U.S. Department of Transportation
Federal Highway Administration

10TH
International Conference on
High-Occupancy Vehicle Systems

Compendium of Technical Papers

August 27-30, 2000
Dallas, Texas

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA-OP-01-041		

4. Title and Subtitle 10th International Conference on High-Occupancy Vehicle Systems: Compendium of Technical Papers	5. Report Date May 2001
	6. Performing Organization Code
7. Author(s) Katherine F. Turnbull	8. Performing Organization Report No. Report
9. Performing Organization Name and Address Texas Transportation Institute The Texas A&M University System College Station, TX 77843-3135	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DTFH61-96-6-000048-PB-F9902
12. Sponsoring Agency Name and Address Operations Office of Travel Management Federal Highway Administration 400 Seventh Street, S.W., HEP-40 Washington, D.C. 20590	13. Type of Report and Period Covered Research: May 2001
	14. Sponsoring Agency Code

15. Supplementary Notes
Jon Obenberger, Highway Operations, Office of Traffic Management, Contracting Officers Technical Representative (COTR)

16. Abstract

This report provides the technical papers submitted as part of the 10th International High-Occupancy Vehicle (HOV) Systems Conference held in Dallas, Texas on August 27-30, 2000. The Conference was sponsored by the Transportation Research Board (TRB), in cooperation with the Federal Highway Administration (FHWA) and the Federal Transit Administration (FTA). Dallas Area Rapid Transit (DART), the Texas Department of Transportation (TxDOT), and the North Central Texas Council of Governments (NCTCOG) were conference hosts.

The ten papers cover a variety of topics including value pricing, air quality, and monitoring and evaluating specific HOV projects. Papers on HOV facilities in Brisbane, Australia and the Netherlands are also included.

The proceedings from the Conference are provided in a separate report, *10th International HOV Systems Conference: Conference Proceedings*..

17. Key Word	18. Distribution Statement
High-occupancy vehicles lanes, HOV lanes, HOV systems, High-Occupancy Toll lanes, HOT lanes, value pricing.	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Table of Contents

HOV Lane Evaluation and Monitoring and the Political Process in Washington State

Paper for the 10th International HOV Conference in Dallas, Texas August 28-30, 2000

by Eldon L. Jacobson
August 25, 2000
Washington State Department of Transportation
1107 NE 45th Street, Suite 535
Seattle, WA 98105-4631
voice (206) 685-3187
e-mail: eldon@u.washington.edu

Disclaimer

Table of Contents

List of Tables

Abstract

The high occupancy vehicle (HOV) system in the Seattle, Washington, area comprises 306 kilometers (191 miles) of freeway HOV lanes open to traffic. The Washington State Department of Transportation (WSDOT) operates this freeway HOV system. The effectiveness of the HOV system is under constant and increasing public scrutiny (especially when the state legislature is in session). To avoid legislation that prescribes how to operate the HOV system, WSDOT has voluntarily made some modifications in HOV system operation.

WSDOT has developed statewide policy that covers HOV operation. The Puget Sound Regional Council, the local metropolitan planning organization, convened an HOV Policy Committee to review the entire WSDOT HOV lane operating policies. The Committee suggested some changes to the statewide policy to make it more appropriate locally.

The WSDOT Office of Urban Mobility (OUM) helps coordinate contacts with the state legislature. OUM also assembles an annual legislative packet about HOV issues that is distributed to every legislator.

To provide data about the effectiveness of the system, an HOV lane evaluation and monitoring project has been ongoing for over 10 years. This monitoring project routinely collects vehicle occupancy and travel time data. The project also includes an extensive public opinion survey and collection of HOV violation and safety information. Funding for the monitoring project has varied in response to management priorities.

The project's annual report combines various data into five primary measures of effectiveness: vehicle volumes, person volume, average vehicle occupancy, speed and trip reliability, and travel time. Three secondary measures of effectiveness are HOV violations, safety, and public opinion. The data are being put onto the Internet in an interactive format that will allow analysts to easily select the specific data they desire. The annual report is available by hard copy or on the Internet.

Enforcement of and education about the HOV lanes are ongoing. The Washington State Patrol writes tickets to motorists observed violating the HOV lane occupancy restriction. The HERO program is a service that encourages motorists to voluntarily report HOV violators by calling (206) 764-HERO. The HERO program is primarily an educational effort that is a vital part of enforcement. The number of reported violations has increased steadily since 1993, with the total annual number of reported violators now exceeding 40,000.

Operational Changes and the Political Process

The high occupancy vehicle (HOV) system in the Seattle, Washington, area comprises 306 kilometers (191 miles) of freeway HOV lanes open to traffic. The Washington State Department of Transportation (WSDOT) operates this freeway HOV system. The effectiveness of the HOV system is under constant and increasing public scrutiny (especially when the state legislature is in session). To avoid legislation that prescribes how to operate the HOV system, WSDOT has voluntarily made some modifications in HOV system operation.

Early 1990s

The legislature in 1991 sent to the Governor for signature a law requiring WSDOT to change from a 3+ person HOV lane requirement to a 2+ person requirement. The Governor decided to line-item veto that portion of the legislation, with the understanding that WSDOT would do a demonstration project of the concept on one HOV lane segment. The 6-month demonstration project was mostly successful,[1] and so the remaining freeway HOV lanes were "voluntarily" converted to 2+-person requirement (with one exception on highway 520 due to poor geometry and safety concerns).

The legislature for the following years mostly stayed out of regulating the operation of the freeway HOV lane system.

As the 90s drew to a close, traffic congestion was gradually increasing every year in the greater Seattle area. The only major new roadway capacity project during the 1990s was the addition of HOV lanes. Virtually no money was spent on general purpose freeway lanes. While most HOV lanes avoid the empty-lane syndrome during the peak commute periods, the lanes do encounter the empty-lane syndrome during off-peak periods (though the general purpose lanes are usually flowing at the speed limit or higher during these times).

The increasing frustration with traffic congestion has led to a gradual increase in the political forces opposed to HOV lanes. The 2000 legislative session was especially interesting because of the many forces pushing for changes to the HOV system.

2000 Legislative Session

During the 2000 legislative session (January to June, 2000) various vocal forces, both public and private, pushed for eliminating various HOV lane restrictions. One person, Tim Eyman, started to push an initiative that eliminated the HOV lanes (Washington State allows the public initiative process). Some public agencies proposed changing the existing 24 hour HOV lane operation to peak period only. To help defend its position with real numbers, WSDOT funded the collection of some weekend occupancy data. See the data section of this report for a summary of the weekend data.

Amazingly, all the proposals died. Tim Eyman revised his initiative by dropping the HOV portion. The Transportation Commission studied and ultimately rejected part-time HOV lane operation.

The HOV Policy committee of the Puget Sound Regional Council (the local MPO) extensively studied HOV lane policy from 1998 into 1999. The HOV Policy committee helped provide local agency support for the WSDOT HOV lane operational policies.

[1] *I-5 North High-Occupancy Vehicle Lane 2+ Occupancy Requirement Demonstration Evaluation*, February 1992, prepared for the Washington State Department of Transportation by the Washington State Transportation Center, University of Washington and Texas Transportation Institute, Texas A & M University

Every month during the legislative session there were a number of HOV lane articles and editorials published in Seattle area newspapers. Here is a chronology of some of the headlines:

January 14, 2000: Motorcyclists' advice: Don't mess with those HOV lanes[2]

January 25, 2000: The hidden crusade for car-pool lanes[3]

February 6, 2000: Congestion just gets worse while area lanes run empty[4]

February 6, 2000: The lanes are doing what they're supposed to do[5]

February 10, 2000: Heavy political traffic crowds the HOV lanes[6]

February 11, 2000: Commuters should reject the 4 percent red herring[7]

March 7, 2000: HOV lanes won't open up despite council vote[8]

March 14, 2000: Locke: Open car-pool lanes on weekends[9]

March 15, 2000: Washington State Transportation Commission will examine opening up HOV lanes on weekends[10]

April 6, 2000: HOV lanes for SOVs move fewer people[11]

April 15, 2000: HOV lanes are a critical solution to congestion[12]

April 21, 2000: Traffic panel rejects the opening up of HOV lanes[13]

May 9, 2000: Eyman drops HOV lane battle, focus goes back to road building[14]

May 18, 2000: State HOV lanes to stay that way, panel decides[15]

June 8, 2000: HOV lane wins county approval[16]

August 17, 2000: HOV lane receives backing by state[17]

August 19, 2000: Nobody nixed (part-time) HOV[18]

Responding to public questions

[2] by Dionne Searcey, Seattle Times Olympia bureau, January 14, 2000
[3] Eastside Journal, Opinion, January 25, 2000
[4] Tacoma NewsTribune, Guest opinion (Open), Washington State Senator Dino Rossi, February 6, 2000
[5] Tacoma NewsTribune, Guest opinion (Shut), Mark Hallenbeck, February 6, 2000
[6] Editorial, Seattle Times, February 10, 2000
[7] Guest columnist, by Greg Nickels, Special to The Times, February 11, 2000
[8] by Neil Modie, Seattle Post-Intelligencer reporter, March 7, 2000
[9] by Tan Vinh and Dionne Searcey, Seattle Times staff reporters, March 14, 2000
[10] News Release by agency
[11] by Tom Allison and Richard Ford, Special to the P-I, Thursday, April 6, 2000
[12] by Aubrey Davis, Opinion, Eastside Journal, 2000-04-15
[13] by Hunter T. George, the Associated Press, Friday, April 21, 2000
[14] by Warren Cornwall, Herald Writer, May 9, 2000
[15] from Northwest Briefing, PI, Thursday, May 18, 2000
[16] by Thomas Ryll, Columbian staff writer, Thursday, June 8, 2000
[17] by Howard Buck, Columbian staff writer, Thursday, August 17, 2000
[18] Editorial, Columbian, Saturday, August 19, 2000

As more and more questions and concerns have been expressed about how and why WSDOT operates the HOV lane system, various information sources have been prepared. One paper was prepared on *Reasons for 24-Hour Freeway HOV Lane Operation in Washington State.*[19] The complete text of the paper is available in Appendix A. The key points of the paper are:

The Washington State Department of Transportation (WSDOT) has chosen 24-hour operation of HOV lanes for a number of reasons. The major reasons for 24-hour operations are as follows:

- We want HOV lanes to benefit people who carpool and ride the bus 24 hours a day.
- The November 1996 vote in the Puget Sound region approving a Regional Transit Authority (now called Sound Transit) implies public support for 24-hour HOV lane operation.
- Computer models of Puget Sound region traffic congestion show that opening the HOV lanes to all traffic outside the peak commute period would not provide enough capacity to positively affect the capacity needs in the region. In addition, opening up the HOV lanes to all traffic during off-peak periods would lead to an increase in air pollution.
- Washington State Patrol enforcement officers indicate that a more complex sign for variable hours for the HOV lane operation would be confusing to some drivers. Also, it would be costly to change the current fixed signs to variable message signs (VMS).
- Surveys of motorists indicate there is strong public support for HOV lanes.

Other reasons for 24-hour operations are as follows:

- When there is no traffic congestion and vehicles are traveling at the speed limit, an extra general-purpose lane is not needed, even though it may provide an opportunity for a driver to pass another vehicle. If traffic is flowing fine in the uncongested lanes, the HOV lanes should be kept open for the benefit of people who carpool or ride the bus.
- Most of the HOV lanes have been built with federal Interstate Completion dollars, and all the environmental documentation was prepared with the expectation that the new lanes would be operated as 24-hour HOV lanes. Changing the operation of the HOV lanes to allow general purpose traffic would probably require the preparation of an Environmental Assessment or an Environmental Impact Statement.
- HOV lanes can be used by emergency vehicles, allowing them to reach accident locations more quickly and possibly save lives. Emergency vehicles such as ambulances, police, and fire vehicles are allowed to use the HOV lanes when their emergency lights are operating. In life-critical emergencies, every second of time saved in getting to an injured person is potentially a life-saver.

[19] Compiled August 7, 1998 by Eldon L. Jacobson with the assistance of Jerry Ayres, William Brown, Jan Pazhouh, Pete Briglia, and Amy O'Brien.

- There is no nationwide precedent for part-time use of freeway HOV lanes. Some parts of the country operate the HOV lanes 24 hours a day as part of an HOV system (for example, southern California in the Los Angeles area). Other areas of the country operate the HOV lanes during peak commute times only as a congestion relief measure, with the HOV lanes open to all users the rest of the time (for example, northern California in the San Francisco Bay area).

- The WSDOT HOV 24-hour operation policy was developed in cooperation with other public agencies, including the Puget Sound Regional Council (PSRC), King County Metro Transit, Pierce Transit, and Community Transit. Changing the policy is possible through a process set up by the Transportation Commission in the *Statewide Freeway HOV Policy*.

National Experience[20]

There are over 100 HOV lane projects in perhaps 20 states, mostly those with large cities and severe congestion.

About 60% of the nation's HOV mileage (over half) operate 24 hours a day, thanks in large part to extensive systems in Seattle, Houston, and the LA basin.

About 2/3 of all projects are peak period only, mirroring a lot of smaller cities across the US and regional consistency found along the East Coast.

Two projects (San Diego and Houston) had so far begun testing either HOV or SOV tolling in conjunction with their previous HOV operations, and one of these was an HOV 2-occupant "buy in".

The following trends were being evidenced:
* Most operational policies evolving toward regional, not national consistency reflecting differing local conditions.
* Tolling is being considered in perhaps a half dozen locations where there is meaningful HOV capacity to sell.
* HOV mileage continues to grow, despite localized experience in New Jersey.

Policy

WSDOT has developed statewide policy that covers HOV operation. The complete text of the policy is printed in Appendix B. The key points of the policy cover:

Freeway HOV System Objectives
Freeway HOV System Policy Executive Summary
General HOV Policy Statement
HOV Coordination between Agencies and Modes
HOV Lane Minimum Thresholds

[20] E-mail from Chuck Fuhs (w/minor edits) Parsons Brinckerhoff, January 19, 1999.

HOV Speed and Reliability Standard
Carpool Definition
Hierarchy of HOV Facility Development
Inside Versus Outside HOV Lanes
Exclusive HOV Ramp Facilities
Requirements for Physically Separated HOV Facilities
General Purpose Lane Conversion to HOV
Hours of Operation
Enforcement Issues and HOV Lane Violations
HOV System Performance
Transportation Demand Management
HOV System Marketing and Promotion
Intelligent Transportation Systems and HOV Bypass
Park and Ride Facilities and Express Transit Stations
HOV Design Standards
Right of Way Reservation
HOV and Land-Use Policy Coordination

The Washington State Transportation Commission, which is the governing body of WSDOT, has separately approved a higher-level Statewide Freeway High Occupancy Vehicle Policy.[21] The complete text of the policy is printed in Appendix C. The key points of the policy cover:

1. <u>High Occupancy Vehicle Systems Objectives</u>
2. <u>Financing HOV System Elements</u>
3. <u>State Responsibilities</u>
4. <u>Regional Flexibility in Selecting HOV as a Strategy</u>
5. <u>Regional Operating Policies</u>
6. <u>HOV Support Programs</u>

The Puget Sound Regional Council, the local metropolitan planning organization, convened an HOV Policy Committee to review the entire WSDOT HOV lane operating policies. The HOV Policy Committee suggested some changes to the statewide policy to make it more appropriate locally (while supporting the overall policy).

The WSDOT Office of Urban Mobility (OUM) helps coordinate contacts with the state legislature. OUM also assembles an annual legislative packet about HOV issues that is distributed to every legislator.

Data

To provide data about the effectiveness of the system, an HOV lane evaluation and monitoring project has been ongoing for over 10 years. This monitoring project routinely collects vehicle occupancy and travel time data during the AM and PM peak periods, Monday thru Friday. The project also includes an extensive public opinion survey and collection of HOV violation and

[21] from WSDOT July, 1997

safety information. Funding for the monitoring project has varied in response to legislative and management priorities. Due to legislative interest in January 2000 WSDOT funded the collection of weekend occupancy data. Traffic volume data indicated the heaviest weekend traffic volumes occurred between 11 AM and 2 PM, so this was the weekend peak period that was selected for data collection.

The following Table 1 shows some of the results, comparing weekend auto occupancy with the more traditional Monday through Friday AM and PM peak periods. It is obvious that auto occupancy goes up on weekends. This is not much of a surprise. More people carpool on weekends, since families and friends make trips together.

Table 1 Weekend Auto Occupancies Compared to Weekday

Location	Lane	Direction	Time Period	ACO
I-5 @ NE 145th St.	GP	NB	**M-F PM**	1.13
(traditional central-	GP	NB	Weekend Midday	1.46
city commute pattern)	HOV	NB	M-F PM	2.13
(radial freeway from	HOV	NB	Weekend Midday	2.42
Seattle's downtown)	GP	SB	M-F AM	1.08
	GP	SB	Weekend Midday	1.60
	HOV	SB	M-F AM	2.10
	HOV	SB	Weekend Midday	2.41
I-405 @ 112th Ave SE	GP	NB	M-F AM	1.03
(ring road with only	GP	NB	M-F PM	1.09
a little directional	GP	NB	Weekend Midday	1.46
peak flow to	HOV	NB	M-F AM	2.08
Bellevue)	HOV	NB	M-F PM	2.15
	HOV	NB	Weekend Midday	2.40
	GP	SB	M-F AM	1.04
	GP	SB	M-F PM	1.05
	GP	SB	Weekend Midday	1.45
	HOV	SB	M-F AM	2.13
	HOV	SB	M-F PM	2.20
	HOV	SB	Weekend Midday	2.30

Acronyms: Average Car Occupancy (ACO), Southbound (SB), Northbound (NB), High Occupancy Vehicle (HOV), General Purpose (GP) lane, Monday thru Friday (M-F).
Notes: M-F data from Q2/98, Weekend Midday data from Mar-April 2000.

An annual report combines various data into five primary measures of effectiveness: vehicle volumes, person volume, average vehicle occupancy, speed and trip reliability, and travel time. Three secondary measures of effectiveness are HOV violations, safety, and public opinion. The data are being put onto the Internet in an interactive format that will allow analysts to easily select the specific data they desire. The annual report is available by hard copy or on the Internet.

The following Table 2 shows HOV lane violation rates. Most violation rates are well below 10% (this is good). The high violation rates all have explanations (such as SOVs allowed in this area, or location is close to a freeway ramp so SOVs are in the HOV lane for a short distance).

Table 2 HOV Lane Violation Rates

Location	Peak/ Direction	Quarter	Violation Rate
SITE #14 I-5 North - Northeast 145th Street	A.M. SB	Q3/98	1.55%
SITE #14 I-5 North - Northeast 145th Street	P.M. NB	Q3/98	2.30%
SITE #25 I-5 Downtown - Albro Place	A.M. NB	Q3/98	31.93%
SITE #25 I-5 Downtown - Albro Place	P.M. SB	Q3/98	1.62%
SITE #34 I-5 South - S 216th St	A.M. NB	Q3/98	1.98%
SITE #34 I-5 South - S 216th St	P.M. SB	Q3/98	1.98%
SITE #42 SR 520 - Yarrow Point	A.M. WB	Q3/98	5.64%
SITE #42 SR 520 - Yarrow Point	P.M. WB	Q3/98	7.63%
SITE #52 I-90 Reversible Lanes	A.M. WB	Q3/98	48.50%
SITE #52 I-90 Reversible Lanes	P.M. EB	Q3/98	43.74%
SITE #57 I-90 - Newport Way	A.M. WB	Q3/98	3.54%
SITE #57 I-90 - Newport Way	P.M. EB	Q3/98	2.63%
SITE #61 I-405 South - Tukwila Parkway	A.M. NB	Q3/98	1.14%
SITE #61 I-405 South - Tukwila Parkway	A.M. SB	Q3/98	4.02%
SITE #61 I-405 South - Tukwila Parkway	P.M. NB	Q3/98	2.81%
SITE #61 I-405 South - Tukwila Parkway	P.M. SB	Q3/98	4.26%
SITE #65 I-405 South - 112 Ave SE/Lk Wash. Blvd	A.M. NB	Q3/98	7.55%
SITE #65 I-405 South - 112 Ave SE/Lk Wash. Blvd	A.M. SB	Q3/98	2.81%
SITE #65 I-405 South - 112 Ave SE/Lk Wash. Blvd	P.M. NB	Q3/98	3.67%
SITE #65 I-405 South - 112 Ave SE/Lk Wash. Blvd	P.M. SB	Q3/98	3.82%
SITE #73b I-405 Central - NE 4th Street	A.M. NB	Q3/98	12.46%
SITE #73b I-405 Central - NE 4th Street	A.M. SB	Q3/98	18.23%
SITE #73b I-405 Central - NE 4th Street	P.M. NB	Q3/98	8.17%
SITE #73b I-405 Central - NE 4th Street	P.M. SB	Q3/98	11.12%
SITE #81 I-405 North - SR 908: Central Way/NE 85th	A.M. SB	Q3/98	11.41%
SITE #81 I-405 North - SR 908: Central Way/NE 85th	P.M. NB	Q3/98	20.61%
SITE #88 I-405 North: Juanita – Woodinville Way/NE 160th	A.M. NB	Q3/98	14.22%
SITE #88 I-405 North: Juanita – Woodinville Way/NE 160th	A.M. SB	Q3/98	3.16%
SITE #88 I-405 North: Juanita – Woodinville Way/NE 160th	P.M. NB	Q3/98	18.45%
SITE #88 I-405 North: Juanita – Woodinville Way/NE 160th	P.M. SB	Q3/98	5.68%
SITE #91 I-5 North @ 112th SE- Everett	A.M. NB	Q3/98	2.56%
SITE #91 I-5 North @ 112th SE- Everett	A.M. SB	Q3/98	4.77%
SITE #91 I-5 North @ 112th SE- Everett	P.M. NB	Q3/98	1.14%
SITE #91 I-5 North @ 112th SE- Everett	P.M. SB	Q3/98	14.00%
SITE #98 SR 167 @ S 208th – Kent	A.M. NB	Q3/98	4.87%
SITE #98 SR 167 @ S 208th – Kent	A.M. SB	Q3/98	12.54%
SITE #98 SR 167 @ S 208th – Kent	P.M. NB	Q3/98	2.24%
SITE #98 SR 167 @ S 208th – Kent	P.M. SB	Q3/98	10.94%

Key: NB = Northbound, SB = Southbound, WB = Westbound, EB = Eastbound,
Q3/98 = 3rd quarter of the calendar year.

The reports are available on the Internet at:
http://www.wsdot.wa.gov/eesc/ATB/atb/reports.html

Enforcement and Education

Enforcement of and education about the HOV lanes are ongoing. The Washington State Patrol writes tickets to motorists observed violating the HOV lane occupancy restriction. The HERO program is a service that encourages motorists to voluntarily report HOV violators by calling (206) 764-HERO. The HERO program is primarily an educational effort that is a vital part of enforcement. The number of reported violations has increased steadily since 1993, with the total annual number of reported violators now exceeding 40,000.

The following Table 3 summarizes the types of HOV tickets and contacts reported by the Washington State Patrol.

Table 3 Washington State Patrol Annual HOV Related Tickets

Type of Action	Arrest Citations	Verbal Warnings	Written Warnings	Accident Citations	Other	Total
1992	3,790	3,717	248	7	21	7,783
1993	3,655	3,389	259	5	33	7,341
1994	2,809	3,159	225	N/A	11	6,204
1995	3,893	2,734	415	N/A	11	7,053
1996	4,784	5,574	327	N/A	23	10,708
1997	7,014	4,786	503	N/A	24	12,327
1998	6,310	4,047	221	N/A	22	10,600
1999	7,915	3,534	190	N/A	20	11,659

Issues listed by Eldon in no particular order 3-23-99 (revised 8-23-00).

1. Staffing below authorized levels in Seattle area due to higher than normal turnover during 1998 (1998 total reflects that). Enforcement during winter of 98-99 was less than normal. A new hire class was trained during the first half of 1999.
2. WSP salaries are same statewide. Seattle area cities and counties pay higher than WSP.
3. Houston transit agency has own police force to enforce barrier separated HOV lanes that were financed by the transit agency. WSDOT has a good working relationship with WSP and is not interested in operating a police agency. Sound Transit may be investigating the cost-effectiveness of transit police (but probably only for station and vehicle security, not HOV lane enforcement).
4. HOV lane enforcement is lower priority than accident response (properly so). HOV enforcement is normally done during peak periods, but this is when most accidents happen, too.

It is physically hard to stand beside or drive in traffic for long periods of time. When not on-the-road WSP troopers are doing paperwork, testifying in court, training, and….

The following Tables 4 and 5 summarize HERO program calls handled and violations reported (respectively). Large increases in violations are associated with the opening of new HOV lanes. Note that reported violations are greater than telephone calls because until recently people could report multiple violations with one telephone call. During 1999 the reporting system was revised to a voice prompt system (or optional Internet system) that allows the reporting of one violation at a time.

Table 4 HERO Program - Number of Calls Handled

	1994	1995	1996	1997	1998	1999
JAN	1070	1427	1643	1757	1846	2259
FEB	1154	1566	2015	2249	2134	2279
MAR	1394	1281	2077	2389	2670	3050
APR	1273	1763	2201	2193	3001	3273
MAY	1540	2324	2005	2400	3100	3063
JUN	1489	2142	2025	2608	2687	3418
JUL	1270	1927	2478	3262	3093	3242
AUG	1474	2351	2229	2830	3181	3066
SEP	1531	2324	2088	3440	2615	2753
OCT	1359	2322	2397	2930	4119	3198
NOV	1344	2350	1500	2105	2602	2847
DEC	1300	1891	1326	1804	2323	2702
TOTAL	16198	23668	23984	29967	33371	35150

Table 5 HERO Program - Number of Licenses Reported

	1994	1995	1996	1997	1998	1999
JAN	1363	1814	2005	1862	2677	2464
FEB	1483	1933	2175	2554	3032	2077
MAR	2032	2804	2569	2740	3766	3769
APR	1783	2158	2727	2320	3339	3862
MAY	1946	3031	2428	2801	4299	3678
JUN	2111	2707	2263	2819	3701	4617
JUL	1814	2214	3030	4240	4544	3799
AUG	1940	2595	3079	3899	4136	3447
SEP	2266	2324	2790	4486	2732	3367
OCT	1994	2322	2847	4204	3208	3731
NOV	1884	2350	1874	3142	3556	3358
DEC	1590	1891	1573	2718	2741	2771
TOTAL	22206	28143	29360	37785	41731	40940

Public Participation in the HOV HERO Program on the Rise[22]

Just because a carpool lane violator doesn't get pulled over, it doesn't mean the violation goes unnoticed. The HERO program for high-occupancy-vehicle (HOV) lanes has shown consistent growth in public participation. The HERO program aims to ensure the rules and spirit of the HOV lanes are observed and respected. By contacting the HERO program either through the 206-764-HERO phone number or using the online reporting form, motorists and their passengers have made a significant contribution to the effort of discouraging the improper use of these lanes.

In 1999, the HERO program received over 35,000 calls and online reports, with close to 41,000 licenses reported. That is nearly double the amount of licenses reported in 1994.

To avoid recurring violations, vehicle owners who are reported for the first time are mailed an informational brochure about the proper use of HOV lanes. Subsequent infraction reports are followed by letters from WSDOT, then the Washington State Patrol informing the motorist of the ticket and fine if they are stopped for violating the HOV lane law. Program statistics show that fewer than six percent of first-time violators are reported a second time, and fewer than one percent are reported a third time. If a patrolman stops a motorist, the fine for violating the HOV lane restriction is $71 and is considered a moving violation.

The HERO program in Puget Sound has garnered national attention. Other states with HOV systems have looked to the Puget Sound HERO program as one model for developing their own enforcement tools. It is an important component of the success of the Puget Sound HOV system. Governor Gary Locke included the HERO program on his list of "Governing for Results" programs, a national project identifying result-focused programs within state government.

The system of reporting violators has been refined through the years. In 1984 when the program began, motorists reported violators by calling 764-HERO and provided the required information on an answering machine. Using the answering machine, critical information was often omitted, or motorists would simply vent their frustrations on the recording, resulting in invalid reports. Just recently, a voice form replaced the telephone answering machine message, ensuring a more complete report and reducing the amount of invalid reports.

The HERO program is a cooperative effort of the Washington State Patrol, The Washington State Department of Transportation, King County DOT, Community Transit, Pierce Transit, and Sound Transit. The Rideshare Group of KING COUNTY DOT manages the program. The program is funded through WSDOT and transit agency support. Callers can access the HERO voice form by dialing (206) 764-HERO. The HERO online form can be found on the Internet at http://transit.metrokc.gov/travel_options/hero.html.

[22] Courtesy of Dwyn Armstrong, King County Metro, April 2000 (updated 8-24-00 by ELJ)

Appendix A

Reasons for 24 Hour Freeway HOV Lane Operation in Washington State

Compiled August 7, 1998 by Eldon L. Jacobson with the assistance of Jerry Ayres, William Brown, Jan Pazhouh, Pete Briglia, and Amy O'Brien.

Introduction

Why do the freeway high occupancy vehicle (HOV) lanes in the Puget Sound region operate 24 hours a day? Why aren't the freeway HOV lanes open to all traffic outside the peak commute time? These and similar questions are frequently asked by citizens.

Twenty-four hour versus peak period designation of HOV facilities has been a topic of discussion since the earliest HOV lanes first opened on I-5 north of downtown Seattle. In addition, during most state legislative sessions in Olympia, legislation is introduced to change the freeway HOV lane hours of operation. Arguments in favor of off-peak use by general purpose traffic are that allowing general purpose traffic in HOV lanes would prevent the perception of empty lanes and would allow general purpose traffic to use the HOV lane to pass slower traffic or to move around freeway incidents.

The Washington State Department of Transportation (WSDOT) has chosen 24-hour operation of HOV lanes for a number of reasons. The major reasons for 24-hour operations are as follows:

- We want HOV lanes to benefit people who carpool and ride the bus 24 hours a day.
- The November 1996 vote in the Puget Sound region approving a Regional Transit Authority (now called Sound Transit) implies public support for 24-hour HOV lane operation.
- Computer models of Puget Sound region traffic congestion show that opening the HOV lanes to all traffic outside the peak commute period would not provide enough capacity to positively affect the capacity needs in the region. In addition, opening up the HOV lanes to all traffic during off-peak periods would lead to an increase in air pollution.
- Washington State Patrol enforcement officers indicate that a more complex sign for variable hours for the HOV lane operation would be confusing to some drivers. Also, it would be costly to change the current fixed signs to variable message signs (VMS).
- Surveys of motorists indicate there is strong public support for HOV lanes.

So while WSDOT could change to part-time operation of the HOV lane system in the Puget Sound region (through a process defined by the Transportation Commission in its *Statewide Freeway HOV System Policy*), WSDOT has chosen to keep the freeway HOV network open to carpools and buses 24 hours a day.

Reasons for 24-Hour Operation

- We want HOV lanes to benefit people who carpool and ride the bus 24 hours a day. Traffic congestion now occurs on weekends and middays at some locations. One example of midday and weekend traffic congestion in the Seattle area is on southbound I-5 approaching the Ship Canal Bridge. This heavily traveled corridor is congested almost every day from about 11 am until 7 pm, seven days a week (plus the normal peak period congestion Monday through Friday between 6 am and 9 am).

  WSDOT wants to provide an incentive for people who carpool and ride the bus at those times as well as the normal commute times. This incentive must be predictable and always present. It is often difficult to form a carpool or to take the bus, so WSDOT wants to reward the people who make this extra effort. Whenever congestion occurs, HOV lanes should be available to provide travel time savings to people who carpool and ride the bus.

- The November 1996 vote in the Puget Sound region approving a Regional Transit Authority (now called Sound Transit) implies public support for 24-hour HOV lane operation. Sound Transit promised three main components in the voter-approved package: a light rail line between Seattle and Sea-Tac Airport, a commuter railroad line on existing railroad tracks, and a regional express bus system that would require access to uncongested HOV lanes 24 hours a day.

  Uncongested HOV lanes ensure transit system reliability. Reliable buses that arrive and depart on the scheduled time are critical to the success and public acceptance of a transit system. Part of the success of the express bus system will be the construction of direct access ramps to allow buses to use left-side HOV lanes. WSDOT will continue to do its part to support the Sound Transit voter-approved partnership and to help transit meet the voters' expectations for success.

- Computer models of Puget Sound region traffic congestion show that opening the HOV lanes to all traffic outside the peak commute period would not provide enough capacity to positively affect the capacity needs in the region. Only the politically, environmentally, and financially unacceptable option of constructing many new costly freeways in the Puget Sound region would possibly help. Most residents in the Puget Sound region oppose the construction of new freeways (or more specifically, they oppose the construction of new freeways when they would be close to their residence).

  In addition, opening up the HOV lanes to all traffic during off-peak periods would lead to an increase in air pollution. The increase in air pollution could possibly put the Puget Sound region back into non-compliance with the Clean Air Act (which could require the return of oxygenated gasoline). One environmentally related goal of WSDOT is to reduce fuel use and pollution. Carpooling and riding the bus should be encouraged as more efficient and less environmentally destructive than using single occupant vehicles.

  Furthermore, increased travel on the freeway network would lead to an increase in traffic through existing traffic bottlenecks (such as downtown Seattle on I-5), increasing congestion at the bottlenecks. We have also found that in the Seattle area (or in any congested area of the country) when new roadway capacity is made available to travelers, within about six months the new capacity is filled up and congestion is as bad as it was before the added capacity. This is due to what is called "latent demand." Latent demand refers to travelers who have the flexibility to choose their time of travel, usually making trips when the roadway is less congested. When new roadway capacity becomes available, these travelers will often shift their start time and fill in open capacity.

- Washington State Patrol enforcement officers indicate that a more complex sign for variable hours for the HOV lane operation would be confusing to some drivers, a point that has been proven in other urban areas of the nation. Freeways signing in the urban areas of Puget Sound is already confusing to some drivers. Some locations already have too many signs for motorists to read.

  Complex signs showing variable hours of HOV lane operation would give people one more excuse to offer law enforcement officers or judges. People could say they were confused. A related issue is how the transition from a general purpose lane to an HOV lane would be enforced. If a sign indicated that an HOV lane operated from 3:00 pm to 6:00 pm, how should the police enforce a violation that occurred at 3:05 pm? Should there be a grace period? What about a driver who had a watch that was 10 minutes slow and reads 2:55 pm?

  Another problem is that the peak period varies depending on the freeway corridor. Congestion on the freeway network in the Puget Sound region now occurs from Marysville in the north to Tacoma in the south and beyond. While there is still a traditional peak period commute to downtown Seattle (inbound in the morning and outbound in the afternoon), other freeway corridors in the Seattle area experience congestion in both directions. WSDOT would have to either pick a generic peak period time of operation that somewhat fit all the HOV lanes, or else pick a specific time of operation for each HOV travel corridor, which would vary depending on congestion conditions.

  If a variable time for HOV operation were chosen, WSDOT traffic operations people would recommend the installation of variable message signs (VMS) to address changing congestion hours rather than less costly fixed signs. VMS would allow much greater operational flexibility of the HOV network. However, it would be costly to change the current fixed signs to VMS. To properly implement a signing system to display variable times for HOV operation would cost an estimated $500,000 per mile (plus an annual increase in operations and maintenance costs).

- Surveys of motorists indicate strong public support for HOV lanes. To the statement "HOV lanes are a good idea," 75% of respondents who drove alone agreed, and 94% of carpool users agreed.

  However, 65% of respondents who drove alone agreed with the statement, "HOV lanes should be opened to all traffic during non-commute hours." For the same statement, 47% of carpool users disagreed, 15% were neutral, and 38% agreed.

Other Reasons

- When there is no traffic congestion and vehicles are traveling at the speed limit, an extra general-purpose lane is not needed, even though it may provide an opportunity for a driver to pass another vehicle. If traffic is flowing fine in the uncongested lanes, the HOV lanes should be kept open for the benefit of people who carpool or ride the bus.

- Most of the HOV lanes have been built with federal Interstate Completion dollars, and all the environmental documentation was prepared with the expectation that the new lanes would be operated as 24 hour HOV lanes. Changing the operation of the HOV lanes to allow general purpose traffic would probably require the preparation of an Environmental Assessment or an Environmental Impact Statement.

- HOV lanes can be used by emergency vehicles, allowing them to reach accident locations more quickly and possibly save lives. Emergency vehicles such as ambulances, police, and fire vehicles are allowed to use the HOV lanes when their emergency lights are operating. In life-critical emergencies, every second of time saved in getting to an injured person is potentially a life saver.

- There is no nationwide precedent for part-time use of freeway HOV lanes. Some parts of the country operate the HOV lanes 24 hours a day as part of an HOV system (for example, southern California in the Los Angeles area). Other areas of the country operate the HOV lanes during peak commute times only as a congestion relief measure, with the HOV lanes open to all users the rest of the time (for example, northern California in the San Francisco Bay area).

  Charles A. Fuhs, a nationwide expert in HOV issues, and an employee of the consulting firm Parsons Brinckerhoff in Los Angeles, in a January 15, 1998, e-mail to WSDOT, said the following: "We've been tracking operation policies for the past 15 years on all U.S. projects. From 1985 to present the ratio of part-time (peak period only) projects to 24-hour projects in the U.S. has remained constant, even as the number of route-miles of HOV lanes have more than quadrupled. About 2/3 of this total have been part-time operations; generally reflecting projects in areas with short durations of congestion. No major area with a 'system' of HOV lanes has ever changed their operation periods. Indeed, the Houston system has lengthened their operation periods to all day (on a system of reversible lanes) and Miami is currently adopting longer operation hours for their I-95 corridor. Shortened peak operating periods have occurred on selected projects, including some in the Bay Area and in Virginia and New York."

  The following areas around North America operate concurrent flow (the kind we have most of in the Puget Sound area) HOV lanes 24 hours a day: Vancouver, BC, Canada; Los Angeles, Orange, Riverside and San Bernandino counties, California; Hartford, Connecticut; Atlanta, Georgia; and Dallas, Texas.

  The following areas around North America operate concurrent flow HOV lanes during peak periods only: Phoenix, Arizona; Santa Clara, San Mateo, Alameda, Contra Costa, and Marin counties, California; Sacramento, California, Denver, Colorado; Fort Lauderdale, Miami, and

Orlando, Florida; Atlanta, Georgia; Honolulu, Hawaii; Montgomery County, Maryland; Boston, Massachusetts; Minneapolis, Minnesota; Morris County, New Jersey; Suffolk County, New York; Ottawa, Ontario, Canada; Nashville Tennessee; Northern Virginia and Norfolk/Virginia Beach, Virginia.

- The WSDOT HOV 24-hour operation policy was developed in cooperation with other public agencies, including the Puget Sound Regional Council (PSRC), King County Metro Transit, Pierce Transit, and Community Transit. Changing the policy is possible through a process set up by the Transportation Commission in the *Statewide Freeway HOV Policy*. The current published policy on hours of operation for freeway HOV lanes is as follows:

  Hours of Operation

  Policy

  1. HOV lanes constructed for HOV purposes shall be reserved for buses, motorcycles, carpools, and vanpools meeting minimum occupancy requirements, 24-hours per day, seven days a week. This policy does not apply to HOV restrictions on ramps.

  2. WSDOT shall solicit private, transit, and local government support in increasing regional efforts to market and educate the general public about the need for a 24-hour, seven-day HOV lane operating policy.

  3. Variable carpool definitions may be based on time of day.

Closing Comments

Contact with citizens and groups around the state has made it clear that the logic behind some things we do, such as how we operate the HOV system, is not always evident to everyone. In addition, we all have intuitive observations regarding driving and decisions about the best use of scarce resources -- and sitting in traffic allows us ample opportunity to think about these things!

The WSDOT Internet web site address for frequently asked questions (FAQs) about this topic is <http://www.wsdot.wa.gov/regions/northwest/hovpage/faq.html>.

The WSDOT Internet web site address for the HOV Lane Evaluation and Monitoring annual data report is <http://www.wsdot.wa.gov/eesc/atb/atb/HOV/Titlepg.html>.

Bibliography

1. Brown, William W. and Eldon L. Jacobson, *HOV Monitoring and Evaluation – Phase III*. Olympia, Washington: Washington State Department of Transportation, August 1997. WA-RD 414.2

2. Ulberg, Cy, Gary Farnsworth, Graciela Etchart, Katherine F. Turnbull, Russell H. Henk, and David L. Schrank, *I-5 North High-Occupancy Vehicle Lane 2+ Occupancy Requirement Demonstration Evaluation*. Seattle, Washington and College Station, Texas Station: Washington State Transportation Center (TRAC) and Texas Transportation Institute, February 1992. Research Project T9233, Task 8.

3. *Washington State Freeway HOV System Policy, Final Report*, Olympia, Washington: Washington State Department of Transportation, November 1991 (reprinted June 1997).

4. Fuhs, Charles A., *High-Occupancy Vehicle Facilities, A Planning, Design, and Operation Manual*. New York, New York: Parsons Brinckerhoff Quade & Douglas, Inc., December 1990. (including Operational Characteristics table updated January 1998).

Appendix B

Washington State Freeway HOV System Policy
Executive Summary

November 1992
Reprinted June 1997
Updated August 2000 by Eldon L. Jacobson
Washington State Department of Transportation
Public Transportation and Rail Division
PO Box 47387
Olympia, Washington 98504-7387

Table of contents (not included)

A Message from Secretary Sid Morrison
Providing the people of Washington with safe and efficient mobility options is a major challenge and goal of the Washington State Department of Transportation (WSDOT). Customers are the focus of everything we do, and our overall vision is to Move it better!

It has long been our priority to provide transportation programs and facilities that enhance our economic vitality and address the growing demands for moving people and goods around and through the state. Voter approval of Sound Move, the ten year Regional Transit System Plan for the Puget Sound region, and the level of planning underway for similar transportation systems in other urban regions of the state emphasize the growing importance and value being placed on these issues.

WSDOT has an established policy regarding the high occupancy vehicle (HOV) system. The goal - provide an infrastructure that supports alternatives to single occupancy vehicle use and encourage people to use higher occupancy modes of travel. Through transportation industry partnerships we can jointly developed a statewide transportation system that meets our needs and is second to none.

At WSDOT we are committed to improving mobility and increasing freeway efficiency. HOV will continue to play a key role in congestion management strategies that allow our transportation systems to move more people and meet current and future mobility needs.

Sid Morrison
Secretary of Transportation

What is the relationship between Commission HOV policy and policy presented in this booklet?
Answer: They are directly related and complement each other.

On May 15, 1996, the Washington State Transportation Commission adopted Statewide Freeway HOV Policy. It is included as part of Washington's Transportation Plan 1997-2016, the 20-year vision for all modes of transportation in Washington State.

The principal features of Commission Statewide HOV Policy are:

- clarification of the state's responsibility to finance construction of freeway HOV lanes, as well as to manage their design, construction and operation.
- provides regional flexibility through a collaborative process between the department and Metropolitan Planning Organizations.
- provides the public an opportunity to influence proposed significant changes in HOV lane policy or operation.
- protects HOV system 'integrity' by requiring that regional HOV operating policies include a HOV speed and reliability standard, and a mechanism to enforce that standard.

The connection with this booklet:

Commission HOV policy designates this Washington State Freeway HOV System Policy as the resource for HOV policy direction. Policies contained herein are comprehensive and intended for immediate use on freeway HOV systems. In regions of the state where HOV systems exist or are being planned, the Commission invites regional review of these policies through a process that is described in the Commission document.*

* For a copy of the Washington State Transportation Commission, Statewide Freeway High Occupancy Vehicle Policy, please write or call:

Jerry Ayres
WSDOT
PO Box 47344
Olympia, WA, 98504-7344
(360) 705-7403

Both of these documents can also be found on the WSDOT Internet home page at:
http://www.wsdot.wa.gov/regions/northwest/hovpage/policy.html
http://www.wsdot.wa.gov/commission/Documents/Catalog.pdf

Freeway HOV System Objectives
Preamble

By satisfying the following overall objectives, the high occupancy vehicle (HOV) system is successfully providing mobility choices consistent with the mission of the Washington State Transportation Commission, Department of Transportation and the goals of state growth management, commute trip reduction and air quality programs. Critical to the success of the

HOV system is public support. These objectives and all decisions regarding the system must reinforce public acceptability of and support for HOV facility development.

The objectives of the HOV systems are to accomplish the following:

- Improve the capability of congested freeway corridors to move more people by increasing the number of persons per vehicle.
- Provide travel time savings and a more reliable trip time to high occupancy vehicles that use the facilities.
- Provide safe travel options for high occupancy vehicles without unduly affecting the safety of the freeway general-purpose mainlines.

Measures of effectiveness used to determine the impact of the HOV system include the following:

- person throughput,
- vehicle occupancy,
- comparative and absolute general-purpose and HOV lane travel times,
- travel time reliability, and
- accident rates.

Brief Policy Development History

In December 1989, the Deputy Secretary of the Washington State Department of Transportation (WSDOT) appointed the WSDOT HOV Study Committee to take an in-depth look at the high occupancy vehicle (HOV) program. The task included review of planning, construction and operations of the freeway HOV system and its relationship to local jurisdictions, including transit agencies affected by the system. The committee was charged with developing recommendations for WSDOT positions and policies for administration and management of the state-owned portion of the HOV system.

Initially, 12 issues were identified for review. Detailed committee discussions identified additional issues that were combined into like categories with the original 12 issues and assigned to team members for subcommittee action. After thorough investigation, discussion and review of existing procedures, policies, and "policies in practice," the HOV Study Committee drafted the HOV Policy Issues report, a compilation of 14 HOV issue areas matched with policy recommendations.

This draft policy statement document was submitted to local and regional jurisdictions throughout the state for technical review, critique and comments.

By early 1991, WSDOT had received guidance and comments from 23 agencies statewide. These comments were then reviewed by the WSDOT HOV Study Committee and incorporated, into a final draft report.

In April 1991, the final draft report was re-circulated to local and regional jurisdictions with an invitation to attend an all-day workshop. The workshop discussion focused on HOV system policy issues and the process through which WSDOT would proceed with adoption of freeway HOV policy.

From workshop discussion, and additional written comments received from jurisdictions, the HOV policy report was again edited, resulting in completion of the Washington State Freeway HOV System Policy - Final Report. WSDOT executives reviewed and commented on the document, and on August 20, 1991, the Deputy Secretary approved adoption of this document as department policy for the state-owned portion of the HOV system.

Freeway HOV policies have been amended several times since 1991. Shortly after issuing the first policy document WSDOT set-up a policy development, review and decision-making process. An executive committee was appointed to make final policy and administrative decisions. This HCT/HOV Policy Board created a multi-agency committee with membership representing regions of the state to help WSDOT management review and amend HOV policy.

In the mid-1990s the Washington State Transportation Commission became more involved in HOV system planning and policy development issues. Through the State Highway System Plan, an element of Washington's Transportation Plan - the financially constrained 20-year multimodal plan for the state - the Commission committed to completing the Puget Sound Freeway Core HOV lanes. Also, in 1995, the Commission appointed an ad hoc committee to help develop a process which allowed for regional flexibility in developing congestion management strategies and mobility solutions; and included the Commission and the public in HOV system policy decision making. Representatives of business and government participated on this committee. The Commission HOV Stakeholder Committee completed their assignment in September 1995 and submitted HOV policy recommendations. At their May 15, 1996 meeting the Transportation Commission adopted Statewide Freeway HOV Policy, which has been included as an element of Washington's Transportation Plan.

The Commission-level HOV policy clarifies the state's responsibility to finance construction of freeway HOV lanes, as well as assuring state control for designing, constructing and operating the freeway HOV system. It also allows for regional flexibility through a collaborative process between WSDOT and Metropolitan Planning Organizations; and allows more opportunity for public and regional input in decision making. It protects HOV system integrity by requiring that a region's HOV operating policies include a HOV speed and reliability standard.

Policies contained in this booklet have been endorsed by the Transportation Commission as HOV system policy for Washington State. These policies are comprehensive and immediately available for use on freeway HOV systems. The HCT/HOV Policy Board will continue to provide administrative oversight of HOV policy development and will work with the Transportation Commission and/or MPOs in the state to amend HOV policy as such needs arise.

Freeway HOV System Policy Executive Summary

The mission of the Washington State Department of Transportation (WSDOT) is to be a transportation team, second to none in the world, meeting the mobility needs of people and products of Washington State. Mission objectives include reducing traffic congestion and enhancing mobility. WSDOT began a strong transportation system management program in the early 1970s. Today, its elements are implemented through the planning, program development and highway construction programs, traffic management systems in urban areas, and Venture Washington, the statewide Intelligent Transportation System (ITS) program.

The overall goals and objectives of the high occupancy vehicle (HOV) program are to maximize the people-carrying capacity of the freeway system by providing incentives to use buses, vanpools and carpools and to provide capacity for future growth in travel demand. Through HOV programs, WSDOT strives to make the best use of existing facilities and maintain current and future highway mobility by increasing freeway efficiency and promoting programs to move more people in fewer vehicles. These programs also serve to mitigate transportation-related pollution and reduce dependency on fossil fuels.

Most existing elements of the HOV system have been designed and constructed under provisions of the Federal Surface Transportation Assistance Act. Future funding for completing the HOV lane system in the Puget Sound region and building HOV projects in other regions of the state is expected to come from federal, state, regional, and private sector sources.

In developing HOV policy, WSDOT managers recognize that no one option to the single occupant vehicle will succeed in enhancing mobility and solving traffic congestion problems. Implementing a variety of HOV system elements serves to complement the overall efficiency of a high capacity transit system and the total transportation network in urban regions.

Also recognized is the importance of planning for support facilities such as park and ride lots and HOV direct access ramps, ITS applications, HOV ramp bypasses, and support services such as express bus service, ridematch services, parking strategies, incident management, and demand management programs. An effort to coordinate support services must be included in planning and designing HOV lanes and facilities.

The following policies are directed specifically toward freeway HOV facilities and services. Many of the same policy issues are also important for arterial HOV facilities. Because of limited operational experience and study of arterial HOV facility applications, specific statements regarding those facilities have not been developed by WSDOT. Several local jurisdictions in the Puget Sound region have implemented arterial HOV facilities and are investigating the most effective ways for operating arterial HOV lanes. It is likely that arterial HOV policies or guidelines will be developed in the future.

This policy document is the result of a coordinated WSDOT/local jurisdiction effort to update the freeway HOV policy that was initially introduced in November 1991. Following are WSDOT policies for the freeway portion of the state HOV system.

General HOV Policy Statement

1. WSDOT regards the HOV system as a high capacity transportation system whose goal is to maximize people moving capability of the state highway system, mitigate transportation-related pollution, and reduce dependency on fossil fuels.

2. Through the state transportation planning process and regional transportation planning organizations, WSDOT shall take a pro-active role in promoting and coordinating the development of HOV systems, transportation demand management activities, and related transportation system management activities. This will be accomplished through support of local jurisdictions and participation in their transportation and land-use planning efforts statewide.

3. WSDOT recognizes that an HOV system may not be the only high capacity transit system in a region depending on adopted regional funding strategies and transportation policies. It is believed that in regions such as the Puget Sound, a completed HOV system must be in place to meet federal environmental clean air standards, and support overall mobility needs and high capacity transportation systems of the future.

4. All policies adopted by WSDOT regarding this system shall be based on providing incentives for people to shift from single occupant vehicles to ridesharing modes.

5. WSDOT's aim is to enhance Washington's quality of life, protect the natural environment, preserve mobility for people today, and ensure personal mobility in the year 2000 and beyond.

HOV Coordination between Agencies and Modes

Policy

1. Coordination is an essential aspect of a successful HOV program. WSDOT shall coordinate HOV efforts with regional and local transportation agencies throughout the planning, design, construction, and operation phases.

2. Intermodal considerations and coordination shall take place throughout the HOV planning and development phases.

3. When changes are to occur to the HOV System, WSDOT shall coordinate such change through a regional process, as designated by the Washington State Transportation Commission and described in Washington's Transportation Plan.

HOV Lane Minimum Thresholds

Policy

HOV lanes are appropriate improvements when current traffic congestion conditions and/or forecasted traffic congestion meet the following criteria:

1. Facility demand exceeds capacity for more than an hour each day as evidenced by level of service E or F (see Glossary for definition).

2. Evidence exists that during peak hours of operation, the HOV lane will move more people than the per lane average of the adjacent general purpose lanes.

3. Local support for construction of the HOV lane is demonstrated through active regional support or public surveys.

4. An HOV route segment may also be justified if it enhances HOV system continuity, for example by providing a link between HOV corridors identified in the Freeway Core HOV Lane System.

HOV Speed and Reliability Standard

Policy

1. It is WSDOT policy to offer a reliable speed and travel time advantage to HOVs, both to offer an incentive to use ridesharing modes and to enhance person carrying capacity into the future. For transit riders especially, a reliable trip time is equally as important as a fast travel speed.

2. HOV lane vehicles should maintain or exceed an average speed of 45 mph or greater at least 90 percent of the times they use that lane during the peak hour (measured for a consecutive six-month period).

Carpool Definition

Policy

1. The statewide base carpool definition for limited access freeways is two or more persons.

2. Exceptions to the base carpool definition may be made in cases where an HOV lane is operated on a converted roadway shoulder, or where safety may be compromised at higher volumes of HOV traffic due to substandard roadway geometrics or by opening day projected volumes.

3. For each new portion of an HOV route segment, the carpool definition shall initially be established during the preliminary engineering phase of the HOV project and shall be carried through the environmental and design report stages, allowing for public and interjurisdictional review and comment.

4. The carpool definition shall be consistent on a HOV route segment. HOV bypasses or ramps leading to the HOV route segment may be treated differently when it is beneficial to that immediate area.

5. Based on results of the HOV System Evaluation, the carpool definition may be increased to mitigate cases where the HOV Speed and Reliability policy is violated. The carpool definition may be decreased to the base definition if it can be demonstrated that the result would increase person volumes without violating the Speed and Reliability policy. This policy allows for variations in the carpool definition by direction.

6. Traffic regulations adopted by WSDOT on June 29, 1984, allow authorized vehicles and vehicles meeting the minimum occupancy definition to use state HOV facilities. Authorized vehicles include motorcycles, buses with 20 or more seats, and public transportation vehicles as defined by state law.

Hierarchy of HOV Facility Development

Policy

1. WSDOT recognizes and supports the concept that a logical hierarchy exists in HOV facility development and shall use this knowledge in statewide planning and analysis of HOV systems. The intent is to plan and design facilities that are amenable to future improvements in the hierarchy.

2. WSDOT shall review its design policies currently in use for HOV route segment facility design, and consider options that will enhance and facilitate future roadway improvements. Examples include: providing right of way for future physically separated facilities, and including transit and other HOV facility access needs in design considerations and policy.

