

2.0. PREREQUISITES FOR HOV AND MANAGED LANES

2.1. Program and Policy Understanding

HOV lanes are one form of managed lane treatment that may be appropriate under certain congested conditions. This section addresses the function of managed lanes by providing a brief program and policy understanding for this application. More information can be found in the NDOT HOV and Ramp Metering Policy Manual.

2.1.1. Background on HOV Lanes

In highly congested corridors where traditional strategies for improving mobility and capacity can not address unmet demand, managed lanes have often been implemented to improve roadway efficiency and provide a mobility alternative. Managed lanes over the past 30 years have typically been termed high-occupancy vehicle (HOV) lanes; they reserve use for mass transit purposes during periods of greatest demand. By offering reserved lanes for multi-person vehicles, HOV lanes emphasize *person movement* rather than traditional *vehicle movement*, thus improving the roadway's ability to move more people in fewer vehicles (Figure 2-1). A definition for HOV lanes is provided below:

A lane(s) or roadway dedicated to the exclusive use of specific high-occupancy vehicles, including buses, carpools, vanpools or a combination thereof, for at least a portion of the day.

This approach only works when an assured level of service in the lane is preserved and time savings that encourage mode shifts to transit, vanpooling and carpooling are realized. To provide this benefit, managed lanes are regulated at a maximum flow rate that is below traditionally defined lane capacity (typically around 1600 to 1800 hourly vehicles/lane). When operated and managed at a high level of service, HOV lanes have a theoretical capacity to move substantially more commuters than general use lanes can during peak demand periods when priority must be assigned to the highest and best use. During these periods, HOV lanes provide significant benefits to those choosing to ride a bus or participate in a vanpool or carpool.

Figure 2-1: I-405 HOV Lanes in Southern California



In 1970 there were only three operating HOV projects on freeways. Today, there are over 150 freeway-based HOV projects. In North America alone, there were over 2500 lane-miles operating in 2003. Practically all HOV lanes were added capacity lanes, not converted from existing travel lanes. Conversion has been tried, and the adverse traffic and political impacts to motorists who were ineligible to use the converted lanes has prevented this approach from being successful, and such attempts have ended in HOV lanes that were returned to general traffic operation.

Early HOV lane treatments allowed buses or 3+ carpools only and were implemented in corridors with high bus transit ridership. Over time, as traffic volumes outpaced expansion of general-purpose lanes, HOV lanes were increasingly implemented to serve buses and vehicles carrying at least two or more occupants as a means to further promote ridesharing, meet growing demand, and utilize HOV lane capacity. The primary tools used to manage HOV lane use were eligibility and access. Eligibility restricts lane use to vehicles with a minimum number of persons traveling in each vehicle. Access has sometimes been restricted to points of ingress and egress to promote better traffic flow. Pricing is now being applied as a third tool on a few HOV projects to better regulate over- and under-utilized conditions.

2.1.2. Background on Managed Lanes

Increasingly HOV benefits to other users through managed lanes is now being pursued in many locations. Managed lane facilities to accommodate a much greater number of users are being implemented in San Diego, Denver, Houston, Atlanta, Dallas and elsewhere. In many cases, these treatments are multi-lane widening projects with some physical separation or delineation from adjacent general use lanes (Figure 2- 2).

Figure 2-2: Managed Lanes on State Route 91 in California



The Federal Highway Administration considers the following definition applicable to managed lanes:

The Federal Highway Administration (FHWA) defines managed lanes as highway facilities or a set of lanes in which operational strategies are implemented and managed (in real time) in response to changing conditions. Managed lanes are distinguished from other traditional forms of lane management strategies in that they are proactively implemented, managed, and may involve using more than one operational strategy.

