DALLAS AREA GUIDANCE

FOR HOV LANE IMPLEMENTATION

DALLAS AREA GUIDANCE

FOR HOV LANE IMPLEMENTATION

Douglas A. Skowronek, PE
Research Engineer
Texas Transportation Institute

Stephen E. Ranft
Engineering Research Associate
Texas Transportation Institute

A. Scott Cothron
Associate Transportation Researcher
Texas Transportation Institute

Research Product 7-4961-P1
Project Number 7-4961
Research Project Title:
An Evaluation of Dallas Area HOV Lanes

Sponsored by the
Texas Department of Transportation

In Cooperation with
U.S. Department of Transportation
Federal Highway Administration

ACKNOWLEDGMENTS

The authors wish to acknowledge those personnel who made special contributions to this research. Special thanks are extended to Carlos Lopez who served as Program Coordinator from the Texas Department of Transportation (TxDOT) Austin office and to Stan Hall who served as Project Director from the TxDOT Dallas District. The authors would also like to acknowledge those who served on the Project Monitoring Committee which included: Terry Sams, TxDOT-Dallas, Charles Riou, TxDOT-Austin, James Kratz, TxDOT-Austin, David Bartz, Federal Highway Administration (FHWA)-Austin, Koorosh Olyai, Dallas Area Rapid Transit (DART), and Dan Rocha, North Central Texas Council of Governments (NCTCOG). Additionally, special thanks are extended to Jim Hunt, TxDOT-Dallas, and to Mahesh Kuimil of DART. Finally, Christy Harris and Tammy Pietrucha of the Texas Transportation Institute (TTI) provided valuable support and technical assistance throughout the duration of the project.

DISCLAIMER

The contents of this report reflect the views of the authors, who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the official views or policies of the Texas Department of Transportation (TxDOT). This report does not constitute a standard specification, or regulation, nor is it intended for construction, bidding, or permit purposes. The engineer in charge was Douglas A. Skowronek, P.E. #80683.

Introduction

Recent nationwide debate concerning the success of high-occupancy vehicle (HOV) lanes to reduce congestion has been fueled by negative public sentiment that such lanes are not serving their purpose. Carpooling declined nationally by an average of 30 percent in the past two decades. Yet, on Texas freeway corridors with mature HOV lanes, recent research has shown an increase in carpooling of 100 percent or greater during the same period.

Implementing an HOV lane in a corridor can provide a number of benefits. Some of these benefits include travel-time savings and trip-time reliability for eligible vehicles, increased person throughput, reduced fuel consumption, decreased vehicle emissions, reduced bus operating costs, and increased efficiency for the entire system.

This document provides guidance related to implementation of HOV lanes in the Dallas area. It is based on the results of a three-year research project sponsored by the Texas Department of Transportation to evaluate effectiveness of operating HOV lanes in the Dallas District. Comprehensive reports were prepared at the end of each year documenting the results of the study (1, 2, 3). HOV lanes are currently operating in four corridors in the Dallas area. They include a movable barrier facility on IH-30 (East R. L. Thornton Freeway), two buffer-separated facilities on IH-35E North (Stemmons Freeway) and IH-635 (LBJ Freeway), and a barrier-separated reversible facility on IH-35E South (South R. L. Thornton Freeway). In addition to evaluating the effectiveness through data collection and evaluation, the research attempted to determine the impacts of barrier-separated versus buffer-separated HOV lanes.

Specific guidelines have not been proposed for the two general types of facilities as each corridor presents unique characteristics that require different treatments. Rather, this document identifies the issues to be considered in the major areas of design and operation. The following sections discuss these issues:

1. Stepwise Process for Implementing Dallas Area HOV Lanes
2. Agencies and Groups Involved in Planning and Implementation
3. Implementation Decision: Buffer-Separated versus Barrier-Separated
4. Geometric Design Considerations
5. Applicable Hours of Operation: Buffer-Separated versus Barrier-Separated
6. Applicable Enforcement Techniques: Buffer-Separated versus Barrier-Separated

1. Stepwise Process for Implementing Dallas Area HOV Lanes

When implementing an HOV facility, planners must consider many issues to help facilitate the planning process. Issues to be considered include:

- Identifying appropriate agencies and groups involved,
- Organizing a multi-agency implementation team,
- Reviewing goals and objectives,
- Identifying key stakeholders,
- Developing an overall approach and schedule,
- Scheduling construction and project phasing,
- Planning for public information, outreach, and marketing,
- Bidding and contracting construction,
- Managing traffic during construction,
- Training operating personnel,
- Conducting pre-operational testing of facility equipment, and
- Monitoring and evaluating the implementation process.

