manage traffic service in the lane.

### The QuickRide System

Under the QuickRide system, still in operation by Houston Metro in 2002, buses and three-plus carpools continue to use the Katy HOT lane free of charge at all times, and single-occupant vehicles continue to be prohibited from the lane. Two-plus carpools may use the lane without charge during the morning and evening rush hours, except during its greatest peaks—from 6:45 AM to 8 AM and from 5 PM to 6 PM Monday through Friday. During these times, when demand for the facility is greatest, two-person carpools may use the lane for a \$2.00 toll; only three-plus carpools use the lane for free.

The exclusion of single-occupant vehicles from the lane makes the Katy QuickRide one of two HOT-lane facilities in the U.S. that does not allow single-occupant users if they are willing to pay a toll. The other is Houston's Northwest Freeway, also part of the QuickRide system. When operated as a regular HOV lane, the Katy lane was at near-gridlock. The decision by QuickRide operators to disallow single occupant drivers to use the lane—even if will-

ing to pay the toll—reflected the corridor's high travel demand and its limited capacity (one reversible lane), as well as SOV use restrictions tied to the HOV lane's original construction financing from the FTA. The admission of single-occupant vehicles (SOV) to QuickRide would quickly congest the facility, unless the fee for SOVs were high enough to deter most from using the lane. Operators expected that the number of two-plus carpools that would take advantage of the buy-in opportunity would still allow the lane to operate at free flow.

### QuickRide Operations

Since its inception on the Katy, the QuickRide system has used fully-automated toll collection. In fact, the Federal Priority Corridor earmark used for the project was designed specifically to fund ITS applications. Original project plans for the Katy included the use of revenue collection technology in the corridor.

Windshield-mounted electronic transponders are issued by Houston Metro, and transponders issued by the Harris County Toll Road Authority (HCRTA) are also accepted at the facility, provided users enroll in the QuickRide program and submit the transponder ID number. The QuickRide application form outlines the facility's operating procedures, applicable fees, required equipment, monthly billing statements, violations and penalties, and conditions for termination of service.

Large digital displays at approaches to the QuickRide lane inform drivers when QuickRide rules are in effect, and overhead readers deduct the toll from the user's prepaid account. An initial balance of \$40 is required on each transponder. When the account balance falls below \$10, the user's credit card is charged to bring the balance back to \$40. Monthly statements reflect all trip costs and credit card charges. In its first year operating QuickRide, Houston Metro limited to 600 the number of transponders issued to use the facili-



ty. As of April 2002, it had issued over 1,500 transponders for QuickRide access on both the Katy Freeway and the Northwest Freeway QuickRide lanes. The initial cap on transponders allowed facility operators to regulate the limited spare capacity on the HOV lane

### QuickRide Public Outreach

Before launching the QuickRide program, Houston Metro and TxDOT, along with a private consultant, conducted a number of focus groups to assess public sentiment toward the proposed fee system. Additionally, the public information staffs of both agencies identified issues that would be important to address when crafting marketing and public information materials for launching the QuickRide program.

Rather than create a separate administrative entity for the QuickRide system, the project sponsors chose to direct potential users to the Metro carpool matching service. In program brochures and on the QuickRide website, potential customers are instructed to call the METRO RideShare Information Line for an application.

In late December 1997, public advertisements for the QuickRide program began to appear in print and radio media outlets. Outreach efforts also included distributing press releases and direct mailing brochures and applications to households in targeted zip codes.

The QuickRide webpage has been another source of information for the public. (See <http://www.houmetro.harris.tx.us/services/quick-ride/asp>.) The site is simple in comparison to webpages for the privately owned SR-91 and publicly operated I-15, but it provides necessary information about the facility and its operations. By contrast, the SR-91 website allows potential users to apply for an account online, and offers current users the ability to manage existing transponder accounts online. The I-15 website provides a downloadable application

form for its FasTrak program. Applicants to the QuickRide program may download an application from the QuickRide webpage or may call the Metro RideShare to request one.

### 7.1.2

#### After Katy Success, QuickRide Expands to US 290

In fall 2000, Houston Metro launched QuickRide operations on a second HOV facility in Houston: the Northwest Freeway, or US 290, which connects the northwest suburbs of Houston with downtown, feeding into the 610 loop. Like the Katy, the Northwest Freeway has hosted an HOV lane for over a decade. As demand for the facility grew rapidly in the late 1990s, Houston Metro studied the possibility of increasing the occupancy requirements on the facility and introducing QuickRide operations. These changes were implemented gradually in 2000, making the Northwest Freeway Houston's second HOT facility.

In 1990, Houston Metro opened an HOV on the Northwest Freeway. The Northwest lane runs for 13.5-miles and has operated as a one-lane barrier-separated reversible HOV lane since its inception. Under HOV operations, travel in the Northwest HOV lane was permitted only for transit, school and private buses, taxis, vanpools and two-plus carpools during the peak morning and evening periods. The lane's design encourages transit use, as most of its access points are through transit stations or park-and-ride lots. Through the 1990s, lane use expanded, and by 1998, the facility served 6,400 vehicles and 16,200 passengers daily. From September 1997 to April 1999, the lane witnessed a 37% increase in the number of peak hour vehicles. This rapid increase, particularly during the AM peak, caused operations to deteriorate. Average speeds in the Northwest HOV-lane slowed to between 20 and 30 mph in the AM peak and the level-of-service sunk to "F."

Crowded HOV conditions also impacted buses and bus passengers using the facility. Buses serving the Northwest's park-and-ride facilities experienced on average 15-minutes of delay as well as increased operating expenses. Additionally, the large number of cars exiting the HOV facility at its terminus at the Northwest Transit Center negatively impacted the efficiency of bus movements and bus transfers that take place there. Commuters who arrive at park-and-rides along the facility and use buses on the Northwest HOV lane to reach downtown were particularly distressed. Commuter complaints to Metro noted deteriorating operations, delays, reliability problems, and lateness.

As Houston Metro considered how to address the situation, the successful three-plus HOV operation on the Katy stood out as a possible solution. Before and after studies of the Katy showed that its HOT lane application had the following positive results:

- It increased the number of three-plus carpools during the peak;
- It redistributed two-plus carpools to before and after the peak hour;
- It increased average traffic speeds and improved the Katy HOV's level of service; and
- It transported the same number of passengers more efficiently.

Metro engineers concluded that implementation of three-plus carpool requirements would restore travel time benefits on the Northwest HOV-lane during the AM peak, when crowding was most problematic. The step was viewed as necessary if Metro was to maintain its policy of operating HOV-lanes at 50 mph or above. TxDOT approved the proposal, and in early 2000, Metro changed occupancy requirements on the Northwest HOV from two-plus to three-plus carpools only during the morning rush. The facility experienced a noticeable drop in usage, alleviating crowding and restoring levels of service for transit users.

In November 2000, high occupancy toll operations were launched on the Northwest Freeway. While three-plus operations in the AM peak had relieved the significant congestion problems, there was now some spare capacity on the lane. As with the Katy HOT lane, the extra capacity was opened to paying two-plus carpools, and it continues to operate on this basis. QuickRide allows paying two-plus carpools to use the lane only in the morning peak when three-plus occupancy requirements are in effect. From 6:45AM to 8:00AM, when the facility serves inbound traffic, three-plus occupant vehicle may use the lane for free, but two-plus vehicles must pay \$2.00 to use the lane. Single-occupant vehicles are never allowed on the Northwest's QuickRide lane, making its occupancy strategy identical to the Katy's. QuickRide transponders are accepted at both the Katy and Northwest high occupancy toll facilities. As of April 2002, over 1,500 transponders were in circulation for use on the two facilities, and an average of 160 users traversed the two facilities each day.

### 7.1.3

#### An Expanded Vision for Katy HOT lanes

The QuickRide Program in place on the Katy Freeway and the Northwest Freeway offers a notable example of HOV operations expanded to incorporate HOT lane use. Moreover, the Katy and Northwest HOT lanes are unique for prohibiting the entry of single-occupant vehicles, even on a fee per trip basis. While the evolution of the QuickRide system is a useful case study in itself, the number of paying users that these two facilities could accommodate is limited. Expansion plans for the Katy Freeway are currently under consideration and could significantly increase the scale and scope of HOT lane operations in the Katy Corridor. As they currently evolve, these plans also provide insight into some aspects of HOT lane planning and implementation.

#### Expansion Plans for the Katy Freeway

In 1995, TxDOT initiated a Major Investment

Study (MIS) of the Katy Freeway corridor. Following federal requirements for major transportation investments, the MIS was intended to identify present and future mobility needs in the corridor, evaluate alternatives for transportation improvements and investments, and assess local environmental and community concerns. The study identified seven alternatives that could be pursued to improve the freeway, ranging from a no-build option to the addition of fixed-guideway transit with improved transit access and feeder routes. The MIS process then examined each alternative for engineering feasibility, transportation impacts, environmental consequences and financial feasibility, and ultimately presented a locally preferred alternative.

The preferred alternative would add one HOV-lane from downtown Houston to IH-610 and from SH-6 to Katy, and would have two special use or managed lanes in each direction between IH-610 and SH-6, one general purpose lane in each direction between IH-610 and Katy, and auxiliary lanes and frontage roads at major intersections. This scheme would expand the Katy's current 11 lanes to 18 lanes, with a total of four general use lanes in each direction, two managed lanes (without defining what type of managed lane) in each direction, and three lanes on frontage roads in each direction. In 1995, TxDOT estimated the plan would cost roughly \$1.1 billion, and revenue from the special use lanes would total \$225 million over 25 years. Construction would begin in 2003 and continue for 10 years, and a combination of Federal and State funds gathered primarily from fuel taxes would finance the construction.

One aspect of the TxDOT proposal that is of particular interest to HOT lane planning is the fact that the operation of the four managed lanes is left unspecified. In fact, according to TxDOT, the managed lane/special use concept was used as a placeholder when developing the preferred alternative, and the TxDOT has contracted with the Texas Transportation Institute

(TTI) to study alternative operational strategies for those lanes. They could, for instance, be used as dedicated truck lanes or as toll lanes.

After the MIS results and a follow up environmental impact study (EIS) were sent to the FHWA for a record of decision, planning for the Katy Freeway corridor took an unexpected turn. In March 2001, the Harris County Toll Road Authority (HCTRA) proposed to assume responsibility for the four managed lanes and to construct them as a regular toll road. HCTRA's offer would create a HCTRA sponsored tollway in the Katy Freeway median, and add to the two toll facilities in Harris County already operated by the authority.

As the traditional toll road operator in the area, HCTRA viewed the planned Katy expansion as an opportunity to add a facility to its operations. The authority would operate the two managed lanes in each direction as toll lanes. HCTRA also offered to provide \$250 million in revenue bonds backed by toll revenue from its existing facilities to finance construction of the Katy special use lanes. HCTRA also offered TxDOT another \$250 million as a loan to be paid back over 10 years; this loan would free other TxDOT funds for spending on other projects in the Houston District.

