



Project Summary Report 4161-S
Project O-4161: Entry-Exit and Intersection Design Criteria
for Barrier-Separated HOV Facilities

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Guidance for Managed Lane Facilities in Texas

High-occupancy vehicle (HOV) lanes provide a mobility option on congested corridors for eligible vehicles in many large metropolitan areas. In recent years, the Texas Department of Transportation (TxDOT) has shown increased interest in revisiting the definition of HOV lanes to ensure that it provides the flexibility for changes in eligibility or variable pricing strategies. To reflect this flexibility, the term “managed lane” is increasingly replacing “HOV lane” terminology at TxDOT. As part of another ongoing TxDOT research project (0-4160), TxDOT developed the following official definition of a managed lane: “A managed lane facility is one that increases the freeway efficiency by packaging various operational and design actions. Lane management operations may be adjusted at any time to better match regional goals.” Based upon this definition, managed lanes include HOV lanes, truck lanes, toll highways, priced lanes, single-occupant vehicle (SOV) express lanes, or any combination of these strategies.

The objective of this project (0-4161) was to provide preliminary guidance for planning, operating, and designing managed lane facilities in Texas. The information provided in this project is intended to be used as

both an introduction to the managed lane concept and to provide preliminary design guidance. TxDOT Project 0-4160, “Operating Freeways with Managed Lanes,” is a multi-year project that has the objective of investigating the complex and interrelated issues surrounding the safe and efficient operation of managed lanes. A managed lanes manual is to be developed to help TxDOT make informed planning, design, and operational decisions when considering managed lane facilities. The preliminary guidance provided in this project (0-4161) will provide a solid knowledge base for that multi-year project (0-4160).

What We Did . . .

The benefits of HOV facilities in Dallas and Houston are well documented. However, TxDOT does not have a set of guidelines for use in the development of managed lane facilities.

Researchers drew from the experiences of leading states in the development of HOV and managed lanes throughout the country to develop a synthesis of guidelines. This information is summarized in TxDOT Report 4161-1: “Preliminary Guidance for Planning, Operating, and Designing Managed Lane Facilities in Texas.” Photographs and schematics are included



Figure 1. Flyover access ramp to barrier-separated reversible HOV facility on I45 (North Freeway) in Houston, Texas



throughout the report to illustrate the elements discussed in the text. The photographs include experiences and examples from across the country; they also include current photographs of Texas facilities.

Figure 1 illustrates a flyover access ramp to the barrier-separated reversible HOV facility along I45 North (North Freeway) in Houston. Figure 2 shows the 24-hour limited access concurrent flow lanes along I635 (LBJ Freeway) in Dallas.

Additionally, this synthesis of guidelines was outlined for inclusion in the on-line version of TxDOT's *Roadway Design Manual*. This new section of the *Design Manual* will focus on design aspects of managed lane facilities, and the topics will be linked to various aspects of managed lane development as presented in Report 4161-1.



Figure 2. Limited access concurrent flow lanes along I635 (LBJ Freeway) in Dallas, Texas

What We Found . . .

Significant portions of Report 4161-1 are based upon the National Cooperative Highway Research Program (NCHRP) *Report 414—HOV Systems Manual*, and this information is applied to the design of managed lane facilities in Texas. The *HOV Systems Manual* provides the most recent and comprehensive summary of all aspects of HOV facility planning, operation, design, enforcement, and implementation as well as equally critical elements of marketing, support facilities (e.g., transit stations), and support programs. It provides a useful foundation for managed lane project guidelines. Design manuals from other states were also used to provide design criteria and practices that are relevant to Texas. Chapters included in Report 4161-1 are summarized in the following paragraphs.

- **Planning.** Multiple agencies and groups are involved in the process of planning managed lane facilities. Report 4161-1 provides a general overview of the planning process, including regional,

corridor, and facility-level planning. The roles and responsibilities of various agencies are discussed, with a particular emphasis on the transit element of planning. Public involvement, general-purpose lane conversion, priority pricing, commercial vehicle use, and environmental issues are also discussed.

- **Operations.** Report 4161-1 discusses operations alternatives, ingress and egress alternatives, vehicle eligibility and vehicle occupancy requirements, transit and support services and facilities, hours of operation, enforcement, incident management, and special operating considerations for managed lane facilities.
- **Design.** The design process is the main focus of Report 4161-1. The basic elements of design are discussed, including geometric characteristics and appropriate design values, cross sections, ingress and egress types and location, enforcement area design,

and other special features. The most frequently encountered design issues are addressed, and the critical link between design and operations is discussed.

- **Signs and Pavement Markings.** Signing and pavement markings for managed lanes should provide information in a clear and consistent manner. The *Manual on Uniform Traffic Control Devices (MUTCD) 2000* includes revised sections on preferential lane markings that address HOV signing and pavement markings. These sections and photographs of existing signs are included in Report 4161-1.
- **Additional Research Needs.** Report 4161-1 also summarizes additional research needs identified through this project, from information in the *HOV Systems Manual*, and by the Transportation Research Board's HOV Systems Committee.

