Technical Report Documentation Page

1. Report No. FHWA/TX-01/1832-S	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle DEFINING SPECIAL-USE LANES		5. Report Date December 1999
		6. Performing Organization Code
7. Author(s) Pamela Murray, Hani S. Mahmassani, and Susan Handy		8. Performing Organization Report No. 1832-S
9. Performing Organization Name and Address Center for Transportation Research The University of Texas at Austin 3208 Red River, Suite 200 Austin, TX 78705-2650		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. 0-1832
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Transfer Section/Construction Division P.O. Box 5080 Austin, TX 78763-5080		13. Type of Report and Period Covered Project Summary Report (9/1/98 — 8/31/99)
		14. Sponsoring Agency Code

15. Supplementary Notes

Project conducted in cooperation with the U. S. Department of Transportation, Federal Highway Administration, and the Texas Department of Transportation.

16. Abstract

This project assessed the feasibility of high-occupancy vehicle (HOV) and high-occupancy vehicle/toll (HOT) facilities. In the first report of this project, current operational facilities were described and guidelines for the operation, design, agency involvement, and monitoring of freeway and arterial HOV lanes were provided. The operational effectiveness of selected configurations was assessed using a specially modified dynamic traffic assignment methodology in combination with a stochastic mode choice model. Computer simulation experiments were conducted using a corridor network in Fort Worth, Texas, as a test bed. The goal of the experiment was to examine the effect of five variables on the average trip time of a network with an HOV/HOT facility. These variables include lane usage and access point restrictions, vehicle eligibility, demand levels, price, and attractiveness of carpooling. The results of the research indicate that there is no one combination of lane usage and access points that consistently out-performs the others under different demand, price, and carpooling attractiveness scenarios. However, because pricing, in combination with HOV facilities, provides greater flexibility in lane utilization under varying demand scenarios, it could be an effective tool for managing congested network corridors.

17. Key Words Special- use lanes, high-occupancy vehicle (HOV), and high-occupancy vehicle/toll (HOT)		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.	
19. Security Classif. (of report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of pages 18	22. Price

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DEFINING SPECIAL-USE LANES

by

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Project Summary Report Number 1832-S

Research Project 0-1832
Defining Special-Use Lanes

Conducted for the

TEXAS DEPARTMENT OF TRANSPORTATION

in cooperation with the

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

by the

CENTER FOR TRANSPORTATION RESEARCH
Bureau of Engineering Research

THE UNIVERSITY OF TEXAS AT AUSTIN

December 1999

IMPLEMENTATION RECOMMENDATIONS

In light of the findings of this research, and based on the authors' synthesis of formal and informal experiences with high-occupancy vehicle (HOV) and high-occupancy vehicle/toll (HOT) facilities, the following implementation recommendations should be considered in the design of special-use facilities:

1. Pricing allows flexibility of roadway usage. Special-use lanes do not have to be restricted to high-occupancy vehicles at all times. Charging single occupant vehicles fees that vary with the time of the day in order to use the extra capacity is a viable way to manage roadway utilization.
2. Although certain network configurations might not perform effectively when only available to HOV's, performance could be improved through pricing.
3. Experience to date with HOT lanes has shown that they can work. The I-15 congestion pricing project in San Diego, California is a leading example.
4. Creating HOV or HOT lanes with access granted only at the end points, essentially express lanes, appears to be the "safest" option, in terms of access point locations, for reducing the average network trip times. More generally, limiting the access points provides greater ability to retain the operational advantages of the restricted-use lanes.
5. Adding capacity to the freeway does not always reduce the average trip times for the system. The benefits of adding lanes may be localized and the construction costs and time costs to the entire system should be carefully considered.
6. Determining the fee that would establish a balance between user cost and roadway utilization requires constant monitoring of the congestion levels and adjustments to the price throughout the day. Project 0-1832 has demonstrated a methodology in the form of a computer program that can be used for this purpose.
7. Public reaction to, and public use of HOV and HOT lanes is of primary importance to the success of the facility. Experience and behavioral studies have shown that public reaction is considerably more favorable when the special-use lane designation applies to an entirely new capacity lane (rather than to existing lanes).
8. It is recommended that several alternative special-use lane configurations and operational strategies be carefully evaluated prior to implementation. This research demonstrated recent dynamic traffic assignment-simulation methodologies are available for this purpose.