Federal review is needed on two counts for the HCTRA plan: (1) for the environmental impacts and (2) for the proposed tolling strategy. First, a supplemental EIS may be required for the HCTRA plan. Although the FHWA had issued a favorable record of decision in February 2002 on the Katy EIS, HCTRA's proposal to build and operate the four center lanes as a tollway was announced after the EIS was submitted to federal authorities. If the potential environmental impacts of HCTRA's operating plan for the four lanes differ significantly from those outlined in the original EIS, FHWA may require a supplemental EIS. This could lengthen the environmental review process and could alter the consensus crafted

on the original expansion plan. As of June 2002, FHWA was determining whether a supplemental EIS was needed. Second, the FHWA will have to approve tolling on the expanded facility—not just for two-plus carpools, but for single occupant vehicles as well. As discussed below, TxDOT and HCTRA have sought approval for the plan through the Value Pricing Pilot Program.

#### 7.1.4 Lessons Learned

##### Public Outreach

Most institutional representatives interviewed for this case study report that a broad consensus favors reconstruction of the freeway. The corridor's extreme congestion and poor road conditions have helped to build support for reconstruction, and the public outreach process followed during the major investment study also worked to identify a solution with broad public support.

Aiming to provide public input and oversight into the study, the MIS process involved years of discussion, planning, and public meetings with businesses, community members and elected officials. A formal Steering Committee for the study included representatives from TxDOT, the City of Houston, the Houston-Galveston Area Council, FTA and FHWA, Houston METRO (the Metropolitan Transit Authority of Harris County), and the Texas Natural Resource Conservation Commission. A Conceptual Advisory Group facilitated input from other neighboring political jurisdictions, business associations, and community groups.

During the study period, a total of 14 public meetings were held and nearly 1400 individuals participated. Public concerns raised during the study addressed operational issues on the existing HOV-lane, including concerns about the limited access points to the QuickRide lane and its limited ability to serve more drivers or to accommodate increasingly two-way travel.

Some expressed the need for greater connectivity between the Katy and other HOV facilities.

Local elected officials, including Congressional representatives, the County Judge, and the area's representative to the three-seat Texas Transportation Commission, have largely voiced approval of the expansion plan. Officials have emphasized the financial advantages to using HCTRA funds to construct toll lanes on the Katy. The public has not had a chance to formally comment on the toll proposal.

##### Institutional Issues

The number of public agencies with an interest in the Katy Freeway makes for complex institutional considerations in planning for HOT lanes in the corridor. Although the Katy Freeway itself is owned and operated by TxDOT, FTA funds were used to construct its median HOV lane, reserving the lane for transit and carpools. Moreover, since its inception, the center HOV lane has been operated by the Houston Metro, a transit agency, under a cooperative agreement between Metro and TxDOT known as the Transitways Master Operations and Maintenance Agreement. When Metro has contemplated changing occupancy requirements or levying tolls for two-plus users on the Katy (or on the Northwest Freeway HOV for that matter), TxDOT has had to approve the measure. Additionally, under the Katy's current configuration, Metro cannot allow SOVs on the QuickRide facility because the FTA's original investment in the lane.

Given current proposals for the Katy's reconstruction and expansion, the future of HOT lanes on the freeway involves additional institutional considerations. For one, HCTRA's offer of \$250 million to finance construction and to operate Katy toll lanes has considerable appeal to local authorities. Financing from HCTRA would allow the project to be built sooner and would free funding formerly designated for the Katy for use on other projects in the region.

Second, because HCTRA's proposal would allow tolling of SOVs on the Katy managed lanes and because the Katy is an interstate, the plan requires FHWA approval. As outlined in the 1998 Transportation Efficiency Act for the 21st Century (TEA-21), the FHWA has the power to approve proposals to test the feasibility of new tolls on existing Interstate highways. HCTRA and TxDOT did seek FHWA approval for construction and operation of four toll lanes within the Katy; however, FHWA declined the request to toll only the four middle lanes on the interstate. FHWA interpreted the TEA-21 provision as giving it discretion over tolling proposals for interstate sections in their entirety, not just for the four center lanes.

HCTRA and TxDOT have subsequently sought and won FHWA approval for the proposal under the Value Pricing Pilot Program. In anticipation of the tolling of the four managed lanes, the two agencies requested a change in the Value Pricing Pilot Program already in place on the Katy. Review of this request by the FHWA's Division Administrator has indicated that the current Value Pricing Pilot Program approval for the Houston area covers the changes anticipated by TxDOT and HCTRA to the Katy Freeway.

A third issue arises because FTA has a stake in the Katy: HCTRA and the FTA must negotiate a plan for transit access to the proposed expanded facility. For instance, will the hours for HOT operations be expanded? Will buses be able to use the facility for deadheading? What would the implications be if the number of buses on the facility increased significantly?

Finally, for the HCTRA proposal to move forward, a host of issues would have to be addressed collectively by TxDOT, HCTRA and the FHWA. FHWA has advised TxDOT and HCTRA to develop a Cooperative Agreement that would implement the project, detail its variable tolling strategy, discuss what parameters would govern the expenditure of Katy toll

revenues, outline data collection efforts for the Value Pricing program, and address the need to collect tolls until the bonds are retired.

## 7.2 SR 91 Express Lanes

### Background

California's 91 Express Lanes™ is a toll facility providing two lanes in each direction between the SR 91/55 junction in Anaheim and the Orange/Riverside County Line. The Lanes run for approximately 10 miles in the median of SR 91 and access points to the Express Lanes are provided only at each end of the facility (Figure 25). The availability of additional publicly owned right-of-way in this super congested corridor played a large role in the facility's creation; the available ROW made it possible to provide two travel lanes in each direction.

The facility is fully automated and users must possess an electronic transponder to use it. Although the project is a toll facility, the 91 Express Lanes function similar to a HOT lane facility in that carpools are encouraged via lower toll rates; vehicles with 3 or more passengers may use the facility at a 50 percent discount.

The SR 91 corridor in which the Lanes are situated is one of the most heavily traveled routes in Orange County, California, and one of the most highly congested freeway corridors in California. On a typical day, roughly 250,000 vehicles use the route, and before the 91 Express Lanes opened, peak period delays between 20 and 40 minutes were common.

### 7.2.1 The Planning Process

Launched in December 1995, the facility not only was a pioneer application of variable pricing in the U.S., but it also was funded only through private investments, the first project born from California's AB 680 legislation



**Figure 25.**  
**SR 91 Express Lanes**  
**Location Map**

passed in 1989. Because the project has been in operation for over six years, valuable usage data on the facility have been collected; these data have enabled researchers to evaluate many aspects of the Lanes' operation and usage. For these reasons, the 91 Express Lanes project provides several insights into the planning and operation of high occupancy toll lanes.

When planning for the toll lanes began, the need for improvements in the highly congested SR 91 corridor had been evident for many years. Public funding was unavailable and would possibly not materialize in the coming years. California legislation AB 680, as well as innovative thinking from elected officials, planners, and the private sector, helped to make another solution and alternative funding possible.

In 1989, AB 680 authorized the California Department of Transportation (Caltrans) to

enter into agreements with private entities for the construction by private entities of four transportation demonstration projects, including at least one in Northern California and one in Southern California. The legislation authorized Caltrans to lease rights-of-way, grant easements, and issue permits to enable private entities to construct transportation facilities supplementing existing state-owned transportation facilities. The law also allowed Caltrans to lease those facilities to the private entities for up to 35 years. The legislation allowed private concessionaires to identify specific projects where a private facility would perform favorably. This is the path pursued for the 91 Express Lanes.

The \$134 million 91 Express Lanes facility was one of the four public-private partnerships made possible by AB 680. It was built entirely with private funds through the California Private Transportation Company (CPTC), a concession company comprised of Peter Kiewit

& Sons, Cofiroute Corporation, and Granite Construction, Inc. No significant public funds were used to build or implement the facility. The California Private Transportation Company and the State of California signed a 35-year franchise agreement under which the CPTC would construct and operate the facility on the leased median right-of-way.

### 7.2.2 Political Considerations and Public Outreach

One prominent factor contributing to the successful implementation of the 91 Express Lanes was the emphasis throughout the planning process on public involvement. During the evaluation and planning of any complex transportation project, planners and agency sponsors have many opportunities to drop the proposal from consideration. The absence of community support is often a major reason leading planners to abandon a potentially worthwhile proposal. In the case of SR 91, project sponsors clearly understood that public acceptance was critical if the effort to create a new transportation option in Southern California was to succeed. As the first privately owned and variably tolled high-occupancy vehicle facility, the 91 Express Lanes would depend on public approval and a supportive clientele.

Unlike the modest outreach efforts of the Sonoma 101 study discussed later in this chapter, the SR 91 example is notable for its direct efforts to assess public acceptance and to build public support for the plan early. From the initial planning stages through the operational phase of the project, the CPTC has continued to communicate with and seek input from the public and its client base.

When variable tolling strategies were first considered for the corridor, preliminary studies assessed travelers' reactions to variable pricing. Comprehensive surveys of travelers and businesses were conducted, and a number of focus groups were convened. Project planners polled

for public acceptance of the project, as well as the projected usage of a HOT lane facility and the willingness to pay for use of it. In fact, project sponsors have suggested that assessments of public support and willingness to pay were highly important factors in the decision to implement the project, as such polls helped assess the facility's potential for profitability.

The planning process for the SR 91 facility also involved broad representation from community, political, government and industry interests. The stakeholders included in the process were the County Board of Supervisors, FHWA, Environmental Defense, the Reason Foundation, the Orange County and Riverside County Transportation Commissions, Caltrans, state legislators, local mayors and council representatives, and the International Bridge, Tunnel and Turnpike Association. A project newsletter produced throughout planning stages kept the public informed of SR 91 plans and progress.

Project sponsors have also noted that several local and state officials championed the project; the involvement of public figures willing to support the project gave the HOT lane plan a distinct advantage.

Public outreach remained a critical component during the project start up phase as well. Once the decision was made to launch the HOT lane facility, project sponsors reached out to national media and public policy makers. Press releases, speaker's bureau engagements, and other public presentations were used to communicate the news of the lanes. Newsletters, radio advertisements, direct mail, and signage along the SR 91 route publicized the coming facility to potential users of the Express Lanes.

Since the lanes opened, the facility operators have surveyed customers every year to determine customer satisfaction and areas for potential service improvements. Also, every few years, non-customers have been surveyed to

identify the incentives needed for them to use the 91 Express Lanes in the future.

Early in the lanes' operation, regular mailings to customers and potential users reported any news about the facility, as well as any operational changes or adjustments to the toll structure. Now, service updates are provided to users via the facility's website at [www.91expresslanes.com](http://www.91expresslanes.com), which is also a one-stop information center for the 91 Express Lanes. The website provides general information about the facility, allows drivers to apply for a 91 Express Lanes account and transponders online, supplies links to live traffic reports, and also enables pass holders to manage their accounts online. The facility's operators also use electronic mail to send customers statements, policy updates, alerts and other important information from the 91 Express Lanes. Account holders can sign up for email notices through the website.

### 7.2.3 Current Operations

Since the 91 Express Lanes were opened in late 1995, the lanes' operational and tolling structures have evolved in response to changing traffic conditions in the corridor and to the sponsor's financial expectations. As operator of the system, the CPTC sets the toll rates, and uses the tolls to maintain an optimal level of service and revenue for the facility. Because the 91 Express Lanes is a fully automated toll facility, vehicles traveling on the facility must have a valid account and an electronic transponder (FasTrak Transponder) mounted on the vehicle.

