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16. Abstract Although managed lanes will largely function under their intended standard operating procedures, certain conditions (i.e., construction, special events, incidents, or emergencies) may require unusual interim use of the facilities. Because interim managed lane use may detract from the facilities' intended performance, carefully crafted interim use policies should guide these decisions. Given the lack of formal policies or guidelines, variability in observed practices and limited understanding of potential benefits or concerns surrounding interim use of managed lanes (noted through a review of published literature and observed national practice), the objectives of this task were to: (1) discern any positive procedural trends in interim managed lane use that could be recommended for widespread implementation, (2) identify and describe potential benefits and concerns surrounding interim use of managed lanes, and (3) assimilate this information into recommended guidelines addressing all aspects of managed lane facility interim use. This information forms the basis of the recommendations contained in the <i>Managed Lanes Manual</i> developed for TxDOT and FHWA. Following a brief introduction, this report describes motivating conditions and strategies for interim use, general considerations for interim use (i.e., operational and safety effects, public acceptance and perceptions, etc.), and national interim use practice and experience. Based on these findings, recommendations for interim use based on the: (1) severity and nature of conditions; (2) time-of-day, anticipated duration, and traffic impacts; and (3) availability of alternative facilities or strategies are provided. Recommended planning activities and requirements for implementation are also provided.					
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# **STRATEGIES FOR INTERIM USE OF MANAGED LANES**

by

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## **DISCLAIMER**

The contents of this report reflect the views of the author, who is responsible for the facts and the accuracy of the data presented herein. This project was conducted in cooperation with the Texas Department of Transportation (TxDOT) and the U.S. Department of Transportation, Federal Highway Administration (FHWA). The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation. The engineers in charge of the overall project were Beverly T. Kuhn (Texas P.E. #80308) and Ginger Daniels Goodin (Texas P.E. #64560). The engineer leading this task was Jodi L. Carson (Texas P.E. #94536).

The United States Government and the State of Texas do not endorse products of manufacturers. Trade or manufacturer's names appear herein solely because they are considered essential to the object of this report.

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# TABLE OF CONTENTS

	Page
<b>List of Tables</b> .....	<b>ix</b>
<b>Chapter 1: Introduction</b> .....	<b>1</b>
Problem Description .....	2
Objectives .....	4
Methodology .....	4
Review of Published Literature and Current Research .....	5
Review of National Practice .....	6
Report Purpose and Contents .....	7
<b>Chapter 2: Background</b> .....	<b>9</b>
Motivating Conditions for Interim Use .....	9
Construction or Maintenance .....	10
Special Events .....	11
Major Incidents .....	11
Emergencies and Evacuation .....	12
Managed Lane Facilities and Characteristics .....	13
Facility Types .....	13
Facility Characteristics Affecting Interim Use .....	17
Operational Strategies for Interim Use .....	22
Suspension of Time-of-Day, Vehicle Occupancy, or Vehicle Type Restrictions .....	23
Suspension of Tolls .....	23
<b>Chapter 3: Considerations for Interim Use</b> .....	<b>25</b>
Operations .....	26
Congestion .....	26
Enforcement and Compliance Rates .....	29
Safety .....	29
Design Standards .....	30
Access .....	30
Public Acceptance/Perception .....	31
Construction or Maintenance .....	32
Special Events .....	33
Major Incidents .....	33
Emergencies and Evacuation .....	34
Monetary Impacts .....	35
Regulatory Integrity .....	35
<b>Chapter 4: National Interim Use Practice and Experience</b> .....	<b>37</b>
Construction or Maintenance .....	37
Special Events .....	40
Major Incidents .....	41
Maryland .....	43

Minnesota .....	43
Texas .....	44
Virginia .....	46
Washington .....	47
Emergencies and Evacuation .....	48
<b>Chapter 5: Recommended Interim Use Practices.....</b>	<b>51</b>
Planning and Preparing for Interim Use .....	51
Transportation System Assessment .....	53
Policy and Legislation Review and Modification.....	53
Inter-agency Coordination Agreements .....	54
Personnel Training .....	56
Interim Use Criteria .....	56
Severity and Nature of Conditions.....	56
Time-of-day, Anticipated Duration, and Traffic Impacts .....	59
Availability of Alternative Facilities or Strategies .....	64
Implementation Requirements .....	67
Inter-agency Communication and Coordination.....	68
On-site Signing and Traffic Control .....	68
Network Traffic Management.....	70
Public Education .....	71
Monitoring and Evaluation .....	72
<b>Chapter 6: Conclusions and Recommendations .....</b>	<b>75</b>
Considerations for Interim Use.....	77
Operations.....	77
Safety .....	78
Public Acceptance/Perception .....	78
Monetary Impacts .....	79
Regulatory Integrity .....	79
Interim Use Criteria and Requirements .....	80
Inter-agency Communication and Coordination.....	80
On-site Signing and Traffic Control .....	82
Network Traffic Management.....	83
Public Education .....	83
Monitoring and Evaluation .....	83
Next Steps.....	84
<b>References.....</b>	<b>87</b>



## LIST OF TABLES

	<b>Page</b>
Table 1. Motivating Conditions for Managed Lane Interim Use.....	10
Table 2. Managed Lane Facility Characteristics Affecting Interim Use Potential.....	18
Table 3. Congestion Conditions Supporting Managed Lane Interim Use.....	26
Table 4. Weekday Time-of-day Supporting Managed Lane Interim Use.....	60
Table 5. TRANSCOM's Roadway Closure and Subsequent Traffic Diversion Criteria (Reiss and Dunn 1991).....	63
Table 6. Recommended Interim Use Criteria.....	81



# CHAPTER 1: INTRODUCTION

In developed urban areas, the provision of sufficient roadway capacity through traditional capital facility expansion is challenged by ever-increasing travel demand, site development, cost, neighborhood impacts, environmental concerns, and other factors. Like other transportation agencies nationwide, the Texas Department of Transportation (TxDOT) is looking to alternative methods to better manage traffic flow and improve the efficiency and operation of existing roadway networks ([Texas Transportation Institute 2002](#)). Managed lanes may offer such an alternative.

Managed lanes encompass a variety of facilities and operational strategies that may be adjusted throughout the day or week to better accommodate travel conditions. Managed lanes utilize time-of-day restrictions, vehicle occupancy restrictions, vehicle type restrictions, value pricing, or a combination of these strategies to keep traffic flowing ([Texas Transportation Institute 2002](#)). In addition to maximizing use of the existing freeway capacity and managing traffic demand, managed lanes offer traveler choices, may improve safety, and may generate revenue, depending upon the operational strategies employed ([Texas Transportation Institute 2002](#)).

Because managed lanes represent a new way of doing business for transportation agencies, the Texas Transportation Institute (TTI), assisted by Texas Southern University, is conducting a multi-year project entitled, *Operating Freeways with Managed Lanes*, to investigate the complex and interrelated issues surrounding the safe and efficient operation of managed lanes and to develop a *Managed Lanes Manual* to help TxDOT and other transportation agencies make informed planning, design, and operational decisions when considering these facilities for their jurisdiction ([TTI 2002](#)). This project is cooperatively sponsored by TxDOT and the Federal Highway Administration (FHWA) and will address such questions as:

## Planning Managed Lanes Facilities

- What are the operational options available for a managed lane facility?
- How does an intended user group(s) affect its design and operations?
- What defines a successful managed lane project?
- How can I fund and finance a managed lane project?

- How do I market a managed lane project to help make it a success?
- How do I integrate other key agencies (transit, toll, law enforcement, etc.) into a managed lane project to help overcome institutional issues and barriers?
- Are there any interim or temporary uses for a managed lane facility?

#### Designing Managed Lanes Facilities

- How do I design a managed lane facility to handle a selected user group?
- How can I design a facility to be flexible for future needs?
- What safety issues do I need to be aware of when designing a facility?
- What interoperability issues do I need to be aware of when designing a facility?
- What information do users need to make decisions about using a managed lane facility?
- What approaches to delivering user information can be used to provide that information appropriately?

#### Operating Managed Lanes Facilities

- What is the best way to enforce a managed lane facility?
- How do I handle incidents on a managed lane facility?
- What staff do I need to manage a managed lane facility and what training do they need?
- How do I evaluate and monitor a managed lane facility to determine success? ([TTI 2002](#))

As part of this larger study, this report responds to the planning-related question of interim or temporary uses for a managed lane facility. A description of the problem, the task objectives, the investigation methodology, and the report purpose and contents are provided below.

### **PROBLEM DESCRIPTION**

Although managed lanes will largely function under their intended standard operating procedures (derived from goals and objectives set earlier in the planning process and related to mobility and congestion, reliability, accessibility, safety, environmental impact, system preservation,

or organizational efficiency), certain conditions may require unusual interim use of the facilities.

Such conditions may include:

- Construction or maintenance activities that result in either a long-term reduction in capacity or a severe, short-term reduction in capacity. To accommodate the existing traffic demand under capacity constraints, managed lane facilities can be opened to general-purpose traffic (i.e., no vehicle type or occupancy restrictions, no tolls) or can provide a staging and/or work area for construction equipment and resources that would otherwise occupy a general-purpose lane.
- Special events that result in a severe, short-term increase in traffic demand. To accommodate the increased traffic demand, managed lane facilities can be opened to general-purpose traffic.
- Major incidents that result in either a long-term reduction in capacity or a severe, short-term reduction in capacity. To accommodate the existing traffic demand under capacity constraints, managed lane facilities can be opened to general-purpose traffic or can provide a staging and/or work area for incident management equipment and resources that would otherwise occupy a general-purpose lane. Managed lanes can also provide access for emergency responders that is safe, secure, and free from traffic congestion.
- Large-scale emergencies and evacuation that result in either a long-term or severe, short-term increase in traffic demand. To accommodate the increased traffic demand, managed lane facilities can be opened to general-purpose traffic. Managed lanes can also be used as staging areas for bus transportation and can be operated in reverse or contraflow to accommodate directional demand.

Because interim use of managed lanes may detract from the facilities' intended use and performance related to mobility and congestion, reliability, accessibility, safety, environmental impact, system preservation, or organizational efficiency, carefully crafted interim use policies developed in the planning stages should guide decisions for the short-term use of managed lanes.

At the time of this investigation, formal policies or guidelines for interim managed lane facilities use were not uncovered. Several areas across the country with high-occupancy vehicle (HOV) facilities (a type of managed lane facility) and proactive incident management programs have developed incident management strategies that include diversion of general traffic to the

HOV lane when a major incident occurs. However, these diversion practices are highly variable; dependent on the configuration of the HOV lane, severity of the incident, judgment of the on-scene field personnel (i.e., the decision to open the HOV lanes to general traffic is often made by a law enforcement officer on the scene without benefit of well-defined criteria for opening the lane) and agency policy (Hoppers 1999).

In addition, little is known about the potential benefits (i.e., congestion mitigation or safety) or concerns (i.e., public acceptance/perception, compliance rates or monetary costs) of interim managed lanes use. Opening managed lanes to general traffic can become politically volatile; managed lane users expect a certain level of service (LOS) which may be compromised with the addition of general traffic. This action can be particularly sensitive if managed lane users are paying a toll to achieve this level of service. Again, the decision to open managed lanes to general traffic for interim use is often made by a law enforcement officer in the field who is likely unaware of the long-term ramifications of such actions (Blume 1998).

## **OBJECTIVES**

Given the: (1) lack of formal policies or guidelines, (2) variability in observed practices, and (3) limited understanding of potential benefits or concerns surrounding interim use of managed lanes, the objectives of this task were to:

- discern any positive trends in interim use procedures for managed lanes (i.e., in published literature or observed practice) that could be recommended for widespread implementation;
- identify and describe potential benefits and concerns surrounding interim use of managed lanes; and
- assimilate this information into recommended guidelines addressing all aspects of managed lane facility interim use.

This information will form the basis of the recommendations contained in the *Managed Lanes Manual* developed for TxDOT and FHWA.

## **METHODOLOGY**

To accomplish the objectives of this task, researchers reviewed: (1) published literature and current research, and (2) national practice related to interim use of managed lane facilities.

## Review of Published Literature and Current Research

A review of published literature and current research was conducted to: (1) discern any positive trends in interim use procedures for managed lanes that could be recommended for widespread implementation, and (2) identify potential benefits and concerns surrounding interim use of managed lanes. Researchers primarily utilized the Transportation Research Information Services (TRIS) online database and the Transportation Research Board's Research in Progress (RIP) database to identify appropriate published literature and current research. The novelty of managed lanes as a traffic management strategy, the diversity of managed lane facility types (i.e., high-occupancy vehicle lanes, exclusive truck lanes, etc.) and the breadth of motivating factors for interim use (i.e., construction and maintenance, special events, etc.) challenged the identification of pertinent literature or current research. Hence, much of the literature reviewed and described in this report is only indirectly related to interim use of managed lane facilities.

Only a single document was uncovered, *Opening HOV Lanes to General Traffic During Major Incidents and Severe Weather Conditions* (Hoppers 1999), that directly addressed interim use of managed lanes. A related document, *Potential Use of Puget Sound HOV Lanes by General-purpose Vehicles in Off-peak Hours: A Summary Paper* (Hallenbeck et al. 2000), also considered use of HOV lanes by general-purpose traffic but during regular off-peak travel periods rather than the infrequent and unusual interim use considered in this investigation. Researchers subsequently had to rely on published literature focused on vehicle-specific (i.e., public transit, large trucks, etc.) or activity-specific (i.e., construction, special events, etc.) strategies for traffic management for additional supporting information. Key supporting references included:

- *Defining Special-use Lanes: Case Studies and Guidelines* (assessing the feasibility of HOV and high-occupancy vehicle/toll (HOT) facilities, Murray et al. 2000);
- *Convertible Roadways and Lanes* (National Cooperative Highway Research Program (NCHRP) Synthesis 340, Wolshon and Lambert 2004);
- *Strategies for Managing Increasing Truck Traffic* (NCHRP Synthesis 314, Douglas 2003);
- *Reducing and Mitigating Impacts of Lane Occupancy During Construction and Maintenance* (NCHRP Synthesis 293, Anderson and Ullman 2000);

- *Transportation Planning and Management for Special Events* (NCHRP 309, [Carson and Bylsma 2003](#));
- *Application of ITS Technology to Hurricane Evacuation Routes* ([Hulett 1999](#)); and
- *Development of an Improved Managed Lanes Framework for Emergency Management Transportation Requirements* ([Patel 2005](#)).

Information from these key published documents was assimilated by researchers; supplemental information from additional references was included as appropriate.

### **Review of National Practice**

When conducting a review of national interim managed lane use practices, similar limitations related to the novelty of managed lanes as a traffic management strategy, the diversity of managed lane facility types, and the breadth of motivating factors for interim use were encountered. Information regarding national interim use practices for managed lane facilities was obtained primarily from two sources: (1) published literature summarizing results of prior national surveys, and (2) individual agency websites accessible through the World Wide Web.

In particular, the survey conducted by [Hoppers \(1999\)](#) was valuable in identifying national practice related to the temporary use of HOV lanes during major incidents or severe weather. In this survey, agency officials responded to a variety of questions regarding their policy on opening HOV lanes to general traffic, the criteria used to determine when the HOV lanes should be opened, and the strategies used to carry out the diversion. Agency officials were also asked to describe the agency coordination required to achieve the diversion. Other useful references that described national interim managed lane use practices included:

- *Convertible Roadways and Lanes* (NCHRP Synthesis 340, [Wolshon and Lambert 2004](#));
- *Strategies for Managing Increasing Truck Traffic* (NCHRP Synthesis 314, [Douglas 2003](#));
- *Reducing and Mitigating Impacts of Lane Occupancy During Construction and Maintenance* (NCHRP Synthesis 293, [Anderson and Ullman 2000](#));
- *Transportation Planning and Management for Special Events* (NCHRP 309, [Carson and Bylsma 2003](#)); and
- *Application of ITS Technology to Hurricane Evacuation Routes* ([Hulett 1999](#)).



Various sources on the World Wide Web provide more current but less comprehensive information about interim use of managed lanes during construction, special events, or major incidents and emergencies.

## **REPORT PURPOSE AND CONTENTS**

Following this introductory information, [Chapter 2](#) describes: (1) potential motivating conditions for managed lane interim use, (2) managed lane facilities and their characteristics that may support or preclude interim use, and (3) general strategies for managed lane interim use. Special considerations related to managed lane interim use, including operations, safety, public acceptance/perception, monetary impacts, and regulatory integrity, are described in [Chapter 3](#). [Chapter 4](#) summarizes national practice related to interim use of managed lanes facilities; observations relate most commonly to the use of HOV lanes by general-purpose traffic during incidents or emergencies. Assimilating the information provided in [Chapters 3 and 4](#), gathered from a review of published literature, current research, and observed practice, [Chapter 5](#) describes recommended practices for interim managed lane use including planning and preparing for interim use, general interim use criteria and implementation requirements. This report concludes with a summary of findings and recommendations related to interim use of managed lane facilities.



## **CHAPTER 2: BACKGROUND**

To best investigate how interim use could affect the operation, safety, and other aspects of a managed lane facility, this chapter provides a description of: (1) the conditions that may motivate interim use, (2) managed lane facilities and respective characteristics that may support or preclude interim use, and (3) general interim use operational strategies for managed lanes.

### **MOTIVATING CONDITIONS FOR INTERIM USE**

Although managed lane facilities will largely function under their intended standard operating procedures, certain conditions may require unusual interim use of the facilities. Such conditions may include:

- construction or maintenance activities that result in either a long-term reduction in capacity or a severe, short-term reduction in capacity;
- special events that result in a severe, short-term increase in traffic demand;
- major incidents that result in either a long-term reduction in capacity or a severe, short-term reduction in capacity; and
- large-scale emergencies and evacuation that result in either a long-term or severe, short-term increase in traffic demand.