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ACKNOWLEDGMENTS

The authors acknowledge the support of TxDOT Program Coordinator Al Kosik. The authors also acknowledge the support and assistance of Ahmed Abdelghany.

Research performed in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

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DEFINING SPECIAL-USE LANES: PROJECT SUMMARY REPORT

Urban congestion can result in traffic delays and in air pollution. In continuing attempts to address urban congestion, transportation agencies have found that physical space for road construction is scarce and that the costs of building more freeways and arterial streets are high, thus discouraging the use of conventional supply-side strategies to alleviate traffic congestion problems. Consequently, transportation agencies are considering operational strategies that will improve the efficiency of existing facilities. Efficiency can be improved, for example, by increasing the person-throughput of the facility, a task accomplished by increasing the average vehicle occupancy. Transit use and carpooling, two methods that can be deployed to increase average vehicle occupancy, can be encouraged through the provision of special-use lanes. Special-use lanes, for the purposes of this research, refer to high-occupancy vehicle (HOV) and high-occupancy/toll (HOT) lanes.

Although a variety of high-occupancy vehicle facilities are in operation across the United States, as of yet there are no standard designs and no operation plans that will guarantee the success of an HOV lane. Within this context, a synthesis of findings and experiences from the current HOV facilities would be helpful in considering new HOV facilities. Various aspects of this concept, including public acceptance, social equity, operation and design issues, and enforcement need to be considered. Unfortunately, the relevant information has been scattered.

Thus, the goal of this work was to assimilate the rather disjointed information regarding existing special-use lanes in the United States. The case studies investigated focused on such operational issues as access points, hours of operation, enforcement provisions, safety, vehicle eligibility, and vehicle-occupancy requirements. This assimilation of information was complemented by carefully designed computer simulation experiments undertaken in developing guidelines for the operation, design, and effective institutional arrangements of special-use lanes.

An extensive literature search, conducted to examine current special-use facilities, is included in this project's research report (Report 1832-1). In that search, the researchers found that, although there have been attempts to accumulate information on special-use lanes deployed around the country, a complete summary is not available. At the same time, the researchers found that several new technological and operational concepts have emerged in the past few years that have considerable potential for successful application. The availability of such material will make decisions relating to special-use lanes easier to present to the public. Information on traveler behavior and characteristics, the political situation, land use, and congestion levels should be acquired along with information relating to safety and construction. A vast amount of the literature appears to be focused on evaluating HOV facilities — particularly those in Houston, Texas — in a positive manner. Stockton et al. (1997) concluded that the HOV lanes on the Katy, North, Northwest, Southwest, and East

RLT Freeways in Texas are successful facilities. In terms of HOT facilities, Kazimi, Supernak, and Koesoemawiria (1998) determined that the I-15 congestion pricing project in San Diego, California, has been fairly successful. Nonetheless, the results of studies undertaken from around the country appear to have limitations that hinder their general applicability.

Realizing the shortcomings of the available literature, the research team conducted computer simulation experiments to investigate various scenarios. Some of the aspects identified in the case studies — for example, lane utilization, accessibility, access restrictions, pricing, demand pattern and mode split — were explored using the dynamic traffic assignment software DYNASMART. The network used for this experiment was based on the south-central corridor in the Fort Worth, Texas, area. Both HOV and HOT lanes were considered with the same lane configurations. For the HOT lanes, tolls were assumed to be collected electronically, and it was assumed that such collection had no influence on the freeway travel speeds.