The 91 Express Lanes offer three types of user accounts, each designed to accommodate customers based on how often they intend to use the facility. The Convenience Plan is designed for infrequent users, the Standard Plan is for motorists who use the toll lanes between 2 and 25 times per month, and the 91 Express Club plan is for frequent users. Monthly payment

minimums and toll discounts vary with each plan. The 91 Express Lanes also offers special discounts for opening a new account with selected credit cards and for referring other customers. In addition, transponder holders are eligible for discounts at several local tourist, recreational and shopping venues. These user options demonstrate the facility's efforts to meet customers' individual needs as closely as possible.

While its original toll structure was successful, the CPTC has adjusted its tolls several times to optimize traffic service and revenue potential on the facility. The first toll increase came in January 1997 and three additional increases have followed. Whereas previously a single toll had applied for the entirety of the peak periods, in September 1997, tolls were adjusted hour by hour during the morning and evening rush hours. Additionally, in January 1998 the original provision that HOV 3+ (carpools of 3 or more persons) could travel for free in the Express Lanes was changed, and HOV 3+ vehicles were thereafter required to pay 50 percent of the basic toll.

Discounted tolls are offered not only to 3+ carpools, but also to zero emission vehicles, motorcycles, and vehicles with disability or veteran license plates. All other vehicles pay the regular tolls.

As of June 2002, tolls on the facility varied from \$1.00 to \$4.75 depending on the time of day and the day of week. The highest toll of \$4.75 applies Monday through Friday from 5 to 6 PM eastbound (peak direction), when demand on the roadway is at its height. On Wednesday and Thursday, the \$4.75 toll begins at 4PM and on Fridays, at 3PM. This suggests that the peak evening period expands as the week draws closer to its end. For the AM westbound peak, a high of \$3.60 is charged Monday through Thursday from 7 to 8 AM (See Tables 7 and 8). In addition to reflecting higher demand during the peak commuting



hours, tolls are also structured to reflect seasonal periods and seasonal trends in travel demand. The facility uses a simple tolling system, with all vehicles using the same entry and exit points. Tolls vary only by time of day and not by the length of trip on the facility, as all trips are the same length. While the tolls are not dynamic—i.e., they do not fluctuate in real-time based on real-time travel conditions—the CPTC regularly evaluates travel patterns and adjusts the toll structure accordingly. Overhead messages at each entrance to the Express Lanes show the current toll amount, so drivers can decide whether they wish to pay the current toll to speed up their trip.

Printed in Tables 7 and 8, the eastbound and westbound toll schedules illustrate how variable tolls are used to regulate demand for the roadway during peak travel periods.

**Table 7.**  
**91 Express Lanes—**  
**Westbound Toll Schedule—**  
**November 2001**

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
<b>Midnight</b>							
1 am				1.00			
2 am							
3 am							
4 am		1.90					
5 am			3.20			3.10	
6 am			3.30			3.20	
7 am			3.60			3.50	1.45
8 am	1.45		3.30			3.20	1.70
9 am		2.65					
10 am							2.45
11 am	2.05						
<b>Noon</b>							
1 pm							2.30
2 pm	2.30			1.70			
3 pm							
4 pm						2.05	
5 pm	2.45						2.45
6 pm						2.40	2.05
7 pm						1.70	
8 pm	2.05						
9 pm				1.00			
10 pm							
11 pm							

**User Profiles**

By the end of 1999, about 124,000 transponders had been issued by the CPTC for use of the 91 Express Lanes. Additionally, public toll road authorities in Orange County had by the same date issued 240,000 transponders that could be used on the public facilities as well as the SR 91 HOT lanes. Weekday two-way traffic on the SR 91 Lanes has averaged roughly between 25,000 and 35,000 vehicles, indicating that a small portion of SR 91 registered users actually use the Lanes on a given weekday. As with other HOT facilities, customers use the Lanes selectively.

Recent evaluations of the 91 Express Lanes also show that certain travelers are more willing to use the tolled facility. Females, particularly women aged 30 to 50, are more likely than other groups to choose a toll road. Additionally, other characteristics appear to affect a driver’s willingness to acquire a transponder to use the facility. Travelers with high incomes and higher education and who are middle aged and are commuters are more likely to acquire a FasTrak transponder.

One of the most important selling factors to users is the reliability of traffic conditions in the Express Lanes. Users value the security that they are unlikely to experience congestion in the Lanes and that any traffic incidents will be addressed quickly and cleared.

**7.2.4 Institutional Issues**

Since the launching of the 91 Express Lanes project, the institutional underpinnings of the facility have witnessed some challenges and changes. In fact, as of spring 2002, arrangements were being made for transfer of ownership of the lanes to a public agency. Although some of these issues have arisen several years into the lanes’ operation, they offer insights that may be useful to projects elsewhere.

First, the non-compete clause that was critical to the lanes’ potential for profitability became a sticky issue. As part of the agreement struck with Caltrans when CPTC initially agreed to finance and construct the toll lanes, Caltrans agreed to non-compete provisions by which it promised not to make improvements or add capacity to the existing general-purpose lanes on SR 91 without consulting with CPTC. Such improvements in the general-purpose lanes would harm CPTC’s ability to recoup investment in the tolled lanes, and thus the non-compete provisions were a primary way to safeguard CPTC’s interest in the Express Lanes. This non-compete agreement proved extremely contentious once it was used to thwart other capacity improvements in the corridor.

In 1999, Caltrans moved to add general purpose lanes in strategic locations on SR 91 to improve on and off ramp movements. The measures were viewed as necessary to address congestion in the SR 91 general use lanes. Discussions between CPTC and Caltrans about the need for and impact of the project failed, and CPTC sued to stop the plans. In a legal settlement, Caltrans withdrew the plans. The strife between the two institutions made explicit CPTC’s dependence on congested general purpose lanes to maintain high usership of the toll lanes, and the lawsuit may have damaged CPTC’s public image. Criticism was especially heavy from Riverside County, where most of the road’s users live, as Riverside commuters resented the high tolls and the state’s inability to address congestion in the corridor. In fact, Riverside County later sued to nullify CPTC’s contract to operate the Express Lanes, arguing that the agreement was an unconstitutional gift of public assets.

Secondly, when CPTC viewed refinancing as necessary for its financial health, the company was unable to win support for the strategy pursued. CPTC attempted to transfer ownership of the 91 Express Lanes to a non-profit organi-

	Sun	Mon	Tue	Wed	Thu	Fri	Sat
<b>Midnight</b>							
1 am							
2 am				1.00			
3 am							
4 am							
5 am							
6 am							
7 am							
8 am	1.35						
9 am				1.70			
10 am	2.05						2.05
11 am							
<b>Noon</b>						2.50	
1 pm	2.40		2.25		2.50	3.90	
2 pm			3.25		3.35		2.40
3 pm		3.50		3.75			
4 pm		4.25		4.75			
5 pm	2.05						
6 pm		3.50	3.65	3.75	3.95	4.25	2.05
7 pm			2.50		3.55	3.95	
8 pm			1.70		2.25	3.55	1.70
9 pm						2.25	
10 pm				1.00		1.70	
11 pm							

**Table 8.**  
**91 Express Lanes—**  
**Eastbound Toll Schedule—**  
**November 2001**

zation called NewTrac in order to capitalize on better financing terms, and this was the object of criticism. NewTrac (a non-profit 501 c (3) corporation founded by a local group of independent businessmen) and CPTC had been in negotiations for NewTrac to purchase the lanes in December of 1999. The sale of the facility to a non-profit company would enable the new owners to reissue debt with tax-exempt bonds while the higher-interest bonds issued privately for construction of the facility were retired. NewTrac representatives projected that the transfer of the 91 Express Lanes from for-profit to non-profit ownership would generate \$400 million to \$500 million in surplus over the next 30 years of operation and that those funds would be returned to the public in the form of improvements to roads in the area. However, several aspects of the deal, including ties between CPTC and buyer NewTrac and the use of state sponsored bonds to purchase the

Lanes, initiated concerns among state and local officials who had traditionally opposed the project. Ultimately, the California state treasurer blocked the deal.

Finally, in April 2002, the Orange County Transportation Authority (OCTA) offered to purchase the 91 Express Lanes Toll Road and the operational franchise agreement from CPTC. OCTA first began considering a possible purchase of the Lanes in fall 2001, when its chairman requested OCTA staff to investigate ways to improve congestion in the 91 corridor, including a possible purchase of the Lanes. Several months later, OCTA entered into formal negotiations with CPTC to purchase the facility. While the sale will not be complete until the California state legislature grants approval to OCTA to levy tolls, OCTA has agreed to pay \$207.5 million for the Lanes.

This planned transfer of ownership from a private to a public entity emphasizes some of the institutional issues that have been sticking points for CPTC. Purchase of the lanes by OCTA would negate the unpopular non-compete clause, allowing improvements in the general purpose lanes on the 91 Freeway. Moreover, not obliged as is CPTC to return profits, OCTA says it will adjust SR 91 toll rates to maximize throughput on the facility instead of profits. OCTA will also consider allowing three-plus carpools to use the facility for free once again. These proposed changes point to the difficulty faced by CPTC in trying to operate a HOT facility in a way that simultaneously met regional mobility needs and also hit private financial goals. OCTA has even suggested that tolls may be eliminated at the end of the franchise agreement in 2030 or sooner, if the agency receives outside funds to pay off remaining debt on the facility.

### 7.2.5 Lessons Learned

The institutional issues involving non-compete clauses, private ownership, and the sale of a

facility by its original, private operator loom large in this case. The political difficulties that lie therein may be instructive.

First, operating a HOT facility presents its own challenges when the facility is owned and operated by a private entity ultimately interested in returning a profit. In this case, public acceptance of the facility wavered in response to legal wrangling with Caltrans and with Riverside County. The non-compete clause that was necessary to protect CPTC's investment also stirred public resentment when it restricted Caltrans' ability to plan and implement capacity improvements on SR 91. OCTA officials are responding to precisely this conflict in moving to acquire the toll lanes.

Second, fostering public understanding and acceptance of the proposed transfer of ownership to the non-profit NewTrac proved difficult. The complexity of the financial advantages may have made it difficult to convey to the public the motivation behind CPTC's decision to pursue that option. This reinforces the challenges involved when the private sector provides what has traditionally been accepted as a public good supplied by the government.

A third lesson to emphasize for future projects is that tolling structures must evolve as demand for the facility evolves over time. For example, although the 91 Express Lanes initially allowed HOV 3+ carpools to travel for free, this policy was adjusted after a few years. The decision to charge carpools 50 percent of the toll enabled facility operators to manage demand for the Lanes while also meeting revenue needs. Additionally, tolls on the facility have been adjusted several times since its opening. A HOT facility uses price to help distribute demand for the facility over time.

Finally, the success of the 91 Express Lanes depends on congestion in the general purpose lanes and on a toll structure that regulates demand so that the facility can always offer a

time savings. These operational parameters are unlike those for traditional highways, and additional public education may be needed to explain them.