Other conditions may warrant consideration of managed lane interim use. Only these four categorical conditions are considered here.

Similarities and differences with respect to the occurrence, impact, and managed lane interim use for each of these motivating conditions are summarized in [Table 1](#) and detailed below. Note that both construction and maintenance and special event activities can be anticipated (i.e., planned) while major incidents and emergencies are often unexpected (i.e., unplanned). Special events and emergencies result in either severe, short-term or long-term increases in traffic demand, while construction or maintenance and major incidents result in long-term or severe short-term reduction in capacity. In each instance, allowing general-purpose traffic to access and utilize the managed lane facility is a strategy to address both the impacts from reduced capacity and increased traffic demand.

**Table 1. Motivating Conditions for Managed Lane Interim Use.**

CONDITION	OCCURRENCE	IMPACT	INTERIM USE
Construction or maintenance	Planned	Long-term or severe, short-term reduction in capacity	Alleviate general-purpose (GP) demand Use as a staging area
Special events	Planned	Severe, short-term increase in traffic demand	Alleviate GP demand
Major incidents	Unplanned	Long-term or severe, short-term reduction in capacity	Alleviate GP demand Use as a staging area
Large-scale emergencies and evacuation	Unplanned	Long-term or severe, short-term increase in traffic demand	Alleviate GP demand Use as a staging area

### **Construction or Maintenance**

Construction or maintenance activities can result in either a long-term reduction or a severe, short-term reduction in capacity, depending on the project characteristics and constraints. The reduction of traffic impacts, including both delay and safety, is receiving significant national attention in recent years. The FHWA is currently sponsoring a study entitled, *Traffic Management Studies for High-volume Roadways*, which seeks to identify optimum contracting, construction, traffic management, and public information strategies (i.e., best practices) to minimize traffic impacts. This project was initiated following an NCHRP Synthesis study, *Reducing and Mitigating Impacts of Lane Occupancy During Construction and Maintenance*, that documented current state practices (Anderson and Ullman 2000).

Variability in project scope and anticipated duration, general-purpose and managed lane facility size and characteristics, site constraints, agency policies regarding contracting and construction (i.e., night paving), technological sophistication for monitoring traffic, etc., challenge the provision of guidance for managed lane interim use during construction or maintenance. Most generally, managed lane facilities can be opened to general-purpose traffic (i.e., no vehicular use or vehicle occupancy restrictions, no tolls, etc.) to accommodate the existing traffic demand under capacity constraints or can provide a staging and/or work area for construction equipment and resources that would otherwise occupy a general-purpose lane.

## Special Events

The National Highway Institute ([Carson et al. 1997](#)) defines a special event as an occurrence that “abnormally increases traffic demand” (unlike construction or maintenance activities or incidents that typically restrict the roadway capacity). Under this definition, special events may include such things as sporting events, parades, fairs, and other planned events. This increase in traffic demand is usually short-term, except for significant special events such as the Olympic Games, but may be severe regardless of duration. To accommodate the increased traffic demand, managed lane facilities can be opened to general-purpose traffic.

## Major Incidents

An incident is traditionally defined as any non-recurrent event, such as a vehicle crash, vehicle breakdown, or special event, that causes: (1) a reduction of roadway capacity, or (2) an abnormal increase in traffic demand ([Carson et al. 1997](#)). Because special events are addressed as a separate motivating condition for managed lane interim use, this investigation considers only incidents that result in a reduction of roadway capacity and only incidents considered to be “major.” An incident is typically categorized as “minor” or “major” on the basis of its expected duration, its location, the number of lanes blocked, and the length of blockage. However, the distinction between a “minor” incident and a “major” incident is not always clear. To illustrate, consider the following set of definitions for a “major” incident:

- any incident that occupies two or more lanes of traffic for two or more hours — Maryland State Highway Administration;
- an incident that typically involves heavy vehicles and/or a spill that requires specialized equipment and an extensive cleanup effort — Massachusetts Highway Department;
- a serious accident or incident that may cause a highway to be closed for six or more hours — Pennsylvania Department of Transportation;
- an incident that occurs on the Interstate System that requires multiple agency involvement to restore vehicular flow to normal volumes; an event that results in significant delay because of the removal of damaged property, roadway structure repair, or hazardous materials containment/cleanup; an event that involves closing a portion of the Interstate System for a significant period of time and rerouting the

Interstate traffic onto primary or secondary roads — Northern Virginia District, Virginia Department of Transportation;

- an incident that requires variable message signing (VMS) and/or blocks travel lanes — New York Department of Transportation; and
- any incident that closes one or more lanes for one or more hours — Northwest Region, Washington State Department of Transportation ([Carson et al. 1997](#)).

Note that the minimum duration defining a major incident ranges from one to six hours.

This lack of clear definition for a “major” incident challenges the ability to define consistent managed lane interim use criteria (i.e., when to allow general-purpose traffic to access and utilize the managed lane facility).

Most generally, major incidents typically affect one or more of the travel lanes, result in area-wide or corridor-wide traffic impacts, require response from multiple agencies or companies, require a more formal response plan, may involve fatalities or hazardous materials, and may require accident investigation. Major incidents occur less frequently but produce more severe impacts ([Carson et al. 1997](#)).

Major incidents can result in either a long-term reduction in capacity or a severe, short-term reduction in capacity. To accommodate the existing traffic demand under capacity constraints, managed lane facilities can be opened to general-purpose traffic or can provide a staging and/or work area for incident management equipment and resources that would otherwise occupy a general-purpose lane. Managed lanes provide access for emergency responders that is safe, secure, and free from traffic congestion.

## **Emergencies and Evacuation**

Distinguishing from major incidents, large-scale emergencies can require evacuation of an area, resulting in either a long-term or severe, short-term increase in traffic demand.

Transportation-related emergencies can result from: (1) natural or weather-related hazards, (2) technological hazards, and (3) civil/political hazards and may include hurricanes, flooding, tornadoes, volcanic eruptions, wildfires, fog, ice and snow storms, earthquakes, asteroid and comet impacts, hazardous materials incidents, radiological incidents, nuclear power plant incidents, chemical plant incidents, utility or telecommunications failures, computer viruses,

terrorism, civil disorder/riots, weapons of mass destruction, bridge or pavement failure, etc. (Hulett 1999).

To accommodate the increased traffic demand resulting from evacuation procedures, managed lane facilities can be opened to general-purpose traffic. Managed lanes can also be used as staging areas for bus transportation and can be operated in reverse or contraflow operation to accommodate directional demand.

## **MANAGED LANE FACILITIES AND CHARACTERISTICS**

“Managed lanes” are defined broadly and differently from agency to agency, including or excluding certain facilities or strategies. Some agencies limit the definition of managed lanes to include only high-occupancy toll lanes while others include a broader array of facilities and strategies including traditional HOV lanes, HOT lanes, exclusive bus or truck lanes, etc. (Obenberger 2004). (Each of these facility types is described below.)

The Federal Highway Administration 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* (Obenberger 2004).

The Texas Department of Transportation provides the following definition:

*A managed lane facility is one that increases freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals* (TTI 2002).

Such breadth and variability in definition, leading to breadth and variability in the facility types and strategies for consideration, challenges the provision of guidelines for interim use.

### **Facility Types**

For this investigation, the following managed lane facilities will be addressed:

- high-occupancy vehicle lanes,
- value-priced and high-occupancy toll lanes,
- exclusive lanes,
- mixed-flow separation/bypass lanes,
- lane restrictions, and

- dual facilities.

Additional or different classifications of managed lane facilities may be defined elsewhere.

### *High Occupancy Vehicle Lanes*

High occupancy vehicle lanes are intended to increase the person-moving capacity of the existing infrastructure by providing travel time advantages to high-occupancy vehicles. HOV lanes include one or more lanes that are restricted to vehicles with a specified occupancy, including carpools, vanpools, and/or buses. HOV lane facilities can operate as: (1) separated two-way or reversible, (2) concurrent, or (3) contraflow and can vary by occupancy level (i.e., buses, vanpools, 3+ carpools, 2+ carpools, etc.) and time of operation (i.e., 24 hours a day, extended hours, peak travel periods) (Kuhn et al. 2003).

**Separated Two-way or Reversible HOV Lanes.** Separated two-way HOV lanes are typically within a freeway right-of-way but physically separated from the general-purpose lanes with concrete barriers or wide painted buffers. Limited access points are provided to eligible vehicles that generally include buses, vanpools, and carpools. Separated two-way HOV lanes are easier to enforce because of the access limitations (TTI et al. 1998).

Similarly, reversible HOV lanes are typically built within the freeway right-of-way and physically separated from the general-purpose lanes. Reversible HOV lanes are intended for areas with high directional traffic splits to accommodate traffic going toward the central business district in the morning and in the outbound direction in the evening. Daily setup to switch travel direction is required for this type of facility (TTI et al. 1998).

A number of additional criticisms have been cited for reversible lane operations:

- violation of driver expectancy,
- safety issues,
- extensive manpower for implementation,
- problems in converting the roadway back to two-way flow without creating bottlenecks, and
- dangerous geometric implications (i.e., adverse superelevation, limited sight distance, etc.) (Ullman et al. 1993, Wohlschlaeger and Ullman 1991, Ullman and Trout 1991).



**Concurrent HOV Lanes.** Concurrent-flow HOV lanes are not physically separated from the general-purpose lanes; access may be continuous or limited to specific points. Concurrent HOV lanes are usually located on the inside lane, but they may also be positioned on the outside lane. Concurrent HOV lanes are generally used by buses, vanpools, and carpools whose traffic moves in the same direction as that of the adjacent general-purpose lanes. Continuous access to concurrent HOV lanes challenges enforcement efforts (TTI et al. 1998).

**Contraflow HOV Lanes.** Contraflow HOV lanes operate in the off-peak direction of travel and are designated for use by eligible buses, vanpools, and carpools traveling in the peak direction. Contraflow HOV lanes are most often separated from the adjacent general-purpose lanes by some type of changeable treatment such as a moveable concrete barrier, plastic posts, or pylons. This changeable separation allows the lane to revert to normal operation (i.e., concurrent HOV, general-purpose, etc.) outside of the peak travel periods. Operating costs for contraflow HOV lanes may be higher than those of other types of HOV facilities, and safety is of greater concern (TTI et al. 1998).

#### *Value-priced and High Occupancy Toll Lanes*

Value-priced and high-occupancy toll lanes are intended to maximize the use of underutilized capacity in a managed lane without exceeding its capacity and creating congestion. HOT lanes allow lower occupancy vehicles to use the existing HOV lanes if they are willing to pay a toll. Variations of HOT lanes include value-priced, value express, and fast and intertwined regular (FAIR) lanes, which may or may not be occupancy driven and typically resemble more traditional toll road facilities. Dynamic toll pricing supports the management of facilities (Kuhn et al. 2003). In some instances, value pricing strategies have focused on potential benefits for commercial vehicles although the success of these efforts was inconclusive due to low commercial vehicle proportions (<3 percent) in the traffic stream (Supernak et al. 1998).

Because value-priced and HOT lanes take advantage of existing HOV lane facilities, these lanes may or may not be physically separated from the general-purpose facility, may operate continuously, during extended hours or only during the peak travel periods, and may have different vehicle occupancy eligibility criteria.

### *Exclusive Lanes*

Exclusive lanes provide a dedicated operational lane to certain vehicles, usually designated by vehicle type and including buses or large trucks. Unlike *lane restrictions* that generally restrict trucks or buses to or from certain lanes on a facility, exclusive lanes provide a physically separated facility reserved for use by trucks or buses (in some instances, other vehicles are allowed to use these lanes but the traffic volumes are generally low and do not impede truck or bus travel). Bus-only lanes seek to attract ridership through decreased delay and high travel time reliability. Truck-only lanes seek to decrease delay, reduce conflicts with passenger cars, and increase safety through physical separation. Exclusive lanes typically operate continuously (Kuhn et al. 2003).

### *Mixed-flow Separation/Bypass Lanes*

The operational intent of mixed-flow separation and bypass lanes is twofold: (1) to improve safety through congested or turbulent traffic flow segments (i.e., a weaving area with significant congestion, a significant grade with a high percent of truck traffic); and (2) to provide time-savings benefits to identified user groups (i.e., priority access for trucks or buses around ramp metering, toll plazas, ferry queues, etc.). Mixed-flow separation and bypass lane facilities typically comprise a separate lane alongside the general-purpose lanes. In general, these lanes are short in length and intended only to bypass spot-location delays (Kuhn et al. 2003).

### *Lane Restrictions*

Lane restrictions limit certain types of vehicles, most commonly large trucks or buses, to specified lanes. Lane restrictions for large trucks may improve operations, reduce accidents, reduce pavement damage and improve construction zone activities where large percentages of trucks degrade speed, comfort and convenience. Because restricted lanes are still open for travel by other types of vehicles, these lanes are not separated from the general-purpose travel lanes. Lane restrictions may be in effect continuously, during extended periods of the day, or only during the peak travel periods. However, access to these restricted lanes by other types of vehicles is continuous.

### *Dual Facilities*

Dual facilities provide physically separated inner and outer roadways in each direction with the inner roadway reserved for light vehicles or cars only and the outer road open to all vehicles, including large trucks and buses. By allowing separation of vehicles with different operating characteristics (i.e., cars and light vehicles versus large trucks and buses), dual facilities serve to reduce congestion and improve safety. Dual facilities operate continuously (Kuhn et al. 2003).

### **Facility Characteristics Affecting Interim Use**

To accurately assess the merit of managed lane interim use, transportation agencies need to consider the (1) potential for benefit, (2) the potential for detriment, and (3) the feasibility and ease of implementation. Three facility characteristics that are most indicative of the potential for interim managed lane use include:

- accessibility including the type and degree of managed lane separation from the general-purpose facility and the number and frequency of ingress/egress points (any design or operating limitations, such as low clearances that preclude large truck use, also limit accessibility and will be discussed in detail in [Chapter 5: Interim Use Criteria and Requirements](#));
- hours of operation (i.e., continuous, extended hours, or peak travel periods only); and
- eligibility criteria including vehicle types, vehicle occupancies, toll structures, etc.

In addition to these facility characteristics, the original motivating goals and objectives that led to the implementation of the managed lane facility (i.e., reduce congestion, improve reliability, and improve safety) may provide a surrogate indicator for public acceptance/perception of interim use. [Table 2](#) summarizes each of these characteristics for the various managed lane facilities considered in this investigation.

### *Motivating Goals and Objectives*

The implementation of a managed lane facility can be motivated by a number of factors. Most commonly, managed lanes are intended to: (1) improve congestion and/or travel time reliability, (2) improve safety, or (3) generate revenue. Managed lane facilities or operational

**Table 2. Managed Lane Facility Characteristics Affecting Interim Use Potential.**

	MOTIVATION				ACCESSIBILITY			HOURS OF OPERATION			ELIGIBILITY		
	Improve congestion	Improve reliability	Improve safety	Generate revenue	No separation	Changeable separation	Physically separated	Peak travel periods	Extended hours	24 hours a day	Occupancy	Type	Toll
High Occupancy Vehicle Lanes	✓	✓			✓	✓	✓	✓	✓	✓	✓		
Separated Two-way or Reversible HOV Lanes	✓	✓					✓	✓	✓		✓		
Concurrent HOV Lanes	✓	✓			✓			✓	✓		✓		
Contraflow HOV Lanes	✓	✓				✓	✓	✓	✓		✓		
Value-priced and High Occupancy Toll Lanes	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓
Exclusive Lanes	✓	✓	✓				✓			✓		✓	
Mixed-flow Separation/Bypass Lanes	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	
Lane Restrictions	✓		✓		✓			✓	✓	✓		✓	
Dual Facilities	✓	✓	✓				✓			✓		✓	

strategies that incorporate some aspect of occupancy requirement (i.e., 2+ carpools, 3+ carpools) or target high-occupancy vehicles, such as buses or vans, are largely motivated by efforts to improve congestion and/or travel time reliability. Those strategies that focus on large trucks are likely intended to improve safety, with secondary concerns for improving congestion and/or travel time reliability and reducing or distributing pavement wear. Value-priced and HOT lanes are intended to improve congestion and/or travel time reliability across the facility by making use of underutilized capacity in the managed lane facility; capacity pricing has the dual benefit of managing congestion while generating revenue for transportation agencies.

Simultaneously considering the motivating factors for managed lane facility implementation and the motivating conditions for interim use (i.e., construction or maintenance, special events, major incidents, emergencies, and evacuation) can suggest the likely level of public acceptance for interim use. During construction or maintenance, special events, major incidents, and emergencies and evacuation, a managed lane facility may be temporarily accessed and utilized by general-purpose traffic — easing delay for general-purpose traffic but potentially increasing delay and compromising reliability and safety for managed lane users. Managed lane users may be more accepting of interim use for unplanned major incidents, emergencies, and evacuations that pose significant safety hazards than construction, maintenance, and special event activities focused on congestion relief. The planned nature of these latter events also provides greater opportunities for traffic management strategies outside of managed lane use (i.e., public information campaigns to encourage transit use, alternative route plans, etc.).

[Chapter 3](#): Considerations for Interim Use discusses public acceptance considerations in greater detail.

### *Accessibility*

The accessibility of the managed lane facility from the general-purpose facility directly impacts the potential for benefit and the feasibility and ease of implementation of interim use. In particular, the type and degree of separation between the facilities and the frequency of ingress/egress points is important. Four common methods are employed for providing access to managed lane facilities: (1) direct merges, (2) slip ramps, (3) direct access ramps, and (4) direct connections from other managed lanes ([Murray et al. 2000](#)). Each of these has advantages and disadvantages for interim use.