The companion project report (Report 1832-1) contains a detailed description of the experimental design and analysis of average trip times with regard to demand, carpooling attractiveness, pricing, lane utilization, access points, and vehicle eligibility. A summary of the findings is provided below:

1. *Demand.* The total number of vehicles generated has little effect on the percentages of SOVs (single-occupant vehicles) and HOVs using the HOT facility that has the special lanes in their travel paths. As anticipated, the average travel time increases with total demand.
2. *Carpooling Attractiveness.* The constant for the shared ride mode utility function was allowed to take on two values in this experiment. The original value was –2.169, and the other value was –1.5. The negative values indicate that for all contributing characteristics of the traveler and the mode, with the exception of sensitivity to generalized cost, the drive-alone mode is preferred to carpooling. The –1.5 indicates a greater affinity for the shared ride mode than does the –2.169. This variation in the utility function allowed for different average trip times for all of the networks, with the exception of the original network. Neither value of the constant provides a lower average trip time for all networks.
3. *Pricing.* The fees charged can have a significant impact on the types of vehicles using the HOT lanes. The higher the charge, the lower the number of SOVs using the roadway. The additional space on the facility, abandoned by the SOVs, becomes available for HOV usage; therefore, as price increases, SOV usage should decrease while HOV usage increases. This was found to be the case, as shown in a representative graph in Figure 1. Pricing can also have an important impact on the average speeds experienced along a freeway. Figures 2 and 3 show two examples of the average speeds found on Network 1 in the northbound direction.

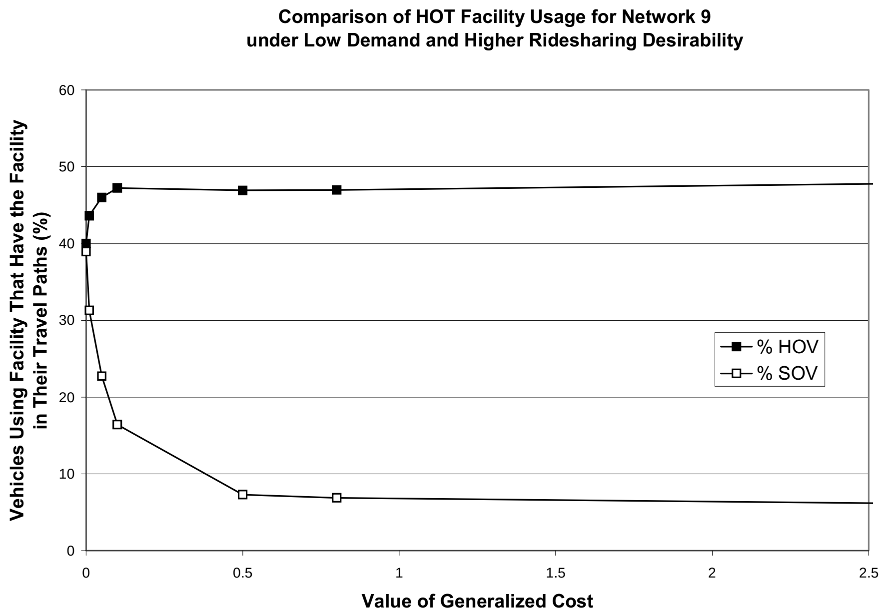

Figure 1. Facility Usage by HOVs and SOVs That Have a HOT Facility in Their Travel Paths