Report 4161-1 emphasizes that it is critical to consider the design and



operation of a managed lane facility simultaneously and that operational treatments are based upon the design of the managed lane facility. Figure 3 shows the link between design and operations necessary to ensure an effective managed lanes project. Right-of-way, funding, and other constraints will normally dictate the extent of design that is possible. Therefore, the design component is shown on the bottom of each set of designs as the foundation of the managed lane facility. The extent of operations necessary to make up the difference is shown at the top. A full design requires fewer operational treatments.

Table 1 lists examples of the operational treatments needed for full and reduced designs on a managed lane. When a full design is used, minimal enforcement is needed: surveillance and detection of incidents on the managed lane facility can be performed by visual inspection, calls from motorists using cellular telephones, and reports from roadside call boxes or commercial traffic reporters. With a full design,

flow metering may not be required, and a consistent speed limit can be provided. When a reduced design is used, there may be a need for more extensive technologies and advanced transportation management systems (ATMS) or integrated transportation management systems (ITMS), in addition to visual inspection reports from motorists and commercial traffic reporters for incident detection. Special or dedicated tow trucks may also be needed to ensure the ability to properly clear incidents. Reduced cross sections included in Report 4161-1 are footnoted with the text “operational treatments should be incorporated if reduced design cross sections are used” to remind the designer of the importance of considering related operational treatments for a given design.

The Researchers Recommend . . .

The researchers recommend that TxDOT planners and designers use the guidelines in Report 4161-1

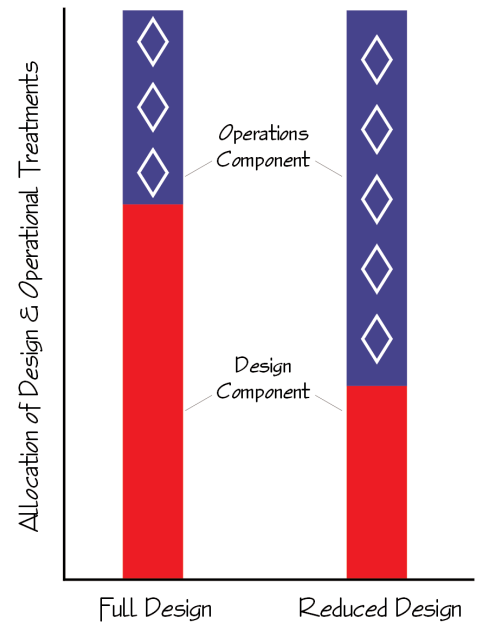


Figure 3. Balance between design and operations for managed lane facility development

when planning, operating, or designing a managed lane facility. Decision makers and representatives of other agencies can also use the report as a source of information and for guidance in making decisions.

The researchers emphasize that the link between the design and operation of managed lane facilities must be carefully considered for both full and reduced designs. When a reduced design is constructed, additional operational elements such as significant enforcement, entry ramp metering, and reduced speed limits at constricted points may be required.

Finally, the researchers recommend that continuing research is needed to address the current issues associated with managed lanes. Report 4161-1 describes these additional research needs.

Table 1. Operational treatments needed for full and reduced design (adapted from NCHRP 414)

Level of Design	Level of Operational Treatments	Example of Operational Treatments
Full	Low	Minimal enforcement
		Visual detection by police, bus operators, motorist assistance patrols, or agency personnel
		Calls from motorists using cellular telephones
		Reports from roadside call boxes
		Information from commercial traffic reporters
		Flow metering may not be required
Reduced	High	Consistent speed limit
		Items noted above for full design
		Automatic vehicle identification (AVI) or inductance loop detectors for vehicle detection
		Closed-circuit television cameras
		Full advanced transportation management systems (ATMS) or integrated transportation management systems (ITMS)
		Dedicated tow trucks with limited turning radius for narrow managed lane width
		Changeable message signs (CMS)
		Entry ramp metering
		Significant enforcement effort
		Lower speed limits at constricted points



For More Details . . .

The research is documented in Report 4161-1, *Guidance for Planning, Operating, and Designing Managed Lane Facilities in Texas*

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To obtain copies of the report, contact Dolores Hott, Texas Transportation Institute, Information & Technology Exchange Center, (979) 845-4853, or e-mail d-hott@tamu.edu. See our on-line catalog at <http://tti.tamu.edu>.

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The research will be used by TxDOT engineers as preliminary guidance for planning, operating, and designing managed lane facilities in Texas. It is envisioned that the TxDOT Roadway Design Manual will be linked to pertinent sections in the research report to create statewide access for use in implementation.

For more information, please contact Bill Knowles, P.E., RTI Research Engineer at (512) 465-7648 or e-mail wknowle@dot.state.tx.us.

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