## 7.3 San Diego I-15 Corridor

### Background

Currently operated under the FasTrak Program of the San Diego Association of Governments (SANDAG), the region's metropolitan planning organization, the high occupancy toll lanes on I-15 have their origin in an HOV facility that first opened in 1988. The two lanes were constructed with Federal Transit Administration dollars in the median of an 8-mile stretch of Interstate 15, extending roughly from the juncture of I-15 and SR 56 to the north and I-15 and SR 163 to the south (Figure 26). Originally intended to attract carpooling commuters heading to downtown San Diego from points north, the HOV lanes were underutilized. To increase usage of the lanes and to supply funding for transit improvements in the I-15 corridor, SANDAG proposed converting the lanes to a HOT facility under the federal Value pricing Pilot Program. The HOV lanes were opened to paying solo drivers in December 1996. Project implementation was structured in two phases, and the use of toll collection technologies on the facility has evolved over time. The number of paying solo drivers has also increased over time. Today, the I-15 HOT facility uses a dynamic, real-time tolling structure, and toll revenue collected on the facility is used for transit service in the corridor including the Inland Breeze peak-period express bus.

### 7.3.1 The Planning Process

Under the program's first phase, called ExpressPass, users were issued a vehicle permit which allowed unlimited use of the HOV lanes. At first, only 500 monthly permits were sold, priced at \$50 each. SANDAG issued 200

more permits in February 1997 and one month later raised the permit price to \$70. In June of 1997, transponders were introduced on the facility. Whereas visual inspection was required previously to determine whether a vehicle had the required window decal permits, transponders allowed for electronic enforcement of permit requirements. The transponders also facilitated the collection of data about usage of the HOT lanes.

In Phase II of the project, begun in March 1998, variably priced per-trip tolls replaced the flat monthly fee. By identifying the project as a FasTrak facility, users from other FasTrak toll facilities in the state could also use I-15. Additionally, Phase II opened I-15's FasTrak program to unlimited membership. The lanes continue to operate in this fashion today. On normal commute days, the toll ranges between \$0.50 to \$4.00, depending on current traffic conditions; however, tolls may be raised up to \$8.00 in the event of severe traffic congestion. To maintain free-flow on the FasTrak lanes at all times, toll rates are adjusted every 6 minutes in response to real-time traffic volumes. The actual toll at any given time is posted on the roadside signs to inform drivers of the current price for using the lanes. To preserve the carpooling incentives that existed with the original HOV lanes, carpools and other vehicles with two or more occupants may always use the FasTrak lanes for free. The lanes operate only during peak hours in the direction of the commute. From 5:30 AM to 11 AM, all vehicles in the HOT lanes



**Figure 26.**  
I-15 FasTrak Location Map

travel southbound; from 11:30 AM to 7:30 PM, all vehicles travel northbound.

Electronic signs at the entrance to the HOT lanes notify motorists of the current toll as they approach the toll lanes. Motorists enter the HOT lanes at normal highway speeds. Toll collection occurs when the motorist travels through the tolling zone, where overhead antennas scan the windshield-mounted transponder and automatically deduct the posted toll from the motorist's pre-paid account.

### 7.3.2

#### Political Considerations and Public Outreach

Like the SR 91 Express Lanes which came before it, the I-15 HOT lane initiative also included early and aggressive efforts to assess public opinion and potential usage of the lanes before the facility was launched. Additionally, the implementing agency SANDAG also has paid close attention to marketing issues throughout project implementation and operational phases.

As a first step, SANDAG contracted with a consultant to collect baseline market survey data. Commuters in the I-15 corridor were queried in focus groups, telephone surveys, and intercept surveys on their attitudes toward variable tolling and traveling in the corridor. The findings from these pre-project studies formed the basis of strategies for pricing and for customer communications. Second, preparation for the first announcement of the project to the press in November 1996 involved significant preliminary planning; SANDAG worked with consultants to develop a project identity and background materials, as well as to formulate a promotion plan for Phase I of the project. A newsletter, the I-15 Express News, was used to introduce the ExpressPass Program as well as to provide updates about the facility as toll operations evolved. Town hall meetings were also held for communities in the corridor to publicize project. To prepare for Phase II,

when the facility transitioned from a monthly pass and to per trip tolls, SANDAG used radio advertisements and a name-the-bus contest to raise public awareness of the coming changes.

The SANDAG I-15 FasTrak Online website provides full documentation of the supporting studies that were used to formulate tolling schedules, marketing plans and promotional materials. The reports are part of the I-15 Value pricing Project Monitoring and Evaluation Services and most are available in pdf format. This online library, found at <http://argo.sandag.org/fastrak/library.html>, also contains downloadable reports on traffic and operations issues during the project's history.

#### Political Champions

The evolution of the I-15 HOT facility project demonstrates the important role that a political champion can play. The elected official who shepherded the I-15 HOT lane proposal through the SANDAG Board of Directors remained an important figure to secure needed support and legislation at the state level.

The origins of I-15's HOT facility lay in SANDAG efforts in the early 1990s to develop air quality control plans. A local elected official (who also served as a SANDAG board member) was concerned with the lack of transit and had proposed construction of a trolley in the I-15 corridor. The existing HOV lanes were underutilized at the time, in part because of limited entry possibilities, and the I-15 general purpose lanes were often congested during peak periods. Aware of the Value pricing Pilot Program (now called the Value Pricing Pilot Program) created by ISTEA in 1991, the SANDAG staff proposed selling the HOV facility's excess capacity and using the funds to support the transit service desired in the corridor. Shepherded by the supportive board member, the SANDAG board passed a resolution in May 1991 to pursue a Value Pricing Demonstration. The project would toll single-

occupant vehicles for use of the I-15 HOV lanes and use the toll revenue for transit service in the corridor.

Although SANDAG's initial grant application to the Value Pricing Pilot Program was denied in 1993, SANDAG won federal approval and a \$7.96 million grant in January 1995, after the FHWA revised the eligibility criteria to include HOT lane projects. In spite of the federal green light for the project, state enabling legislation was needed to allow the HOV lane conversion at the center of the SANDAG plan. (California state law stipulates that only 2+ person carpools are permitted in HOV lanes.)

The same elected official who championed the project on the SANDAG board also played a key role in moving the project past the state level hurdles. After moving to a position in the State Assembly, the official sponsored the original enabling legislation for the HOT facility. Passed in 1993, Assembly Bill 713 authorized a four-year demonstration project from 1994 through 1998. The statute also required that the lanes maintain a particular level of service for HOV users, and that project revenues be used for transit service and HOV facility improvements in the I-15 corridor. When the demonstration project was due to sunset in 1998, the same elected official was an important advocate for its extension through January 2000 via AB 267. Since then, the legislation has gone through other rounds of sunset dates and extensions, and each time supporters in the state assembly and senate have been important backers.

### 7.3.3 Lessons Learned

As noted above, the I-15 FasTrak Online website provides access to numerous studies, reports and evaluations completed during the development of the I-15 HOT lanes. The reports discussing "Implementation Procedures, Policies, Agreements and Barriers" offer particular insight into lessons useful both

for the I-15's future and for the development of similar projects elsewhere. Some of these findings include:

- Team effort among key stakeholders is important for ensuring consensus and maintaining momentum from project planning to implementation.
- A local, influential political champion may explain why the I-15 project was implemented while other value pricing proposals have not been realized.
- Strong community outreach efforts to citizens, community groups, and elected officials must continue throughout project planning, implementation and operation to communicate information regarding project goals, plans, progress and benefits.
- Detailed project agreements may be needed to specify the roles and responsibilities of participating agencies and other parties. These should be arranged as early in the project process as possible, leaving some flexibility for unexpected issues.
- Dynamic tolling involves significant technical and administrative complexities. The project schedule should budget time to plan and implement new technologies, institutional arrangements and administrative procedures.
- Reciprocity with other toll agencies is important. Data compatibility and revenue transfer are key issues to work out.

### 7.3.4. Plans for Expansion

Given the growth in vehicles using I-15 over the last decade and the success of the FasTrak HOT lanes on the highway, SANDAG and Caltrans are now considering plans to expand capacity in the I-15 corridor, with emphasis on accommodating HOV travel. As of early 2002, over 250,000 vehicles a day travel on Interstate 15, representing an increase of 100,000 vehicles per day from 10 years ago. Forecasts sug-

gest that future traffic volumes on I-15 will continue to increase, as will the number of people living in San Diego County.

The plans under consideration, known as the “I-15 Managed Lanes,” would extend the I-15 HOT lanes north as far as SR 78 in Escondido and would create a 20-mile, two-directional managed lane facility. The proposal would use advanced technologies to monitor traffic service on the road, detect problems, and keep vehicles moving. The system would allow changing the lane configuration to accommodate peak directions and would also provide more entry and exit points to the lanes. To evaluate this proposed expansion, a consultant team is currently studying the proposal’s operational and financial feasibility.

An 800-person telephone survey of I-15 users conducted in fall 2001 indicate that the majority of motorists support the lanes, and that motorists with the most extensive experience with the FasTrak lanes are the most ardent supporters. Ninety-one percent of users supported having a time saving option on I-15, and 66 percent of I-15 users who do not use the FasTrak lanes support them. Moreover, I-15 users overwhelmingly support the facility’s expansion.

## 7.4 US Route 101 Corridor—Marin and Sonoma Counties

### Background

Constructed in the 1950s as a four-lane highway, the US Route 101 corridor through California’s Sonoma and Marin Counties has experienced significant residential and commercial development and considerable population growth in recent decades. The corridor provides vital connections for commuters among Marin, Sonoma, and San Francisco Counties and is an important link in the regional transportation system. As in many corridors serving high-growth suburban locations throughout

the country, increasing numbers of drivers and vehicles together with sharply rising vehicle-miles traveled have produced severe traffic congestion on the roadway.

While earlier planning studies had proposed the addition of new high occupancy vehicle (HOV) lanes in the corridor, scarce funding prevented the construction of additional lanes. Consequently, in December 1995, the Metropolitan Transportation Commission (MTC)—the region’s metropolitan planning organization—and the Sonoma County Transportation Authority (SCTA) began discussing the possibility of using tolls to help finance a new HOT lane in the corridor. In 1997, as part of the FHWA Value Pricing Pilot Program, a study was initiated to examine the proposed addition of priced express lanes in the median of US 101, from the Marin County line to just north of the City of Santa Rosa in Sonoma County.

Completed in January 1999, the Sonoma County US 101 Variable Pricing Study found that toll lanes in Sonoma County from Windsor to SR 116 in Petaluma (approximately 25 miles) would provide congestion management benefits and produce revenue for all operating and substantial capital costs (Figure 27). Although Marin County initially declined to consider the HOT lanes due to concerns about additional highway capacity and growth inducement, Marin subsequently decided to study HOT lane alternatives also. An additional 11.5 mile segment in Marin and Sonoma counties known as the “Novato Narrows” was examined in the study US 101 Variable Pricing Study: State Route 37 to the Petaluma River Bridge. The study found that the extended lanes would be physically and financially feasible, though as a stand-alone project they would not perform as well financially as the 25-mile Sonoma segment.

### 7.4.1

#### Sonoma Study: Approach and Findings

Although the Sonoma effort did not invest significant effort in public outreach, it did address essential technical aspects of HOT lane feasibility. After preliminary analysis showed that further study of the HOT lane concept would be useful, a consultant was brought on to conduct a variable pricing study for the corridor, and a budget of \$280,000 was established for the effort.