**Direct Merges.** The direct merge approach allows vehicles to enter a managed lane facility from an adjacent general-purpose lane (i.e., continuous access). This method is normally used with concurrent-flow HOV lanes, concurrent-flow value-priced or HOT lanes, and lane restrictions. Direct merges provide the greatest degree of accessibility to a managed lane and, hence, provide the greatest degree of flexibility for interim use. Direct merges also experience the greatest conflicts with general-purpose traffic when merging and present difficulty of enforcement when standard operations are resumed (Murray et al. 1999).

**Slip Ramps.** Slip ramps provide access to barrier-separated managed lane facilities by providing a gap in the barrier and permitting either the ingress or egress of traffic (i.e., eligible users during standard operation and general-purpose traffic or others during interim use). Slip ramps can be used to provide access to separated, two-way or reversible HOV, value-priced or HOT lanes, contraflow HOV, value-priced or HOT lanes, exclusive lanes, mixed-flow separation/bypass lanes, or dual facilities that are barrier-separated. Because slip ramps provide only periodic access to the managed lane facility, accessibility to the lane for interim use is somewhat limited. At ingress and egress points, merging with the adjacent freeway lanes may cause some conflicts (Murray et al. 2000).

**Direct Access Ramps.** For grade-separated facilities, direct access or grade-separated ramps allow exclusive access for eligible managed lane users. Direct access ramps can be used to connect the managed lane facility with adjacent roads, park-and-ride lots, transit stations, ports and freight terminals, etc. While the limited access and distinct destinations has appeal under standard managed lane operations, direct access ramps challenge the potential for interim use of these same facilities (Murray et al. 2000).

**Direct Connections from Other Managed Lane Facilities.** Managed lanes on one freeway may be directly connected to the managed lanes on another freeway. This connection offers travel time savings that would not be available if the vehicles were required to exit the managed lane facility on one freeway, merge with general-purpose traffic, use the freeway interchange, and enter the other managed lane facility. The lower merging requirements are another benefit to this method (Murray et al. 2000).

In general, interim use that is motivated by planned events such as construction or maintenance and special events is more flexible in accommodating limited ingress/egress managed lanes facilities. Traffic management efforts can be combined with public information

campaigns prior to an event to encourage utilization of the managed lanes and provide accessibility information. Interim use motivated by major incidents, which are unpredictable in both frequency and location, and emergencies, which have area-wide impacts, require a more readily accessible managed lane, with either continuous or frequent access points.

### *Hours of Operation*

Managed lanes are most often operated: (1) continuously, 24 hours a day, (2) during extended hours, or (3) during the peak travel period only.

**Continuous, 24 hours.** Some managed lane facilities are restricted 24 hours a day to provide eligible users with continuous travel time savings and reliability. This approach simplifies enforcement and reduces motorist confusion but encourages the potential public perception that the lanes are not sufficiently utilized (Murray et al. 2000).

**Extended Hours.** The usual hours of operation under the extended hours strategy are 6:00 a.m. to 11:00 a.m. and 3:00 p.m. to 7:00 p.m., which correspond to periods of high congestion. This strategy is especially appropriate for contraflow HOV, value-priced and HOT lanes and separated two-way or reversible HOV, because of the preparation required for the facility. Potential disadvantages of extended operating hours include motorist confusion, enforcement difficulty, and signing and pavement marking requirements (Murray et al. 2000).

**Peak Travel Period Only.** The minimum number of hours that a managed lane facility can operate is during the peak period only. The peak period usually falls from 6:00 a.m. to 9:00 a.m. and between 4:00 p.m. to 6:00 p.m. The types of managed lane facilities that normally operate under this plan are contraflow HOV, value-priced and HOT lanes and concurrent-flow HOV, value-priced and HOT lanes (Murray et al. 2000).

Related to the hours of operation is the use of the facility in the non-operating periods. Managed lane facilities with extended hours or peak period-only hours provide an opportunity for other vehicles to use the lanes at other times. For example, concurrent-flow HOV lanes may be converted back to general-purpose lanes or shoulders during non-peak period. Contraflow HOV lanes may revert back to the mixed traffic lanes during the off periods. About half of the nation's HOV lanes operate part-time, either during extended hours or peak periods, with the lanes reverting to general traffic use when they are not restricted. The remaining half of the HOV facilities operates on a 24-hour basis (TTI et al. 1998).

If short-term conditions don't coincide with the hours of managed lane operation, no benefits will result from interim use (i.e., no underutilized capacity is "reserved" for use in the managed lane outside of operating hours). Additionally, at- or near-capacity conditions may limit interim-use benefits for managed lanes operating only during peak travel periods. Hence, more limited hours of operation also limit the potential for interim use.

### *Eligibility*

Managed lane use eligibility under standard operating conditions is defined by vehicle type, vehicle occupancy, or a willingness to pay a toll. The eligibility criteria largely control the amount of excess or underutilized capacity available in the managed lane. Managed lane facilities that have more limiting eligibility criteria, such as 3+ occupancy requirements or truck- or bus-only constraints provide excess capacity and, hence, greater opportunity for interim use benefits. Standard operating strategies aimed at maximizing underutilized capacity day-to-day in the managed lanes, including sticker programs and tolling, may minimize the benefits achieved during interim use (i.e., if the managed lane capacity is already fully utilized).

The type of vehicles eligible to use a managed lane facility is also indicative of the level of facility design. Among the vehicles that could be permitted on the facility are buses, vans, cars, light trucks, motorcycles, commercial vehicles and trucks, taxis, airport shuttles, and emergency vehicles. If a managed lane facility has been designed to accommodate large trucks and/or buses, the facility design standards will likely be sufficient if the lane is opened to general-purpose traffic. If, on the other hand, the managed lane facility has been designed for passenger cars and light trucks, design standards for acceleration and deceleration lanes, vertical clearances, and turning radii may be insufficient for large trucks and buses. The mix of vehicles resulting from interim use of the facility may cause safety concerns, geometric design issues, and disincentives to use transit or rideshare programs.

## **OPERATIONAL STRATEGIES FOR INTERIM USE**

Managed lane facilities rely on different operational strategies to keep traffic flowing during standard operation. These strategies include:

- time-of-day restrictions – allowing access to managed lanes at certain times of the day (i.e., peak hours);



- vehicle occupancy restrictions – allowing access to managed lanes by vehicles having a minimum defined person-occupancy (i.e., 2+ carpool, 3+ carpool);
- vehicle type restrictions – allowing access to managed lanes by certain types of vehicles (i.e., buses, trucks); and
- value pricing – allowing access to managed lanes by travelers who are willing to pay a fixed or variable toll, irrespective of vehicle occupancy or type restrictions.

These same strategies used to “manage” facility use may be modified or eliminated to provide for interim use of the facility. Specifically, common strategies that may be employed during managed lane interim use include:

- suspension of time-of-day, vehicle occupancy, or vehicle type restrictions; and
- suspension of tolls.

### **Suspension of Time-of-Day, Vehicle Occupancy, or Vehicle Type Restrictions**

During unusual conditions, managed lanes may be opened to all traffic regardless of time-of-day, vehicle occupancy, or vehicle type restrictions. Several issues need to be examined when considering this option. Bottlenecks may form at the terminus of the managed lane, which may reduce capacity and offset any potential benefits. Confusion may result because not all motorists may be familiar with managed lane facilities; public awareness prior to interim use is needed to ease confusion. The beginning and end of the managed lane interim-use period must be clearly defined and relayed to the motoring public so that the managed lane can return to standard operating procedures. Furthermore, dropping time-of-day, vehicle occupancy, or vehicle type limitations sets precedents for similar actions in the future which may compromise managed lane compliance during standard operation and increase the need for enforcement (Ullman et al. 1993, Wohlschlaeger and Ullman 1991).

### **Suspension of Tolls**

Either singularly or in combination with the suspension of time-of-day, vehicle occupancy, or vehicle type restrictions, tolls can be temporarily suspended during periods of interim use. Historically, agencies have suspended toll collection during emergencies to increase capacity and reduce bottlenecks created by the toll collection process. Automated toll collection technologies reduce the potential for bottlenecks at toll plazas, but this strategy still provides an

alternative when: (1) no suitable alternative routes exist, and (2) motorists would be forced to pay tolls (Ullman et al. 1993, Wohlschlaeger and Ullman 1991).

To invoke this practice, cooperative agreements should be established between public agencies and the toll authority prior to implementation. Motorists may be notified of the temporary toll suspension through the use of special signing, real-time information displays, or public service announcements. As with other restriction suspensions, temporary toll suspension sets a precedent for similar actions in the future and may result in motorist pressure to suspend tolls when conditions do not warrant such action.

## **CHAPTER 3: CONSIDERATIONS FOR INTERIM USE**

The interim use of managed lane facilities during construction or maintenance, special events, major incidents, or emergencies and evacuation has short-term advantages and disadvantages as well as long-term effects that need to be considered prior to any action. In the short term, managed lane interim use may: (1) reduce congestion and delay for general-purpose traffic during times of increased traffic demand or constrained capacity, (2) improve access to a work zone or incident scene, (3) provide a greater level of safety at a work zone or incident scene by reducing stop-and-go traffic, and (4) speed evacuation clearance. These benefits are tempered by: (1) an increase in congestion and delay and a reduction in travel time reliability for managed lane users, (2) a potential decrease in safety for managed lane users through increased exposure to conflict, (3) a potential decrease in managed lane compliance and consequent increase in required enforcement effort, following return to standard operations, and (4) a reduction in revenue if existing tolls are temporarily suspended. In the long term, frequent interim use of managed lanes outside of their intended purpose may: (1) serve as a disincentive for transit use or carpooling, (2) encourage negative public perceptions, (3) compromise the regulatory conditions under which the lane was originally implemented, and (4) ultimately lead to reversion of the managed lane to a general-purpose lane.

Understanding the short-term and long-term implications of interim managed lane use will help to ensure sound decision-making and action. What congestion relief benefits would result if managed lane use and operation was altered temporarily? Would the interim use of managed lanes create safety concerns? Would operational problems be created through the interim use of managed lanes? Would these changes have adverse impacts on future managed lanes facility formation and/or managed lane compliance rates? What would be the monetary impacts of temporarily altering managed lane use? Would interim use sufficiently change the intended use of the facility and, hence, compromise the regulatory integrity under which the facility was implemented? This chapter describes these general considerations categorized as: (1) operations, including enforcement; (2) safety; (3) public acceptance/perception; (4) monetary impacts; and (5) regulatory integrity.

## OPERATIONS

The interim use of managed lane facilities affects both the managed lane and general-purpose facilities' level of congestion and enforcement efforts for managed lane compliance following return to standard operations. Secondary areas of impact may include facility access and egress points and adjacent road network performance.

### Congestion

When managed lanes are opened to general-purpose traffic during interim periods of unusually high traffic demand or capacity constraints, the intended result is an improvement in congestion levels for general-purpose traffic with a slight detrimental effect on managed lane congestion levels. The degree of improved congestion experienced by the general-purpose traffic depends upon: (1) the nature of the motivating condition (i.e., duration, extent, etc.), (2) the current congestion levels in the general-purpose lanes, and (3) the current utilization of the managed lane facility.

To realize congestion relief benefits through interim use of managed lane facilities:

- Excess capacity must be available on the managed lane facility; capacity expressed in terms of vehicle-movement rather than person-movement is more intuitive for determining available “space” in the lane for general-purpose traffic.
- Some level of congestion must be present on the general-purpose lanes; where no facility congestion exists, motorists are unmotivated to change their course.
- If congestion is present on both the managed lane facility and general-purpose lanes, the level of congestion in the managed lanes should be less than the congestion in the general-purpose lanes; if higher, managed lanes-eligible vehicles will opt to use the general-purpose lanes because of a perceived greater time savings.

Table 3 depicts these conditions in matrix form.

**Table 3. Congestion Conditions Supporting Managed Lane Interim Use.**

Managed Lane Facilities	General-purpose Facilities	
	Uncongested	Congested
Uncongested	NO BENEFIT	BENEFIT
Congested	NO BENEFIT	NO / BENEFIT <sup>1</sup>

<sup>1</sup> Benefit only if: (1) the managed lane facility has excess capacity, and (2) the level of congestion on the managed lane is less than the level of congestion on the general-purpose facility.

### *Peak Commute Periods*

These findings related to congestion and interim use of managed lanes have an empirical basis. In a study conducted by [Hallenbeck et al. \(2000\)](#), researchers investigated the potential congestion effects of allowing general-purpose traffic into Seattle-area HOV lanes during:

- peak commute periods,
- late night periods,
- weekends,
- midday weekday periods, and
- under incident conditions.

During peak commute periods, [Hallenbeck et al. \(2000\)](#) observed high vehicle volumes in both the HOV and general-purpose lanes. Because the HOV lanes are heavily used during this time period, researchers suggest that removal of HOV lane restrictions would generally result in an increase in congestion and delay, as well as a decrease in person throughput. Removal of HOV lane restrictions would also cause a mode shift away from shared ride transportation and to single occupant vehicle (SOV) travel. Hence, when both the managed lane facility and the general-purpose facility are congested to an extent where no excess capacity exists in the managed lane, congestion and delay may actually increase across the facility.

### *Late Night*

Late at night, both HOV lane and general-purpose traffic travels basically free from congestion, according to Seattle-area researchers. Thus, [Hallenbeck et al. \(2000\)](#) purport that a change in the current HOV regulatory practice to allow nighttime general-purpose use of HOV lanes would result in no practical change in freeway performance.

### *Weekends*

Data collected by the Washington State Department of Transportation (WSDOT) indicate that the number of vehicles eligible to use HOV lanes on weekends generally varies from 30 to 60 percent, depending on the facility and time-of-day. Given these eligibility rates, HOV lane usage on weekends is basically a function of whether sufficient congestion exists in the general-purpose lanes to encourage eligible vehicles to use the HOV lanes ([Hallenbeck et al. 2000](#)).

### *Midday Weekdays*

Seattle-area researchers were most challenged to determine the potential congestion-related benefits of interim HOV lane use during the midday weekday periods. Because no spare capacity exists in the peak hour, almost all traffic volume growth occurs in the “off-peak” hours, with most “commute growth” occurring in the shoulders of the peak period (i.e., 6:00 a.m. to 6:30 a.m., 8:30 a.m. to 9:00 a.m., 3:30 p.m. to 4:00 p.m., and 6:30 p.m. to 7:30 p.m.). HOV lane volume growth is also occurring most rapidly in the shoulders of the peak HOV periods. It is during the edges of these shoulder periods that the most congestion relief could be obtained by relaxing the current HOV regulations. During the edges of the shoulder periods, the greatest difference exists between general-purpose and HOV lane congestion levels, with the HOV lane experiencing low levels of congestion and the general-purpose lanes experiencing higher levels of congestion.

Researchers caution, however, that the penalties for removing the HOV restrictions would also be greatest during these same periods. HOV lane performance and reliability during these periods is particularly critical to the transit operators, as buses operating early in the shoulder period can make additional trips later in the peak if they can travel quickly and reliably. This significantly reduces the number of buses and drivers needed to serve the commute market ([Hallenbeck et al. 2000](#)).

### *Under Incident Conditions*

Under incident conditions, [Hallenbeck et al. \(2000\)](#) notes that congestion would still occur even if the HOV lanes were opened to general traffic. The congestion backup would be slightly shorter (geographically), but HOV vehicles (often buses) would suffer a significant decrease in trip reliability. In addition, the loss of HOV lanes would mean that all lanes would be congested, not just the general-purpose lanes. This would reduce the ability of emergency response vehicles to use the HOV lanes to access the incident scene and would increase response times to major incidents. This in turn might actually increase the duration of incidents and result in a net increase in congestion durations for larger incidents ([Hallenbeck et al. 2000](#)).

### **Enforcement and Compliance Rates**

In addition to operational considerations related to congestion, facility managers should consider the potential impacts on managed lane compliance and enforcement. One concern with

interim managed lane use is that managed lane violations would increase during subsequent standard lane operations (i.e., non-interim use periods). Experience elsewhere in the country with high-occupancy vehicle lanes has indicated that violation rates increase near the beginning and end of the HOV-only time period (Hallenbeck et al. 2000). Experience has also shown that violations tend to generate other violations. That is, the more violations that motorists observe, the more likely they are to violate those restrictions themselves (Hallenbeck et al. 2000).

In addition, interim use of one particular managed lane facility may adversely effect compliance of another managed lane facility, depending on the circumstances of use (i.e., motorists may use the altered operation of some lanes as an excuse for using other managed lane facilities in the same fashion, producing a significant increase in violations). Impacts may be less dramatic for weekend and off-peak interim use than for interim use during peak commute periods.

The degree of managed lane violation following a return to standard operations is a function of how well the public is informed of the operational conditions and how heavily the operational conditions are enforced. The availability of additional public information and enforcement resources during post-interim use periods should be considered.

## **SAFETY**

Safety-related benefits attributable to the interim use of managed lanes include: (1) improved access to an incident scene by emergency responders, (2) improved safety for emergency responders at the scene of an incident, construction personnel at a work zone, and motorists approaching either an incident scene or a work zone, and (3) quicker clearance during an evacuation. These safety benefits will either be realized by moving fewer vehicles to or through the scene of an incident or a work zone (i.e., reduced backup and exposure) or by moving more vehicles away from the scene of a hazard. The use of managed lane facilities provides one option to accomplish this; use of alternate routes, including county and local street networks, should be considered in comparison or in conjunction with the interim use of managed lanes. Because these facilities may not have been designed with this type or level of traffic in mind, interim use of these facilities may result in compromised safety. Only managed lane design and access considerations will be addressed here. For a full description of recommended

design standards and access for managed lane facilities, the reader is referred to the *Interim Manual for Managed Lanes* (Kuhn et al. 2003).