3. WSDOT shall establish financial strategies to cooperatively develop HOV support facilities that will best benefit a region's HOV system.

Inside Versus Outside HOV Lanes

Policy

Flexible criteria for the location of HOV lanes will allow for variations based on specific corridor needs.

Generally speaking:

1. Outside HOV lanes are most appropriate for a corridor with widely dispersed trip patterns, such as a freeway serving suburb to suburb trips, with bus routes that exit and enter at nearly every interchange.

2. Inside HOV lanes are most appropriate for a corridor with concentrated trip patterns, such as a freeway serving trips to or from the central business district or very large activity center and characterized by express bus service.

3. The decision to pursue development of inside HOV lanes shall trigger an evaluation of transit and other HOV access issues within the corridor. This evaluation should include a comprehensive analysis of alternatives, such as provision of direct HOV lane access.

Exclusive HOV Ramp Facilities

Policy

1. Exclusive HOV ramps with direct access to inside HOV lanes or physically separated HOV roadways optimize HOV system efficiency.

2. WSDOT shall establish financial strategies to cooperatively develop exclusive HOV ramp projects that will best benefit a region's HOV system.

3. WSDOT shall seek to work with local transit agencies and governments in the regions of the state to design policies and procedures leading to development of an exclusive HOV ramp program.

Requirements for Physically Separated HOV Facilities

Policy

1. Consideration shall be given to physically separated HOV roadways when forecasted HOV demand is high, merging and/or weaving problems are severe, or general purpose lane congestion is severe.

2. If strong directional flows are present and projected to continue in the future with off-peak directions rarely congested, reversible roadways may be appropriate.

3. Two-directional, separated HOV roadways shall be considered when directional splits are relatively even for the number of lanes present, there is a demand for ridesharing in both directions during peak hours, or there is a large volume of buses adversely affected by congestion in the off-peak hours or reverse commute direction.

4. WSDOT shall establish financial strategies to cooperatively develop separated roadway facilities to enhance and benefit a region's HOV system.

General Purpose Lane Conversion to HOV

Policy

1. When proposing projects to address capacity deficiencies, one of the alternatives to be considered shall be the conversion of a general purpose lane to an HOV lane.

Hours of Operation

Policy

1. HOV lanes constructed for HOV purposes shall be reserved for buses, motorcycles, carpools, and vanpools meeting minimum occupancy requirements, 24-hours per day, seven days a week. This policy does not apply to HOV restriction on ramps.

2. WSDOT shall solicit private, transit, and local government support in increasing regional efforts to market and educate the general public about the need for a 24-hour, seven-day HOV lane operating policy.

3. Variable carpool definitions may be based on time of day.

Enforcement Issues and HOV Lane Violations

Policy

1. WSDOT fully supports the HERO program to discourage improper use of HOV lanes by providing a telephone hotline citizens can use to report HOV lane violators. WSDOT will continue to promote the program in regions where HOV systems exist or are planned.

2. WSDOT encourages enforcement of the HOV lanes by the Washington State Patrol.

3. WSDOT recognizes the importance of enforcement when a HOV facility first opens and shall fund enforcement for the first six months of HOV lane operation.

4. WSDOT is committed to designing and constructing HOV facilities that incorporate safe enforcement features and solicit the Washington State Patrol's involvement in design and review of HOV lane development.

5. WSDOT shall keep regulations and signing clear and consistent to avoid driver confusion.

6. To deter violations, WSDOT shall assign a team to work with the Washington State Patrol to develop and propose legislation creating a separate citation category for HOV violations and which carries an increased, graduated penalty.

HOV System Performance

Policy

1. To accurately evaluate the system's effectiveness, WSDOT will annually collect and analyze HOV lane data including volume, vehicle occupancy, travel time savings, and violation rates.

2. WSDOT shall continue encouraging support and participation from other agencies in the gathering and use of this data.

3. WSDOT shall prepare an annual HOV system report documenting system performance. Performance of general purpose lanes will be included for comparative purposes.

Transportation Demand Management

Policy

1. WSDOT shall continue being a leader in development and promotion of transportation demand management programs and strategies. This includes development of commute trip-reduction plans and other programs for WSDOT employees.

2. WSDOT recognizes and supports transportation demand management measures as essential components of an effectively operating HOV system.

3. WSDOT shall continue supporting other programs and initiatives designed to promote transportation demand management measures, similar to those established by the Washington State Ridesharing Organization and King County Economic Development Council's Commuter Challenge Campaign.

4. WSDOT shall promote and support transportation demand management legislation and lead the way for its implementation. WSDOT shall be a proactive partner with local governments in developing commute trip-reduction and other transportation demand management plans.

HOV System Marketing and Promotion

Policy

1. All activities shall be coordinated with all appropriate WSDOT public affairs offices.

2. WSDOT shall promote maximum use of the HOV system through education and marketing programs. Promotion of the positive aspects of the HOV system shall include targeting people not using the system.

3. WSDOT Olympia Service Center's divisions shall work with and through the WSDOT Office of Urban Mobility, WSDOT Public Transportation and Rail Division, and the appropriate WSDOT region offices to assure effective coordination of HOV promotions with transit agencies and local and regional governments.

4. Where appropriate, WSDOT HOV promotional activities shall be coordinated with and done in conjunction with local and regional jurisdictional efforts statewide.

5. Education and marketing elements shall be included in project development and construction expense for each major HOV project.

Intelligent Transportation Systems and HOV Bypass

Policy

1. All planning for and use of Intelligent Transportation Systems (ITS) elements on a freeway corridor shall be carried out through close coordination with local agencies within the corridor.

2. ITS components will be used in heavily congested areas to mitigate traffic congestion, assist with managing incidents, and improve mobility on the freeway system. High occupancy vehicle lanes and ITS systems will be constructed concurrently whenever possible.

3. WSDOT shall review ramp metering justification during project development for all improvements to congested freeways in regions of the state where operating speeds are regularly less than 50 mph for at least one half hour during peak commute hours.

4. Ramp metering may be used as a technique to mitigate the effects of heavy congestion in the general purpose lanes.

5. WSDOT shall construct HOV bypasses when ramp metering is installed and operational studies show that a benefit to HOVs could be expected.

6. WSDOT shall continue to promote and implement elements of the incident management program.

Park and Ride Facilities and Express Transit Stations

Policy

WSDOT recognizes that for an HOV system to operate effectively there must be a network of park and ride lots and, where appropriate, express transit stations strategically located. Transit services must be adequately scheduled to support the HOV system elements.

1. WSDOT shall continue working with local transit agencies and local governments to coordinate park and ride lot development and implement management policies to address security, enforcement, and operational issues.

2. WSDOT shall continue working with local governments and transit agencies to ensure new express transit stations and related transit facilities are designed to operate successfully.

3. WSDOT shall continue working with transit, local and regional jurisdictions, and the private sector to support site selection and development of mutually beneficial park and ride lot facilities.

HOV Design Standards

Policy

1. WSDOT shall encourage HOV priority treatments for all highway capacity improvement and transit benefit projects. This will occur through Design Manual guidelines that favor HOV system development and support.

2. WSDOT shall review current design policies for HOV lane facilities and make provisions allowing for future HOV improvements where practical. Examples include: providing right of way for future physically separated facilities and providing shoulder and enforcement areas to increase system safety elements.

Right of Way Reservation

Policy

1. WSDOT supports the concept of right of way reservation in corridors identified for short- and long-term high capacity transit and HOV projects.

2. WSDOT shall continue seeking ways to remove constraints and improve current policy and practices relating to right of way reservation.

HOV and Land-Use Policy Coordination

Policy

1. WSDOT is committed to working with local governments to assure implementation of coordinated land-use policies encouraging development of HOV facilities that support adopted land-use policies.

2. WSDOT shall take a proactive role on state and regional planning levels to coordinate development of HOV systems in line with local and regional land-use policies and which support federal and state environmental goals.

Appendix Index

- Transportation Demand Management (TDM) Programs and Function (**not** included in this document)
- HOV System and Traffic Management System Function (**not** included in this document)
- Freeway Core HOV Lane System (Map) Function (**not** included in this document)
- Publicly Funded Park and Ride Lots Function (**not** included in this document)
- Glossary
- WSDOT High Capacity Transit/High Occupancy Vehicle Policy Board

Glossary

Barrier-Separated Facility: HOV lane (or lanes) that is (are) physically separated from adjacent mixed flow freeway lanes.

Buffer-Separated Facility: An HOV lane separated from adjacent mixed flow freeway lanes by a designated buffer width of one foot or more.

Bus/Carpool Priority Control: Element of traffic control that gives preferential treatment to buses, vanpools, and carpools.

Busway: A preferential roadway or ramp designed for exclusive use by buses, located either in separate right of way or within the freeway corridor. Busways are normally physically separated facilities.

Commute Trip Reduction: A TDM strategy that encourages the use of alternative transportation modes for commute trips by reducing reliance on single occupancy vehicle travel.

Concurrent Flow Lane: A lane on which, during the entire day or during certain hours of the day, high occupancy vehicles operate in the same direction as the adjacent mixed flow of traffic.

Continuous HOV Lane: An HOV lane on a directional roadway with no gaps between individual HOV segments along its length.

Contraflow Lane: A lane on which, during the entire day or during certain hours of the day, high occupancy vehicles operate in a direction opposite that of adjacent traffic. For freeway applications the lane is separated by pylons or moveable barriers.

Direct Access: Ability of transit or other ridesharing modes to directly access HOV lane without merging across general purpose lanes. An exclusive ramp facility is one way to provide this access. For outside HOV lanes a right hand ramp may also be used.

Freeway and Arterial Management Effort (FAME): A comprehensive research and operations program aimed at developing and implementing strategies to address urban congestion and enhance mobility.

HOV Route Segment: Represents the length of an HOV lane, between termini located at freeway to freeway interchanges. This definition, as it applies to the policy entitled CARPOOL DEFINITION, is not intended to rule out variations in the required vehicle occupancy by direction or time of day, but is intended to provide reasonable consistency throughout the entire length of each HOV route segment.

Intelligent Transportation Systems (ITS): The application of data processing, communications, control, and electronics to improve safety and efficiency.

Level of Service (LOS): A qualitative measure that incorporates the collective factors of speed, travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs provided by a highway facility under a particular volume condition.

Operational characteristics:
LOS A: A condition of free flow in which there is little or no restriction on speed or maneuverability caused by the presence of other vehicles.
LOS B: A condition of stable flow in which operating speed is beginning to be restricted by other traffic.
LOS C: A condition of stable flow in which the volume and density levels are beginning to restrict drivers in their freedom to select speed, change lanes, or pass.
LOS D: A condition approaching unstable flow in which tolerable average operating speeds are maintained but are subject to sudden variations.
LOS E: A condition of unstable flow in which operating speeds are lower with some momentary stoppages. The upper limit of this LOS is the capacity of the facility.
LOS F: A condition of forced-flow in which speed and rate of flow are low with frequent stoppages occurring for short or long periods of time; with density continuing to increase causing the highway to act as a storage area.

Park and Ride Lot: A parking facility where individuals rendezvous to use carpools, vanpools, or public transportation as a transfer of mode with their private automobile. The facility may or may not be served by public transportation.

Ridesharing: A form of transportation in which more than one person shares in the use of a vehicle to make a trip. The concept of ridesharing usually applies to carpools and vanpools, but also applies to riding the bus.

Surveillance, Control and Driver Information System: The name given to those elements of the traffic management system which are used to collect traffic data and relay highway construction and traffic information to the traveling public. System elements include electronic surveillance stations, ramp meters, closed-circuit television, variable message signs, and highway advisory radio.

Traffic Management Systems: A group of transportation system management and transportation demand management techniques in the central Puget Sound area enabling more efficient use of the transportation network. System elements include: improved signal systems, park and ride lots, HOV lanes, express bus service, carpool and vanpool programs, electronic surveillance stations, ramp meters, closed circuit television monitoring, variable message signs, highway advisory radio, and ridesharing support services and programs.

Transportation Demand Management: Measures designed to reduce the number of single occupant vehicle trips during the peak traffic period. Measures include person trip reduction strategies, which eliminate trips completely, vehicle trip reduction strategies that accommodate person trips in fewer vehicles, and peak period modification strategies that move trips out of the most congested periods.

Washington's Transportation Plan: A planning instrument that guides investments and provides the 20-year vision and policy direction for multimodal transportation development in the state.

Washington State Department of Transportation High Capacity Transit/High Occupancy Vehicle Policy Board
Gerry Smith, *Chair*
Skip Burch
Jim Clemen
Gary F. Demich
Paula Hammond
Reneé Montgelas
John Okamoto
Jim Slakey
Jim Toohey
Gretchen White
Gene Fong, Federal Highway Administration

File: Washington State Freeway HOV System Policy reprinted June 97.doc

Appendix C

Washington State Transportation Commission

Statewide Freeway High Occupancy Vehicle Policy

Preamble

The Transportation Commission views High Occupancy Vehicle (HOV) programs and facilities as elements of a state transportation system that serve to improve overall mobility in congested regions by increasing the people moving efficiency and capacity of freeways and providing incentives for people to choose higher occupancy modes of travel.

The Commission recognizes that different regions will choose to manage congestion with different solutions. This policy specifies a collaborative process between the Washington State Department of Transportation (WSDOT) and Metropolitan Planning Organizations (MPOs) to define the role HOV facilities will play in an urban region's transportation mix, and how those facilities will be planned and operated. The WSDOT retains the responsibility to ensure that HOV facilities are safe and understandable to the user, and that they are managed so as to continue to achieve their objectives into the future. The Commission retains ultimate responsibility to ensure facilities are developed and operated according to HOV system objectives.

Statewide Freeway HOV Policy

1. High Occupancy Vehicle Systems Objectives

The objectives of high occupancy vehicle systems are to:

- improve mobility by increasing the people moving efficiency and capacity of freeways;
- provide reliable travel time savings for people who choose higher occupancy vehicle modes of travel;
- improve efficiency and safety of both transit and highways.

2. Financing HOV System Elements

The Commission assumes the responsibility to seek funding for freeway HOV lanes. It is understood that the funding of other HOV System facilities, such as park and ride lots, key transfer facilities and access ramps, is the shared responsibility of all parties which benefit from and have interest in HOV system completion.

3. State Responsibilities

WSDOT retains responsibility to design, construct and operate HOV facilities. Adherence to accepted design and traffic operation standards will assure that the facilities meet safety standards and driver expectations. In addition to implementing regionally established policies, WSDOT shall decide individual carpool definition or HOV user eligibility cases which are not specifically addressed by regional policy. The Washington State Patrol (WSP) retains primary responsibility for enforcing freeway HOV lane restrictions.

4. Regional Flexibility in Selecting HOV as a Strategy

Each MPO in the state shall decide through the regional transportation plan the role and extent of HOV facilities for addressing congestion within the region.

5. Regional Operating Policies

Each MPO choosing to implement HOV facilities through their regional transportation plan shall propose operating policies for HOV facilities. These policies shall be developed and updated through a process that involves a standing committee of stakeholders, under the auspices of the Metropolitan Planning Organization chosen jointly by the WSDOT and the MPO. This committee shall represent, at a minimum, all transit agencies within the MPO region, WSDOT, WSP, local governments, and representation from HOV users, general freeway users, freight and environmental interests. At a minimum, regional operating policies must:

- Support HOV system objectives noted in item # 1 above;
- Be open to public review and comment before adoption and when significant changes are proposed;
- Include a speed and reliability standard that ensures that HOV facilities will continue to provide a reliable travel time advantage over traffic in general purpose lanes when congestion is present, and a mechanism to enforce that standard; and,
- Adhere to statewide design and traffic operation standards developed by the WSDOT to ensure safety and driver expectancy.

Policies proposed by this committee shall be presented for concurrence to the MPO and WSDOT. In the absence of mutual concurrence by the two parties on a regional proposal to change a given operating policy, the Transportation Commission will consider the expressed positions of all parties and, as the “owner” ultimately responsible for

operation of the facility, make a final decision on the disposition of the proposed change.
The WSDOT document titled "Washington State Freeway HOV System Policy - Executive Summary, Reprinted June 1997," shall be considered and used as interim policy until a regional operating policy is developed through the above process.

6. HOV Support Programs

When HOV projects are defined, construction funds should be set aside for an initial emphasis enforcement effort. Ongoing programs to monitor HOV lane performance and to promote HOV use through public education should be adequately funded. The Transportation Commission recognizes and supports transportation demand management measures as essential components of an effectively operating HOV system.

Access and enforcement needs of transit, ridesharing services and the WSP should be considered as an integral part of planning, designing, and operating HOV lanes.

Preferential lane treatment in The Netherlands (Provisions for specific target groups)

John P. Boender, CROW, The Netherlands

Summary

There is a limited amount of road infrastructure available in The Netherlands, making it sometimes difficult for road users to gain access to certain destinations. In order to provide a solution to this limited infrastructure, road authorities have increasingly started to incorporate provisions within the road infrastructure aimed at specific target groups of users. In urban areas, this ‘public property’ has been a feature of the landscape for some time now. Take for example segregated bus lanes.
In actual practice the incorporation of special provisions within the road infrastructure, for use by particular target groups, acts contrary to the traditional principles, i.e. that the road infrastructure is intended for general use. With the application of target-group provisions, the finite capacity of the infrastructure may be divided in other ways. The issues relating to policy of whether or not to incorporate provisions for a particular target group have been defined here as well as the types of provision, their individual properties and the planning process. This provides a platform for thinking in terms of networks of provisions.

Why target-group provisions?

A ‘target-group provision’ is an infrastructural measure, which is of benefit to one or more groups or categories of traffic using the road network (the “target group”), in relation to other categories of traffic. A special provision will bolster the position of such a target group.
Provisions for specific target groups are intended to alter the distribution of the limited capacity of road available. Within municipal boundaries, the capacity of intersections (junctions and cross-roads) will have a considerable impact on the free flow of traffic. The facility of planning for free-flowing public transport and a right of way regulation at traffic lights can ensure that public transport is able to proceed to destinations more or less unimpeded. On and adjacent to many main highways, such as motorways, the capacity is often insufficient during peak traffic hours to ensure a problem-free flow of traffic. Provisions for “efficient” modes of transport (multiple passengers per transport vehicle) and economically important (freight and commercial) traffic will then be able to limit the amount of detrimental social impact.
When provisions are made available for the benefit of particular target groups this may indirectly affect the mobility exhibited by travellers, which in turn results in those modes of transport being stimulated which have less “costs” (in terms of space, financial means and environmental effects) associated with them.
Therefore, there are two types of motivation behind the application of provisions for special target groups instead of there being a generic provision:

- Guaranteeing a certain level of quality for journeys, made by target groups which are considered important;
- Influencing the mobility behaviour of travellers.

Government policy

Under the present Dutch government policy on traffic and transport, special target-group lanes are regarded as measures to improve accessibility. With this policy, obstacles caused by traffic congestion are removed to facilitate better access for certain categories of road users, particularly those categories of traffic which are economically important such as business traffic and collective passenger traffic. At a provincial authority level, this particularly concerns the construction of segregated bus lanes and giving priority in right of way to public transport at intersections. The policy of individual municipal authorities is aimed at preventing excessive volumes of vehicular traffic from entering town and city centres. To facilitate this end, public transport is stimulated meaning that, among other measures, special provisions for particular target groups will be made available such as unimpeded bus lanes and tram lines.

At the moment new government policy is being formulated, with a central part of the thinking being that journeys are themselves regarded as a positive aspect, but that any nuisance resulting from these should be kept to a minimum. Introducing charges or tolls would seem in this case to be one of the best ways of attaining this goal. Target groups in effect select themselves by having extra money available for particular journeys, made at set times using a certain mode of transport.

Classification of provisions

There are many types of target-group provisions which vary in scale from allowing a right of way regulation for buses at urban intersections to making provision for a parallel road network accessible only to traffic paying road charges or tolls.
Apart from differences in scale, the provisions may also differ from one another in other ways. The most significant features are the effect on capacity, the method of selection and the specific target group concerned.

Capacity effect

Depending on the location of the particular target-group provision concerned, in relation to bottlenecks and in general, with regard to primary traffic space, three situations are distinguished according to capacity effect:

- where the target-group provision makes use of additional infrastructure, whereby the pressure on a bottleneck holdup is relieved; the effect being an increase in capacity.
- where the target group has the facility of its' own infrastructure to circumvent the bottleneck area, which will however be at the cost of the capacity available to other traffic; the overall capacity will be reduced.
- where a particular target group is led to or through the bottleneck area by means of a priority regulation, but where this target group is filtered in with other traffic where the bottleneck actually occurs so that the total capacity remains at about the same level.

There are no fundamental differences between (1) and (2) ; the effect of (1) can also be achieved if the capacity is firstly increased by applying extra infrastructure, and if this extra infrastructure is then subsequently converted to a target group provision (2). The difference in implementation strategy may however have quite considerable consequences for acceptance of the provision by road users.

Method of selection

Target group traffic may be selected according to appearance, distinguishing marks or by payment.

- Distinction on the basis of appearance may relate to the vehicle as well as the occupants of a vehicle. In the first case in practice, it concerns provisions for target groups such as heavy goods vehicles and busses (e.g. a bus sluice). In the second case it concerns the number of occupants in a private/passenger car.
- Distinguishing marks ('tags') are often applied in the case of urban traffic, particularly with busses, ambulances etc. Tags these days are often electronically detectable.
- Tolls are a method of selection of target groups that have been applied in numerous countries for decades. A unique property of the payment method of selection is that the users are able to decide for themselves whether or not they belong in a particular target group or category, in other words whether the advantage gained from such is worth the extra costs involved. The American concept of the HoT-lane and the issues of toll lanes in The Netherlands are based on payment as a method of selection. Payment of road charges or tolls is possibly the only viable method of selection for the target group of private business transport.

Target group

At the present time, various target groups have been distinguished in The Netherlands. In the case of inter-urban traffic, this concerns buses, car-poolers, goods traffic, business traffic, through traffic, traffic coming from or heading to a particular origin or destination and toll traffic. In the case of urban traffic it concerns public transport (buses and trams) as well as taxis and ambulances (often as a secondary target group or a public transport line).
In the future other target groups may emerge such as ultra short / narrow vehicles, environmentally friendly vehicles and elderly users.

Effects of target-group provisions

Traffic flow

Provisions for specific target groups appear to be very effective in lowering journey times for a particular target group with regard to the situation before the introduction of the provision. The most important conditions are that the target-group provision is kept congestion-free, and that the bottleneck, which was the original reason for applying the target-group provision, is not simply shifted to a point some distance up or down the road from the provision, where there was previously no congestion.

Target-group provisions are usually effective with regard to lowering journey times for target groups in relation to those for other traffic. A somewhat peculiar condition is that the total capacity at the bottleneck area may not be increased in such a way that would cause other traffic to be able to proceed freely and without encountering congestion after the target-group provision has been introduced. In other words: the success of the target-group provision is conditional upon the (periodic) occurrence of congestion to other traffic.
It appears that a general improvement in traffic flow, i.e. including that with other traffic, only seems to be brought about under special circumstances.

Influence exerted by the value placed on journey time

Journey time, and loss of time due to travelling, does not have the same value attached to it by all road users. Statistically speaking the importance associated with journey time varies according to the type of vehicle and the motive for travelling. Compared to the lone commuter driver, the value attached to journey time by business traffic and car-pooling with 3 or more occupants is on average three times higher, and it is at a factor of five times higher for goods traffic and up to forty times as high for a fully loaded bus in rush hour traffic.
If the traffic system only offers generic provisions then these cannot however be converted into a maximum joint effectiveness. With target-group provisions this may well partially be taken into consideration.

Effective exploitation of available space

Within the context of motorized private car traffic, specific target groups in traffic (car-poolers and in particular, public transport) make more efficient use of the available space than other traffic. In other words: if there is a given amount of space then a larger volume of people can be transported per hour. This is particularly the case in urban areas, where 700 passenger cars are able to proceed on a lane 3 metres wide every hour, which often amounts to less than 1000 persons. If the lane were to be exclusively used by public transport, then the same space would be enough for 90 buses or 60 trams per hour, having a capacity of 7000 and 15,000 persons respectively. Experience in the United States indicates that where a target group provision is applied the capacity will increase by up to 3000 persons per hour or more.

Selecting a mode of transport

Those factors which influence the choice of mode of transport are often the most important motives for introducing target group provisions. By offering shorter journey times or financial advantages by applying target group provisions it is possible to achieve the desired choice of modes of transport (more car-poolers).

Exploitation of infrastructure

Traditionally the construction and management of road infrastructure in The Netherlands has been entirely paid for by the government. The target group policy offers the government the possibility of reducing costs or even recouping part or all of that investment. This is particularly the case with pay-lanes and toll roads. The fees charged for using these pay-lanes and toll roads pay for the upkeep (to a certain extent) of the roads.

Planning and Design of Provisions

The first phase ‘Initiative’ concerns estimating the magnitude of the problem and gaining some clarity about the political desirability of the solution. Further elaboration of the problem analysis and coming up with solution directions are at the core of the phase on ‘Exploration’. The next phase on ‘Planning’ concentrates on the issue of what type of action to take in tackling the traffic and transport problem. Solution directions are developed into alternatives. Special attention is given to the activities concerned with the construction and modification of the roads already earmarked for involvement or yet to be assessed. In the ‘Definitive design’ phase, matters to be covered include details of the plan for the approach to realization, planning incorporation, land acquisition and obtaining the relevant permits. The 'Realization phase' covers such matters as opting for an introduction strategy and limiting the hindrance caused by building work. Before the penultimate phase of 'Usage' commences, it is necessary to work out exactly how the provision will operate. The monitoring of results is also included in this phase. The whole process is concluded with the 'Adaptation phase'. It should always be possible to adapt a provision intended for a specific target group as circumstances may change in the course of time in such a way that renders the original provision obsolete as a solution to the prevalent traffic problems which have developed in the meantime. The process is not completed until the provision functions according to plan.

The target-group provision should not be too hastily regarded as a solution to all the problems in the first few phases of the process. Apart from having certain advantages, there are also certain significant disadvantages associated with target-group provisions, which mean that they are not always the best solution to a given problem.

<u>Communication</u>

Communication has a vital role to play in all the various phases. Good communications are particularly crucial in gaining public support for a provision. Communication with road users is essential if it is decided to reduce existing road capacity for the benefit of specific target groups. It is difficult to explain the reasons why a conscious decision has been made to design target-group provisions which will not operate at maximum capacity while other traffic is stuck in a traffic jam. It is vital to inform the general public of the reasoning behind a particular target-group provision as early as the design phase. This includes explaining the advantages involved in relation to other possible solutions, explaining how the provision will work and which particular target groups will be considered in the process.

<u>Introduction strategy</u>

Prior to a provision being used in practice, it is necessary to establish an introduction strategy.
In this, it is projected that usage of the provision by a particular target group, is initially often far below that of the eventual intended usage. Examples of strategies include:
1. a provision being put into use by the target group(s) it was intended for, immediately following completion of construction;
2. a provision being initially opened to a broader target group;
3. a provision being initially opened to all traffic.
Strategy 1 may lead to the *"empty lane syndrome"* and acceptance problems. Strategy 3 may also lead to acceptance problems, especially at a point when it becomes apparent that use of the provision will have to be limited at some time afterwards. If following construction, the amount of target-group traffic proves insufficient to justify exclusive access to the provision, then strategy 2 would be the preferred choice.

Network of Provisions

A traditional approach to a provision for a specific target group is to construct it at a point where there is a serious bottleneck. The drawback with this approach is that people and goods are not simply moved from one point directly ahead of the bottleneck to another point immediately behind it. Road users will choose a great variety of routes within a network or corridor and usually move through networks managed by various different road authorities. It is also important that other road users are offered good alternatives to a particular route if a provision for a specific target group takes away existing road capacity. This is important for the sake of gaining public support for the provision and ensuring its effectiveness.

A network approach to a target-group provision is on the rise in the United States. This does not so much mean just solving individual bottlenecks, but is concerned with improving traffic flow for target groups in their journeys over the entire road network.

If well executed a network approach can have many advantages. The target-group traffic is given the opportunity of moving around a road network in a rapid and reliable way. This projects a positive image of the target group in general. They will gain more widespread public support, including financial support, for offering alternative modes of transport at the network level. There are economies of scale to be gained in the construction and utilization of a target-group provision in the areas of construction costs of links, maintenance of provisions, incident management, information and perhaps even payment systems. The latter advantage is that a network will be given a flexible and assured future, within a secure framework, providing smooth traffic flow for target groups.

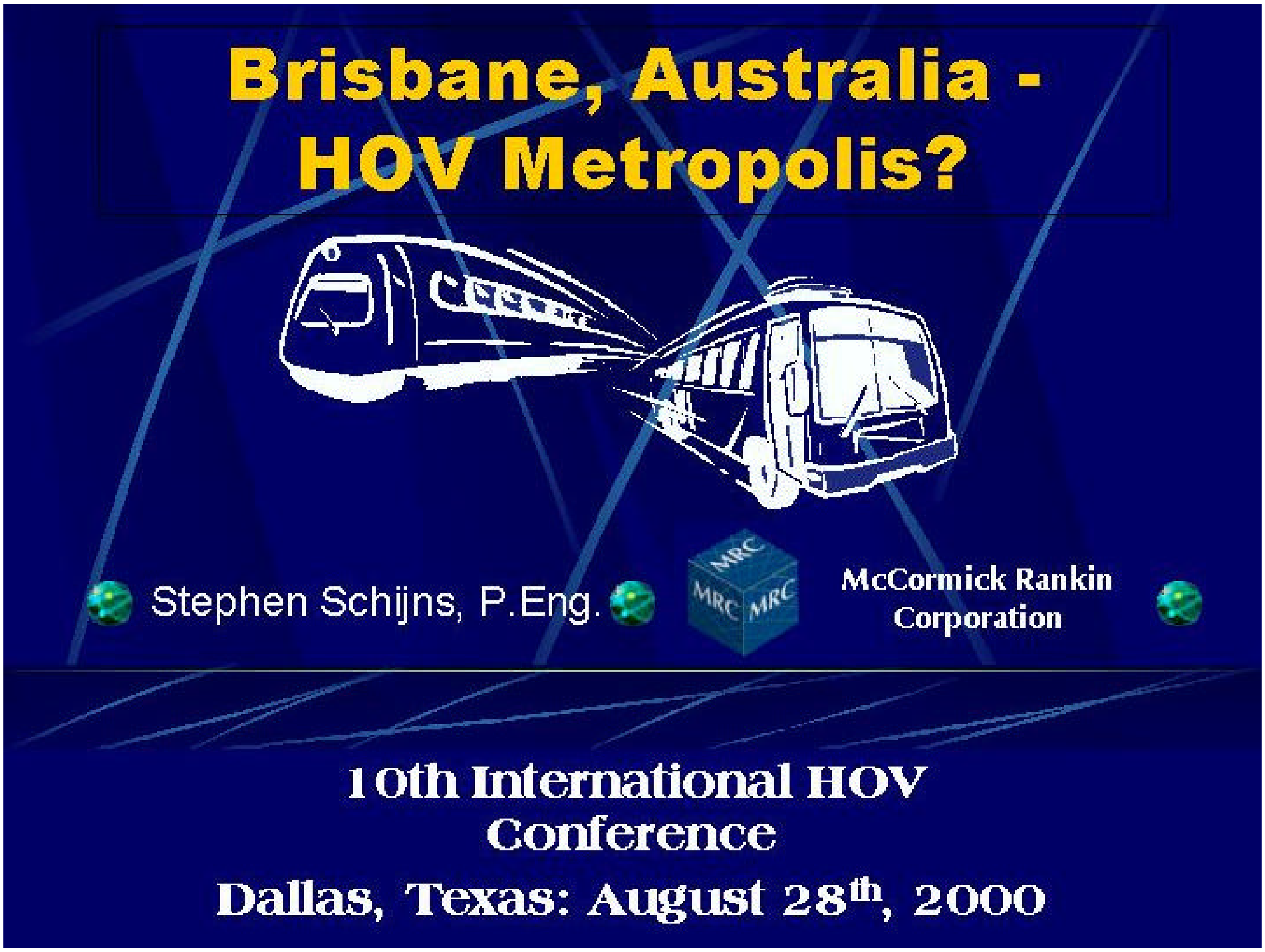
Bringing about a target-group network is expensive however and requires careful consideration. That is why strict conditions must be applied with regard to the envisaged future, co-operation, ancillary measures and feasibility. That is why it is also vitally important that there is a good implementation strategy.
If it is not possible to construct the network in one go, then it is obvious that the most essential parts and the “core” of the network be constructed in one operation and that other parts, which will certainly become essential in the course of time, are executed in a phased construction plan.

Conclusions

1. Target-group provisions have acquired an undisputed position within the urban traffic scene in The Netherlands and have slowly but surely also started to expand to include space in the inter-urban environment.
2. Provisions come in various types and on varying scales of magnitude and have their own individual effects on capacity, selection systems, target groups as well as advantages and disadvantages.
3. Dutch government policy tends to favour self-selection of target groups by instituting charges.
4. Thinking in terms of provision networks offers a flexible and established future framework for the traffic flow of special target groups.

Reference material

Provisions for target groups, with policy according to execution. CROW- publication 148.
Ede, June 2000.



"Brisbane, Australia – HOV Metropolis?"

August, 2000

Stephen Schijns, P. Eng.
McCormick Rankin Corporation
Mississauga, Ontario, Canada / Brisbane, Queensland, Australia

schijns@compuserve.com

Brisbane, Australia – HOV Metropolis?

Abstract

Brisbane is a thriving subtropical metropolis of 1.7 million people on Australia's east coast. It features a diverse yet fragmented transportation system currently undergoing both significant stress and rapid upgrading. High Occupancy Vehicle (HOV) lanes have been implemented over the past two decades on selected arterials but the stage is being set for a major expansion of the region's HOV program. The wide range of HOV projects and the planning context in which they are emerging will be of interest to international HOV practitioners.

Specific aspects of the Brisbane experience addressed include:

- Arterial HOV and Bus lanes: operational experience and lessons learned
- South East Transit Project: state-of-the-art Busway + freeway HOV lane project
- Freeway HOV lanes: 2+ vs 3+ vs 4+ issues
- Brisbane HOV Network Study: an arterial network that makes sense
- Integrated Regional Transport Plan: the pro-transit big picture
- HOV Enforcement - the quest for success
- HOV Problems - from the familiar to the unique
- International HOV Experience – what's applicable, what's not

The author is able to provide a comprehensive overview of the Brisbane situation with regard to the interests of international practitioners. He has been active in the North American bus / HOV sector for many years, and is currently working in Brisbane on several of the region's major HOV initiatives.

1. Brisbane – Setting and Transportation Context

The aim of this report is to take a guided tour through the HOV scene in Brisbane, Australia.

Brisbane is a modern growth-oriented city on Australia's East Coast, at the hub of a region with a population of 1.7 Million. The 2% average annual growth rate is fuelled by both immigration and an influx from elsewhere in Australia.

Brisbane, after Sydney and Melbourne, anchors Australia's third most populous region.

As capital of Queensland, Australia's second-largest state, Brisbane and its surroundings take up half the state's population. It has no real rivals - the next largest city in Queensland outside the Brisbane sphere of influence is Townsville, at 120,000. And past that, there are a few more centres and lots of open space - Queensland runs 2000 km north to south and 1500 km east to west!

Physically, Brisbane lies on a coastal plain, interrupted by some low rounded hills from a volcanic past. The winding Brisbane River is navigable but ocean-going vessels are restricted to piers near its mouth. The river pours into Moreton Bay, a large shallow basin protected from the open ocean by a string of barrier sand islands, which are among the world's largest.

The heart of the city lies some 10 km inland, cradled in one of the bends of the river, and is surrounded by some hilly terrain.

The subtropical climate is very pleasant, with daytime highs in the 20 to 30 degree range all year round - somewhat akin to that of Miami. The summer can be very humid, with periods of heavy rain. The suburbs sometimes experience a light winter frost but the city has never seen snow.

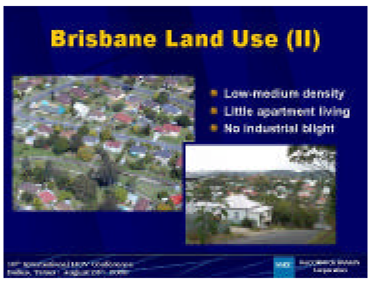
There is a ring of suburban centres, usually anchored by regional-scale shopping malls, at about a 10 km radius from the CBD. These tend not to have dense office or residential development; they are strictly commercial. There are no "Edge Cities" on the American model; the urban area simply sprawls until it fades into large-lot rural properties.

The Australian assumption that everyone owns a home manifests itself in Brisbane in vast areas of low-density residential development. There is little apartment living except for singles or urbanites. As a consequence there is little densification around transport hubs or other forms of transit-oriented land use.

Brisbane is very much a city of neighborhoods; while many such areas have long since seen their heyday come and go, it is still possible to rely on your local "main street" or shopping centre for most needs. Some are being revitalized.

It is not a heavy industrial town; warehouses dominate instead. They are concentrated around rail and airport hubs, fairly well segregated from residential lands.

The obsolete industrial areas surrounding the CBD have undergone a startling transformation in the last twenty years. The nightlife scene of Fortitude Valley is attracting residential redevelopment projects, and World Expo ‘88 saw the entire South Bank of the river across from the CBD get cleared. It has become a superb urban park - complete with sandy saltwater beach - as well as the State cultural centre (museum, gallery, library, etc.). The revitalization is stretching further into West End, where a wonderful urban mix continues to evolve, just minutes from the CBD.



Brisbane spreads both north and south along the coast and inland to the established cities of Ipswich and Toowoomba, which are evolving into bedroom suburbs to some extent. Sprawl is limited only by substantial forest and wetland reserves.

Some 70 km to the south is the booming Gold Coast, home to 300,000+ people and the country’s greatest concentration of high-density development in the apartments and resorts along the ocean. There is no break in the development along the Pacific Motorway between Brisbane and the Gold Coast.

The Sunshine Coast 100 km to the north of Brisbane is a bit further away and less-developed, but development is creeping in to fill the gap.

2. Brisbane Transportation Situation

Brisbane has a rather skeletal **freeway** system; the **Pacific Motorway** is a 6 - to 8-lane freeway joining the CBD to the Gold Coast in the south.

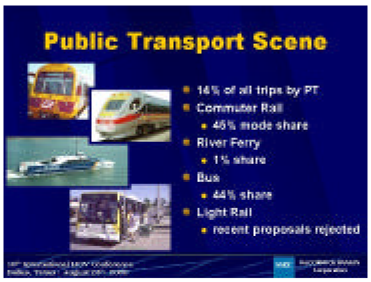
The **Bruce Highway** starts in the northern suburbs as a four lane freeway and heads north to the Sunshine Coast and some 1,700 km further to Cairns.

The four lane **Gateway Motorway** skirts eastern Brisbane as a bypass for through travel; it also picks up local trips because it is one of the few river crossings (via a toll bridge).

The **Ipswich Motorway** and the **Centenary Highway** are also four lane freeways; they pick up commuter trips from the west but stop a few miles short of the CBD.

The **Logan Motorway** is a southern bypass, and is a four lane toll road.

The **arterial** system is extensive but for reasons of history and topography it is both irregular and discontinuous. It is not connected particularly well with the freeway network. Both the City and the State have arterial responsibilities.



The historic backbone of the public transport system is the 6-line **commuter rail** system. This electric system runs half-hour service all day, with 10 minute frequencies on key routes in the peak. A private extension to the Airport is under construction. The rail system operates on a standalone basis and is poorly integrated with the bus services.

One of the greatest flaws in the entire Brisbane transport scheme is the lack of river crossings - there are only six road bridges in all - but political aversion to any new bridges has stalled the issue. One consequence is that central Brisbane is served by a successful high-speed commuter catamaran run as well as by several more traditional cross-river **ferries**.

Another recent initiative, to reintroduce **Light Rail** to the streets of the CBD, stirred up a lot of interest but ultimately failed to make its economic and ridership case and has just been terminated. Brisbane once had an extensive tram network but it was ripped up in the 1960s.

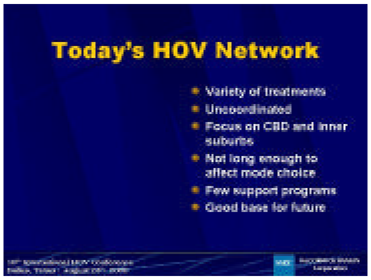
The City of Brisbane is almost unique in Australia in that it runs its own **bus operation**; elsewhere it is a state undertaking. Nevertheless, bus infrastructrure such as terminals, park & ride lots, and busways are usually built by the state. Bus services in adjacent communities are contracted by the state; those buses run express into the CBD but have limited pick-up rights within Brisbane.

The rail system is also independent of the bus systems and there has historically been little effort aimed towards service **integration**; the state-led Integrated Regional Transport Plan has triggered a major effort towards overcoming this foregone opportunity with integrated fares, services, and facilities but there is a long way to go.

3. Brisbane HOV Scene

The HOV scene in Brisbane is an active, growing part of the regional transport picture.

3.1 Overview



Brisbane has implemented a wide range of **bus priority** measures over the past thirty years. They have primarily been opportunistic queue jumps or lane conversions, focused on inner city and inner suburban trouble points. Recent years have seen a few extended HOV (3+) lane treatments on suburban arterials hosting busy bus routes.

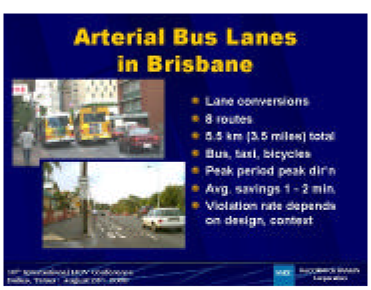
There has been little focus on **carpool** promotion or support programs to date - only priority parking in some City-owned CBD lots and a brief ridematching pilot project come to mind.

HOV projects have, to date, been developed in isolation; an **HOV network** strategy study been undertaken just recently.

Performance of existing HOV facilities has been adequate on a standalone basis, but rarely do travel time-savings mount up to a great enough level to influence mode choice.
Bus operators and enforcement agencies have not generally been involved in developing plans; most priority lanes still feature curbside bus stops rather than indented bus bays, for example. Violation rates for arterial T3 lanes are quite high, and police presence low.

HOV facilities to date have not required a great deal of money to build and operate; they have been designed to take advantage of opportunities. Consequently, there remain operational flaws in some of them, and signage and pavement marking is minimal. However, “cheap and reasonably effective” is still a better result than most cities can boast. Particularly noteworthy is that most of the 14 km of Bus and HOV lanes has been through lane conversion from General Purpose.

3.2 Bus Lanes



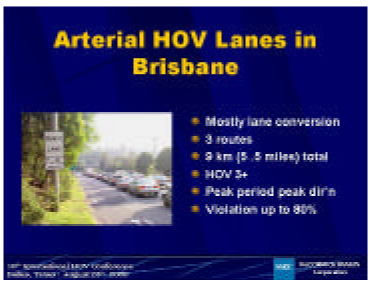
Central Brisbane features eight relatively short **bus lanes**, aimed at getting buses past congested groups of traffic signals and in to or out of the CBD. There are a couple of traditional city centre bus lanes as well, but they are so full of stopped buses during peak periods the City hardly needed to bother with putting a sign up discouraging other users.

All of the bus lanes have been low-cost low-impact opportunistic facilities, and most use the curb lane on one-way streets and leave at least two lanes for general traffic. They seem to have been slipped in over the years with a minimum of public fuss.

They only save a minute or two apiece, so existing bus lanes are not likely to have much impact on mode choice. They do help buses stick to schedule in the congested CBD. Violation is less of a problem than with the HOV3+ lanes; either the Bus Lanes are full of buses and are unattractive to violators, or they are clearly seen as risky facilities where a violator is easy to spot. There are operational problems, however, at intersections where heavy turning vehicle demand clogs the bus lane on its approach.

The Coronation Drive Bus Lanes, currently being implemented, are part of a $AU20M job to widen and restructure a major arterial to a consistent five lane cross section, which will have a reversible centre lane and thus allow a curb-side bus lane in the peak direction during peak periods alongside two general purpose lanes each way at all times.

3.3 Arterial HOV Lanes



There are three arterial HOV (3+) lanes in operation in Brisbane, as of mid-2000:
- Lutwyche Road, 3.1 km long am peak approaching the city from the north
- Mains Road, 3.4 km long am peak feeding the SE Freeway 10 km from the CBD
- Kelvin Grove Road in the north west, 1.2 km pm peak outbound and 2.1 km inbound am peak

All were implemented as HOV 3+ in the 1990s through lane conversions on busy 6-lane routes featuring heavy bus volumes.

A fourth arterial facility is under construction - the 6 km long HOV lane on Waterworks Road in the north west was promoted as 3+ but resistance to the traffic and community impact has meant it will be implemented at 2+.

As is typical of arterial HOV lanes, scheduled enforcement is not adequate to keep violation rates down, particularly for lightly-used 3+ lanes.

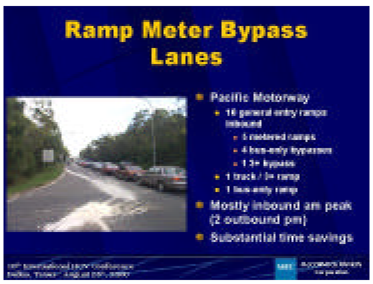
3.4 Bus Queue-Jumps

The first bus priority measures implemented in Brisbane were mainly simple queue jumps at selected inbound congestion points. A few feed the South East Freeway and others allow buses to sneak past general traffic on the approaches to a traffic signal.

There are a few other odds and ends in place - a couple of brief bus-only contraflow lanes in the CBD, a little one-way bus tunnel under the South East Freeway (recently superseded by the South East Busway), and some bus-only ramps on the South East Freeway (also now superseded).

These facilities came from a hodge-podge of programs - some were Brisbane City initiatives to help their Brisbane Transport buses along, others were on Department of Main Roads facilities, while Queensland Transport was sometimes able to contribut infrastructure funding as well. There are even occasional Commonwealth (national) funding programs which can be tapped in to. While each facility continues to function largely as planned, they do not act together nor were they planned in a coherent manner

3.5 Ramp Meter Bypass Lanes



The South East Freeway is a constrained four- and six-lane facility which experiences severe inbound congestion for up to 20 km during the a.m. peak period. Outbound p.m. peak congestion is also extensive.

Ramp metering has been used for many years to manage entering flows so as to preserve an acceptable level of freeway operations. The Department of Main Roads controls both the freeway and several approaching arterials, and they have not been afraid to let substantial queues build on the arterials in order to keep the freeway moving.

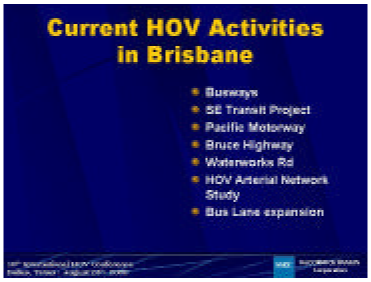
Main Roads does, however, have a policy of providing ramp meter bypass lanes for priority vehicles wherever there is a physical fit and there is a bus demand. Most are for buses only, although the one which links an arterial HOV 3+ lane to the freeway (pictured) is open to 3+ carpools. South of Brisbane, one ramp is open only to trucks and HOVs; in that case general purpose traffic has been excluded because there is not enough queue storage length to meter the ramp. The queues at metered ramps generate travel time savings of up to ten minutes for bypass lane vehicles.

The opening of the South East Busway will make most of the bus bypass lanes redundant. Though no decision has yet been made as to their fate, conversion to HOV 3+ use is an obvious opportunity, in concert with the freeway HOV lanes under construction and with feeder arterials.

The bypass lanes are rarely enforced but violation rates sit at a sustainable level - you have to be pretty brazen to regularly drive past dozens of queued vehicles and then merge in to the head of the queue in an ineligible vehicle.

4. Current HOV Activities

4.1 Key Projects



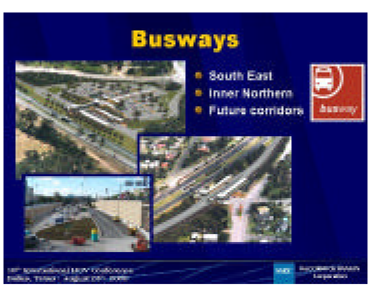
The HOV front in South East Queensland is an active one at this point. Following from the Integrated Regional Transport Plan there is substantial investment in transport infrastructure going on, with Public Transport and HOV facilities getting their fair share.

The flagship project is the upgrading of **the Pacific Motorway** corridor to eight lanes between Brisbane and the Gold Coast; this takes the form of a 43 km long freeway widening, creation of 20 km of HOV lanes, and a 20 km busway - a $AU 1.5 billion undertaking in all. The freeway HOV lanes will be the first of their kind in Queensland and a lot is riding on their success. Similarly, Brisbane has staked its transport future on the busway system, so the **South East Busway** will be watched with keen interest as it takes its place in the region's transport system.

On the arterial side, the focus has traditionally been on bus priority and bus lanes, with the **Coronation Drive** "Tidal Flow" bus lane project the most significant commitment to that principle. City Council has not shied away from implementing HOV lanes on arterials if they make sense. The arterial bus lanes and HOV lane, however, are at a point where most of the "easy" ones have been implemented and some of the problems which have arisen need to be addressed.

The City and State governments are therefore collaborating on **an HOV Arterial Network Study**, to define planning principles, put forth design guidelines, and develop a network plan and implementation strategy for a coherent system of on-street priority to buses and carpools.

4.2 Busways Coming to Brisbane



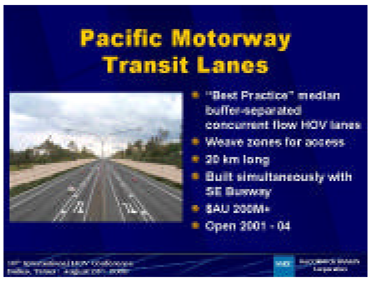
Brisbane is implementing a set of **busways** on the Ottawa, Canada model. They will be two lane bus-only roadways on their own alignments, connecting bus stations and interchanges every kilometre or so.

The first one, through South Bank and along the Pacific Motorway, will open in stages between October 2000 and May 2001. Part of it parallels the new freeway HOV lanes, to open concurrently. A second leg extending northward from the underground CBD bus station is late in the planning process and will be implemented in stages over the next few years.

Once Busways have settled in and their benefits properly assessed, decisions will be made about if and how to move forward with busways or bus rapid transit in the four other corridors identified in the mid-nineties Busway strategy plan.

The busways are forcing a restructuring of bus services in Brisbane, which in turn will affect the need for bus priority on roads feeding busway stations and limit the role of parallel HOV lanes to supporting carpools only.

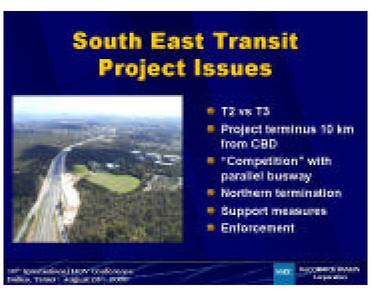
4.3 Pacific Motorway HOV Lanes



The centrepiece of the current HOV program in Queensland is the addition of HOV lanes to **the Pacific Motorway (South East Freeway)**, the state's busiest roadway. Built together with the South East Busway and the Pacific Motorway widening to the south as part of a commitment to eight-lane the highway between Brisbane and the Gold Coast, the HOV lanes will extend 20 km through suburban Brisbane.

A buffer-separated design was selected, with 24 hour operation and designated zones for access / egress. Design principles drew from a review of world's Best Practice, of which the California guidelines were most representative.

The project is under construction in stages, with 5 km opening at the end of 2000, another 7 km open in 2002, and the remainder to follow. The first stage parallels the new Busway while the rest functions as an extension of the Busway by allowing fast reliable bus travel to the southern suburbs. Consideration is being given to providing direct bus-only or HOV ramps between the freeway HOV lanes and two bus terminals and a park & ride lot.
The freeway is reasonably congested; HOV lane users will expect travel time savings in the 5 - 10 minute range during peak periods, along with an end to the frustrating variability in travel times.



The HOV lanes on the Pacific Motorway do not extend to the city centre; the 8-laning commitment does not apply to within 10 km of the CBD since the freeway is already six lanes from there in, and the busway makes up the other two lanes. This dramatically reduces the carpool travel time savings available and hence the mode shift incentive. For buses it is not an issue since they have a free run in via the parallel busway.

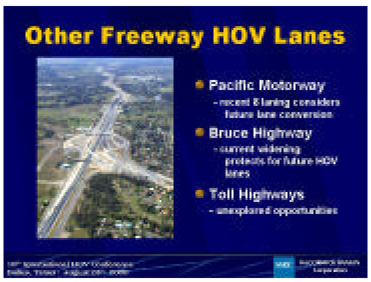
There is some reticence to pursue the issue because promoting downtown-oriented carpool travel appears contrary to promoting bus use in the same corridor (especially when such a major investment has just been made in the Busway).

This leaves the HOV lane terminating in a congested zone at Mains Road. It also has a big impact on the vehicle eligibility assessment, because adding a lane of two-occupant carpools to the bottleneck will have a dramatic impact on congestion. This almost forces the HOV lane to be restricted to 3+ to protect the downstream operations. However, 3+ volumes are so low (particularly once the buses have been shifted to the busway) that the whole HOV project is at risk of becoming unsustainable technically and politically.

Compounding this situation is the immaturity of the HOV support program in Queensland. As the state's first major HOV initiative, the South East Transit Project does not have a built-in set of park and ride lots, ridesharing promotion, employer-based measures, guaranteed ride home, or any of the other contributors to success. The enforcement of freeway HOV lanes is also new to the state.

It will be fascinating to see how this all plays out over the next couple of years!

4.4 Other Freeway HOV Prospects



The Department of Main Roads has assessed the HOV potential of most of the Brisbane-area freeway network, and is protecting for future HOV lanes in its planning.

The 43 km of **Pacific Motorway** between Brisbane and the Gold Coast to the south was recently subject to a $AU750M upgrade to eight lanes; while HOV lanes were considered, the eight-laning should take care of today's traffic woes for some time. Furthermore, due to the high proportion of vacation / recreational traffic, the peak period is actually on weekends and the lane would have to operate at 4+ if it were to operate without congestion! As the South East Transit Project is completed, the portion of the Pacific Motorway closest to Brisbane would be a candidate for lane conversion during weekday peak periods.

The **Bruce Highway** to the north of Brisbane is a four lane freeway which requires upgrading; current plans are to upgrade to six general purpose lanes, and reserve any subsequent widening for HOV purposes.