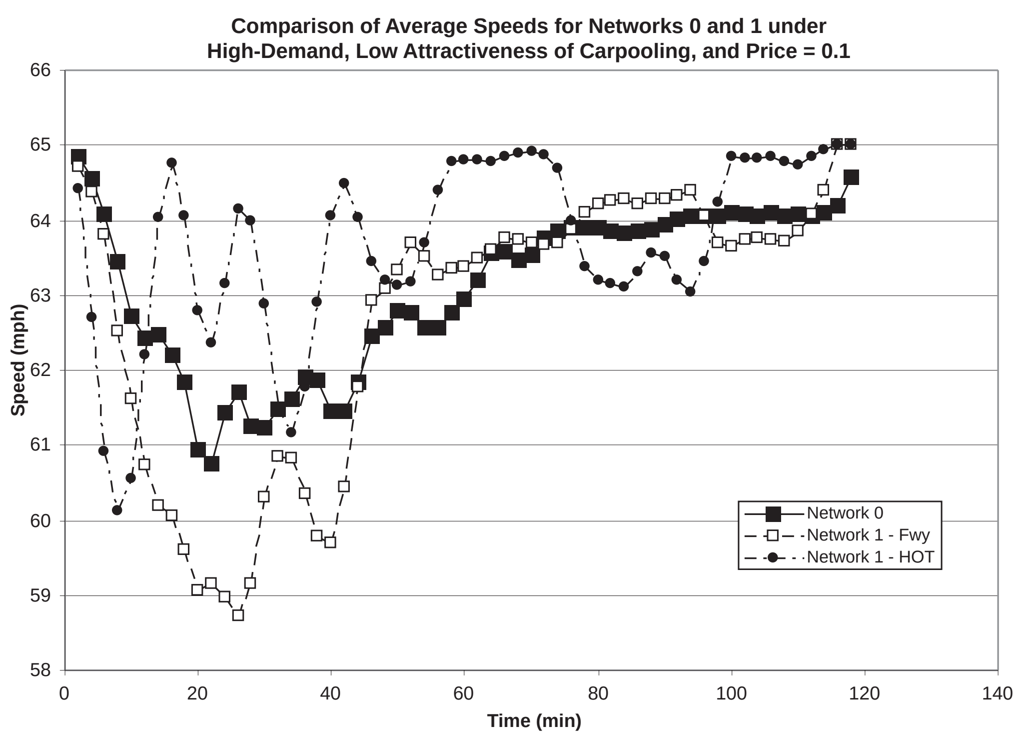

Figure 2. Comparison of Average Speeds for the Northbound Direction under Medium Pricing