## **Design Standards**

New construction managed lane facilities may have been built to a lower design standard than general-purpose lanes. These “design deviations” were approved because of the relatively modest traffic volumes expected in the lanes and the familiarity of the driver using the facility (i.e., during peak travel times, the majority of drivers are commuters familiar with the decision points and traffic conditions). Under these conditions, FHWA permits (on a case-by-case basis) modest relaxation of normal Interstate design standards. If the managed lane use is changed, the basic assumptions about their operating conditions would no longer be valid. FHWA requires a complete review of these design deviations before allowing the adoption of new operating rules. Geometric changes may be necessary to address safety and liability concerns caused by design based on geometry that is sub-standard for routinely high volumes of general traffic (Hallenbeck et al. 2000).

One example is the design of ramp tapers and merging and diverging areas. Where ramp tapers and merging and diverging areas have been designed to accommodate high volumes of traffic, safety is not an issue. However, where design constraints have limited merging and diverging areas, it would not be feasible to tolerate substantial increases in managed lane traffic without extensive reconstruction (Hallenbeck et al. 2000).

## **Access**

Direct access facilities serving managed lane users may enter or exit the roadway on either the left- or right-hand side. Opening these interchanges to general-purpose traffic may result in hazardous merging conditions if volumes in the managed lanes were substantially higher than designed for (Hallenbeck et al. 2000). This may be particularly true with the high proportion of unfamiliar motorists using the facility.

Also related to the presence of unfamiliar motorists on a managed lane facility is the adequacy of information at major decision points. At entrances to limited access lanes, motorists make a basic decision about what route provides them the best advantage. Some motorists make the choice early on, deliberately merging over to the lanes well before the decision point. However, experience has shown that other motorists make the choices at the last minute,



merging over several lanes in just a few hundred feet. If general-purpose traffic were allowed in the managed lanes, access points and termination points, where the managed lane ends with a merge to the general-purpose lanes, a higher frequency of accidents may occur ([Hallenbeck et al. 2000](#)).

## **PUBLIC ACCEPTANCE/PERCEPTION**

Users of managed lane facilities are making some concession to do so — either riding with one or more other individuals, taking public transit or paying a toll — for real or perceived personal benefits related to travel time savings, travel time reliability, or safety. As such, facility managers are tasked with providing an elevated level of service (i.e., keeping the average HOV lane speed above 45 miles per hour) to managed lane users to ensure facility credibility.

If the managed lane restrictions are lifted too often for interim use, managed lane users may question the value of the lane. This issue becomes particularly sensitive if motorists are paying a toll for managed lane use. Also, general-purpose traffic may become accustomed to traveling in the managed lane, increasing violations, challenging enforcement, and decreasing incentive for high-occupancy travel.

While frequency of interim use plays an important role in determining public acceptance and perception, motivation for interim use (i.e., construction or maintenance, special events, major incidents, and emergencies and evacuation) may also be significant in determining public response. Managed lane users may be more accepting of interim use for unplanned major incidents, emergencies, and evacuations that pose significant safety hazards than construction, maintenance, and special event activities focused on congestion relief. The planned nature of these latter events also provides greater opportunities for traffic management strategies outside of managed lane use (i.e., public information campaigns to encourage transit use, alternative route plans, etc.).

### **Construction or Maintenance**

Construction or maintenance activities result in either a long-term reduction in capacity or a severe, short-term reduction in capacity. To accommodate the existing traffic demand under capacity constraints, managed lane facilities can be opened to general-purpose traffic (i.e., no vehicle type or occupancy restrictions, no tolls, etc.) or can provide a staging and/or work area

for construction equipment and resources that would otherwise occupy a general-purpose lane. The primary intent of interim managed lane use for construction or maintenance activities is to reduce congestion (for general-purpose traffic to the detriment of managed lane traffic); secondary benefits relate to improved safety for on-site workers and improved access to the work zone.

Regardless of project duration, construction or maintenance of a particular roadway segment is a rare event. However, the motoring public may perceive a higher frequency of occurrence, encountering multiple construction or maintenance activities during their travels. Hence, the interim use of managed lane facilities for construction or maintenance activities may encounter unusually high resistance from the motoring public based on a perceived rather than real frequency of occurrence.

Secondly, and perhaps more importantly, the planned nature of construction and maintenance activities provides greater opportunities for traffic management strategies outside of managed lane use. These may include public information campaigns to encourage transit use, alternative route plans, or other. By pursuing other traffic management alternatives and maintaining the integrity of the managed lane facility, travelers have sufficient time to weigh the advantages and disadvantages of various travel options. Those travelers who choose to carpool, take transit, or pay a toll are rewarded with a higher level of transportation service.

Lastly, opening the managed lane facility to general-purpose traffic during construction or maintenance activities sets precedents that may lead to “abuse” of the managed lane facility. Comprehensive preplanning that considers traffic management and public information as a priority should be encouraged; project managers and contractors should not rely on the use of managed lanes as an “easy” source for excess capacity.

### **Special Events**

Special events typically result in a severe, short-term increase in traffic demand. Special events vary in both magnitude and frequency. Large events may occur annually while smaller events, such as sporting events, may occur one or more times per week. Special events typically take place during non-peak commute hours. To accommodate the increased traffic demand, managed lane facilities can be opened to general-purpose traffic. The primary intent of interim

managed lane use for special events is to reduce congestion (for general-purpose traffic to the detriment of managed lane traffic).

As with construction and maintenance activities, the planned nature of special events provides greater opportunities for traffic management strategies outside of managed lane use. These may include public information campaigns to encourage transit use, carpool or vanpool parking incentives at the special event venue, incentives to encourage staggered arrival times (i.e., local restaurant coupons to encourage early arrival to the event) or other. Again, by pursuing other traffic management alternatives and maintaining the integrity of the managed lane facility, travelers have sufficient time to weigh the advantages and disadvantages of various travel options. Those travelers who choose to carpool, take transit, or pay a toll are rewarded with a higher level of transportation service.

The potentially high frequency combined with the “entertainment” nature of special events may lead to strong public resistance for interim managed lane use; however, the occurrence of these events outside of peak commute periods may temper this resistance.

## **Major Incidents**

Major incidents result in either a long-term reduction in capacity or a severe, short-term reduction in capacity. To accommodate the existing traffic demand under capacity constraints, managed lane facilities can be opened to general-purpose traffic or can provide a staging and/or work area for incident management equipment and resources that would otherwise occupy a general-purpose lane. Managed lanes can also be used to provide access for emergency responders that is safe, secure, and free from traffic congestion. Hence, the primary intent of interim managed lane use for major incidents is to reduce congestion (for general-purpose traffic to the detriment of managed lane traffic); secondary benefits relate to improved safety for on-site responders and improved access to the incident scene.

While the motivation for interim managed lane use is similar for major incidents and construction or maintenance — to reduce congestion for general-purpose traffic, to improve safety for on-site personnel, and to enhance access to the scene — fundamental differences may make managed lane users more accepting of interim use for major incidents. First, the potential exposure hazard is greater for emergency responders during a major incident than construction personnel; the planned nature of construction or maintenance activities allows for the setup of

appropriate traffic control devices and signing to protect the scene. Hence, diverting traffic away from the scene of an incident has a greater potential for improving personnel and motorist safety. Secondly, enhancing access to a construction site will speed the construction process but enhancing access to the scene of an incident can directly affect the survivability of injured motorists.

The challenge will be to define appropriate incident conditions under which interim managed lane use is appropriate. If criteria are set to low (i.e., incidents lasting one or more hours), the frequency of interim use will detract from the managed lane facility's intended use. If criteria are set too high (i.e., incidents lasting six or more hours), the infrequent occurrence of events would preclude benefits from interim use of managed lanes. These criteria may become dynamic, similar to occupancy criteria (i.e., 2+ versus 3+ carpools), with the incident conditions defining appropriate interim managed lane use adjusting up or down depending upon the frequency of occurrence.

### **Emergencies and Evacuation**

Large-scale emergencies and evacuation result in either a long-term or severe, short-term increase in traffic demand. To accommodate the increased traffic demand, managed lane facilities can be opened to general-purpose traffic. Managed lanes can also be used as staging areas for bus transportation and can be operated in reverse or contraflow to accommodate directional demand. The intent of interim managed lane use during major emergencies and evacuation is to minimize the clearance time away from the point of hazard. Emergencies and subsequent evacuation are infrequent and generally pose life-threatening conditions. Because of the significant safety hazards and life-threatening nature of emergencies and evacuation, little public resistance to interim use of managed lane facilities under these conditions is anticipated.

### **MONETARY IMPACTS**

The most direct monetary impact resulting from interim use of managed lane facilities relates to the temporary suspension of tolls on value-priced or HOT facilities. The amount of revenue loss depends upon the toll rates of the facility, the utilization of the managed lane, and the duration of interim use.

Additional costs associated with interim managed lane use may also be significant. These associated costs may originate from a number of sources related to signing and public information, post-interim use enforcement, the need to “fix” any design deficiencies that are not acceptable for general traffic conditions (i.e., widening existing shoulders, removing or relocating signs and signal heads, and a variety of other geometric improvements) and potential environmental commitment violation penalties to the FHWA and Environmental Protection Agency (EPA) if managed lane facility goals are focused on reducing environmental impact.

While these types of costs can vary widely depending on the facility type and conditions, [Hallenbeck et al. \(2000\)](#) estimated that the cost for converting existing HOV lanes to allow general traffic on weekends for the southern section of I-405 and all of SR 167 in the greater Seattle, Washington, area was more than \$1 million. These costs included construction, signing, environmental reviews, and other.

## **REGULATORY INTEGRITY**

Changes in managed lane operational strategies have the potential to violate environmental commitments made both to the federal government (FHWA and EPA) and various local communities. According to [Hallenbeck et al. \(2000\)](#), FHWA has stated that opening HOV lanes to general traffic on weekends or for midday operations is a significant action that would require WSDOT to complete project documentation required by the National Environmental Policy Act (NEPA.) Part of that process is documentation of previous environmental commitments. A partial review of WSDOT documentation found that corridor-wide commitments were made in the I-90 corridor and in the SR 522 corridor, as well as at the locations of transit-only interchanges and other facilities throughout the region.

As a second example, the *I-15 Congestion Pricing Project* in San Diego, California, required enactment of state legislation to allow single-occupant vehicles to use the express lanes for a fee. Assembly Bill 713 (1994) contained two key restrictions: (1) the level of service for the express lanes must remain at its original state, which was determined to be LOS C and (2) project revenue must be used for improving transit service and the HOV facility ([Schreffler et al. 1998](#)).

The first example that considered recurring interim use of a managed lane facility (i.e., during weekends or during midday weekdays) and the second example that considered a

permanent change to managed lane operations may distinguish themselves from the non-recurrent interim use of managed lanes considered here. Nonetheless, a careful review of governing legislation should be performed prior to any interim managed lane use to ensure that operational strategies are appropriate.

## **CHAPTER 4: NATIONAL INTERIM USE PRACTICE AND EXPERIENCE**

The novelty of managed lanes as a traffic management strategy, the diversity of managed lane facility types and the breadth of motivating factors for interim use limited the utility of findings from a review of national interim managed lane use and experience. Most often, interim use of managed lane facilities was included as one potential strategy under a larger procedural umbrella (i.e., as part of an incident response plan). As such, this chapter is organized to reflect the “activity-based” nature of the information uncovered, as well as to coincide with the motivating conditions for interim managed lane use.

Significant examples of reversible lane use were uncovered, particularly to address capacity constraints resulting from construction or maintenance activities or direction traffic demands resulting from special events. In no case were reversible lane operations combined with additional managed lane strategies (i.e., reversible lane capacity restricted by vehicle occupancy, vehicle type, or a willingness to pay a toll). Hence, these examples were omitted from further investigation. Reversible lanes may, however, present future opportunities for implementation of managed lane strategies.

### **CONSTRUCTION OR MAINTENANCE**

During construction or maintenance activities, managed lane facilities can be opened to general-purpose traffic (i.e., no vehicular use or vehicle occupancy restrictions, no tolls, etc.) to accommodate the existing traffic demand under capacity constraints or can provide a staging and/or work area for construction equipment and resources that would otherwise occupy a general-purpose lane. The frequency with which motorists may encounter construction or maintenance activities, the potential for general-purpose congestion relief to the detriment of managed lane users, and the precedent for managed lane abuse by contractors and project managers were cited previously as drawbacks to this approach.

The only evidence of interim managed lane use under this approach was by the Washington State Department of Transportation who report often allowing all vehicles into Seattle-area HOV lanes to reduce construction related delays. This practice, however, was only

employed during nighttime construction when facility congestion is minimal and no practical change in freeway performance would result (Hallenbeck et al. 2000).

An alternative approach, and one that is receiving more favor nationally, is to continue standard operation of the managed lane as incentive for its use. A number of states have successfully combined the existence of managed lane facilities (typically HOV lanes) with a directed public information campaign to encourage their use during construction. In the *Frequently Asked Questions* section of their agency's webpage, the Los Angeles County Metropolitan Transportation Authority (MTA) has the following response posted regarding area HOV lane use during construction or maintenance activities:

*Why are HOV lane restrictions typically enforced during construction projects, even when other lanes may be temporarily closed?*

*Most states will continue to enforce HOV lane restrictions during construction projects as part of their efforts to reduce traffic in construction areas by encouraging people to use carpools, vanpools and buses. In addition, the maintenance of HOV facilities during construction projects may be critical to helping buses maintain reliable schedules so people can make connections and appointments on time. In some instances, HOV facilities have been specifically created for the duration of the construction project to promote carpool, vanpool and bus usage as a means of managing traffic during construction* ([www.mta.net/projects\\_plans/HOV/faqs.htm](http://www.mta.net/projects_plans/HOV/faqs.htm)).

In some instances, temporary managed lane facilities, utilizing an existing lane, the shoulder, or lane narrowing techniques, were specifically created to encourage person-movement through the construction site. One example, as described on the project's website, is the T-Rex Project in Denver, Colorado ([www.trexproject.com](http://www.trexproject.com)):

*T-REX HOV Lane:*

*Temporary Bus/HOV (High Occupancy Vehicle) lanes are now the inside lanes (nearest the median) of I-25 from Dry Creek Road to Evans Avenue. One Bus/HOV lane has been added in each direction. These lanes are offered exclusively to buses, motorists who participate in carpools (two or more persons in a vehicle), vanpools and motorcycles during peak drive times. Peak hours are*



*from 6 a.m. to 9 a.m. and again from 3 p.m. to 6:30 p.m., Monday through Friday. At all other times, these lanes are open to all motorists.*

*The Transportation Expansion (T-REX) Project designated these new lanes as Bus/HOV to encourage carpooling, vanpooling, transit ridership and as a mitigation tool throughout the construction process. T-REX has subsidies available that are designed to encourage bus ridership and vanpooling through the T-REX corridor. The more people who take advantage of these Bus/HOV lanes, the easier the commute becomes for everyone.*

During major construction along I-95 in 1991, the Virginia Department of Transportation (VDOT) simultaneously implemented 24-hour-a-day shoulder lane travel for general-purpose traffic in conjunction with the existing HOV-3 lane operation as an interim strategy to relieve the congestion. I-95 is an eight-lane divided freeway; the left lane was designated for HOV-3 vehicles during the peak hour, and the remaining two lanes and right shoulder were used as conventional lanes. Before implementing this strategy, shoulder lanes were reinforced to handle the traffic load, and emergency pull-off locations were designated with pavement markings and signs. The HOV and shoulder travel lane carried 47 percent and 63 percent of the total vehicles and travelers. No adverse effects on general traffic accident frequency or rate were noted. The inherent disadvantages of roadways without shoulders (travel lane shoulders preclude use by emergency vehicles) suggest this strategy should be used only as an interim measure and in special situations ([Chen 1995](#)).

Ideally, efforts to mitigate the impacts of construction and maintenance operations should begin even before the decision to construct or reconstruct a facility has been made and should comprehensively consider an area's transportation system consisting of:

- general-purpose lanes;
- managed lanes (high-occupancy lanes, bus lanes, etc.);
- public transit (light or heavy rail);
- park-and-ride access points;
- transit-oriented development in the area; and
- bike and pedestrian facilities ([Toolbox for Alleviating Traffic Congestion and Enhancing Mobility 1997](#)).

In addition, this phase of planning should include travel demand management considerations, which will support the associated multimodal infrastructure that is being considered for implementation ([Toolbox for Alleviating Traffic Congestion and Enhancing Mobility 1997](#)).

In certain project situations, such as a high-volume freeway in an urban area, traffic management and control costs typically extend beyond the project limits onto other roadways and travel modes in the corridor. Beginning in 1986, FHWA began allowing greater flexibility in the use of federal construction dollars to alleviate widespread congestion effects ([The Flexibility Document 1986](#)).

## **SPECIAL EVENTS**

During special events, typically resulting in a severe, short-term increase in traffic demand, managed lane facilities can be opened to general-purpose traffic. This strategy reduces congestion for general-purpose traffic to the detriment of managed lane traffic. This level of service “trade-off,” combined with the potentially high frequency of occurrence and “entertainment” nature of special events may lead to strong public resistance for interim managed lane use.

An alternative approach, gaining prevalence in construction and maintenance activities, is to continue standard operation of the managed lane as incentive for its use. The planned nature of special events provides greater opportunities for traffic management strategies outside of managed lane use that may include public information campaigns to encourage transit use, carpool or vanpool parking incentives at the special event venue, incentives to encourage staggered arrival times (i.e., local restaurant coupons to encourage early arrival to the event), or other.

A review of national practice revealed numerous examples of alternative, yet supportive, traffic management strategies for special events:

- Safeco Field in Seattle, Washington, promotes HOV use to and from game events by advertising high-occupancy vehicle parking rates. Participating lot locations are listed on the ballpark website and telephone hotlines ([Rankin 1998](#)).