The two toll freeways serving Brisbane, the **Logan Motorway** and the **Gateway Motorway**, show some long-term HOV potential. It is unclear as to whether HOV lanes per se would ever be implemented on those facilities, or whether HOV priority would be granted via the toll mechanism. HOV queue bypasses at toll plazas are an obvious opportunity.

4.5 Waterworks Road – Arterial HOV 2+!

Waterworks Road funnels traffic from the west and northwestern suburbs towards central Brisbane on a roadway that varies between two and five lanes in width. It passes through several streetfront commercial areas as well as through established residential zones, on a hilly and winding alignment.

The route suffers from severe congestion during peak periods, particularly in the peak direction, and hosts up to twenty buses per hour. Planned improvements take the form of selected widenings to create a continuous four lane cross section.

Brisbane City Council's experience with arterial HOV lanes combined with the principles of the regional transport plan led Council to proposed HOV 3+ lanes on the improved segment of Waterworks Road. The widening plan was controversial in the community; HOV lanes were seen as a stalking horse for adding general purpose traffic capacity in the constrained corridor.

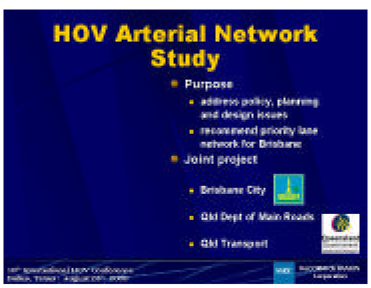
Operationally, HOV 3+ proved to be problematic, since it implied removing non-HOVs from the stand-up lanes at signalized intersections in order to give buses and the few 3+ carpools "head-of-the-queue" treatment. Not all intersections have storage for turn lanes either, and Queensland's "no turn on red" rule also hampers HOVs' queue-jumping abilities. The net travel time impact for all road users would be worse than doing nothing at all.

The compromise is an HOV 2+ lane, which evens out the queues at signals, produces a well-used lane which is accepted in the community, and still provides a reasonable level of priority for HOVs. It is now under construction.

A critical unresolved issue is the lack of bus bays on Waterworks Road, which will result in stopped buses blocking what is supposed to be the priority lane.

4.6 HOV Arterial Network Study

Brisbane City Council, Queensland Transport, and the Queensland Department of Main Roads have recently cooperated on a wide-ranging HOV Arterial Network Study, undertaken by McCormick Rankin and local firm PPK Environment and Infrastructure.



The aim of the study was twofold:
- identify general policy / planning / design issues associated with priority lanes, be they Bus Lanes or HOV Lanes, and recommend practical solutions / approaches for Brisbane; and
- identify, analyze, and recommend priority treatments (if applicable) on arterial roads in Brisbane, the collective outcome representing an HOV Network Plan for Brisbane.

Issues such as the role of arterial HOV lanes in the Integrated Regional Transport Plan, road widening vs. lane conversion, 2+ vs 3+ vs Bus-only designation, the type of lane, operating hours, individual treatments vs. region-wide consistency, etc. were addressed in the Network Study. The State agencies were particularly interested in establishing an analysis methodology that was transferable to other areas within Queensland, while every party had a great interest in the route-specific plans and associated implementation issues and costs.

There were three major elements to the study, therefore:

- setting the basic policy and design ground rules;
- developing functional plans for HOV priority and alternatives on 200 km (125 miles) of arterial and freeway; and
- developing and applying a methodology to screen and analyse those corridors (and options within corridors) to generate a set of recommendations for implementation over time.

The policy issues were addressed by applying "best practice" from around the world to the specific Brisbane situation. The full range of potential arterial treatments was considered, and support program elements were outlined.

Various network strategies were considered, and a "bottom up" approach selected, building the network from its individual corridors rather than a "top down" effort to fit a standard strategy across the city. The "top down" strategy worked in Toronto, where a relatively uniform arterial grid provided some consistency, but Brisbane's fragmented road network meant that each corridor had to be assessed on its own merits.

This methodology was put into a four-step process:

1) assess all corridors and select the most promising for closer investigation
2) develop and recommend reasonable HOV priority measures for each corridor from (1)
3) combine routes and priority measures to produce a network concept
4) reassess individual corridor recommendations in light of the network context.

A standard menu of analysis factors was defined at the start, with the application of the factors varying according to the level of analysis. The factors covered a broad range of HOV issues, including HOV demand, traffic impact, planning goals, community context, operations, cost-effectiveness, and bicycle impact.

At the preliminary screening level in considering some 400 km (250 miles) of arterial road, for instance, "HOV demand" was represented by "bus per hour in the peak hour peak direction". This limited the data requirements yet allowed a "level playing field" for comparing corridors.

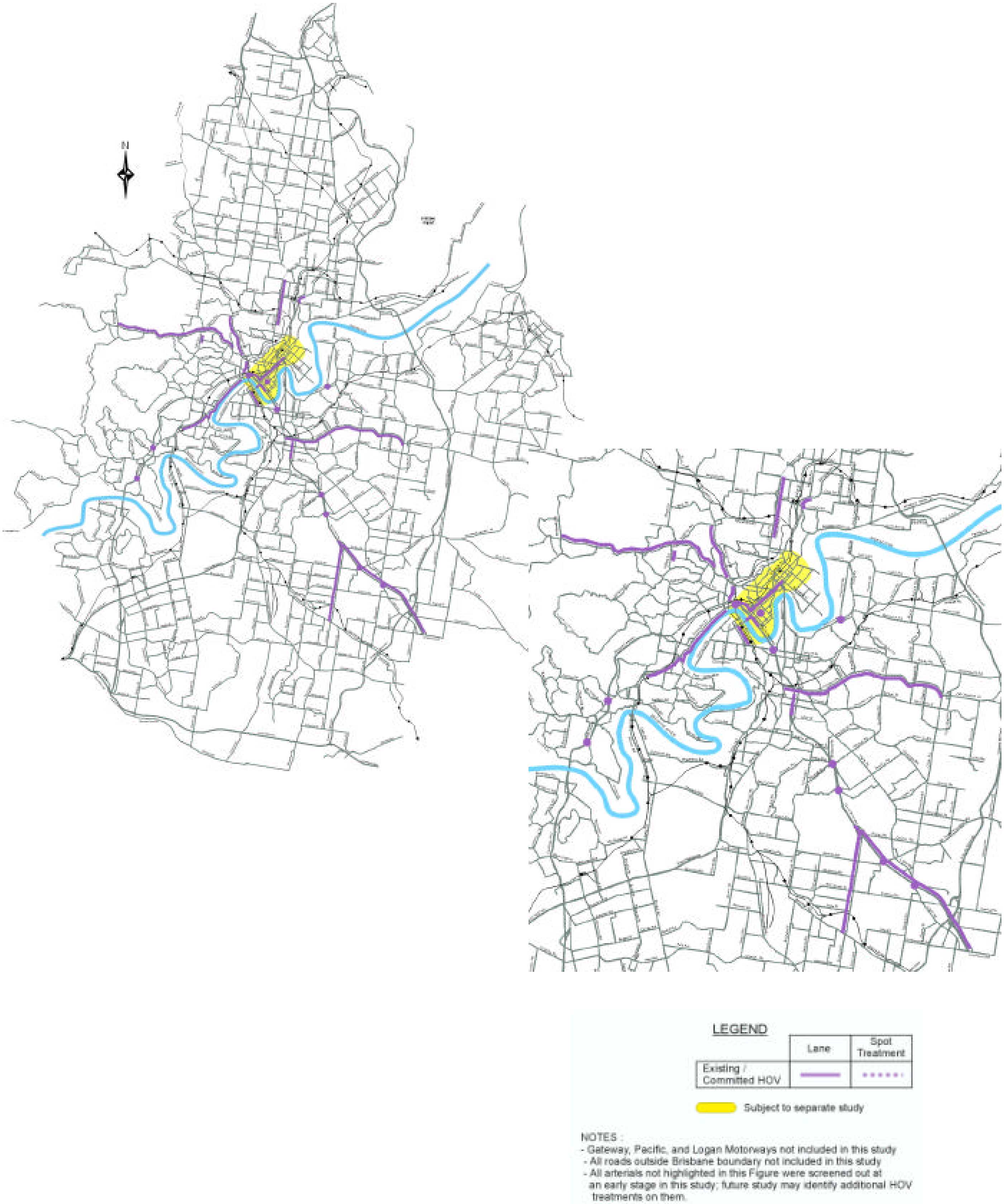
Once the specific treatment options were developed, the second-tier assessment used bus patronage counts, route maps, carpool counts, mode shift estimates from traffic impact analysis, and growth projections to define demand and allow a comparison of alternatives. The "HOV Lane" treatments developed for all of the 200 km of short-listed corridors were based on field review and engineering judgement; determination of whether they would most appropriately operate as Bus-only, 3+, or 2+ was left to the analysis process, except for a few bus-only opportunities which emerged in some locations.

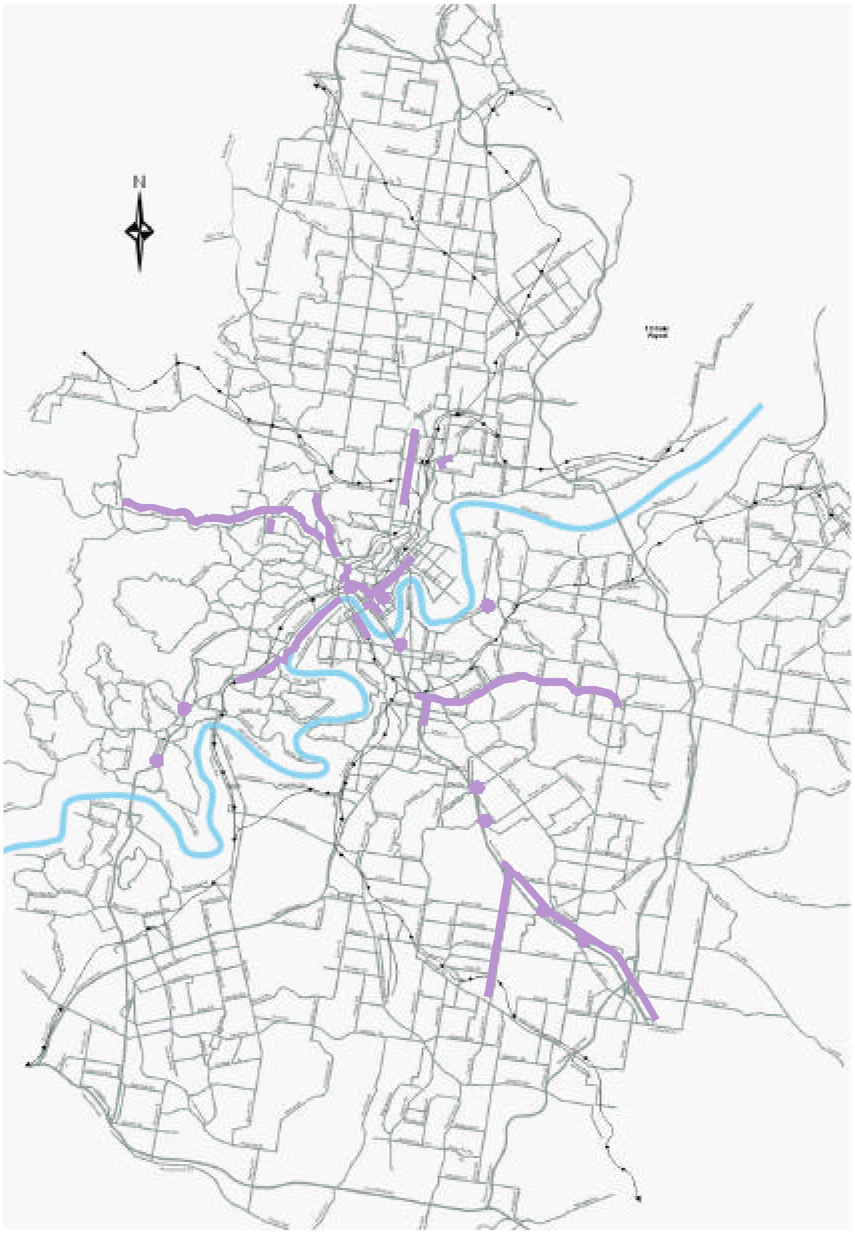
The preliminary results suggest an ultimate HOV network of in the order of 150 km of arterial and freeway (with selected additional corridors not within the study scope likely to bring the full extent over the 200 km mark in time). Most arterials ended up at 3+, to strike the necessary balance between bus priority and operational integrity. There are some viable 2+ arterial candidates, though. They are mainly lane conversions since there is neither the opportunity nor the rationale to widen arterials in most cases. The network absorbs all of the existing HOV lanes and facilities.

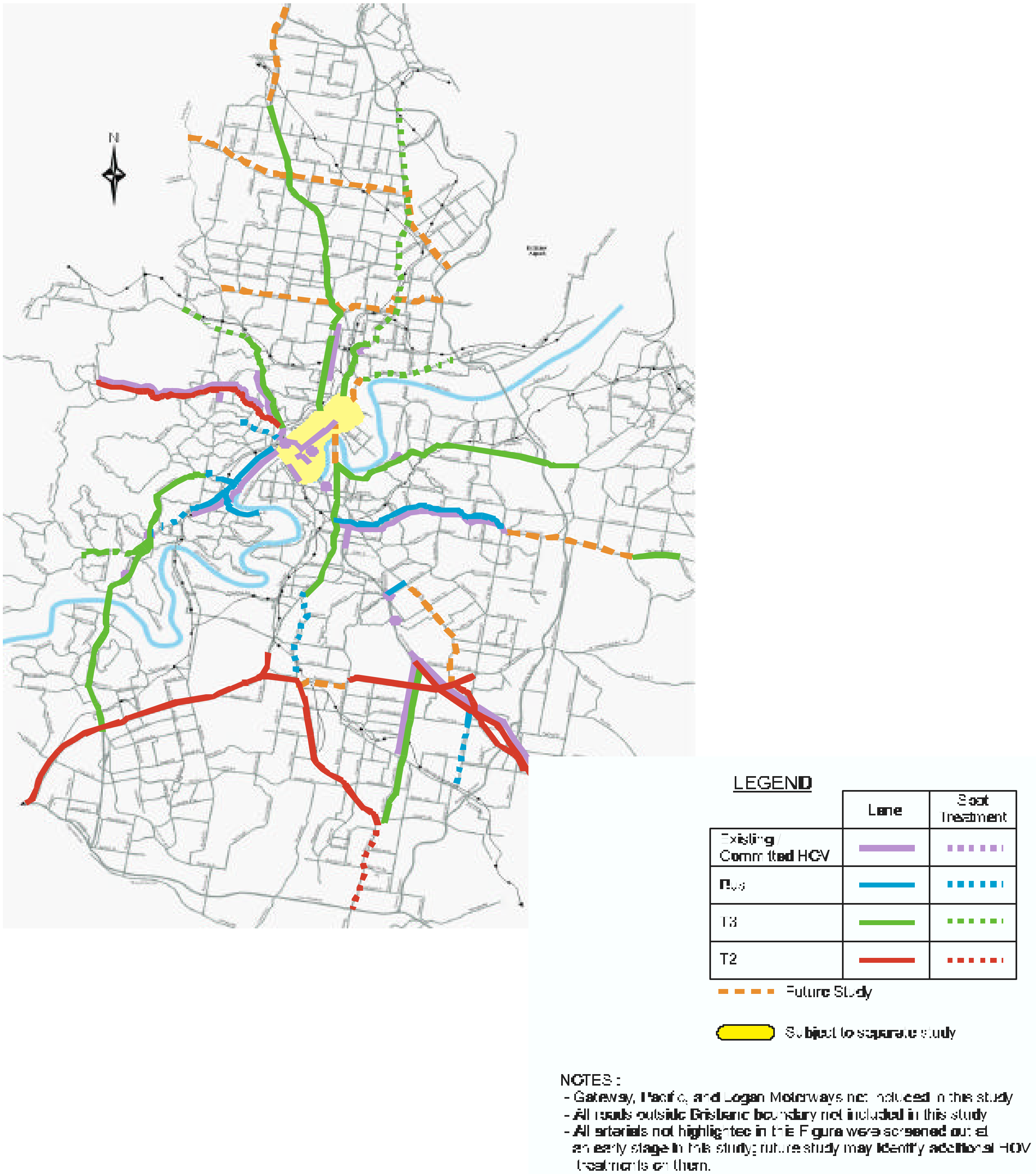
All but one of the freeway segments emerged as added-lane 2+ recommendations; the exception suffers from significant downstream constraints which mitigate against adding substantial traffic to the area (this may be resolved over time).

The recommended network now goes into the approvals stage, and hopefully absorbed (along with the planning guidelines and assessment methodology) into the ongoing implementation programs of the respective proponents.

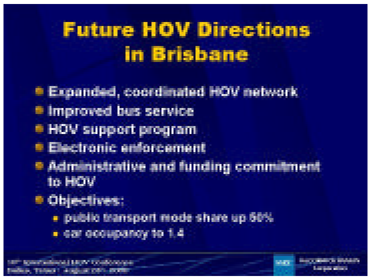
Figure 1: Recommended HOV Network




N


N
LEGEND
Lane
Spot Treatment
Existing / Committed HOV
Bus
T3
T2
Future Study
Subject to separate study
NOTES :
- Gateway, Pacific, and Logan Motorways not included in this study
- All roads outside Brisbane boundary not included in this study
- All arterials not highlighted in this Figure were screened out at an early stage in this study; future study may identify additional HOV treatments on them.

5. The Future for HOV in Brisbane



Brisbane stands on the threshold of a momentous leap into the unknown. The Transport Vision has been articulated, and it includes substantial reliance on shared-ride travel, which in turn implies a much-expanded HOV network and a coordinated effort to support HOV use. A substantial increase (simultaneously, and in terms of person-kilometres of travel, almost equivalently) in both public transport mode share and private auto occupancy rate is to be the result.

Aside from the physical manifestation of HOV lanes on arterials and freeways, there are significant opportunities in the less-visible areas of interjurisdictional coordination, electronic enforcement, and promotion of a "leave your car at home" ethos among commuters.

The actual HOV market in Brisbane is only poorly understood at this point, but the region won't be getting very good answers until there is more infrastructure on the ground and greater awareness of transport issues among the populace. In that sense, the infrastructure horse has to be put ahead of the marketing carrot, which in itself requires a considerable political and executive commitment to the idea.

The Integrated Regional Transport Plan, the Pacific Motorway HOV lanes, the ongoing work by City Council to provide bus priority on the streets, and the endorsement of the Arterial HOV Network Study provide a solid indication of the level of support present, and that commitment presages a potential Golden Age for buses and carpools, and a transformation of South East Queensland's transport situation.

Concerns remain, however. Brisbane has not yet come to grips with two key aspects of HOV:

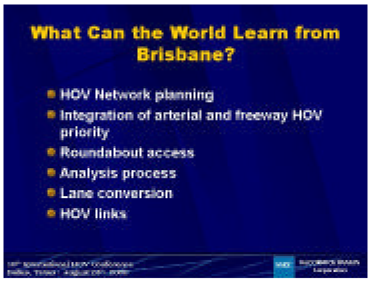
- the critical importance of HOV support programs; and
- the ability to control, or at least influence, land use to be less auto-reliant.

There is considerable fear that bus lanes and HOV lanes are being developed and applied simply as infrastructure, while little attention is paid to the support programs that really shape the market demands. Things like vanpooling, ridematching, Guaranteed Ride Home, preferential parking for carpools, and the whole notion of the public sector influencing private sector participation in transport (via Transportation Management Associations, Employee Transportation Coordinators, transportation allowances, etc.) are far behind the "best practice". It would appear that such programs will be necessary for the Brisbane HOV Network to be sustainable.

Brisbane has been somewhat of a boom town over the past couple of decades, and development has been guided only loosely with little overt shaping of the land use - transport relationship.

Accordingly, the transport system has suffered and will continue to be hostage to a low-density development ethos.

In addition, Brisbane has a long way to go yet in terms of signage, pavement marking, and highlighting the HOV lane on the road. Another area Brisbane is actively pursuing (and looking for guidance overseas) is the use of electronic enforcement for bus lanes and HOV lanes.



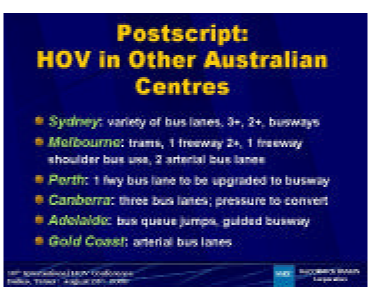
Brisbane does, however, have an enviable track record in simply getting on with the job. A great deal has been accomplished over the past two decades. Opportunities have been seized to implement bus and carpool priority with little fanfare or outcry.

The effort to create the Integrated Regional Transport Plan, and the subsequent interagency cooperation in developing a true regional HOV strategy, is admirable. Arterial HOV lanes can never be effective in inducing modal change without a network plan; Brisbane is one of the few cities in the world to develop such a plan. In doing so, a step-by-step analysis process was used to work from the "top down" from network principles to corridor-specific treatments and back up a coherent network plan.

The network development process clearly showed the value of a "horses for courses" approach as opposed to applying uniform region-wide standards for eligibility, layout, etc. It also yielded some innovative treatments at Tee intersections, roundabouts, and complex intersections.

In Brisbane, it is clearly recognized that getting the bus to the busway reliably and quickly is nearly as important as building the busway itself; similarly, carpools can gain as much advantage at a single ramp meter bypass lane as over several kilometres of expensive freeway HOV lane. Coordinating arterial priority treatments with high-capacity trunk routes is a critical part of the HOV network plan.

6. The Australian HOV Scene – A Snapshot



Australia's capital cities have almost all pursued bus priority measures of some sort, and the two largest cities, Sydney and Melbourne, have dabbled in the carpool area as well. In no case, however, can there be claimed to be an HOV network built or planned.

Sydney, with its legendary traffic congestion, has been fairly aggressive in establishing bus priority measures and bus lanes; most six lane arterials there either have bus or carpool lanes or have been considered for them. Unusually, rental cars are allowed in HOV lanes in Sydney! There is a 90 km (55 mile) long network of busways under development in Sydney. There is a stretch of freeway median busway in use as well, with an island bus stop. Arterial priority lanes are poorly enforced, have few bus bays, and suffer from violation.

Melbourne's public transport system is heavily reliant on trams (streetcars) and there is thus less need for bus priority than in most cities. There is one 3 km (2 mile) stretch of freeway shoulder bus lane (including an awkward weave across a major entry ramp) and a couple of arterial bus lanes in the city.

Perth's Kwinana Freeway has a lengthy bus lane which is being upgraded to busway standard; there are a few other bus priority treatments in town, but no carpool promotion.

Canberra has a busway with few buses, an arterial median-side bus lane, and a kerbside arterial bus lane which changed to T3 upon implementation.

Adelaide has dozens of bus queue-jumps and the famous guided busway, but no carpool facilities.

Gold Coast, south of Brisbane, has implemented some arterial bus lanes and more are in the works. Innovative coloured patches highlighting the lane may catch on elsewhere.

While there are national guidelines for Preferential Lane signage etc., they only cover the basic situations and in practice each State applies a mix of the national standards and local practices.

FAIR Lanes: A New Approach to Manage Congested Freeway Lanes

Patrick DeCorla-Souza, AICP
Federal Highway Administration (FHWA)
400 Seventh St. SW, HPTS, Room 3324
Washington DC 20590
Tel (202)-366-4076
Fax (202)-366-7696
patrick.decorla-souza@fhwa.dot.gov

April 5, 2000

Abstract

FAIR Lanes: A New Approach to Manage Congested Freeway Lanes

Patrick DeCorla-Souza, AICP
FHWA, Washington, DC

Value pricing has successfully been used to manage freeway congestion in the U.S. in conjunction with *new* traffic lanes, and on existing toll facilities and high-occupancy vehicle (HOV) lanes converted to High-Occupancy/Toll (HOT) lanes. However, strategies which involve converting free lanes to toll lanes are extremely difficult for the public to accept. The objections could be overcome using an innovative concept called "Fast and Intertwined Regular lanes" or FAIR lanes. This concept involves separating congested freeway lanes into two sections: Fast lanes and Regular lanes. The Fast lanes would be electronically tolled express lanes, where tolls are set in real time to limit traffic to the free-flowing maximum. The Regular lanes would continue to be free with constricted flow as at present, but drivers would be compensated with credits for giving up their right to free use of the Fast lanes. This paper analyzes the travel impacts, financial feasibility and economic efficiency of the concept, and discusses public acceptability issues.

FAIR Lanes: A New Approach to Manage Congested Freeway Lanes

Patrick DeCorla-Souza, AICP
FHWA, Washington, DC

INTRODUCTION

In major metropolitan areas, freeway traffic bottlenecks significantly reduce vehicle throughput during rush hours due to constricted flow, especially in the vicinity of freeway on-ramps. A recent study estimated that the number of vehicles carried by a congested lane is between 1,200 and 1,700 vehicles per hour, whereas a lane operating at maximum capacity carries 2,200 vehicles per hour (1). If traffic flow breakdowns can be prevented, more vehicles could be carried each hour at higher speeds on currently congested freeway segments. Ramp metering and value pricing (also known as congestion pricing) are two ways to prevent breakdowns in traffic flow in the face of heavy peak demand.

Ramp metering has been successfully implemented in the U.S. in several metropolitan areas. However, equity issues have stymied more widespread use of ramp metering. Congestion is often created by queues backing up onto arterials at access ramps. Those using upstream ramps, generally in suburbs or ex-urbs, have reduced delays and improved service at the cost of greater delays for those using downstream ramps, generally in the inner city.

Value pricing entails assessing relatively higher prices for travel during periods of peak demand, using tolls that vary by time of day. The concept is often used to manage peak demand in the private sector. For example, airline ticket prices during peak seasons are higher than in off-peak. Higher prices for peak period highway travel encourage motorists to seek other options, such as travel by other modes, on other routes, or at other times of the day. Recently, interest in value pricing has increased in the U.S., because electronic toll collection (ETC) technology eliminates the need for toll booths and allows tolls to be collected without the vehicle having to stop or slow down. Two toll roads, Highway 407 in Toronto, Canada, and CityLink in Melbourne, Australia, have implemented exclusive open road highway speed tolling. In Houston, high speed electronic toll lanes collect about 40% of the 270,000 daily tolls. High speed tolls are also collected on the SR 91 express lanes and the Transportation Corridor Agencies' toll facilities in Orange County, California, on Atlanta's GA-400, and on Denver's E-470. In the New York area, over half of all toll transactions are now conducted with an E-ZPass electronic tag, and over 3 million e-tags are in use.

Value pricing has successfully been implemented in California, Texas and Florida (2). This year, it is scheduled for implementation on the New Jersey Turnpike concurrently with the introduction of E-ZPass. Value pricing and is being considered for implementation in several other States. However, to date variable tolls have been implemented only on existing toll facilities, on *new* traffic lanes, or on existing high-occupancy vehicle (HOV) lanes converted to High-Occupancy/Toll (HOT) lanes. HOT lanes involve use of spare HOV lane capacity by tolled single-occupant vehicles (SOVs). Public resistance has prevented conversion of existing free general purpose lanes to priced lanes. Public resistance stems from a variety of factors. Only a few motorists value the time savings due to reduced congestion somewhat higher than the price increase. Tolls are perceived as a new "tax" leading to bigger government, and as having a disproportional impact on low income groups. Commuters feel they are being charged for using roads that they have “already paid for". Many have no other option but to drive during peak periods and pay any tolls that may be imposed.

THE “FAIR LANES” CONCEPT

This article discusses an innovative value pricing concept developed to alleviate the public concerns about conversion of free lanes to value priced lanes. The concept, called “Fast and Intertwined Regular Lanes” or FAIR lanes, involves separating freeway lanes using plastic pylons and striping (see Figure 1), into two sections: Fast lanes and Regular lanes. The Fast lanes would be electronically tolled express lanes, where tolls are set in real time to limit traffic to the free-flowing maximum. As in the case of the I-15 HOT lanes in San Diego, tolls are structured to vary according to the level of traffic in the Fast lanes (3). As traffic volume approaches capacity, tolls are increased to deter entry by additional vehicles into the Fast lanes. Motorists are advised of the toll rate changes using electronic message boards located in advance of the entry points to the Fast lanes (see Figure 2). This ensures that the lane offers a faster and more reliable trip than the Regular lanes.

The Regular lanes would be free lanes. Constricted flow would continue, but drivers would be compensated with credits. Credits could be used as toll payments on days when they choose to use the express lanes, or as payment for transit or parking at commuter park-and-ride lots in the corridor. The credits would compensate motorists for giving up their right to use the converted lanes, and for any added delays they feel they might face. The credits would be funded from toll revenues from the Fast lanes. Motorists in the Regular lanes would also need electronic toll tags, so that their use of Regular lanes can be recorded and their accounts credited. FAIR lanes would operate only in peak hours.

Out-of-state motorists will be able to avail themselves of congestion-free travel on the Fast lanes if they have compatible transponders and inter-state billing agreements are in place. Generally, transponder compatibility exists within regions of the U.S., and inter-state agreements are being put in place. Within the U.S., there are currently three systems for electronic toll collection. An active synchronous system (by Mark IV Inc.) is used in the Northeast and Midwest; a backscatter asynchronous system (by Amtech) is used in the South; and the open California Title 21 standard (similar to Amtech’s product) is used in California and Colorado (4). Currently, efforts by FHWA to establish a new North American standard for electronic tolling have reached an impasse. Interest in deployment of FAIR lanes could provide an additional inducement to resume these efforts. In the meanwhile, motorists without transponders or with incompatible transponders can continue to use Regular lanes, although they will not be able to get credits.

Accurate automated enforcement systems are available commercially. If a vehicle attempts to use Fast lanes without a valid transponder, a photographic image of the vehicle’s license plate would be captured. The identity of the vehicle would be confirmed by a participating

Department of Motor Vehicles (DMV). The vehicle owner would then be issued a bill for the toll and administrative fees. Such a system by MFS Transportation Systems is currently operational at the Violations Processing Center, Secaucus, New Jersey. There may be political pressures to allow carpoolers free use of Fast lanes, to provide an incentive to increase carpool mode shares. However, it is more difficult to automatically monitor and enforce vehicle occupancy requirements. Manual enforcement using police officers would be necessary, as on the I-15 HOT lanes in San Diego. This could substantially increase enforcement costs, as well as reduce the pool of revenues available to compensate Regular lane users. Policy makers will need to trade off increased monetary rewards to carpoolers against higher enforcement costs and reduced monetary rewards to Regular lane drivers.

In the long term, as FAIR lanes are implemented across a metropolitan area, credits on the Regular lanes could be discontinued, eliminating the incentive for traffic to divert to Regular lanes from other facilities and from off-peak periods. Instead of credits going to Regular lane motorists only, credits could be provided to all taxpayers in the form of rebates on vehicle use taxes. This would also eliminate operating costs for credit accounts.

The most significant benefit of FAIR lanes from the public's perspective is that travelers would have increased choices. Motorists could continue to be stuck in traffic (as they were before) but be compensated, they could zip along without delays and pay for the premium service, or they could use much improved transit or ridesharing services. Express bus service would improve since buses could use the Fast lanes and not have to contend with congestion. Carpooling would get a boost, since solo drivers could save time as well as tolls by sharing the ride and using the Fast lanes. On the I-15 HOT lanes in San Diego, carpools increased by 30% after the HOV lanes were converted to HOT lanes (3).

FAIR lanes would allow more vehicles through each hour on currently congested freeway segments, since Fast lanes would carry more vehicles per hour than they did under constricted flow conditions. This could increase freeway capacity during peak hours with minimal or no addition of pavement or right-of-way. However, dividing a freeway into 2 sections could actually lower capacity *during off-peak hours*, unless plastic pylon separators can be removed after rush hours. This is because the capacity per lane of a freeway increases slightly from 2,200 vehicles per hour for 2 contiguous lanes to 2,300 vehicles per hour for a 3-or-more contiguous (non-separated) lanes, due to greater flexibility to change lanes (5).

FAIR lanes would result in significant reductions in overall delay and emissions. Depending on the rates set for credit compensation, they could generate surplus funds. Surpluses could be used to fund improvements to the FAIR lanes or to fund improved transit or transit fare discounts in the corridor. Funding transit service from surplus toll revenues is justified because each driver induced to ride transit reduces traffic demand and therefore congestion on the Regular lanes. This benefits both Regular lane motorists, who have reduced delays, and Fast lane motorists, who pay less in tolls because toll rates tend to be lower when there are reduced delays in the Regular lanes.

AN ILLUSTRATION

This section illustrates the FAIR lanes concept using a prototypical 8-lane freeway with 4 lanes in each direction. The freeway has a severely congested segment 10 miles in length and interchanges at approximately one-mile intervals. The congested segment has an average daily traffic (ADT) volume of 208,000. This is typical of many 8 lane freeways in major metropolitan areas in the U.S. For example, in 1998, the 60 mile Washington DC Beltway had over 19 miles with more than 200,000 ADT, with its highest segment carrying 262,400 ADT (6).

With FAIR lanes, existing lanes will be divided into two sections in each direction: 2 Fast lanes and 2 Regular lanes. The FAIR lanes will operate for the entire length of the bottleneck segment of the freeway, so that there will be no congestion back up into the Fast lanes at the point where Fast and Regular lanes merge downstream. Further, any intermediate entrances to or exits from the Fast lanes will be by way of ramps which directly connect to the Fast lanes (see Figure 3). Fast lane drivers will not have to weave through the Regular lanes to get in or out of the Fast lanes. Direct connector ramps are currently used on several existing HOV facilities such as Washington DC's Shirley Highway.

Performance: Table 1 provides performance estimates for FAIR lane operation for a four hour PM peak period, from 3:30 pm through 7:30 pm. Traffic flow is constricted on the free lanes in the base case and on the Regular lanes in the FAIR lanes alternative due to heavy on-ramp flows to the freeway. The constricted flow volume is 1,450 vehicles per lane per hour, the mid-point of the range of 1,200 to 1,700 vehicles per hour per lane typically observed under constricted flow conditions (1). On the Fast lanes, a speed of 60 mph will be maintained. Using tolls adjusted in real time, traffic volumes will be limited to 2,000 vehicles per lane per hour to ensure that no breakdowns in traffic flow occur. The speed and service volume are based on the maximum service volume at Level of Service D (5). Average speed estimates for the base case and for Regular lanes are based on microsimulation of a prototypical freeway segment (7). The procedures used to get the speed estimates incorporate the dynamic effects of queuing and peak-spreading, and account for day-to-day variations in traffic.

As the results in Table 1 show, FAIR lanes increase vehicle throughput during the PM peak period from 23,200 vehicles to 27,600 vehicles in each direction. Delay, calculated as the difference between travel time at actual speeds and travel time at a speed of 60 mph, is cut in half. Speeds averaged over all lanes for the 4 hour period increase from 25.5 mph to 38.3 mph.

Financial Impacts: Table 2 provides financial estimates. FAIR lanes are assumed to be in operation only on weekdays, with the exception of holidays. In addition to the 4 hour PM peak operation, a 2 hour operation in the AM peak is assumed. Credits in the Regular lanes are set at 50% of the toll charges in the Fast lanes. The toll charges in the Fast lanes are calculated under the assumption that each driver in the Fast lanes is willing to suffer a "loss" of $12.00 to save an hour of his or her commuting time. This $12.00 "loss" would be comprised of $8.00 in tolls and a corresponding "loss" of $4.00 in credits that he or she could have obtained per hour of delay in the Regular lanes. Thus, a 1.5 min./mile travel time delay in the Regular lanes, relative to travel time at 60 mph, would result in a toll of 20 cents per mile (i.e., 1.5/60 X $8.00) or $2.00 for the 10 mile drive in the Fast lanes. A corresponding credit of 10 cents per mile or $1.00 would result in the Regular lanes. For comparison, tolls paid on SR 91 in Southern California imply that drivers are willing to pay $13.31 to $275 per hour saved (8). Of course, in reality toll charges and corresponding credit rates would be set in real time, as in the case of the HOT lanes on I-15 in San Diego, to ensure that Level of Service D "capacity" on the Fast lanes is fully utilized.

Annualized toll and credit transaction costs include amortized capital costs for electronic tolling infrastructure on all lanes, and costs for operation and maintenance (O & M). O & M costs include costs for electronic equipment, administration of toll/credit accounts, enforcement, incident management and public relations. The estimates are based on costs for the HOT lanes on I-15 in San Diego (3). Costs are adjusted to account for the higher traffic volumes on the FAIR lanes. Capital costs for the needed direct connector ramps at two intermediate points on the 10 mile segment are estimated at $20 million, or an annualized cost of about $2 million.

As Table 2 shows, toll revenues would exceed $21 million annually. After about $8 million in credits are disbursed to Regular lane users, net revenues would exceed $13 million. With annualized costs of $6 million, there would be a surplus of funds amounting to more than $7 million annually, which could be used to fund corridor improvements and reimburse means-tested low income motorists. Additionally, annual fuel tax receipts from travel on the FAIR lanes would amount to $3.6 million, assuming a fuel tax rate of 40 cents per gallon and fuel consumption rates based on FHWA procedures (7).

Economic Efficiency: Table 3 provides results from a benefit-cost analysis. To provide a conservative estimate of mobility benefits, an average vehicle occupancy of 1.0 is assumed in all lanes. Also, the additional vehicles carried in the FAIR lanes (4,400 vehicles per direction daily in the PM peak period) are assumed to save no time. It is presumed that they are comprised of motorists who have diverted to the FAIR lanes from other facilities or other times of the day for the purpose of obtaining credits. An average value of time of $12.00 per hour is assumed. In reality, drivers in the Fast lanes would value their time at a higher level, while drivers in the Regular lanes would value their time at alower level. (If motorists in the Regular lanes valued their time above $12.00 per hour, they would have chosen to use the Fast lanes). For comparison, the US Department of Transportation recommends use of a value of time of $8.90 per person hour for local travel and $12.20 per person hour for inter-city travel, in 1995 dollars (9). Fuel cost was estimated at $1.40 per gallon, including taxes. Pollutant emissions rate changes are based on national data, and monetary values are based on data for Washington DC (7).

Table 3 shows that annual benefits far exceed annualized implementation costs. User mobility benefits are over $20 million annually. Total benefits, after emission reduction benefits and revenues to the government are accounted for, exceed $33 million annually, yielding a benefit-cost ratio of 5.6.

PUBLIC ACCEPTABILITY

Motorists using Fast lanes would perceive the FAIR lanes as being fair. The reason they choose to use the Fast lanes is that the value they place on the time saved is equal to or greater than the toll they pay. Those who don't value time savings in the Fast lanes more than the toll charge have the option to use the Regular lanes. They would also perceive FAIR lanes as being fair, because they receive fair compensation for giving up their right to use the Fast lanes. Also, if additional motorists are not attracted to the Regular lanes to take advantage of the credits, congestion in the Regular lanes would actually be *reduced* due to an increase in vehicle throughput on the freeway. Credits earned by motorists in the Regular lanes would allow them to drive free of charge and congestion-free on Fast lanes on days when they are in a hurry. This is something impossible to do at any price under "un-FAIR lane" operation. Studies of travelers on the free lanes of SR-91 in Southern California have found that even those who do not regularly use the toll lanes value highly the option to use them on occasions when they have emergency situations that require them to get somewhere in a hurry. For example, when they are required to pay $1.00 for each minute that they are late in picking up a child at a day care center, drivers prefer to pay the toll rather than be stuck on the freeway, and are happy that the option exists.

A concern that has arisen with implementation of HOT lanes is that such priced facilities will create a "class system" on public highways, with disproportionally higher mobility benefits going to higher income classes. With FAIR lanes, this concern is addressed. Low income commuters who ride transit enjoy faster and more frequent service on the Fast lanes, possibly at lower fares subsidized from surplus revenues. Those who drive are able to use credits received in the Regular lanes to avail themselves of congestion-free drives on the Fast lanes, increasing their mobility. Additionally, policy makers could decide to increase the rate of compensation in the Regular lanes or to provide toll discounts in the Fast lanes for means-tested low income drivers identified through their toll tags.

Environmental groups will support FAIR lanes because solo drivers would have an incentive to form carpools to save on tolls, and transit commuters would get faster and more frequent service at lower fares. Environmental groups would also see the achievement of emission reductions due to improved traffic flow as being consistent with their goals. Fiscal conservatives will accept FAIR lanes because the concept is revenue-neutral. If there are revenue surpluses, they will be given back to commuters within the corridor through service improvements. Business groups will find Fast lanes appealing, because the value of time saved and of travel time reliability is higher for business travel.

TESTING THE CONCEPT

Without a pilot demonstration of the concept, it will be difficult for FAIR lane proponents to convince the public that delays in the Regular lanes will not get worse. A pilot test of the FAIR lanes concept may be considered:

1. *On any congested freeway facility*: A facility with 4 or more existing lanes in each direction is preferred. This allows a minimum of 2 lanes in each of the two sections. A 2 lane Fast section operates at a significantly higher level of service than a single lane typical of HOV facilities, since it allows faster moving vehicles to pass slower ones.

2. *On underused HOV lanes being considered for conversion into a HOT lane or a free mixed-flow lane*: By adding an existing adjacent free lane to the HOV lane, a 2 lane Fast section can be created, and the rest of the free lanes can be converted to Regular lanes.

3. *When adding a lane on a freeway*: An existing adjacent free lane can be combined with the added lane to create a Fast section.

4. *On a toll road scheduled to be converted to free operation because its bonds are soon to be paid off*: Revenues from Fast lanes could fund continuing maintenance needs, reducing the drain on existing tax resources.

Preferably, parallel routes should not be available in the corridor. This will limit opportunities for diversion of traffic to the FAIR lanes facility. Federal funding to test the FAIR lanes concept may be obtained through FHWA's Value Pricing Pilot Program, which is authorized by the Transportation Equity Act for the 21st Century (TEA-21).

CONCLUSIONS

FAIR lanes can improve the political acceptability of converting existing free lanes on congested freeway facilities to value priced lanes. They can reduce freeway delays and emissions, provide incentives to carpool and ride transit, provide more choices to travelers, and provide a highly valued option even for those who do not choose to use Fast lanes. Revenue surpluses from tolls can be used to improve transportation facilities and transit service in the corridor. Metropolitan areas with existing congested facilities have a unique opportunity to test the concept using federal support under FHWA's Value Pricing Pilot Program.

Acknowledgments: The views expressed in this article are those of the author alone and do not represent the policies of the Federal Highway Administration or the U.S. Department of Transportation. The author would like to acknowledge the valuable review comments received from Kiran Bhatt of K.T. Analytics, Kenneth Small of the University of California at Irvine, Ed Sullivan of California Polytechnic State University at San Luis Obispo, and Peter Samuel of Toll Roads Newsletter.

REFERENCES

1. The Legislative Analyst's Office, State of California. HOV Lanes in California: Are They Achieving Their Goals? January 7, 2000.

2. Berg, John T., Kim Kawada, Mark Burris, Chris Swenson, Loyd Smith and Ed Sullivan. "Value Pricing Pilot Program". TR News, pp 3-10. Transportation Research Board. September-October, 1999.

3. Hultgren, Lee , and Kim Kawada. "San Diego's Interstate 15 High-Occupancy/Toll lane Facility Using Value Pricing". ITE Journal, pp 22-27. June 1999.

4. Toll Roads Newsletter, January 2000.

5. Transportation Research Board. Highway Capacity Manual. Special Report 209. Washington DC. 1994.

6. FHWA. “Most Traveled Highways by Urbanized Area”. Highway Information Quarterly, p 5. December 1999.

7. FHWA, Participant Notebook for NHI course no. 15257 “Estimating the Impacts of Urban Transportation Alternatives”, Publication No. FHWA-HI-94-053, December 1995.

8. Mallinckrodt, Jack. The Willingness-To-Pay for Time Savings. AJM Engineering. Oct 22, 1999.

9. USDOT. Memorandum on Departmental Guidance for Valuation of Travel Time in Economic Analysis. April 9, 1997.

AUTHOR’S BIOGRAPHY

Patrick DeCorla-Souza is Team Leader for Value Pricing in the Office of Transportation Policy Studies at the Federal Highway Administration (FHWA) in Washington, D.C. He has published papers and articles in the areas of land use/ transportation interactions, air quality planning, travel demand forecasting, road pricing, and multi-modal transportation evaluation and benefit-cost analysis. Patrick DeCorla-Souza holds an M.S. in Planning from Florida State University and an M.S. in Civil Engineering from the University of Toledo. He is a Member of the Institute of Transportation Engineers (ITE), a Charter Member of the American Institute of Certified Planners (AICP), a Member of the American Planning Association (APA), and a Member of the Committee on Urban Transportation Economics and Planning of the American Society of Civil Engineers (ASCE). He is a member of several committees of the Transportation Research Board (TRB), and chairs TRB’s Joint Subcommittee on Pricing.

FIGURE 1. Plastic pylons separate toll lanes from free lanes on SR 91 in Southern California

FIGURE 2. Message board in advance of entrance to I-15 HOT lanes in San Diego, CA provides information on the current toll rate

FIGURE 3. Direct connector ramps can provide access to inside Fast lanes without the need to merge into and out of congested traffic on Regular lanes.

TABLE 1. PERFORMANCE IMPACTS OF FAIR LANES

	BASE CASE	FAIR LANES		
	All Lanes	**Fast Lanes**	**Regular Lanes**	**Total**
Traffic Volumes				
3:30-4:30 pm	5,800	4,000	2,900	6,900
4:30-5:30 pm	5,800	4,000	2,900	6,900
5:30-6:30 pm	5,800	4,000	2,900	6,900
6:30-7:30 pm	5,800	4,000	2,900	6,900
Total	23,200	16,000	11,600	27,600
~~Average Speeds (mph)~~				
3:30-4:30 pm	28.87	60.00	28.87	41.29
4:30-5:30 pm	24.31	60.00	24.31	37.10
5:30-6:30 pm	23.30	60.00	23.30	36.10
6:30-7:30 pm	26.26	60.00	26.26	38.96
Average	25.51	60.00	25.51	38.26
Delay (min/mi)				
3:30-4:30 pm	1.08	0.00	1.08	
4:30-5:30 pm	1.47	0.00	1.47	
5:30-6:30 pm	1.58	0.00	1.58	
6:30-7:30 pm	1.28	0.00	1.28	
Average	1.35	0.00	1.35	
~~Total Delay for 10 mile segment,both directions (hours)~~				
3:30-4:30 pm	2,085	0	1,042	1,042
4:30-5:30 pm	2,838	0	1,419	1,419
5:30-6:30 pm	3,045	0	1,523	1,523
6:30-7:30 pm	2,484	0	1,242	1,242
Total	10,452	0	5,226	5,226

TABLE 2. FINANCIAL IMPACTS OF FAIR LANES

	Fast Lanes	Regular Lanes	Total
Toll Rate (cents/mile)			
3:30-4:30 pm	14.4	-7.2	
4:30-5:30 pm	19.6	-9.8	
5:30-6:30 pm	21.0	-10.5	
6:30-7:30 pm	17.1	-8.6	
Average	18.0	-9.0	
~~Annual Revenues for 10 mile segment, both directions (million $)~~			
PM peak period	14.42	-5.23	9.19
AM peak period	7.21	-2.61	4.60
Total	21.63	-7.84	13.79
Annualized Capital and O&M Costs (million $)			
Toll/credit transaction costs	2.00	2.00	4.00
Direct connector ramp costs	2.00	0.00	2.00
Total	4.00	2.00	6.00
Surplus of revenues over costs (million $)			7.79
Annual fuel consumption (million gals.)	4.80	4.30	9.10
Annual gas tax receipts (million $)	1.92	1.72	3.64

TABLE 3. ECONOMIC EFFICIENCY OF FAIR LANES

USER BENEFITS

Mobility Benefits

Total time saved by all PM peak travelers (hours/day)	360.42
Total annual mobility benefits (million $)	32.44

Out-of-Pocket and Fuel Cost Changes

Net annual tolls, i.e., tolls less credits (million $)	13.79
Annual fuel cost changes (million $)	-1.59
Net annual user benefits	20.24

~~ANNUAL EMISSION COST CHANGES~~

HC emissions change (tons/year)	-71.43
CO emissions change (tons/yr)	-273.82
NOx emissions change (tons/yr)	133.60
Total emissions cost change (million $)	-0.33

SUMMARY OF BENEFITS AND COSTS (million $ annually)

User benefits	20.24
Emissions benefits	0.00
Net revenues to toll agency	13.79
Loss of fuel tax receipts to government	-0.45
Total annual benefits	33.57
Annualized costs (million $)	6.00
Benefit/Cost Ratio	5.60

Maryland Department of Transportation Value Pricing Study: Executive Summary – Micelle D. Hoffman

Introduction

Value Pricing is a tool that has been employed successfully in four locations in the United States and in numerous other locations around the world. It is an emerging concept that involves a system of fees or tolls, which vary according to the level of congestion. Value pricing of congested facilities can include new or existing toll-free roads, new or existing toll facilities, or new or existing High Occupancy Vehicle (HOV) facilities. Higher tolls are usually charged when congestion is heaviest and delay is at its worst. The use of limited road capacity is rationalized by encouraging some peak period users to shift to off-peak periods, HOV modes, transit, or less congested routes. In addition, value pricing could include optional fees paid by drivers of lower-occupancy vehicles to gain access to dedicated road facilities, providing a superior level of service and offering time savings compared to the parallel free facilities.

The Maryland Department of Transportation (MDOT), through the Federal Highway Administration's (FHWA) Value Pricing Pilot Program, is conducting a one-year value pricing study that will consider a full range of value pricing strategies, including High Occupancy/Toll (HOT) lanes, where lower-occupancy vehicles pay a toll to use HOV lanes. The FHWA is providing funds to support the development, operation, and evaluation of innovative road and parking pricing pilot projects. Public agencies interested in implementing and evaluating certain innovative pricing programs are eligible to apply for grants under the Value Pricing Pilot Program authorized by Section 1216(a) of the Transportation Equity Act for the 21st Century (TEA-21). The program's intent is to demonstrate and evaluate road and parking pricing concepts that could help address highway congestion.

Background

Currently, the Washington D.C. area has the second worse congestion in the United States, according to the most recent Texas Transportation Institute (TTI) study. Similarly, the Baltimore metropolitan area is experiencing major peak congestion on the interstate and arterial roadway system. It is forecasted that the number of households and jobs will increase in both the Washington, D.C. and Baltimore metropolitan regions, resulting in a continued increase in traffic volumes and congestion.

The Maryland Department of Transportation recognizes that value pricing strategies have the potential to benefit a number of corridors throughout the congested Washington, D.C. and Baltimore metropolitan areas; and has therefore identified several high-priority corridors and toll facilities that should be considered under the study. The ten facilities in this study include five highway corridors owned by the State Highway Administration (SHA) and five toll facility corridors owned by the Maryland Transportation Authority (MdTA):

- I-270 from I-495 (Capital Beltway) to I-70 (Frederick County)
- I-95/I-495 (Maryland portion of the Capital Beltway)
- MD 210 (I-495 to MD 228)
- US 50 (I-495 to US 301)
- I-95 (between the Washington and Baltimore Beltways)
- Fort McHenry Tunnel (I-95)
- Baltimore Harbor Tunnel (I-895)
- Francis Scott Key Bridge (I-695)
- US 50/US 301 (William Preston Lane Memorial (Bay) Bridge)
- I-95 (between the Baltimore Fort McHenry Tunnel and Delaware)

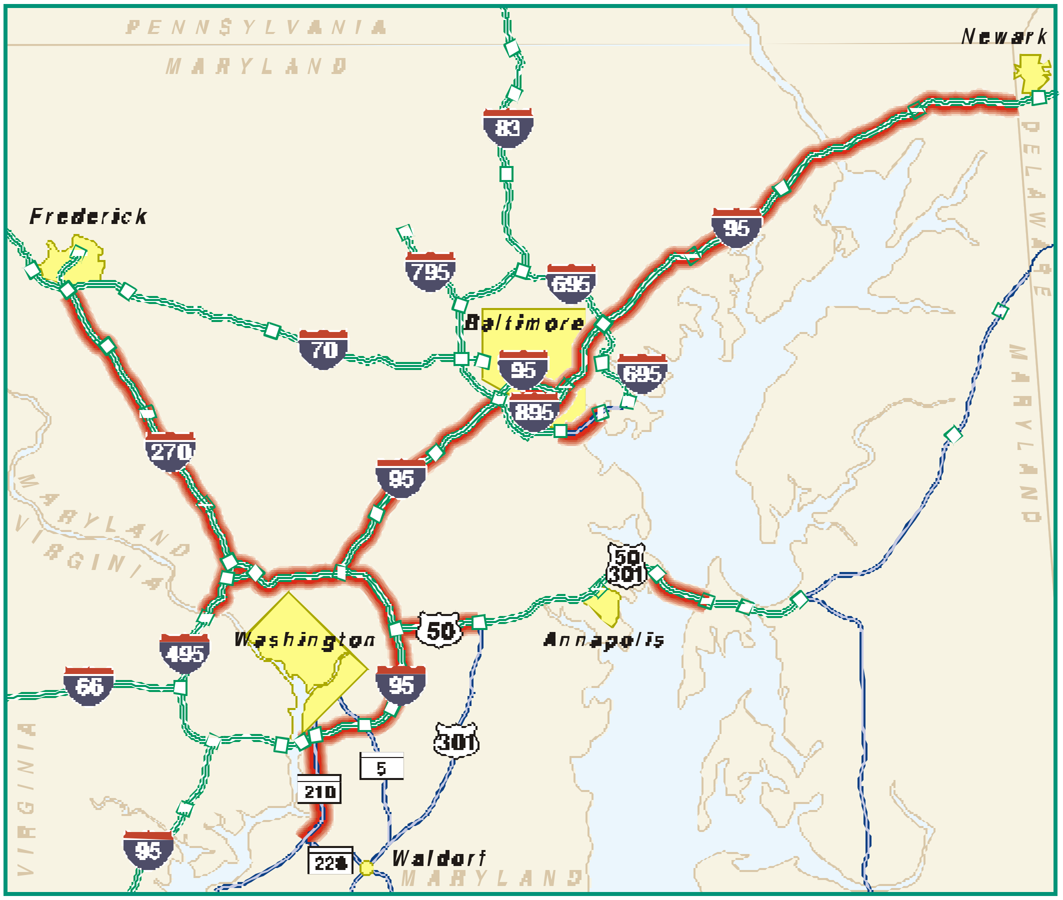


Figure 1: Study Area Map

The ten corridors are shown in the map below and are all considered high-priority for this Value Pricing Study because they are congested, provide critical links in the regional roadway network, and currently have or are under consideration for the implementation of HOV lanes or tolls.