Managed lanes are dedicated lanes or roadways implemented in congested freeway corridors that are actively controlled through a variety of real-time strategies to limit flow rates and thereby preserve an acceptable level of service. By taking such measures, managed lanes generate significant travel benefits, including time savings and improved reliability, and improved operational efficiency to the roadway system. Such lanes can be added either along with new roadway facilities or as modifications to existing facilities; they should not typically be converted from existing lanes. Managed lanes can be considered for specific bottlenecks, as corridor treatments, or as networks or systems in a metropolitan region. Managed lanes must, by virtue of how the management tools are applied, exclude some users so as to preserve their travel benefits. This means that a “highest and best use” operational policy must be assigned to the managed roadway when overall corridor roadway capacity is exceeded and benefits can be provided.

2.1.3. Prerequisite Conditions

An implicit set of conditions that must exist for HOV or any other form of managed lanes to be considered viable includes the following:

- ◆ *Congestion.* A recurring congestion problem to level of service of D or worse (defined as average speeds below 30 mph) within a corridor or region during the defined peak hours each weekday.
- ◆ *Limited resources.* A significant backlog of unmet travel demand and lack of available resources (right-of-way, funding, regional consensus or environmental issues) to address capacity deficiencies in a more conventional means through adding roadway or transit capacity.
- ◆ *Desire to promote mobility.* An interest and ability by agency stakeholders to minimally or incrementally increase roadway capacity by managing its use to specific dedicated purposes to ensure that a high level of service can be provided as an alternative to recurring congestion for at least some users. The public must support this approach.

Managed lanes are a congestion management strategy, and accordingly, there must be the presence of congestion for considering this approach. Congestion, defined as average corridor speeds below 30 mph for several miles for several hours each commute period, must exist on a recurring basis for the accrued benefits to be realized. If added capacity improvements are programmed to eliminate congestion in the future, then there is no incentive to proactively manage specific lanes on a freeway. Conversely, not managing

some congested lanes eliminates a travel alternative to corridor users and precludes the potential to preserve some level of mobility to users as demand grows and congestion returns in a corridor.

Two common reasons why many metropolitan areas are adopting managed lanes into their long range plans is the inability to meet demand through conventional widening and/or the inadequacy of funding to make the needed roadway capacity improvements. Each issue responds to a different set of corridor policy objectives and outcomes. If the corridor cannot be sufficiently widened to meet demand, either due to physical constraints, environmental concerns, available right-of-way or other reasons, then preserving some of the added capacity for managed lanes meets a mobility goal that might otherwise not be attainable. If funding constraints limit the ability to add capacity, then this capacity may be tolled and managed to augment revenue generation as a goal. Attempting to satisfy both goals could pit one against the other. For example, promotion of carpools and transit could consume much of an added lane capacity, leaving little to be sold for revenue generation. But if revenue generation is prioritized, then few vehicles can be given a free ride, thus not promoting ridesharing. Other corridor conditions suitable for consideration of managed lanes include:

- Relatively long distance trips, since lanes are oriented to the left, or next to the median barrier.
- Sufficient demand to consider the user group appropriate.
- Ability to load and unload the managed lane system without significantly impacting either managed or regular traffic roadways.

2.2. Goals and Objectives

2.2.1. Goals

Based on national experience, goals for the implementation of managed lanes include, but are not limited to the following:

- ◆ Maintaining or improving mobility
- ◆ Improving roadway operation efficiency and reliability
- ◆ Promoting transit and ridesharing
- ◆ Addressing environmental considerations and adopted land uses
- ◆ Enhancing air quality (compared to no-build and conventional build alternatives)
- ◆ Maintaining safety
- ◆ Providing travel options to meet user needs, such as “time-sensitive” travel, and
- ◆ Addressing economic and financial considerations

Traditionally, the first six goals were associated with HOV lane planning and implementation. As technology has evolved to allow electronic pricing to become more accepted, the latter two goals have been used on projects that address multiple user groups.

The following HOV/managed lane goals and objectives were identified and developed with local Las Vegas stakeholders in workshops held in Spring 2005. They discussed parameters and considerations for each:

Goal #1: Optimize the movement of people and goods (goal was changed from initial draft by the group)

- ◆ The primary regional goal is to move more people which also translates to increasing the overall vehicle occupancy rate which is extremely low in Las Vegas.
- ◆ Everyone needs to realize it can take a long time to change commuter travel behavior and that the benefits of an HOV/managed lanes system may be realized slowly over a long period of time.
- ◆ This goal is best measured by reviewing change in average vehicle occupancy over time.

