Managed Lanes: The Future of Freeway Travel

TRANSPORTATION OFFICIALS ARE EXPLORING THE USE OF MANAGED LANES TO ADDRESS MOBILITY NEEDS IN FREEWAY CORRIDORS. THIS FEATURE PRESENTS EXAMPLES OF MANAGED LANES IN OPERATION AND ADDRESSES THEIR FUTURE, INCLUDING NEW PROJECTS ON THE HORIZON AND UNRESOLVED ISSUES ASSOCIATED WITH DESIGNING AND OPERATING A FULLY FLEXIBLE MANAGED LANE FACILITY.

BY GINGER GOODIN, P.E.

INTRODUCTION

Transportation agencies are facing the growing challenges of traffic congestion and a limited ability to expand freeway capacity due to construction costs, right-of-way constraints and environmental and societal impacts. As a result, transportation officials are exploring the use of managed lanes to address mobility needs in freeway corridors, particularly where major expansion has limited feasibility.

Managed lanes provide travel options in a congested corridor through minimal capacity expansion and operational strategies that seek to manage travel demand and potentially improve transit and other forms of ridesharing (see Figure 1). The managed lanes approach is gaining interest around the United States as a strategy that combines these elements to make the most effective and efficient use of a freeway facility.

WHAT ARE MANAGED LANES?

The term "managed lanes" is increasingly recognized in the transportation profession. However, none of the managed lane facilities in operation today is communicated to the public using this term. As a project description, "managed lanes" could have a negative connotation to the general public, indicating that lanes are being managed or regulated or implying that the current freeway system is not effectively managed.

The term is gaining widespread use in the profession and will remain a useful professional term, but the managed lanes approach may be better communicated to the public at the project level using terms such as "express lanes," "toll express lanes," "value lanes," "fast lanes," or even "flex lanes."

Within the transportation profession, the term has different meanings depending upon the agency. In some agencies, managed lanes are commonly thought of as high-occupancy toll (HOT) lanes—facilities that employ pricing and vehicle eligibility to maintain free-flow conditions and provide high-occupancy vehicle (HOV) preference.

In other agencies, a broader definition is customary, in which various management tools and techniques are combined to improve freeway efficiency and meet certain corridor and community objectives. This broader definition of managed lanes includes HOV lanes, value-priced lanes (including HOT lanes) and exclusive or special use lanes, such as express, bus-only, or truck-only lanes.

Figure 2 captures the potential lane management applications that fall into this broad definition of managed lanes. On the left of the diagram are applications of a single operational strategy—pricing, vehicle eligibility, or access control. On the right are more complicated managed lane facilities that blend more than one of these strategies. The multifaceted facilities on the far right of the diagram incorporate or blend multiple lane management strategies.

ACTIVE MANAGEMENT

The Federal Highway Administration (FHWA) views managed lanes in this broad sense, as highway facilities or sets of lanes where operational strategies are proactively implemented (in real time) and managed in response to changing conditions.[1] Lane management strategies have been used by agencies for decades to improve flow on freeway facilities. The distinction between managed lanes and other traditional forms of freeway lane management is the operating philosophy of active management.

Under this philosophy, an operating agency proactively manages demand and available capacity on a facility by applying new strategies or modifying existing strategies. From the outset, the agency defines the operating objectives for the managed lanes and the kinds of actions that will be taken once predefined performance thresh-

Figure 1. Katy HOV lane in Houston, TX, USA.

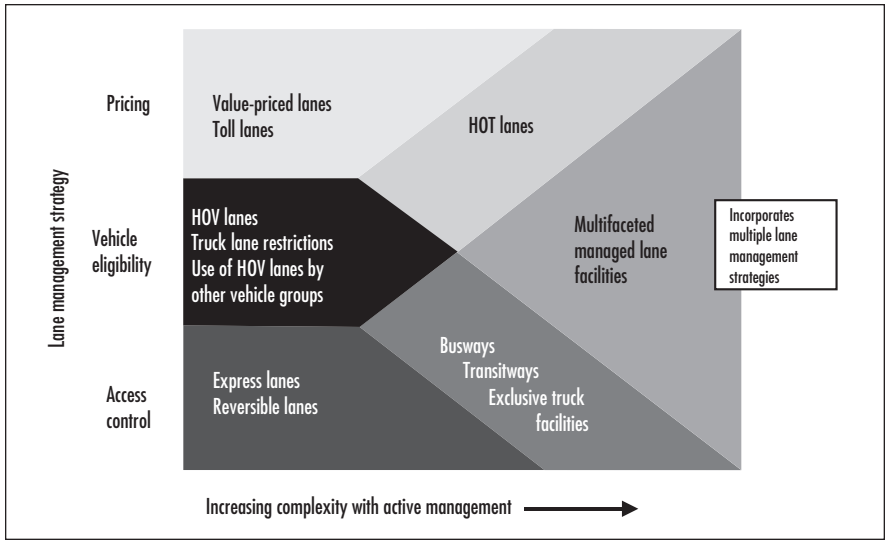

Figure 2. Types of managed lanes. Source: Managed and Priced Lanes: Summary of Workshop Results. Federal Highway Administration and Transportation Research Board, Key Biscayne, FL, USA, November 2003.