Value pricing has been a viable transportation policy option for addressing congestion and funding shortages in many localities in the United States. The projects and studies discussed in this report have broken new ground and provide important lessons for other agencies interested in exploring the use of pricing to enhance urban mobility. The FHWA Value Pricing Pilot Program mirrors active interest in other countries in North America, Europe and Asia, where value pricing is either in use, or is being studied. The early results from operational projects show that travelers are willing to pay for improvements in transportation service, and that pricing can lead to more efficient use of existing highway capacity.

Study Approach

To explore the potential of value pricing, MDOT applied for and was awarded a grant by the FHWA to perform a broad-based regional feasibility study of value pricing strategies. The study will investigate value pricing strategies on the ten transportation facilities in the Baltimore-Washington area listed above.

This study, which began in the Fall of 1999, will take approximately one year to complete and will include support from governmental agencies and a number of stakeholders. This study is part of MDOT's overall effort to aggressively continue to examine alternative ways to help mitigate highway congestion. This study is being conducted in two phases. The first phase considered a broad range of value pricing strategies. These strategies were screened to refine them into a smaller number of options by eliminating value pricing strategies based on established criteria. The remaining strategies are undergoing a more detailed analysis in the second phase, which is currently underway. Study recommendations will be used to determine whether to pursue value pricing on some or all of the corridors. The next step would be to perform detailed project planning for new/proposed facilities or to develop a detailed implementation plan for existing facilities.

At the end of this study, recommendations will be developed and incorporated into the transportation plan, as appropriate. In addition, several corridors are the focus of current, ongoing SHA or MdTA planning studies. In these cases, recommendations from the Value Pricing Study will be input directly into the ongoing planning for the specific corridor. A final report will outline project recommendations and an initial implementation plan addressing regulatory, technical, fiscal, and public outreach aspects and requirements for the next steps.

Determining the feasibility of the study alternatives has required knowledge of the perspectives of various interest groups, affected parties, and the public at large. Therefore, the Study Team has continued to focus on public involvement throughout the study. The public involvement process has included:

- Quarterly Newsletters
- Project Web Site
- Workshops
- Focus Group Briefings
- Media Presentations.

Some of the values pricing options and supporting measures included in this study are:

- Time of Day and Occupancy Price Differentials for Toll Facilities
- High Occupancy/Toll (HOT) Lanes
- Variable and Dynamic Pricing (variable pricing based on current real time congestion levels)
- Improved Transit Service
- Park & Ride Lots
- Selected Direct HOV/HOT Freeway-to-Freeway Connectors
- Selected Direct HOV/HOT Ramps at Existing Interchanges Serving Major Activity Centers.

A Steering Committee has been established to provide regular input into the study and to monitor study results. The Steering Committee has a central interest in decisions for the Value Pricing Study from an implementation standpoint. The Steering Committee provides input relating to the scope of the project, evaluation criteria, and recommendations. It also serves as the advisory body for policy direction and formulation as it relates to the goals and objectives of this study. Steering Committee membership includes:

- Federal Highway Administration (Division and Headquarters)
- Federal Transit Administration
- Maryland Department of Transportation and its Modal Administrations
- Metropolitan Planning Organizations
- Local Government
- Consultant Team

A Stakeholder Group has been established to review study progress and provide feedback. It consists of representatives from a wide range of transportation interests as follows:

- American Automobile Association
- Maryland Trucking Association
- Environmental Defense Fund
- Chesapeake Bay Foundation
- Greater Washington Board of Trade
- Greater Baltimore Alliance
- MWCOG Citizens Advisory Committee
- BMC Citizens Advisory Committee
- Montgomery County Civic Association
- Prince George’s County Civic Association
- Sierra Club
- Toll Facilities Newsletter
- Independent Truckers & Drivers Association
- Retired Consultant

The Stakeholder Group meets to provide input into the development of project concepts, evaluation of value pricing alternatives, and formulation of final implementation recommendations.

Phase I of Maryland’s Study

The first phase of Maryland’s two-phase study included consideration of a broad range of value pricing options. Phase I included an investigation of the localities that have implemented or studied value pricing programs, both nationally and internationally, and preliminary screening to eliminate value pricing strategies based on established criteria. Results of the Phase I activities are described below.

National and International Case Studies

Value pricing projects have been successfully implemented in four corridors to date and several other studies are ongoing throughout the United States. In addition, there are several international projects in place or under study. Pilot projects in various phases are underway in the following areas:

Programs in Operation:

- Houston, Texas (I-10, Katy Freeway)
- Lee County, Florida (Cape Coral and Midpoint Bridges)
- Orange County, California (SR 91)
- San Diego, California (I-15)

Studies:

- Boulder, Colorado
- Maine Turnpike, Maine
- Minneapolis - Saint Paul, Minnesota
- Portland, Oregon
- San Francisco - Oakland Bay Bridge, California
- Seattle, Washington
- Sonoma County,
- Los Angeles, California (SR 14, and SR 57)
- Westchester County, New York
- Palmdale, California (SR 14)
- Orange County, California (SR 57)
- Maricopa County (Phoenix Area), Arizona.

International projects include:

- A1 and A14 Motorways, Paris, France
- City Center Toll Rings, Norway
- Cordon Pricing, Singapore
- England (study underway)
- Netherlands (study underway)
- Express Toll Route Highway 407 in Toronto, Canada
- Stuttgart, Germany (MobilPASS demonstration project)
- Seoul, South Korea
- Hong Kong, China

Figure 2: I-15, San Diego, California

Each of the projects in operation is different, but they all provide valuable information that may be applied to the Baltimore-Washington region. In addition, the projects provide insight into "real-life" applications, public acceptance/support, implementation hurdles, and lessons learned. Most importantly, they show success in increasing carpools, changing travel behavior, and reducing congestion. Value pricing or High Occupancy/Toll lane concepts offer potential to help manage traffic congestion and provide a choice for travelers willing to pay a premium for less congested conditions.

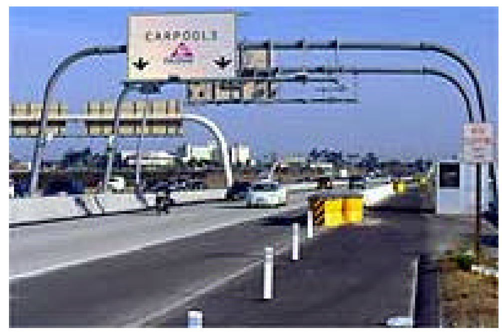


Figure 3: I-15, San Diego, California

Figure 4: SR 91, Orange County, California

The early results from operational projects show that travelers are willing to pay for improvements in transportation service, and that pricing can lead to more efficient use of existing highway capacity. People make cost-based decisions for transportation, just as they do in other parts of their economic lives, and those responses can serve as important guides for transportation planners and policy makers in Maryland. Specifically, these projects tell us:

- Road users highly value time savings.
- Value Pricing can reduce congestion.
- Electronic tolling technology allows variable tolls to be collected at highway speeds.
- Value pricing can be fair and equitable, because adverse impacts can be addressed and mitigated.
- Well designed outreach and careful nurturing of supporting constituencies are critical factors in acceptance.
- Successful programs will require packaging with collateral actions.

Phase I Screening

Utilizing data on national and international value pricing experiences and the evaluation of related plan actions in Maryland, the Study Team developed screening criteria to qualitatively assess which value pricing strategies make sense in each corridor. These strategies will be forwarded to Phase II for a more detailed technical analysis.

The screening criteria were developed largely through researching criteria used in other studies and adapting them to Maryland's study and study goals. In addition, some strategies, by definition, would not apply to a given facility. For example, because drivers pay a toll to use the Fort McHenry Tunnel, it already represents a *spot* location. Also, because of their proximity to one another, the three Baltimore Harbor crossings would be considered part of a *regional* strategy. Therefore, the *facility* and *corridor* strategies, as we have defined them, have been eliminated on these roads. This pre-screen resulted in the elimination of two strategies: *cordon* pricing (based on an imaginary line around an area) due to the nature of traffic patterns and business districts in Maryland, and *static* tolls (same price at all times) because these already exist in Maryland and would provide no further incentive to change travel patterns.

The criteria were divided into six categories:

- Transportation System Performance
- Implementation
- Equity
- Conformity with other Policies
- Societal and Market Effects
- Public Acceptance.

Only subsets of these criteria were used during Phase I. The results of this screening process are summarized below.

Transportation System Performance, which will be further quantified in Phase II of the study, generally compares the cost of a strategy in terms of time and money. For example, implementing manual toll collection on I-270, the Capital Beltway, MD 210, US 50 and I-95 north of Baltimore, all high-speed highways, would likely negate any time savings and therefore has been eliminated from further study. Similarly, constructing new lanes for any of the Baltimore Harbor Crossings for the purposes of implementing a value pricing system would be cost-prohibitive, and has also been eliminated from further consideration. For all of the other facilities, no strategies can be eliminated due to cost.

The ***Implementation/Legality*** category of criteria was found to apply to all strategies to roughly the same degree. In this case, the Study Team carefully evaluated each strategy relative to its peers, rather than as a single entity. With the passage of recent federal funding legislation (TEA -21), the federal restrictions on introducing tolls on federal facilities have been eliminated for participants in the Value Pricing Program. At the state level, the majority of the legal issues revolve around the division of power within MDOT (i.e. MdTA as the toll organization and SHA as the non-toll organization). None of these issues eliminated any strategies.

Equity issues are a highly controversial component of the value pricing study. While the goal of any value pricing project is to create a net benefit to society, the question, "at what cost?" must be asked. In Phase I, equity evaluation was limited to this simple measure: to what extent could people shift to other transportation options in response to congestion pricing? To this end, the Study Team decided that they would not consider converting any currently unpriced roadway into an *entirely* tolled facility. Only strategies that conversion of a general-purpose lane to a managed lane in conjunction with lane additions will be considered. While this decision was made for several reasons, the result is that there will always be an alternative to the priced facility, in the form of the remaining unpriced general-purpose lanes.

Transportation projects have always been closely related to land use and development patterns. Thus, it is important to evaluate value pricing strategies in terms of ***Conformity with other Policies*** (i.e., existing land use and transportation). The Study Team will evaluate these impacts as part of Phase II.

The ***Societal and Market Effects*** category was used to address other relevant impacts that can accompany transportation changes such as environmental impacts, air quality, energy consumption, employment, freight, and community/neighborhood impacts. In Phase I, the Study Team assessed potential community and neighborhood effects associated with potential diversion of traffic to parallel routes and the ability of these roads to absorb this additional traffic. If a large amount of traffic indeed diverts to a parallel, free facility, the advantages of pricing a facility may be lost. One of the goals of Maryland's pricing project is to maintain the availability of free lanes so that motorists will continue to have the choice of traveling without paying any tolls. With this choice in mind, spot scale pricing has been eliminated from consideration on I-270, I-495, MD 210, US 50, and I-95 (except for the I-95 bridge over the Susquehanna, which is currently tolled).

Lessons learned from other value pricing projects has indicated that ***Public Acceptance*** depends on the type of pricing and the quality of alternatives available, and will be higher when drivers have an on-the-road choice of travel options and routes. New, innovative, and better alternatives, both for auto and transit travel, can increase public acceptance. Implementation of value pricing strategies and specifically High Occupancy Toll (HOT) lanes, are primarily about giving the travelling public expanded choices. The study recognizes that, for a value pricing project to be successful, it must not create a perception that motorists will have fewer choices. In Phase I, the focus of screening was on the lessons others have learned in their value pricing studies and the previous experience of Maryland's transportation officials with respect to implementing managed lanes.

Phase II of Maryland's Study

The Value Pricing strategies carried forward from Phase I have been combined into Alternatives in the form of design concepts and pricing scenarios for further, more detailed evaluation in Phase II. Each of the ten study locations was evaluated with respect to the six categories of criteria developed in Phase I. Many of the study locations have more than one design concept identified for study to enable consideration of both short-term and long-term improvements. The Study Team used the general screening criteria to develop a list of more specific measures of effectiveness (MOE's) for Phase II analysis. The MOE's provide a more appropriate way to quantitatively and qualitatively evaluate the alternatives with respect to one another.

Scenario I includes one managed priced lane (by time of day and vehicle occupancy) in each direction, separated by a buffer. This scenario will be studied on I-270, I-495, US 50, MD 210, I-95 between the Washington and Baltimore Beltways, and I-95 between the Fort McHenry Tunnel and Delaware.

Scenario II includes two managed priced lanes in each direction, separated by a buffer and involves adding and converting some existing general-purpose and HOV lanes. This scenario is being studied for I-270, I-95 between the Beltways, and I-95 between the Fort McHenry Tunnel and Delaware.

Scenario III, which is being studied for I-270, MD 210, and I-95 between the Beltways, includes a two-lane reversible priced HOT system in the median separated by barriers in some segments and two managed priced lanes in each direction separated by a barrier in other segments.

Also, for the currently tolled facilities (the Baltimore Harbor Crossings and the Bay Bridge), the Study Team will perform a regional evaluation of pricing based on the time of day, season, and vehicle occupancy rates.

Next Steps

Other potential ancillary enhancements that could be investigated for the facilities include express transit service restructuring; park-&-ride lots; selected direct HOV/HOT freeway-to-freeway connectors; selected direct HOV/HOT ramps at existing interchanges serving major activity centers; targeted marketing approaches for under-utilized corridors; and redefining HOV/HOT lane corridors.

In addition, there are several major policy issues that will need to be addressed in the upcoming year in order to determine the feasibility of implementing value pricing strategies in the region and to facilitate support, approval, and implementation of those strategies. As evidenced by other national examples of value pricing, political support for the programs was key to their success.

Two of the biggest issues facing this initiative are implementation and equity. Throughout the course of the MDOT study, legislative issues have been identified. These may include:

- New/modified legislation to allow tolling on existing non-toll facilities
- Developing legislative support for value pricing projects
- Building public support
- Addressing equity issues such as “double-taxation” or “Lexus lane” perceptions
- Giving policy direction on the use of new facilities vs. existing facilities (new lanes vs. take-away lanes.

VALUE PRICING FROM PALMDALE TO LOS ANGELES

Authored by:
Deborah Redman, Southern California Association of Governments
Kevin Haboian, Parsons
Jon Green, Parsons
Fred Pearson, Parsons Brinckerhoff

Acknowledgements:
Original Focus Group material prepared by The DeVinny Group and
Urban and Transportation Consulting
(Carolyn DeVinny, Stuart Anderson and David Ungemah)
was edited for inclusion in this paper

Prepared for:
10th International HOV Conference August 28-30, 2000

1. INTRODUCTION

Southern California Association of Governments (SCAG) is embarking on an innovative approach to provide highway users options to reduce commuting time. Specifically, SCAG is evaluating the impacts of implementation of high occupancy toll (HOT) lanes along a 35-mile stretch of State Route (SR) 14 in Los Angeles County, one of the most congested freeway corridors in the County, now and in future years. As a means of providing free-flow conditions to both high occupancy vehicles (HOVs) and non-HOVs willing to pay a fee, an additional lane would be added to the existing HOV lane, creating a two-lane HOT facility in each direction. Despite active regional hostility toward HOV lanes and current controversy over local Express Lanes, public outreach indicates the corridor communities are willing to consider the concept. Due to length of the facility, several innovative operational concepts are being addressed. First, intermediate access points are being proposed at approximately three-mile intervals along the facility. Since the concept is to have the HOVs use the HOT facility for free, special toll verification areas would be constructed between each access point to properly segregate HOVs from toll paying non-HOVs, thereby simplifying enforcement. Finally, to properly balance demand along the length of the 35-mile facility, toll rates along the facility would vary based on the level of usage within the HOT lanes with rate variations along the corridor's segments. The features of this project will be useful for practitioners and agencies considering value pricing and HOT lane projects in their area.

2.0 BACKGROUND

2.1 HOT Lane Concept

HOT lanes are freeway lanes which are used by buses and carpools at reduced or no cost and by single occupancy vehicles (SOVs), or carpools with fewer than the required minimum number of passengers, for a fee. HOT lanes encourage the use of transit and carpools, but also serve a greater variety of users and generate revenue. Tolls for HOT lanes are adjusted to maintain smooth traffic flowing conditions for both High Occupancy Vehicle (HOV) and toll-paying customers at all times.

SCAG's interest in the HOT lane concept stems from recommendations by their REACH (Reduce Emissions and Congestion on Highways) Task Force, which was formed to investigate innovative pricing techniques to maximize the utilization and efficiency of transportation systems. The REACH Task Force issued a report in 1997 that concluded the HOT lane concept represented a promising approach for balancing transportation demand versus capacity and encouraging the use of transit and ridesharing while also generating revenue.

The REACH task force approved the following HOT lane recommendations:

A. Begin immediately to conduct necessary feasibility studies, in consultation with stakeholders. In accordance with the study results, select appropriate project sites, specify project design and establish a fee structure that includes consideration of an emission-based charge. Resolve issues related to public acceptability, equity, capacity and operations, safety, enforcement, system continuity and interconnectivity, technical and economic feasibility and regulatory/legal authority. Investigate the relationship between HOT lanes and vehicle occupancy, and demonstrate, or establish the means to demonstrate, whether a HOT lane project will adversely impact the HOV system or average vehicle occupancy on carpool lanes that may be selected for implementation.
B. Implement HOT lane demonstration projects within the region by1999, if feasible.
C. Evaluate the HOT lane demonstration projects for their impacts on congestion and air quality, compared to HOV lanes, and, if appropriate, develop an effective regional HOT lane system that utilizes existing and/or new carpool lanes.
D. Implementing agencies should research and select congestion pricing technology necessary to conduct HOT lane demonstration projects in a technically sound manner, and should facilitate such development by communicating policy directions and technological needs and specifications to appropriate expert communities.

Following the recommendations of the REACH Task Force, SCAG evaluated potential candidate corridors for possible implementation of the HOT lane concept. As a result the 1998 SCAG Regional Transportation Plan (RTP) designated the SR 14 as a potential HOT lane corridor, and recommended that a feasibility study be conducted.

The following sections of this paper highlight the alternatives, public outreach effort, selected design and operational concepts, and the financial assessment of the SR 14 HOT lane feasibility study.

2.2 SR 14 Study Objectives

The objectives of the study were to:

1. Address Severe Congestion on SR 14. The Antelope Valley Freeway is the only freeway route directly connecting the Antelope Valley with the Los Angeles Basin and San Fernando Valley. Even with freeway widening and construction of High Occupancy Vehicle (HOV) lanes, the freeway has become severely overloaded.

2. Evaluate High Occupancy Toll Lanes as an Interim Solution. Evaluate whether HOT (High Occupancy Toll) lanes are a feasible and acceptable alternative to help manage congestion in the corridor. Evaluate under what circumstances and at what cost, motorists would be willing to choose to use these lanes.

3. Evaluate Alternative Scenarios. Evaluate other scenarios suggested by North County community leaders, residents, and planners. These scenarios included:

- Construction of a new corridor through the mountains linking North County with the 210 Freeway
- Construction of a new corridor across the high desert
- Building out SR 14

4. Inform Decision-Makers. Throughout the study, involve the public, local officials and decision-makers in the project and keep them informed. Provide decision-makers with enough information to move toward selection of one or more alternatives that would provide (1) mid-term and (2) long-term solutions to the congestion problem in the area.

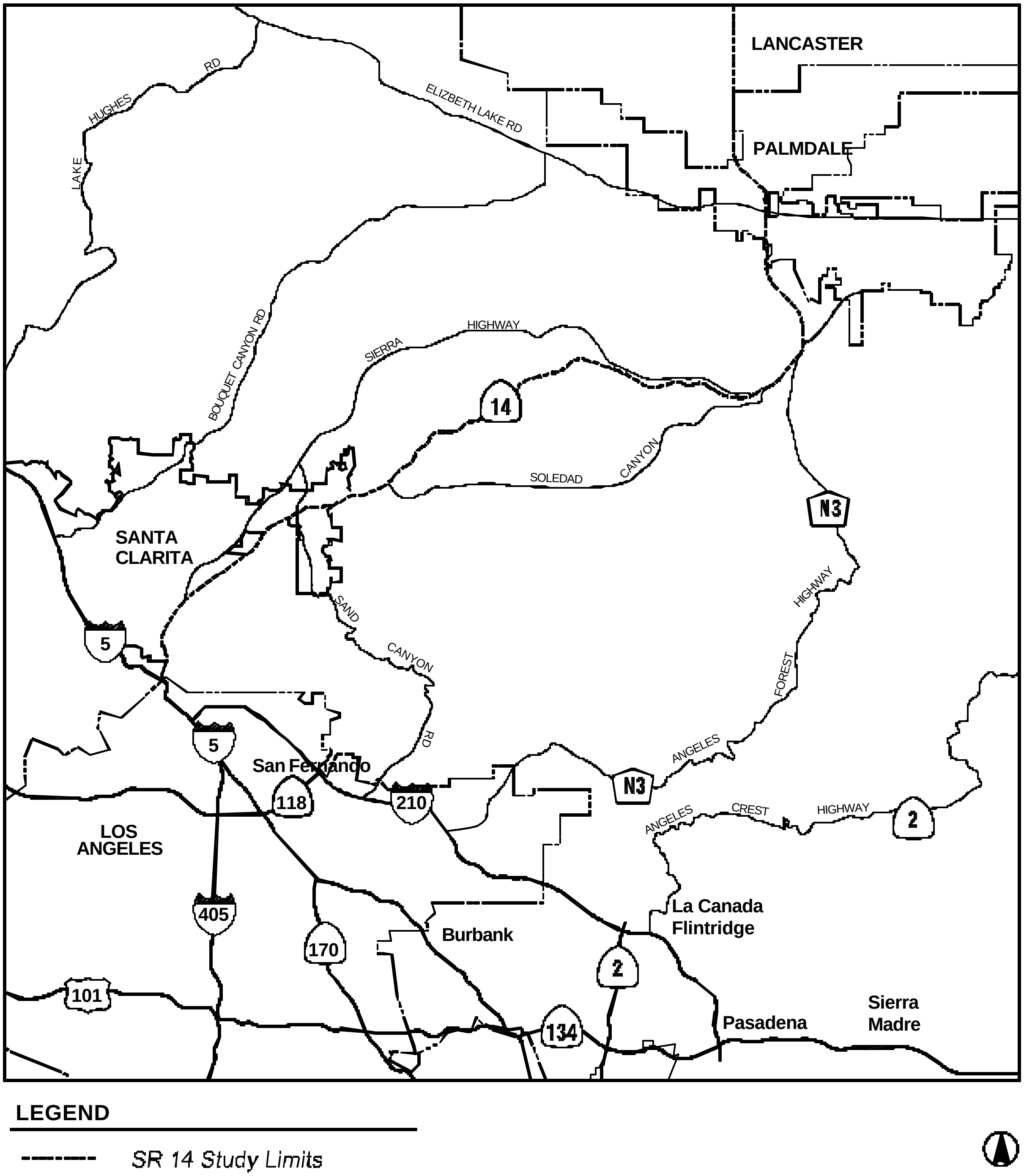
2.3 Existing Facility

The study area for the SR 14 Corridor is illustrated in Figure 2-1. At the time of this study in February 2000, the project corridor included one HOV lane in each direction from approximately San Fernando Road to Escondido Canyon Road. The number of general-purpose through lanes along the study corridor varies, as defined below.

- eight lanes (four each direction) between I-5 and San Fernando Road;
- six lanes (three each direction) between San Fernando Road and Sand Canyon Road;
- four lanes (two each direction) between Sand Canyon Road and Angeles Forest Highway:
- five lanes (two northbound, three southbound) between Angeles Forest Highway & Route 138 East; and
- six lanes (three each direction between Route 138 East and Avenue L.

In addition, there are non-continuous truck climbing lanes and auxiliary lanes at various locations along the SR 14 corridor.

Figure 2-1
SR 14 Corridor Alternatives Study



2.4 High Traffic Demand

The SR 14 Freeway is the primary transportation link between the rapidly growing Antelope Valley communities of Palmdale, Lancaster and other corridor communities and the San Fernando Valley/Los Angeles Basin. In addition, Metrolink commuter rail service is provided along the corridor, with stations located in Santa Clarita, Palmdale and Lancaster. The Antelope Valley Transportation Authority provides SR 14 corridor express bus service to Santa Clarita, the San Fernando Valley and Los Angeles.

This corridor is severely congested during peak periods, with delays, backup, bottlenecks and stop and go conditions occurring on a regular basis. In addition, steep corridor grades, mountainous terrain and elevations, limited number of lanes and the mix of trucks, cars and recreational vehicles combine to present numerous driving challenges which further constrain capacity and reduce the reliability of travel times through the SR 14 corridor.

Average daily traffic (ADT) volumes along the SR 14 corridor range from 128,000 north of I-5 to 72,000 at Avenue L, and drop to 57,000 at Angeles Forest Highway. Maximum peak hour directional volumes are 8,800 in the southbound AM peak hour and 7,700 in the northbound PM peak hour. Traffic volumes have increased dramatically in recent years, reflecting strong local corridor traffic growth.

Table 2-1 summarizes peak hour traffic volumes and directional distribution patterns for the corridor. The AM peak hour directional distribution of traffic ranges from 80/20 at San Fernando Road (south end of corridor) to 67/33 at Avenue F in Lancaster (north end of corridor). The PM peak hour directional distribution is more balanced, ranging from 70/30 at San Fernando Road to 60/40 at Avenue F. As traffic has grown in recent years, the peak hour directional distribution has become more balanced, and it is anticipated that this trend will continue, thus reducing the potential viability of reversible flow freeway operation through the corridor. Congested speeds under 20 mph and congestion durations of one to two hours are experienced in the southbound AM peak hours and PM northbound peak hours.

TABLE 2-1
EXISTING SR 14 TRAFFIC VOLUMES & DIRECTIONAL DATA

LOCATION	**TWO WAY TOTAL PEAK HOUR VOLUME**		**PEAK/OFF-PEAK DIRECTION TRAFFIC PERCENTAGES**		**PEAK/OFF-PEAK DIRECTION TRAFFIC VOLUMES**	
	AM	**PM**	**AM**	**PM**	**AM**	**PM**
Southern End	11,000	11,000	80/20	70/30	8,800/2,200	7,700/3,300
Middle	5,035	5,710	85/15	73/27	4,280/755	4,170/1,540
Northern End	2,140	2,685	67/33	60/40	1,435/705	1,610/1,075

The SR 14 corridor is projected to experience a substantial increase in traffic and congestion over the next 20 years. Based on the SCAG Regional Transportation Plan, travelers using the SR 14 corridor spend less than 50 percent of their travel time in delay conditions. By the year 2020, the forecasts indicate that 50 to 100 percent of corridor travel time will be spent in delay.

Traffic demand forecasts prepared for this study indicate SR 14 corridor traffic growth rates of 79% to 97% by the year 2020. Table 2-2 presents a comparison of base year versus year 2020 traffic volumes. The SR 14 corridor will experience severe overloads and greatly increased congestion by the year 2020 unless major capacity improvements are implemented.

TABLE 2-2
EXISTING VS. YEAR 2020 PEAK HOUR CORRIDOR DEMAND

	NO. OF	EXISTING		YEAR 2020	
	LANES	AM	PM	AM	PM
North of I-5 (south end of SR 14)					
Northbound	5	2,257	7,850	4,871	13,204
Southbound	5	8,302	4,244	14,049	10,615
TOTAL	**10**	**10,559**	**12,094**	**18,920**	**23,819**
North of Sand Canyon (Middle)					
Northbound	3	1,498	4,956	4,261	8,841
Southbound	3	5,329	2,934	9,258	8,127
TOTAL	**6**	**6,827**	**7,890**	**13,519**	**16,968**
South of Angeles Forest (north end)					
Northbound	2	1,615	4,289	3,624	8,383
Southbound	2	4,483	3,090	9,087	7,362
TOTAL	**4**	**6,098**	**7,379**	**12,711**	**15,745**

3.0 ALTERNATIVES CONSIDERED

In response to current and projected growth demands, the 1998 SCAG Regional Transportation Plan (RTP) recommended construction of HOT lanes as a major improvement concept for the SR 14 corridor. Two existing HOT lane facilities in the Southern California region are the privately financed 91 Express Lanes in Orange County on SR 91 between State Route 55 and the Riverside County Line, and the I-15 reversible HOT lane in San Diego County. The SR 14 study, including the engineering feasibility study and other components, provide the data necessary to ascertain if HOT lanes can help to improve the mobility of people and vehicles through the SR 14 corridor.

The SR 14 Corridor Improvement Alternatives Study included three primary alternatives:

- Alternative 1: No Project Alternative;
- Alternative 2: Bi-directional HOT Lane Facility (two lanes each direction); and
- Alternative 3: Three-Lane Reversible HOT Lanes with Moveable Barrier.

A brief description of each of the above alternatives is presented below. Typical sections for each of the above alternatives are provided in Figures 3-1, 3-2 and 3-3.

3.1 Alternative 1: The No Project Alternative

This alternative includes a single high occupancy vehicle (HOV) lane in each direction along SR 14 throughout the entire study area from I-5 through Avenue L in Lancaster, approximately 40 miles. The number of general-purpose lanes would remain the same as in the existing facility.

3.2 Alternative 2: Four Lane HOT Facility

This alternative provides a four-lane (two lanes each direction) express lane facility from approximately I-5/San Fernando Road to Palmdale Boulevard in Palmdale. The proposed SR 14 HOT Lanes would not extend to Avenue L in Lancaster because the fiscal analysis presented in Section 7 of this paper indicates that HOT Lanes between Palmdale Boulevard and Avenue L would not be financially viable. Single occupant vehicles (SOVs) willing to pay a fee and HOVs would be eligible to use the above facility. The express lanes would be physically separated from the general-purpose lanes via fixed pavement delineators, similar to the 91 Express Lanes in Orange County. At grade access to the SR 14 Express Lanes from adjacent general-purpose lanes would be accommodated at intermediate ingress/egress locations. The access locations would be located to serve demands from local arterial interchanges.

The number of general-purpose lanes, auxiliary lanes and truck climbing lanes would remain the same as in the existing facility.

3.3 Alternative 3: Three Lane Reversible HOT Lane Facility

This alternative seeks to take advantage of the demand directionality and minimize the roadway footprint in the SR 14 corridor by using a reversible facility to serve the peak travel direction. This option would provide two express lanes serving the peak travel direction, but it would also accommodate one express lane/HOV lane serving the off-peak direction. Moveable barrier technology would be used to shift the two-lane facility from the southbound direction in the AM to the northbound direction in the PM. Access to the express lanes could be accommodated at intermediate at-grade ingress/egress locations.

Similar to Alternative 2, the number of general-purpose lanes, auxiliary lanes and truck climbing lanes would remain the same as in the existing facility.

3.4 Other Local Alternatives

In addition to the primary HOT Lane Alternatives, the local cities wanted to consider other potential solutions for congestion relief (see Section 4.1). These alternatives included a general purpose lane on SR 14 (Buildout), a new highway through the San Gabriel Mountains, and improvements to a crossing highway, SR 138, known as the High Desert Corridor.

A comparison of the timesaving benefits, construction costs and environmental impacts of the project alternatives are provided in Table 3-1.

3.5 Cost Estimates

Compared to Alternative 1, the additional capital cost to construct Alternative 2 and Alternative 3 was estimated to be approximately $826 and $752 million, respectively, as shown in Table 3-1. These estimates are conceptual.

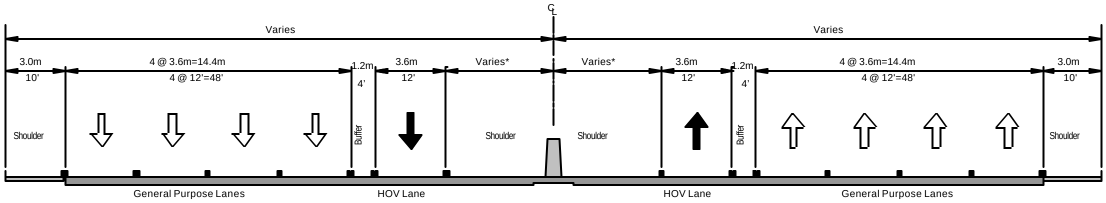
As shown in the typical sections, Alternative 3 would require less widening compared to Alternative 2. The reduced width in Alternative 3 would result in cost savings associated with less Asphalt Concrete (AC) paving for shoulders, less earthwork, smaller retaining wall structures, and reduced right-of-way acquisition. However, the reversible operation would require a specialized moveable barrier that is much more expensive than a typical fixed barrier. The above moveable barrier costs partially offset the facility widening cost savings.

In addition, it should be noted that there would be additional long-term operation and maintenance (O&M) costs for Alternative 3 compared to Alternative 2. These additional costs would encompass operations associated with transitioning the moveable barrier, barrier transfer machine(s), gates necessary for reversing directions at the reversible entry/exit areas, etc. For the above reasons, Alternative 2 (Four Lane HOT Facility) was viewed as the preferred HOT lane alternative.

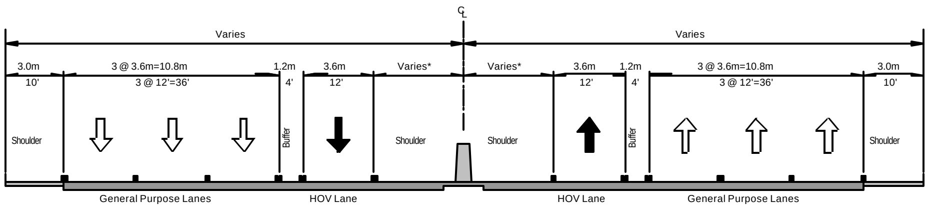
The Buildout and High Desert Corridor Alternatives have similar costs, at $806 and $800 million respectively. The new highway alternative would be significantly more expensive, at $1.8 billion.

FIGURE 3-1
SR 14 IMPROVEMENT PROJECT
Alternative 1: No Project Alternative

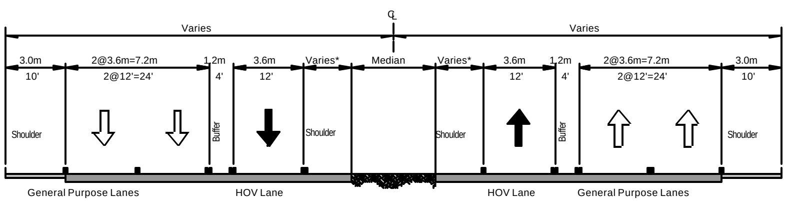
Between I-5 & San Fernando Road



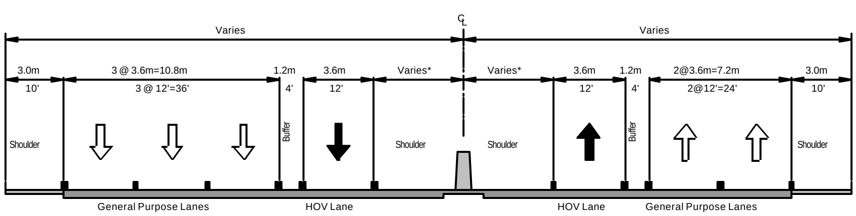
Between San Fernando Road & Soledad Canyon Road



Between Soledad Canyon Road & Angeles Forrest Highway



Between Angeles Forrest Highway & Route 138



Between Route 138 & Avenue L

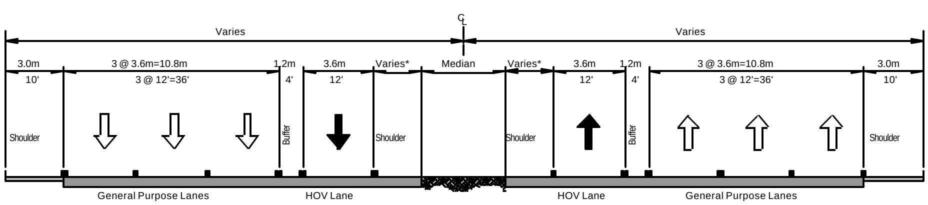
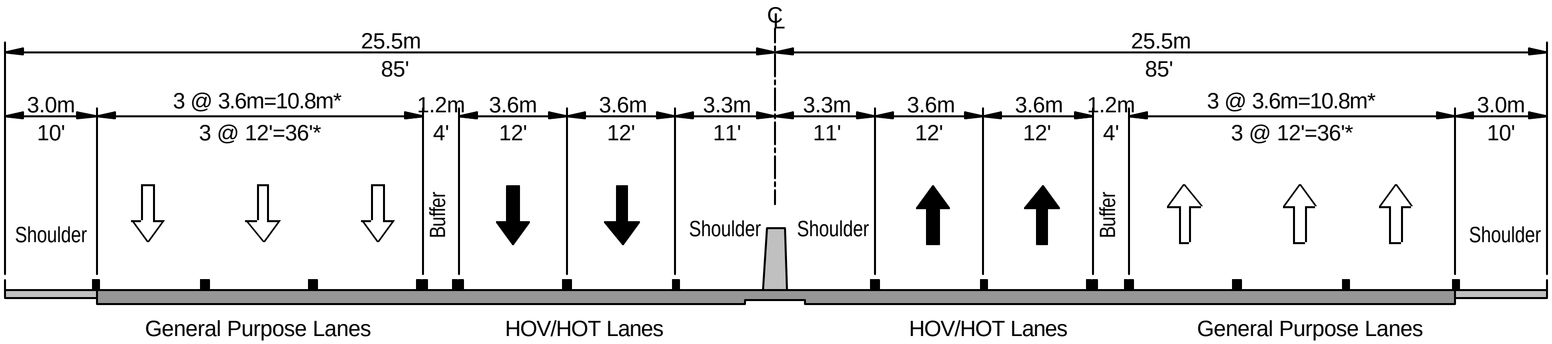


Figure 3-2
SR 14 Improvement Project

Alternative 2: Bi-Directional Express Lane Facility

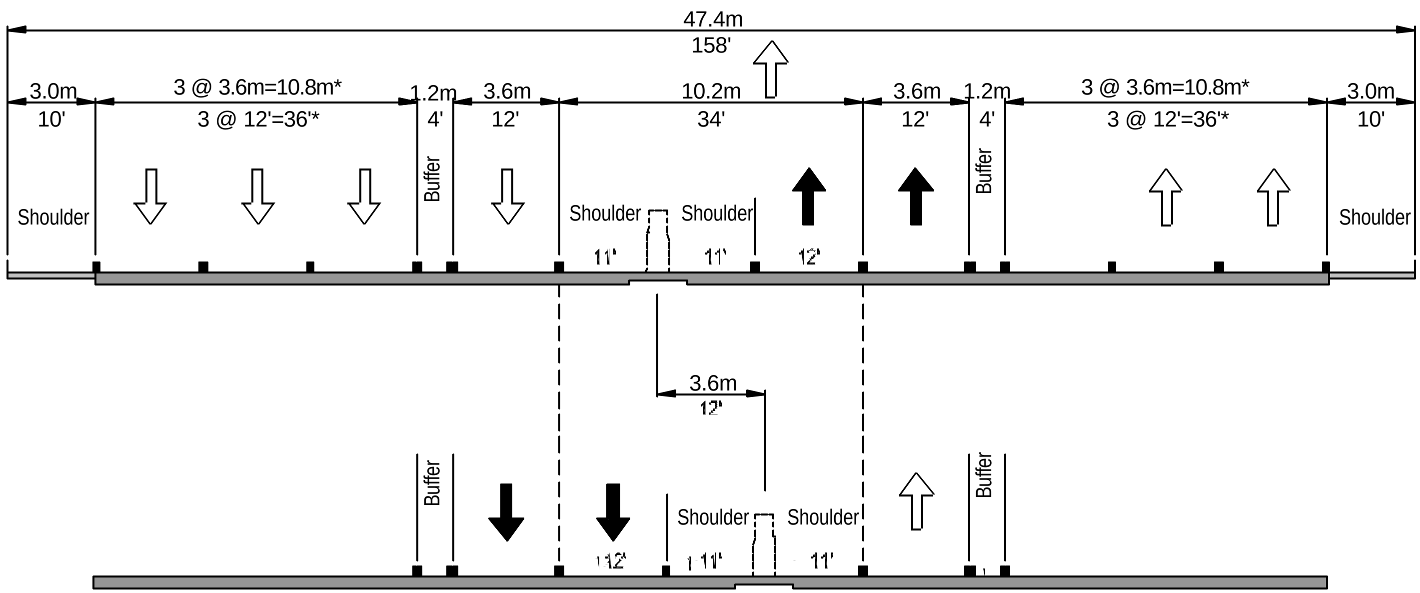


* Number of general purpose lanes, auxiliary lanes and truck lanes would be as defined in the No Project Alternative.

Figure 3-3

SR 14 Improvement Project

Alternative 3: Three-Lane Reversible Express Lane Facility with Moveable Barrier



* Number of general purpose lanes, auxiliary lanes and truck lanes would be as defined in the No Project Alternative.

4.0 PUBLIC OUTREACH EFFORT

4.1 Project Study Scope Development: The First Phase of Outreach

Although the Southern California Association of Governments had secured funding, through Caltrans, to study the feasibility of a High Occupancy/Toll (HOT) Lane on State Route 14 (SR 14, the Antelope Valley Freeway) it was important to the SCAG Project Manager that the entire study be conducted in a cooperative collaboration with as many stakeholders as possible. To that end, the original project scope (focused solely on a HOT lane alternative to be studied for technical, financial and political feasibility) was expanded to include a number of other potential solutions for congestion relief and mobility enhancement. These alternatives, brought forth from the communities of Palmdale, Lancaster and Santa Clarita, as well as from the impetus of Los Angeles County Supervisor Michael Antonovich, were funded through SCAG's subregional work plan. The corridor cities reprogrammed a portion of their subregional monies to add modeling and analysis of alternatives including construction of a general purpose lane on SR 14; a new route through the San Gabriel Mountains connecting the Antelope Valley to the 210 freeway at La Canada/Flintridge, and an examination of any impacts that improvements to SR 138 (a crossing freeway on the north end of the SR 14 known as the High Desert Corridor) might have on SR 14 congestion (see Table 3-1). The development of the scope, the Request for Proposals, consultant selection process and subsequent project direction, product review and the outreach program itself, was entirely open and subject to influence from all involved stakeholders.

A Technical Review Team (TRT) composed of SCAG (project lead agency), the SR 14 corridor cities of Lancaster, Palmdale and Santa Clarita, the County of Los Angeles, Caltrans, the Los Angeles County Metropolitan Transportation Authority, the Automobile Club of Southern California and the technical consultants met monthly for 16 months to complete the project.

4.2 Project Startup: Initial Interviews and Briefings

Mayors of Palmdale and Lancaster

At the beginning of the project, private briefings were held with the mayors of Palmdale and Lancaster—Jim Ledford and Frank Roberts, respectively. Mayor Ledford's expectations for the project were 1) there be public input; 2) that the consultant team would evaluate *long term* access to the Antelope Valley, including an honest effort on SR 138; and 3) the consultants would examine need for a 3rd corridor. These expectations were agreed to, and in fact, were met through the explicit terms of the scope of work.

The process for exploring the concept of HOT lanes encouraged Mayor Ledford. He predicted SR 138 will come up in public involvement activities; it was best to know ahead of time how to answer. Mayor Ledford advised 1) talking with the existing SR 138 task force and 2) including SR 138 in all analysis, as he believes SR 138 could be a great bypass corridor of the Los Angeles basin for travel between central California and San Diego.

In terms of meetings and participants, Mayor Ledford requested the involvement of the Board of Trade and the North County Transportation Coalition. Presentations to these groups were made as study results became available, and a cordial relationship developed between the members of the groups and the project study team.

Lancaster Mayor Frank Roberts, who became a Los Angeles County Metropolitan Transportation Authority Board member halfway through the SR 14 study had different concerns. Mayor Roberts asked that the study team avoid the stigma of "HOV", which he viewed as signifying "underutilization" to many in his jurisdiction; and he urged the team to remember that public satisfaction would derive only from a general improvement of traffic flow in the corridor.

Mayor Roberts was a proponent of the study, suggesting that it fit in well with new employment opportunities developing in Lancaster (mentioning Michaels and RiteAid warehouses by name). He suggested developing a tie-in with the SR14.COM web site survey with the local college and other employers.

In terms of meetings and participants, Mayor Roberts suggested the North County Transportation Coalition serve as a Policy Advisory Committee. Additionally, he advised including the SR 138 Task Force, Board of Trade, and the Greater Antelope Valley Economic Development Association.

In general, the Employee Transportation Coordinators and others interviewed within the Antelope Valley were not too concerned about traffic, as the employees who commuted were driving against the peak direction. Their opinions regarding HOT lanes were not notably different from the participants of the focus groups, whose reactions are detailed below. This outreach effort did not prove exceptionally revealing or helpful.

4.3 Media Coverage of the Project

Press Release

The initial press release generated half a dozen local newspaper articles, and approximately 20 telephone calls or e-mails to the SCAG project manager. The callers were contacted and interviewed, and proved to be an exceptionally articulate and thoughtful group of citizens. An attempt to recruit this self-selected group of concerned citizens for a special focus group failed, when all but one or two refused to participate beyond their initial contribution.

SR14.com—Website Development

A project website at WWW.SR14.COM was established from March 1999 to January 2000. It was registered on the following popular Internet Search Engines: Yahoo, Alta Vista, Excite, Lycos, Infoseek, HotBot, Northernlight, WebCrawler, What-U-Seek, InfoSpace, and QuestFinder. A search for “SR 14”, “State Route 14”, “Antelope Valley”, “San Fernando Valley”, “Santa Clarita Valley”, “Palmdale”, “Lancaster”, “Santa Clarita”, or any of these with the word “traffic” would yield a listing to the web site.

The web site featured updates on project activities; maps and data that allowed visitors to make *an informed decision*; opportunities to discuss results *with each other;* survey information; be added to the project mailing list; receive e-mail updates of information (as it is released); and a clearinghouse for local transportation links.

The web site was designed by David Ungemah (Urban & Transportation Group) to provide the most information possible that, at the same time, ensured simplicity and ease-of-use. The goal was for visitors to be able to make rational judgements and pass on information to others. The website received approximately 200 hits—less than hoped for, despite advertising with flyers, at outreach events, and through several media press releases.

4.4 Focus Groups

Over the period March 1999 – April 2000, The DeVinny Group and Urban & Transportation Consulting conducted six focus groups in three phases of two focus groups each. This effort was designed to ascertain the level of political and public support for and opposition to several transportation improvement concepts as developed by the SR 14 Technical Review Team (TRT.) After review of a range of the most viable mobility improvement scenarios, the TRT focused on three alternatives: Buildout of SR 14; High Occupancy Toll (HOT) lanes; and a new mountain corridor. Outreach activities reflected targeted audiences as well as a random sampling of commuters in the SR 14 corridor, in addition to the activities conducted by DeVinny/Urban & Transportation Consulting.

4.4.1 Findings and Conclusions from Phase One Formal Focus Groups in Santa Clarita and Palmdale: May 1999

The Alternatives

In Phase I, the facilitator presented five general transportation improvement alternatives to both focus group participants. These alternatives were:

- #1: No new construction beyond that which is already planned (i.e., simply continue the HOV lanes to Lancaster and provide operational improvements)
- #2: Build a HOT/express lane facility
- #3: Construct new truck lanes
- #4: Build a new reversible, general use facility
- #5: Design and construct a new route to I-210 from the Antelope Valley

<u>Santa Clarita Focus Group:</u>

On Wednesday, 26 May 1999, a focus group of SR 14 commuters was held in the Santa Clarita Valley. A total of sixteen commuters discussed for two hours general transportation concerns and five potential transportation improvement alternatives along SR 14.

Participants identified the following issues facing the community:

- Increasing growth and development has led to heavy traffic
- Lack of proper safety and maintenance on area roads
- Foreclosures and other signs of economic distress
- An increase in child abuse in the Antelope Valley
- A lack of adequate transit service coverage, particularly to non-downtown activity centers
- Too infrequent rail service
- Accidents, unsafe driving, and traffic on SR 14
- Increase in crime
- Overwhelmed schools
- Air pollution

Palmdale Focus Group

On Thursday, 27 May 1999, a focus group of SR 14 commuters was held in the City of Palmdale. A total of sixteen commuters discussed for two hours general transportation concerns and five potential transportation improvement alternatives along SR 14. Seven participants drove alone, three carpooled, and an additional three vanpooled. Residential locations were scattered throughout the Antelope Valley, the Santa Clarita Valley, and Canyon Country.

In an opening exercise, twelve of thirteen participants identified traffic within their top three "community issues" deemed crucial. When asked for issues that they related specifically to transportation within their area, they responded as follows:

- Need better law enforcement of HOV lanes and of speeding prior to known bottlenecks (where accidents tend to occur)
- SR 14 is too crowded for high speeds
- Employment in the Antelope Valley would help keep travelers off SR 14
- Accidents tend to be created by slow-moving trucks trying to pass each other

This focus group, more than the Santa Clarita group, was highly interested in transportation-related issues on SR 14 specifically. They tended to be traditional in their approach and opinionated regarding the alternatives suggested by the facilitator. Based upon the conversation around the table, the following general conclusions can be proposed.

1. **Employment and transportation are inherently linked.** As with the Santa Clarita focus group, participants noted on numerous occasions the lack of quality employment in the Antelope Valley. As they see it, bringing more employment to the north end of the County would do more to reduce traffic and congestion on SR 14 than any of the alternatives identified.

2. **Certain terms have resonance.** The terms "traffic flow below the speed limit" and "stop and go" have particular resonance with participants when it comes to thinking about congestion. These phrases may have applicability in terms of future marketing for any alternative. Furthermore, many participants connected traveling at a certain mph as the difference between "congested" and "uncongested". Connecting an alternative with prospective speed of travel may have resonance in future marketing.

3. **"We all want to play" syndrome.** The Palmdale focus group participants were even more concerned with receiving a reduction in traffic without having to pay for it than were the Santa Clarita participants. The general perception was that it was better for all people to have access to the investment rather than pay a fee, especially since it would be paid for with public funds. Interestingly, this is not a reflection of equity impacts, as this concern rates the lowest on the importance scale. Rather, it appears that this concern stems from the "we all want to play" syndrome. This is reflected in that almost all participants stated new general-purpose lanes would be highly desired, above all other options. For future marketing and targeted outreach, it may be helpful to test messages that address the "value" from paying a fee – as was performed by the facilitator with the group.

4. **Consider the impacts to employment location.** Residents are keenly aware of the lack of employment in the North County area. A prospective preferred alternative should not only maintain the current job/housing balance, but ideally it should also encourage additional employment in the Antelope Valley.

4.4.2 Findings and Conclusions from Phase 2 Focus Groups: March 2000

For this Phase 2 of focus groups, the five alternatives were reduced to three: Buildout; HOT lanes and Mountain Route. Key findings:

1. Participants evaluated the alternatives by a variety of factors, including time savings, estimated time to project completion, cost and impact on the environment.
2. Concerns about project completion dates were related both to the amount of time motorists would have to endure construction delays, as well as how soon benefits resulting from the completed project would be available to them.
3. Based on the criteria described above, of those things that were most important to the participants, the HOT lanes alternatives was the most appealing of three alternatives presented, in both sessions.
4. Participants responded to the notion of having more "choices" as commuters.
5. The popularity of HOT lanes seemed to focus on the reliability of time savings**.**
6. People easily put the hypothetical tolls within the context of providing reliable commute alternatives that seemed fair, continued to promote the notion of carpooling and transit, and could reduce commuters' daily stress.
7. In the Northridge session, none of the participants would use a HOT lane every day at a cost of 10 cents per mile. Four out of seven would use it every day at a cost of 5 cents per mile. In the Palmdale session, seven out of 11 participants would use a HOT lane every day at a cost of 10 cents per mile. One would pay as high as 20 cents per mile for daily usage.
8. People understood that tolls would have to be adjusted to manage demand and to maintain the reliably quicker commute trips during the peaks.
9. The key selling points of the HOT lane concept included: optional to drivers, reduces stress, reliable way to save time and it's still free to carpoolers.

4.4.3 Findings and Conclusions from Phase 3 Focus Group: April 2000

The primary advantage of HOT lanes was "choice" and the primary disadvantage was identified as "cost." When asked to create an "ad campaign" to sell HOT lanes, the following points were elicited from the group:

- Congestion relief
- Reduced travel time
- Travel time reliability
- Faster funding for project implementation
- Options in case of personal need or emergency
- Safer, more reliable options in case of traffic incident, snow, rain or wind (frequent occurrences along this freeway)

When asked to develop an argument *against* building a HOT lane, the following issues were identified:

- Cost to individual
- Cost of project to society
- Length of time to build—delays benefits and produces construction-related delays over a period of many years
- Belief that government should provide this facility free ("we pay taxes already")

When asked to give first and second choice marks to four names currently being used for high occupancy toll lanes, the following choices resulted:

Facility Name	1st Choice	2nd Choice
Express Lanes	6	5
Fast Track	5	6
HOT Lanes	0	0
Choices Lanes	0	0

None of the participants voted for “HOT Lanes” (particularly after one pointed out that most of them lived in the desert) and none voted for “Choices Lanes.”

Price Sensitivity

Using simplified costs, the facilitator asked how many participants would pay a series of per-mile fees and how many would decline to pay, for a set of time savings related to travel on a HOT lane facility covering the entire stretch from Palmdale to I-5:

At 5 cents a mile for a total of $1.45*:*
Six would pay to save 20 minutes
Eight would pay to save 30 minutes

At 10 cents a mile for a total of $2.90:
None would pay to save 20 minutes
Six would pay to save 30 minutes

At 20 cents a miles for a total $5.80
None would pay to save 30 minutes
Six would pay to save 40 minutes *in an emergency*

Next, the group was asked to focus on the very congested southbound morning peak trip, and provided with “segmented” trip costs. Responses were as follows:

Avenue P to Crown Valley (10 miles) for a 10 minute savings starting at $1 (10 cents/mile:
No votes No votes

Crown Valley to I-5 (20 miles) for 30-minute savings starting at $4 (20 cents per mile):
Five would do it once a week and two, twice a week

I-5 Connector (2 miles) for a 20 minute savings at $2 ($1 per mile):
Four would pay once a week, three twice a week

$3 one way to save 20 minutes through the I-5 connector ($1.50 per mile):
One person would pay “occasionally “

Package price between Palmdale and through the 1-5 connector, allowing time savings of one hour for $6.50 (21 cents per mile):
Six would pay once a week and two would pay twice a week.