- At the Staples Center and the Los Angeles Convention Center in California, close-in loading areas and off-street storage for buses helps to encourage transit use ([Gibson and Rifkin 2000](#)).
- Coors Field in Denver, Colorado, makes extensive use of park-and-ride lots from all over the Denver area ([Carson and Bylsma 2003](#))
- The Phoenix International Raceway (PIR) in Arizona provides handicapped-accessible bus transportation but also issues special parking tickets to disabled attendees that allow them special access to parking lots immediately adjacent to the raceway. Also, PIR encourages motorists to enter the raceway using a variety of routes. PIR also utilizes a dedicated park-and-ride facility during the NASCAR Winston Cup Race. The lot can accommodate 5500 vehicles; 30 buses carry fans to PIR before the race and 50 buses return them to the lot afterward ([Carson and Bylsma 2003](#)).
- During the 2002 Winter Olympic Games held in Salt Lake City, Utah, free or reduced transit fares for event ticket holders were offered, and handicapped-accessible shuttle buses were provided to and from area park-and-ride lots allowing disabled patrons to take full advantage of the system. The Utah Transportation Authority (UTA) utilized the TRAX light rail system with 18 stations; UTA borrowed 33 additional light rail vehicles during the Games. Also, 1000 borrowed buses supplemented the existing 600 owned by the UTA ([TRAX Facts 2001](#)).

Each of these strategies supports and encourages continued standard operation of the managed lane rather than an interim use plan that opens the managed lane to general-purpose traffic during these times.

## **MAJOR INCIDENTS**

Most generally, “major” incidents typically affect one or more of the travel lanes, result in area-wide or corridor-wide traffic impacts, require response from multiple agencies or companies, require a more formal response plan, may involve fatalities or hazardous materials, and may require accident investigation. Major incidents occur less frequently but produce more severe impacts ([Carson et al. 1997](#)). To adequately define consistent interim managed lane use

criteria under incident conditions, a more specific definition of “major” is required. As described earlier in this report, the definition of a major incident varies across the country:

- any incident that occupies two or more lanes of traffic for two or more hours — Maryland State Highway Administration;
- an incident that typically involves heavy vehicles and/or a spill that requires specialized equipment and an extensive cleanup effort — Massachusetts Highway Department;
- a serious accident or incident that may cause a highway to be closed for six or more hours — Pennsylvania Department of Transportation;
- an incident that occurs on the Interstate System that requires multiple agency involvement to restore vehicular flow to normal volumes; an event that results in significant delay because of the removal of damaged property, roadway structure repair, or hazardous materials containment/cleanup; an event that involves closing a portion of the Interstate System for a significant period of time and rerouting the Interstate traffic onto primary or secondary roads — Northern Virginia District, Virginia Department of Transportation;
- an incident that requires variable message signing and/or blocks travel lanes — New York Department of Transportation; and
- any incident that closes one or more lanes for one or more hours — Northwest Region, Washington State Department of Transportation (Carson et al. 1997).

Note that the minimum duration defining a major incident ranges from one to six hours.

Despite the variability in definition of a major incident from state to state, the practice of managed lane interim use for major incidents is common, particularly with respect to HOV lane interim use. In a survey conducted by Hoppers (1999), agency officials were asked a variety of questions regarding their policy on opening HOV lanes to general traffic, the criteria used to determine when the HOV lanes should be opened, and the strategies used to carry out the diversion. Agency officials were also asked to describe the agency coordination required to achieve the diversion. In all, five states responded including Maryland, Minnesota, Texas, Virginia, and Washington.

## **Maryland**

Two concurrent HOV lanes are operated by the Maryland State Highway Administration (SHA) along I-270. The lanes are separated from the general-purpose lanes by a two-foot buffer. Vehicles with an occupancy of two or greater are allowed access to the HOV lanes between 6:00 a.m. and 9:00 a.m. for southbound traffic and from 3:30 p.m. to 6:30 p.m. for the northbound direction. All traffic is allowed to use the lanes outside of these hours ([Blume 1998](#)).

Maryland allows interim use of the HOV lane by general-purpose traffic during major incidents and severe weather but follows no predetermined criteria for lifting the restrictions. It depends generally on the extent of the incident, time of the incident, and the length of the queue. A network of variable message signs and highway advisory radio along with media reports, coordinated through the Statewide Operations Center, informs drivers to use the HOV lane. Also, field personnel set up arrow boards and direct the diversion process in order to ensure drivers are aware of the situation and are clearly told the proper action. Once the restrictions on the HOV lane are lifted, the lane remains open to general-purpose traffic for the duration of the peak period; it is difficult to clear the lanes of general-purpose traffic after diversion ([Hoppers 1999](#)).

## **Minnesota**

In Minneapolis-St. Paul, Minnesota, three HOV facilities operate within the freeway network around the Twin Cities:

- I-394 west of Highway 100 is a concurrent facility that is reserved for HOVs with an occupancy level of two or more between 6:00 a.m. and 9:00 a.m. for eastbound traffic and 3:00 p.m. to 6:00 p.m. for westbound traffic. This section of I-394 has two general-purpose lanes and two concurrent HOV lanes.
- I-394 east of Highway 100 is a reversible, barrier-separated lane that is open to eastbound HOVs between 6:00 a.m. and 1:00 p.m. and westbound traffic between 2:00 p.m. and midnight. This section of I-394 consists of three general-purpose lanes and two reversible lanes in the middle of the freeway.
- I-35W is a concurrent facility available to HOVs between 6:00 a.m. and 9:00 a.m. and 3:00 p.m. to 6:00 p.m. in each direction. I-35W has three general-purpose lanes and two HOV lanes located on the inside of the freeway.

General-purpose traffic is allowed to use the concurrent facilities while restrictions are not in place (Hoppers 1999).

The Minnesota State Police responding to an incident have the authority to implement interim use of these HOV lane facilities during major incidents or severe weather. There is no set policy or criteria for the diversion of general traffic to HOV lanes although the Minnesota Department of Transportation is committed to ensuring that the HOV lane facilities are available to HOV users during specified operating hours (Hoppers 1999). The three HOV facilities operate within a surveillance network composed of loop detectors, closed-circuit television cameras (CCTVs), regular police patrol, and citizen calls. Motorist information is given to drivers by VMS, highway advisory radio, and through the media (Hoppers 1999).

## **Texas**

### *Dallas*

In Dallas, the East R.L. Thornton Freeway Contraflow HOV (I-30) lane is open to vehicles with an occupancy level of two or more between 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m. The inside freeway lane in the off-peak direction of travel is dedicated for HOVs in the peak direction. Traffic is separated by a moveable concrete barrier. The reversal process, which involves changing and constructing a temporary barricade of pylons, takes approximately two hours. There are no emergency access gates along the length of the barrier.

If a major incident significantly blocks the I-30 main-lanes, on-site personnel from the Dallas Area Rapid Transit (DART) recommends whether or not the HOV lane should be opened to general traffic. Since there are no emergency access gates that can be opened on the non-peak side, the contraflow facility cannot be reversed to divert non-peak main-lane traffic. Also, only the barrier transfer machine can move the barrier to allow non-peak traffic into the HOV lane. According to officials, HOV lane diversion has only occurred a couple of times on I-30 (Blume 1998).

Two additional concurrent HOV facilities operate in Dallas; I-35E and I-635. These lanes are open to vehicles with at least two occupants 24 hours a day and are separated from the general-purpose lanes by a double-wide stripe. The lanes designate two entrances and two exits. Both freeway facilities have three general-purpose lanes in each direction (Hoppers 1999).

The Dallas Area Rapid Transit allows the diversion of general traffic to HOV lanes under severely congested conditions, but to maintain the credibility of the HOV lane, its use by general-purpose traffic should be as a last resort in an incident management plan. Preferred alternatives include the use of shoulders as travel lanes and alternate route diversion. HOV lane diversion occurs an average of five to six times a year on I-635 and I-35E. The transit police and local police on the scene of the incidents make the decision to open the HOV lane to the general traffic without the benefits of set criteria to follow to determine when the lane should be opened. Variable message signs, cones, flags, and media announcements are used to direct motorists to the HOV lane. Once the driver of a single occupant vehicle bypasses the incident, he or she is expected to merge back onto the general-purpose lane; occupancy levels are enforced at a reasonable distance from the incident (Hoppers 1999).

### *Houston*

In Houston, five barrier-separated HOV lanes with an occupancy level of two or more are operated by the Houston Metropolitan Transit Authority (METRO) and the Texas Department of Transportation. Each facility is a one-lane facility except for a short two-lane section on U.S. 290. I-45N, I-45S, U.S. 59S, and U.S. 290 allow inbound vehicles to travel between 5:00 a.m. and 11:00 a.m. and outbound traffic between 2:00 p.m. and 8:00 p.m. during the weekdays. I-45S is also open to inbound HOV traffic from 3:00 p.m. to 9:00 p.m. on weekends in the summer (Blume 1998). The fifth facility, the I-10 HOV lane, is a HOT lane. The facility is open between 5:00 a.m. and 6:45 a.m. and from 8:00 a.m. to 11:00 a.m. Vehicles with an occupancy level of three or more travel the HOV lane for free between 6:45 a.m. and 8:00 a.m. while vehicles with only two occupants must pay a toll. The outbound traffic travels on the HOV lane between 2:00 p.m. and 5:00 p.m. and 6:00 p.m. to 8:00 p.m. Vehicles are tolled in the same manner as inbound HOVs between 5:00 p.m. and 6:00 p.m. Outbound vehicles with an occupancy of two or more are allowed to travel on Saturdays between 5:00 a.m. and 8:00 p.m. while on Sundays the same restrictions are used for the inbound traffic (Blume 1998).

Interim HOV lane use by general-purpose traffic is implemented approximately 10 times per year. Houston does not have a specific set of criteria that are followed to make a decision to lift the HOV restrictions. METRO's police personnel can decide to open the HOV lane to general-purpose traffic if a major incident causes extreme congestion and there is not an

available diversion route for traffic. VMS upstream of the incident provide motorists with diversion information. The messages are changed by METRO officers stationed at TranStar. The media is also used extensively to give the public information on the traffic situation (Hoppers 1999).

## **Virginia**

The Shirley Highway HOV facility is a two-lane, reversible, barrier-separated system. The northbound direction of the Shirley Highway is open to HOVs from 6:00 a.m. to 9:00 a.m. on Monday through Thursdays and open to all general traffic from 9:00 a.m. to 11:00 a.m. and 10:00 p.m. to 6:00 a.m. In the southbound direction, the HOV lane is open to HOVs from 3:30 p.m. to 6:00 p.m. and to all traffic from 1:00 p.m. to 3:30 p.m. and between 6:00 p.m. and 8:00 p.m. On Fridays, southbound HOVs are allowed to travel on the HOV lanes between 12:00 p.m. and 6:00 p.m. The lanes are opened to all southbound traffic from 6:00 p.m. on Friday to 8:00 a.m. on Sunday and then reopened to all northbound traffic from 10:00 a.m. Sunday to 6:00 a.m. Monday (Blume 1998).

The Virginia Department of Transportation (VDOT) and the state and local police are responsible for incident management on the Shirley Highway. Diverting general traffic to the HOV lanes has been a very successful and popular idea with the public and local media. Officials estimated that the decision to divert traffic onto the HOV lane occurs approximately 10 times per year. The decision is made jointly between the state police on the scene of the incident and VDOT. When HOV lane volumes are high, VDOT is reluctant to divert general-purpose traffic. Also, if an incident occurs in the non-peak direction of travel (i.e., low levels of congestion), VDOT will not allow general traffic to divert to the HOV lane (Blume 1998).

Specific criteria used to determine if the HOV lane should be opened to general traffic relates to the time it takes to clear the incident and the percentage of reduced capacity caused by the incident. If the operation of clearing a major incident lasts longer than two hours, then the restrictions on the HOV lane will be lifted. Also, when an incident blocks 50 percent of the main-lanes in the peak direction, then traffic will be diverted to the HOV lane. This provides the only example uncovered of specific managed lane interim use criteria.

VDOT maintains a network of VMS to alert drivers of any changes in the HOV lane restrictions. The VMS will inform the driver of no restriction if the HOV lane is opened to



general traffic. The restriction will last until the end of the peak period. VDOT also undertakes public information efforts to raise awareness about interim HOV lane use. From their *Frequently Asked Questions* webpage, VDOT has posted the following response:

***Why are HOV lane restrictions lifted when there is an accident?***

***Doesn't VDOT want to reduce congestion and pollution by encouraging carpooling?*** *VDOT does strive to encourage carpooling to reduce congestion and pollution on our highways, so we seldom lift HOV restrictions. Decisions to lift HOV restrictions are made in conjunction with, or at the request of the Virginia State Police Department. The police only make such a request if an accident is deemed to be a major incident that will take an extended period of time to clear. I know it is frustrating to see solo motorists enjoying the HOV lanes when you are "playing by the rules," but you will notice that even during snow conditions, HOV lane restrictions are not lifted unless the main lines are blocked (Virginia Department of Transportation website, [www.virginiadot.org/comtravel/hov-rulesfaq.asp](http://www.virginiadot.org/comtravel/hov-rulesfaq.asp)).*

## **Washington**

The Washington Department of Transportation operates a number of different types of HOV facilities. Concurrent facilities operate on I-405, SR 167, and SR 520 while reversible and concurrent HOV lanes operate on I-5 and I-90:

- I-405 HOV lanes have an occupancy definition of two or greater, which is enforced 24 hours a day.
- SR 167 HOV lanes are open to traffic 24 hours a day with an occupancy greater than one between South Grady Way and 84<sup>th</sup> Avenue South.
- A shoulder HOV lane on westbound SR 520 requires vehicles with three or more occupants and is enforced 24 hours a day.
- I-5 reversible lanes are open to HOVs with two or more occupants between 5:00 a.m. and 8:30 a.m. and from 12:00 p.m. to 4:00 a.m. in the peak direction. The number of lanes provided by the facility varies from one to four.

- I-90 HOV lanes include a reversible HOV roadway with an occupancy requirement of two or more between Seattle and Bellevue and 24-hour HOV lanes on the westbound and eastbound mainline between Bellevue and Issaquah (Hoppers 1999).

Washington State Patrol (WSP) has the authority to open the HOV lane to general traffic when a major incident occurs, although no set criteria exist to support this decision. The decision generally depends on the severity of the incident, time-of-day, and the availability of diversion routes other than the HOV lane. The time-of-day that the incident occurs is an extremely important factor to the decision of opening the HOV lane. The Washington State Department of Transportation is committed to providing efficient movement on the HOV lanes and, hence, prefers other incident management strategies (i.e., shoulder lane travel, alternate route diversion, etc.) over interim use of HOV lanes. WSDOT will generally not open the HOV lane to general-purpose traffic during the peak period to maintain travel time and reliability for HOVs (Hoppers 1999).

When interim HOV lane use is necessary, a network of VMS and portable signs, along with police officers direct the traffic into the HOV lane and around the incident (Hoppers 1999).

## **EMERGENCIES AND EVACUATION**

Distinguishing from major incidents, large-scale emergencies can require evacuation of an area, resulting in either a long-term or severe, short-term increase in traffic demand. The range of traffic impacts reported nationally is dramatic. As an example, consider the range of clearance times reported for hurricane evacuation events (clearance time represents the total time elapsed from an evacuation issuance until all vehicles have cleared the roads in an evacuation area):

- In Florida, evacuation clearance times have ranged from 3.5 to 51 hours.
- The Mississippi Emergency Management Agency (MEMA) reports historical clearance times ranging from 12 to 24 hours.
- North Carolina Emergency Management (NCEM) reports evacuation clearance times for the barrier islands ranging from 8 to 30 hours.
- The South Carolina Emergency Preparedness Division (SCEPD) reports evacuation clearance times ranging from 12 to 30 hours.

- In Texas, evacuation clearance times range from two hours for a Category 1 hurricane to 30 hours for a Category 5 hurricane (Hulett 1999).

To accommodate the increased traffic demand resulting from evacuation procedures, managed lane facilities can be opened to general-purpose traffic. Managed lanes can also be used as staging areas for bus transportation and can be operated in reverse or contraflow operation to accommodate directional demand.

The most prevalent traffic management strategy during emergencies and evacuation, as observed in national practice, is the use of existing roadway capacity through reverse-flow or contraflow operations. Again, considering emergencies related to hurricane events, Urbina and Wolshon (2003) note that 15 states have plans for the use of contraflow operation for hurricane evacuation. This is significant when only a subset of states is affected by hurricane threat. These plans vary considerably in their design and management and segment lengths, which range from less than 10 miles to greater than 120 miles (Urbina and Wolshon 2003). The use of reverse flow or contraflow during evacuation differs from non-emergency uses in that the scope of the threat places a premium on efficiency. Thus, “luxuries” such as route choice, access and egress availability, and even some standard safety measures will be sacrificed to move a high number of people out of the threat area (Wolshon 2001 and Wolshon 2002).

In a survey conducted by Hulett (1999), emergency management and transportation agencies were contacted to learn what practices are used for large-scale hurricane evacuation in each state and to assess their effectiveness. State agencies in states along the Gulf Coast and most of the Atlantic Coast were targeted due to their high hurricane frequency. Many states cited using or having a plan in place for reversible flow operations on major Interstates or freeways throughout the region:

- In Georgia, the Georgia Emergency Management Agency (GEMA) has developed a contingency plan for one-way operations along a segment of IH-16; this has never been implemented due to the high number of personnel needed for safe operation.
- The Maryland Emergency Management Agency (MEMA) has a similar one-way operations plan that they implemented during Hurricane Gloria (1985) and Hurricane Emily (1993). Evacuation of Maryland’s barrier islands involves conversion of major freeways to one-way operations using changeable message signs and arrow boards along the routes to direct motorists. Shoulders are kept open for disabled

vehicles and emergency services vehicles. State police and barricades and/or barrels are placed at all closed ramps to maintain one-way flow in the appropriate direction.