olds are met. The following examples show how demand on a managed lane facility can be reduced through a specific action:

- To maintain a speed of 60 miles per hour (mph), the operating agency raises the toll rate on a priced facility.
- To ensure that bus operating speeds of 50 mph can be maintained, the agency raises the occupancy requirement to use an HOV lane.
- To operate within a volume threshold of 1,500 vehicles per hour per lane, the agency closes an on-ramp to express lanes during peak periods.

The core of the active management philosophy is the development of clear performance objectives and operating threshold values that directly relate to the goals of the project. Additionally, a managed lane facility can be designed and operated to achieve different objectives during different days of the week or times of the day. For example, a facility could operate as HOV or HOT lanes during peak periods, toll express lanes during off-peak periods and, potentially, a truck-only facility during certain times of the day.

RATIONALE FOR CONSIDERING MANAGED LANES

Transportation agencies may have a number of reasons for considering managed lanes in a freeway corridor. Among them are the following:

- The inability to build enough lanes to address congestion during peak periods: Because of construction and right-of-way costs, environmental concerns, or community issues, it may not be possible to expand the cross-section of a freeway to offer congestion-free travel at all times of the day. Managed lanes can provide a congestion "relief valve" to offer faster trips during peak periods.
- The desire to offer travel options in a congested corridor: Building on the success of HOV facilities, managed lanes can provide travel time savings for buses, vanpools and carpools, creating an incentive to shift modes from single-occupant vehicles (SOV) to various forms of ridesharing. The idea of implementing bus rapid transit (BRT) within managed lanes as a way of providing high-capacity mass transit service evolved from the HOV experience.
- The need to address funding issues and the potential for revenue generation: As transportation funding declines, agencies are looking at managed lanes as a way to implement freeway improvements while covering all or a portion of capital costs, paying for operating expenses, or funding additional transportation improvements in a corridor (including transit service).
- The desire to increase the effectiveness of HOV lanes: Employing management strategies such as pricing to existing HOV lanes has the potential to preserve person-movement objectives while enhancing an HOV lane's effectiveness in meeting other corridor-wide goals.
- The need to separate large vehicles: For safety considerations in corridors with heavy truck volumes, an operating agency may want to separate large trucks from other vehicles using a managed lanes approach.

In considering managed lanes for a particular corridor, an agency may seek a combination of project objectives, both in the short term (10 years) and for long-range needs (20 to 30 years). Designing for a flexible managed lane system will allow the agency to modify operations in response to changes in travel patterns in the corridor as well as longer-term changes in broader community goals.

MANAGED LANES IN OPERATION TODAY

The following section highlights four operational managed lane facilities that employ the three primary management strategies: pricing, vehicle eligibility and access control.[2] All four projects have been proving grounds for variable road pricing under the FHWA Value Pricing Pilot Program, which offers funding and technical guidance for testing and evaluating pricing strategies to manage demand. Table 1 provides a summary of the four projects for comparison purposes.

Table 1. Characteristics of operating managed lanes.

Project	Number of lanes per direction	Project objectives	Daily corridor volume[a]	Daily managed lanes volume[a]	Percentage of exempt vehicles[a]	Revenue (in millions, 2003)[a]	Use of revenue
State Route 91 Express Lanes	Two	• Provide a fast, safe and reliable commute • Maintain financial viability of lanes	290,000	35,000	20 percent	$26	60 percent debt service; 40 percent operations
Interstate 15 FasTrak Express Lanes	Two (reversible)	• Provide better use of available capacity • Fund new transit service	270,000	30,000	75 percent	$2.2	55 percent operations; 45 percent transit service
Interstate 10 and U.S. 290 QuickRide	One (reversible)	• Provide better use of available capacity • Maintain bus operating speeds	210,000	9,200	98 percent	$0.15	100 percent operations
New Jersey Turnpike Dual-Dual Section	Six	• Separate large trucks • Provide flexible operations during heavy congestion	200,000	200,000	0 percent	$200[b]	45 percent debt service; 45 percent operations; 10 percent other

Note: [a] Approximate values are given for comparison purposes. [b] 2003 total revenue proportioned by vehicle miles traveled for dual-dual section.
Source: *First Consolidated Toll Road Annual Report 2003*. New Jersey Turnpike Authority, Trenton, NJ, USA, 2003.