Although we can see here some discontinuity in valuation of time savings, there is a surprising willingness to pay on a fairly frequent basis an amount considered by politicians to be an outrageous fee: $0.21 per mile to achieve an hour (one-way) in trip time savings.

When asked to what they would like to tell the elected officials responsible for decision-making on SR 14 issues, they answered:

- Add more transit, expand frequency of service and redesign routes to fit customer needs
- Explore more alternatives (these were not identified)
- Inform the public about research and potential solutions

- Don't take any general purpose lanes away either for HOT or HOV lanes

Findings and Conclusions:

1. *It's not a matter of "what to do," it's a matter of "just do something!" The focus group participants were concerned about growth in traffic on SR 14, and were frustrated with the slow pace of regional and state government to initiate potential transportation improvements. The group agreed that widening, in some fashion, must take place soon.*
2. *All participants agreed that the Buildout alternative's additional travel lane would become congested shortly after opening to traffic. Yet, all but one person stated it would still be a wise investment. Improvements due to relieve a bottleneck near Acton were mentioned.*
3. *The two-lane HOT lane option is particularly appealing to existing HOV users. This support is due to the opportunity to pass slower-moving vehicles in the HOT lanes if there are two lanes in each direction.*
4. *Equity and environmental concerns are not as important as the ability to guarantee traffic flow and distribute costs between taxpayers and users. Equity impacts were identified and associated with the HOT lane facility; however this did not move support from HOT to Buildout.*

4.5 Final Round of Briefings and Presentations of Study Results

Following a previous introductory presentation in the spring of 1999, in the late fall of 1999 the consultant team and SCAG project manager provided an extensive presentation to the Antelope Valley Board of Trade. Approximately 100 business and community leaders were present, along with local print and broadcast news reporters. Reaction was reasoned, mild in its opposition, and politely enthusiastic about the very focus of regional attention on this Northern Los Angeles County freeway.

A strong effort was mounted during the final months of the project to "find a champion" for one of the alternatives. It was no secret that SCAG and Caltrans hoped to advance the HOT lane concept as the best solution, though an effort was made to present all alternatives' strengths and weaknesses objectively. A number of briefings were made to key stakeholders and elected officials.

A private one-hour briefing to State Assemblyman George Runner was deemed a success because the Assemblyman listened carefully, and rather than throwing the presenters out of his office, promised to support taking both the buildout and HOT lane alternatives to the next stage of analysis. Complicating this stated position, however, was his bill, AB 1871, which proposed opening up the not-yet-completed HOV lanes on SR 14 to all traffic during off-peak hours, and providing continuous access along the 35-mile length of the facility. Obviously, a HOT lane proposal that strengthened rather than weakened the need for 24-hour HOV operation was not in harmony with the goals of AB 1871.

A final project presentation was made by the consultant team and the SCAG project manager to the North County Transportation Coalition meeting in April 2000. The presentation included the very points that allowed many focus group participants to find in favor of HOT lanes. In addition, Brian Pessaro from the San Diego Association of Governments gave a succinct, factual and compelling presentation on the success of the I-15 Value Lanes in San Diego. The points covered by Mr. Pessaro would seem to have answered many of the concerns raised by attendees around the table. But at the end of the meeting, the Mayor of Palmdale, Hon. Jim Ledford, reiterated the following points which had been the mayor's themes since the inception of the project:

- North Los Angeles County has not received its "fair share" from the transportation funding system (Caltrans, MTA, SCAG).
- Pricing is a way to "shore up" a dysfunctional government structure—the dysfunction itself should be addressed!
- Pricing is unfair to North LA County residents if implemented in isolation.

Mayor Ledford's arguments did not change in response to counterarguments suggesting that the enhanced financial viability of the HOT lane alternative, plus its guaranteed maintenance of two lanes, each way, of acceptable level of service over time made it an attractive option.

Another member of the NCTC, having misunderstood the multiple purposes contained in pricing strategies, objected to the possibility that "people would be paying tolls long after the facility bond was paid." Despite strenuous effort to explain the demand management role that tolls would pay in maintaining the desired level of service on the facility, this individual did not change position.

4.6 Overall Outreach Effort Lessons Learned and Conclusions

1. Participants defined the alternatives in terms of timing and impacts**.** The focus group participants and stakeholders interviewed, as a group, did not state a clear preference for one alternative over the others. Individually, though, pockets of support existed for each alternative. How commuters chose between the alternatives depended upon their perception of how the alternatives compared on key issues.

2. Timing. Participants stated a desire for some relief as soon as possible. This tended to take support away from the Mountain Corridor alternative.

3. Construction impacts. Participants were concerned about the impacts construction may have on traffic. HOT lanes, in general, were seen as having less of an impact from construction.

4. Cost. Participants were concerned with both 1) the cost to the individual, and, 2) the cost to society for the alternatives. All alternatives were viewed critically for this issue.
5. SR 14 Buildout generates both support as well as concerns about features of this alternative. Focus group participants generally supported the SR 14 Buildout option as an initial opinion, although many were concerned that: 1) the expanded general purpose lanes would become congested soon after construction, 2) the timeline for construction is too far in the future, and 3) that construction would cause substantial traffic impacts on SR 14. Often after learning of the "choice" and the guaranteed level of service provided by the HOT lane alternative, support for the Buildout option softened.

   Conclusion: The SR 14 option would likely receive initial support in the community. However, concerns regarding the lifespan of project-related congestion relief, project completion timeline, and construction impacts would need to be addressed realistically in order to build increased support for the alternative.

6. HOT lanes have a measure of support that can be built upon, though cost is a concern. Although participants were not unanimously enthusiastic for the HOT lane concept, a majority of participants stated they would accept HOT lanes as they would be less costly to taxpayers than the Buildout alternative for SR 14. One focus group featured a majority of participants who actually favored the HOT lane concept over the Buildout option, based upon societal cost, traffic management, and the two-lane benefit to carpoolers. Principal factors contributing to HOT lane support are:

   a. Two lanes in each direction (providing the ability to pass slow-moving vehicles in the HOV lanes)
   b. Travel time savings
   c. Safety improvements
   d. Provision of a viable option to commuters

Conclusion: See #7 below.

7. Support for HOT lanes on SR 14 is directly related to education about HOT lane experiences elsewhere and forecasted results on SR 14. Participants were far more supportive of HOT lanes when more detailed information was provided pertaining to: 1) forecasted traffic and travel-time savings on SR 14; 2) experiences on I-15 and SR 91; and 3) implementation / "on the road" details for SR 14 HOT lanes. This information allowed some focus group participants to compare HOT lanes against the other options independent of the initial "gut reaction".

   Conclusion: Residents of the Antelope Valley may support HOT lanes on SR 14. However, these residents respond to HOT lanes better when detailed information is provided about why HOT lanes are being considered, how they would be implemented, what has been the national experience to date with HOT lanes, and how they most likely would affect the resident's commute on SR 14.

8. Some participants would be willing to use the HOT lanes, often "every day," if the option were available to them. Carpoolers and vanpoolers stated they would use the lanes every day. Most who drove alone would use it once or twice a week when they were running late, wanted to sleep in, or had to get to an appointment or family activity after work. The majority of participants that would never use the lanes stated that they may not be able to afford the HOT lanes or would not use them because they are philosophically opposed to the concept of paying to avoid congestion.
   Conclusion: HOT lane use on SR 14 would likely parallel that of I-15 and SR 91, with occasional use by FasTrak members and with continued, strong use by HOVs.

9. Participants strongly desire more effective and frequent Metrolink services. Although the focus groups did not directly address Metrolink and other transit services, participants across all groups continually raised the need for more effective and frequent Metrolink services. In particular, participants stated a need for 1) more variety of destinations available from the Antelope Valley, and, 2) an increase in departures and arrivals per day.

   Conclusion: Any implementation of the SR 14 alternatives should include substantial consideration for enhanced Metrolink service. In particular, construction impacts and long-term traffic concerns with the alternatives may be partly alleviated by enhanced rapid transit service from the Antelope Valley.

10. Commuters consistently stated a need for a better job / housing balance in the Antelope Valley**.** Consistently, participants commented that the best solution, in their minds, for resolving traffic on SR 14 was to bring a greater number of quality jobs and employment to the Antelope Valley.

    Conclusion: Economic development, although rarely paired with transportation investments, should be considered and pursued in conjunction with a major investment to the SR 14 corridor.

11. When ranked, HOT lanes are the most preferred, followed closely by SR 14 Buildout, and finally the Mountain Corridor. Across all focus groups, there is a slight preference for HOT lanes over the other two alternatives. The principal reason for HOT lane support appears to be 1) reduced cost to taxpayers, and, 2) more rapid deployment and/or implementation. SR 14 Buildout also is favored, although some participants were concerned with the high cost to taxpayers. The Mountain Corridor also received support, however, most participants stated it would not serve their travel needs and it could detrimentally affect the natural environment.

    Conclusion: All alternatives were, generally, considered positive steps for the improvement of transportation from the Antelope Valley, although the new Mountain Corridor did not carry as much support as either HOT lanes or SR 14 Buildout.

4.7 Outreach Effort Recommendations

1. If HOT lanes were ever to be advanced as a preferred alternative, SCAG should conduct an extensive marketing and education campaign, starting with illustrating the experiences on I-15 and SR 91. In order to promote the HOT lanes concept as better than other options for Antelope Valley commuters, SCAG and the corridor communities would need to implement a very careful, targeted, and visible marketing and education campaign. This campaign would emphasize the experiences on I-15 and SR 91. Residents would be made aware of HOT lanes' benefits for travel-time savings and guarantees, how HOT lanes would work on SR 14 (including enforcement, account maintenance, etc.), and how HOT lanes have worked on other facilities. Visible education and marketing appears to be the key for HOT lanes support in the Antelope Valley. Given the amount of time residents currently spend commuting, and the resultant strain on their time budgets, it would be difficult to carve out the needed time for issue-related education. Creativity and innovation would be required.

2. Identify specific transit improvements to potentially accompany the preferred alternative. All focus groups and stakeholder meetings eventually discussed the need for enhanced transit service both within the Antelope Valley and connecting to both the Los Angeles basin and San Fernando Valley. SCAG, Antelope Valley Transportation Authority, LACMTA, and other agencies should work to identify specific transit improvements that would accompany the preferred alternative. This will most likely move support towards the preferred alternative.

5. DESIGN ISSUES

The alternatives presented in Section 3 of this paper were evaluated from an engineering perspective based on design requirements of the California State Department of Transportation (Caltrans). Typical engineering features (i.e. roadway impacts, structures, utilities, slopes, right-of-way, interchange modifications) were assessed to determine the physical impacts associated with each alternative. An overall summary of the engineering features is presented in Table 5-1.

In performing the engineering evaluation two design features of the SR 14 HOT Lane Feasibility Study surfaced as unique opportunities for this project as compared to existing HOT lane facilities. These features, intermediate access points and toll verification areas are highlighted below.

5.1 Intermediate Access

Existing HOT lane facilities in Southern California do not contain intermediate access locations, as they are pipeline facilities of relatively modest lengths. The 91 and I-15 Express Lanes are approximately 10 and seven miles long, respectively, with no intermediate access. The above HOT lane facilities physically separate the HOT lanes from the mixed flow lanes via a barrier separation for the I-15 reversible lanes and fixed pavement delineators for the 91 Express lanes. It was apparent early in the SR 14 study that the proposed 36-mile length of the HOT lane facility necessitated the consideration of intermediate access points as a means of accommodating ingress/egress movements.

The demand forecasts for the SR 14 HOT lane facility indicated that utilization of the HOT lanes varied considerably along the 36-mile length. The two directional HOT lanes generally approached peak period capacity in the southern portion of the corridor, while the middle and northern portion of the corridor experienced considerably less demand. As a means of attaining better peak period utilization of the HOT lane facility it was decided to provide intermediate access locations such that commuters with destinations within the proposed 36-mile facility would thereby have the opportunity to use the HOT lanes. In addition, given the operational concept for the HOT lanes was to operate on a 24-hour basis (see Section 6) the intermediate access would afford better utilization during the off-peak periods.

A typical intermediate access location for the HOT lanes is conceptually illustrated in Figure 5-1. This configuration is identical to the access concept Southern California uses for their HOV facilities. The only difference between the two is that the HOT lanes would have a physical separation (fixed pavement delineators) along the entire length of the facility, other than the access locations, whereas existing HOV facilities have a painted buffer separation.

The frequency of the intermediate access locations was also a consideration as too much access could offset the reliability and operational integrity of the HOT lanes and insufficient access could still result in insufficient utilization of the facility. In addition, as a means of properly collecting tolls for usage of the HOT lanes, and also simplifying the enforcement function, there needed to be sufficient distance between access locations to accommodate toll verification areas (see next section). As a result of the above considerations, the SR 14 HOT lane access locations were placed at approximately three-mile intervals. Figure 5-2 provides schematic representation of the intermediate access locations proposed for SR 14 HOT lane facility.

a

Table 5-1
Summary of Engineering Feasibility Analysis
SR 14 HOT Lane Alternatives

EVALUATION CRITERIA	Alternative 1 No Project 2 HOV Lanes Non-Reversible	Alternative 2 4 HOV/HOT Lanes Non-Reversible	Alternative 3 3 HOV/HOT Lanes Reversible Operation
1. Number of HOV/HOT Lanes	2 HOV Lanes	4 HOV/HOT Lanes, 36 miles	3 HOV/HOT Lanes, 36 miles
2. Total Width Required (1)	164 feet	170 feet	158 feet
3. Center Columns Accommodated Within Typical Section (2)	Yes	Yes	No
4. Additional R/W Required	No	Yes, along 8 corridor miles, rural areas, no relocations assumed	Yes, along 8 corridor miles, rural areas, no relocations assumed
5. Utility Relocations	No	Minimal	Minimal
6. Provides Increased Capacity	No	One additional lane in each direction, 24 hours	One additional lane in peck direction, peak hours only
7. Traffic Operations Complexity	Conventional HOV operation	Conventional HOV operation with HOT added	Reversible lane operation twice daily for HOV, with HOT added
8. Design Standards	Full Caltrans Standards	Full Caltrans Standards	Full Caltrans Standards
9. Freeway Widening and Rock Removal Required	No	Yes, in most of the corridor	Yes, but less widening than Alternative 2
10. Interchange Modifications Required	No	Nine Interchanges	Eight Interchanges
11. Overcrossing Modifications Required	No	Yes, 4 of 16 existing overcrossings to be replaced	Yes, 16 of 16 existing overcrossings to be modified or replaced
12. Undercrossing Modifications Required	No	Yes, 29 UC's to be widened 23 feet or more	Yes, 29 UC's to be widened 17 feet or more
13. Sight Distance Improvements Required per Caltrans	Yes	Yes	Yes
14. HOV/HOT Lane Direct Connectors at I-5	One lane HOV connectors are assumed in each alternative	One lane HOV connectors are Assumed in each alternative	One lane HOV connectors are assumed in each alternative
15. Traffic Management Plan (TMP)	None Required	Major traffic impact during Construction, TMP required	Major traffic impact during construction, TMP required
16. Preliminary Cost Estimates	N/A	$826 million (3)	$752 million plus additional O & M costs (3)

1) Total width between outside of shoulders. Assumes 22 foot median and three 12 foot general purpose lanes in each direction for each alternative. Existing median width varies. Existing minimum typical freeway R/W width is 280 feet.

2) Alternatives 1 and 2 will accommodate overcrossing center columns if typical selection is flared four feet. Alternative 3 would require an additional 32 feet of widening to provide standard shoulders and avoid splitting HOV/HOT lanes around columns.

3) Cost estimates for HOT Lane facilities will be offset by potential toll revenues of $250 to $300 million.

Figure 5-1

Proposed SR 14 Intermediate Access Locations

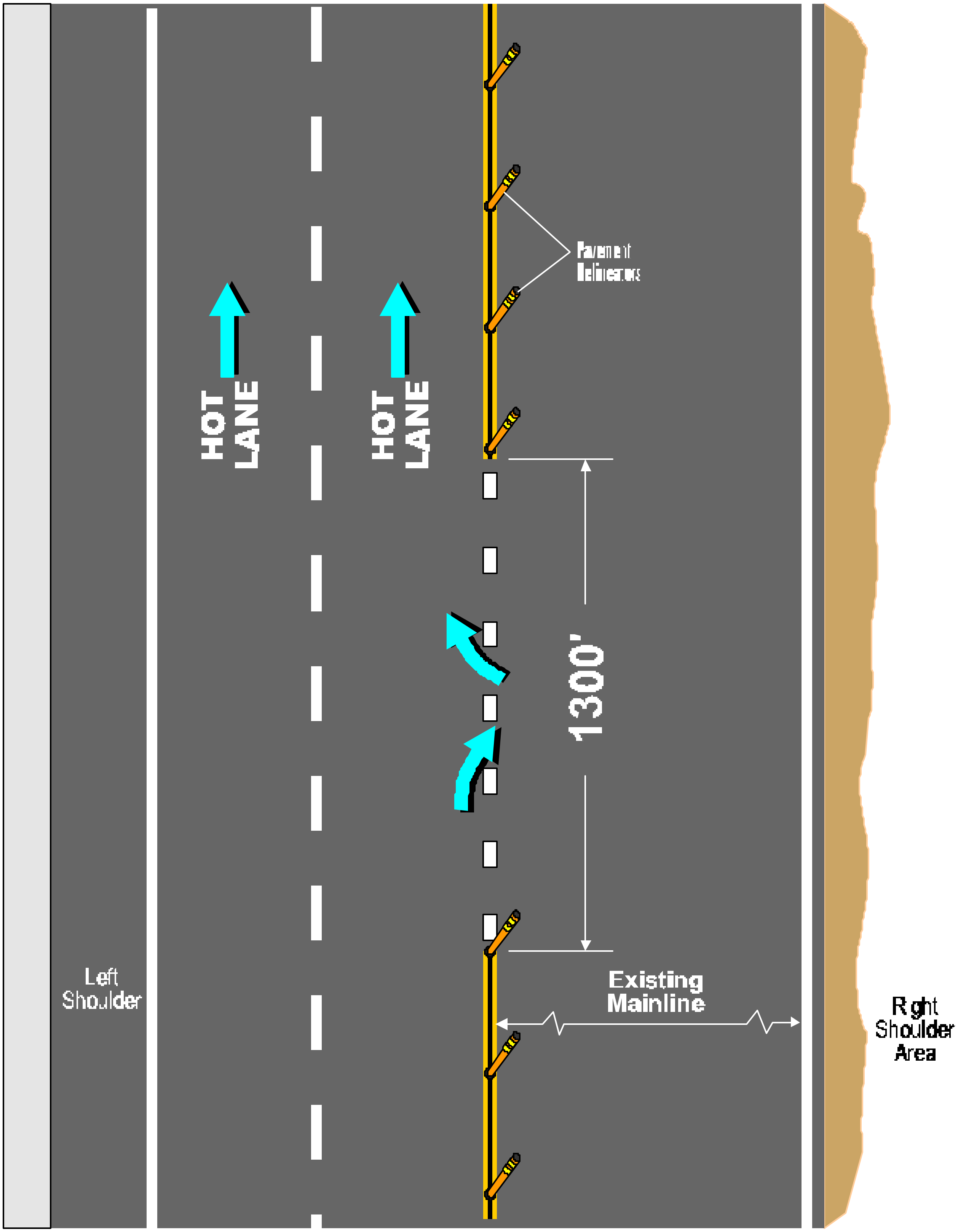


Figure 5-2
SR 14 Corridor Alternatives Study

5.2 Toll Verification Zones

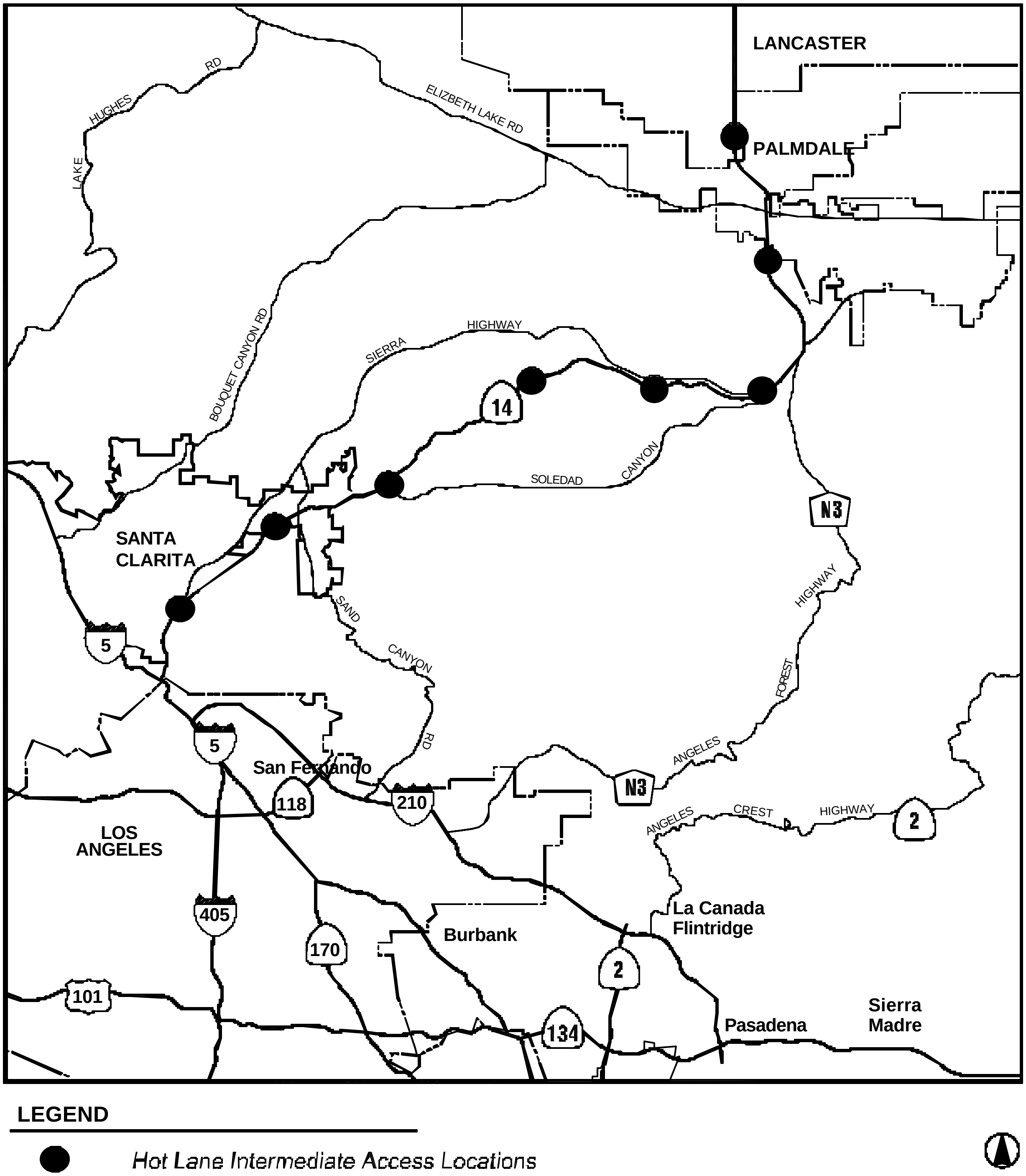
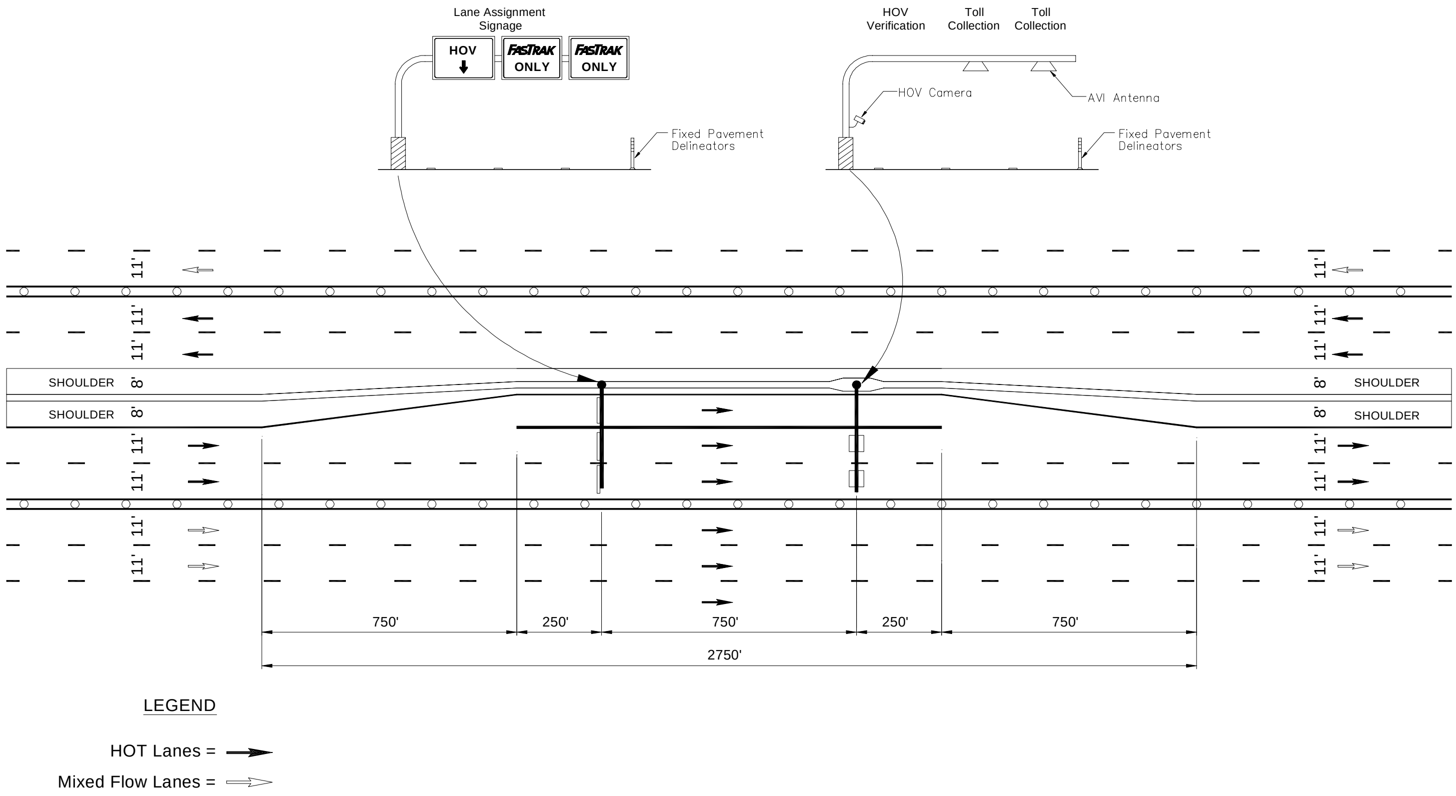


Figure 5-3
HOV Verification Turnout Lane Design Concept



6. OPERATIONAL CONCEPTS

Planning for a managed HOT lane that offers a travel time benefit to a select number of users requires consideration of a number of operational and policy elements. Policy will establish what the lane(s) look like, which the lane is intended to serve, how it will be operated and enforced, how and when tolls will be assessed and collected, and whether toll and/or HOV violations will be enforced. Some of these assumptions are intuitive, based upon local and regional agencies' policies and standards of practice, such as how an HOV user is defined among the various HOV lanes currently in operation. Some policy issues require investigation and discussion because no local examples or rationale readily exist. Some policies work in conjunction with each other as they are interrelated. For example, a reversible lane by nature will have to have prescribed periods when it will operate one direction or the other. Other policies that have been developed are generated from regional or statewide standards of practice which experience shows have met with concurrence form the various affected designs, operating and enforcing agencies.

Each policy element contains various options that may warrant testing. Depending on the importance of the element, several different options may need to be modeled to assess if one or more offer HOT lane feasibility. For example, different levels of available capacity occur for the options of allowing 2+ or 3+ carpools to use the lane for free. In addition, the acceptability of the various alternatives must be assessed and included in the selection process. For example, the selection of 3+ carpools might not be acceptable to the local and regional agencies even though it makes the HOT lane concept more financially viable.

Setting policy assumptions are important as input to the modeling process that help determine the amount of demand that the HOT lane alternative will generate. And, demand will affect potential benefits and impacts that are being measured to assess feasibility. A list of policy elements was presented early in the study along with various options for technical review team discussion. These formed the basis for discussion of how these would best be applied to the SR 14 corridor.

Each issue area was discussed during the course of the study, and a series of trade-offs were made to reach a preliminary recommendation on each. Additional policy elements were raised once the modeling work was begun in order to confirm assumptions that went into the modeling effort. These recommendations formed the basis for assumptions that generated cost and revenue comparisons for various scenarios. The follow list of final policy elements (Table 6-1) was generated from this effort, with recommendations presented for each element.

Table 6-1
SR 14 HOT Lanes Operational Policy Selections

Issue	Options	Policy Selected
User Groups: HOV 3+, HOV-2, SOVs	Cars, Trucks, ILEVs, others?	Two axle vehicles and buses only. Rationale: maintain HOV policy
Pay Groups	Who should be free, who pays?	SOVs tolled; HOVs (2+) free
Transponders Required	Toll payers, HOVs, or all	Toll Payers Only Rationale: Cost of issuing transponders (~$30) and maintaining non-revenue accounts
Movements Served	Peak direction, off-peak direction, or all	Tolling whenever lanes are open. Rationale: Operation automated for toll collection & toll violation enforcement. Simplified signing. Less motorist confusion.
Access	Same or greater than current HOV practice? Any intermediate access? Demand driven by forecast demand? How facilitated?	Intermediate access similar to current HOV access (2-3 mile intervals) with intermediate tolling between access openings. No direct access.
Operational Management Thresholds	Minimum and maximum volume per lane/hour	Minimum per lane: 500 veh/hour Maximum per lane: above LOS D 1500 veh/hour/lane for one lane; 1700 veh/hour for two lanes*
Permitted Speeds	Urban or highest allowed by state law	Same as adjacent roadway
Enforcement	Same as SR 91 Same as I-15 Same as proposed for SR 91 OC or US 101 Hybrid of above? Automated occupancy enforcement?	Automated enforcement for toll infractions (requires verification lane); manual on-site enforcement by CHP for occupancy infractions.
Verification Provisions for Occupancy	Manual or Automated	Manual based upon visual observations by CHP from standard CHP HOV enforcement areas in design
Verification for Tolling	Same as SR 91 CTPC or I-15 experience? Automated or semi-automated or none?	Transponders, remote monitoring, automated license plate capture of violators, and citation by mail Verification lane(s) designated for toll payers needed for automation of license plate capture.
Levels of Scofflaw Traffic Deemed Acceptable	HOV: 5%: excellent & 10%: good Tolls: 2.5%: average	Assume 10% of lane volume taken by scofflaws with 2.5% being toll violators
Toll Rates	Fixed, variable by time of day, variable by time, fully dynamic	Fully dynamic with uniform corridor pricing (similar to I-15). Rationale: Provides demand management to maintain LOS.

Issue	Options	Policy Selected
Toll Rate Basis	Per segment or per mile or per use	Toll concept is on a mileage basis in each toll segment, such that a toll transaction is priced from the mileage of each use/trip, at rates that vary with congestion in each toll segment. Rationale: High tolls only when congestion/demand is high.
Tolls Rates used for Patronage Estimate	Range: $0.05 to $0.35 per mile;	Nominal value was $0.10 per mile. Minimum fee should be at least cover cost of transaction processing: $0.10 to $0.25 per toll transaction (i.e., trip)
Hours of Operation	24 hours, 14-16 hours or peak periods only	Tolling whenever lanes are open (24 hours). Rationale: Operation automated for toll collection & toll violation enforcement. Simplified signing. Less motorist confusion.
Administration and Operations Management	Caltrans, Transportation Authority or 3rd party	Public Agency. Public-private partnership may be possible.
Financing	Public funds, private bonds backed by public agency, private bonds or combinations	Public funds augmented by private bonds backed by public agency. Rationale: Lowest cost approach.
Opening Year and Period of Operation to Evaluate	Opening: 2005, 2007, 2010, later Period: 20, 25, 30 years	Open in 2010 with 30 year period (bond payback) Rationale: Earliest opening; Typical toll-backed bond payback period.
Signage and Communication	Fixed, variable or combinations thereof	Fixed signs for traffic control, user groups, & hours of operation. Dynamic signs only for toll rates.
Toll Segments: Costs and Verification Lanes	Toll collection & verification equipment, verification lanes as well as signage needed for each toll segment.	Provide verification lane(s) for each toll segment to allow automation of violation enforcement Design has 10 toll segments in each direction with toll verification lanes.
Income included in Revenue Estimates	Tolls, toll violations, HOV violations, or combination	Tolls and toll violation fees/fines only. Rationale: HOV violation fines allocated through separate legal basis.
Revenue policy	Where will excess revenues go? Who should decide?	Recovery of operation and maintenance costs first. Surplus revenue (after debt service), if any, to corridor transit and rideshare services.

* Recommend not allowing toll payers when HOV volumes exceed 1400 vehicles per hour per lane for single lane, and 1600 vehicles per hour per lane for two lanes.

7. FINANCIAL FEASIBILITY

7.1 Methodology and Assumptions

The financial evaluation consists of developing a forecast of patronage and revenues in the HOT Lanes based upon toll levels and traffic demand volumes, and estimating recurring costs of operation (as well as the non-recurring toll system installation costs). From these, the net revenues and cash flow over a period of years can be forecast which provides sufficient information to perform the financial evaluation. The fiscal viability assessment used the criterion: Could the HOT lane alternative, as conceived for this study, operate at a level of service sufficient to draw patronage to generate sufficient net revenues over a thirty year period to provide a significant source for recovery of a significant portion of the new lanes' construction costs? For simplicity, all revenue values in this section are shown as constant (i.e., 1999) dollars.

7.1.1 Operational Concept and Policy Assumptions

A number of operational and policy issues affect the finances of the HOT Lanes. For completeness, the key operational concepts for this fiscal analysis include:

- User Groups,
- Pay Groups,
- Operational management thresholds,
- Verification Provisions of Occupancy,
- Verification for Tolling,
- Toll Rates and Basis,
- Hours of Operation,
- Administration and Operation Management,
- Financing,
- Opening Year and Period of Operation to Evaluate,
- Toll Segments: Costs and Verification Lanes, and
- Income included in Revenue Estimates.

The options and selected policy approaches for each of these issues is presented above in Table 6-1. These policy selections were made for the purpose of this study's financial analysis. If the SR 14 HOT Lanes are implemented, the actual policies will be established by the appropriate decision-makers.

7.1.2 Traffic Modeling Forecasts of Demand

The key measures of the financial viability of the HOT Lanes are the patronage and revenue estimates that are based upon an evaluation of traffic projections. For this Study, the HOT lane alternative's traffic projections were developed using both the SCAG and the Palmdale models. The SCAG traffic model was used from I-5 to Avenue S in Palmdale and the Palmdale traffic model was used from Crown Valley Road to Avenue L in Palmdale. Based upon recommendations from the traffic modelers, who produced these results, and the rationale that both models are equally weighted, the two models' traffic volumes in the overlap region were averaged for this analysis.

Model runs were made for a three-hour AM peak period (6:00 to 9:00 AM) and a four-hour PM peak period (3:00 to 7:00 PM) as follows:

- Year 2010, toll rate of $0.10/mile for the HOT2 operational configuration,
- Year 2020, toll rate of $0.10/mile for both the HOT2 and HOT3 configurations, and
- Year 2020, toll rate of $0.20/mile for the HOT2 configuration.

The traffic level forecasts from the models demonstrated there is very low demand for HOT lanes north of Palmdale Blvd. In these three segments (i.e., Palmdale to Avenue P, on to Avenue N, and on to Avenue L) the highest level of traffic in any of the model runs is less than 700 vehicles per hour per lane, with most being under 500. The general purpose lanes are experiencing unrestricted, free flow traffic even in the Y2020 conditions on SR 14 "north" of Palmdale Blvd., so the toll-payer volumes are very low even at $0.10/mile. The carpool volumes (HOV 2 or 3) are also very low in both 2010 and 2020. There appears to be insufficient traffic volumes in this region to justify building two HOV or HOT lanes in each direction. From this, we concluded in performing the financial analysis that building the 5.7 miles of four HOT lanes between Palmdale Blvd. and Avenue L is not financially viable due to lack of expected patronage. Therefore, we eliminated the northern segments of the baseline design in our financial analyses since the revenues would be negligible from that region of free-flow traffic on SR 14.

The traffic volumes (forecast for SR 14 HOT Lanes in the segments south of Palmdale Blvd.) are much higher. These volumes are near or over 2,000 vehicles/hour/lane for the predominant commute directions (i.e., southbound in the AM and northbound in the PM) in nearly all the cases discussed above, and as shown in the tables in Appendix A. From this, we could see that the southern 34.3 miles of HOT Lanes should have a significant level of patronage that was worth further analysis and evaluation.

7.1.3 Patronage and Level of Service Goal for HOT Lanes

The key to the viability of the HOT lanes is to maintain (if possible) a time savings incentive for the HOT lane patrons. We estimate that an 8-20 mph differential in speed between the general-purpose lanes and the HOT Lanes should provide a high value time savings incentive for a toll patron. For example, 20 minutes could be saved over a 30-mile trip, at a constant 45-mph speed versus 30-mph. In the SR 14 traffic analyses, the model forecasts that there will be an average speed differential of 8 to 11 mph in 2020. In addition, the models provide forecasts of actual timesavings of between 8 and 23 minutes between the HOT and general-purpose lanes, depending upon the time of day -- with the larger, 20-minute savings in the peak times and in the predominant commute directions. And, since the average HOT Lane user will perceive an even larger time saving, we conclude that there should be sufficient demand in 2010 to nearly fill (and in 2020 to more than fill) the HOT Lanes during peak periods in the primary commute directions at $0.10/mile toll rates. The issue for SR 14 is how to keep the toll payer patronage in the HOT Lane down to maintain an acceptable level of service for the HOV and the toll-paying motorists.

To that end, a goal of level of service (LOS) at or better than LOS D was set for the HOT lane alternative. The basic definitions and relations between LOS and other freeway traffic measures are illustrated below. These are simplifications intended to assist the reader of this financial analysis. For details and exact definitions, please consult the Highway Capacity Manual.

Table 7-1
Simplified Freeway Traffic Basics

Level of Service (LOS)	Vehicle/Capacity Ratio (V/C)	Vehicle Volumes* (vehicles/lane/hour)	Vehicle Speeds (mph)
F	Various	Various	Various
E	1.0	2200-2300	58-60
D	0.72-0.88	2015*	63
C	0.72-0.75	1644	68.5
B	0.49-0.51	1120	70
A	0.30-0.32	700	70

* For HOV or HOT lanes, recommended maximum is 1500 v/l/hr for one-lane facility and 1700 v/l/hr for two-lane facility in order to be at or above LOS D.

Since the models are forecasting vehicle to capacity (V/C) ratios over 1.1 for the general purpose lanes during peak periods in the predominant commute directions, we estimate that a threshold of at (or better than) LOS D should provide relative speeds and time savings sufficient to make the HOT Lanes attractive to HOVs and to toll-paying motorists. For the two-adjacent lane configuration of the SR 14 HOT lane design envisioned for this Study, LOS D as an operating limit means that the traffic volume in the HOT lanes should be kept at or below 1,700 vehicles per hour per lane. Note that in one-lane configurations, the HOT Lane LOS D goal would limit the traffic volume to be at or below 1,500 per lane per hour. Dynamic value pricing, such as that implemented on the I-15 Express Lanes in San Diego, provides the demand management means to have that control. However, the SCAG and Palmdale traffic models do not have the capability to represent dynamic pricing on HOT lanes, so value pricing needs to be determined using judgement (and manual adjustments to the models' traffic forecasts) based upon reasonable assumptions and traffic engineering principles. Likewise, the models do not represent the HOV scofflaws or the toll violators, both of whom use up the available carpool lanes' capacities. Therefore, to perform a realistic fiscal evaluation, all of these issues have been included. The assumptions and principles used to incorporate these issues in this evaluation are discussed in the next few subsections.

7.1.4 HOV Scofflaw Rates and Impacts

The traffic models do not include motorists who violate the laws and drive in the carpool lanes although they do not have the required number of occupants. These HOV scofflaws use the excess capacity in the carpool lanes which is the asset being offered for those willing to pay a toll. Caltrans rates HOV scofflaw rates of 10% as good and 5% as excellent. These HOV scofflaw rates actually vary as a function of congestion (and frustration) as well as the numbers of California Highway Patrol (CHP) officers deployed for HOV violation enforcement. Experience in HOT lane operations, gained from the I-15 Express Lanes, is showing that the HOV scofflaw rates definitely decrease when the legal toll alternative is offered and the CHP presence on the HOV facility is kept high and visible. Therefore, the recurring operating costs for the HOT lanes, discussed below, assumes that an extra CHP presence (i.e., 4000 hours and 320,000 miles per year) must be maintained to preserve the lane capacity for those honest carpools and those non-HOVs willing to pay tolls. This HOT lane investment in HOV violation enforcement should maintain the HOV scofflaw rates between 5% and 10%. In addition, there will be additional revenues resulting from the HOV violation fines as a result of this vigorous enforcement. However, the resulting increase in HOV violation fines, which are distributed to various government agencies including SCAG and the cities along SR 14, is not included in this fiscal analysis as a "return on investment." This is viewed as an unmeasured, positive side benefit of operating the HOT lanes.

Note that HOV scofflaws exist in carpool lanes throughout the country and they exist independent of the HOT Lane concept. Studies of the I-15 Express Lanes seem to indicate that providing motorists with the toll paying option under a HOT Lane operation lowers HOV scofflaw rates. The CHP do their best to enforce the HOV requirements, but counting occupants is difficult with modern vehicles' styles and window tint treatments. In our opinion, the best deterrence to the HOV scofflaws is the presence of CHP officers and the posting of large signs indicating the size of the fine for HOV use violations. However, congested general-purpose lanes and frustrated motorists prevent elimination of HOV violations. Thus, any fiscal evaluation needs to include these HOV scofflaws as part of a realistic assessment. Also, note that HOV scofflaws are different than toll violators in ways that will be discussed and clarified below.

Nonetheless, for the SR 14 Study's financial assessment, the analysis assumes that all the traffic model's estimates of "legal" HOV traffic is increased by an HOV Scofflaw percentage factor due to the inclusion of HOV scofflaws. This represents a loss in potential tolls that needs to be minimized through vigorous enforcement but, in the real world, cannot be ignored. The HOV enforcement "investment" in operating costs, along with the presence of several video cameras that could assist HOV enforcement in the toll collection zones, should maintain the HOV scofflaw rates at or below 10%. For this fiscal analysis, 10% HOV scofflaw rates for all conditions is used for the "expected" cases to represent a realistic conservative estimate of actual HOV traffic levels. In addition, for this Study, parametric sensitivity analyses are performed to estimate the impact of 5%, 10% and 20% HOV scofflaw rates.

7.1.5 Patronage and Revenue Forecasts

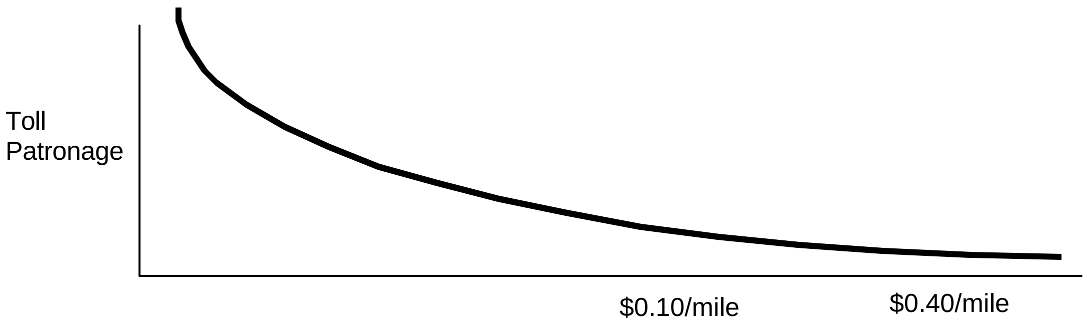
The model results form the basis for the patronage estimates of this analysis. However, two adjustments were made to the model results that we believe correct for model deficiencies and oddities. The SCAG model did not forecast any toll payer usage in the "reverse commute" HOT lanes except for one condition when excessive use was forecast. These were deemed model deficiencies and oddities and adjustments that match our 91 Express Lanes and I-15 Express Lanes experience and observations. These adjustments are described in the Study Final Report.

The change of HOT lane use during the period from 2020 through 2040 was estimated by extrapolation based upon a factor of 2% annual traffic growth starting from the results for the 2020 conditions. The traffic growth rate of 2%, (typical for Southern California traffic growth) was selected to provide a moderate, conservative forecast.

Demand and Time Savings Conclusions — As mentioned above, the conclusion drawn from the model results is that there appears to be a high level of demand for the available HOT Lanes' capacity for toll-payers at toll rates at or above $0.10/mile. Similarly, we conclude from the model results that there is sufficient time savings in using the HOT Lanes versus the general purpose lanes to reward the toll payer. Finally, although capacity limits and lane reductions may cause delays for the SB SR 14 toll patrons at the southern terminus of the HOT Lanes at the I-5, we are assuming that the overall time savings will be sufficient for the toll-payer who will (at a minimum) arrive there faster than those who stay in the general purpose lanes. Indeed, as was noted in the 91 Express Lanes user surveys and measurements for the evaluation effort led by Dr. Ed Sullivan of Cal Poly San Luis Obispo, the motorists' perceived time savings are much more than their actual time savings.

Effects of Toll Rate Changes — Previous public opinion polls (especially the SR 91 (West) HOT Lane Feasibility Study conducted by OCTA) have shown, to a first order of approximation, for tolls between $0.10 to $0.40 per mile, that the percentage of willing toll payers is inversely proportional to the percentage change of the toll rates. That is, a 20% increase in the toll rates (e.g., from $0.20 to $0.25 per mile) reduces the toll traffic by about 20% during peak periods. (Note that this applies as an approximation, since in the limit there appears to be a small group of motorists who will, on certain days, always be willing to pay the toll at any reasonable rate. These are the high-value of time motorists who are the opposite of those who are never willing to pay tolls.)

Simulating the Effects of Dynamic Value Pricing — The SR 91 public opinion poll data indicates that the price-patronage elasticity is a straight-line, linear relation. In this linear range of pricing, we are seeing the asymptote of a hyperbolic curve that can be approximated by a straight line (with a negative slope for increasing toll rates), such as illustrated here.



The poll data and this approximation indicate a one-to-one relationship between a toll rate percentage increase and a toll patron percentage decrease. For this, we conclude that a reasonable estimate of the effect of toll rates on patronage is to vary the estimates of toll-paying traffic volumes from the model by a ratio of toll prices (e.g., new "trial" toll rate/modeled toll rate). For example, if according to the model results 2,000 vehicles per hour per lane are willing to pay a toll of $0.20/mile, then we could project that 1,000 v/h/l are willing to pay a toll of $0.40/mile. Of course, this is an approximation (and one not necessarily reflected by these traffic models), but it certainly serves until more accurate (and probably complex) toll price-to-patronage relationships are developed (assuming this ever can be quantified by a group behavioral model). This price-ratio scaling of the toll patronage from the models was used to simulate dynamic value pricing. The above approach was used to determine the toll rates that would provide toll patronage at or below the maximum LOS goal of 1,700 v/h/l for the HOT Lanes conditions evaluated for this feasibility study. This methodology was used only to decrease the models' forecast volumes of toll payers by raising toll prices. The dynamic toll pricing was not set at lower than the models' estimates to raise the toll-paying volumes. This technique was only used to solve for a rate that would decrease the toll-payer demand estimated by the models to get down to the LOS goal (e.g., 1,700 v/h/l). Therefore, we believe that this is, in general, a fairly conservative method of estimating the toll patronage.

The price sensitivity of real SR 14 drivers willing to pay tolls should be confirmed and evaluated further as part of future public opinion polls which would be needed to support a bond-rating patronage and revenue forecast. Note that this initial financial feasibility effort is intended to provide estimates of future patronage and revenue, but is not sufficient to support a bond indenture.

The effect of value pricing on patronage is simulated in the patronage and revenue estimates presented below using this approach. This is the same technique and cost sensitivity that were initially developed for the SR 91 (West) HOT Lane Feasibility Study conducted for OCTA in 1997, and were used for the SR 57 HOT Lane Feasibility Study, also for OCTA in 1999.

Representing the HOT Lane's Available Capacity for Toll-Payers — As one would expect, when we extrapolate the HOV2 usage out beyond 2020 starting with the models' forecasts of between 1,200 and 1,500 v/h/l during peak periods, the capacity available for toll-payers disappears. Then, when the HOV2 usage grows to exceed the LOS goals and/or starts to go higher than V/C > 1.0 in the HOT2 Lanes, it will be time to consider changing to a carpool definition of 3+. This will certainly be true for the southern end of the SR 14 HOT Lanes based upon the SCAG model's forecast. Therefore, in our patronage estimation for this Study, we needed to establish a criterion for determining when the HOT Lanes are full of HOV2s such that toll-payers will no longer be allowed to "buy-in" to the HOT Lanes. One of the reasons for the above criterion is that the price increases needed to "scale" the toll-payer demand down in these extreme conditions (e.g., a HOT Lane nearly full of carpools) become excessively large -- and outside our poll data and certainly beyond our region where linear approximations for price elasticity apply. For example, using dynamic pricing, a toll-payer demand of 2,000 v/h/l at \$0.20/mile that would reduce the traffic to 100 v/h/l (i.e., all the capacity that is available since the HOV2s are at 1,600 v/h/l) might require a price increase factor of 20 producing a toll of \$4.00/mile. Therefore, when a contiguous set of toll segments start to reach the LOS goal for traffic volumes, we recommend closing the HOT Lanes to toll-payers. For this Study, we used HOV2 volumes of around 1,600 v/h/l to represent HOV capacity; that is, when a HOT lane cannot reasonably accommodate toll payers. Of course, the HOV2 volumes can exceed that level since there is no traffic demand management control available. But, we have assumed that the toll-payers should be kept out of the HOT Lanes during periods when the HOV2 volumes reach or exceed 1,600.

In the years of 2030 and 2040, the southern segments of the SR 14 HOT Lanes for the extrapolated HOV2 traffic volumes in the predominant commute directions exceed the 1,600 v/h/l threshold discussed above. Initially from I-5 to Sand Canyon Road and later to Escondido Canyon Road, HOT2 Lanes would need to be closed to toll-payers. Interestingly, the segments north of Escondido Canyon Road did not fill up with HOV2s for the traffic projections used in this analysis. Since the last two northern segments are nine miles and 1.6 miles, we envision a viable HOT2 Lanes operation in the 2030 and 2040 time periods. Therefore, for the HOT2 alternative cases, we assumed that during peak periods for the AM (i.e., SB) commute, there would need to be an extended egress area for the toll-payers to be able to exit. We expect a re-striping treatment requiring an auxiliary transition lane for the toll-payers or, preferably, an extended egress similar to the nearly 2-mile transition area at the eastern terminus of the 91 Express Lanes would be needed -- if the region does not change to a HOV3+ carpool definition. In addition, for the HOT2 alternative projections in this era, an extended ingress might be required when the NB peak period toll-payers would be allowed into the HOT2 Lanes for these "northern" segments (e.g., at Escondido Canyon Road).

7.1.6 Toll Violations

As there are HOV scofflaws, experience in the electronic tolls industry in general and on Orange County toll roads in particular is that there is a low, steady level of toll violators where there are no toll gates, no toll attendants, and no CHP. The national and local experience is that electronic toll violations run at 2 to 5% of the toll transactions. Technology exists and is installed to capture images of toll violators' license plates with a high accuracy. Also, California civil code laws are in place to permit toll authorities to fine motorists up to \$76 and to place "holds" on those motorists' annual vehicle registration with the Department of Motor Vehicles (DMV) to enforce payment of these fines and unpaid tolls. Nevertheless, there is a small set of motorists who believe that they can "beat the system" and drive on the toll roads without valid toll debit accounts and/or electronic transponders. The HOT lane facility's violation enforcement system assumed for this study should recover the majority of these violators' tolls, but at a cost over and above the normal electronic toll collection costs. Therefore, for completeness and because the toll violation fines are a potentially significant source of toll revenues, the effects of toll violators are included in this fiscal assessment. For the "expected" Case a, the conservative toll violation rate of 2.5% (the national average estimated by the International Bridge, Turnpike and Tunnel Association, IBTTA, from surveys of its' member toll authorities) was used. *In other cases, the toll violation rates of 5% and 10% are evaluated.*

For HOT Lanes, a toll violator is a non-HOV motorist who while driving in the HOT Lanes drives through the toll verification lane without a transponder or with a transponder without a good debit account standing. The signage will need to be developed that makes it clear that a motorist driving into the "FasTrak Only" lanes must have a valid "FasTrak" transponder and account or be in violation of the civil code which can lead to a fine of as much as $76. The toll violators normally will be notified by mail via the vehicle's license plate image captured electronically by the automated toll violation enforcement system while in the toll collection and/or verification zone. Collection is performed by the toll authority using fees, fines and (when necessary) placing a "hold" at the DMV until the toll violation payments are made. On the other hand, an HOV scofflaw is a non-HOV motorist who drives through the adjacent HOV-Only lanes at the toll collection zones on the HOT Lanes. The signage will make it clear that if a motorist is an HOV scofflaw (i.e., violator of the vehicle code driving in the HOV-Only zone) that they will be subject to the HOV violation fine of at least $271. The HOV scofflaws will be ticketed by the CHP as with current carpool violation enforcement. Collection of this vehicle code violation is performed by traffic court of the local jurisdiction.

The violation enforcement revenues are included in this financial analysis. Details are provided in the Study Final Report. One key, conservative assumption is that the toll violators will drive the length of the HOT lane such that the number of violators is the peak value of the toll violations in all the toll segments, rather than the sum of the segments' violators. This is considered to be conservative as it minimizes the toll violation revenue potential. Note the net effect of this conservatism could underestimate the toll violation revenues by as much as a factor of two or three. In addition, this estimation approach is equivalent to the HOT lane's toll authority adopting a policy of charging one violation for the violator who drives the entire HOT lane. The toll violation costs are based upon realistic factors experienced by electronic toll operations. The toll violation processing costs are increased by a 40% contingency factor for further conservatism.