The exact process used will depend on the:

- Scope of the effort,
- Type of facility being considered,
- Characteristics of the specific corridor, and
- Institutional relationships.

2. Agencies and Groups Involved in Planning and Implementing

The planning team must define a clear set of objectives and measures of success before it designs the project. Possible objectives could be to enhance bus transit operations, encourage modal shift, or to improve air quality. Numerous agencies and groups will be involved in the planning, design, and operation of the project. The participation and input of these agencies and individuals is key to ensuring that all issues and objectives are met.

Agencies that may be involved in this process, along with their potential type of input will vary with geographic location. For the HOV lanes studied in this project, the agencies and input included:

Texas Department of Transportation-Dallas District
- Project management
- Bid preparation, bid letting, and contracting
- Project phasing
- Managing traffic during construction
- Training operating personnel
- Pre-operational testing
- Public information, marketing, and public relations

Dallas Area Rapid Transit (DART)
- Project management
- Bid preparation, bid letting, and
- contracting
- Project phasing
- Training of bus operating personnel and field staff
- Training of bus support staff
- Training transit police
- Coordination with judicial personnel
- Pre-operational testing
- Public information, marketing, public relations

North Central Texas Council of Governments (NCTCOG)
- Assistance in facilitating meetings and multi-agency coordination
- Assurance that projects were included in necessary planning and programming documents

Federal Highway Administration (FHWA)
- Funding support
- Overall approval of various steps

Texas Department of Public Safety (DPS)
- Training of enforcement personnel
- Coordination with judicial personnel

Judicial System
- Enforcement of fines/penalties for violation of occupancy requirements or operating regulations

EMS, Fire, and other Emergency Personnel
- Training of personnel on response to incidents, accidents, special situations, and major emergencies
- Pre-operational testing of emergency equipment and procedures

Tow Truck Operators
- Training of personnel on procedures for providing assistance with disabled vehicles
- Pre-operational testing of removing disabled vehicles

3. Implementation Decision: Buffer-Separated versus Barrier-Separated

Planning for HOV facilities typically occurs at a regional level as part of the long-range transportation planning process or other region-wide studies. The decision on which type of facility to implement (buffer- or barrier-separated) occurs at the corridor level and must be based on regional and corridor-specific information including quantitative (such as traffic data) and qualitative (such as public perception) data. Details of the specific information should include a variety of different elements such as congestion levels, travel patterns, projected demand, and physical characteristics of the roadway.

This section identifies issues that should be considered for the two types of facilities. The pros and cons of buffer-separated and barrier-separated are listed below.

Buffer-Separated HOV Lanes

Pros:

- Cost of developing and implementing buffer-separated HOV lanes is usually lower.
- Less right-of-way is usually required.
- Lanes can often be implemented faster.

Cons:

- Violation of vehicle-occupancy requirements is more common.
- Travel-time reliability is lower due to the potential for incidents in adjacent general-purpose lane(s).
- Users may have difficulty merging across the general-purpose lanes to enter or exit the HOV lanes.

Barrier-Separated HOV Lanes (Two-way and Reversible)

Pros:

- Enforcement and operation are enhanced with the exclusive facility.
- Separate facility enhances operation environment for buses.
- Available right-of-way may exist in the freeway median to allow for the addition of a reversible lane.
- Reversible lanes may provide a cost-effective approach to add extra capacity during the peak hours in the peak direction of travel.

Cons:

- Right-of-way requirements for a two-way facility are greater and associated costs are higher.
- Cost of barrier used for separation is expensive.
- The capital and operation costs associated with reversible lane access facilities, park-and-ride lots, and other supporting components are expensive.

4. Geometric Design Considerations

Every possible design unique to a specific situation cannot be addressed. However, some of the most frequently encountered design issues such as cross-sections, design speed, and gradients are documented in published reports by the Transportation Research Board (4), the American Association of State Highway and Transportation Officials (5), and the Texas Transportation Institute (6).

This research project identified two additional treatments to be considered and, if possible, included in the design of a proposed HOV lane facility. Researchers found that the location of the endpoint on an HOV lane, as well as the location of the access/egress points on a lane, greatly affected the operational effectiveness of the facility. The following geometric design treatments should be considered when planning a facility.