The consultant screened initial alternatives using the following evaluation criteria, which bear witness to the multiple objectives often involved in a HOT lane endeavor:

- Congestion and travel time savings for new and existing lanes;
- Compatibility with federal/state highway design standards;
- Capital and operating costs;
- Enforceability of toll and HOV requirements;
- Tolling feasibility and effectiveness;
- Operational impacts to arterials and local streets;
- Potential environmental flaws;
- Ability to enhance corridor transit operations;
- Equity; and
- Ability to finance

After initial screening, two main alternatives and their variations were selected for further evaluation. Alternatives 1 and 2 differed primarily in length of the HOT lane and in the number of access points. Alternative 1 featured a 15-mile facility with the possibility of (1a) four or (1b) six access locations. Alternative 2 featured a 25-mile facility with the possibility of (2a) five or (2b) eight access locations.

The study considered two design alternatives, median lanes and a more expensive option which would upgrade inside and outside free-way shoulders. Capital cost estimates ranged from \$85 million to \$179 million depending



**Figure 27.**  
Sonoma County Route 101  
Location Map

on the design alternative, and the average operating and maintenance costs estimates ranged from \$1.6 to \$1.8 million per year.

Travel forecasts identified the likely demand for each alternative in 2005 and 2015. Demand estimates found that 45 percent of the HOV-lane users would be 2-person carpools and that to maximize revenue potential, 2-person carpools should be charged the same toll rate as single occupant vehicles. Carpools of 3+ could be allowed to use the lane for free.

The feasibility study considered two tolling options: (1) a flat per-mile toll that was higher at certain times of day, but remained constant for all highway segments, and (2) a variable per-mile rate that varied by time of day and by corridor segment, depending on congestion at specific locations.

Revenue projections found that the variably priced toll lane would produce more toll revenue, as well as provide more reliable speeds in the lane. Annual gross revenues from revenue-



maximizing tolls (using variable tolls) ranged from \$4.6 million to \$5.8 million in 2005, depending on the alternative and variation considered. The study emphasized revenue maximization as tolls were considered primarily so the facility could pay for itself.

A financial analysis of the four alternatives considered estimated traffic growth, borrowing costs, inflation, and the application of a flat or variable toll. The analysis assumed the toll lane would be financed using bonds supported by the lifetime revenues of the facility. The analysis found that the variable toll generally produced a higher yield and that the variable toll alternatives could actually pay for most or all of a basic HOV lane median widening project and a substantial portion of the more expensive design alternative.

The feasibility study also considered what institutional arrangements would be needed to support the toll facility. Aside from state-owned toll bridges, the state of California operated no toll roads at the time of the study (1997). Thus, an HOV/Toll lane would likely require some new institutional arrangements. The study suggested that because the projected revenue for the project was substantial, defraying all of the project's operating costs and a large portion of its capital cost, it might be possible to attract private sector capital. Even if private sector investment were not needed or sought, the report noted that possibilities for private sector participation existed in some elements of the project, such as operations and maintenance.

Several possibilities were examined in the study:

- 1) Publicly financed, developed, owned and operated HOV/Toll lanes. Under this option, Caltrans would develop, finance, own and operate the HOV/toll lanes. First call on the funds would be for facility maintenance and operations. The net toll revenues

would be available for further corridor improvements.

- 2) Private or public/private finance, ownership or operation. The report suggests that, if the corridor continues to suffer from limited access to new funding, the facility could rely on toll revenues for its development and finance. A number of ownership and operating relationships could be used to engage the private sector. The pattern of ownership would affect risk-sharing, financing terms, and access to types of financial instruments. Options would include:
  - Build-Own-Operate (BOO) and Build-Operate-Transfer (BOT);
  - Build-Transfer-Operate (BTO) and;
  - Partial Ownership and Operation & Maintenance Agreements.

Because there has been no movement to implement the HOT lane proposal, these institutional frameworks have not received further consideration.

#### 7.4.2

##### The Marin Study: Approach and Findings

Once the Sonoma County study established the potential feasibility of toll lanes on US 101, Marin County was encouraged to evaluate the potential for HOT lanes on an additional 11.5-mile segment in Marin and Sonoma counties known as the "Novato Narrows." That study, US 101 Variable Pricing Study: State Route 37 to the Petaluma River Bridge, also found that the lanes would be physically and financially feasible.

The variable pricing study conducted for the Marin-Sonoma section of US 101 considered a no-build alternative along with (A) north- and southbound free HOV lanes, (B) north- and southbound tolled and buffered HOV lanes, (C) one reversible free HOV lane, and (D) one reversible tolled HOV lane. The analysis identified travel demand forecasts for the years 2005 and 2015, capital costs, operations and maintenance

nance costs, and the operational feasibility of each scenario. For the tolled scenarios (B) and (D), the study analyzed revenue generation using variable tolls that would optimize revenue and regulate demand, so the lanes would retain travel time savings to attract motorists.

Considering the effects on congestion, the study found that when compared with the base case/no build scenario, both the free and the tolled HOV lane options provided substantial travel time savings to users (approximately 10-12 minutes over the 11.5 miles) and significantly increased person-throughput.

Like the Sonoma study before it, this analysis also considered (1) a flat tolling option that changed by time of day only and (2) a variable toll that changed by time of day and by corridor segment, depending on congestion levels. Like the Sonoma study, the variable toll in this case was also expected to generate slightly higher revenue although it would not produce a significantly different performance level compared with the “flat” time-of-day toll.

A unique component of the Marin study was the assumption that passenger rail service would be operating in the proposed HOT lane corridor in 2015. Citizens in Marin and neighboring counties have called for establishing passenger transit service using the Northwestern Pacific Railroad right-of-way in the US 101 corridor. Although no definitive plans have been adopted for the right-of-way, the Marin study considered the effect of the proposed toll lane on rail ridership, concluding that the travel time savings offered by the free HOV lane or toll lane options would likely divert a small number of potential rail riders to the highway.

Another prominent issue that arose in this study was anti-growth sentiment. In Marin County, proposed highway expansions have received intense public scrutiny over potential growth inducement. The US 101 HOT lane

proposal also raised such concerns in Sonoma. Resistance to growth and sprawl subsequently influenced the selection of proposed access points for the Sonoma HOT lanes, as access points were discouraged in rural and other areas where growth was not desired. This instance suggests the importance of addressing local concerns in HOT lane proposals and plans, and also shows how HOT facilities and local land use plans might be coordinated to steer growth toward some areas and away from others.

### 7.4.3 Lessons Learned

Although both feasibility studies indicated the encouraging potential of HOT lanes on US 101, toll lanes have not been advanced. Understanding why provides insight into the political and public dimensions of HOT lane projects that can determine whether an innovative project like toll lanes is advanced.

While elected officials showed interest in tolled high occupancy vehicle lanes for the US 101 corridor and funded two studies to determine their feasibility, HOT lanes came to be viewed as a funding measure of last resort. There was skepticism among officials that the public would accept tolled highway lanes. Moreover, at the same time that variable pricing initiatives were studied for the 101 corridor, local officials also sought funding for US 101 improvements through sales tax referenda in Sonoma and Marin Counties.

Officials considered a sales tax a more conventional and palatable way to raise money for the needed lanes, because the public was more familiar with this financing method. However, voters rejected sales tax initiatives in 1998 (Sonoma and Marin) and in 2000 (Sonoma). Another sales tax referendum may appear on the Sonoma County ballot in 2002.

Additionally, local officials also sought state funding for the highway widening, and, partial

state funding for some segments has since been secured. The 1998 Regional Transportation Plan allocated some funding to widen Highway 101 in Sonoma County, building carpool lanes along more than two-thirds the length of Highway 101 between the Marin County line and Windsor. While the additional funding needed to complete the project is uncertain, local officials have not pursued the tolling option, and the variable pricing studies have not been publicly promoted.

As a matter of financial pragmatism, the concurrent pursuit by local government of tolling studies, dedicated sales tax, and state grants to fund the proposed road improvements is logical; however it may have hampered the advance of a toll lane initiative in this case. For the time being, the local political leadership seems reluctant to initiate public discussion of tolls on the 101 while voters are also considering sales tax measures. As with many HOT lane initiatives, there is also general hesitation to pursue a tolling plan that may be perceived as another tax rather than as another travel option.

Public outreach regarding tolled express lanes on the US 101 has also been extremely limited. Public input was sought during the feasibility study process, but this was accomplished largely through a 25-member advisory committee composed of members of business, environmental, and labor groups, political representatives, and civic groups. Study sponsors chose not to widely publicize or promote the HOT lane concept, and the absence of a visible and vocal public champion created an additional hurdle for the Sonoma 101 HOT lane proposal.

## 7.5 The Denver Value Express Lane Feasibility Study

### Background

The planning for high occupancy toll lanes in Denver, Colorado, provides a unique case

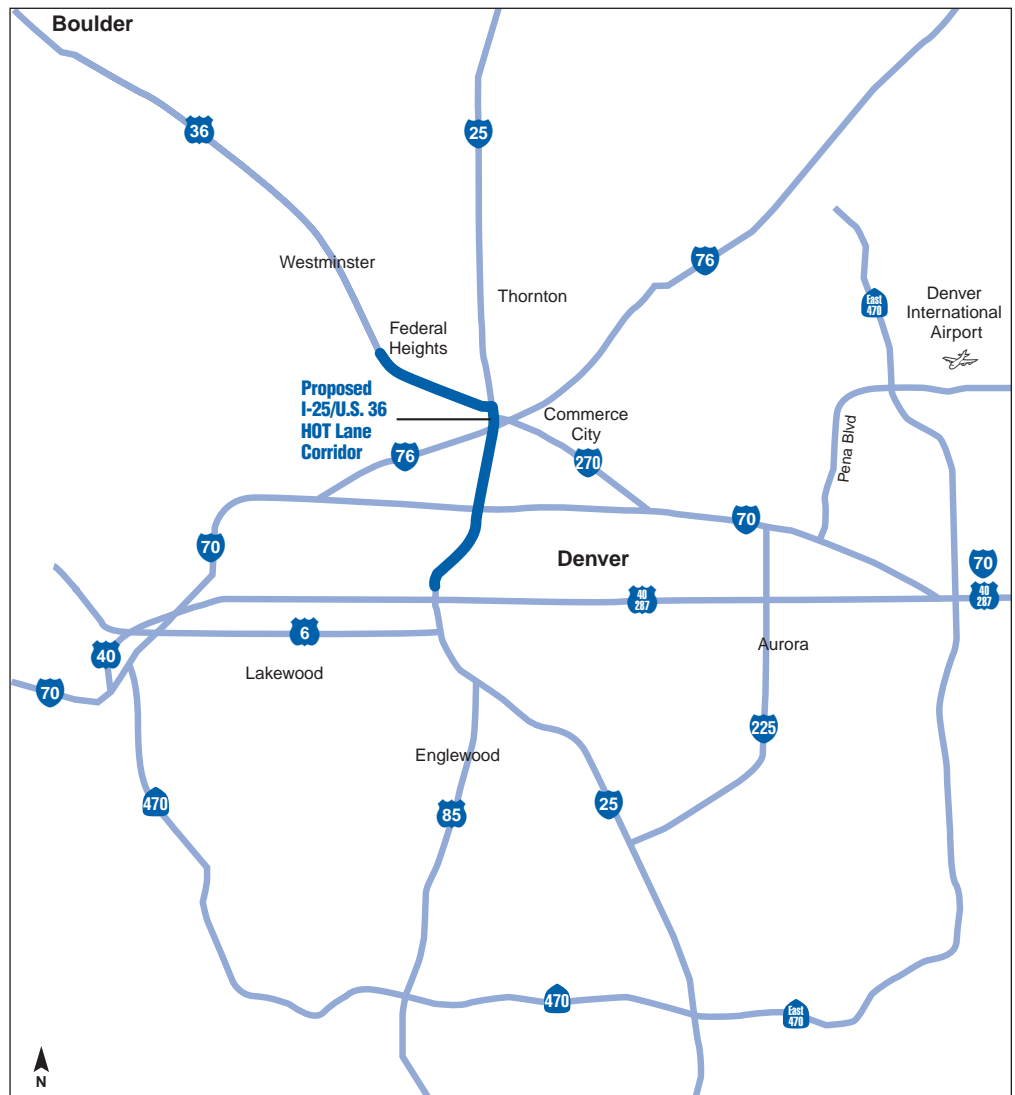
study demonstrating the important role played by state legislation in stimulating interest in HOT lane solutions. Unlike cases where the impetus for a HOT project or proposal arose from congested conditions on a specific facility, the Denver example was greatly accelerated by a piece of state legislation and the state legislator who championed it. Independently, the Colorado Department of Transportation (CDOT) had begun investigating the conversion of I-25 lanes north of Denver from HOV operation to HOT operation, in order to better utilize that facility.