Goal #2: Provide incentives to share the ride

- ◆ Time savings and trip reliability are the motivation for people to use HOV or managed lanes and must be preserved for the facilities to be successful.

Goal #3: Increase bus transit efficiency

- ◆ RTC will define how they want transit efficiency to be measured. Various other locales monitor transit on time performance as a measure for this goal.

Goal #4: Not unduly impact traffic operations or transit services

- ◆ This goal specifically discourages using general purpose lane conversion of existing operating lanes to get the managed lane implemented, particularly where implementation adversely affects existing traffic demand and travel patterns. (Programmed expansion may be able to be re-designated as managed lanes in the planning, environmental and design phases.)
- ◆ The operation of managed lanes (i.e. weaving at access points) should not excessively impact other traffic using the freeway or arterial street system.
- ◆ Transit ridership should be enhanced as a result of adding the HOV or managed lane, and not cause loss of current or future transit ridership that may be served on other parallel transit guideway investments.

Goal #5: Have public support

- ◆ HOV/managed lanes need to have public support. It was felt that responsibility for monitoring public support of managed lanes will likely fall to RTC.
- ◆ In assessing overall support for managed lanes, it is important to specifically ask people how they feel about them. This question should be asked of users and non-users of the managed lanes.

- ◆ Marketing and outreach can only be effective if the concept and its application are sound. Managed lanes are a transportation product and good planning, design and operation is necessary to ensure they have public understanding and support.

Goal #6: Consider value pricing as a means to optimize system performance

- ◆ Value pricing is primarily considered as a traffic management tool, not primarily to generate revenues from managed lanes.
- ◆ Managed lanes should be available for use by all income groups through pricing preference (free or discounted use) to carpool, vanpool and transit users. Priced lanes must be equitable to all users.

Goal #7: Promote goods movement by trucking if possible

- ◆ Trucking promotes regional economic development. Major highway routes are of strategic significance to the State and respective cities in Nevada. Improved mobility for person movement *and trucking* is a statewide objective.
- ◆ Managed lanes should be offered to trucks where safe, practicable and beneficial without compromising the overarching goal of promoting greater person movement in congested corridors.

More information related to the establishment of a vision for HOV lanes and ramp metering goals can be found in the companion *HOV/Managed Lanes and Ramp Metering Policy Manual*, section 2.2.2.

2.2.2. Objectives

Objectives describe how the goal will be addressed and can be region or corridor specific. Each area in the state which considers the implementation of managed lanes will need to consider a specific set of objectives that are derived from the regional and statewide goals described above. Following is a list of illustrative examples:

- ◆ Increasing person-moving capacity of the roadway
- ◆ Promoting transit and ridesharing mode split
- ◆ Optimizing vehicle-carrying capacity
- ◆ Promoting travel time savings, reliability, or efficiency for selected travel modes
- ◆ Promoting air quality by increasing ridesharing and transit as part of a conformity plan
- ◆ Increasing funding opportunities for new mobility improvements by generating revenue to offset capital and operating expenses
- ◆ Enhancing existing transit investments and services in the region/corridor
- ◆ Providing a greater choice in serving multi-modal needs (people, goods, services)
- ◆ Improving the movement of commerce (goods and services movements)
- ◆ Supporting community land use and development goals, particularly to major areas of employment

A wide variety of methods are available in both the planning and project operation and monitoring stages to gauge how effective the project could be or has been in addressing specific objectives. These will be described in Section 6.0 of this manual.

2.3. Management Tools

As noted earlier, management strategies to regulate demand currently fall into one of three broad categories:

- Eligibility
- Pricing
- Access

While these strategies are applied in other traffic management applications and may offer benefits, definitions applied herein are in the context of currently operating HOV-related managed lane concepts and applications. A wide variety of emerging projects are likely to expand the manner and context for how each strategy is applied. Each strategy can be operated and implemented individually or in combination, depending on the unique travel demand conditions associated with each project setting. Each is described in more detail below.