- In Texas, major cities along evacuation routes, such as Houston and San Antonio, use lane control signals and closed-circuit television cameras already in place along major Interstates and freeways to control and monitor traffic flow.
- The Louisiana State Police (LSP), the Louisiana Office of Emergency Preparedness, and the Louisiana Department of Transportation and Development (LDOTD), developed an evacuation plan for the New Orleans metropolitan area that relies on contraflow operation of I-10 and I-55.

While the interim use of managed lanes was not specifically addressed by any of these states, the utilization of any excess capacity likely includes the use of managed lanes through urban areas.

## **CHAPTER 5: RECOMMENDED INTERIM USE PRACTICES**

Based on the limited information available from related published literature, current research, and observed national practice, this chapter provides recommendations for interim managed lane use including planning and preparing for interim use, potential interim use criteria, and possible implementation requirements.

### **PLANNING AND PREPARING FOR INTERIM USE**

Although interim use of managed lanes facilities is taking place currently, the consistency and success with which this strategy can be applied can be significantly improved with planning and preparation. In particular, managing agencies should:

- Assess the current transportation system, including: (1) the managed lane facility regarding its appropriateness for interim use, (2) the general-purpose facility regarding its potential for alternative interim operational strategies (i.e., temporarily utilizing the shoulder as a travel lane), and (3) other network facilities regarding their appropriateness as alternate routes.
- Review and modify, as necessary, any internal agency policies or state or federal legislation that preclude the interim use of managed lane facilities.
- Develop inter-agency coordination agreements; particularly important between law enforcement who are often first on the scene and making the decision to utilize the managed lane facility and the transportation agencies who can support this decision-making process.
- Incorporate provisions for training in interim managed lane use strategies into appropriate personnel training programs (i.e., transportation operations personnel, law enforcement academy cadets, etc.).

### **Transportation System Assessment**

The most fundamental preparation measure a transportation agency can take prior to implementing interim use strategies for managed lanes is to assess the existing transportation system and analyze its ability to function outside of standard operations. In particular, this

assessment should include: (1) the managed lane facility and its appropriateness for interim use, (2) the general-purpose facility and its potential for alternative interim operational strategies (i.e., temporarily utilizing the shoulder as a travel lane), and (3) other network facilities and their appropriateness as alternate routes. Specific considerations for each are listed below.

### *Managed Lane Facility*

Managed lane facility considerations include the following:

- capacity and geometric constraints, including accessibility;
- general operating characteristics (i.e., hours of operation, occupancy requirements, tolling structure, etc.);
- availability of an operations center where information from the police and/or other highway operating personnel to the other agencies involved is relayed;
- technologies available for monitoring traffic (i.e., loop detectors, radar, video, regular police patrol, etc.);
- technologies available for communicating with the motoring public; and
- manpower and traffic control device availability for real-time traffic management if needed.

### *General-purpose Facility*

General-purpose facility considerations include the following:

- capacity and geometric constraints including bridges or overpasses that may preclude shoulder lane travel;
- availability and condition (i.e., paved, reinforced, etc.) of suitable shoulder capacity;
- manpower and traffic control device availability for “creating” an additional lane out of existing capacity (i.e., providing three narrow lanes instead of two 12-foot lanes and a shoulder); and
- manpower and traffic control device availability for real-time traffic management if needed.

### *Other Network Facilities*

Other network facility considerations include the following:

- capacity and geometric constraints of likely alternative routes;
- capacity of critical signalized and unsignalized intersections;
- technologies available for monitoring traffic (i.e., loop detectors, radar, video, regular police patrol, etc.);
- technologies available for communicating with the motoring public;
- “sensitive” locations within the system (i.e., schools, hospitals, etc.); and
- manpower and traffic control device availability for real-time traffic management if needed.

Consideration of the general-purpose facility and its potential for alternative interim operational strategies (i.e., temporarily utilizing the shoulder as a travel lane) and other network facilities and their appropriateness as alternate routes is particularly important. A number of agencies cited the importance of maintaining a higher level of service in the managed lane facilities and a desire to exhaust alternative traffic management strategies prior to interim managed lane use. In each case, temporary conditions, such as construction or malfunctioning traffic control devices, should also be kept up-to-date and included in the assessment.

### **Policy and Legislation Review and Modification**

When managed lane facilities are implemented, many agencies simultaneously implement policies governing their use. In addition, the implementation of managed lanes may be tied to environmental commitments made both to the federal government (FHWA and EPA) and various local communities (Hallenbeck et al. 2000). Accompanying state legislation may also define managed lane use requirements, a minimum level of service to be maintained, revenue use, and other considerations (Schreffler et al. 1998). Interim use of managed lanes has the potential to violate each of these governing conditions. The following series of questions can support an internal review of such a policy or legislation (Hoppers 1999):

- Does your agency currently allow the use of managed lane facilities by general traffic for temporary durations?

If no, an agency must identify whether interim use prohibition is governed by agency policy, state or federal agreement, or state or federal legislation. In some instances, an agency may discover no formal means for prohibition; interim use has not been pursued out of

“tradition” (i.e., agency has never done that before). Depending on the level of governance affecting interim managed lane use, different approaches will be required for change.

If yes, consider whether any aspects of the policy or procedures need to be changed or more well-defined:

- What conditions prompt this action (i.e., major incident, emergency, special event, holiday season, etc.)?
- What criteria are used to determine if and when interim use of managed lane facilities should occur?
- How long is the general traffic allowed to travel on the managed lane after the motivating condition has ceased?
- Does your agency have a formal plan in place for the interim use of managed lane facilities (i.e., how to direct motorists into and out of the lane, how to provide motorist information, etc.)?
- Is motorist diversion voluntary, mandatory, or variable depending on conditions?
- Does your agency actively measure the performance of managed lane interim use strategies (i.e., motorist delay, queue length, estimated secondary accidents, or estimated flow rate before and during use)?

Although the policies observed in practice are very general in nature with no specific criteria defined for supporting decisions related to interim use, a noted priority for preserving a higher level of service in the managed lane facility is consistent. Minnesota, Virginia, and Washington each indicated that agency policy supported standard operations for managed lane facilities except when traffic congestion was severe and no other traffic management alternatives were available (Hoppers 1999). Any policies, legislation, or changes put into place need to be consistent with local priorities.

### **Inter-agency Coordination Agreements**

When planning for and operating a managed lane facility under standard conditions, the level of involvement is limited, comprising primarily transportation agencies, transit agencies, trucking companies, law enforcement agencies, and tolling authorities, depending on the nature of the managed lane facility. Under usual, non-standard operating conditions such as construction or maintenance, special events, major incidents, or emergencies and evacuation, the



scope of involvement becomes much larger. While it is important to appropriately involve all potential stakeholders in the planning process for managed lane facilities, not all require formal coordination agreements for participation.

When determining which inter-agency relationships could most benefit from a formal coordination agreement to support interim managed lane use, an agency first needs to identify (Hoppers 1999):

- Which agencies are responsible for or most actively involved in construction and maintenance activities, special events, incident management, emergency management, and managed lane operations in your area?
- Who has the authority to open the managed lane to general-purpose traffic under each of these conditions?
- How do these different agencies currently coordinate that action?

For construction and maintenance activities, the managing transportation agency typically decides or approves recommendations to temporarily utilize the managed lane facility. Similarly, though no examples of interim managed lane use were found nationally, special event coordinators are required to submit requests to managing transportation agencies when modifications to the existing traffic flow are desired. In each of these cases, the managing transportation agency decides whether or not managed lanes will operate under interim use conditions.

For major incidents, emergencies, and evacuation, law enforcement agencies typically have the authority and make the decision to open managed lane facilities to general-purpose traffic. Typically, the decision to open the managed lane facility to general traffic is often made by a law enforcement officer on the scene without benefit of well-defined criteria for opening the lane, with little coordination or communication with the managing transportation agency and with little awareness of the long-term ramifications of such actions.

Inter-agency coordination agreements between law enforcement and managing transportation agencies could greatly enhance the existing decision-making process and ensure consistency with the managing transportation agency's policies and priorities for the managed lane facility. In addition to providing interim managed lane use guidance and support to law enforcement personnel during incidents or emergencies, an inter-agency coordination agreement could include:

- chain of command within an agency and among agencies,
- address and phone list of key personnel in each agency,
- agency lists of available manpower and equipment capabilities,
- method and sequence of alerting each agency during a major incident or emergency, and
- mutual-aid agreements to enable the sharing of resources and personnel and the crossing of jurisdictional boundaries (Hulett 1999).

### **Personnel Training**

Personnel training helps to ensure that any change in policy, agreement, or legislation is successfully implemented. Common forms of training include workshops, short courses, conferences, video training tapes, informal staff meetings, and mock incident and emergency exercises. Inter-agency training is particularly beneficial to support newly developed or modified inter-agency coordination agreements. For managed lane interim use, incorporating awareness training into law enforcement academy training may provide an efficient method for encouraging consistent decision-making related to interim managed lane use. Training also promotes safe practices and helps minimize liability.

### **INTERIM USE CRITERIA**

A set of criteria that defines when a managed lane facility should be opened for interim use is imperative to provide consistency: (1) in operation under non-standard conditions, and (2) with the managing transportation agency's policies and priorities for the facility (i.e., to preserve a higher level of service for managed lane users). These interim use criteria must be tailored to each facility but, in general, should consider the following:

- severity and nature of the conditions;
- time-of-day, anticipated duration and anticipated traffic impacts; and
- availability of alternative facilities or strategies.

### **Severity and Nature of Conditions**

Considering the motivating factors for interim use of managed lane facilities (i.e., construction or maintenance, special events, major incidents, emergencies, and evacuation), the

severity and nature of conditions results in two primary effects: (1) higher than normal congestion levels, and/or (2) compromised safety. Safety-related impacts are perceived to be more “severe” than congestion-related impacts, regardless of the degree of congestion. Further, unplanned events, such as major incidents or emergencies, are perceived to be more “severe” than planned events that include construction or maintenance activities or special events; planned events can utilize alternative traffic management strategies (i.e., HOV incentives, alternative routes, etc.).

Given these observations, the motivating conditions for interim managed lane use can be prioritized as follows:

- Priority 1 - Emergencies and Evacuation,
- Priority 2 - Major Incidents,
- Priority 3 - Construction or Maintenance Activities, and
- Priority 4 - Special Events.

#### *Priority 1 - Emergencies and Evacuation*

Emergencies and subsequent evacuation are infrequent and generally pose life-threatening conditions. Because of the significant safety hazards and life-threatening nature of emergencies and evacuation, interim use of managed lane facilities under these conditions is recommended. If life-threatening conditions exist, motorists with a heightened sense of anxiety may opt to use the underutilized managed lane facility on their own regardless of the managed lane use criteria. If that happens, a bigger problem may be created than allowing motorists to use the facility in a controlled fashion.

Under emergency conditions, the decision to open the managed lane for non-standard operations is largely driven by the decision to evacuate, eliminating indecision related to the time-of-day, duration of condition, level of impact, etc. Once evacuation procedures have been ordered, managing agencies should initiate steps to provide for interim use of the managed lane facility as requested. These procedures should be well-documented in an area emergency response plan.

#### *Priority 2 - Major Incidents*

The motivation for interim managed lane use is similar for major incidents and construction or maintenance activities (described below) — to reduce congestion for general-

purpose traffic, to improve safety for on-site personnel, and to enhance access to the scene. Fundamental differences, however, make interim managed lane use during major incidents a higher priority. First, the potential exposure hazard is greater for emergency responders during a major incident than construction personnel; the planned nature of construction or maintenance activities allows for the setup of appropriate traffic control devices and signing to protect the scene. Secondly, enhancing access to the scene of an incident can directly affect the survivability of injured motorists.

Given these fundamental differences, interim managed lane use during major incidents is recommended but agencies are strongly cautioned to define and follow carefully developed criteria for interim use under these conditions (i.e., incidents affecting three or more general-purpose lanes with an expected duration in excess of four hours). Further guidance for defining these criteria is provided in the next section (*Time-of-day, Anticipated Duration, and Traffic Impacts*).

### *Priority 3 - Construction or Maintenance Activities*

The primary intent of interim managed lane use for construction or maintenance activities is to reduce congestion; secondary benefits relate to improved safety for on-site workers and improved access to the work zone. Opening the managed lane facility to general-purpose traffic during construction or maintenance activities sets precedents that may lead to “abuse” of the managed lane facility. Further, the interim use of managed lane facilities for construction or maintenance activities may encounter unusually high resistance from the motoring public based on a perceived rather than real frequency of occurrence because of multiple simultaneous construction projects in a region.

Observed as a more prevalent practice nationally, continued standard operation of a managed lane facility is combined with alternative traffic management strategies (i.e., transit incentives, alternate route diversion, etc.) to ease congestion through the work zone.

Given the potential for public resistance, the availability of alternative traffic management strategies and a noted national consensus in practice, interim use of managed lanes during construction or maintenance is not recommended. Instead, construction and maintenance activities should be used as opportunities to encourage use of the managed lane under its intended operating structure.

In instances where no alternative exists to temporarily using a managed lane facility in non-standard operation during construction or maintenance, every effort should be made to schedule activities such that no substantive change in facility performance results. An example would include diverting general traffic to an HOV lane during nighttime construction activities when HOV lane and general-purpose traffic volumes are sufficiently low.

#### *Priority 4 - Special Events*

Given the singular focus on congestion relief for general-purpose traffic, combined with the potentially high frequency and the “entertainment” nature of special events, interim use of managed lanes during special events is not recommended. The occurrence of these events outside of peak commute periods is of benefit although insufficient to overcome the noted drawbacks. As with construction and maintenance activities, the planned nature of special events provides greater opportunities for traffic management strategies outside of managed lane use. Special events should be used as opportunities to encourage use of the managed lane under its intended operating structure.

#### **Time-of-day, Anticipated Duration, and Traffic Impacts**

In addition to the severity and nature of conditions, the time-of-day, anticipated duration of the condition, and the resulting traffic impacts — all interrelated — play an important role in determining the appropriateness of managed lane interim use. Recall that the interim use of managed lanes is intended to result in an improvement in congestion levels for general-purpose traffic with only a slight detrimental effect on managed lane performance. The degree of improved congestion experienced by the general-purpose traffic depends upon: (1) the duration and extent of the motivating condition, (2) the current congestion levels in the general-purpose lanes, and (3) the current utilization of the managed lane facility. The congestion levels in the general-purpose lane and the utilization of the managed lane facility are both dependent upon the time-of-day. In turn, high levels of congestion and utilization could affect the overall duration of conditions (i.e., extend the time for an incident to clear).

Because the interim use of managed lane facilities is not recommended for construction or maintenance activities or special events and because emergencies typically last eight to 30+ hours and the decision to evacuate during an emergency largely drives the decision to utilize the

managed lane facility for interim use (i.e., less indecision about when to use the lane), much of the following discussion relates to managed lane interim use under major incident conditions.

*Time-of-day*

Recall that for congestion relief benefits to be realized through interim use of managed lane facilities:

1. Excess capacity must be available on the managed lane facility (vehicle not person-moving capacity).
2. Some level of congestion must be present on the general-purpose lanes.
3. If congestion is present on both the managed lane facility and the general-purpose lanes, the level of congestion in the managed lanes should be less than the congestion in the general-purpose lanes.

Table 3, provided early in this report, presented this information matrix form, depicting potential congestion conditions supporting managed lane interim use. Building upon this approach, consider this same information segregated by general weekday time-of-day periods (see Table 4).

Hence, when considering time-of-day criteria for managed lane interim use, it appears as though midday time periods present the only real opportunity for benefit during weekdays. Managed lane volumes may be high during peak commute periods. Adding general-purpose traffic to an already “at capacity” facility will not result in short-term benefits to traffic flow. Conversely, traffic late at night travels basically free from congestion. Therefore, removing the managed lane restrictions late at night would have no impact on congestion.

**Table 4. Weekday Time-of-day Supporting Managed Lane Interim Use.**

<b>Weekday Time-of-day</b>	<b>Managed Lane Facilities</b>	<b>General-purpose Facilities</b>	<b>Managed Lane Interim Use</b>
<b>Morning Peak 6 a.m. – 9 a.m.</b>	<b>Congested</b>	<b>Congested</b>	<b>NO BENEFIT</b>
<b>Midday 9 a.m. – 3 p.m.</b>	<b>Uncongested</b>	<b>Congested/ Uncongested</b>	<b>BENEFIT<sup>1</sup></b>
<b>Evening Peak 3 p.m. – 6 p.m.</b>	<b>Congested</b>	<b>Congested</b>	<b>NO BENEFIT</b>
<b>Nighttime 6 p.m. to 6 a.m.</b>	<b>Uncongested</b>	<b>Uncongested</b>	<b>NO BENEFIT</b>

<sup>1</sup> Benefit only if: (1) the managed lane facility has excess capacity and (2) the level of congestion on the managed lane is less than the level of congestion on the general-purpose facility.

During weekday midday periods, the general-purpose lanes and the managed lane volumes likely experience the greatest difference in traffic volumes; general-purpose traffic may be relatively high compared to managed lane traffic. While congestion conditions appear suitable for interim use — excess capacity in the managed lanes with moderate to severe congestion levels in the general-purpose lanes — facility managers should be sensitive to the performance and reliability needs of managed lane users during this time. In particular, transit operators may be dependent on quick and reliable travel during midday periods to adhere to certain trip and schedule requirements.

During weekends, variable traffic patterns by time-of-day, day of year, and locale challenge the development of a more specific time-of-day criteria for interim managed lane use. In general, if conditions suggest potential interim use of the managed lane facilities, decision-makers should confirm that: (1) excess capacity is available on the managed lane facility, (2) some level of congestion exists on the general-purpose lanes, and (3) if congestion is present on both facilities, congestion levels on the managed lane facility are less than the congestion levels on the general-purpose facility. In conjunction with other interim use criteria, such as the nature and severity of the motivating condition and the availability of alternative facilities or strategies, confirmation of this three-part criteria suggests appropriate use of a managed lane facility.