In 1999, one Colorado state senator initiated efforts to launch a bill designed to address the underutilization of high-occupancy vehicle lanes in the state. The bill, known as Senate Bill 88 (SB 88) and supported by a number of other state legislators, aimed to legislate the application of value pricing to make fuller use of under-utilized HOV lanes in the state. The bill's sponsor pointed in particular to several HOV facilities in the Denver metropolitan area that often operated below capacity. These included HOV lanes on I-25 north of Denver, US 36 connecting Denver and Boulder, and on Santa Fe Drive.

Passed in 1999 with support of CDOT, SB 88 mandated the CDOT to examine the desirability and feasibility of implementing high occupancy toll lanes. The bill required CDOT to solicit expressions of interest in converting an existing HOV lane to a HOT lane using a private contractor. In absence of a qualified bidder to operate the lane, CDOT would possibly have to undertake the operation of the HOT facility. Precisely these points of the bill make it unique: (1) The bill did not seek simply to open the HOV lanes for use as general purpose lanes, but rather acknowledged the available capacity on the HOV lanes as a resource and a commodity; and (2) The bill required CDOT to seek the participation of the private sector in the conversion from an HOV-lane to a HOT facility. In fact, the senator who championed

the bill noted that using a private contractor to convert and operate the lane would spare taxpayers the associated financial obligations. With the assistance of CDOT’s value pricing expert, the state senator was able to forge a unique coalition, including the environmental community and trucking interests, that was essential in getting the bill passed.

As in other U.S. metropolitan areas that have begun to examine the potential application of HOT facilities in their transportation network, growth has been a primary factor leading Denver to consider HOT lanes. From 1990 to 1996, population in the Denver metropolitan area increased 14.5 percent to 2.13 million people. Some project population to grow another 30 percent by 2020, and employment in the region is expected to increase 35 percent by 2020. At the same time, vehicle miles traveled have increased at a much higher rate, rising 5.2 percent annually from 1990 to 1995.



**Figure 28.** Proposed I-25/U.S. 36 HOT Lane Corridor Location Map

**7.5.1 The Value Express Lane Feasibility Study**

In June 1999, CDOT launched the Value Express Lanes Study to examine the potential application of HOT lanes in the Denver metropolitan area. As indicated in the statute that prompted the study, the policy premise underlying Value Express Lanes is to maximize the use of HOV lanes by allowing SOV drivers to pay to use them, while also maintaining the incentive to carpool and take the bus. Funding for the study came from CDOT and the Federal Highway Administration, and study partners included the Regional Transportation District (RTD), the Denver Regional Council of Governments (DRCOG), and the US 36

Transportation Management Organization (US 36 TMO).

The study included two phases. The first phase would assess the potential application of HOT lanes in a number of corridors throughout the Denver region, including Adams, Arapahoe, Boulder, Denver, Douglas and Jefferson counties. The aim of this macro study was to identify candidates that could be recommended for future project and corridor planning efforts and more focused feasibility studies. The second phase involved a more detailed feasibility analysis of HOT lanes on US 36 and north I-25’s existing HOV facility.

## 7.5.2 The Regional Assessment

The first step in identifying candidate HOT facility projects involved a broad look at corridors in and around the Denver metropolitan area. This regional assessment consisted of identifying and screening twelve potential corridors in order to select candidates for more advanced feasibility studies. This first cut proceeded with steps to:

1. Identify potential candidate corridors;
2. Develop a criteria matrix;
3. Collect corridor data; and
4. Evaluate the corridors.

After identifying the twelve corridors to be studied, located within CDOT's Denver metropolitan region, criteria were developed by which each candidate corridor could be evaluated. For each criterion, each candidate corridor received a score of high, medium, or low. The criteria addressed the factors that might make a corridor more suitable for HOT lane application. They included:

- (1) Traffic/excess capacity: Traffic conditions on each corridor were examined, including peak hour volume to capacity, estimated daily hours of congestion, and the length of the congested portion of the facility. High scoring corridors exhibited a peak hour volume to capacity ratio of 0.9 to 1.0 or greater, experienced congestion for at least 2 hours in the AM or PM peak, and had congested segments that stretched for 5 to 10 miles.
- (2) Corridor/Transportation Planning: This criterion examined current planning efforts for each corridor. Corridors scored higher where short- and long-term investments under consideration included or could include an HOV-lane alternative.
- (3) Right of Way: The study assumed that Value Express Lanes would not take away general purpose lanes, implying that any HOT facility application would require new capacity.

For this reason, the availability of right of way in the candidate corridors was an important consideration. Corridors received higher scores for this factor when they had adequate right of way to construct additional lanes or when only a small amount of right of way would need to be acquired to accommodate a HOT lane.

- (4) Design considerations: This criterion considered how each proposed corridor could connect with the larger transportation network. Candidates that received higher scores were those corridors that would or could connect to other existing HOV facilities; link to other facilities and freely accept traffic from and/or supply traffic to those facilities, and absorb and integrate traffic accepted at entry points.
- (5) Travel behavior: This factor considered travel patterns in each corridor. Corridors that served commuter travel characterized by heavy flows in a peak-dominant direction or that served a large proportion of long distance trips were considered better candidates.

These criteria make clear how a HOT facility might be expected to perform in the Region. Additionally, assumptions outlined in the screening analysis also make clear some of the policy choices underlying the study. For example, the study assumes that a HOT application would be most compatible with an existing or planned HOV lane, that buses and carpools would be expected to use the HOT facility for free, and that some recurring congestion is necessary in order for travelers to be willing to pay a toll to avoid the congestion. Also, the study explicitly notes that a HOT lane cannot replace an existing general purpose lane, however where a new general purpose lane is currently planned a HOT lane should be considered in future alternatives analysis. The study also notes that costs were not used in this first screening, given the assumption that few HOT lanes would recover the full cost of adding lanes through tolling.

After relevant data about each corridor was collected and reviewed, each corridor was assessed for its suitability to serve as a Value Express Lanes candidate. Three corridors scored in the high range, indicating potentially high compatibility with Value Express Lanes.

- US 36 (Boulder Turnpike) from I-25 to Boulder
- North I-25 from US 36 to 120th Ave.
- C-470 from Wadsworth to I-25

These corridors showed sufficient promise for HOT lane application due to their high traffic volumes, high proportion of longer trips, encouraging forecasts for carpool and bus use, and/or sufficient right of way to accommodate a HOT lane.

### 7.5.3

#### The I-25 and US 36 Corridor

Phase two of the Value Express Lanes Study looked specifically at the I-25 /US 36 corridor leading from downtown Denver to Boulder, linking two of the three largest employment centers in the Denver region (Figure 28). The corridor is heavily used by regional transit service, and the US 36 portion was recently the subject of a major investment study that recommended bus rapid transit, regional rail, road improvements and a bikeway for the corridor. The challenge of the Value Express Lanes Study was to consider a HOT application on this facility that acknowledged recent US 36 MIS recommendations and could meet existing commitments to level of service B on I-25's Downtown Express.

Since 1995, I-25 has hosted the FTA funded Downtown Express Bus/HOV facility. The facility has experienced tremendous growth in users since its opening. Three years after opening, it carried 7,000 vehicles per weekday, almost twice as many as when it first opened. By 1998, daily ridership counting bus passengers and carpoolers totaled over 24,000 people per day. Because this facility was built with fed-

eral funds, the RTD is obligated to meet level of service B for buses and carpools.

The US 36 corridor connects to North I-25 and leads northwest to Boulder. Regional transit service on US 36 also carries significant ridership serving Denver and Boulder. Residential and employment growth in the center of the corridor continue to place new travel demands on the roadway. In 1998 by the Regional Transportation District (RTD) began a collaborative effort to identify potential solutions to long-term transportation needs in the corridor. The US 36 Major Investment Study (MIS) involved representatives from US 36 communities, CDOT, local agencies, regional agencies, federal agencies, and special interest groups. It identified as a locally preferred alternative a package of corridor improvements including bus rapid transit (BRT)/high occupancy vehicle lanes (HOV), regional rail (a double-track, starter rail system), roadway improvements and a bikeway.

The Value Express Lanes Feasibility Study proposes conversion of the I-25/US 36 HOV facility to a HOT facility or Value Express Lanes. The study proposes that the bus rapid transit improvement planned for US 36 be constructed as a HOT facility, and it proposes in general to maintain the advantage of transit and carpooling in the corridor by instituting a hierarchy among users of the facility. This proposed hierarchy would prioritize vehicles on the facility from highest to lowest, favoring buses and transit, then vanpools or three-plus carpools, then two-person carpools, then low-emission vehicles, and finally single-occupant vehicles (toll payers). The study also stipulates that tolls would be collected by electronic toll collection (ETC) technology.

Three conceptual alternatives were studied in order to consider a range of interventions to implement a HOT facility in the corridor. After examining minimum, moderate, and maximum investment alternatives, each promising a

greater level of HOT facility use and revenue return, the study concluded generally that:

- The “Value Express Lanes” concept would be technically feasible on the I-25 and US 36 HOV facilities. The lanes could be implemented with no detrimental effect on existing carpool and bus level of service.
- Value Express Lanes are financially feasible on I-25 and US 36 HOV facilities; they would raise enough revenue to cover expenses, including annual operations, enforcement and maintenance, as well as capital costs associated with tolling. It would take roughly six years for the facility to break even, according to financial estimates.
- The minimum investment alternative should be implemented in the short-term, while the feasibility of the more significant alternatives is analyzed further.
- Although public surveys did not indicate more than marginal support for the Value Express Lanes, the public did express frustration with “empty HOV lanes” and there was often support for the HOT application as a way to maximize use of the existing lanes.

#### 7.5.4 Public Outreach

Similar to the case of SR 91 in Southern California, the Denver Value Express Lanes Feasibility Study included a significant effort to assess commuter opinions, attitudes and ideas about the possible implementation of a HOT

facility in the region. Public outreach efforts included ten employer-based focus groups held in two rounds, one random digit dialing telephone survey that reached roughly 450 respondents, and ten open focus group sessions for commuters that travel on the segments of US 36 and I-25 North identified as most promising for Value Express Lane implementation in phase one of the study.