2.3.1. Eligibility

Restricting a dedicated lane to specific users will limit vehicle demand. User restrictions on HOV lanes have taken the form of eligibility requirements based on the requisite minimum number of people traveling in a vehicle (Figure 2-3). Over the years, restrictions on HOV lanes has evolved to include various occupancy levels (e.g. HOV with a minimum of 2, 3, or 4 occupants) and types of occupancy-exempt vehicles (e.g., motorcycles, Inherently Low Emission Vehicles (ILEV), emergency vehicles, and in some states hybrid vehicles). Other examples include designated bus-only or truck/freight-only roadway facilities. Restrictions can be in effect 24 hours or vary by time of day or day of the week. A managed lane using a variable eligibility strategy may restrict use to HOVs with a minimum of three or more occupants during the peak commute hours, and relax restrictions to include lower occupancy vehicles and occupancy-exempt vehicles or other users during off-periods (e.g., Houston, Los Angeles).

2.3.2. Pricing

By the mid-1990s HOV pricing was tested as a means to address under-utilization of HOV lanes, such as the I-15 project in San Diego, and over-utilization of HOV lanes in the case of the I-10 Katy Freeway project in Houston (Figure 2-4). While pre-paid sticker programs have been used to restrict and justify users in HOV programs, the growing likelihood of pricing as a means to readily manage demand is facilitated by the development of electronic toll collection (ETC) technology as an increasingly practical and inexpensive tool. Pricing can help maximize the use of available pavement while continuing to prioritize operation for HOVs. The introduction of pricing is seen by some as an opportunity to further manage a dedicated lane facility by allowing other users into the lanes as capacity is available.

Figure 2-3: Typical Eligibility Restriction on an HOV Lane



Figure 2-4: Pricing Sign on I-15 Lanes in San Diego



Management of dedicated lanes using congestion or demand-based pricing has evolved in recent years and is now termed *value pricing*, under a pilot program sponsored by the Federal Highway Administration. Value pricing involves charging a fee or toll to travel on a lane or roadway, which varies according to time of day (peak/off-peak) and day of week or by the level of congestion on a roadway or facility. While value pricing has potential in many different contexts, the primary purpose is to manage demand by varying the pricing so that the facility is not allowed to become congested. Higher tolls are usually charged when congestion is heaviest and delay is at its worst, while lower tolls or free access may be provided to some or all users during periods of lowest demand. Pricing is applied to better balance demand to lane capacity, and can encourage some peak period users to shift to lower demand periods. Pricing can give preference to selected user groups, as has been demonstrated on several HOV lanes, so that lower occupancy vehicles pay a higher price than higher occupancy vehicles. Pricing is implemented using electronic toll tag readers, and most vehicles are required to have a toll tag to use the facility.

Pricing has been implemented in a limited number of areas on existing HOV lanes. Value pricing may permit all vehicles to access the managed lanes, or only a select user group. Revenue generated from value pricing in these situations typically cover the administrative costs associated with toll collection and may help cover other expenditures such as capital costs associated with construction or operations associated with providing enforcement or transit services. Enforcement of pricing may be automated if electronic toll tags are employed and all users are treated equally, or enforcement may be more complicated if pricing preferences are applied to selected users, thereby requiring increased on-site law enforcement.

Value pricing examples on previous HOV lanes can be found on I-15 in San Diego and I-10 and US 290 in Houston. SR 91 in Orange County, California, is an example of a managed roadway that provides access to all traffic for a toll and preferential pricing for HOVs. This latter example also connects to HOV restricted lanes located on either end of the project as part of a dedicated lane system.

2.3.3. Access

Limiting access has traditionally been applied to express lanes and some HOV lanes (e.g., Houston, Los Angeles, Dallas) as a means of regulating entry and exit movements (Figure 5). Restricting access by this means helps ensure the lanes do not become overloaded regardless of the level of demand they generate, and access restrictions may help alleviate specific bottlenecks where short distance trips cause a lane to exceed its capacity.