7.1.7 Costs for HOT Lane Implementation and Operation

Toll System Capital Costs - The cost estimate for the HOT Lanes' Toll System's non-recurring capital expenditures shown in Table 7-2 would be spent in order to implement the HOT lanes' toll system and infrastructure. Unit costs and quantities have been developed as shown in Table 7-2 for the recommended 36.3 mile facility terminating at Palmdale Blvd. For this top level financial feasibility evaluation, one can see that these toll system costs which include 40% contingency (i.e., $18 million) are relatively minor (less than 5%) compared to the freeway improvement construction costs and are being included primarily for completeness. Note that there are nine toll segments and 18 toll collection zones in this recommended HOT Lane alternative.

The suggested infrastructure improvements are underground conduit runs under the freeway for power and telephone lines (from the median to the toll equipment located along the right shoulder), new signage for the HOT lanes (both fixed and changeable), pavement delineators at 12-foot intervals, sign bridges, camera poles, and paint. Modifications to the median spacing barrier to accommodate changeable message signs (CMS) are also required. Estimates of the back room, Host computer and software are included, although this might be provided if this function were shared with another California toll operator *e.g.*, CPTC, TCA, Caltrans, *etc*.). The on-site toll equipment (sensors, cameras, computers and installation) cost of $200,000 is a conservative estimate that includes the violation enforcement license plate imaging capability and highly reliable, self-monitoring equipment. Management for the implementation and startup marketing costs are also included as shown in Table 7-2. The electronic toll transponder costs of about $30 are shown only for needed stock on hand (e.g., 10,000 tags) as it assumed that the primary transponder costs (e.g., for 50,000 or more tags) are initially offset by pre-paid toll account balances (e.g., $40) required to establish patron debit accounts

Table 7-2
HOT Lanes Capital Expenditures

For 36.4-mile facility *Computed numbers for reduced set of toll segments (9)*

	Unit Costs	*Quantity*	*Total*
Toll System & Infrastructure			
CMS	$85,000	18	$1,530,000
CMS Installation	$100,000	18	$1,800,000
Toll Zone Construction	$50,000	18	$900,000
On Site Toll Equipment	$200,000	18	$3,600,000
Communications Equipment	$1,500,000	1	$1,500,000
Added Fixed Signage	$30,000	18	$540,000
Pavement Delineators	$25	26,080	$652,000
Surveillance Cameras	$3,000	108	$324,000
Camera Poles & Installation	$2,000	108	$216,000
Host Computer	$500,000	1	$500,000
Host Software	$250,000	1	$250,000
Traffic Center Equipment	$125,000	1	$125,000
Management			
Authority Management	$300,000	1	$300,000
PS&E/System Oversight	$350,000	1	$350,000
Marketing (Pre-Opening)	$150,000	1	$150,000
Transponders	$30	10,000	$300,000
Contingency	40%	1	$5,214,800
	Toll System Subtotals=		$18,251,800

Recurring Costs for HOT Lanes Operation and Maintenance — The estimated annual recurring costs for any of the HOT Lanes alternatives being considered are provided in Table 7-3. These estimates follow the recurring costs developed for a 10-mile HOT lane facility analyzed in the 1997 SR 91 (West) HOT Lanes Feasibility Study that were refined in the more recent, 1999 SR 57 HOT Lanes Feasibility Study for OCTA. Note the CHP costs are included, as noted above, although this is only to accomplish vigorous enforcement of the HOV violations.

Table 7-3
HOT Lanes Recurring Costs

Recurring Costs:	**Unit Costs**	**Quantity**	**Total ($/Year)**
Enforcement and Security:			
- CHP: labor	$50	4,000	$200,000
mileage	$0.40	320,000	$128,000
- Security and Roadway Assistance	$150,000	1	$150,000
Administration:			
- Authority management	$200,000	1	$200,000
- Authority auditing	$50,000	1	$50,000
Transponders:	($25)	15,000	-$375,000
- Toll Account Balances (offsetting cash flow)	$25	15,000	$375,000
Maintenance:			
- Toll System Software	$50,000	1	$50,000
- Toll System Hardware	$100,000	1	$100,000
- Pavement Delineators	$25	13000	$325,000
- Caltrans Additional Maintenance	$325,000	1	$325,000
Marketing:	$150,000	1	$150,000
Contingency (~40%):			$672,000
		Subtotal=	**$2,350,000**
Toll Operations and Collection:			
- Fee per Transaction* **Range:**	**$0.10 to $0.25 per transaction**		
*Assumed Ticketing Type toll collection			

Estimates for "extra" Caltrans maintenance and to replenish the pavement delineators are shown. The "fixed" recurring cost subtotals are shown to be about $2.35 million for this SR 14 HOT Lanes facility. As shown at the bottom of Table 7-3, the major additional toll operations cost is the per transaction fees which are estimated to range from $0.10 to $0.25 per transaction. Although, electronic toll processing costs per toll transaction must be developed in association with the operator, the most recent survey from the IBTTA has shown that the average operating costs for electronic tolls is approximately $0.11 per transaction. However, direct experience with local toll operations, including the Transportation Corridor Agencies (TCA) in Orange County, indicates that this is more representative of the low end of the range of toll operations costs. To represent the lower-cost end and the higher-cost end, toll processing costs of $0.10 and $0.25 per transaction, respectively, were used in this fiscal feasibility study, in all cases examined, to bound this variable cost.

One other key assumption being made in the toll cost per transaction methodology being used herein is that a toll "transaction" is the total trip along the HOT Lanes facility that is being taken by that toll-payer. This is referred to as "ticketing" toll collection by the tolls industry since it means that the cost of that toll transaction is computed by the distance and the rates for the toll segments traveled for that trip. For reference, this is the method of tolling on the Pennsylvania and New Jersey Turnpikes. The other method of tolling most often used is referred to as “barrier” tolling in which everyone who drives through this toll zone pays a given toll. This is the method used for toll bridges, tunnels and many toll roads such as the Toll Roads in Orange County, California, operated by TCA. The assumption of “ticketing” tolls for the SR 14 HOT Lanes is being used in the methodology here since it provides a better visualization of how the tolls will be computed (i.e., on a per mile basis). Actually, either tolling method will work on a HOT Lane. However, for this long, proposed SR 14 facility with multiple ingress/egress locations, "ticketing" toll collection seems more appropriate and descriptive. In addition, this provides a lower-cost basis for defining a toll "transaction" in the computation of toll processing costs.

7.1.8 Net Revenue Estimation

To compute the net revenue, the gross toll revenue income estimates and the net toll violation enforcement revenues are added together, then the toll processing costs and the other recurring costs are subtracted to compute the net revenues for each of the four years analyzed (e.g., 2010, 2020, 2030, and 2040).

7.1.9 Cash Flow Analysis

Startup Year — In the HOT Lane cases analyzed, the year 2010 is intended to denote the initial year of operation for the HOT2 case for the SR 14 HOT Lanes. However, these estimates are actually more representative of 2011, since the initial year of operation will build slowly and only achieve 60% to 80% of the forecast (i.e., potential) revenue levels. To represent that well-known phenomenon, in all cash flow and other fiscal evaluations, as well as in figures below that illustrate these net revenue estimates (either annual levels or cumulative revenue values), the initial year (2010) is adjusted to account for this first year toll startup. Specifically, the cash flow evaluations below will only use 70% of these "startup year" potential levels and the 2010 net revenue forecasts are being used for 2011, the interpolated forecasts for 2011 are used for 2012, etc., through 2020, the first decade of operation. Interpolation between forecast years (2010, 2020, 2030, and 2040) is simply straight line interpolation.

7.1.10 Toll Revenue Bonds and Debt Coverage Requirements

Toll revenue bonds usually require a debt coverage ratio of from 1.3 to 2.0. That is, the bonds are backed by net toll revenues that would exceed the debt service payment by between 30% and 100%. The higher the debt coverage ratio, the lower the risk to bond holders; therefore, the lower the interest that would be needed to sell the bonds. Any sophisticated level of fiscal bond analysis was not attempted for this feasibility study, however some assumptions and "rules of thumb" have been used to estimate the amount of money that the projected toll revenue stream could finance. We have assumed that a debt coverage ratio of about 1.3 would be sufficient for "reasonable" tax-exempt bonds (interest rates that would be similar to the toll revenue bonds that have funded the Toll Roads under TCA). However, the annual net revenues vary with time, so the usual, simple computation of net present value of the future cash flow cannot be used. Rather a simple rule of thumb was used for this fiscal analysis -- which was checked and confirmed by a very conservative, net present value computation. The rule of thumb was that net annual cash flow should be sufficient to cover about 10 times that level. In other words, $20 million of annual cash after expenses should be sufficient to cover the debt service (and fund) bonds for about $200 million. For simplicity that result is presented below for estimated bond levels. However, note that these are relatively conservative since time-varying annual payments are often arranged to permit larger bonds to be established and sold. Again, although we kept it simple, we have confirmed this "rule of thumb" as being quite reasonable based upon the net present value of the cash flow forecasts.

7.2 Alternatives Evaluated

There were two alternatives evaluated for the financial feasibility, for the recommended 36.4 mile, SR 14 HOT Lane facility are:

1) HOT 2+ for the entire period from 2010 through 2040, and

2) HOT 2+ from 2010 through 2020 and HOT 3+ from 2021 through 2040.

The first alternative evaluated was chosen to investigate how the growing HOV2+ usage impacts the fiscal viability as the carpool demand uses up the spare capacity (at least during the peak periods) over the thirty year period. In the HOT2 alternative, we assumed that the carpool definition is kept at the 2+ level -- although the carpool demand exceeds the HOT Lanes' capacity during peak periods on much of the facility. The second alternative was chosen to represent a likely scenario for the SR 14 HOT Lanes: opening as a HOT2+ facility and then converting to a HOT3+ facility "at such time when the regional carpool definition is changed to HOV3+". We have chosen to affect this shift in carpool definition (i.e., going from 2+ to 3+) in 2021 for this second alternative, but the year was arbitrary. This second HOT2/3 alternative is intended to show what is most likely to happen when the carpool demand grows to fill the capacity and if it is decided to change the carpool definition. A third alternative, HOT3+ for the entire period was not evaluated at this time, however we do know that a HOT3 facility will definitely be more fiscally successful than the two alternatives that we did evaluate.

7.3 Sensitivity Analysis and Scenarios Evaluated

There are a number of assumptions and factors that we varied to perform a variety of sensitivity analyses. These factors include:

- HOV scofflaw rates,
- Toll Violation rates,
- Off-peak usage levels,
- Peak Periods' durations,
- Dynamic Toll Pricing approaches, and
- Toll Processing costs.

The approach taken, primarily to limit the number of conditions to be analyzed to a reasonable number, was to establish scenarios wherein the combination of these factors produce bounding conditions such as better/best, expected, low, and lowest. These six bounding scenarios are listed in Table 7-4 below. Note that Case a is the "expected" set of conditions for the HOT2 alternative. Likewise, Case e is the "expected" set of conditions for the HOT2/3 alternative.

Note that the upper and lower bound for Toll Processing costs (i.e., $0.10/transaction and

Table 7-4

Bounding Scenarios Analyzed for SR-14 HOT Lanes

CASE:	a	b	c	d	d1	e
Conditions:	HOT2+	HOT2+	HOT2+	HOT2+	HOT2+	HOT2+(2010 to 2020) HOT3+(2021 to 2040)
HOV Scofflaw Rate	10%	10%	5%	20%	20%	10%
Toll Violation Rate	2.5%	2.5%	5%	10%	10%	2.5%
Off-peak Usage:						
-- daily off-peak use*	2 peak hours	2 peak hours	3 peak hours	1 peak hour	1 peak hour	2 peak hours
-- weekend day/weekday	30%	30%	40%	20%	20%	30%
Peaks Periods Duration:						
-- Y2010 AM PM (hrs)	3.0 4.0	3.0 4.0	3.0 4.0	3.0 4.0	3.0 4.0	3.0 4.0
-- Y2020 AM PM (hrs)	3.33 4.33	3.33 4.33	3.33 4.33	3.2 4.2	3.2 4.2	3.33 4.33
-- Y2030 AM PM (hrs)	3.67 4.67	3.67 4.67	3.67 4.67	3.4 4.4	3.4 4.4	3.67 4.67
-- Y2040 AM PM (hrs)	4.0 5.0	4.0 5.0	4.0 5.0	3.6 4.6	3.6 4.6	4.0 5.0
Dynamic Toll Pricing	by toll segment	by corridor	by toll segment	by corridor	by corridor	by toll segment
Other					no violation enforcement	
Case Description:	***expected***	***expected***	***better***	***low***	***lowest***	***expected***

* half AM peak hrs. and half PM peak hrs.

$0.25/transaction) were included in all six scenarios, which produced twelve different financial analyses.

7.4 Financial Assessment of the Alternatives

The estimated cumulative net revenue potential versus time is plotted in Figure 7-1 for six of the bounding scenarios (i.e., the HOT2 and HOT2/3 expected cases and the HOT2 better and low cases). As shown in Figure 7-1, the "expected" and "low" scenarios follow about the same general cumulative revenue path until between years 2020 and 2025, then they take divergent paths. These divergent paths reflect how the varying conditions impact the revenues as the HOV2 demand grows to fill the HOT Lanes' capacity during peak periods for major stretches of the road beyond 2020. Also, note that the "better" HOT2 case (i.e., Case c) is around $100 million above these other cases around the year 2020. Finally, the "expected" HOT2/3 cases are seen to grow rapidly after 2020 and are surpassing the "better" (more optimistic) HOT2 case between 2030 and 2035.

The annual revenue data is plotted in Figure 7-2 versus time for the same six bounding scenarios shown in the prior figure. Figure 7-2 shows the net annual revenues on the left hand scale, while on the right hand scale we show the approximate amount that could be repaid via loans or toll bonds by these cases' average annual revenues. The ranges of annual net revenues shown in Table 7-5, for these twelve various scenarios, are the revenue cash flow that would be assessed for bonds or other loans (i.e., TIFIA, if eligible). This key summary chart shows that HOT2 and HOT2/3 alternatives for the whole range of conditions and factors that were evaluated for the twelve scenarios should be sufficient to service debt of between $200-250 million (low case) and close to $300 million (expected and better) HOT2 cases. In addition, for the HOT2/3 cases, Figure 7-2 indicates that, once the HOT3 operation begins, refinancing could be appropriate. Finally, for all the scenarios and alternatives evaluated, a significant portion of the construction costs could be financed using the revenue streams shown in Figure 7-2 — say 35 to 40% for the HOT2 and as much as 45 to 50% for the HOT2/3.

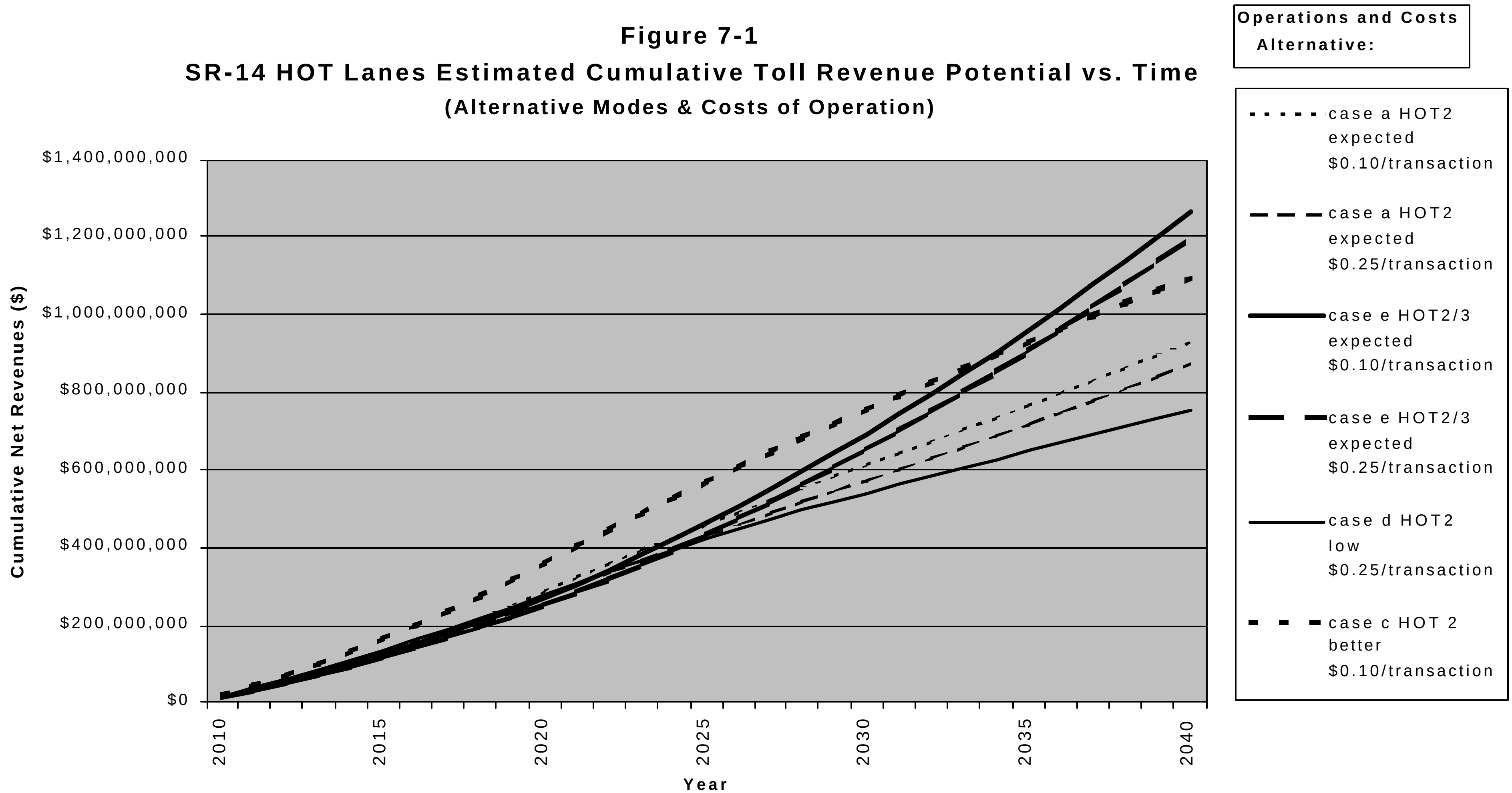
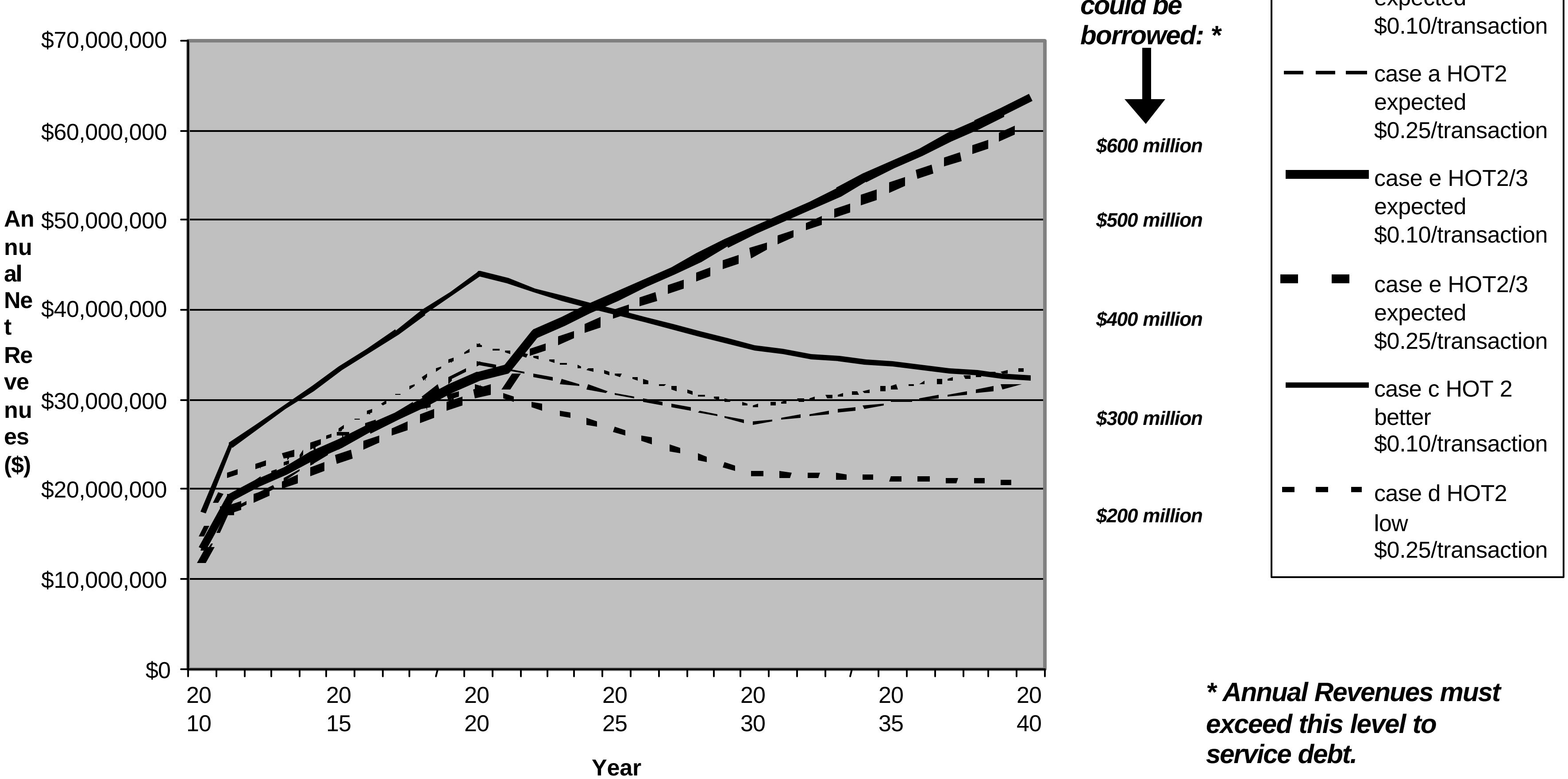


Figure 7-1
SR-14 HOT Lanes Estimated Cumulative Toll Revenue Potential vs. Time
(Alternative Modes & Costs of Operation)
Operations and Costs Alternative:
case a HOT2 expected $0.10/transaction
case a HOT2 expected $0.25/transaction
case e HOT2/3 expected $0.10/transaction
case e HOT2/3 expected $0.25/transaction
case d HOT2 low $0.25/transaction
case c HOT 2 better $0.10/transaction
Cumulative Net Revenues ($)
$1,400,000,000
$1,200,000,000
$1,000,000,000
$800,000,000
$600,000,000
$400,000,000
$200,000,000
$0
2010
2015
2020
2025
2030
2035
2040
Year

Figure 7-2

SR-14 HOT Lanes Annual Estimated Toll Revenue Potential vs. Time

(Alternative Modes & Costs of Operation)



7.5 Financial Conclusions and Recommendations

Two key conclusions can be reached from this fiscal analysis:

1. The HOT lanes north of Palmdale Blvd. do not have sufficient toll paying ridership to make it worthwhile. The general-purpose lanes are open and there is no financial return to expand/build HOT lanes. Also, there is low HOV usage as well. Thus, we recommend that the project not include the 5.7 miles north of Palmdale Blvd.

2. Cumulative 30-year net revenues are forecast to be between $800 million and $1.1 billion — see Figure 7-1. The net toll revenues (before debt service, but after estimated operating costs) appear sufficient to finance between $250 million and $300 million in construction funds from toll revenue bonds with the projected cash flow from the various bounding cases analyzed -- see Figure 7-2. The toll system capital cost is estimated to be $18 million -- see Table 7-2. The construction costs for the HOT lanes are estimated at about $807 million for Alternative 2 (the two-lane facility analyzed here) and include the toll/HOV verification zones that allow automated toll violation enforcement. So, using the $807 million for civil construction and adding $18 million for toll systems capital costs, we would need around $825 million. Clearly, these fiscal scenarios will not finance the full construction of the HOV/HOT lanes on SR 14 but it would appear that it would certainly qualify for a road construction bond (or possibly TIFIA loans) that could provide a significant percentage (e.g., 30 to 35%) of that required. If opening as a HOT3+ facility is a viable option, then it might be worthwhile to assess this third alternative since it will produce higher net annual revenues (closer to $30-35 million annually, rather than the $20-30 million annually for the HOT2 alternative) during the 2010 through 2020 decade. However, if true, this level of HOT3 revenues would still not be sufficient to finance more than slightly over 40% of the estimated construction costs. To accomplish that, annual toll revenues closer to $80 million annually would be needed. And, as illustrated in Figure 7-2, $80 million annual net revenues is not likely until the freeways are severely congested, the peak periods significantly spread and the demand forces prices up from around $0.10 to 0.15 to nearly three times that level of cost per mile.

8.0 SR 14 HOT LANE STUDY CONCLUSIONS

Status of Study

After the completion of the SR 14 engineering and financial analysis, a strong effort was mounted to "find a champion" for one of the alternatives. The regional agencies hoped to advance the HOT lane concept, but wanted local political support for the HOT lane operation. It was felt that the results of the focus group indicated a willingness of the public to try, on an interim basis, the HOT lane alternative. However, the local politicians did not want to pursue an alternative that required their constituents to pay for using a transportation facility. They elected to pursue implementation of an additional general-purpose lane. As a result, the HOT lane concept for SR 14 will be placed on the shelf.

The People are More Willing to Innovate

Again and again, we find that:

- Familiarity with HOT lane or express lane operation leads to increased acceptance
- Enough people in every focus group embrace the pricing alternative to make it viable
- The motoring public is more willing to include pricing in the mix of mobility options than are most elected officials
- The public does understand the relationship of land use to transportation, and is frustrated with government's inability to effect a remedy to the jobs/housing imbalance

- As many as two thirds to three fourths of focus group participants did not think the SR 14 HOV lane facility provided a sufficient incentive, in itself, to carpool. Part of this was due to HOV lane congestion related to its one-lane configuration (slow moving vehicles causing back up or dangerous maneuvers.) People recognized that the HOT lane (2 lanes each direction) addressed this problem in an effective manner for both HOVs and toll-payers.

Governmental Hygiene and the Leadership Vacuum

From the technical, operational and revenue perspectives, the SR 14 HOT lane facility could be a success, and be constructed to provide a mobility option that could, uniquely, be sustained over time. In addition, it could preserve the policy goals related to HOV lanes. Yet, because government is perceived not to have clean hands, it is extremely difficult for agency staff (even with consultant support) to command the legitimacy and authority necessary to convince a wary elected official to risk such innovation. Pricing projects are seen as having only "down sides" for elected officials, and have won converts primarily under ideal circumstances like those found in San Diego several years ago.

Further, as long as local politicians choose to displace larger issues onto project-level decisions, HOT lanes—and other pricing projects—will fail to find champions. To overcome objections of "general unfairness" with respect to the geographic distribution both with respect to existing transportation funding and of incrementally advanced pricing projects, governmental agencies must have more than analysis. Government agency must establish its right to an extensive budget and expert staff resources devoted to education, outreach, marketing, creativity and public involvement. Unfortunately, not only are public relations/marketing efforts not customary budget items within transportation agencies, such use of resources can be subject to challenge related to federal and state funding criteria, and is resisted from ideological perspectives both within the public and the private sectors.

A further challenge exists with respect to term limits of California politicians. Even when one or two elected officials do embrace the notion of transportation user fees, it is difficult to mount an effort that can outlive their term in office, and so become implemented.

Perhaps, with regional government unable to persuade potential local champions, and prohibited from addressing the public at large, it remains for the idea of pricing to re-emerge as a demand from the people themselves at some point in our congested future.

Developing Transportation and Air Quality Messages For Public Education Campaigns:

"It All Adds Up To Cleaner Air"

edited by

Nan Miller, AICP
North Central Texas Council of Governments

10th International HOV Conference
Dallas, Texas
August 28-30, 2000

"It All Adds Up To Cleaner Air"

It All Adds Up to Cleaner Air is a unique collaborative effort of the U.S. Department of Transportation's (DOT) Federal Highway Administration (FHWA), the U.S. Environmental Protection Agency's (EPA) Office of Transportation and Air Quality, and DOT's Federal Transit Administration. The initiative is a multi-level public education and partnership-building program to inform the public about the connections between their transportation choices, traffic congestion, air pollution, and public health. The program emphasizes simple actions people can take that are convenient and can make a difference in air quality when practiced on a wide-scale basis. This community-based effort focuses on three core messages:

(1) Trip-chaining, or combining errands into a single car trip; thus, cutting down on "cold starts" that produce greater exhaust emissions, and fewer total miles driven;
(2) Maintaining the car in top running condition because out-of-tune vehicles account for a disproportionately large share of auto emissions; and
(3) Choosing alternate modes of transportation such as, sharing a ride, car or vanpooling, taking mass transit, biking, or walking, to reduce congestion and transportation emissions by eliminating auto trips.

Research played a critical role in developing the *It All Adds Up to Cleaner Air* public education and information initiative. A variety of secondary and primary research was conducted to gain a greater understanding of the transportation choices and messages that could encourage environmentally-conscious choices by individuals, communities, and organizations. These studies were conducted by Equals Three Communications at the request of FHWA, EPA's Office of Transportation and Air Quality, and FTA. The research was undertaken to explore ways of supporting state departments of transportation and metropolitan planning organizations in their efforts to comply with the requirements of the Intermodal Surface Transportation Efficiency Act of 1991 and the Clean Air Act Amendments of 1990.

Developing consumer-based messages that were relevant, and motivated the public to take action, was a critical aspect of the national initiative and imperative to the development of a successful community-based program. It was vital that the overarching message themes resonate across communities that varied greatly in the range of available transportation options and awareness levels, and provide a range of interchangeable components that communities could select from to customize the initiative for their unique situations. The primary challenge was to identify an overarching theme to encourage change in social norms, deliver consistent transportation and air quality facts that motivated individuals to change their actions, and provide for the greatest degree of flexibility possible in selecting messages at the local level.

Secondary Research

Literature Review

An extensive review of national, regional and local public education programs on transportation and air quality, along with other DOT and EPA initiatives, provided information on the "gaps" in public education efforts, and identified the need for a nationally-implemented program. Other key information from the literature review included potential barriers, opportunities, messages and methods for maximizing target audience participation. The research revealed that, although there are many national, local and regional organizations implementing transportation and air quality programs, inconsistent messages are directed at the general public. Also, many of the current and recent programs have focused primarily on health messages and other quality of life issues, such as time savings and stress relief, as opposed to reducing traffic congestion.

Benefits for both locally and nationally implemented programs were found in the preliminary research. Most notably, local programs include opportunities for "face-to-face" relationships with the target audience (the general driving public) and are best at addressing community issues. Programs implemented at the national level enable the message to reach the broadest audience, establish the issue as a national priority, and are usually more comprehensive and long-term. Analysis of these benefits provided a basis for developing a national initiative with a strong community-based component.

Review of Existing Transportation Air Quality Programs

In 1994, the National Association of Regional Councils (NARC) sponsored a project, *Personal and Public Strategies for Improving Air Quality: A Public Education Campaign*. NARC conducted a thorough review of public information and outreach programs across the country. In December 1994, they convened a stakeholder conference of 40 representatives from a variety of organizations with interests in both transportation and air quality. From the review and the stakeholder conference, a framework for organizing public education/outreach campaigns began to emerge. In the report, NARC made a wide range of observations and recommendations, including:

Messages disseminated by public education programs are inconsistent.
Messages do not clearly link transportation choices to air quality.
Messages related to air quality and mobility need a credible rationale.
Broad-based support from the public is essential.
The messages must be simple and understandable to be effective.
The performance of public education programs must be measured over time.

Target Audience Research

To identify segments of the general public who would be most amenable to changing their transportation behaviors to improve air quality, Equals Three Communications reviewed demographic and psychographic research regarding the public's transportation habits along with their attitudes and behavior related to the environment. These studies included The Roper Green Gauge Study (a long-term study of consumer attitudes and behaviors related to the environment), Mediamark Research Inc., Index (syndicated market research on purchasing behavior categorized by demographics and media) and additional regional/state quantitative and qualitative research.

The Roper Organization uses a clustering technique to divide Americans into the following five behavioral categories based primarily on whether or not they have engaged in a list of "environmentally-friendly" practices: True-blue Greens, Greenback Greens, Sprouts, Grousers and Basic Browns. Dividing the general public in this way helps to show which audience segment would be most willing to listen to, and potentially act on, messages pertaining to transportation choices and the effects such choices have on the environment.

Following is a summary of each category:

True-blue Greens – This group's behavior reflects their strong environmental concerns. They are distinguished by high levels of education and social involvement, and their ranks grew from

11 percent of the population in 1990 to 14 percent in 1993. As leaders of the environmental movement, this group would be most likely to know the air quality effects of their transportation choices; however, their professional-level jobs and other commitments may force them to sometimes stray from their environmental commitment.

Greenback Greens – This is the segment of the general population most willing to pay more for environmentally-safe products and services. They are also pro-environment voters and contribute to environmental organizations. However, they are reluctant to make substantial behavior changes, because they desire convenience and may perceive they have limited transportation options for responsibilities such as childcare. While they are willing to pay substantially more for less-polluting gasoline, they have not been willing to cut back on their use of automobiles. In a 1992 Roper poll, a solid majority of this market segment stated that they are too busy to make changes in their lifestyle in order to help the environment. One reason for this reluctance to change may be that 43 percent have children under the age of 13 compared with 34 percent of the general public. Day care and errands lock them into exclusive use of their cars. Members of this segment are predominantly female, highly educated and hold white-collar and executive or professional jobs.

Sprouts – This key "swing" group is slightly older than the Greenback Greens and has grown rapidly since 1990. Members of this market segment are moving out of the awareness phase and are just beginning to accept environmental messages. Although they are ambivalent about environmental regulations, approximately 40 percent regularly recycle newspapers and believe that individuals can reduce air pollution caused by automobile exhaust. Members of this segment are the most likely to be married (71 percent) and are second only to True-blue Greens at holding executive and professional positions (22 percent). Their professional work status may provide opportunities for flexible arrangements regarding their commute.

Grousers – This group has been shrinking in the last few years, with many former Grousers becoming either Sprouts or Basic Browns. Grousers are indifferent to the environment; however, they rationalize their indifference as identifying them with the mainstream. In 11 out of 14 environmentally-friendly practices, Grousers exhibit a lower level of commitment than the national average. The majority of Grousers say that companies, not the public, should solve environmental problems and that they are too busy to make lifestyle changes for the environment. This segment's median household income is below average and a large percentage have a high-school education or less. Their transportation choices most likely reflect a low-level of environmental commitment, although they may use public transportation for economic reasons.

Basic Browns – This group conducts virtually no environmental activities. Unlike the Grousers, they do not rationalize their behavior. Instead, their indifference stems from the belief that there is little individuals can do about most environmental problems. This group has grown from 28 percent of the population in 1990 to 32 percent in 1993. A large majority of the Basic Browns ended their formal education at the high-school level and hold blue-collar jobs. Sixty percent are married and almost half live in the Southern region of the United States. Like the Grousers, they may be relatively high users of public transportation for economic reasons.

Who Can We Reach and Affect?

Based on initial analysis of the data, the Greenback Greens and the Sprouts were selected for further research as the potential primary targets for the Transportation and Air Quality initiative.

Greenback Greens were considered an important target audience because they are likely to have the resources to change their transportation behavior, but they may not be convinced that it is important or relevant for them to do so. An environmental message alone may not tempt this group to change their behavior, but because they describe their lifestyles as busy, they may be swayed by other potential benefits of transportation alternatives, such as time savings and reduced stress. In addition, the initiative should also target non-commuting trips, such as shopping and taxiing children that contribute to air quality and congestion problems. According to a variety of sources, these non-work-related trips account for three-fourths of vehicle trips.

Sprouts were thought to be a key sub-population for the initiative because they believe that individuals can contribute to reducing air pollution, and many already have adjusted to recycling newspapers and other small actions that benefit the environment. Sprouts may be the types of people most open to messages that use analogies or identify individual actions, which cumulatively result in benefits for the entire community. An environmental message will most likely affect this group, and the added benefits of less traffic congestion may bolster message appeal.

True-blue Greens, who are highly involved in environmental concerns, will probably most easily comprehend the program messages because they understand transportation and air quality issues and are making decisions based on this knowledge. Although they would support the initiative, a program targeted to True-blue Greens was determined to be “preaching to the choir.” Therefore, it was not considered necessary to target messages directly to this audience, however, messages would provide reinforcement for their current practices.

At the time of this study, Sprouts and Greenback Greens together accounted for 41 percent of the population, with slightly more than half being female. Well-educated (54 percent college educated), they are likely to be in white-collar or executive/professional occupations (43 percent) and more than 60 percent are married (71 percent for Sprouts). Primarily white, their average age is 38, their median income is approximately $32,000, and 38 percent have children under the age of 13. As with most of the general population, they define themselves as politically and socially conservative and they live in all areas of the country.

In addition to the Roper poll, Equals Three Communications reviewed regional and local-level research conducted on target audiences for similar initiatives. The Pennsylvania Department of Transportation and the Washington, DC/Baltimore metropolitan area clustered audiences by their potential for adopting or changing behavior, and defined a group called “Early Adopters” as people who recognize that air pollution is a problem and feel that they personally can make a difference. This segment turned out to be primarily female, 18- to 34-year old college graduates employed in white-collar occupations. This profile tracks with the “Sprouts” profile, although more were women. Similar to the Roper poll, the two local studies estimated this subgroup to be approximately 40 percent of the population.

Who Will Be Hard To Reach?

Grousers and Basic Browns were anticipated to be most unlikely to heed messages on the environmental effects of transportation choices. These groups may even “fight back” if a message asks them to make a personal sacrifice for the environment. Primarily for this reason, the initiative messages should not present the driver as the “bad guy.” It will be important to be clear that we are not asking people to give up their automobile or not to drive, but just to consider the benefits of using transportation alternatives and making other behavioral changes.

Formative Research

A. Target Audience Focus Groups

During February 1996, four two-hour focus groups were conducted to obtain information about transportation and air quality issues related to the general driving public. The study was conducted primarily to identify key issues and potential communications strategies in developing the public education and information initiative. Participants were asked to describe their basic driving patterns, transportation choices or alternatives to driving, air quality in general and how they may or may not contribute to air pollution, and provide reactions to message concepts. Participants were representatives of the general driving public, although some of the participants were commercial drivers and drivers who use their cars in their work.

Focus groups are structured discussions that typically include 8 to 10 people. A professional moderator leads the group through a discussion of opinions on a particular issue, product of idea. In the focus groups conducted for the initiative, participants were recruited through a screener by reputable field services, and offered a small cash incentive for their participation. Each set of focus groups conducted for this project, unless otherwise noted, contained a mixture of men and women and held considerable variation in terms of age, occupation, income level and some minority representation.

The groups were held in two regions of the country: the Northeast (Philadelphia) and West (Denver). A total of 38 automobile and commercial drivers participated in the study. Each group contained both men and women, and held considerable variation in terms of age, occupation, and income levels, and some minority representation.

As in all studies of this kind, the results reflect the opinions and attitudes of a limited number of people, and therefore, should be regarded as suggestive rather than definitive. The research was not intended to be quantitative or to provide a probability sample of the population from which the participants were selected. It should also be noted that these sessions were shaped by discussions with individuals with a direct interest in transportation and air quality issues, namely industry and association executives and state Department of Transportation and Metropolitan Planning Organization (MPO) representatives. These qualifications relate to all the focus groups and target-audience testing conducted for the *It All Adds Up to Cleaner Air* campaign.

Key Findings:

Time spent in the car. Focus group participants said they accepted the amount of time spent in their cars and adjusted their behaviors accordingly. Many noted that driving time was spent mentally preparing for or unwinding from the workday and planning errands.

Leaving the car at home. Participants were not intrinsically against the idea of leaving their cars at home, but believed it was more appropriate for those who have more routine schedules. While some of the participants want ready access to their cars, others may simply need more motivation, flexibility, and support to seek alternatives to single-occupant-vehicle driving. In terms of potential motivators, short- and longer-term financial incentives were most highly rated, although, there seemed to be important regional differences. Some participants in the Denver group gave greater importance to incentives such as a cleaner environment or health-related topics.

The hidden costs of driving. One test hypothesis for the focus groups was that the general public did not fully understand the true, or “hidden,” costs of operating a car. Such costs may include uninsured accidents, air pollution and opportunities lost through subsidies which reduce fuel costs. The funding agencies wished to test whether informing drivers of these hidden costs might motivate them to consider options to solo driving. Regardless of how the hidden costs of driving were presented, participants did not place a great deal of importance on them.

Air quality. Participants in both cities voiced strong opinions about their perceptions of poor air quality in their areas, and participants in the Denver groups were more knowledgeable about potential causes and effects. In fact, knowledge of the situation and its possible causes or main contributors was so specific that any public information efforts would have to be equally specific in order to be relevant. Participants were also quite knowledgeable about the many ways they may be contributing to poor air quality, but few volunteered to change either their driving or purchasing behavior to mitigate those contributions.

Public information initiatives. Participants had fairly good levels of awareness of marketing programs relating to public transportation or issue-related initiatives, such as recycling. Participants did not have positive impressions of the campaigns themselves, and did not believe such campaigns, as a whole, are effective. In describing these kinds of initiatives, participants continually stressed the need for communicating convenience. This was reinforced in the subsequent discussions on message statements. In terms of potential program sponsors, those entities or individuals closest to the target audience were thought to be the most effective communicators, due to their knowledge about local market conditions and the needs of the community. Friends and family were rated as the most-favored potential messengers and the federal government the least-favored messenger.

Message statements. Overall, the convenience, effectiveness, and simplicity of specific actions were the most appealing aspects within the messages. To be effective, messages must balance how individual actions can help improve air quality and mobility, while placing the individual’s (i.e., automobile driver) responsibility in context with that of other entities’ (i.e., business and government).

B. Latino Focus Groups

Two focus groups among Latinos were conducted in 1998 in San Jose, California by Equals Three Communications, working with Garcia Research Associates, a Hispanic research firm located in the Bay Area of San Francisco. The focus groups were designed to gather exploratory information to expand the national messages to reach Hispanic audiences across the nation, and to support the San Francisco pilot site as they developed information programs to meet the needs of Hispanic transit riders.

One group was conducted in Spanish, while the other was conducted in English by the same moderator using the same discussion guide. Qualified respondents met specific criteria outline in the screener questionnaire, namely Latinos who use public transportation, rideshare or drive alone to work.

Key Findings:

The participants were very concerned about job security and economic issues such as the cost of living. They also expressed concern about personal safety and education.

Air quality was not mentioned on an unaided basis, although traffic congestion was a concern. The English speakers seemed much more environmentally conscious than the Spanish speakers who tended to be less critical and less demanding than their English-speaking counterparts. The English speakers saw degrading air quality as the cause of the increased incidence of asthma, particularly among children and seniors.

The Spanish speakers were much more likely to blame commercial and industrial sources of pollution than the English speakers who more readily acknowledged the role of privately owned automobiles in the air pollution problem.

Both groups were aware of government regulations and felt such restrictions were important, even when the regulations directly effected them in the form of Smog Check programs and costly fuel additives.

There was a perception that local air quality and congestion has worsened over the last ten years, although they felt they were still better off than larger cities such as Los Angeles, Mexico City or New York. Despite feeling relatively lucky, these respondents expressed willingness to undertake behavior changes that would benefit the environment.

The Latino respondents were satisfied with transportation options available but felt that the system had limits and new programs and systems would have to be put into place to deal with population growth in the area.
Television, radio and newspapers were reported as the best way to disseminate general information about transit issues. They recommended that more specific information and brochures be distributed not only at the transit systems, but also at schools, libraries, hospitals, clinics, malls, laundromats, parks and churches, among others. The post office was mentioned as a key location by the Spanish-speaking group.

Concept and Message Testing Focus Groups

A. Concept Testing with the Target Audience

Focus groups held in Dover, Delaware and Albany, New York were critical in shaping the initiative's target audiences. Based on participants' input, combined with that of previous focus groups, the audience segmentation was revisited. Focus groups revealed that many participants did not see environmental benefits as a convincing reason for change and indicated other benefits were more relevant. Therefore, the strategy shifted from those who are most likely to change based on environmental reasons to the general driving public. Those who would consider the environment as one of many positive benefits to adopting environmentally-conscious transportation choices became our secondary target audience.

All the focus groups mentioned in this report were conducted with representatives of the general driving and commuting public. Because the initiative messages were designed to target members of the driving public who were moderately knowledgeable of air quality and transportation issues, and were willing to make some changes that would benefit the environment, the screener was designed to exclude both ultra-pro-environmental individuals, and those that were not willing to make any changes in their personal transportation habits.

1. Dover, Delaware Focus Groups

In 1997, two focus groups were conducted in Dover to obtain information that would be used to develop marketing materials to raise awareness of the relationship between personal transportation habits, congestion, and air quality. Dover was selected as a pilot site to assist with the development and implementation of a local initiative that could draw on local transportation options and be delivered by a local coalition of private and public organizations.

The information obtained in the Dover groups not only assisted in the development of the local aspect of the initiative, but provided valuable insight into candidates for national messages and how locations similar to Dover might react to this initiative.

Dover participants were asked about their awareness of local air quality and congestion issues, then were asked to provide feedback on a campaign positioning statement and some message concepts, presented in an “ad like” format. A total of 16 automobile drivers and commuters participated in the study

Key Findings:

Environmental concerns were not among the highest priorities of many Dover commuters. Crime, wavering trust in state and national elected official and government, day-to-day economics and global issues appeared to occupy far more “share of mind” than issues related to the environment.

Many group members bristled at the suggestion that they should be doing something about the environment because they believed they were already participating in a variety of direct and indirect environmentally “friendly” activities. Specifically in the automotive category, group members pointed to their use of lead-free gasoline and motor vehicles with pollution controls, and their adherence to state emission standards testing as examples of their ongoing support of the environment.

Many persons were willing to share responsibility for protecting the environment. But they bristled at the suggestion that they should feel either personally guilty for its demise or responsible for its renewal. The people who took part in this study were willing to take part in what they believed was a larger group effort required to restore and maintain the health of the environment. However, they firmly rejected, and were even insulted by the notion that they should have felt any personal responsibility for the condition of the environment or personal burden for its renewal.

Many Dover commuters did not perceive there to be a problem with the quality of air in central Delaware. The people who took part in this study outlined a variety of environmental concerns. They did not however, perceive there to be any problems with air quality in metropolitan Dover.

There being no perceived problem, there was no urgency associated with restoring air quality. The people who took part in this study believed that air quality was worthy of preservation, though they suggested that it would be a difficult task to convince local citizens to take actions to meet this end.

Dover’s most significant contributors to environmental deterioration were perceived to be industrial polluters located outside Dover.

Traffic congestion in Dover was said to be largely a function of transient motorists and “Race Weekend” visitors.

Although some Dover commuters were predisposed to abandon their personal motor vehicle in the name of environmentalism, their perceived ability to do so was hindered by a lack of alternate modes.

Nearly all of the persons taking part in this study agreed, at least conceptually, with the premise of the campaign positioning statement, which read: "My travel choices have an effect on air quality and congestion in my community, and ultimately on quality of life." However, they did not like what they perceived to be its pointed "accusatory" tone. Initially, almost everyone who took part in this study was to some extent insulted by the campaign positioning statement. Upon further discussion, it was determined that they in fact agreed with the statement, but resented its implication (primarily through the use of the pronoun "my") that individuals are personally responsible for environmental deterioration and for its renewal.

The extent to which twelve "ad-like" concepts were embraced or rejected appeared to have been determined by 1) perceived applicability to Dover; 2) overall credibility, and, 3) recognition of an air quality problem in Dover.

Nearly all participants agreed that a local coalition would be a credible source to deliver a message on the local situation and options.

2. Albany, New York Focus Groups

In 1997, two focus groups were also held in Albany to obtain information to help develop marketing materials to raise awareness of the relationship between personal transportation habits, congestion, and air quality. The information obtained in the Albany groups assisted in the development of the local aspect of the initiative, and provided valuable insight into candidates for national messages and how locations similar to Albany might react to this initiative. A total of 20 automobile drivers and commuters participated in the Albany study.

Key Findings:

Group members did not perceive any serious problems with air quality in the Albany metropolitan area.

Regarding their concerns about the local environment, the Albany group members put the focus on environmental issues other than air pollution.

Albany group members knew that use of motor vehicles ultimately affects the environment. However, they did not believe current conditions warrant any change in their driving habits.

Congestion was not perceived to be a problem in Albany. Group members described traffic congestion in the Albany metro area as a highly-localized, time-limited problem.

There was no awareness of the Commuter Register or Guaranteed Ride Home program. Even after understanding Guaranteed Ride Home, participants were not convinced it would work effectively or quickly enough in an emergency situation.

Albany group members believed that significant change in driving habits could only, or most effectively, be achieved through legislation.

Even those who were predisposed to consider other modes of transportation, complained that there were few, if any, viable alternatives to personal automobiles for Albany-area drivers. Group members said that Albany's bus system worked only for those who commuted from suburbs into Albany's central business and government area. Carpooling, vanpooling and other shared-ride initiatives were non-existent or unnoticed. Bicycling or walking were seen as unsuitable for people who lived in the suburbs because of the lack of sidewalks and time/safety issues.

"Chaining" was already happening, but not for air quality or congestion relief reasons. Some of the group members were already linking commuting and errands. But they did so for time savings and convenience. Most said that if those stimuli did not exist, they most likely would not have considered trip chaining purely for environmental reasons.

The focus groups also provided interesting feedback regarding the development of any initiative or program designed to influence changes in personal driving habits:

This initiative could only succeed if it was built upon a foundation of highly credible and compelling evidence that an air quality or congestion problem existed. Before they would even consider alternative "solutions," group members commented strongly and repeatedly that they needed to be convinced that an air quality or congestion problem existed.

Relieving traffic congestion appeared to be a far more effective influencer than reducing air pollution. However, because they didn't perceive that Albany had a serious congestion problem, group members saw little reason to give this issue much attention. Although no true consensus appeared to exist, group members seemed most predisposed to alter their driving habits if they believed that both big organizations and individuals were working together to improve air quality and traffic congestion. Preservation of quality of life was another strong motivator, although again not one that was perceived to be an important issue at present in the Albany area.

Among the program elements shown to Albany group participants, only messages that spoke about carpooling were perceived to be relevant.

The messages presented on automobile maintenance were considered too generic to be either noticed or compelling. Group members felt that those messages could have been coming from anywhere — from the automotive industry to neighborhood tune-up shops. The advice the messages conveyed was considered by most group members to be so basic as to be unnecessary.

B. Message Testing with the Target Audience

In 1997, two focus groups were also held in Milwaukee, Wisconsin to obtain information to help develop marketing materials to raise awareness of the relationship between personal transportation habits, congestion, and air quality. The information obtained in the Milwaukee groups assisted in the development of the local aspect of the initiative, and provided valuable insight into candidates for national messages and how locations similar to Milwaukee might react to this initiative.

Key Findings:

Participants were not blind to their area's environmental challenges. But other problems had higher priority.

Traffic congestion was more of an issue to many Milwaukee-area residents. Most saw it to be a function of time, growth and poor highway planning. There was little question among the people taking part in this study that traffic volume had increased resulting in congestion in the Milwaukee area. Participants said that traffic on all roads was increasing, especially along busy suburban retail corridors. However, they said the most severe congestion was limited to people who commuted between the suburbs and the city center during “rush” hours.

Study participants were aware that there were some alternatives to driving alone. However, none were more than marginally predisposed to use these alternatives. Many study participants believed attempts to promote voluntary changes in personal driving habits were futile.

Most study participants believed they were already taking steps to help improve local air quality. Members of both groups said that residents of the Milwaukee area were mandated to bypass some of their vehicles’ performance in order to accommodate a more environmentally-friendly fuel formulation. They further believed that they were singled out to be “guinea pigs” while people and industry “down south” in Chicago and Northern Indiana (sources that most group members believe are the real polluters) had not yet been required to step-up to environmental regulations.

Within this context, study participants had interestingly similar impressions of the three creative approaches reviewed in this study. All three creative approaches were developed to support the initiative theme, *It All Adds Up to Cleaner Air*, that was developed based on feedback from previous consumer and stakeholder focus groups. The first campaign used humor and reflected the lifestyle and increasing demand made on individuals who felt as though they were already doing as much as they possibly could. The second campaign, that came be know as the Anthem campaign, used rich visuals and an uplifting audio to convey a “band wagon” approach to call the public to action and to avoid eliciting the negative emotions found in earlier focus groups when individuals thought they were being told to change their transportation choices. The third campaign used an animated character to bring humor and emotion to the campaign. Key feedback from participants included the following:

Study participants were most open to the heightened congratulatory approach used in the campaign that reflected lifestyle, although they were somewhat perturbed by the intensity of these three spots.

The Anthem campaign, which uses a creative approach that is difficult to fully communicate in anything less than its completed form, was clearly understood by all group members. Group members appeared to be drawn to the beauty of the concept and the calming background music. Participants suggested that the “transportation choices” segment display a wider range of options, including options available in all communities.

Study participants believed the most credible presenter of those messages would be a coalition of consumer, advocacy and governmental groups. United in a coalition having a strong state-level connection, study participants believed that these organizations would “keep an eye on one another” and be able to produce a credible, powerful message.

Program Development Research

Initiative Pilot Phase

In 1997, three communities received support from the federal partners (FHWA, EPA and FTA) to pilot test the national initiative, which was designed to initiate or expand community-based efforts to reduce traffic congestion and improve air quality. The communities also introduced the federally-sponsored *It All Adds Up to Cleaner Air* campaign. One of the nation's largest metropolitan areas, San Francisco, California, one medium-sized city, Milwaukee, Wisconsin, and a rural area, Dover, Delaware, were selected as pilot sites. Each of the sites collaborated with community groups, businesses, and environmental groups to implement and sustain the program within their own communities.

The pilot phase included a comprehensive evaluation that tracked the implementation of the pilot program, including activities conducted a the community level, use of media messages, the initiative's impact on the public resulting in recommendations for the launch of the 1999 demonstration community phase. Because this initiative is designed to support existing efforts and identify successful community strategies, the evaluation encompassed all activities reported by the pilot sites to support the initiative's objectives of increasing awareness of the relationship between transportation and air quality and increasing awareness of alternate modes of transportation. The findings of the pilot phase provided valuable insight in continuing to develop a national initiative to meet the needs of a diverse array of communities, lay the foundation for a sustainable effort, and ultimately inspire the public to take action.

Key Findings:

Community participation during the pilot phase was pivotal in developing and refining the national initiative.

Many strategies selected by communities provided overarching themes while other approaches were very tailored to specific local needs or expertise. Although common "best practices" such as close collaboration with community organizations were identified, communities customized their strategies based on their unique needs.