Based on this outreach to employers, commuters, and the general public, study sponsors concluded that while general support for the HOT concept was only marginal, people felt impatient with underutilized HOV lanes and often supported the Value Express Lanes concept as a means of maximizing use of HOV lanes.

Some other key findings from the surveys and focus groups include:

- Most drivers in the Denver metro area are adversely affected by traffic. At least once per week, most drivers find themselves stuck in traffic. Nearly one-third of all drivers find themselves stuck in traffic and late for work in a typical week.
- There seems to be a learning curve among the public regarding HOT lanes. Some participants in the focus groups became more supportive of the concept as they understood more about the possible transportation improvements and the funding for the facilities. Discussing real life examples such as San Diego’s I-15 HOT lane or SR 91’s FasTrak helped participants to understand the concept.
- Drivers identified benefits to include more trip flexibility and choice, time savings, and reduced stress.
- Participants expressed concern about the fairness of restricting lane use to those who could pay when the original HOV lane was paid for with tax dollars. Others also expressed concern that a HOT facility was

The Colorado Department of Transportation has mounted a website devoted to the Value Express Lanes Feasibility Study. Found at <http://www.valuelanes.com/>, this site is extremely valuable for the wealth of study documents that are available for download. Four separate reports describe the commuter and employer focus groups as well as the telephone interviews conducted for the study. These documents include detailed analysis of participant responses, original survey and questionnaire instruments, and descriptions of methodologies used.

only a temporary solution because their limited available capacity would be used as growth in the region continued.

- People had different opinions about the use of toll revenues. Some thought it should support road improvements and others, transit. Some did not want the tolls to be absorbed into general government revenue.
- When queried, roughly two-thirds of participants felt potential Value Express Lanes should be operated by a public entity rather than a private organization.

Although the US 36/I-25 HOT lane proposal was still under consideration by FHWA's Value Pricing Pilot Program in mid-2002, this type of preliminary outreach can lay the groundwork for successful implementation of HOT projects in the future. Project sponsors now have a firmer understanding of public reactions to HOT lane and variable pricing concepts. Sponsors also know more about the circumstances under which the public might consider using such a facility.

### 7.5.5 Next Steps

Since the completion of the Value Express Lanes Feasibility Study, CDOT submitted an application to the FHWA Value Pricing Pilot Program for design, construction, maintenance and monitoring of the facility, however FHWA

had not yet acted on the application as of mid-2002. The cost of the project may create some complications, as the HOT conversion in the entire corridor depends on the \$11 million HOV lane project that must occur on I-25 first.

Locally, all relevant policy players at CDOT, RTD, the City of Denver, and the Denver Regional Council of Governments (COG), as well as FTA and FHWA, have indicated some level of support of the proposal, and a group of officials from these agencies is currently examining technical issues associated with the project.

A separate recommendation of the Value Express Lanes Feasibility Study was that CDOT should explore yet other opportunities for Value Express Lanes. In particular, it recommended a feasibility assessment for a HOT facility on C-470, one of the corridors identified that scored well in the initial assessment of twelve regional corridors.

CDOT has applied for and received FY '01 federal funding for studying HOT lanes in this corridor. The Value Pricing Pilot Program will provide \$500K for a feasibility analysis similar to that conducted for the US 36/I-25 corridor. As of early 2002, CDOT was preparing to release a Request for Proposals to solicit consultant help with the study.



# Chapter 8

## A Guide to HOT Lane Development— Lessons Learned

### 8.1

#### Rationale

Against the backdrop of increasing roadway congestion in major urban areas, a decline in mode share for car pools, and expanded implementation of HOV networks, HOT lanes represent a promising opportunity to provide new and enhanced mobility options for motorists and transit users on congested highway corridors.

- HOT operations can maximize the efficiency of existing highway capacity by increasing the volumes on HOV facilities without degrading levels of service. The value of existing HOV facilities is maintained and additional service is offered.
- HOT lanes can provide reliable, uncongested service levels for non-HOV motorists who are willing to pay the price.

This combination of features demonstrates the promise of managing existing or new capacity in metropolitan areas. HOT lane networks provide a richer array of mobility services to car-poolers, transit riders, urgent trip makers and other users. In addition they generate a new source of revenue which can be used to offset their implementation costs and support other transportation improvements, including enhanced transit service.

### 8.2

#### Requisites

Given that the HOT lane concept is relatively new and has not yet been widely deployed, it is important to recognize the contexts into which HOT lanes can be most effectively introduced. These include:

- High density corridors typical of larger metropolitan area with limited travel options and a lack of parallel highway routes where a new HOT facility can appeal to several travel markets;
- Newly created HOV facilities where HOT operations can maximize use of the expanded lane capacity;
- Congested HOV facilities where a transition from HOV 2 to HOV 3 eligibility provides available capacity for HOT users; and
- Underutilized HOV facilities where paying SOV users can utilize the excess capacity with level of service maintained by pricing.

While it is possible to allow limited scale HOT lane use on single-lane HOV facilities, it is preferable to implement HOT operations on facilities providing more than one travel lane per direction.

### 8.3

#### Benefits

HOT lanes bring a wide variety of benefits to the driving public and transit users alike. When applied in conjunction with other management tools and the sensible, targeted provision of additional lane capacity, HOT lanes have the potential to afford significant improvements in congested travel corridors. The primary benefits of HOT lanes are that they provide the driving public with a new choice—premium and predictable travel conditions—on corridors where conditions would otherwise be congested. At the same time they maximize the use of managed lanes—including HOV lanes—without causing traffic service to fall below desired levels. These powerful dynamics also afford a wide range of related benefits, including:

- Superior, consistent, and dependable travel times, particularly during peak travel periods;
- New revenue sources that can be used to support the construction of the HOT lanes

themselves or other initiatives, such as improved transit service;

- Traffic service improvements on congested parallel general-purpose highway lanes by drawing vehicles off parallel local streets and improving corridor-wide mobility;
- Faster highway trips for transit vehicles that may encourage expanded express bus service;
- Environmental advantages by providing opportunities to encourage carpooling, improve transit service, and move more people in fewer vehicles at faster speeds; and
- Increased efficiency of managed lane facilities making them attractive in regions that might not otherwise consider them and eliminating potential pressure to convert under performing HOV lanes to general-purpose use.

## 8.4 Lessons Learned

Despite its many benefits, the HOT concept has generated spirited debate among transportation professionals, politicians, and public advocates. Most of these discussions have focused on the public’s willingness to pay for premium travel conditions in congested highway corridors and the perceived equity issues involved in providing such service to those who choose to pay for it.

Extensive survey efforts demonstrate that the four existing HOT facilities are popular with local motorists. Moreover this support is consistent among motorists of all income levels, including both those who use existing HOT lanes on a regular basis and those who do not. Experience has show that most motorists use HOT facilities on a selective basis when trip purpose justifies the expense—regardless of income.

Additional public opinion research conducted around the country demonstrates that the pub-

lic understands the value pricing concept and that a majority of motorists in many congested areas would be willing to pay for improved travel conditions. These results suggest that the public at large may be more willing than political leaders to support new HOT lane projects.

Effective public outreach is essential in garnering support for the HOT lanes and must continue throughout project planning, implementation and operation. New concepts such as HOT lanes are heavily dependent on the support of respected public figures who are willing to act as vocal project champions. They may include elected officials, community advocates, or private sector leaders who are recognized consensus builders. Experience demonstrates that a single champion can “make or break” a HOT project.

There are a number of other lessons that can be culled from the nation’s collective experience to date, including several key conceptual and institutional findings:

- HOV conversions may often be the most attractive approach for implementing HOT lanes;
- A team effort among key stakeholders is important gaining consensus and maintaining momentum from project planning to implementation;
- A variety of public institutional and private sponsors can develop HOT lane projects;
- Enabling legislation and interagency agreements specifying roles and responsibilities are often needed;
- Decisions on issues such as tolling structures, occupancy requirements, and technology may require interagency coordination;
- Dynamic tolling may require HOT lane sponsors to develop new technologies, institutional arrangements and administrative procedures;

- Reciprocity with other toll agencies is advantageous and should include data compatibility and revenue transfer capabilities; and
- Private funding brings access to new capital funds, but private debt service costs may be higher than those for public agencies.

With four HOT lane facilities operating in the United States in mid-2002, the potential of the HOT lane concept is not yet fully recognized and may not be considered in some situations where it could be appropriate. The HOT lane concept provides a cost-effective opportunity to allow the nation's extensive HOV and express lane networks to be managed and operated more efficiently. HOT lanes provide new opportunities for transit vehicles, HOVs, and

other paying motorists to avoid congested highway lanes, while at the same time easing congestion on parallel general purpose lanes. Moreover, in addition to enhancing mobility at the corridor level, HOT lanes also generate new revenue streams that can be used to pay for their own implementation or to support other transportation improvements including transit service enhancements.

Professional and policy communities in the United States are just beginning to recognize the powerful benefits HOT lanes provide and build on the nation's initial HOT lane experiments. It is hoped that the information contained in the guide will encourage continued expansion of the concept.

# Glossary

**Automatic Vehicle Identification (AVI):** A technology system using transponders on vehicles and outside sensors to determine if vehicles on toll lanes are carrying a valid transponder and what the vehicle's classification is (truck vs. passenger car, SOV vs. HOV). This system also processes the appropriate toll transaction based on the information.

**Benefit-Cost Ratio (BCR):** The ratio of a project's present value benefits to its present value costs. The BCR is useful for comparing projects of different scale or financial size since it assesses economic efficiency.

**Closed Circuit Television (CCTV):** A video monitoring and security system used to provide continuous traffic monitoring by the facility operator along the length of the facility and particularly at points of entry and tolling locations.

**Detector Loops (Loop Detector Amplifiers):** An AVC system component imbedded in the pavement and used to detect and classify the type of vehicles passing over them. The loops are linked to the lane controller and can be used individually to count traffic or to trigger the violation enforcement cameras or in tandem to measure vehicle speeds.

**Differential Pricing (Variable Pricing):** Time-of-day pricing and tolls that vary by other factors like facility location, season, day-of-week, or air quality impact.

**Dynamic Pricing:** Tolls that vary in real time in response to changing congestion levels, as opposed to variable pricing that follows a fixed schedule.

**Economic Rate of Return (ERR):** The economic rate of return (ERR), sometimes referred to as the internal rate of return, gives the effective discount rate for which the project's benefits would just equal its costs, in present value terms. In other words, it is the discount rate that yields a BCR of 1.0.

**Electronic Toll Collection (ETC):** Systems deploying various communications and electronic technologies to support the automated collection of payment at toll booths and other collection points. Collectively, the application of these technologies increase system throughput, improve customer service, enhance safety, and reduce environmental impacts.

**Express Lanes:** A lane or set of lanes physically separated or barriered from the general-purpose capacity provided within major roadway corridors. Express lane access is managed by limiting the number of entranced and exit points to the facility. Express lanes may be operated as reversible flow facilities or bi-directional facilities.

**E-ZPass:** An electronic toll collection technology deployed by a regional consortium of transportation agencies in Delaware, New Jersey and New York. The technology is compatible with similar systems used by tolling agencies in several northeastern states. Plans call for the deployment of E-ZPass on more than 700 toll lanes along 415 miles of roads, tunnels and bridges in the Northeast United States.