Figure 5: Ramp Gating Applied to I-5 in Seattle



HOV access restrictions are applied on most lane treatments in the Los Angeles area where system demand is high. Access is also restricted in various multi-lane facilities and on reversible facilities where positive separation between opposing flow is required. On some roadways, like the New Jersey Turnpike, entry is managed or metered into separate, parallel roadways so that preference can be given to one of the two roadways when traffic conditions warrant. Access can be restricted under normal conditions 1) by metering demand at entrance ramps via the use of traffic signals or gates, 2) by limiting access at specific ramps to selected users like HOVs (I-5 Seattle downtown ramps) or 3) by limiting the number of entrance and exit ramps so that free flow is ensured along restricted lanes (examples include I-5N Seattle, I-94 Chicago and I-15 San Diego). In several areas, such as Chicago and Seattle, this latter application is sometimes referred to as *express lanes*, and the lanes are open to all traffic. Once traffic enters the express lanes, vehicles can typically travel at unimpeded speeds to downstream exits. Some restricted access lanes like those in Seattle and New Jersey include HOV priority ramps or HOV lanes, or they connect to HOV lanes on either end.

2.4. Organizational Support

The primary partners in HOV/Managed Lane projects nationwide include state DOTs, FHWA and local agencies (MPOs, transit providers and enforcement agencies (state/municipal)). The role each serves is distinct and related to the specific implementation, operation, enforcement and monitoring activities of individual projects and the regional system as a whole. Nationally, these roles have been exercised by different agencies at various levels. Most of the 150 HOV and managed lane freeway projects nationwide were planned, implemented, operated and maintained by the

respective state DOT. This is logical since the improvements for every project are located within roadway facilities placed on state right-of-way, and the state DOT typically has the skills and expertise for roadway projects, operations and maintenance. However, in some areas, transit agencies, MPOs, county and regional transportation authorities and the private sector have provided some of these functions. The best example systems involve true partnering in which each agency relies on the best resources available to accomplish specific functions—essentially each agency contributes the skills that represent their specific role. Table 2-1 provides a summary of potential partners to be involved in HOV and managed lane implementation.

Table 2-1: Agencies and Groups Involved in Planning HOV Lane Facilities

Agency or Group	Potential Roles and Responsibilities
State Department of Transportation	<ul style="list-style-type: none"> • Overall project responsibility on freeways and state-owned roads • Responsible for planning process or assisting with planning • Staffing multi-agency team or participating on team • Incident management planning
Transit Agency	<ul style="list-style-type: none"> • Overall planning for transit facility investments • Responsible for assisting in transit investments located on state ROW • Bus operations planning • Staffing multi-agency team or participating on team
Local Municipalities	<ul style="list-style-type: none"> • Identify transportation needs of community • Direct access interface with arterial street and traffic signal network • Support role with other HOV and transit related facilities • Assisting with planning process • Staffing on multi-agency team or participating on team
State and Local Police	<ul style="list-style-type: none"> • Assist with the planning process • Lead role on enforcement planning • Coordination with judicial personnel • Participate on multi-agency team • Incident management planning
Metropolitan Planning Organization (MPO)	<ul style="list-style-type: none"> • May lead regional HOV planning efforts • Assist in facilitating meetings and interagency coordination • Ensure that projects are included in necessary planning and programming documents • May have policies related to HOV or managed lane facilities • Participate on multi-agency team
Federal Agencies: Federal Highway Administration (FHWA), Federal Transit Administration (FTA)	<ul style="list-style-type: none"> • Funding support • Overall approval of various steps • Provide technical assistance • Participate on multi-agency team
Consultants and Contractors	<ul style="list-style-type: none"> • May be hired to conduct portions of overall planning studies and implementation process, activities and schedules • May staff or assist multi-agency teams
Rideshare Agency	<ul style="list-style-type: none"> • Assist with planning rideshare facilities • Participate on multi-agency team

Table 2-1: Agencies and Groups Involved in Planning HOV Facilities (Continued)

Agency or Group	Potential Roles and Responsibilities
Toll Authorities	<ul style="list-style-type: none"> • Assist with planning and implementing pricing components • Lead or support role in planning for facility operations • Lead or support in planning for project funding and financing
Other Groups	Assorted project-related advisory roles and responsibilities as they relate to a particular group in the public involvement process. Other groups may include elected officials, business groups, judicial system, emergency/EMS personnel, tow truck providers, transportation management associations, advocacy groups, and special user groups: (trucking, taxi, limousine, etc.)