These time-of-day recommendations for interim managed lane use are: (1) supported by related findings in published literature (Blume 1998, Hallenbeck et al. 2000), and (2) consistent with national practice. Departments of Transportation in Minnesota, Washington, and Virginia expressed a reluctance to allow general-purpose traffic into managed lane facilities during the peak commute periods citing a loss on managed lane credibility and integrity. Often, managed lane use marketing touts the avoidance of incident-induced congestion as a reason for use.

### *Anticipated Duration and Traffic Impacts*

The anticipated duration of the motivating condition for interim managed lane use (i.e., major incident, emergency, and evacuation) is difficult for managing personnel to accurately predict, may change as new conditions unfold, and may be extended as a result of attendant conditions (i.e., the amount of traffic backup resulting from an incident). The anticipated traffic impact is also difficult to estimate and is highly dependent on the duration of the condition.

Again, because emergencies and evacuation are severe in scope and duration (typically lasting eight to 30+ hours) and because the decision to evacuate during an emergency largely drives the decision to utilize the managed lane facility for interim use (i.e., less indecision about when to use the lane), much of following discussion relates to managed lane interim use under major incident conditions.

Interim use criteria on the basis of the anticipated duration of the condition and the resulting traffic impact must be sensitive to the practical decision-making process that takes place. While it may be desirable to base the decision for interim managed lane use on quantifiable metrics such as volume-capacity ratio thresholds in both the managed lane and general-purpose facilities (traffic management center could provide information on the volume-capacity ratio to field personnel from surveillance cameras and loop detectors), less quantifiable but more readily observable metrics from the field can speed the decision-making process and, hence, may be more beneficial. Under major incident conditions, law enforcement personnel on the scene have the authority and decision-making responsibility for managed lane interim use. Appropriate criteria for managed lane interim use under major incident conditions may include: (1) the anticipated duration for clearing the incident based on the incident characteristics (i.e., fatality, multiple vehicle involvement, large truck involvement, etc.), and (2) the number of general-purpose lanes impacted by observation.

Following a review of published literature and national interim managed lane use practice, only a single agency had similarly defined criteria for interim managed lane use. The Virginia Department of Transportation opens its HOV lane facility to general-purpose traffic if an incident blocks 50 percent of the main-lanes in the peak direction and is expected to take two hours or more to clear. While this was the only example uncovered that defined managed lane interim use, a number of transportation agencies, in cooperation with law enforcement agencies, use similar criteria to define when road closures are put into effect under major incident conditions. An example of such a policy is provided in the *Transportation Operation's Coordinating Committee's (TRANSCOM's) Incident Management Plan for I-287, New York State Thruway through Rockland County* (Reiss and Dunn 1991, see Table 5). TRANSCOM has defined appropriate conditions by time-of-day, day of week, estimated incident duration, and lanes blocked for roadway closures and subsequent traffic diversion off of the mainline.



**Table 5. TRANSCOM's Roadway Closure and Subsequent Traffic Diversion Criteria  
(Reiss and Dunn 1991).**

Time-of-day	Estimated Duration	Lanes Blocked		
		1	2	3+
<b>Weekday</b>				
Midnight to 5:00 a.m.	1 hour			
	2 to 4 hours			
	More than 4 hours			Voluntary Diversion
5:01 a.m. to 11:00 a.m. and 2:01 p.m. to 8:00 p.m.	1 hour			Long-term Diversion
	2 to 4 hours	Voluntary Diversion	Mandatory Diversion	Long-term Diversion
	More than 4 hours	Voluntary Diversion	Mandatory Diversion	Long-term Diversion
11:01 a.m. to 2:00 a.m. and 8:01 p.m. to Midnight	1 hour			Mandatory Diversion
	2 to 4 hours		Voluntary Diversion	Mandatory Diversion
	More than 4 hours	Voluntary Diversion	Mandatory Diversion	Mandatory Diversion
<b>Weekend</b>				
8:01 a.m. to 9:00 p.m.	1 hour			Mandatory Diversion
	2 to 4 hours		Voluntary Diversion	Mandatory Diversion
	More than 4 hours	Voluntary Diversion	Mandatory Diversion	Mandatory Diversion
9:01 p.m. to 8:00 a.m.	1 hour			
	2 to 4 hours			
	More than 4 hours			Voluntary Diversion

These same guidelines can be used to direct the decision to open managed lane facilities for interim use. In addition to congestion mitigation, diversion of traffic to the managed lanes facility may improve access to the incident scene by emergency responders and may lessen the likelihood for a secondary incident. In addition, there is some benefit to have consistent criteria for similar types of actions (i.e., diverting traffic to alternate routes or utilizing excess capacity in managed lane facilities).

The specific time-of-day, duration, and lane blockage thresholds are dependent upon local traffic and facility characteristics. Agencies should define appropriate *local* incident, traffic, and facility conditions under which interim managed lane use is appropriate. If criteria are set too low (i.e., incidents lasting one or more hours), the frequency of interim use will detract from the managed lane facility's intended use. If criteria are set too high (i.e., incidents lasting six or more hours), the infrequent occurrence of events would preclude benefits from interim use of managed lanes. These criteria may be dynamic over time, similar to occupancy criteria (i.e., 2+ versus 3+ carpools), with the incident conditions defining appropriate interim managed lane use adjusting up or down depending upon the frequency of occurrence.

Once interim use has been implemented, it is important to determine if the managed lanes will remain open for the duration of the operating period or if they will be available to all traffic only during the duration of the event (i.e., until the incident is cleared). For managed lane facilities with 24-hour operating periods, standard operation should resume as soon as the motivating event has ended (i.e., the incident has been cleared or the emergency threat has passed). For managed lane facilities with defined peak or extended hour operating periods, it may not be feasible to reinstate standard operating criteria immediately following an event. Several examples exist nationally of agency policies that will keep the managed lane facility open to general traffic throughout the remainder of the operating period, once interim use has been implemented.

### **Availability of Alternative Facilities or Strategies**

When considering the availability of alternative facilities or strategies as criteria for allowing interim managed lane use, the following discussion will again be limited to major incident conditions. Interim use of managed lane facilities is not recommended for construction or maintenance activities or special events; the planned nature of these conditions allows for

pursuit of public information and travel demand management strategies that enhance rather than compromise the standard operation of the managed lane. Emergencies and evacuation require high speed, high volume facilities — characteristics common to managed lane facilities. Under emergency conditions, additional alternate route facilities may be used in conjunction with the primary alternative route, but use of the managed lane for evacuation should not be impeded.

Considering major incident conditions, a number of agencies cited the importance of maintaining a higher level of service in the managed lane facilities and a desire to exhaust alternative traffic management strategies prior to interim managed lane use. As such, the availability of: (1) alternative routes for general-purpose traffic, and (2) alternative interim operational strategies (i.e., temporarily utilizing the shoulder as a travel lane) for the general-purpose facility should be fully considered prior to implementing interim use of the managed lane. Alternate route use is typically preferred over alternative operational strategies; alternative operational strategies may expose motorists to substandard design conditions and may be confusing.

#### *Alternative Facilities*

The availability of alternative facilities or routes is location-dependent and hence, cannot be defined with specificity here. However, researchers provide general recommendations for selecting and utilizing alternative routes. Many areas already have an alternate route plan developed as part of incident management efforts or a larger emergency management plan. In general, before diverting traffic off of the general-purpose facilities, the following considerations should be addressed:

- capacity and geometric constraints of likely alternative routes;
- capacity of critical signalized and unsignalized intersections;
- technologies available for monitoring traffic (i.e., loop detectors, radar, video, regular police patrol, etc.);
- technologies available for communicating with the motoring public;
- “sensitive” locations within the system (i.e., schools, hospitals, etc.);
- manpower and traffic control device availability for real-time traffic management if needed; and

- construction, maintenance, or other temporary activities that may affect the capacity of likely alternate routes.

Short-term traffic diversion poses less of a concern than long-term traffic diversion. Regular commuters will be more comfortable diverting than unfamiliar travelers. Also, cooperative agreements may be required between state and local jurisdictions to allow active direction to non-state alternate routes. If implemented effectively, use of alternate facilities provides a successful option outside of interim managed lane use.

### *Alternative Strategies*

In addition to the use of alternative facilities, alternative operational strategies may be employed during major incident conditions. Alternative interim use strategies include using shoulders as temporary travel lanes, implementing reversible flow on facilities and implementing temporary vehicle restrictions.

**Shoulder Travel.** Along I-66, through suburban Virginia and Washington, D.C., the right shoulders of I-66 are used as an additional travel lane to accommodate traffic during peak period travel times, providing three unrestricted travel lanes during the periods when the left (median) lane is converted for restricted HOV use. Empirical observation and experience have not shown any significant increases in accidents or driver confusion in this area. Anecdotal evidence also suggests that the driving public has been supportive of the lanes, and few complaints have been received. Interestingly, the Virginia Department of Transportation has received complaints when the shoulder lanes are not opened during off-peak periods, when capacity-restricting incidents occur in the other lanes. For this reason, VDOT maintains a flexible operating policy that allows them to activate the shoulder lane as an incident management tool to increase the segment capacity when conditions warrant their use ([Wolshon and Lambert 2004](#)).

For this strategy to be effective, the shoulders need to be of sufficient width and structure to withstand repeated traffic loading and potential heavy vehicle traffic loading. Locations where the shoulder width is constrained (i.e., overpasses, bridges, etc.) will result in bottlenecks and limit the utility of this strategy. Shoulder travel may also impede access to or from an incident scene by emergency responders. Measures, such as temporary signing and law enforcement personnel on-site, may also be required to ease motorist confusion; driving on the

shoulder violates driver expectancies. This strategy could be achieved through the use of law enforcement personnel to direct traffic to the shoulder (Ullman et al. 1993).

**Reversible Flow.** Utilizing reversible flow strategies on existing facilities can be effective with certain limitations. Reverse flow operations have been typically reserved for long duration or recurrent activities such as alleviating capacity constraints during construction or accommodating directional flow during peak periods or during special events. In these instances, significant preplanning has taken place, and sufficient permanent or temporary traffic control devices have been put into place. For unplanned, infrequent occurrence, implementation of reverse flow is more challenging and includes concerns with:

- violation of driver expectancy,
- safety issues,
- extensive manpower for implementation,
- problems in converting the roadway back to two-way flow without creating bottlenecks, and
- dangerous geometric implications (i.e., adverse superelevation, limited sight distance, etc.) (Ullman et al. 1993, Ullman and Trout 1991, Wohlschlaeger and Ullman 1991).

Under major incident conditions, reverse flow may be appropriately limited to ramp facilities and for clearing traffic that reached the incident scene prior to implementation of an alternate route diversion. Qualified personnel on-site should actively direct this activity.

**Vehicle Restrictions.** To alleviate traffic demand at the scene of an incident, the movement of certain vehicles, such as oversize cargoes and mobile homes, can be restricted until standard operations can resume. These restrictions are only appropriate if the unusual conditions are anticipated to last for an extended duration (Hulett 1999).

## **IMPLEMENTATION REQUIREMENTS**

In addition to identifying *when* interim managed lane use should occur, it is important to determine *how* interim managed lane use should occur, including any accompanying actions that support implementation. Important considerations include inter-agency communication and coordination, on-site signing and traffic control, network traffic management, public education, and monitoring and evaluation.

## **Inter-agency Communication and Coordination**

When planning for and operating a managed lane facility under standard conditions, the level of involvement is limited, comprising primarily transportation agencies, transit agencies, trucking companies, law enforcement agencies, and tolling authorities, depending on the nature of the managed lane facility. Under usual, non-standard operating conditions such as construction or maintenance, special events, major incidents, or emergencies and evacuation, the scope of involvement becomes much larger.

For interim managed lane use under major incident or emergency conditions, a communication and coordination linkage between law enforcement and transportation agencies is critical. Law enforcement personnel on-site typically prompt the implementation of interim use; transportation agencies have the traffic control (i.e., cones, barrels, signing, etc.) and technological resources to support this implementation, reducing traffic congestion and maintaining safety. Law enforcement needs to communicate both the start of interim use and the end of interim use following the event, allowing transportation agencies to ready appropriate resources and provide accurate and timely motorist information to reduce traffic demand through the affected site.

Communication and coordination between law enforcement and transportation agencies is challenged both by protocol and technological limitations (i.e., interoperable radio systems). Protocol-based challenges can be overcome through inter-agency training and inter-agency coordination agreements but may require a change in agency policy. Technological challenges may be overcome by exchanging radio units, using cellular telephones or communicating through a centrally accessible traffic or emergency operations center. In either case, preplanning should occur to overcome these challenges prior to an event.

## **On-site Signing and Traffic Control**

During managed lane interim use, traditional channelizing devices such as cones, tubes, barrels, and barricades can be used to:

- indicate a roadway or ramp closure;
- split a lane, shoulder, or ramp into two narrow lanes to increase capacity; or
- supplement other law enforcement directives ([Ullman et al. 1991](#)).

Where available, lane control signals may also be used to control on-site traffic. Lane control signals display X's and arrows over individual travel lanes or alongside the roadway to show whether a lane is open or closed (Blume 1998). Green arrows, yellow X's (or diagonal arrows), and red X's indicate if a lane is open, about to close, or closed, respectively.

Similarly, flashers can be used to signify lane use. Flashers that are blinking would signify that traffic in the managed lane is restricted. If the flashers are turned off, general-purpose traffic is allowed to enter the managed lane. Flashers are most effective if motorists are familiar with their use (i.e., if flashers are used to indicate peak or extended hour managed lane operations).

These traffic control devices must be accompanied by adequate signing, directing a motorist to the managed lane and also directing the motorist out of the managed lane, either downstream of the event or following its termination.

Clear and concise information will reduce any confusion for the motorist. A person who is accustomed to driving in the main-lanes might not be familiar with the managed lane facility. Key information to provide includes:

- reason for diversion to the managed lane facility,
- whether the diversion is voluntary or mandatory,
- length of time or distance that the motorist is allowed to continue to drive on the managed lane, and
- availability of entrance and exit points, if the managed lane facility is physically separated from the general-purpose facility.

Temporary static signs can be used to relay limited information to the motoring public. Flip-down signs can be permanently mounted along the managed lane facility, or free-standing signs can be brought to the site and placed where needed. While these signs present only limited information, their availability and flexibility in placement provides significant benefit.

Portable or permanent variable message signs (also called dynamic or changeable message signs) provide additional information, in real time. VMS messages are typically limited to three lines of brief text. Hoppers (1999) suggests the following message for managed lane interim use under major incident conditions:

MAJOR ACCIDENT  
1 MILE AHEAD

## USE HOV LANE

Variable message signs can be permanently located along the managed lane facility corridor (used for day-to-day traffic management) or available on mobile trailers. Transportation agencies may have unused portable VMS at a storage facility for use or may opt to temporarily borrow portable VMS from nearby construction projects for this use.

VMS information can be supplemented with either portable or permanent Highway Advisory Radio (HAR). HAR requires a motorist to tune their radio to a specified a.m. frequency, where more detailed and potentially bilingual information is provided. Often, static signs and changeable message signs will direct motorists to tune to the HAR frequency for supplemental information.

Similarly, the media (radio or television) is a very useful tool in providing the public with travel condition information. Radio-based media can reach motorists on-site, approaching the site or not yet departed from work, home or another location. Television-based media can reach motorists not yet departed from their home. The media can be used to inform the general public of:

- the level of congestion on the general-purpose and managed lane facility,
- available alternate routes,
- managed lane diversion, and
- available exits if they choose to divert to the managed lane ([Hoppers 1999](#)).

A working relationship and possible cooperative agreements with the media should be in place prior to an event to establish a protocol for communications and to stress the importance of accurate real-time information.

## **Network Traffic Management**

In addition to controlling traffic on-site, it is important to consider the larger traffic impacts. Traffic management or emergency operations centers, through the use of closed-circuit television cameras or other surveillance technologies, can monitor traffic on the affected managed lane and general-purpose facility, upstream and downstream of the affected facility, and along alternative routes. Through careful and widespread surveillance, transportation agencies can better identify and remedy potential problems and support decisions related to a return to standard operation for the managed lane facility.



Network traffic management often requires cooperation between state and local jurisdictions to adequately accommodate diversion traffic. Even if the managed lane facility is open for interim use by general-purpose traffic, many motorists will opt to take alternate local routes rather than the managed lane facility. Local jurisdictions may need to modify traffic signal timings to provide additional green time or implement other traffic management strategies to accommodate this increase in demand. Hence, early and continuous communication with the local jurisdictions regarding the state of the general-purpose and managed lane facility is important.

### **Public Education**

Prior to a motivating event, public education efforts may be used to familiarize motorists with managed lane interim use procedures. A number of state transportation agencies provide general information regarding their interim managed lane use practices via the World Wide Web. Most often, this information is a response to a “frequently asked question” on the agency’s website. This information should be carefully crafted to: (1) communicate the potential for occasional use to general-purpose traffic, and (2) reassure managed lane users of the infrequent nature of this use. The Virginia Department of Transportation provides a good example of this balance:

*Why are HOV lane restrictions lifted when there is an accident?  
Doesn't VDOT want to reduce congestion and pollution by encouraging carpooling? VDOT does strive to encourage carpooling to reduce congestion and pollution on our highways, so we seldom lift HOV restrictions. Decisions to lift HOV restrictions are made in conjunction with, or at the request of the Virginia State Police Department. The police only make such a request if an accident is deemed to be a major incident that will take an extended period of time to clear. I know it is frustrating to see solo motorists enjoying the HOV lanes when you are “playing by the rules,” but you will notice that even during snow conditions, HOV lane restrictions are not lifted unless the main lines are blocked (Virginia Department of Transportation website, [www.virginiadot.org/comtravel/hov-rulesfaq.asp](http://www.virginiadot.org/comtravel/hov-rulesfaq.asp)).*

## Monitoring and Evaluation

If a managing agency opts to allow interim use of managed lane facilities, an accompanying monitoring and evaluation plan should be developed. Monitoring and evaluation of interim use strategies will support decisions related to the conditions under which interim use is implemented (i.e., the duration and impact of an incident) and will provide the necessary information to justify these decisions. Performance metrics for interim managed lane use should relate to the intent of the motivating event and should include:

- congestion levels on both the managed lane and general-purpose facility before and during interim use,
- safety of both motorists and responders, and
- public acceptance/perception.