**Fees for Entering:** These are tolls charged to vehicles entering a particular facility or an area but which do not depend on the distance traveled on the facility or in the area.

**High-Occupancy Toll Lanes (HOT lanes):** Managed, limited-access, and normally barrier-separated highway lanes that provide free or reduced cost access to HOVs, and also make excess capacity available to other vehicles not meeting occupancy requirements at a market price.

**High-Occupancy Vehicle (HOV):** A passenger vehicle carrying more than a specified minimum number of passengers, such as an automobile carrying more than one or more than two people. HOVs include carpools and vanpools, as well as buses.

**HOV Lane:** An exclusive traffic lane or facility limited to carrying HOVs and certain other qualified vehicles.

**Inherently Low Emission Vehicles (ILEV):** Alternative fuel, clean air vehicles. Certain states (e.g. California) have authorized the use of ILEVs in HOV lanes regardless of occupancy (Assembly Bill 71). Related terms include Zero-Emission vehicles (ZEVs), Ultra-Low-Emission (ULEV), and Super-Ultra-Low-Emission (SULEV) vehicles powered by alternative fuels.

**Incident Management:** Managing forms of non-recurring congestion, such as spills, collisions, immobile vehicles, or any other impediment to smooth, continuous flow of traffic on freeways.

**Infrared Light Curtains:** An ETC system component installed in pairs to sense the separation between two vehicles passing through a lane, as well as height depending on the number of beams deployed. The information passed on to the lane controller is used in conjunction with the loop detectors to support the correct grouping of axles and to identify large trucks or vehicles pulling trailers.

**Intelligent Transportation Systems (ITS):** A broad range of diverse technologies such as information processing, communications, control, and electronics which can help transportation systems in many ways, including congestion management.

**Interoperability:** The ability to provide of reciprocal privileges for users of electronic toll collection systems on other facilities equipped with ETC systems.

**Lane Controller:** A micro processor ETC component that coordinates the activities of all equipment in a single lane and generates the transactions assigned to individual customers using that lane.

**Lane Management Tools:**

**Access**—Limiting or metering vehicle ingress to the lane or spacing access so that demand cannot overwhelm HOT lane capacity. See also *Limited Access*.

**Eligibility**—Limiting lane use to specific types of users, such as HOVs, motorcycles, low emission vehicles, or trucks. For most typical HOT lane settings, eligibility requirements would be used during selected hours or at specific access ramps.

**Pricing**—Imposing a user fee on a lane that helps regulate demand by time of day or day of week. The fee increases during periods of highest demand.

**Level-of-Service (LOS):** Also known as “Traffic Service,” LOS is a qualitative measure describing operational conditions within a traffic stream. LOS assesses conditions in terms of speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety. Six levels of service are defined by letter designations from A to F, with LOS A representing the best operating conditions, and LOS F the worst.

**Limited Access:** Access management used to restrict entry to a facility based upon facility congestion levels or operational condition, such as the presence of an accident or maintenance activities. Access may be restricted by 1) metering signals, or 2) limiting the number of entrances and exits. Some restricted access lanes include HOV priority.

**Managed Lane:** A lane or lanes designed and operated to achieve stated goals by managing access via user group, pricing, or other criteria. A managed lane facility typically provides improved travel conditions to eligible users.

**Metropolitan Planning Organization (MPO):** Federally mandated regional organizations responsible for comprehensive transportation planning and programming for in urbanized areas. Work products include the Transportation Plan, the Transportation Improvement Program, and the Unified Planning Work Program.

**Mileage-Based Fee:** A vehicular toll based on the vehicle miles traveled (VMT) in the jurisdiction.

**Mixed-Flow:** Combined flow of HOV vehicles and SOV vehicles.

**Motor Vehicle Fuel Tax:** Federal and state taxes levied on gasoline and other fuels.

**Open Road Tolling:** Fully automated electronic tolling in an open road environment allowing vehicles to travel at normal speeds when passing through toll collection points.

**Price Elasticity of Demand:** A measure of the sensitivity of demand for a commodity to a change in its price. It equals the percentage change in consumption of the commodity that results from a one-percent change in its price. The greater the elasticity, the more price-sensitive the demand for the commodity.

**Queue Jump:** Elevated ramps or at-grade lanes that can be used by motorists stopped in traffic to bypass congestion.

**Reversible Flow:** Lanes that can be operated in reverse direction to reduce congestion during certain peak periods.

**Revenue Neutral:** Revenue-neutral pricing strategies involve rebating some or all of the revenue generated by pricing to toll payers, where generating revenue is not an objective of value pricing.

**Road Pricing:** An umbrella phrase that covers all charges imposed on those who use roadways. The term includes such traditional revenue sources as fuel taxes and license fees as well as charges that vary with time of day, the specific road used, and vehicle size and weight.

**Single Occupant Vehicle (SOV):** A vehicle occupied by only one person.

**Time-of-day Pricing:** Facility tolls that vary by time-of-day in response to varying congestion levels. Typically, such tolls are higher during peak periods when the congestion is most severe. Many sectors of the economy (telephone, electric utilities, and airlines) use such pricing to manage demand within the available capacity.

**Toll Road:** A road or section of road where motorists are charged a fee (or toll).

**Toll Violation Camera:** Fixed, short range, still cameras used to obtain single frame pictures which are deployed in individual lanes at tolling points. Toll violation cameras are aimed and focused to obtain images of the license plates of violating vehicles.

**Transponder:** An electronic tag mounted on a license plate, built into a vehicle, or placed on the dashboard. The tag is read electronically by an electronic tolling device that automatically assesses the amount of the user fee.

**Transportation Demand Management (TDM):** Actions that improve transportation system efficiency.

cy by altering system demand using such strategies and facilities as: pricing, ridesharing; park-and-ride facilities; transit friendly development/zoning; and employer-based programs, such as staggered work hours and telecommuting. TDM programs improve the efficiency of existing facilities by changing demand patterns rather than embarking on capital improvements.

**Transportation System Management (TSM):** Integrated protocols and computerized ITS systems used to manage roadway and transit facilities. TSM techniques improve system capacity without physical expansion or behavioral changes. Typical TSM measures involve continuous management and operation of traffic systems, and utilize integrated traffic control systems, incident management programs, and traffic control centers.

**Treadle:** A pressure-sensitive device inserted in the pavement designed for directional counting of vehicle axles passing over them. These sensors are used as inputs to the lane controller to provide information on axle count and vehicle direction of travel, depending on the order in which the stripes are hit.

**User Management:** User management defines how and which types of users can utilize a facility, such as HOV occupancy requirements, access points, barrier separation, and user fees. Restrictions may vary by time of day or day of the week.

**Value Pricing:** Value pricing is a concept that uses monetary incentives to manage congestion during peak travel periods on tolled highways and crossing facilities.

**Variable Message Signs (VMS):** Electronic signage that employs ITS technology and centralized control systems to change messages in real time, providing motorists with timely and useful information.

**Vehicle Hours Traveled (VHT):** Total vehicle hours expended traveling on the roadway network in a specified area during a specified time period.

**Vehicle Miles Traveled (VMT):** The measurement of the total miles traveled by all vehicles in a specified area during a specified time.

**Vehicle Enforcement Systems (VES):** Manual and computer systems used to enforce vehicle and motorist compliance with the usage guidelines for HOT lanes

**Vehicle Separators/Profilers:** An AVI system component located on a gantry or at the side of a lane. They perform functions similar to light curtains. The class of vehicles is determined based on the profile of the passing vehicle.

**Video Surveillance:** The use of pan-tilt-zoom, steerable moving picture cameras to survey a toll plaza, ETC collection area, or a segment of roadway to monitor for incidents.

*Several glossary definitions were prepared by the Transportation Research Board's Joint Subcommittee on Pricing*

# Index

## A

access points, 4, 34, 40, 46, 51, 71  
advisory committee, 32, 33, 94  
air quality, 3, 33, 63  
Automatic Vehicle Classification, 49

## B

benefit-cost ratio, 61  
bonds, 31, 55, 58, 78, 85

## C

capital costs, 60, 72, 90  
consensus building, 8, 9, 23, 32, 36

## E

electronic toll collection (ETC), 3, 4, 11, 27, 31, 48  
enforcement, 19, 31, 40, 48, 68-70  
    video enforcement, 50  
equity, 9, 11, 21, 24, 28-30  
excess capacity, 6  
E-Z Pass, 31

## F

FasTrak, 5, 31, 83-84, 87-90  
Federal Transit Administration (FTA), 14, 57, 74, 87

## G

grade separated access, 46

## I

I-15, 5, 7, 14, 30, 31, 35, 48, 57, 87-90  
incident management, 8, 70-71  
infrared light curtains, 49  
Inland Breeze Bus, 31  
innovative finance, 59-60  
Intelligent Transportation Systems (ITS), 2, 51, 59  
interoperability, 19  
Interstate Highway System, 13, 16, 19  
Interstate Toll Pilot Program, 16

## K

Katy Freeway, 5, 7, 14, 64, 66, 73-80

## L

lane controller, 49, 50  
lane management, 3, 64-66  
lane separation, 11, 37-45  
    mountable curb markers, 43  
    tubular markers, 43  
    retractable markers, 43-44  
lane use signal, 51  
loop detector, 49, 51, 60

## M

managed capacity, 64-65  
marketing, 13, 22, 27, 33-35, 76, 88  
media, 25, 34, 35, 82

## N

National Environmental Protection Act  
(NEPA), 21, 62  
noise, 43, 62, 63  
non-compete clause, 85-86

## O

operating costs, 31, 60, 91  
operator, 12, 13, 16, 19, 92  
owner, 12, 13, 16, 19, 84-85, 92

## P

penalties 70, 75  
pricing, 28, 51-60  
    dynamic pricing, 4, 47, 55, 57, 60, 89, 101  
    fixed rate, flat rate, 4, 17  
    point-to-point toll rates, 17  
    value pricing, 3, 17, 25, 51-60  
    Value Pricing Pilot Program, 19  
private sector participation, 13, 15-16, 86, 92, 94  
privacy, 31  
public outreach, 21-36, 76, 79, 82-83, 88-89, 94,  
    98-99  
public transit, 2, 5-6, 13, 14-15, 25, 31, 57, 73-80,  
    87-90, 97  
public-private partnership, 17, 63, 81

## Q

QuickRide, 5, 64, 73-80

## R

revenue  
    bonds backed by, 58-59, 78  
    disposition of, 30-31  
    forecasting, 55, 56, 91-92  
    generation of, 26-27

## S

Section 129 loans, 59  
signage, 46-48, 47, 60, 68  
    variable message sign, 47-48, 48, 51  
sponsor, 12-15, 13, 57  
SR 91, 5, 35, 35, 43, 47, 57, 80-87  
state funds, 58, 78, 93-94

## T

TEA-21, 16, 19-20, 57, 80  
tolling authority, 16-17  
transponder. *See Automatic Vehicle Classification*  
Transportation Infrastructure Finance and  
    Innovation Act (TIFIA), 59-60  
travel demand forecasting, 9, 51-54  
turnpike, 13

## U

user fees, 2, 28

## V

value pricing. *See pricing*

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