Source: Adapted from Reference 1.

Coordination is an essential aspect of any successful transportation program. NDOT will need to coordinate with the respective local transportation agencies to effectively address all the functional areas required for a successful HOV or managed lane project. In Las Vegas and Reno areas, the primary agency for coordination will be the RTC. Others may include state and local police, private transportation service providers, and municipal/county jurisdictions. Each may need to be involved at a different point in the implementation process, including planning, design, construction, and operation phases. When operational changes are to occur in the managed lanes, it will be the responsibility of NDOT to coordinate such changes with the agencies and jurisdictions specifically affected by the change. Lead and support roles for planning, implementation, operation and monitoring of HOV lanes in Nevada are detailed in Section 2.3.3 in the NDOT HOV/Ramp Metering Policy Manual.

Specific roles may be assigned on a project-by-project basis or regionally. In each case the lead agency is charged with the responsibility of coordinating and communicating with partnering agencies in addressing issues of common interest and concern. The overall goal of a HOV/Managed Lane organizational structure is to foster development of lane treatments and associated facilities that can best meet regional and corridor-specific congestion management needs by promoting more efficient travel, primarily for higher occupancy vehicles and other users as they can be accommodated.

2.5. Resource Needs

Successful HOV lane development and implementation requires a commitment to build, maintain and operate the lanes in perpetuity. Operation requirements are more intense than for overall freeway operations, because demand must be aggressively managed and usage enforced. The enforcement aspect of HOV lanes requires both early involvement of respective policing entities and ongoing commitment. Sometimes this commitment entails dedicated staffing assigned to enforcement. Resource needs also involve other agencies who will be responsible for transit services and rideshare promotion; roles not traditionally included on highway projects. Pricing lane use may also require a toll administrator to handle the transactions associated with collecting tolls. Experience indicates each of these functions vary widely, depending on available and interested agency partners.

2.5.1. Functional Needs by Facility Type

Table 2-2 provides a reference of the typical resource needs by degree of significance for different types of HOV and managed lane facilities:

Table 2-2: Resource Needs for Different HOV Facilities

<u>Type of Roadway Facility</u>	<u>Resource Need</u>	<u>Significance</u>
Concurrent flow lanes in both directions -barrier separated	Daily monitoring/Incident management	Closer monitoring needed, but allows for diversion of traffic around an incident
	Enforcement	Moderate
	Maintenance of related traffic control devices	No different than adjacent lanes
Concurrent flow lanes in both directions -buffer separated	Daily monitoring/Incident management	No different than adjacent lanes
	Enforcement	Significant because lanes are easy to violate
	Maintenance of related traffic control devices	No different than adjacent lanes
Reversible flow HOV lane(s)	Daily monitoring/Incident management	Significant—lanes must be reversed before/after each peak period, gates opened/closed
	Enforcement	Significant increase due to potential wrong way movements
	Maintenance of related traffic control devices	Significant increase in need for redundancy and rapid maintenance responsiveness for safety reasons
Ramp meter queue bypasses	Incident management	Low
	Enforcement	No different than enforcement required for ramp metering
	Maintenance of related traffic control devices	No different than for ramp metering, unless HOVs get metered at a differential rate from adjacent traffic

2.5.2. Funding

Funding for HOV lanes is typically from a match of federal, state and local highway funding sources. Some projects or transit support facilities to HOV lane projects have been implemented with matching funding from the Federal Transit Administration (FTA). The State DOT is typically the sponsoring agency since the vast majority of HOV and managed lanes are located on roadway facilities owned by the State. The process of planning and programming funding is sometimes augmented or shared with a local transportation agency such as RTC. In such instance, the local agency is responsible for regional transportation planning, programming and providing input on prioritizing projects for their respective region.