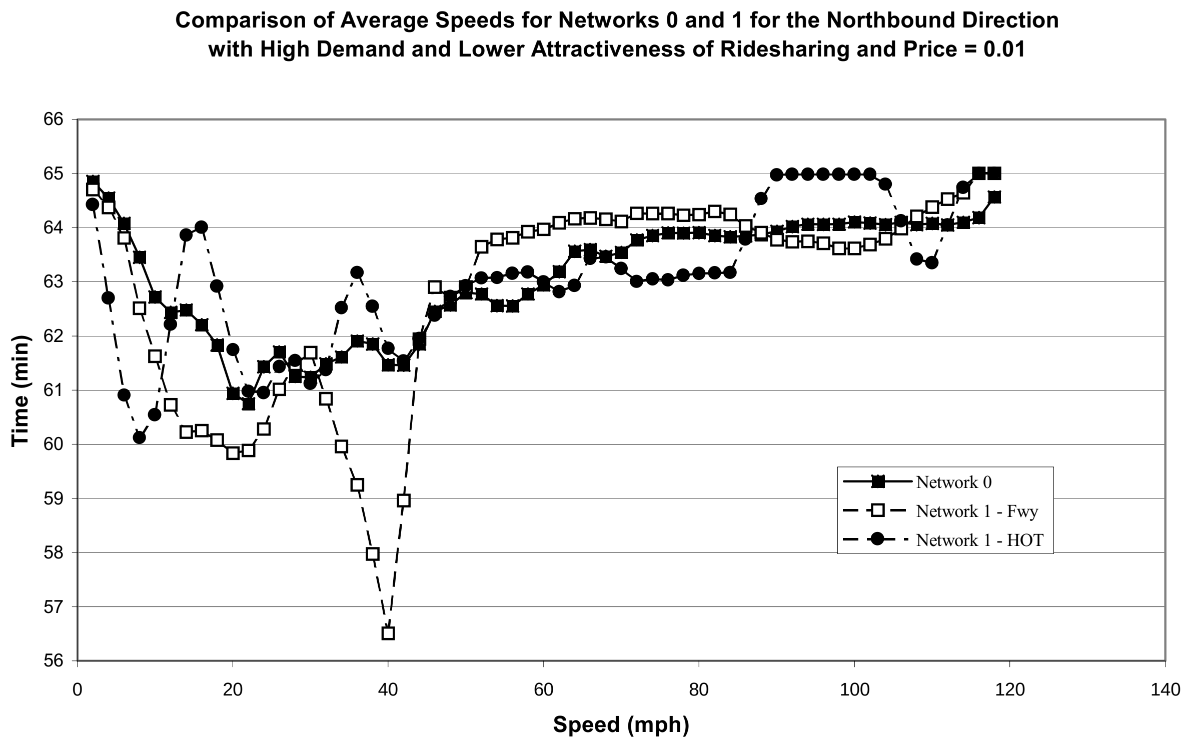

Figure 3. Comparison of Average Speeds for the Northbound Direction under Low Pricing

As can be seen from Figure 2, except for the initial 15 minutes, either the three freeway main lanes of Network 1 or the HOT lane operates at speeds higher than those of four freeway lanes of Network 0. An important observation is that the HOT lane typically operates at a speed higher than that of the general-purpose lanes of Network 1; this observation is important because, for special facilities to be successful, they should offer improved conditions. This situation would be even more significant if the demand were higher, which would result in greater congestion and lower speeds on the freeway. Figure 3 demonstrates results similar to those in Figure 2. Comparing Figures 2 and 3 suggests that the higher pricing leads to a smoother evolution of average freeway speeds for Network 1.

4. *Lane Utilization, Access Points, and Vehicle Eligibility*. There is no one lane and access point configuration that will perform the best under all conditions. The demand structures used here prevented certain types of HOV/HOT facilities from being successful. There was not enough of a sufficient directional split to allow contra-flow facilities to be considered. The reversible facilities did not reduce the average trip times to the extent that other configurations did. Providing direct access ramps has the benefit of allowing HOT lane users to avoid merging from the freeway main lanes. These ramps also allow users to bypass the freeway ramps, which may become congested.

Table 1 summarizes the network and pricing treatments that were successful for the experimental scenarios. Under low demand, almost any configuration will provide shorter average trip times. To the system as a whole, smaller numbers of access points tend to be more beneficial than continuous access. In the low demand case, the provision of additional roadway capacity always resulted in improved performance in the network consideration. Such improved performance was not found, however, in cases of higher demand levels. When the volumes are higher, the traffic must be managed. One way to guide traffic is by charging a fee to low-occupancy vehicles. To charge this toll, electronic toll collectors will have to be placed at entrance/exit-ways. The number of points at which the vehicles may access/exit the facility will determine the number of collectors needed. The access point configuration could also act a management tool. If the facility is not convenient for certain trips, people will not use it for that specific purpose.

Careful analysis must be performed for each individual situation where special-use lanes are considered. The lack of a high directional split prohibits contra-flow and reversible HOV/HOT facilities from being the optimal use of the roadway. The characteristics of the roadway users should be obtained to determine sensitivity to cost and inherent utilities associated with each mode. Overall roadway demand also plays a key role in outlining the scenario. Once a scenario description has been obtained, Table 1 can provide a useful guide by which to respond to the issues of access, adding capacity, pricing levels, and to determine whether the HOV-only facility may be successful.

Table 1. Summary of Successful Strategies for Various Scenarios

Scenario Description	Access Points	Add Capacity	Pricing	HOV only
Low demand, higher ridesharing attractiveness	Any	Okay for either HOV or HOT	Any	Yes
Medium demand, higher ridesharing attractiveness	Endpoints only or same as freeway	Okay for HOV only, not if pricing	Any	Yes
High demand, higher ridesharing attractiveness	Endpoints only	No	Any	Yes
Low demand, lower ridesharing attractiveness	Any	Okay for either HOV or HOT	Any	Yes
Medium demand, lower ridesharing attractiveness	Endpoints only or same as freeway	Okay for either HOV or HOT	Any	Yes
High demand, lower ridesharing attractiveness	Endpoints only	No	Any	Yes

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