Endpoint of HOV Lane

- Do not end/terminate an HOV lane in an area of congestion.

- Provide, if possible or feasible, the HOV lane traffic its own travel lane as vehicles exit the facility into the general-purpose lanes, either at an intermediate access point or at the terminus. If providing their own travel lane requires that a general-purpose lane be dropped, it should be dropped as an exit-only lane to a freeway exit ramp at a known location with high exiting volumes. This provides lane balance for the general-purpose lanes immediately before and after the access location.

Access/Egress

- Direct connection ramps are the preferred access type. Other access types require weaving across general-purpose lanes. Therefore, the maximum distance available should be provided between the HOV lane access point and the nearest freeway entrance or exit ramp to safely accommodate weaving vehicles. A minimum of 800 feet per lane change should be available to accomplish the weaving maneuver.

- Intermediate access openings, or merge areas, of 1300 to 1500 feet are desirable (6). These openings should safely accommodate vehicles weaving to and from the HOV lane. The merge area is effectively a Type A weave and the total weaving volume should, if possible, be estimated to determine if a longer opening is required. A large volume of weaving vehicles may require a separate weave lane between the HOV lane and the inside general-purpose lane to minimize operational disruptions

Ë HOV lane access/egress should not be located on a horizontal curve due to sight distance issues. The horizontal sight distance problem is compounded when there is a speed differential between adjacent lanes, as is the case with buffer-separated concurrent-flow HOV lanes. A vertical curve also poses a potential sight distance problem; however, this is not as critical as horizontal sight distance problems.

Ë The preferred location of an HOV lane access/egress is between a freeway exit ramp and entrance ramp configuration. Vehicles undertaking risky maneuvers cause safety implications of the reverse scenario of an entrance ramp and exit ramp configuration. These maneuvers would be recognizable as vehicles making quick lane changes to exit the freeway from the HOV lane or entering the freeway and trying to access the HOV lane within a short linear distance.

5. Applicable Hours of Operation: Buffer-Separated versus Barrier-Separated

Typically, barrier-separated HOV lanes are reversible so that they can serve the peak-direction commuting traffic; thus, they usually cannot operate 24 hours a day. Buffer-separated HOV lanes offer the option to either operate 24 hours a day or during peak periods only so that they can be used as general-purpose lanes or shoulders during specified non-peak hours of the day. Drawbacks of a "part-time" buffer-separated lane can include confusion for commuters, difficult enforcement and incident management, and increased signing needs. The following issues need to be considered when planning the hours of operation for an HOV facility.

Buffer-Separated

24-Hour Operation

- Minimal motorist confusion regarding operating hours
- Travel-time savings and reliability during peak travel period
- Travel-time reliability potential in off-peak hours
- Ongoing enforcement difficult in off-peak hours
- Mandatory lane closures to perform maintenance
- Negative public perception if facility is not well used during the off-peak hours
- Increase in single-occupant violators in off-peak hours if not enforced

Extended Operation Hours

- Travel-time savings and reliability during peak travel period
- Travel-time reliability potential in off-peak hours
- Increased motorist confusion over operating hours
- Increased motorist confusion regarding operational issues of HOV lane
- Negative public perception if facility is not well used during the off-peak hours
- Ongoing enforcement difficult in off-peak hours
- Safety issues

Peak Period-Only Hours

- Travel-time savings and reliability during peak travel period
- Increased motorist confusion over operating hours
- Increased motorist confusion regarding operational issues of HOV lane
- Ongoing enforcement difficult in non-operational hours
- Safety issues

Special Events Hours

- Helps manage traffic during major events
- Provides opportunity to introduce lane to non-users
- Causes difficult enforcement
- Creates potential for confusion in first-time users unaware of operating procedures

Barrier-Separated

24-Hour Operation

Ë Minimal motorist confusion regarding operating hours
Ë Travel-time savings and reliability during peak travel period
Ë Travel-time reliability potential in off-peak hours
Ë No allowance for reversal of HOV lane direction
Ë Mandatory lane closures to perform maintenance
Ë Ongoing enforcement difficult in off-peak hours
Ë Negative public perception if facility is not well used during the off-peak hours
Ë Limitation of only one direction of travel for 24-hour operation or required two-lane bi-directional operation at substantial cost