Funding needs to be considered in project planning include capital project functions (planning, design, construction administration, etc.), costs associated with operations such as enforcement staffing, training, operations management and monitoring performance of operations; and maintenance needs (typically roadway and structures but sometimes inclusive of specialized traffic control devices or tolling equipment). Estimates of these costs should be included in the budget development and capital programming activities. Some costs may be related to one time events such as project

openings, where extraordinary needs associated with enforcement are most concentrated. Project marketing costs need to be considered, primarily for project opening and for ongoing activities of the project. Operations and maintenance costs can be funded from local, state and federal (e.g. STP) funds. Local funding may come from transit providers, particularly where there is a significant transit service component associated with operations.

Agency staff should look for cost effective ways to include HOV improvements as part of other funded projects. For example, a programmed resurfacing project may provide an opportunity to add a median HOV lane. With adequate knowledge of programmed projects, agency resources and funding sources, many elements of a corridor or regional HOV lane system may be able to be implemented with a minimum of extra investment, or such investment targeted to specific projects which are strategic to the effectiveness of an overall plan.

HOV project costs vary depending on the type of facility. All involve roadway widening or restriping in some cases to maximize available pavement use. Restripe treatments can cost \$3 to \$5 million per route-mile, assuming one new lane in each direction. Full widening within available right-of-way can cost \$8-15 million or more per route-mile. Barrier separated treatments are much more expensive than buffer-separated treatments due to the extra shoulder requirements, but empirical data show various operational benefits including safer performance, improved reliability and higher overall speeds. Soft barriers (traffic channelizers and pylons) are applied on some projects to reduce this cost, but maintenance costs to maintain and replace these can run \$30,000 per mile annually.

Enforcement represents the most common and significant ongoing operation and maintenance cost over and above the investment already made for regional traffic management. HOV enforcement costs vary widely. An order-of-magnitude cost for concurrent flow lane enforcement on a non-dedicated basis is about \$20,000 per mile annually for a modest level of police presence. This level will need to be greatest during the first six months of a new project opening.

2.5.3. Phasing

HOV and managed lane treatments are often part of a larger transportation investment program for a corridor, becoming part of an overall plan which may include a variety of other improvements. These opportunities often set the stage for development of an implementation plan. Rarely do HOV lanes lead this program; specific projects are almost always part of an overall widening program with a much more overarching basis for how investments are made.

Most regions have based a phasing plan on implementing projects of opportunity first, focusing on adding dedicated lanes along a corridor, and then gradually coming back and adding access and safety enhancements as demand warrants. This context builds on two premises. Adding dedicated lanes before adding transit or access improvements is usually more cost effective to achieve early benefits so long as the link being added is

long enough to provide meaningful time savings to generate demand. The second premise in some areas is that if the demand does not materialize, it is easier to take the HOV restriction away and convert the dedicated lane to some other use if direct access investments are not included (i.e., plan for potential failure rather than plan for potential success). More commonly, enhancements have been added as HOV lane use grows and lane capacity is reached.

Phasing for a “first” project in any region sets the stage for overall public perceptions and can affect the success of a managed lane strategy for many years. If the first project is a success, there is less scrutiny on subsequent expansion; if it fails, there is a lowered likelihood that the public will support another similar project. Few projects have actually “failed” or been terminated over the past 30 years, but some projects have been marginalized to the point that they are no longer viable in meeting their original goals. Goals may need to change over time to meet changing commute and demand requirements. Most common pitfalls for failure relate to a lack of congestion (resulting in few benefits), inadequate demand and lax enforcement.

Ideally, a first project addresses the region’s most significant congestion bottleneck, serves transit and rideshare needs well, can generate an early level of acceptable demand and is supported by a variety of local partnering agencies at all levels. Not all of these factors need to exist, but they can compliment one another and make the role of marketing more effective with different stakeholders so that all perceive benefits.