As expected, the initiative's impact on the general driving public was limited to changes in awareness. It was initially anticipated that the complex nature of changing travel patterns would require 1-4 years. The results of this study do not suggest that any significant changes in behavior occurred during the pilot campaign; however, there is evidence in all three markets that the initiative was noticed. Recall of messages, programs and activities that draw attention to the relationship between personal driving habits and local air quality increased markedly between the times of the pre- and post-campaign surveys.

The key learning obtained from the pilot phase of the initiative encouraged the federal partners to refine and expand the program to support fourteen new demonstration communities in 1999, and make the initiative materials available to additional communities. The new demonstration communities introduced the *It All Adds Up to Cleaner Air* initiative in their locales at the beginning of the 1999 ozone season.

Alliance for Clean Air and Transportation

To complement and reinforce local efforts, the federal agencies are serving as a catalyst to establish a national coalition, the Alliance for Clean Air and Transportation. The Coalition is made up of a broad spectrum of public and private organizations that share common objectives and strategies that will ultimately reduce traffic congestion and improve air quality, as well as the quality of life and health of the general public. The Coalition establishes support for core transportation and air quality messages and ensures the long-term sustainability of the initiative. In addition, the Alliance is creating a network of regional and national intermediaries, mobilizing existing resources to increase program effectiveness, and facilitating dialogue to enlist broad-based support and reach a large number of people through credible sources.

Overall Results

Following are highlights of the results of the “It All Adds Up to Cleaner Air” initiative achieved to date:

The pilot program generated nearly half a million dollars in advertising space. Pre- and post-surveys showed that recall of messages, programs and activities increased markedly.

The initiative expanded to 14 new communities, which received Federal support in the form of research, creative materials, an orientation workshop, the Resource Toolkit, and limited funding.

Nearly 80 communities in the U.S., two in Canada, and one in Australia have requested program materials to assist in local customization and distribution.

More than 20 national organizations have formed the Steering Committee of the Alliance for Clean Air and Transportation. The Alliance expects to recruit up to 160 new members during the next year, and will launch new initiatives focussing on second-generation messages for an educated public.

“Highlights,” an informative newsletter, is produced every two months based on progress reports from the 14 Demonstration Communities. It allows communities to learn from each other by summarizing activities and innovations that go on in each.

The “It All Adds Up to cleaner Air” campaign has a web site: www.epa.gov/otaq/traq/traqpedo/italladd. Visitors can access television, radio and print public service announcements, outdoor signs, outreach materials, and collateral materials. The web site also contains links to other resources such as Commuter Connections, Commuter Choice, Ozone Action!, the Federal Highway Administration, Federal Transit Administration and the Environmental Protection Agency.

HOV Performance Monitoring: Two Reports, Multiple Conclusions

1. Abstract

The Massachusetts Highway Department (MassHighway) recently completed two monitoring reports for the two High Occupancy Vehicle (HOV) facilities that they operate. One report was for HOV lane performance and the other for air quality. The reports were required under 310 CMR 7.37 "State Air Pollution Control Regulation" (1) and are administered by the Massachusetts Department of Environmental Protection (DEP). The regulation was issued in 1991 and revised in 1996. The regulations require performance and air quality monitoring for each HOV lane including standards for both requirements that must be met.

The performance report presents the travel-time savings that HOVs experience for both HOV lanes. The regulation requires a HOV travel-time saving of one minute per mile versus the adjacent general-purpose lanes and a level of service C. The performance report shows that the HOV lanes are providing substantial travel-time savings during the morning commute and more modest savings during the afternoon commute. The afternoon commute savings do not meet regulatory requirements. The two agencies, DEP and MassHighway, draw different conclusions from the report results.

The air quality report is directly related to the performance report and uses much of the same data in the analysis. The report is a before and after analysis on what effect the HOV lanes have had on air quality. This "before and after" analysis required more detailed data than the performance report. Additional analysis was performed to reflect operational changes in the HOV lanes and what effect they had on air quality.

The two agencies involved, MassHighway and DEP, had conflicting interpretations of the results of the two reports. The two reports demonstrate the need and importance of early communications between regulatory and operational agencies. They also stress the importance of realistic, flexible HOV performance and air quality standards that should be based on sound tested transportation principles.

2. Introduction

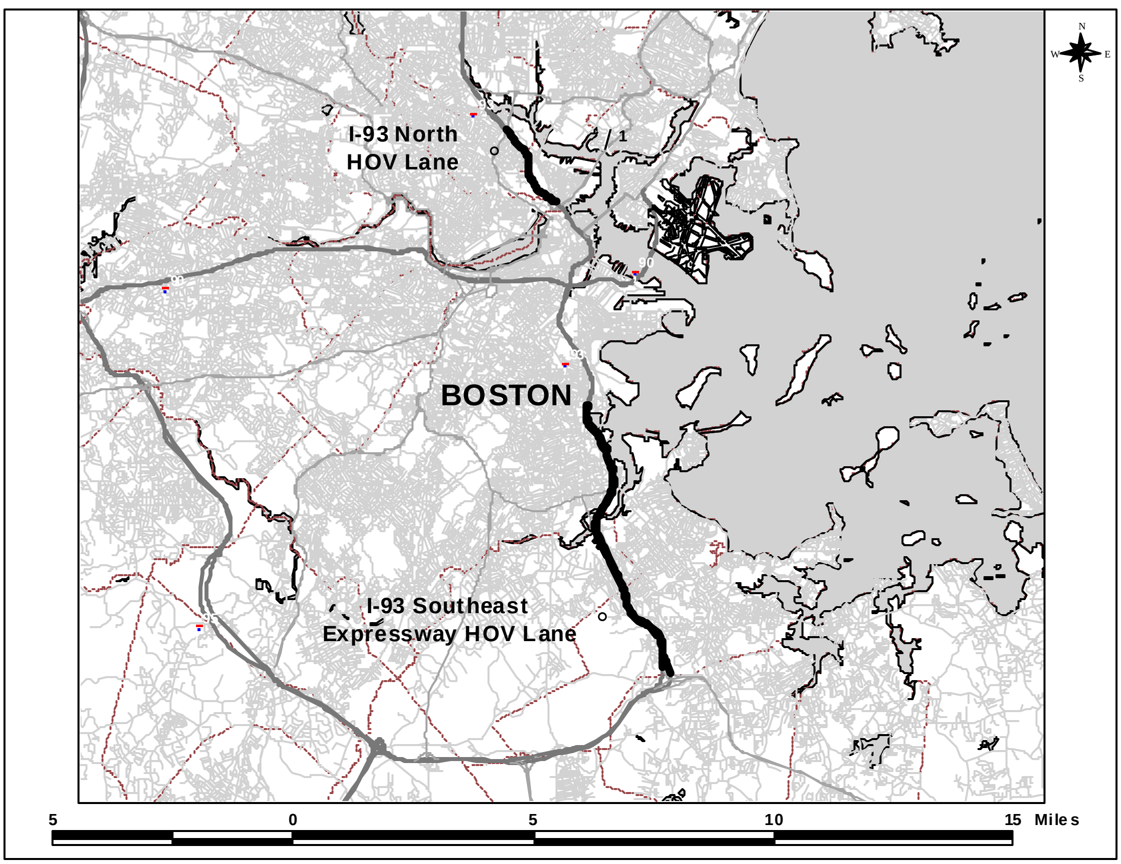
The Massachusetts Highway Department (MassHighway) has continually monitored performance on its two High Occupancy Vehicle (HOV) lanes since they began operating. The HOV lane on I-93 North is a southbound concurrent flow lane approximately two miles in length and operates between 6 A.M. and 10 A.M. for vehicles with two or more passengers. The I-93 South (Southeast Expressway) contraflow lane is six miles in length and operates from 6 A.M. to 10 A.M. northbound and from 3 P.M. to 7 P.M. southbound (see Diagram 1). Both HOV lanes are physically separated from the general-purpose lanes; the I-93 North lane by a raised permanent median, the Southeast Expressway by a movable barrier. Both HOV lanes merge back into general-purpose traffic at their termini.

The HOV lanes as they exist today are a result of the Massachusetts Air Pollution

Regulation 310 CMR 7.37 that was issued in 1991 and revised in 1996 (1). The regulations are administered by the Massachusetts Department of Environmental Protection (DEP). The regulations required MassHighway to study the feasibility of the northward extension of the existing I-93 North lane as well as the creation of an HOV lane on I-93 (Southeast Expressway) between I-90 and Route 3. The results of the studies were the northward extension of the existing I-93 North lane by one mile to its current two-mile length as well as the creation of the contraflow movable lane on the Southeast Expressway. The regulations also include requirements to report on the performance and air quality effect of both HOV lanes. MassHighway completed and submitted a performance report in January 2000 and an air quality report in February 2000 (2) (3). An entry requirement change from 3+ to 2+ in June 1999 on the Southeast Expressway facility increased the amount of attention the lanes were receiving for performance standards. Additional analysis was conducted to reflect this change.

DEP examined the analysis results strictly from an environmental and regulatory perspective, whereas MassHighway viewed the results from a broader transportation perspective. The HOV performance monitoring program reports and their results illustrate how conflicting interpretations of monitoring analyses demonstrate the need for flexible, realistic performance regulations based on sound transportation planning principles.

Diagram 1
I-93 North and I-93 Southeast Expressway HOV Lanes



Source: Massachusetts Highway Department

3. Performance Report Overview

The performance report was the first document completed and submitted to DEP in January 2000. The performance standard has two requirements of HOV performance that must be met: 1) a minimum Level Of Service (LOS) of C; and 2) average HOV trip times that are at least one minute per mile less than average trip times on adjacent general purpose traffic lanes during peak hours of travel (1). MassHighway conducts travel-time runs on regional express highways as part of their congestion management system. Travel-time runs are conducted periodically on the HOV lane to assess operational needs. Past HOV travel-time runs have resulted in operational changes such as entry-level requirement changes as well as operating hour changes.

The performance analysis used a series of vehicle trips to collect the time required to travel the length of a roadway segment. A roadway segment was defined as the length of the HOV lanes and their corresponding adjacent general-purpose lanes. A number of travel-time runs were performed during HOV operating hours on both the general-purpose and HOV lanes. An average was calculated from the runs to determine averaged travel times, by hour, for both the general-purpose lanes and HOV lanes. Subtracting the HOV travel-time from the general-purpose travel time resulted in the travel-time savings for the HOV lanes. Each HOV operating period was analyzed separately.

Between its opening in 1995 and June 1999, when the entry requirement permanently changed to two persons per vehicle, the performance of the Southeast Expressway HOV lane had never been in question because HOV volumes were not high enough to cause delays at the merge with general-purpose traffic. Initially MassHighway was prepared to use data collected in spring 1999; after the entry requirement change DEP requested data that reflected this change. MassHighway compiled additional travel-time runs in the fall 1999 after the change. The I-93 North analysis uses summer 1999 data since no operational changes occurred since this time.

A. Southeast Expressway

Travel times were collected for both the morning and afternoon commute during operating hours (6:00 A.M. to 10:00 A.M. and 3:00 P.M. to 7:00 P.M.) of the HOV lane. General-purpose and HOV travel time runs were performed in July and November 1999. The November travel-time runs were collected to confirm the July travel-time results since the runs were performed within a month of the entry change and traffic may not have completely adjusted to the change.

Permanent count stations monitor traffic volumes on the general-purpose lanes. HOV volumes are taken daily by manual counts. Ramp counts are taken only for special requests such as analytical reasons. MassHighway conducted ramp counts, both northbound and southbound, on the Southeast Expressway in 1994 and 1999.

Northbound Southeast Expressway volumes approaching downtown Boston experience significant delays during the morning commute. Traffic flows significantly better during the afternoon commute because traffic is flowing away from an area of high congestion to an area of low congestion. The southbound contraflow HOV lane also provides a bypass around a bottleneck in the general-purpose lanes for all southbound vehicles using the Southeast Expressway.

A1. Northbound

Table 1 shows the travel-time results for both the general-purpose and HOV lanes for the morning northbound commute.

Table 1
Southeast Expressway Northbound
AM Peak Period
Fall 1999

Time of Day	**6-7**	**7-8**	**8-9**	**9-10**	***Peak - Period*** **Average**
Travel Time (minutes:seconds)					
General Lanes	12:30	19:30	18:07	8:47	14:21
HOV Lane	6:47	8:25	6:14	5:43	7:05
Time Saved	5:43	10:48	11:53	3:04	8:33
Time Saved/Mile	1:03	1:59	2:11	0:34	1:34

Number of Vehicles					
General Lanes End-to-End	4,600	3,400	3,200	3,600	14,800
HOV Lane	1,200	1,400	900	500	4,000
Total End-to-End	5,800	4,800	4,100	4,100	18,800
HOV Percent End-to-End	21%	29%	22%	12%	21%
Travel Speeds (mph)					
General Lanes	26	17	18	37	23
HOV Lane	48	39	52	57	46

Source: "Recent Findings on Boston Area HOV Lane Use and Performance" [see References]

Table 1 shows that HOVs enjoy the most travel-time savings during the middle peak hours of 7-9 when general-purpose lane speeds average 17 and 18 mph. Travel-time savings for the last hour of HOV lane operation (9-10 A.M.) are modest because congestion decreases and general-purpose lane travel speeds increase to an average of 37 mph. The average travel-time savings for the four-hour morning operating period of the HOV lane are calculated by weighting the hourly travel-time savings by the number of HOV's per hour and averaging it over the four-hour time frame. Savings per mile are calculated by dividing the timesavings by the 5.41-mile length of the lane.

A2. Southbound

Southbound operations on the Southeast Expressway differ from morning operations because traffic is being "funneled" out of an area of high congestion into an area of low congestion. Table 2 shows the results of the travel-time runs conducted for the afternoon peak.

Table 2
Southeast Expressway Southbound
PM Peak Period
Fall 1999

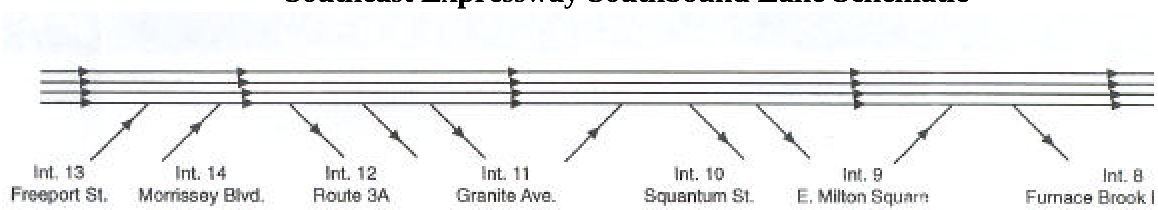
Time of Day	**3-4**	**4-5**	**5-6**	**6-7**	***Peak - Period*** **Average**
Travel Time (minutes:seconds)					
General Lanes	7:08	8:45	9:41	7:29	8:09
HOV Lane	6:33	6:33	6:33	6:33	6:33
Time Saved	0:35	2:12	3:08	0:56	1:48
Time saved/mile	0:06	0:24	0:35	0:10	0:20
Number of Vehicles					
General Lanes end-to-end	5,000	3,900	4,000	4,700	17, 600
HOV Lane	900	1,000	1,000	700	3,600
Total end-to-end	5,900	4,900	5,000	5,400	21,200
HOV Percent end-to-end	15%	20%	20%	13%	17%
Travel Speeds (mph)					
General Lanes	46	37	34	43	40
HOV Lane	50	50	50	50	50

Source: “Recent Findings on Boston Area HOV Lane Use and Performance”

Table 2 shows more modest travel-time savings for vehicles using the HOV lane during the afternoon period. The reason is not because the HOV lane performs badly – it operates at near free flow speeds for the entire four-hour period. Rather, the reason is that the general-purpose lane traffic operates well during the afternoon. The HOV lane is one reason for this.

As the Southeast Expressway leaves Boston for destinations south there is a weaving area at the Morrissey Boulevard (Exit 14) on-ramp and the Route 3A (Exit 12) off-ramp. This weaving area functions like a bottleneck, dropping the number of through-lanes from four to essentially three (see Diagram 2). The HOV lane, in essence, creates a by-pass for approximately 1,000 vehicles an hour during the peak period. This “bypass” results in faster speeds and improved operations at the weaving area for general-purpose traffic. Without the HOV lane an additional 1,000 vehicles an hour would be in the general-purpose lanes causing greater queues at the weaving area. More vehicles, HOV and general-purpose combined, travel through the study area in the afternoon as compared to the morning.

Diagram 2
Southeast Expressway Southbound Lane Schematic

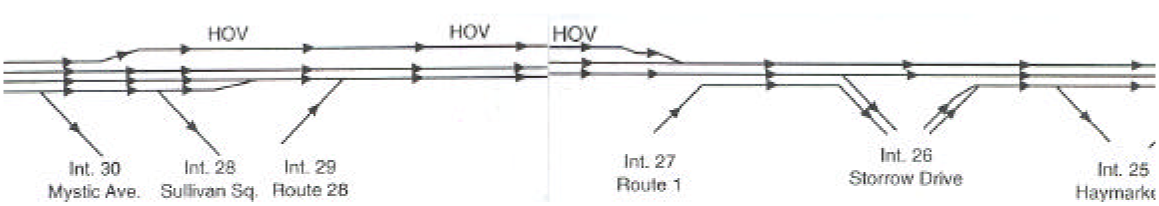


Source: "Southeast Expressway Southbound Route/Lane Schematic" (4)

B. I-93 North

The I-93 North southbound HOV lane is slightly over two miles in length and operates only during the morning commute from 6 A.M. to 10 A.M. The merge back into the general-purpose lanes is well striped and queuing is typically not a concern. There are fewer general-purpose lanes on this approach into Boston than on the Southeast Expressway. The four-lane approach is reduced to three when the HOV lane "takes away" a general-purpose lane and then drops again to two general-purpose lanes just after the Sullivan Square off-ramp about a mile later (see Diagram 3). In short, the number of general-purpose lanes is reduced from four to two in a very short span of roadway. As one would anticipate, this, combined with high volumes, causes delays during the morning commute. Vehicle volumes from 1999, both general-purpose and the HOV lane, are used in the analysis. Table 3 shows the results of travel-time runs conducted in summer 1999.

Diagram 3
I-93 North Southbound Lane Schematic



Source: "Traffic Volumes on the Central Artery: 1977-1999" (5)

Table 3
I-93 North Southbound
AM Peak Period
Summer 1999

<u>Time of Day</u>		**6-7**	**7-8**	**8-9**	**9-10**	***Peak - Period*** **Average**
<u>Travel Time (minutes:seconds)</u>						
General Lanes		9:36	12:10	12:15	7:42	10:22
HOV Lane		2:32	2:32	2:32	2:32	2:32
Time Saved		7:04	9:38	9:43	5:10	7:58
Time Saved/Mile	3:28	4:44	4:47	2:32	3:55	
<u>Number of Vehicles</u>						
General Lanes End-to-End	2,300	2,100	2,100	2,200	8,700	
HOV Lane		1,000	1,100	1,100	1,000	4,200
Total End-to-End	3,300	3,200	3,200	3,200	12,900	
HOV Percent End-to-End	30%	34%	34%	31%	33%	
<u>Travel Speeds (mph)</u>						
General Lanes		13	10	10	16	12
HOV Lane		48	48	48	48	48

Source: "Recent Findings on Boston Area HOV Lane Use and Performance"

Table 3 shows that users of the I-93 North HOV lane are enjoying significant travel-time savings. The major reason is that the general-purpose lanes are moving along at slower speeds (an average of 12 mph) due to the availability of only two general-purpose lanes and the merge with the Route 1 on-ramp traffic downstream. HOVs save an average of almost 8 minutes versus general-purpose traffic over a relatively short stretch of roadway (2 miles). The minute per mile savings is almost four minutes per mile, exceeding the regulatory requirement of one minute per mile.

C. Level of Service Analysis

310 CMR 7.37 requires MassHighway to perform a Level of Service (LOS) analysis for each of the three HOV segments: Southeast Expressway northbound, Southeast Expressway southbound, and I-93 North southbound. MassHighway performed the LOS analysis using methods prescribed in the 1997 Highway Capacity Manual (6). The LOS measurement for a basic freeway segment uses density, expressed as passenger cars per mile per lane. The 1999

data are used in the analysis.

HOV lanes require operational behavior different from that of a traditional freeway lane. MassHighway's HOV lanes are all barrier-separated, and have only one entrance and exit point; as a result, HOVs do not have to contend with traffic switching lanes. The entire experience of an HOV accelerating, traveling at free-flow speed, decelerating to safely merge, and occasionally moving in a queue, is captured in the average travel speed over the entire length of the lane. The analysis was performed using the average speeds over the entire operating period. Other factors include percentage of buses and vans, peak-hour factor, and driver familiarity with the facility. All three HOV lanes operate at Level of Service C, thus fulfilling the regulatory requirement.

D. Performance Report Review

The Performance Report demonstrates that all three HOV lanes provide travel-time savings to users of the lanes. The lanes share many characteristics such as similar operating hours and a 2+-entry requirement. The HOV lanes differ in their configuration and the expressway system that they augment, such as the number of adjacent general-purpose lanes. The performance report shows that general-purpose traffic also benefits from the existence of HOV lanes demonstrated by the southbound operations of the Southeast Expressway.

4. Air Quality Report Overview

The Air Pollution Regulation 310 CMR 7.37 (11) states that MassHighway "shall submit a report to the Department documenting the quantitative effects of such HOV lanes or projects on levels of VOC, CO, and NOx in the areas affected. (1)" This before/after analysis was included in the design of the regulation as a one-time requirement of MassHighway. DEP approved MassHighway's proposed method for determining air quality effects using travel-time speeds, vehicle volumes, and appropriate emission factors. An analysis was conducted for each of the three operating periods: the morning Southeast Expressway, the afternoon Southeast Expressway, and the morning I-93 North by hour. The air quality report was submitted in February 2000.

The air quality report required more detailed data and analysis than the performance report. Data was required by road segment – defined as a section of road between on and off-ramps. Travel speeds and vehicle volumes were required by segment. Periodic travel-time runs collected in both the general-purpose lanes and the HOV lane produce average travel speeds. Emission factors were applied to the respective average speed of vehicles per segment. There are different emission factors for each speed. Emission factors change periodically to reflect vehicle fleet turnover. In short, for each segment of roadway the following are required: general-purpose lane volume, an HOV lane volume, average travel speed and a corresponding emission factor.

The "before" and "after" years were selected based upon the availability of data. Where data did not exist, assumptions were made based upon current knowledge. The before and after time periods refer to before and after the respective carpool lanes were opened (Southeast Expressway) or lengthened (I-93 North) to its current state. In addition to the before/after analysis another set of analyses was conducted for each lane. The Southeast Expressway extra analyses were performed to show the effects of changing the entry requirement in June 1999 from 3+ to 2+. The I-93 North analysis was performed to show the air quality effects of restriping the southern-terminus merge and an extension in the operating hours in Spring 1999 from 6:30-9:30 A.M. to 6:00- 10:00 A.M. The additional analyses reflect current operations.

A. I-93 Southeast Expressway

MassHighway selected the spring of 1994 as the "before" condition and the Spring of 1996 as the "after" condition due to the availability of data for these two time periods. The Southeast Expressway HOV lane opened in November 1995. MassHighway faced many challenges in the air quality analysis, particularly with the Southeast Expressway. One challenge, mentioned above, is that emission factors change over time to reflect vehicle fleet turnover and new air quality programs. MassHighway chose to conduct two analyses: one using the same emission factors for both years; another using the respective year's factors. There are no emission factors available for 1994, so 1995 factors were used. Factors are available for 1996.

A combination of mainline and ramp counts results is needed to produce volumes by road segment. Ramp counts are necessary to account for the traffic entering and exiting the Southeast Expressway for the length of the HOV lane. Permanent count stations along the Expressway provided mainline counts. Ramp counts were available only for 1994. Due to the lack of 1996 ramp data, volumes during the morning peak period in 1994 were held constant for 1996 volumes The Southeast Expressway is at capacity, and has been for several years, heading into downtown Boston in the morning so traffic volumes have not substantially risen. Based on these assumptions, the general-purpose lane volumes for 1996 were calculated by subtracting the 1996 HOV lane volumes from the 1994 data. HOV volumes on the Southeast Expressway are taken on a daily basis.

TABLE 4
Emission Levels For Conditions
Before and After the Construction of the Southeast Expressway HOV Lane
AM Conditions with Emissions Factors Held Constant

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1994				
6-7 AM	59,742	88,877	352,902	582,655
7-8 AM	72,611	75,574	472,505	777,648
8-9 AM	58,559	72,935	366,025	603,562
9-10 AM	44,955	101,130	340,830	559,951
Total	235,867	338,516	1,532,262	2,523,816
Spring 1996				
6-7 AM	70,057	87,135	437,493	721,611
7-8 AM	71,233	76,253	466,852	768,106
8-9 AM	68,197	73,580	443,583	729,641
9-10 AM	46,406	82,960	272,026	448,298
Total	255,893	319,928	1,619,954	2,667,656
% Increase/Decrease (1994 to 1996)	8%	-5%	6%	6%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

TABLE 5
Comparison of Emission Levels For Conditions
Before and After the Construction of the HOV Lane
On the Southeast Expressway
PM Conditions with Emissions Factors Held Constant

ANALYSIS	**EMISSION LEVELS (grams)**			
PERIOD	**VOC**	**NOx**	**Summer CO**	**Winter CO**
<u>Spring 1994</u>				
3-4 PM	61,719	109,873	353,232	581,709
4-5 PM	77,063	106,877	460,796	761,179
5-6 PM	80,727	106,004	492,074	812,338
6-7 PM	59,656	97,797	345,529	569,685
Total	279,165	420,551	1,651,631	2,724,911
<u>Spring 1996</u>				
3-4 PM	68,052	120,528	398,749	657,061
4-5 PM	74,789	152,517	441,275	727,918
5-6 PM	74,399	121,459	440,045	725,736
6-7 PM	60,370	108,562	352,063	580,021
Total	277,610	503,066	1,632,132	2,690,736
% Increase/Decrease	-1%	20%	-1%	-1%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

Tables 4 and 5 show an air quality difference between the morning and afternoon commutes on the Southeast Expressway. Morning emissions generally increase while afternoon emissions decrease. However, this is not true for all emittants. NOx has somewhat of an inverse relationship to higher speeds than the other emittants do. VOC and CO emissions decrease as speeds approach 55 miles per hour and then begin to increase. NOx emission levels decrease up to 20 miles per hour and then begin to increase as speeds increase. As a result, NOx emissions decreased during the morning commute and increased during the evening commute. The reason is that, as noted in section A2, travel-speeds in the general-purpose lanes in the afternoon are significantly higher.

TABLE 6
Comparison of Emission Levels For Conditions
Before and After the Construction of the HOV Lane
On the Southeast Expressway
AM Conditions Using Different Emission Factors

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1994				
6-7 AM	59,742	88,877	352,902	582,655
7-8 AM	72,611	75,574	472,505	777,648
8-9 AM	58,559	72,935	366,025	603,562
9-10 AM	44,955	101,130	340,830	559,951
Total	235,867	338,516	1,532,262	2,523,816
Spring 1996				
6-7 AM	51,541	79,963	319,774	600,117
7-8 AM	52,565	66,527	346,433	647,030
8-9 AM	50,391	64,181	328,375	613,197
9-10 AM	33,790	72,095	192,105	361,280
Total	188,287	282,766	1,186,687	2,221,624
% Increase/Decrease	-20%	-16%	-23%	-12%

Source: “Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North”

TABLE 7
Comparison of Emission Levels For Conditions
Before and After the Construction of the HOV Lane
On the Southeast Expressway
PM Conditions Using Different Emission Factors

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1994				
3-4 PM	61,719	109,873	353,232	581,709
4-5 PM	77,063	106,877	460,796	761,179
5-6 PM	80,727	106,004	492,074	812,338
6-7 PM	59,656	97,797	345,529	569,685
Total	279,165	420,551	1,651,631	2,724,911
Spring 1996				
3-4 PM	49,504	104,791	281,568	529,449
4-5 PM	54,555	104,237	314,036	590,959
5-6 PM	54,312	105,666	313,208	589,218
6-7 PM	43,832	94,402	247,955	466,236
Total	202,203	409,096	1,156,767	2,175,862
% Increase/Decrease	-28%	-3%	-30%	-20%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

The above tables using the different emission factors show substantial differences from the analysis using the same factors. All of the input data is the same with the exception of the emission factors for the A.M. and P.M. conditions. All emissions decrease in both the morning and afternoon operating periods. It is clear that the analysis is sensitive to the different emission factors.

A1. Change in Occupancy Requirement

On June 1, 1999 MassHighway changed the occupancy requirement on the Southeast Expressway HOV lane from 3+/limited 2+ to a complete 2+ entry policy. The DEP requested that the air quality analysis reflect this change. In response, MassHighway included additional analysis to reflect the occupancy requirement change. This analysis consisted of another before/after set of calculations; spring 1999 was used as the "before" time period and fall 1999 was used as the "after" condition.

Traffic counts were taken for the Southeast Expressway general-purpose lanes and ramps during fall 1999. The result is a complete set of vehicle counts by segment for 1999. No counts were taken in spring 1999, therefore the fall 1999 counts are used as both the before and after volumes in the analysis. Obtaining ramp counts for the entire Southeast Expressway would have been prohibitively expensive and time consuming given the large number of on and off-ramps as well as the difficulty of keeping the automatic traffic tubes from being damaged. Ramp counts occur usually only as a result of a special request. The ramps were counted specifically for the HOV lane before and after analysis.

General-purpose travel-time runs were conducted during the fall 1998 and early spring 1999. These travel-times served as the "before" travel speed data. The HOV lane was operating at freeflow speeds before the occupancy change because vehicle volumes were less than maximum operating capacity. The "after" data travel-time runs were conducted in the early summer 1999 and then compared to derived speeds based on fall 1999 counts. The comparison confirmed the observed speeds from the earlier travel-time runs.

As expected, vehicle volumes increased as a result of the lower entry requirement as expected. Travel-time and speeds decreased from freeflow (55 mph) to approximately 50 mph as a result of the increased volumes in the HOV lane. Queuing began occurring during the morning commute at the northern end of the lane as the HOV traffic merges with the slower-moving general-purpose lanes. This occurs typically during the peak hour of usage of the HOV lane (7-8 A.M.).

The air quality of the entry requirement change is displayed in the table below. The same emission factors (1999) are used for both the before after analysis. As in previous analyses, the morning and afternoon conditions are analyzed separately.

Table 8
Effect of 1999 Entry Change on Emissions on the Southeast Expressway
AM Conditions

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1999				
6-7 AM	55,500	102,391	395,861	615,444
7-8 AM	58,884	91,355	462,560	721,072
8-9 AM	54,481	82,454	432,108	672,900
9-10 AM	35,873	83,763	235,708	362,736
Total	204,738	359,963	1,526,237	2,372,152
Fall 1999				
6-7 AM	60,442	102,205	454,792	708,128
7-8 AM	66,954	94,478	531,191	824,633
8-9 AM	58,495	84,139	465,086	722,557
9-10 AM	37,587	83,707	254,466	392,492
Total	223,478	364,529	1,705,535	2,647,810
% Increase/Decrease from Spring 1999 to Fall 1999	9%	1%	12%	12%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

TABLE 9
Effect of 1999 Entry Change on Emissions on the Southeast Expressway
PM Conditions

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1999				
3-4 PM	54,805	133,054	348,625	534,518
4-5 PM	56,243	117,127	377,583	584,488
5-6 PM	58,145	115,853	400,010	620,322
6-7 PM	48,445	130,597	307,603	469,774
Total	217,638	496,631	1,433,821	2,209,102
Fall 1999				
3-4 PM	55,345	132,233	353,497	542,610
4-5 PM	56,652	119,790	388,461	600,275
5-6 PM	59,485	116,245	418,761	649,206
6-7 PM	51,354	119,372	329,917	507,181
Total	222,836	487,640	1,490,636	2,299,272
% Increase/Decrease from Spring 1999 to Fall 1999	2%	-2%	4%	4%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

Tables 8 and 9 show slight increases in emissions in both the morning and afternoon commuting periods. The morning commute shows larger increases due to slower travel speeds. The increase is also a result of an increase in the number of HOV's merging back into the general-purpose lanes. MassHighway staff concluded that the increases in emissions were due to increased volumes and not necessarily the result of the HOV lane. An additional analysis was performed to demonstrate this conclusion.

MassHighway and CTPS analysts also believed that other factors, most notably natural growth in the amount of traffic, contributed significantly to the fact the emissions had risen substantially and did not accurately reflect the HOV lane effect. Another "set" of analysis was performed to try and isolate the effect the HOV lane had on air quality. Only actions taken by MassHighway (implementation and entry requirement changes) were considered. Tables 10 and 11 show the results of this analysis.

Table 10
Comparison of 1994 to 1999 Conditions
Without the Influence of Traffic Growth
AM Conditions

	EMISSION LEVELS (grams)			
	VOC	**NOx**	**Summer CO**	**Winter CO**
Emissions Difference from 1999 Entry Requirement Change (from Table 8)	18,740	4,566	179,298	275,658
1996 Emissions	188,287	282,766	1,186,687	2,221,624
Total 1996 with Entry Requirement Change	207,027	287,332	1,365,985	2,497,282
1994 Emissions	235,867	338,516	1,532,262	2,523,816
% Change from 1994 to 1996 with Entry Requirement Change	-12%	-15%	-11%	-1%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

Table 11
Comparison of 1994 to 1999 Conditions
Without the Influence of Traffic Growth
PM Conditions

	EMISSION LEVELS (grams)			
	VOC	**NOx**	**Summer CO**	**Winter CO**
Emissions Difference from 1999 Entry Requirement Change	5,198	-8,991	56,815	90,170
1996 Emissions	202,203	409,096	1,156,767	2,175,862
Total 1996 with Entry Requirement Change	207,401	400,105	1,213,582	2,266,032
1994 Emissions	279,165	420,551	1,651,631	2,724,911
% Decrease from 1994 to 1996 with Entry Requirement Change	-26%	-5%	-27%	-17%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

Tables 10 and 11 illustrate the air quality changes associated with the entry requirement change. As the tables illustrate, the analysis was conducted by adding the difference of the 1999 entry change to 1996 numbers and then comparing the result to the 1994 data. The result is that all emissions decreased in both the morning and afternoon operating periods.

B. I-93 North HOV Lane

The analysis for the I-93 North concurrent-flow lane is more straightforward due to the relative simplicity of the lane compared to the Southeast Expressway. As part of 310 CMR 7.37 MassHighway examined the feasibility of the northward extension of the existing 1-mile concurrent-flow lane. The result was a one-mile extension northward in 1994 to its current distance of 2 miles. Similar to the Southeast Expressway, a before and after air quality analysis was required to document the effect the extension had. Both general-purpose and HOV lanes are included in the analysis.

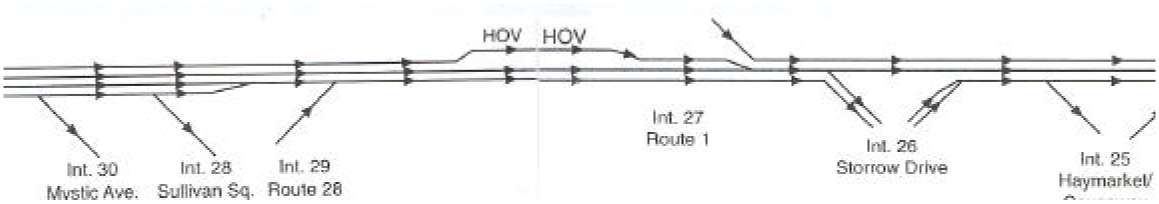
The analysis is more simple than the Southeast Expressway because the I-93 North lane only operates during the morning commute and has not undergone any entry requirement changes within recent years. Vehicle volumes are available for this area for 1992, and remained relatively stable through 1994. Travel-time runs were conducted during the spring of 1994 before the lane extension was added and then again during the fall 1994 after the lane extension was completed and normal operations resumed.

Although traffic volumes remained relatively stable in this area from 1992 to 1994, the lengthening of the HOV lane effectively eliminated a general-purpose lane for the one mile that the HOV lane was extended. In short, the four general-purpose lanes had to merge into three lanes sooner than they did before the extension. The number of general-purpose lanes drops to two lanes shortly after the drop to three lanes (see Diagram 3). The result of this was an increase in general-purpose travel-time corresponding with slower vehicle speeds.

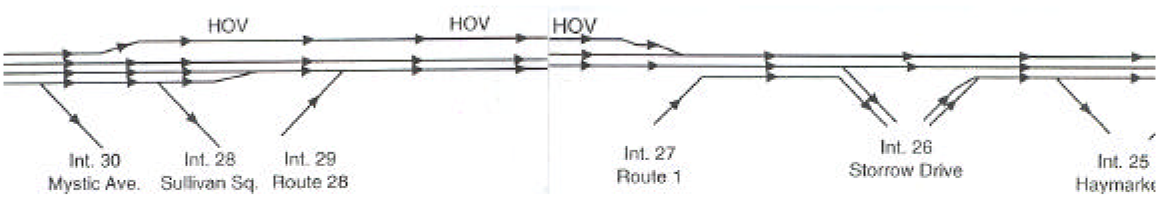
Another factor in this study area was a change in the traffic pattern downstream of the HOV lane section of roadway due to a change in ramp alignment. The Route 1 on-ramp to I-93 was formerly a left-side merge. Storrow Drive, a heavily used roadway running along the Charles River, has a right hand off-ramp within a short distance of the Route 1 merge that created a dangerous weave. This weave was eliminated in September 1994 by the opening of a new Route 1 on-ramp that merges with I-93 on the right hand side (see Diagram 4). The effect this change has should be accounted for while looking at the analysis.

Diagram 4
Change in Route 1 Merge with I-93 North Schematic

Pre-1994:



Post-1994:



Source: "Traffic Volumes on the Central Artery: 1977-1999"

The emission factors used in the analysis are from 1995 because no factors are available for 1994. The table below shows the results.

TABLE 12
Comparison of Emission Levels for Conditions on Interstate 93 North Before and After the Lengthening of the HOV Lane

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Spring 1994				
6-7 AM	24,612	42,886	194,227	319,191
7-8 AM	33,346	41,554	210,783	344,906
8-9 AM	32,483	37,008	204,107	334,493
9-10 AM	24,668	40,430	184,571	303,313
Total	115,109	161,878	793,688	1,301,903
Fall 1994				
6-7 AM	24,738	40,180	168,988	277,857
7-8 AM	34,639	40,075	220,050	360,821
8-9 AM	35,291	41,841	240,452	393,989
9-10 AM	30,203	42,164	222,756	365,055
Total	124,871	164,260	852,246	1,397,722
% Increase from Spring 1994 to Fall 1994	8%	1%	7%	7%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

The results of the analysis show an increase in each of the four categories of emittants, although it is not clear whether the increase is related to the HOV lane extension or traffic reacting to the new Route 1 on-ramp.

Two changes to the I-93 North lane occurred in 1999: 1) the restriping of the downstream merge section and 2) the change in operating hours. The restriping of the merge section allows a more gradual merge for HOV traffic back into the general-purpose lanes. Operating hours were extended from the initial 6:30 A.M. to 9:30 A.M. to 6:00 A.M. to 10:00 A.M. The table below shows the air quality results of these changes.

TABLE 13
Comparison of Emission Levels for Conditions on Interstate 93 North After Restriping and Extension of Operating Hours

ANALYSIS PERIOD	EMISSION LEVELS (grams) VOC	NOx	Summer CO	Winter CO
Fall 1998				
6-7 AM	24,131	47,215	187,255	288,158
7-8 AM	32,683	41,675	260,461	402,785
8-9 AM	30,640	38,552	245,057	379,266
9-10 AM	21,976	37,763	169,191	261,563
Total	109,430	165,205	861,964	1,331,772
Summer 1999				
6-7 AM	26,604	48,326	206,778	318,325
7-8 AM	32,715	43,084	258,357	399,638
8-9 AM	30,348	39,957	240,119	371,617
9-10 AM	23,237	38,670	178,414	275,951
Total	112,904	170,037	883,668	1,365,531
% Increase from Fall 1998 to Summer 1999	3%	3%	3%	3%

Source: "Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North"

Table 13 shows emissions rising slightly, 3%, for each category between fall 1998 and summer 1999. However, traffic volumes on heavily used alternative, parallel routes declined during this time as the result of better traffic operations on I-93. This traffic was likely attracted onto I-93 because of improved operations due to the restriping and extended operating hours.

C. Air Quality Report Review

The DEP regulations as they are written provide great opportunities for interpretation, especially for an operational agency (MassHighway) and a regulatory agency (DEP). As anticipated, the two agencies had different interpretations of the air quality analysis results.

Unlike the performance standard portion of the regulation (discussed above), the air quality portion of the regulation does not provide quantifiable parameters that must be met. The definition section of the regulation states that the HOV lanes must result in "greater improvement in air quality for VOC, CO and NOx…in the long and short term. (1)"

Several assumptions had to be made for the input data because some data does not exist. This is especially true for some of the vehicle volumes. As described above, ramp counts are necessary for the air quality analysis for the Southeast Expressway to account for traffic entering and exiting the Expressway along the section of roadway adjacent to the HOV lane. There are twenty one ramps that need to be counted. This is not as significant an issue on I-93 North because there is only one on/off ramp combination along the HOV lane. The I-93 North HOV lane is not counted daily like the Expressway HOV lane. Thus, when vehicle volumes are necessary, automatic traffic recorders must be placed on the lane. Other data assumptions included the emission factors as discussed earlier.

It is clear that several conclusions can be made from the multiple sets of analyses performed. The morning and afternoon emission results on the Southeast Expressway clearly reflect the improved traffic operations in the afternoon as described in the performance report. The inverse relationship that NOx has to higher speeds, compared to the other emittants, makes it unlikely that all three emittants will decrease.

5. Agency Responses

While MassHighway views the performance of the lanes as a success, the DEP draws a few different conclusions based on their environmental perspective. One of DEP's primary concerns is that the afternoon operations of the Southeast Expressway do not meet the minute per mile travel savings required by the regulations. This, in fact, is true yet MassHighway believes this is not a sign that the HOV lane is failing but rather that the general-purpose lanes are benefiting from the presence of the HOV lane. Other factors, such as traffic on parallel routes, are not considered in the regulations. Although the HOV lane clearly provides a benefit to overall traffic operations during the afternoon commute, the lane does not meet the regulatory requirements.

The two agencies also drew varied conclusions on the air quality report. DEP had several questions and concerns regarding the report. Their obvious concern was that emissions had risen in recent years (1996 to 1999 analyses) and more importantly, when the occupancy requirement was lowered from 3+ to 2+. MassHighway pointed out the positives in the report such as the increased number of HOV's on both facilities. The difficult part of trying to quantify the HOV lanes' effect on air quality is that there are many factors beyond the control of any agency (i.e. natural growth in traffic) which may outweigh the HOV lane's benefit.

One such factor is traffic on parallel, alternative routes. Like most urban areas, Boston has arterial routes and other local roads that run parallel to the main interstate roadway (I-93). The average commuter is aware of these routes and uses them as an alternative route into Boston and surrounding communities. Many commuters use these routes believing they provide faster travel times than I-93. The Southeast Expressway contraflow lane, in effect, creates a new lane exclusively for HOV use. So HOVs that would normally be using the general-purpose lanes are removed from these lanes. This indirectly provides additional capacity for single occupant vehicles on the general-purpose lanes, perhaps attracting vehicles from alternative routes.

The air quality report demonstrates how sensitive the analysis method is to emission factors; demonstrated when using the emission factor as the only variable (holding speed and volumes constant) while comparing 1994 to 1996. Is the HOV lane the reason why emissions decrease or is it the use of different emission factors? It was not clear, for example, whether traffic operations on the general-purpose lanes are the reason for emission changes. The need for clear and concise regulations is very important to address these issues to eliminate confusion during and after the analysis is performed. Other considerations, such as benefits to general traffic, should also be considered for monitoring regulations.

6. Conclusions

Following the submittal of the performance and air quality reports, MassHighway and DEP discussed their perspectives of the two results. These discussions made it very clear that DEP was quite concerned with the entry requirement change on the Southeast Expressway and how it would affect the performance and air quality of the lanes. As this paper has described, the air quality analysis is not a clear-cut process. Depending on what set of analyses one looks at, a number of different conclusions can be drawn. Although MassHighway was specifically concerned with satisfying the regulation, what MassHighway considers a success may not be a success in DEP's opinion. This is a result of the agencies different roles; MassHighway is concerned with operating safe, efficient HOV lanes that provide benefits to carpools, vanpools, and buses, whereas DEP is more concerned with the air quality impacts associated with the lanes.

The exercise of preparing both reports stressed the importance of designing regulatory standards that are realistic, well defined, and based on sound transportation principles. The HOV lanes are one piece in a complex transportation network that includes many modes of travel. Benefits from the lane can be indirect as well as direct and are not always quantifiable. The Southeast Expressway afternoon operations are a prime example of this. Although the afternoon performance of the HOV lane does not meet the minute per mile travel-time savings standard during each hour of operation, the HOV lane does operate at free-flow speed and provides a by-pass around a weaving area for 1,000 vehicles an hour. Removing 1,000 HOV's from the general-purpose lanes provides a direct benefit to the general-purpose traffic and allows them to travel at higher speeds than they would be able to if the HOV lane did not exist.

Another factor to consider is traffic volumes on parallel routes. Both approaches to Boston have parallel routes that are used by commuters who feel that these routes are faster than I-93. If the Expressway's performance improves it is highly likely that vehicles using alternate routes will choose to use I-93. The decrease of "cut-through" traffic through local neighborhoods is clearly a positive result.

The air quality and performance reports are prime examples of how two different agencies can have multiple interpretations of the same two reports. It is inevitable that agencies with different perspectives will have varying conclusions of the same results. However, it emphasizes the need for agency coordination to gain agreement beforehand on acceptable, practical monitoring measures. These measures should be based on sound transportation practice and knowledge and flexible enough to account for unforeseen benefits that may directly, or indirectly, benefit from the existence of an HOV lane.

Acknowledgements

Anne McGahan and Bill Kutner from the Central Transportation Planning Staff for their fine analytical work on the two reports. The Statewide Planning Unit from MassHighway- Planning for their help editing the paper. Mark Berger from MassHighway-Planning for his help on the graphics for the paper. Luisa Paiewonsky, Director, MassHighway- Planning, for her invaluable assistance in concepts and editing of the paper.

References

1. 310 Code Mass. Regs § 7.37. *Air Pollution Control Regulations.*

2. Kuttner, B. *Recent Findings on Boston Area HOV Lane Use and Performance.* Technical Memorandum. Central Transportation Planning Staff. Boston, January 2000.

3. McGahan, A. *Air Quality Analysis of Conditions of the High Occupancy Vehicle Lane on the Southeast Expressway and I-93 North.* Technical Memorandum. Central Transportation Planning Staff. Boston, February 2000.

4. Lisco, T. *Southeast Expressway Southbound: Freeport Street to Braintree Split – AM Peak Period Balanced Volumes: 1999.* Traffic Flow Map. Central Transportation Planning Staff. Boston, March 2000.

5. Lisco,T., Gillis, J. *Traffic Volumes on the Central Artery: 1977-1999.* Traffic Volume Report. Central Transportation Planning Staff. Boston, June 2000.

6. *Highway Capacity Manual.* Special Report 209. Transportation Research Board. December 1997.

HOV LANES ON THE LONG ISLAND EXPRESSWAY: HOW ARE THEY DOING?

Paper presented at the 10th International HOV Conference
August 28-30, 2000

NANCY L. O'CONNELL, WILLIAM R. THORNEWELL, WAYNE R. UGOLIK
MARTIN YOUCHAH

NEW YORK STATE DEPARTMENT OF TRANSPORTATION

ABSTRACT

On May 25, 1994, New York State opened its first suburban HOV lanes along a twelve-mile segment of the Long Island Expressway (LIE), I-495, in Suffolk County on Long Island. Since then, the HOV lanes have grown to 30 miles (48 km) in length and construction of the last planned 10-mile section is well underway.

The New York State Department of Transportation (NYSDOT) remains committed to successful HOV-lane implementation on Long Island. By a number of measures NYSDOT is achieving this objective: new carpools are being generated; usage is growing; the average volume exceeds1,200 two-plus vehicles during the peak hour; and compliance is better than 95%.

Keeping the public informed of HOV usage trends and promoting the lanes has been a priority since the lanes first opened. NYSDOT also maintains interagency coordination on policy and operational issues via the LIE/HOV Task Force, which has met 45 times since 1991.

This paper presents an overview of LIE HOV usage statistics, public-outreach techniques being used, operational issues, and some challenges to the integrity of the HOV lanes that have been faced.

BACKGROUND

The Long Island Expressway (LIE), I-495, extends from the Queens-Midtown Tunnel in New York City through the Borough of Queens into Nassau and Suffolk Counties for a total length of 70 miles (112 km). High Occupancy Vehicle (HOV) lanes were opened on May 25, 1994 *in both directions* along a 12-mile (19.2 km) stretch of the LIE between Interchange 49 (State Route 110) and Interchange 57 (State Route 454) in Suffolk County, New York (Figure 1). This was the first time that HOV lanes were implemented in suburban New York State.

In June 1998, the second segment of HOV lanes was opened along 8 miles (12.8 km) of the LIE between Interchange 40 (State Route 25 in Jericho) in Nassau County and Interchange 49. The easternmost 10-mile (16 km) HOV-lane segment between Interchange 57 and Interchange 64 (State Route 112 in Medford) was opened in stages beginning in July 1999; the segment was fully opened in September 1999. No federal funds were used for any of the planning, design or construction of the LIE HOV lanes.

At the time of writing, the LIE HOV-lane system extends 30 miles (48 km) in each direction. The final planned 10-mile (16 km) segment of the LIE HOV lanes between the Queens/Nassau border and Interchange 40 is under construction with an anticipated completion in late 2003 or early 2004.

The HOV-lane segments east of Interchange 40 were constructed within the former median areas of the LIE and required no widening on the outside of the original LIE “footprint.” The segment west of Interchange 40 did not include a median and the HOV-lane design required “widening on the outside” of the LIE.

LONG ISLAND EXPRESSWAY (I495) HOV LANES

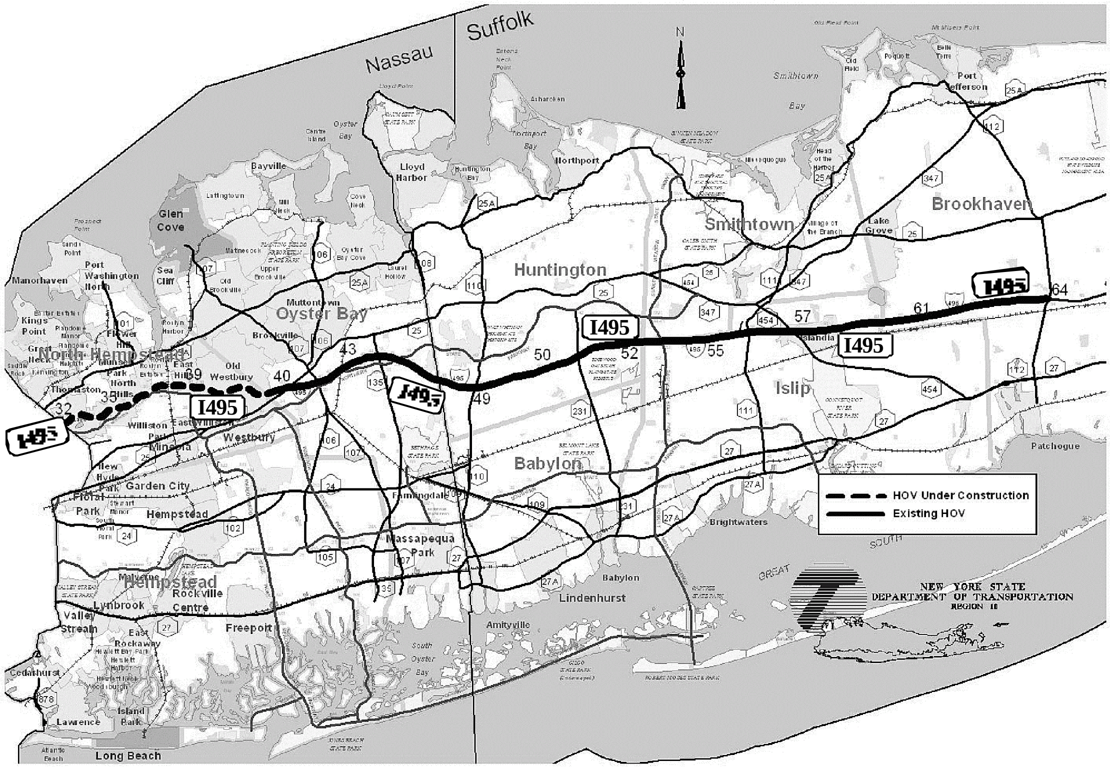


Figure 5

The typical HOV-lane cross section varies by location. Generally, the segments east of Interchange 49 include a twelve-foot (3.7 m) HOV travel lane in each direction which is augmented by a 4' (1.2 m) painted "a buffer zone," separating the HOV lane from the "third" general-purpose lane, and a nearly continuous 10' to 13'9" (3.0 to 4.2 m) full-depth-paved "breakdown" shoulder, located to the immediate left of the HOV lane. The shoulders are used for enforcement pullovers and vehicle breakdowns.

A concrete median barrier separates the two directions. At a number of locations, official access between directions is provided via a "slip ramp-type" break in the concrete barrier. This design enables official vehicles to park protected while observing traffic. Enforcement is provided by the Nassau County and Suffolk County Police Departments under a contract with the New York State Department of Transportation.

To the west of Interchange 49, a twelve-foot (3.7 m) HOV travel lane is provided in each direction. However, the painted "buffer zone," separating the HOV lane from the "third" general-purpose lane, is reduced from 4' (1.2 m) to 2' (0.6 m), proceeding east to west. In addition, the left-hand shoulder is typically replaced by a 2' (0.6 m) to 4' (1.2 m) offset from the concrete barrier. In the narrower cross sections, enforcement areas are provided to the immediate left of the HOV lane at discrete locations.

The LIE HOV lanes are limited access, allowing vehicles to enter or to exit only at designated locations. Crossing the "buffer zone" is a violation of law. Entrances are distinguished from exits; they are marked with overhead signs and pavement striping.

Along segments to the east of Interchange 40, acceleration/merging lanes (at HOV-lane entrances) and deceleration/merging lanes (at HOV-lane exits) are provided. However, along the segment to the west of Interchange 40, no such merging lanes can be provided due to constricted width of the LIE in the area. Figure 2 shows general entry and exit configurations for segments east of Interchange 40. Figure 3 shows general entry and exit configurations for segments west of Interchange 40.