Extended Operation Hours

Ë Travel-time savings and reliability during peak travel period
Ë Travel-time reliability potential in off-peak hours
Ë Time available for reversing HOV lane travel direction
Ë Time available for minor maintenance of facility
Ë Operating hours easily posted
Ë Easier enforcement
Ë Negative public perception if facility is not well used during the off-peak hours

Peak Period-Only Hours

Ë Travel-time savings and reliability during peak travel period
Ë Time available for reversing HOV lane travel direction
Ë Time available for maintenance of facility
Ë Operating hours easily posted
Ë Easier enforcement

Special Events Hours

Ë Helps manage traffic during major events
Ë Easier enforcement
Ë Provides opportunity to introduce lane to non-users
Ë Creates potential for confusion in first-time users unaware of operating procedures

6. Applicable Enforcement Techniques: Buffer-Separated versus Barrier-Separated

Several different types of enforcement techniques can be used to monitor HOV lanes. The most common methods include:

- *Stationary enforcement*, which includes the assignment of personnel to specific locations along the facility
- *Roving enforcement,* where vehicles constantly patrol the length of the facility
- *Team patrols,* which are a combination of stationary and roving enforcement working in unison
- *Self-enforcement,* which is a motorist-based program to report violators

Advantages and disadvantages for each method of enforcement based on the type of HOV facility are identified and listed below:

Buffer-Separated

Stationary Enforcement Patrols

- Must provide adequate enforcement areas along HOV lane limits
- Enforcement provided by patrol cars, motorcycles, and other vehicle types
- Greater visibility for enforcement
- May use advanced technology for monitoring
- Violators able to egress from the HOV lane to avoid enforcement areas
- Limited number of enforcement locations
- Safety issues

Roving Enforcement Patrols

- May rove in HOV lane or on adjacent general-purpose lane
- Enforcement provided by patrol cars and/or motorcycles
- Safety issues
- Difficult to use advanced technology for monitoring

Team Patrols

- Greater visibility for enforcement
- May utilize advanced technology for monitoring
- Violators able to egress from the HOV lane to avoid enforcement areas
- Limited number of enforcement locations
- Safety issues

Self-Enforcement

- Allows public to be involved
- May reduce dependency on other enforcement strategies
- Not a stand-alone enforcement technique
- Requires legislation to enact

Barrier-Separated

Stationary Enforcement Patrols

Ë Must provide enforcement areas at beginning and end of HOV lane
Ë Enforcement provided by patrol cars, motorcycles, and other vehicle types
Ë Barrier may provide more protection to enforcement officers
Ë Violators unable to egress from the HOV lane to avoid enforcement areas
Ë Greater visibility for enforcement
Ë May use advanced technology for monitoring
Ë Design may require more access breaks in barrier

Roving Enforcement Patrols

Ë Enforcement provided by patrol cars and/or motorcycles
Ë Difficult to enforce by roving patrols in adjacent general-purpose lanes
Ë Difficult to use advanced technology for monitoring

Team Patrols

Ë Greater visibility for enforcement
Ë May use advanced technology for monitoring
Ë Requires more enforcement personnel
Ë May require more access breaks in barrier

Self-Enforcement

Ë Allows the public to be involved
Ë May reduce dependency on other enforcement strategies
Ë Not a stand-alone enforcement technique
Ë Requires legislation to enact

References

1. D.A. Skowronek, S.E. Ranft, A.S. Cothron, *An Evaluation of Dallas Area HOV Lanes, Year 2000,* Research Report 4961-2, Texas Transportation Institute, The Texas A&M University System, College Station, TX, 2002.

2. D.A. Skowronek, S.E. Ranft, A.S. Cothron, *An Evaluation of Dallas Area HOV Lanes, Year 2001,* Research Report 4961-4, Texas Transportation Institute, The Texas A&M University System, College Station, TX, 2002.

3. D.A. Skowronek, S.E. Ranft, A.S. Cothron, *An Evaluation of Dallas Area HOV Lanes, Year 2002,* Research Report 4961-6, Texas Transportation Institute, The Texas A&M University System, College Station, TX, 2002.

4. *HOV Systems Manual*, NCHRP Report 414, Transportation Research Board, Washington, DC, 1998.

5. *Guide for the Design of High-Occupancy Vehicle Facilities*, American Association of State Highway and Transportation Officials, Washington, DC, 1992.

6. W.L. Eisele, et. al., *Guidance for Planning, Operating, and Designing Managed Lane Facilities in Texas,* Research Report 4161-1, Texas Transportation Institute, The Texas A&M University System, College Station, TX, 2001.