Congestion levels, expressed in terms of vehicles per hour per lane, travel time, travel speed, etc., can be monitored by a traffic management center using surveillance technologies (i.e., electronic loop detectors, closed-circuit television cameras, etc.). A minor compromise in the managed lane level of service and a corresponding improvement in the general-purpose facility level of service are desirable. A dramatic decrease in the managed lane level of service may suggest a reevaluation of interim managed lane use criteria or discontinued interim use, especially if a negligible change is observed on the general-purpose facility.

Safety information can be obtained through accident records for the motoring public and through agency on-the-job injury reports for responders. A separate record of secondary incidents should be maintained; accident records don't distinguish secondary incidents. An improvement in responder safety suggests continuation of managed lane interim use. These observations should be tempered with any observed increase in motorist-involved incidents at managed lane ingress or egress points or elsewhere along the facility attributable to motorist unfamiliarity or confusion. An increase in motorist-involved incidents at these locations suggests a need for improved signing and traffic control at these locations or may prompt discontinued interim use of the managed lane facility.

Lastly, a survey of users and non-users of the managed lane facility should be performed to determine the public's opinion on whether the managed lane should have been opened to general traffic. This survey can be conducted as an online survey or, depending on the nature of the managed lane facility, can be distributed in hardcopy form to known managed lane users

(i.e., transit riders, motorists with toll tags, etc.). If the latter survey method is pursued, an effort should also be made to solicit the opinions on non-managed lane users who may or may not feel strongly about being able to utilize managed lanes during unusual conditions.

Performance metrics in each of these areas (i.e., congestion, safety and public acceptance/perception) should be considered in combination to help shape and improve strategies for interim managed lane use. These evaluation activities should be repeated periodically to capture changes in traffic volumes and travel patterns as well as changes in attitude toward the interim use of the managed lane facility.



## **CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS**

Although managed lanes will largely function under their intended standard operating procedures, certain conditions such as construction or maintenance, special events, major incidents or large-scale emergencies and evacuation may require unusual interim use of the facilities. Because interim use of managed lanes may detract from the facilities' intended use and performance related to mobility and congestion, reliability, accessibility, safety, environmental impact, system preservation, or organizational efficiency, carefully crafted interim use policies developed in the planning stages should guide decisions for the short-term use of managed lanes.

At the time of this investigation, formal policies or guidelines for interim managed lane facilities use were not uncovered. Several areas across the country with high-occupancy vehicle facilities (a type of managed lane facility) and proactive incident management programs have developed incident management strategies that include diversion of general traffic to the HOV lane when a major incident occurs. However, these diversion practices are highly variable; dependent on the configuration of the HOV lane, severity of the incident, judgment of the on-scene field personnel (i.e., the decision to open the HOV lanes to general traffic is often made by a law enforcement officer on the scene without benefit of well-defined criteria for opening the lane) and agency policy (Hoppers 1999).

In addition, little is known about the potential benefits (i.e., congestion mitigation, safety, etc.) or concerns (i.e., public acceptance/perception, compliance rates, monetary costs, etc.) of interim managed lanes use. Opening managed lanes to general traffic can become politically volatile; managed lane users expect a certain level of service which may be compromised with the addition of general traffic. This action can be particularly sensitive if managed lane users are paying a toll to achieve this level of service. Again, the decision to open managed lanes to general traffic for interim use is often made by a law enforcement officer in the field who is likely unaware of the long-term ramifications of such actions (Blume 1998).

Given the: (1) lack of formal policies or guidelines, (2) variability in observed practices, and (3) limited understanding of potential benefits or concerns surrounding interim use of managed lanes, the objectives of this task were to:

- Discern any positive trends in interim use procedures for managed lanes (i.e., in published literature or observed practice) that could be recommended for widespread implementation.
- Identify and describe potential benefits and concerns surrounding interim use of managed lanes.
- Assimilate this information into recommended guidelines addressing all aspects of managed lane facility interim use.

To accomplish the objectives of this task, researchers reviewed: (1) published literature and current research, and (2) national practice related to interim use of managed lane facilities. A review of published literature and current research was conducted to: (1) discern any positive trends in interim use procedures for managed lanes that could be recommended for widespread implementation, and (2) identify potential benefits and concerns surrounding interim use of managed lanes. The novelty of managed lanes as a traffic management strategy, the diversity of managed lane facility types (i.e., high-occupancy vehicle lanes, exclusive truck lanes, etc.) and the breadth of motivating factors for interim use (i.e., construction and maintenance, special events, etc.) challenged the identification of pertinent literature or current research. Hence, much of the literature reviewed and described in this report is only indirectly related to interim use of managed lane facilities.

When conducting a review of national interim managed lane use practices, similar limitations related to the novelty of managed lanes as a traffic management strategy, the diversity of managed lane facility types, and the breadth of motivating factors for interim use were encountered. Information regarding national interim use practices for managed lane facilities was obtained primarily from two sources: (1) published literature summarizing results of prior national surveys, and (2) individual agency websites accessible through the World Wide Web. In particular, the survey conducted by Hoppers (1999) was valuable in identifying national practice related to the temporary use of HOV lanes during major incidents or severe weather. In this survey, agency officials were asked a variety of questions regarding their policy on opening HOV lanes to general traffic, the criteria used to determine when the HOV lanes should be opened, and the strategies used to carry out the diversion. Agency officials were also asked to describe the agency coordination required to achieve the diversion. Various sources on the

World Wide Web provide more current but less comprehensive information about interim use of managed lanes during construction, special events, or major incidents and emergencies.

## **CONSIDERATIONS FOR INTERIM USE**

Key considerations related to operational and safety impacts, public acceptance/perception, monetary impacts, and regulatory integrity, as uncovered in the published literature and through observation of national practice, are summarized below:

### **Operations**

- Interim managed lane use relies on the suspension of time-of-day, vehicle occupancy, or vehicle type restrictions and/or the suspension of tolls to temporarily encourage or mandate lane use by general-purpose traffic.
- Prevalent national practice is to utilize managed lane facilities for unplanned, safety-related events such as major incidents or emergencies. Planned events, such as construction and maintenance or special events, can be used to encourage use of managed lane facilities under standard operation (i.e., transit incentives, alternate routes, etc.).
- For congestion relief benefits to be realized through interim use of managed lane facilities: (1) excess capacity must be available on the managed lane facility; (2) some level of congestion must be present on the general-purpose lanes; and (3) if congestion is present on both the managed lane facility and the general-purpose lanes, the level of congestion in the managed lanes should be less than the congestion in the general-purpose lanes.
- Hence, appropriate times of day for interim managed lane use may only include midday. During the peak commute periods, both the managed lane facility and the general-purpose facility are typically congested. Also, travel time reliability for managed lane users is of utmost importance. At night, both the managed lane facility and the general-purpose facility are typically uncongested.
- Interim use may have adverse compliance effects on the affected facility as well as other managed lane facilities; additional enforcement resources may be required.

- Prevalent national practice is to resume standard operations as soon as possible following the event on 24-hour managed lane facilities and at the end of the specified operational period on a peak period or extended hour managed lane facility (i.e., resume standard operations during the subsequent operational period to simplify enforcement).

## **Safety**

- Safety-related benefits attributable to the interim use of managed lanes include: (1) improved access to an incident scene by emergency responders, (2) improved safety for emergency responders at the scene of an incident, construction personnel at a work zone, and motorists approaching either an incident scene or a work zone, and (3) quicker clearance during an evacuation. These safety benefits will either be realized by moving fewer vehicles to or through the scene of an incident or a work zone (i.e., reduced backup and exposure) or by moving more vehicles away from the scene of a hazard.
- Safety-related concerns relate to the design and accessibility of managed lane facilities. A review of possible design deviations at ramp tapers, merge and diverge areas, and other potential points of conflict should be conducted prior to interim use. In addition, the sufficiency of guidance at major access decision points should be reviewed with the unfamiliar driver in mind.

## **Public Acceptance/Perception**

- Users of managed lane facilities are making some concession to do so — either riding with one or more other individuals, taking public transit, or paying a toll — for real or perceived personal benefits related to travel time savings, travel time reliability, or safety. If the managed lane restrictions are lifted too often for interim use, managed lane users may question the value of the lane. Also, general-purpose traffic may become accustomed to traveling in the managed lane, increasing violations, challenging enforcement, and decreasing incentive for high-occupancy travel.



- While frequency of interim use plays an important role in determining public acceptance and perception, motivation for interim use (i.e., construction or maintenance, special events, major incidents, and emergencies and evacuation) may also be significant in determining public response. Managed lane users may be more accepting of interim use for unplanned major incidents, emergencies, and evacuations that pose significant safety hazards than construction, maintenance, and special event activities focused on congestion relief. The planned nature of these latter events also provides greater opportunities for traffic management strategies outside of managed lane use (i.e., public information campaigns to encourage transit use, alternative route plans, etc.).
- Prevalent national practice is to maintain standard operations of the managed lane facility during the peak commute periods unless conditions are extremely severe.

### **Monetary Impacts**

- The most direct monetary impact resulting from interim use of managed lane facilities relates to the temporary suspension of tolls on value-priced or high-occupancy toll facilities. The amount of revenue loss depends upon the toll rates of the facility, the utilization of the managed lane, and the duration of interim use.
- Additional costs associated with interim managed lane use may originate from a number of sources related to signing and public information, post-interim use enforcement, the need to “fix” any design deficiencies that are not acceptable for general traffic conditions (i.e., widening existing shoulders, removing or relocating signs and signal heads, and a variety of other geometric improvements) and potential environmental commitment violation penalties to the FHWA and Environmental Protection Agency if managed lane facility goals are focused on reducing environmental impact.

### **Regulatory Integrity**

- Changes in managed lane operational strategies have the potential to violate environmental commitments to the federal government (FHWA and EPA) and various local communities or may require enactment or modification of state

legislation. Examples of each exist in national practice; however, the proposals included recurrent interim use (i.e., during weekends or during midday weekdays) and permanent changes to managed lanes operations, respectively.

## **INTERIM USE CRITERIA AND REQUIREMENTS**

A set of criteria that defines when a managed lane facility should be opened for interim use is imperative to provide consistency: (1) in operation under non-standard conditions, and (2) with the managing transportation agency's policies and priorities for the facility (i.e., to preserve a higher level of service for managed lane users). These interim use criteria must be tailored to each facility but, in general, should consider the following:

- severity and nature of the conditions;
- time-of-day, anticipated duration, and anticipated traffic impacts; and
- availability of alternative facilities or strategies.

[Table 6](#) provides a summary of general recommendations considering each of these criteria.

While beneficial in lending consistency to practice, interim use criteria for managed lanes cannot account for every situation and location. Therefore, the decision to utilize managed lane facilities under interim use still relies upon the good judgment and experience of on-site personnel.

In addition to identifying *when* interim managed lane use should occur, it is important to determine *how* interim managed lane use should occur, including any accompanying actions that support implementation. Important considerations related to inter-agency communication and coordination, on-site signing and traffic control, network traffic management, public education and monitoring and evaluation are summarized below:

### **Inter-agency Communication and Coordination**

- For interim managed lane use under major incident or emergency conditions, a communication and coordination linkage between law enforcement and transportation agencies is critical.

**Table 6. Recommended Interim Use Criteria.**

Criteria		Recommendation
Severity and Nature of Conditions	Emergencies and Evacuation	Recommended
	Major Incidents	Recommended with carefully defined criteria for interim use
	Construction or Maintenance	Not recommended, if necessary, schedule to minimize performance impacts (i.e., nighttime construction)
	Special Events	Not recommended
Time-of-day	Morning Peak	Not recommended, both the managed lane and general-purpose lanes are congested and travel time reliability is key to managed lane users
	Midday	Recommended if the level of congestion in the managed lane is less than the level of congestion in the general-purpose lanes
	Evening Peak	Not recommended, both the managed lane and general-purpose lanes are congested and travel time reliability is key to managed lane users
	Nighttime	Not recommended, both the managed lane and general-purpose lanes are uncongested
Anticipated Duration and Traffic Impacts	Locally Defined	<p>Define in terms of event duration and lanes impacted; interim use strategy may vary by time-of-day</p> <p>Criteria may be dynamic to control frequency of interim use</p> <p>24-hour managed lane facilities should resume normal operation as soon as possible following an event</p> <p>Peak period or extended operations should continue interim use through the remainder of the operational period to simplify enforcement</p>
Availability of Alternative Facilities or Strategies	Locally Defined	<p>Use of alternative facilities and of alternative operational strategies on the general-purpose facility (i.e., shoulder travel) should be considered prior to interim managed lane use.</p> <p>Use of alternative facilities is preferred; alternative operational strategies may compromise design or safety standards.</p>

- Communication and coordination between law enforcement and transportation agencies is challenged both by protocol and technological limitations (i.e., interoperable radio systems). Protocol-based challenges can be overcome through inter-agency training and inter-agency coordination agreements but may require a change in agency policy. Technological challenges may be overcome by exchanging radio units, using cellular telephones, or communicating through a centrally accessible traffic or emergency operations center. In either case, preplanning should occur to overcome these challenges prior to an event.

### **On-site Signing and Traffic Control**

- During managed lane interim use, traditional channelizing devices (i.e., cones, tubes, barrels, and barricades), lane control signals, or flashers can indicate interim managed lane use.
- Traffic control devices must be accompanied by adequate signing, directing a motorist to the managed lane and also directing the motorist out of the managed lane, either downstream of the event or following its termination.
- Clear and concise information, including the reason for diversion to the managed lane facility, whether the diversion is voluntary or mandatory, length of time or distance that the motorist is allowed to continue to drive on the managed lane, and availability of entrance and exit points, if the managed lane facility is physically separated from the general-purpose facility, must be presented to reduce any confusion for the motorist.
- Temporary static signs or portable or permanent variable message signs can relay limited information to the motoring public.
- Portable or permanent Highway Advisory Radio or commercial media can supplement the information provided through signing.
- A working relationship and possible cooperative agreements with the media should be in place prior to an event to establish a protocol for communications and to stress the importance of accurate real-time information.

## **Network Traffic Management**

- Traffic management or emergency operations centers, through the use of closed-circuit television cameras or other surveillance technologies, can monitor traffic on the affected managed lane and general-purpose facility, upstream and downstream of the affected facility and along alternative routes to better identify and remedy potential problems and to support decisions related to a return to standard operation for the managed lane facility.
- Even if the managed lane facility is open for interim use by general-purpose traffic, many motorists will opt to take alternate local routes rather than the managed lane facility. Hence, early and continuous communication with the local jurisdictions regarding the state of the general-purpose and managed lane facility is important.

## **Public Education**

- For general public education, prevalent national practice is to provide general information regarding their interim managed lane use practices via the World Wide Web. Most often, this information is contained as a response to a “frequently asked question” on the agency’s website.

## **Monitoring and Evaluation**

- Monitoring and evaluation of interim use strategies will support decisions related to the conditions under which interim use is implemented (i.e., the duration and impact of an incident) and will provide the necessary information to justify these decisions.
- Performance metrics for interim managed lane use should relate to the intent of the motivating event and should include: congestion levels on both the managed lane and general-purpose facility before and during interim use, safety of both motorists and responders, and public acceptance/perception.
- Congestion levels, expressed in terms of vehicles per hour per lane, travel time, travel speed, etc., can be monitored by a traffic management center using surveillance technologies (i.e., electronic loop detectors, closed-circuit television cameras, etc.). A minor compromise in the managed lane level of service and a corresponding improvement in the general-purpose facility level of service are

desirable. A dramatic decrease in the managed lane level of service may suggest a reevaluation of interim managed lane use criteria or discontinued interim use, especially if a negligible change is observed on the general-purpose facility.

- Safety information can be obtained through accident records for the motoring public and through agency on-the-job injury reports for responders. A separate record of secondary incidents should be maintained; accident records don't distinguish secondary incidents. An improvement in responder safety suggests continuation of managed lane interim use. These observations should be tempered with any observed increase in motorist-involved incidents at managed lane ingress or egress points or elsewhere along the facility attributable to motorist unfamiliarity or confusion. An increase in motorist-involved incidents at these locations suggests a need for improved signing and traffic control at these locations or may prompt discontinued interim use of the managed lane facility.
- Lastly, a survey of users and non-users of the managed lane facility should be performed to determine the public's opinion on whether the managed lane should have been opened to general traffic. This survey can be conducted as an online survey or, depending on the nature of the managed lane facility, can be distributed in hardcopy form.

## **NEXT STEPS**

The information summarized in this chapter represents an assimilation of information contained in published literature and observed through national practice regarding interim use of managed lane facilities. This information represents a significant step in understanding the potential benefits and concerns surrounding interim use of managed lanes and encouraging consistency in practice by providing general interim use criteria. For this information to be of most use, managing agencies need to take the next step to define local conditions leading to appropriate interim managed lane use. This includes defining appropriate times of day when congestion levels would support interim managed lane use (i.e., excess capacity in the managed lane, congestion in the general-purpose lane, etc.) and identifying and investigating the suitability of alternative facilities or operational strategies that could be utilized in place of or in conjunction with interim managed lane use.

As additional interim use policies are developed for managed lane facilities (only the Virginia Department of Transportation was found to have any type of formal interim use policy), and consistency in interim use practice evolves, more can be learned about the potential benefits and concerns surrounding interim managed lane use.





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