State Route 91 Express Lanes, Orange County, CA, USA

The State Route (SR) 91 Express Lanes in California were the first in the United States to vary tolls by the level of congestion on the roadway. Built within the median of SR 91 and opened in 1995, the four express lanes are 10 miles in length with no intermediate access. Two lanes are provided in each direction and they are separated from the main lanes by plastic pylons and a painted buffer.

Toll rates are set according to the level of congestion typically experienced on the roadway, making peak periods the most expensive time to travel. Although the facility is open 24 hours per day and seven days per week and tolls are charged at all times, the operators use price to maintain free-flow speeds on the express lanes at all times.

Tolls are paid exclusively through electronic collection. Facility users must have an account and a transponder. The facility also encourages travel in HOVs. Carpools with three or more occupants (HOV3+), motorcycles, zero-emission vehicles and vehicles with disabled person license plates are free at all times, with the exception of the evening peak period in the peak direction, when HOVs are charged 50 percent of the posted toll.

Interstate 15 FasTrak Express Lanes, San Diego, CA, USA

The Interstate 15 (I-15) FasTrak Express Lanes in San Diego, CA, are operated by the San Diego Association of Governments (SANDAG). On the eight-mile, two-lane reversible facility, the express lanes are separated from the main lanes by concrete barriers. Access is available only at the termini.

The express lanes originally were operated as HOV lanes but often had unused capacity available. In 1996, the HOV lanes were converted to HOT lanes. SOVs are charged to use the facility and HOVs travel free of charge.

The I-15 express lanes use dynamic tolling—the first of its kind implemented. Toll rates typically vary from $0.50 to $4.00 but can rise as high as $8.00 in severely congested conditions. Technology deployed in the corridor allows for the assessment of current traffic conditions. The toll rate is adjusted dynamically to ensure free-flow conditions in the express lanes.

Dynamic message signs posted prior to the entrance of the facility alert drivers to the current toll. As with the SR 91 Express Lanes, all users must be registered and must have an established FasTrak account, which allows tolls to be collected electronically.

Interstate 10 and U.S. 290 QuickRide, Houston, TX, USA

A slightly different pricing project has been implemented on Interstate 10 (I-10), also known as the Katy Freeway, and U.S. 290, referred to as the Northwest Freeway, in Houston, TX, USA. The program, which is marketed under the name QuickRide, began operating on the Katy Freeway HOV lane in January 1998 and was expanded to the Northwest Freeway HOV lane in 2000.

Both are one-lane reversible facilities separated from the main lanes with a concrete barrier. Access is allowed at intermediate locations in addition to the termini. Each lane is approximately 13 miles long. The facilities essentially operate as HOV lanes in off-peak periods and HOT lanes during peak periods, although SOVs are never allowed.

Both HOV lanes operate with a 3+ restriction during peak periods, which was imposed when the lanes became congested and impeded bus operations. However, this 3+ restriction left unused capacity when HOVs with two persons (HOV2) were no longer allowed. The Metropolitan Transit Authority of Harris County, the operator of the HOV lanes, worked with the Texas Department of Transportation and FHWA to implement tolling of HOV2s during the 3+ restriction as a way to better utilize the available capacity on the HOV lane.

QuickRide is operated much like the FasTrak program in California. HOV2s are required to establish an account and are issued a transponder. HOV2s that wish to travel on the facility during the 3+ restriction are charged $2.00 each way via the transponder.

New Jersey Turnpike Dual-Dual Section

The New Jersey Turnpike is a limited access toll road that utilizes a variety of man-

Table 2. Selected managed lanes projects with planned opening before 2010.

Project	Design characteristics	Operations and management	Estimated opening
Interstate 394, Minneapolis, MN, USA	• HOV to HOT conversion • 11 miles total, 8 miles with one lane per direction with striped buffer separation and mid-point access	HOV2+ free with variable pricing	Spring 2005
Interstate 25, Denver, CO, USA	• HOV to HOT conversion • 7.5 miles, two-lane reversible with barrier separation	HOV2+ free with variable pricing	Fall 2005
State Route 167, Seattle,WA, USA	• HOV to HOT conversion • 9 miles, one lane per direction with channelizer separation and mid-point access	HOV2+ free with variable pricing	2007
Interstate 30, Dallas, TX, USA	• New managed lanes • 15 miles, 2 to 4 lanes per direction with channelizer separation and mid-point access	HOV3+ free with variable pricing	Late 2007
Interstate 15, San Diego Express Lanes expansion	• New managed lanes • 20 miles, 4 total managed lanes with flexible lane assignment using movable barrier system, barrier separated from main lanes with mid-point access	HOV2+ free with variable pricing, BRT emphasis	Beginning 2007 through 2010
Interstate 680, Alameda County, CA, USA	• HOV to HOT conversion • 14 miles, one lane per direction with striped buffer separation and mid-point access	HOV2+ free with variable pricing	Mid-2007
Interstate 10, Houston Katy QuickRide expansion	• New managed lanes • 23 miles, 13 miles with 2 lanes per direction, barrier separation and mid-point access	HOV3+ free with variable pricing, peak-period express bus emphasis	Beginning 2009

Source: *Overview of High Occupancy Toll Lanes Across the Country*. Washington State Department of Transportation, August 2004.

agement techniques to optimize flow. In the 1970s, a 32-mile segment of the roadway was expanded into two separate roadways. The objectives of the "dual-dual" roadway were to improve operations and safety by separating heavy vehicles from light vehicles and to increase capacity in the most heavily traveled section of the turnpike.

It also was intended to provide greater flexibility for using the roadway during periods of heavy congestion, such as a major incident, because changeable message sign technology could be applied to warn approaching drivers and divert them to the less-congested roadway.

The six inside lanes of the dual-dual roadway are for automobiles only; the six outer lanes accommodate all vehicle types. The lanes are separated by concrete barriers. Each part of the roadway has its own entrance and exit ramps. There are periodic openings in each of the roadways to allow traffic to be diverted from one facility to the other as conditions may warrant.

Between interchanges 11 and 14, the left-most lane of the outer roadway is designated as an HOV lane during peak periods. The HOV lanes are reserved for cars and vans carrying three or more persons and all buses and motorcycles. These lanes act as general purpose lanes at times other than the peak and are open to all traffic.

The New Jersey Turnpike Authority has implemented a value pricing incentive to shift travel out of the peak. Customers using E-ZPass electronic toll collection and traveling in off-peak hours receive a 20-percent discount off the toll rate.

THE FUTURE OF MANAGED LANES

As transportation agencies around the United States embrace the managed lanes approach, there also is recognition that the idea is more than a concept—practical implementation issues need to be addressed through further research and development. Although examples such as California's 91 Express Lanes and I-15 FasTrak Express Lanes are frequently cited as models of successful projects, they are somewhat simplistic in their operating approach.

Next-generation projects currently under development are more complex in terms of multiple ingress/egress locations, access treatment, enforcement and transit integration. Table 2 highlights several projects around the United States in the planning and development stages with near-term implementation.

Of particular interest are those that are addressing some of the challenging issues associated with managed lanes, as this mobility strategy encompasses the full range of possibilities—and complexities.[3,4] Each new challenge poses tough questions that have not been tackled in the projects currently in operation:

- Multiple mid-point ingress/egress points and the ripple effect on technical and operational complexity, including tolling operations, lane separation, enforcement, safety and driver information.
- Buffer or striped separation between managed and general purpose lanes and the ability to effectively enforce access restrictions and toll evasion.
- The role of revenue generation and the competing objectives of maximizing person movement through HOV exemptions and maximizing revenue.
- The role of bus transit, including BRT, and its integration in managed lane operations.
- Improved methods for enforcement of HOV preference in managed lanes.
- Signing and motorist information needs in an operating environment where strategies may change dynamically and where competition with signing in adjacent freeway lanes may create driver information overload.
- Sustaining operational flexibility over the life cycle of the facility and

communicating to policy-makers and the public that freeway express lane operations will be adjusted as needed over time according to predefined performance objectives.

- Equity and environmental justice concerns, which have been addressed successfully on some projects but have been problematic on others.
- Analytical tools that estimate travel demand, revenue projections and operational impacts interactively.
- Integration of managed lane projects into the existing and planned transportation system (freeway, arterial and transit systems) and connectivity with other managed lanes.
- Dynamic operations beyond pricing, including methods and approaches to dynamically modify vehicle eligibility or access on a managed lane facility.
- Legislative authority, particularly related to operating agencies and their powers to operate as toll authorities in collecting fines and enforcing compliance using automated techniques.

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GINGER GOODIN, *P.E., is a research engineer with the Texas Transportation Institute and has 20 years of experience in transportation planning, design and operations. Her research areas are managed lanes, HOV systems and tolling implementation. She is involved in managed lanes research and project development efforts in Texas, including two projects funded under the FHWA Value Pricing Pilot Program. She chairs the newly formed Transportation Research Board Managed Lanes Joint Subcommittee and is a member of ITE.*