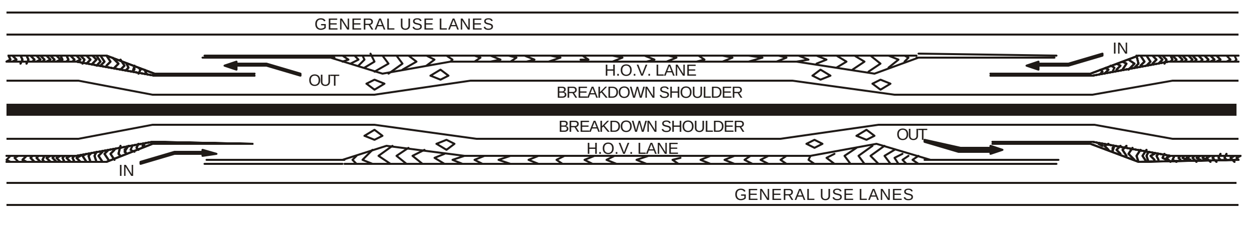


Figure 2

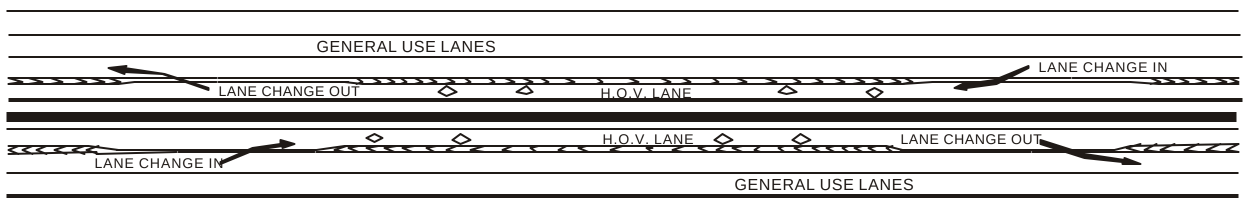


Figure 3

The LIE HOV lanes are reserved for use by passenger vehicles with two or more occupants, buses and motorcycles between 6:00 and 10:00 in the morning, and 3:00 to 8:00 in the evening, Monday through Friday only. At all other times, the HOV lanes are available to all passenger vehicles, regardless of occupancy.

Fixed and variable message signs are posted throughout the length of the HOV lanes. They are used to inform motorists about the usage restrictions, HOV-lane entry and exiting locations, as well as maximum and minimum speed limits. The posted speed limit in the HOV lanes, like the general-purpose lanes on the LIE, is 55 mph (88 kmph); the posted minimum is 40 mph (64 kmph).

The implementation of the HOV lanes on the LIE was preceded by careful planning which began in the late 1980's, as well as an extensive public-outreach effort. In1991, the LIE HOV Task Force was established by the New York State Department of Transportation (NYSDOT). The Task Force has met 45 times since then and continues to meet on a regular basis. It brings together local government and elected officials, law enforcement agencies, mass transit agencies, the business community, environmental groups, and other special interests groups, including the Automobile Club of New York (AAA). The Task Force has provided advisory opinions on key HOV-lane issues including hours of operation, enforcement, occupancy requirements, signing, incident management, transit programs, outreach and support services. As a result of formal task force recommendations, numerous actions and policies to support the successful operation of the HOV lanes were implemented Initial planning and marketing for the LIE HOV lanes, as well as the LIE/HOV Task Force are more fully described in [1].

LIE HOV-LANE MONITORING PROGRAM

Responding to a recommendation of the LIE/HOV Task Force, the NYSDOT implemented a comprehensive monitoring program to:

1. gather and evaluate data on HOV-lane utilization, vehicle occupancy rates, travel speeds, compliance with HOV lane rules, etc.;
2. obtain feedback from HOV users and non-users; and,
3. keep the public, the media, elected officials, the LIE/HOV Task Force and other stakeholders informed about the HOV lanes.

The data is obtained in several ways. First, HOV-lane and general-purpose-lane traffic volumes are obtained on a continuing basis. Second, field observations are periodically undertaken to estimate vehicle occupancy rates, travel speeds and HOV lane compliance rates. Third, surveys are used to help understand user (and non-user) perceptions of the HOV lanes and obtain other important information about travel behavior patterns. Finally, focus groups have been conducted to gain qualitative insights into public impressions about HOV lanes and ridesharing.

The first survey was conducted in 1995. It was followed by similar surveys in 1997 and 1999. A complete description of the survey methodology and findings from the 1995 survey, as well as initial results from the monitoring program are reported in [2].

This paper provides an update to [2] by summarizing:

1. HOV-lane volume trends for the period June 1994 through May 2000;
2. Results of the 1999 survey of HOV-lane users conducted in March 1999;
3. Public outreach efforts;
4. Operational issues; and
5. Criticism of the LIE HOV lanes.

GROWTH OF LIE HOV-LANE USE

HOV-lane traffic volumes are obtained on a continuous basis via electronic detectors imbedded in the HOV lanes and general-purpose lanes. The traffic volume data is arrayed on an hourly basis. For one specific “control site,” which was established when the HOV lanes were first opened in 1994, these data are summarized into average-annual-weekday hourly traffic volumes (AAWHT) by “HOV-Implementation-Year” (defined as June through May since the LIE HOV lanes first opened on May 25, 1994). Although the HOV lanes are directional, the AAWHT data are summarized only for the peak direction in the morning and the peak direction in the afternoon.

The control site is located between Interchange 49 and Interchange 50 of the LIE, just to the east of State Route 110. Because of its location and the prevailing travel patterns on Long Island, the control site is the “maximum load point” for the HOV lanes for both the morning and the afternoon peak directions:

- Interchange 49 serves a major employment area on Long Island; the area also has the second highest aggregate number of trip attractions on Long Island during the morning weekday peak period.
- Travel on Long Island continues to follow a prevailing east-to-west (westbound) pattern during the weekday morning peak period and a west-to-east (eastbound) pattern during the weekday afternoon peak period. This is the result of development trends on Long Island that have seen residential populations “moving eastward” since the 1950's. (New job growth is projected to move eastward as well. Thus, over time, a peak directional split will not be discernible.)

The following is a summary of HOV-lane usage trends (AAWHT) at the control site for the westbound morning peak direction and the eastbound afternoon peak direction:

- Westbound AAWHT increased 52% from 660 HOVs per hour during the morning peak hour (7:00 AM to 8:00 AM) in the first year of HOV-lane operation to 1,000 HOVs per morning peak hour in the sixth year (Figure 4).
- Eastbound AAWHT increased 47% from 870 HOVs per hour during the afternoon peak hour (5:00 PM to 6:00 PM) in the first year of HOV-lane operation to 1,275 HOVs per afternoon peak hour during the sixth year (Figure 5).
- Early in the planning phase for the LIE HOV-lane system, reaching a threshold of 800 HOVs per hour was established as one measure of “HOV-lane effectiveness.” While there has been a steady increase in HOV-lane usage and a “spreading of the HOV-lane peak period” from the first year of operation through the sixth year of operation, striking jumps in usage were observed after extensions of the HOV-lanes were opened (Figure 6). It was at the beginning of the fifth year that the second HOV-lane segment (8 miles/12.8 km long) was opened and by the fourth month of the sixth year of operation, the third HOV-lane segment (10 miles/16 km long) was opened.
- During the first four years of HOV-lane operation, when only the initial 12-mile (19.3 km) HOV-lane segment was in operation, AAWHT in the morning peak direction (westbound from 6:00 AM to 10:00 AM) never reached the 800-HOVs-per-hour threshold; AAWHT in the afternoon peak direction (eastbound from 3:00 PM to 8:00 PM) reached this level of usage for only two of the five afternoon peak hours.
- During the fifth and sixth years of operation, AAWHT in the peak direction exceeded the 800 HOVs per hour threshold for seven of the nine HOV-reserved hours.
- During the first three years of HOV-lane operation, AAWHT never reached 1,000 HOVs per hour.
- During the fourth year, AAWHT in the peak direction reached 1,000 vehicles per hour for one hour during the afternoon peak period.
- During the fifth year, AAWHT in the peak direction was approximately 1,000 or more vehicles per hour for two hours during the afternoon peak period.

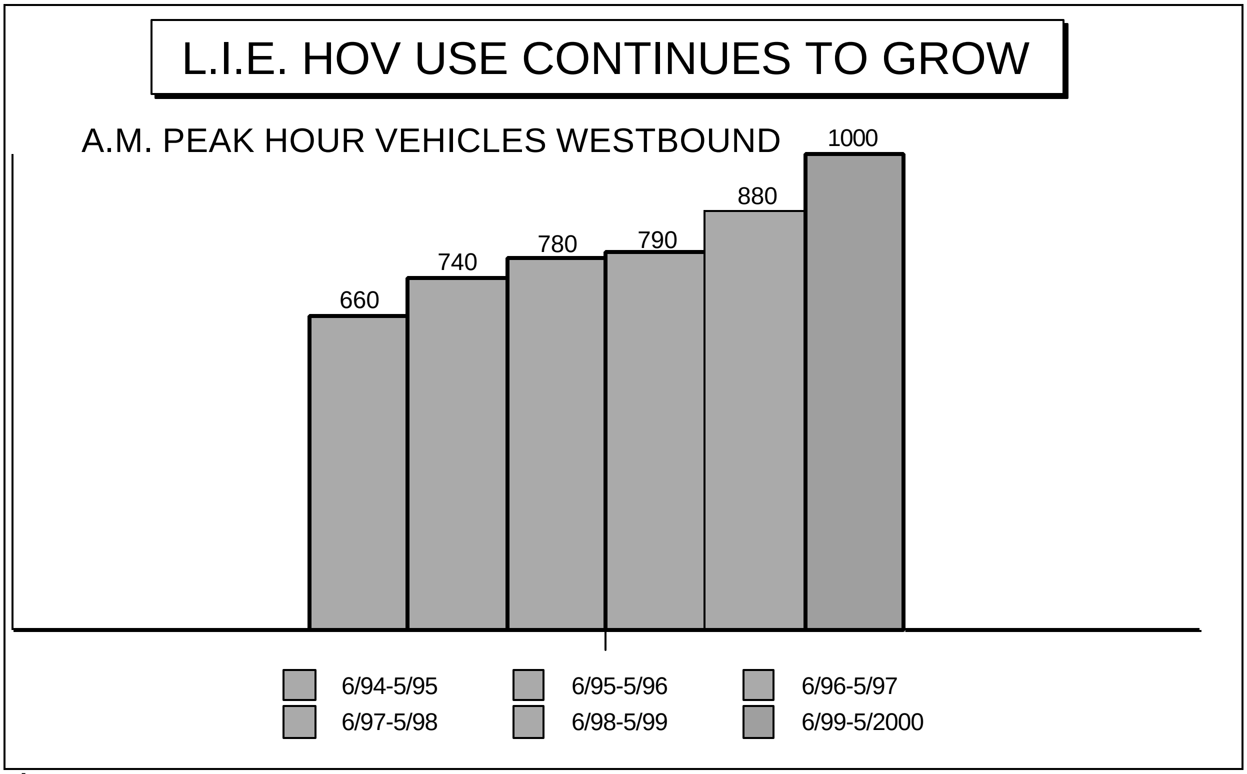


Figure 4

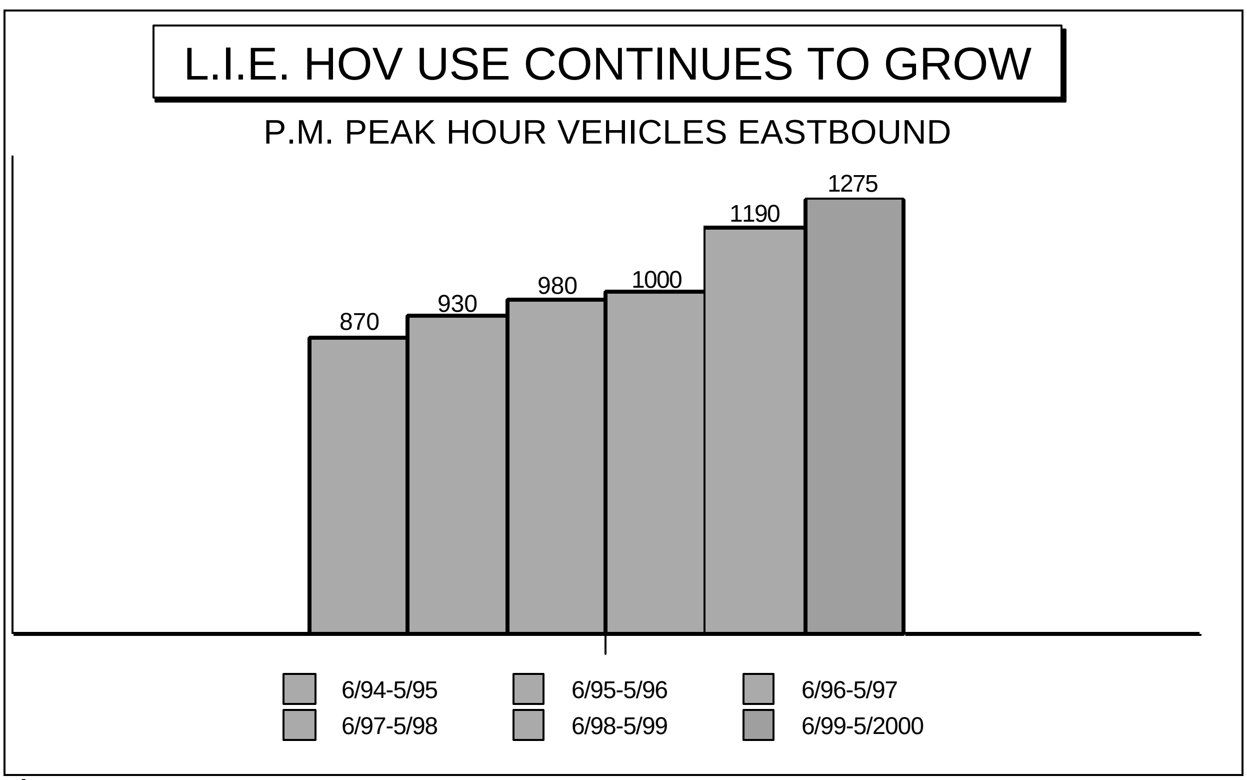


Figure 5

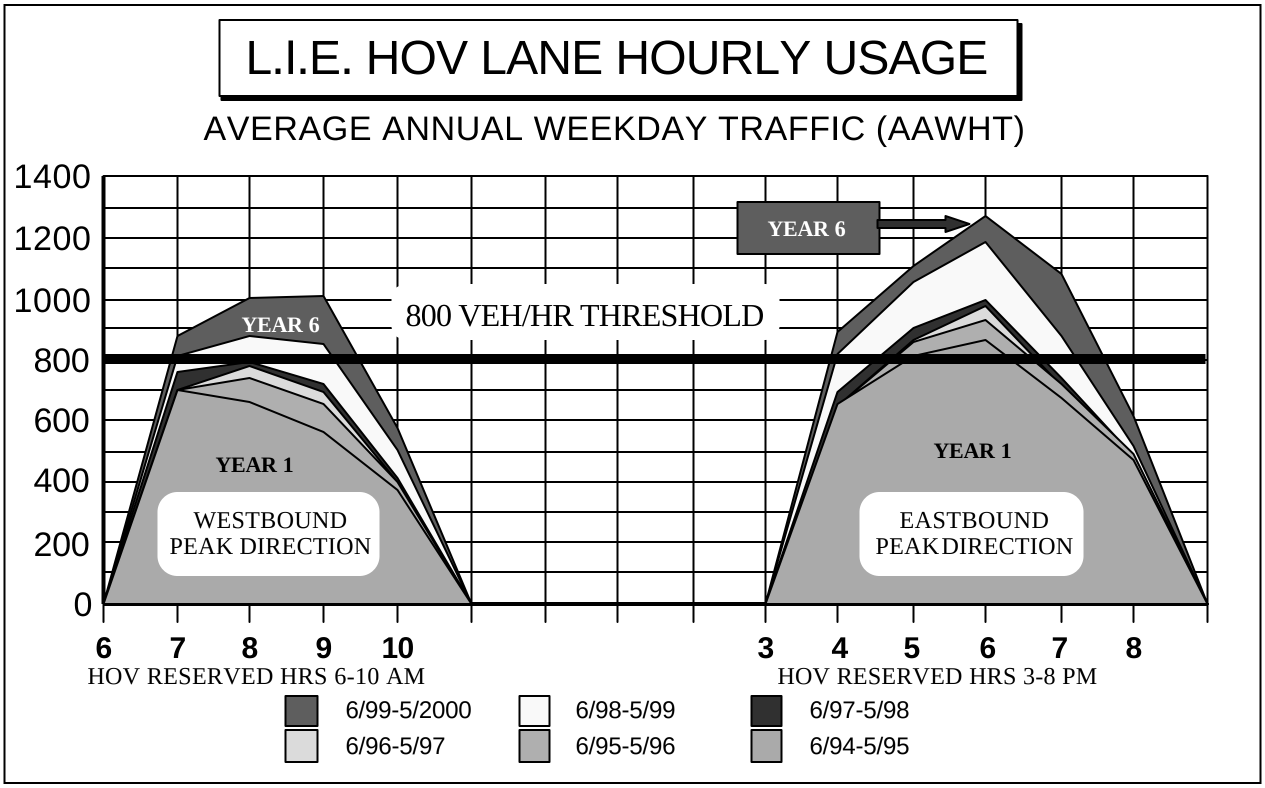


Figure 6

- During the sixth year of operation, AAWHT in the peak direction was approximately 1,000 or more vehicles per hour for five of the nine HOV-reserved hours: two hours during the morning and three hours during the afternoon.

VEHICLE OCCUPANCY FOR THE FACILITY

Another important measure of the effectiveness of the LIE HOV lanes in managing congestion is their influence on the Average Vehicle Occupancy (AVO) of the entire facility. Periodically, field observations are made to determine the number of occupants in vehicles passing the control point in the HOV lanes and in the general-purpose lanes. This information is used to calculate the HOV-lane compliance rate, the AVO for the HOV lanes, the AVO for the general-purpose lanes (GPLs) and the AVO for all lanes combined in the peak direction.

In November 1993, six months prior to the opening of HOV lanes on the LIE, the facility AVO was calculated based on field observations at the control site. This provided a baseline for comparing the most recent occupancy data, which was collected in October 1999. The facility AVO at the control site has increased by 14.0% since the HOV lanes opened.

Morning Peak Period (6 AM to 10 AM):
Westbound HOV-Lane Compliance with Occupancy Rule: 97.8%

HOVL AVO 1999	GPL AVO 1999	All 4 Lanes AVO 1999	All 3 Lanes AVO 1993
2.50	1.13	1.30	1.14

Afternoon Peak Period (3 PM to 8 PM):
Eastbound HOV-Lane Compliance with Occupancy Rule: 98.2%

HOVL AVO 1999	GPL AVO 1999	All 4 Lanes AVO 1999	All 3 Lanes AVO 1993
2.47	1.09	1.33	1.16

By the sixth year of operation, in the peak direction during the peak hour (5:00 PM to 6:00 PM) the LIE HOV lane carried 52% more people than any general-purpose lane. This means that during the peak hour, the HOV lane typically carried *more than one-third* of all the people using the LIE in the peak direction (Figure 7).

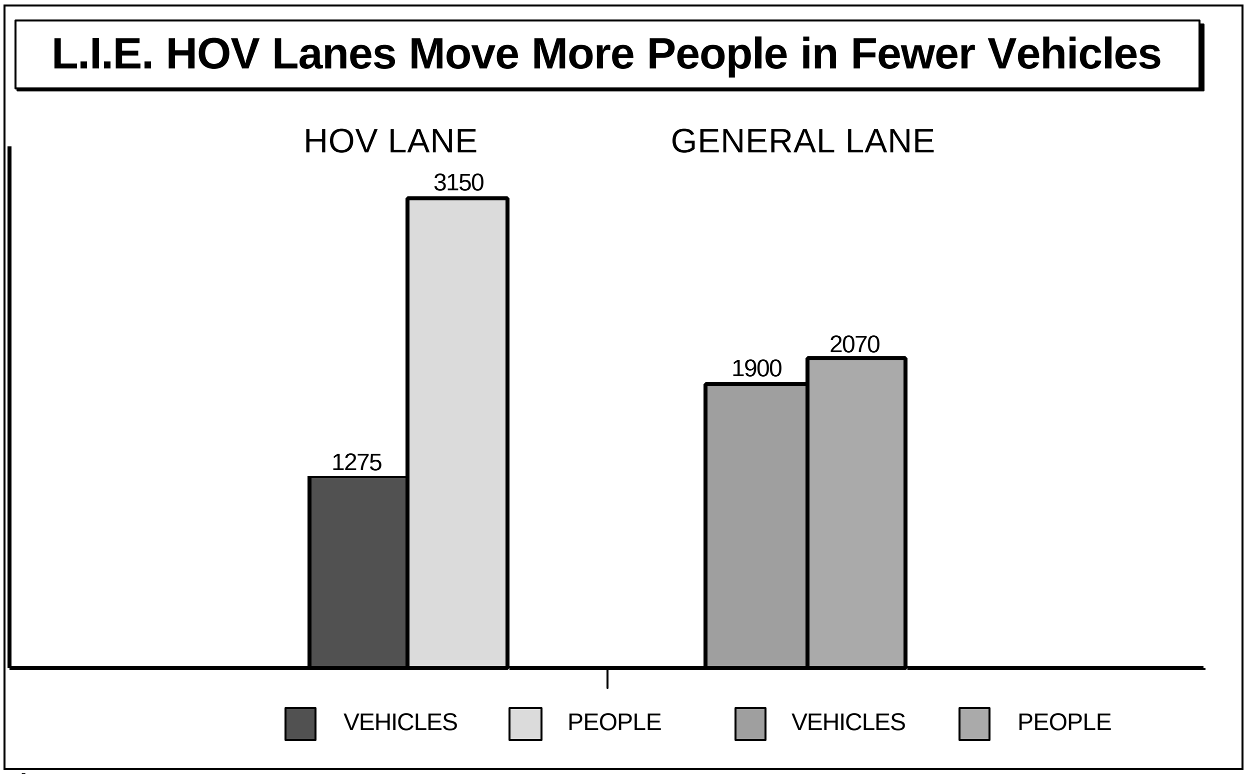


Figure 7

TRAVEL SPEEDS

Although speed data for the HOV lanes has not been rigorously collected for some time, spot checks during the weekday peak periods support the statement that travel speeds in the LIE HOV lanes typically exceed 60 mph (96 kmph). However, as one might expect, when HOV-lane traffic approaches an area where the general-purpose lanes are significantly slower-moving or stopped, then traffic in the HOV lanes will momentarily slow before quickly regaining speed.

Speed data was collected in October 1999 for the general-purpose lanes only. During both the morning and the afternoon peak hours, the average speed in the general-purpose lanes for traveling the entire 30 miles (48 km) in the peak directions between Interchange 40 and Interchange 64 (parallel to the HOV lanes) was determined to be approximately 40 mph (64 kmph). However, speeds dipped to below 30 mph (48 kmph) at a number of locations.

HOV-LANE USER SURVEY

Similar to the 1995 and 1997 HOV-lane user surveys, the 1999 user-survey population was determined by recording license plates during HOV-reserved hours at the control site and mailing a survey form to vehicle registrants. The mail-back response rate was 24%; 1,076 user survey forms were completed and returned.

SURVEY FINDINGS

Below are some highlights from the 1999 HOV-lane user survey. It should be noted that comparison of the 1995, 1997 and 1999 HOV-lane user surveys revealed there were generally only slight differences in overall responses to virtually all questions —*except that reported "new carpooling" has been steadily and markedly increasing*.

New ridesharing

- 27% of the respondents to the 1999 survey stated that they joined, formed or increased the size of a carpool because of the HOV lanes. Factoring in their reported frequency of use of the HOV lanes and expanding to the survey population led to the estimate that the HOV lanes have directly contributed to more than 3,700 new regular carpoolers.
  - In the 1995 survey, 6% of respondents said they joined or formed a carpool while in the 1997 survey, 17% reported they did so.
- 14% of the respondents to the 1999 survey reported that they now share rides occasionally to use the HOV lanes. This result has not changed noticeably since the 1995 survey was taken. Factoring in frequency of use and expanding, led to the estimate that more than 14,000 people now share rides occasionally to use the HOV lanes.

Patterns of Use

- 40% of the respondents said they used the HOV lanes four or five days per week.
- 71% reported they had used the HOV lanes for more than one year.
- 26% reported that they switched from parallel limited-access facilities to use the HOV lanes; 10% said they switched from signalized arterials or local roads.

Reasons for using the HOV lanes

- 74% of users stated that they used the HOV lanes to save time.
- 34% of users stated that they used the HOV lanes because they provided travel-time reliability.
- 21% of users cited cost savings as a reason for using the HOV lanes.

Reported Travel-Time Savings

The average reported travel time savings was 15 minutes. Of those who quantified a travel-time savings:

- 91% said the HOV lanes saved them 6 or more minutes of travel time.
- 74% said the HOV lanes saved them more than 10 minutes of travel time.
- 48% said the HOV lanes saved them more than 15 minutes in travel time.
- 25% said the HOV lanes saved them more than 20 minutes in travel time.

Trip Purpose

Survey respondents were asked to identify the purpose of the last trip they made in the HOV lanes during HOV-reserved hours.

- 60% reported traveling to or from work.
- 17% reported recreational or shopping trips or another non-work-related purpose.
- 8% reported traveling to/from school.
- 3% reported traveling to/from a business meeting.

Opinions about the HOV-lanes

- 56% of users agreed that the HOV lanes motivate people to carpool.
- 75% said the HOV lanes contribute to better traffic flow.
- 78% said they were safe to use.
- 79% felt they are less stressful to travel.
- 81% said they should be extended in length.

GENERAL-PURPOSE-LANE SURVEY

At the same time the 1999 HOV-lane user survey was conducted, license plates for a randomly selected sample of vehicles in the general-purpose lanes were recorded at the control site and a survey form was mailed to vehicle registrants. The mail-back response rate was 22%; 792 general-purpose-lane user survey forms were completed and returned.

SURVEY FINDINGS

Below are some highlights of answers given by respondents to the general-purpose-lane survey:

- 79% reported they were not regular users of the HOV lanes during the HOV-reserved hours.
- 20% said they regularly used the HOV lanes during reserved hours.
- 83% used the HOV lanes during non-HOV-reserved hours.

Opinions about the HOV-lanes

- 28% agreed that the HOV lanes motivate people to carpool.
- 45% said the HOV lanes contribute to better traffic flow.
- 53% said they felt the HOV lanes were safe to use.
- 46% felt the HOV lanes are less stressful to travel.
- 51% felt the HOV lanes should be extended in length while 19% said the HOV lanes should not be extended.

Reasons for *not* using the HOV lanes

- 13% stated the HOV lanes would not provide a time savings.
- 33% preferred to drive alone.
- 35% said they could not find a carpool partner.

PUBLIC OUTREACH

The strategy for marketing the LIE HOV lanes and promoting ridesharing on Long Island has evolved significantly since the planning for the HOV lanes began in the late 1980's. Initial efforts focused on introducing the HOV-lane concept and promoting potential benefits to key stakeholders in order to gain project support. The efforts involved reaching out directly to both public and private interests. These initial efforts are described fully in [1].

FOCUS GROUPS

As described in [1], focus groups have been used as a key component of the marketing and public outreach effort. The initial focus groups were conducted in 1991 prior to HOV lane opening. They involved commuters and employers in separate sessions. Early results revealed that commuters and employers alike failed to understand the objectives of HOV-lane implementation and they expressed misgivings about forming carpools. Based on input from the focus groups, a significant part of the initial LIE HOV outreach effort was placed on information-sharing with major employers who could then share that information with employees.

In early 1995, about eight (8) months after HOV lanes first opened on Long Island, focus groups were conducted with HOV-lane users and separately with non-users. The focus groups were formed by using the vehicle registrant address information gathered as part of the first HOV user and general-use-lane user surveys. Twenty-two (22) HOV-lane user participants were split between two sessions. Of these, twelve (12) were carpoolers before the HOV lanes opened, five (5) started carpooling when the HOV lanes opened and the remaining carpooled with family members to use the HOV lane. The new carpoolers indicated their carpools were formed because of the HOV lanes as well as employee commute option actions at their workplace.

The recommendations developed from these focus groups included the following:

- Provide additional educational programs to Long Islanders on what “HOV” and the diamond symbol mean, as well as pertinent HOV regulations.
- Extend the HOV lanes to provide greater time savings and encourage more carpools.

- Encourage carpooling not only by promoting the HOV lanes but by placing emphasis on the benefits of carpooling, such as relaxing, socializing, financial savings, and not having to drive every day.

On the basis of these recommendations, it was decided to develop a comprehensive Island-wide "Travel Demand Management (TDM) Public Outreach and Education Program" which continues today with federal funding support. As it evolved, the program was also refined using input from additional focus groups.

A set of five (5) focus groups were conducted in February 1996, to investigate marketing strategies to help educate, gain more public acceptance of the HOV lanes and increase participation in using alternatives to drive-alone commuting. Focus group sessions were divided by age and type of employment (e.g., hourly or salaried employees).

Many participants expressed frustration with traffic congestion on Long Island. Generally, they were receptive to the idea of carpooling, provided they could find someone who lives nearby, works at the same location and has the same working hours.

Women participants said they liked the social aspect of "sharing rides;" however, they said they did not want to carpool with strangers. Older women participants expressed interest in mass transit (especially buses) because they didn't like driving in bad weather or heavy traffic. Younger drivers expressed more interest in social activities than making a commitment to carpool, as they juggled part-time jobs, school and recreation.

Subsequent focus groups were conducted in 1997 and in 1998 to test various marketing concepts and explore ways to motivate ridesharing among commuters and employers. Acceptance of carpooling was found to be driven by a variety of factors including:

- length of commute
- job function (sales jobs and executives were less interested in carpooling)
- accessibility and knowledge of carpool partner
- incentives - saving time and/or money, guaranteed-ride-home, preferred parking for carpoolers

The reasons expressed for not carpooling included:

- lack of control
- lack of convenience
- lack of flexibility
- concerns about commitment
- safety concerns

While "save-the-environment" promotional strategies were judged somewhat compelling, focus group participants said such messages were not strong enough to change driving behavior. According to focus group participants, the most compelling promotional messages would be:

- saving money and wear-and-tear on their cars
- decreasing stress associated with navigating traffic filled highways
- getting to work on time (reliability)

Employers did not indicate a strong sense of responsibility for helping to reduce congestion on the roadways by encouraging their employees to carpool or use other commute options. Nevertheless, they admitted that benefits might accrue from carpool programs. The benefits noted included:

- increasing pool of qualified candidates for employment
- enhancing their ability to attract and retain employees
- decreasing congestion on the road
- increasing on-time attendance
- increasing the number of available parking spaces

TDM OUTREACH AND PUBLIC EDUCATION PROGRAM

Using the information from these various focus groups, a continuing TDM Outreach and Public Education Program has been implemented. This provides educational programs and media promotions to increase public awareness of ridesharing and reinforce strategies to help reduce vehicle congestion during peak commuting periods. The program includes:

- Market research.
- General rideshare promotions involving radio, tv and print-ad campaigns conducted twice each year.
- Special radio, tv and print-ad campaigns for the LIE HOV lanes and the Suffolk Clipper Commuter Express (a high-quality commuter express bus demonstration project developed in conjunction with the HOV lanes).
- An annual "Thank-you-for-Ridesharing" event held at an area park-and-ride lot. This involves live radio, live music, prizes and information about ridesharing and the HOV lanes.
- The "Come Go With Me" poster contest conducted at Long Island's elementary schools to educate children about the benefits of ridesharing and using the HOV lanes. More than 1,000 poster entries are received each year. Winners are awarded prizes at the annual Thank-you-for-Ridesharing event.
- The Commute Alternatives Program (CAP) which provides employers with computer ridematching, commuter information kiosks, a guaranteed-ride-home program, and site-specific trip-reduction programs.
- Bi-monthly publication of the Commuters' Register, a free paper featuring articles about alternatives to driving alone and classified "carpooler wanted" ads.
- Rideshare promotional materials including brochures, calendars, posters, etc.
- An Ozone-Alert program which included development of a brochure for distribution to major employers to re-educate them about ground-level ozone and the importance of ridesharing to help reduce ozone. CAP-member employers are advised one day in advance of predicted "ozone-alert days." Variable message signs on area roadways are also used to advise motorists in advance of alerts and to encourage them to rideshare.

OPERATIONAL ISSUES

Enforcement

Effective enforcement of the LIE HOV-lane regulations has had a major effect on the success of the HOV lanes. When the planning for HOV-lane operation was begun, the LIE/HOV Task Force discussed at length many enforcement issues including the types of enforcement strategies that may be employed.

In 1992, the NYSDOT arranged a field trip to Los Angeles and Orange Counties, California for key stakeholders including representatives of the Nassau County and Suffolk County Police Departments, which have responsibility for enforcing traffic laws on the Long Island Expressway. In addition, a representative of the Automobile Club of New York (AAA) and representatives of NYSDOT participated in the field trip. An intensive 2-day seminar was conducted involving panel discussions, meetings and field observation of HOV-lane operation and enforcement strategies. Due in large measure to the interest and dedication of Caltrans and the California Highway Patrol, who participated in the seminar, the success of the field trip was immediate: Those who attended became strong advocates of HOV lanes.

A report was prepared summarizing the lessons learned from the field trip. Presented to the LIE/HOV Task Force by the AAA representative, the report recommended a highly visible, dedicated enforcement strategy with a modest fine structure. It also recommended that HOV-lane violations should be differentiated into two types: occupancy violations and buffer-crossing violations. Both would be enforced using existing New York State laws. The Task Force agreed with the report and formally submitted a recommendation to the NYSDOT endorsing it.

The recommendation was implemented by the NYSDOT. By an executive order of the Department of Motor Vehicles, it was arranged that no “points” would be assessed on drivers’ records for occupancy violations; however, points would be assessed for buffer crossings, which were viewed as more serious safety violations. HOV-lane enforcement is accomplished via contracts with both county police departments. The contracts provide for dedicated, highly visible enforcement during weekday peak periods. The contracts, which are managed and administered by the NYSDOT, are financed with federal and state funds.

The effectiveness of the enforcement program is apparent. Peak period compliance with the 2-pus occupancy rule has consistently exceeded 95%.

Buffer Crossings

Buffer crossing violations are frequently reported by motorists (34% of respondents to the 1999 HOV-lane user survey said they observed frequent illegal buffer crossings and 44% said they observed occasional buffer crossings). However, attempts to document buffer violations by reviewing video tapes recorded at various locations along the LIE show few violations relative to the volume of vehicles using the HOV lanes. In terms of the number of tickets issued by police, the ratio of buffer-crossing violations to occupancy violations is about 1-to-5.

Passing in the HOV Lanes

Because of the single-lane-in-each-direction design, vehicles in the HOV lanes often travel in platoons with the leading vehicle setting the pace. No opportunities for passing within the HOV lanes are provided. One can argue that since average HOV-lane speeds are typically above the posted speed limit, there is no need for passing. Yet, 20% of the HOV-lane users surveyed in 1999 reported frequently being passed by cars cutting out and in across the buffer or using an entry or exit merging lane improperly; 56% reported being passed occasionally. One-third of the respondents reported that motorists frequently travel "too slow" in the HOV lanes. Informal observations have suggested that this may occur predominantly during off-peak hours or when the general-purpose lanes are operating without delays.

HOV-Lane Entry and Exit locations

A number of inquiries have been received about the location of HOV-lane entry and exit points. Some have questioned the limited-access design of the HOV lanes. The design policy that was adopted required restricting access to/from the HOV lanes to prevent cars from darting in and out of the HOV lane disrupting traffic flow and endangering drivers. In the interest of safety and operating efficiency, this design policy remains in effect. The selection of HOV-lane access locations was based on interchange volumes and future traffic projections established in the early 1990's. Current traffic data is being reviewed to help determine whether adjustments to the access locations may be necessary.

Pickup Trucks

A "No-Trucks-in-the-HOV-lanes" regulation was implemented when the HOV lanes first opened. Even though light-duty pickups have become the vehicle of choice for many vehicle owners and their families who use these vehicles exclusively for daily passenger transportation, the New York State Vehicle and Traffic Law (VTL) classifies all pickup trucks as "trucks." There is no differentiation in the VTL between a tractor-trailer combination and a small pickup truck—legally, both are trucks. Thus, police routinely ticketed pickup trucks in the HOV lanes even if they were occupied by two or more people. A number of complaints were received by the NYSDOT from pickup-truck drivers who wanted to use the HOV lanes legally.

Until recently, all pickups were also required by the Department of Motor Vehicles to carry "commercial" license plates. However, through the efforts of a state senator, who is a member of the LIE/HOV Task Force, these regulations were changed. The change enabled non-commercially-used "light-duty" pickup trucks to be registered as passenger vehicles. Acting on the recommendation of the LIE/HOV Task Force, the NYSDOT then changed the "no-trucks" signs to "No <u>Commercial</u> Trucks in the HOV lanes." Thus, most light-duty, personal-use pickups are now allowed to use the HOV lanes provided they also meet occupancy requirements.

Currently, during peak periods the number of light-duty, non-commercially-used pickup trucks on the LIE ranges between 200 and 300 per hour with only about 7% carrying two or more persons. However, this new regulation will provide a greater opportunity for new "pickup-truck carpools" to form.

HOV-lane Signing

In the 1999 HOV-lane user survey, 35% of the respondents said they misunderstood the HOV-lane signing. In response, the NYSDOT has utilized Variable Message Signs to help clarify messages and provide more detailed information.

Temporary Changes to HOV-lane Operating Rules

In case of accidents or other localized incidents, the police agencies have the authority to modify HOV-lane usage rules. In particular, police may temporarily divert general traffic into the HOV lane. However, when the operational effectiveness of the highway system is severely affected during an emergency (e.g., a major snowstorm), it may be appropriate to temporarily alter operating rules on a system-wide basis. Only the NYSDOT has the authority to modify HOV-lane usage regulations on a system-wide basis.

The NYSDOT established a policy to guide its decision-making about when to temporarily alter HOV-lane operating rules and how to notify police agencies, the media and the traveling public. The policy was developed to be consistent with the general direction provided by the LIE/HOV Task Force. The policy has been used only four times: twice during major snowstorms; once during a major airplane crash off the coast of Long Island; and once during a major forest fire. In all cases, the HOV lane regulations were re-established as soon as it was safe and practical to do so in order to maintain the integrity of the HOV lanes.

CRITICISM OF THE HOV LANES

The LIE HOV lanes have been criticized from a number of fronts. The claims made by detractors of the LIE HOV lanes are typical and they are often overstated. Some examples follow:

- The HOV lanes exclude the most prevalent class of vehicles (single-occupancy vehicles – or SOVs) during weekday peak periods when lane capacity is most needed, so the lanes should be opened to SOVs.
- They are not “filled” with cars.
- They don’t generate carpools.
- They are filled with “cheating SOVs.”
- No one can carpool on Long Island.
- HOV lanes are “excuses” for highway expansions.

However, the criticism has moderated over the past two years. One explanation is that the LIE HOV-lane monitoring program has enabled the NYSDOT to respond with up-to-date documentation showing the effectiveness of the HOV lanes. This information is regularly shared with the media at press events and it is used to develop educational messages for the TDM Outreach and Education Program such as:

- The HOV lanes have increased ridesharing.
- The HOV lane moves 50% more people than any regular lane during the peak hour.

- The HOV lane carries more than *one-third* of all the people using the LIE in the peak direction in *one-quarter* of the roadway during the peak hour;
- HOV-lane use continues to grow.
- The occupancy-violation rate is very low.
- There are more Long Islanders carpooling during the morning rush hours than Long Islanders traveling to work in Manhattan on the Long Island Rail Road, which is the busiest commuter railroad in the United States. (This fact was developed during a separate effort, the Long Island Transportation Plan to Manage Congestion - LITP2000.)

Another reason the criticism may have softened is that HOV-lane use has reached the point where it is obvious by casual observation that the lanes are being used by a growing and significant number of ridesharing people.

NYSDOT representatives have also participated on local tv news shows, which have provided another venue to widely share HOV data and to describe why the focus of efficient commuter transportation on Long Island should be on moving more <u>people</u> rather than just more vehicles. It was also explained that as carpooling increases the number of vehicles used decreases . . . The fewer vehicles there are on the roads, the less overall congestion and pollution there is . . . So everyone reaps the benefits of the HOV lanes whether they carpool or not.

In a February 2000 poll of 1,024 people on Long Island, conducted by *Newsday*, 41% strongly-favored and 16% somewhat-favored converting the LIE HOV lanes into regular traffic lanes. While it appears the majority has yet to swing over to favoring the HOV lanes, the gap is closing and the negativism is fading in degree.

CONCLUSIONS

By using its comprehensive HOV-lane monitoring program, the NYSDOT has publicly demonstrated the success of the LIE HOV lanes via press releases, the media, public events and its TDM Outreach and Public Education Program. Using up-to-date empirical data, this monitoring program has provided the means to help move the public and other stakeholders toward a better understanding of the LIE HOV lanes.

Periodic surveys, continuous HOV-lane and general-purpose-lane traffic volume data, together with regular field observations of occupancy rates, violation rates, safety and operational issues will continue to be employed. The information gathered will also be used to develop more effective promotional programs supporting ridesharing, transit and HOV-lane use.

Despite their success, it is likely that some criticism of HOV lanes will continue. It will be necessary to respond to critics with facts about HOV-lane effectiveness, while at the same time avoiding any temptation to “oversell” HOV lanes.

HOV-lane systems should be portrayed as one way to improve travel within congested corridors, but not the only way. Important objectives of HOV lanes that need constant reinforcement are:

- HOV lanes are lanes that are managed to provide an improved level-of-service for users.
- HOV lanes offer travel options in congested corridors.

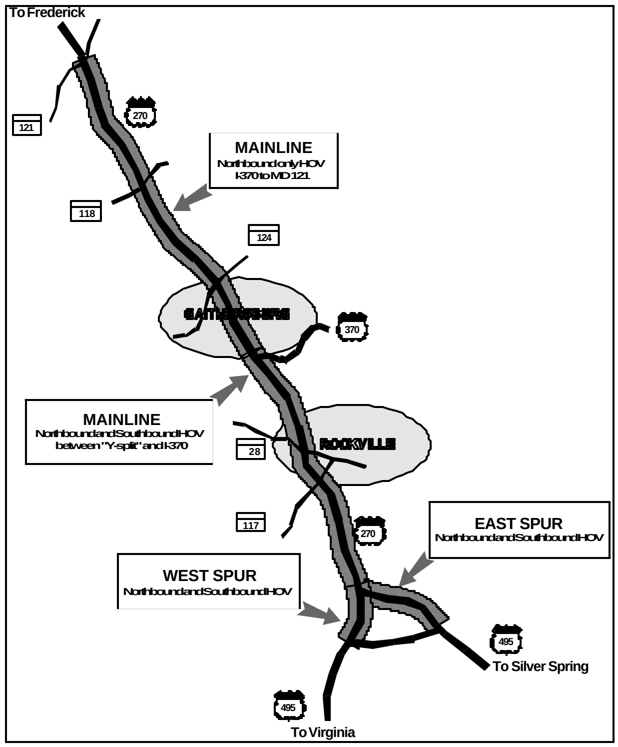
- HOV lanes move more people more effectively than general-purpose lanes during periods of peak travel demand.
- HOV lanes are catalysts for improving surface transit services and increasing ridesharing.
- HOV lanes manage system-wide congestion, but will not eliminate congestion.

Adopting a proactive program of public outreach and education about HOV lanes is a critical ingredient for success. Any criticisms of HOV lanes should be viewed as opportunities to share important facts. So, it is also important to always be prepared to respond quickly with current data about HOV-lane effectiveness and to also describe HOV-support actions that are provided such as carpool matching, park-and-ride lots and transit services.

REFERENCES

1. Bloch, M. Campbell Jackson, W. Ugolik, and M. Cooperman. Marketing a High-Occupancy-Vehicle Lane in a Suburban Setting: Long Island Expressway Experience. In *Transportation Research Record 1446*, TRB, National Research Council, Washington, D.C., 1994, pp. 38-43.
2. W. Ugolik, N. O'Connell, J. Gluck, and A. Sookram. Evaluation of High–Occupancy Vehicle Lanes on the Long Island Expressway. In *Transportation Research Record 1554*, TRB, National Research Council, Washington, D.C., 1996, pp. 110–120.

Maryland's High Occupancy Vehicle (HOV) Lanes: Who is Using Them and Why?



By

Michelle D. Hoffman

Maryland State Highway Administration

ABSTRACT

The purpose of this paper/presentation is to determine if there is a disproportionate share of individuals utilizing the restricted HOV lanes in the I-270 Corridor in Maryland. Who is using the HOV lanes on I-270 and why? It is important to understand the long-term trends for carpooling in order to determine the future of the HOV lanes. Understanding the characteristics of the HOV lane, or carpool users, will provide insight into how to best create future transportation system and demand management improvements.

Data was gathered for I-270 by the Maryland State Highway Administration (SHA) using a license plate survey (October/early November, 1999) at three locations on I-270. Three high speed video cameras collected license plate information over five days (October 10, 19, 21, 22 and November 11, 1999) in both the morning (6:00 – 9:00 AM) and evening (3:30 – 6:30 PM) peak period of both HOV and non-HOV users. A survey/questionnaire was distributed in November/December (1999) to a stratified random sample of 7,002 addresses, of which 6,556, or 94%, were deliverable by the post office and 1,028 responded (16% response).

The I-270 Survey has helped to better understand who is utilizing the I-270 Corridor. Socio-Demographically, we have learned that gender, education, age, and employment characteristics do not impact carpool decisions on I-270, since men and women are using the facility equally, regardless of their employer, education level or age. While federal government employees might be more inclined to carpool, this did not show enough differentiation to statistically factor into why motorists are carpooling on I-270.

To understand why motorists are carpooling, the I-270 Survey tried to discern the motivating factors for motorists to carpool in the HOV lanes. Similar to the national trend, both origins and destinations have spread throughout the suburbs of the I-270 Corridor. Only 8% of the destinations were to Washington, DC, a metropolitan area which once was the major employment center for the region. Now jobs have followed households into the suburbs of both Maryland and Virginia. Most motorists are traveling I-270 alone (86%) more than five days per week (75%). The survey showed that both trip time and trip length did not factor into the decision to carpool, with over half of the respondents not willing to convert to a carpool regardless of any travel time savings. The last factor, income, seemed to have a small variation amongst motorist's tendency to carpool, but only by approximately 5%, not enough to show a statistical difference.

In the end, the survey showed us that the trip making characteristics are not altered based on trip time, trip length, travel time savings, or income. In fact, carpools along I-270, similar to the national trends, are likely being formed based on multiple worker households who have convenient destinations. The two most significant factors attributing to this trend are the spreading development densities and the complex commuting patterns driven by the need for commuters to "trip chain."

The survey also helped highlight motorists motivations to carpool and attitudes towards HOV lanes. Motivators included only the guaranteed ride home program and improved trip time reliability (and then only HOV lane respondents). Respondents indicated that increased parking costs would not have an appreciable impact. It was also helpful to understand that there was not

much support, regardless of HOV lane use, for allowing certain classes of single occupancy drivers, such as Inherently Low Emission Vehicles (ILEVs) or emergency staff, to use the HOV lanes. Finally, we learned that the vast majority of respondents, regardless of occupancy, were in favor of the option of allowing SOVs to pay a minimal ($1.00 – $2.00) fee to use the HOV Lanes.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

ACKNOWLEDGEMENTS

I would like to take this opportunity to express my gratitude for the guidance and assistance of a few individuals and companies who have contributed to the effort involved in completing this report.

- Neil J. Pedersen of the Maryland State Highway Administration who provided motivation, guidance, technical assistance and an unbiased review,
- George Walton of Parsons Brinckerhoff, Quade and Douglas, Inc., who provided technical assistance and an unbiased review,
- Robert Ritter of the Eno Transportation Foundation, Inc., who also provided an unbiased review, and
- The Maryland State Highway Administration, Parsons Brinckerhoff, Quade and Douglas, Inc., Pacific Rim Resources, and Daniel Consulting, Inc., who made the I-270 survey possible.

CHAPTER 1: INTRODUCTION

1-1: Overview

High Occupancy Vehicle (HOV) lanes are restricted lanes, which have been reserved for vehicles that maximize their occupancies or passengers, such as carpools, vanpools, buses and motorcycles, during designated time periods. Therefore, by definition, HOV lanes move more people than a general-purpose lane, and are critical where there is a high traffic demand, to move more people in fewer vehicles. Often, HOV lanes also provide a reduced and more predictable travel time. In order to initiate a high occupancy vehicle or carpool, individuals must be able to creatively find someone with similar origins (home) and destinations (work), similar work hours, as well as similar dispositions (especially for longer journeys) (Pedersen, 1999).

HOV lanes currently exist on I-270 mainline and the spurs in Montgomery County, Maryland. Along I-270, special signs noting "HOV-2", as well as special striping and diamond markings, are evident along the northbound and southbound left lanes. Please refer to Figure 1.

Figure 1: I-270 HOV Lanes Looking North

Data on the traffic volumes, automobile occupancy rates and violation rates have been collected semiannually since early 1997. This semiannual data on the I-270 HOV system shows that this system is meeting national performance criteria and is considered a success. For example, nationally accepted performance criteria for HOV lanes include a travel time savings of one minute per mile and a person demand that exceeds the adjacent general-purpose lanes, based on the type of facility (Walton, 1999). The automobile occupancy rate on I-270 has been, and continues to, gradually increase, as do the number of carpools.

This carpool trend on I-270 in Maryland, similar to the national carpool trend, has been on the decline (Reid, 1998), changing from 17 percent in 1980 to 15 percent in 1998. Despite this decline, HOV lane systems are being developed and expanded along most metropolitan areas, including the Washington metropolitan area and more specifically, the I-270 Corridor, in an effort to optimize transportation systems and move "people" more efficiently. It is estimated that over 1,200 miles of

Figure 2: I-270 HOV Lanes Looking North

HOV lanes exist in the United States (Cervero, 1999).

Is there a disproportionate group of individuals utilizing the restricted HOV lanes in the I-270 Corridor? (Please refer to Figure 2 displaying the I-270 facility with the morning peak period HOV lanes in the left, or inside, lane.) More specifically, as claimed by the public, do government workers, two income families, families with school children and people with standard 9-5 jobs, have a better opportunity or preference to use the I-270 HOV lanes (Weisman, 1998). Who is using the HOV lanes on I-270 and why?

It is important to understand the long-term trends for carpooling in order to determine the future of the HOV lanes. The metropolitan areas cannot continue to widen their facilities endlessly because of environmental, physical and fiscal constraints. Figure 3, to the right, shows the I-270/US 15 Multi-Modal Corridor Study, a Maryland initiative to plan for highway and transit improvements. Furthermore, small system and demand management improvements, while important, cannot reduce congestion alone. Therefore, all transportation strategies must be implemented in collaboration to create the most efficient transportation systems. Understanding the characteristics of the HOV lane, or carpool users, will provide insight into how to best implement some future transportation system and demand management improvements.

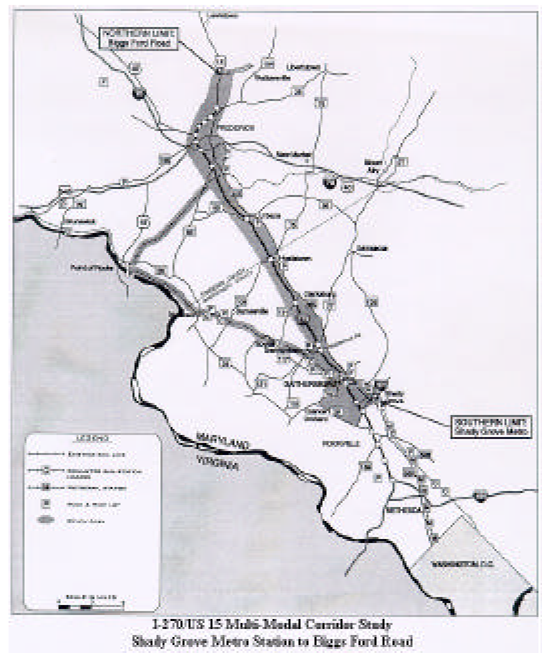


Figure 3: I-270/US 15 Corridor Study

This report will first discuss the importance of this research for transportation planning and how the survey was conducted (Chapter 1: Introduction). Then in Chapter 2 (Commuting Trends in America), this report will outline national commuting trends and in Chapter 3 (Carpooling Patterns in America), it will outline national carpooling patterns, including the socio-demographical and trip making data of who is carpooling and why. Next, this document will describe HOV lanes (Chapter 4: HOV Lanes) and, more specifically HOV lanes in Maryland on I-270 (Chapter 5: I-270 HOV Lanes). Ultimately, this report will discuss the results of the survey on I-270 in Maryland (Chapter 6), relating the data to the national trends and concluding with (Chapter 7) what these survey results have taught us and how they might be applied to future evaluations or transportation plans.

<u>1-2: Literature Review</u>

Research methods included use of the Internet, searching sites such as the National Transportation Library and the Transportation Research Board. In addition, the following publications were reviewed: the Institute of Transportation Engineers Journal, the Transportation Journal, the Transportation Research Journal, Transportation Quarterly, and the Journal of American Planning Association.

Except for the articles shown in the bibliography of this report, there are very few articles on specifics of the nation's HOV lanes. The only three articles found on this subject (listed in the bibliography) include a study conducted in Southern California of 15 vanpool programs (Ferguson, 1993), a 1987 survey on carpool behavior on Route 55 in Orange County, California (Guiliano, 1990) and a 1977 Shirley Highway (I-395) evaluation of carpool trends (Virginia Department of Transportation, 1977). None of these reports distinguished a relationship between the general-purpose lanes and HOV lanes to clearly correlate who (socio-demographically) is using the HOV lanes, compared to adjacent mixed use lanes, and why, their motivation. Further evaluation of carpool trends, using several documents from the Eno Transportation Foundation, Inc. and articles and papers, mostly research by Erik Ferguson (1990, 1994, 1997), Robert Poole, Jr. (1999) and Roger Teal (1987), hypothesized on why people carpooled. This research, however, did not have statistics related to existing HOV lanes.

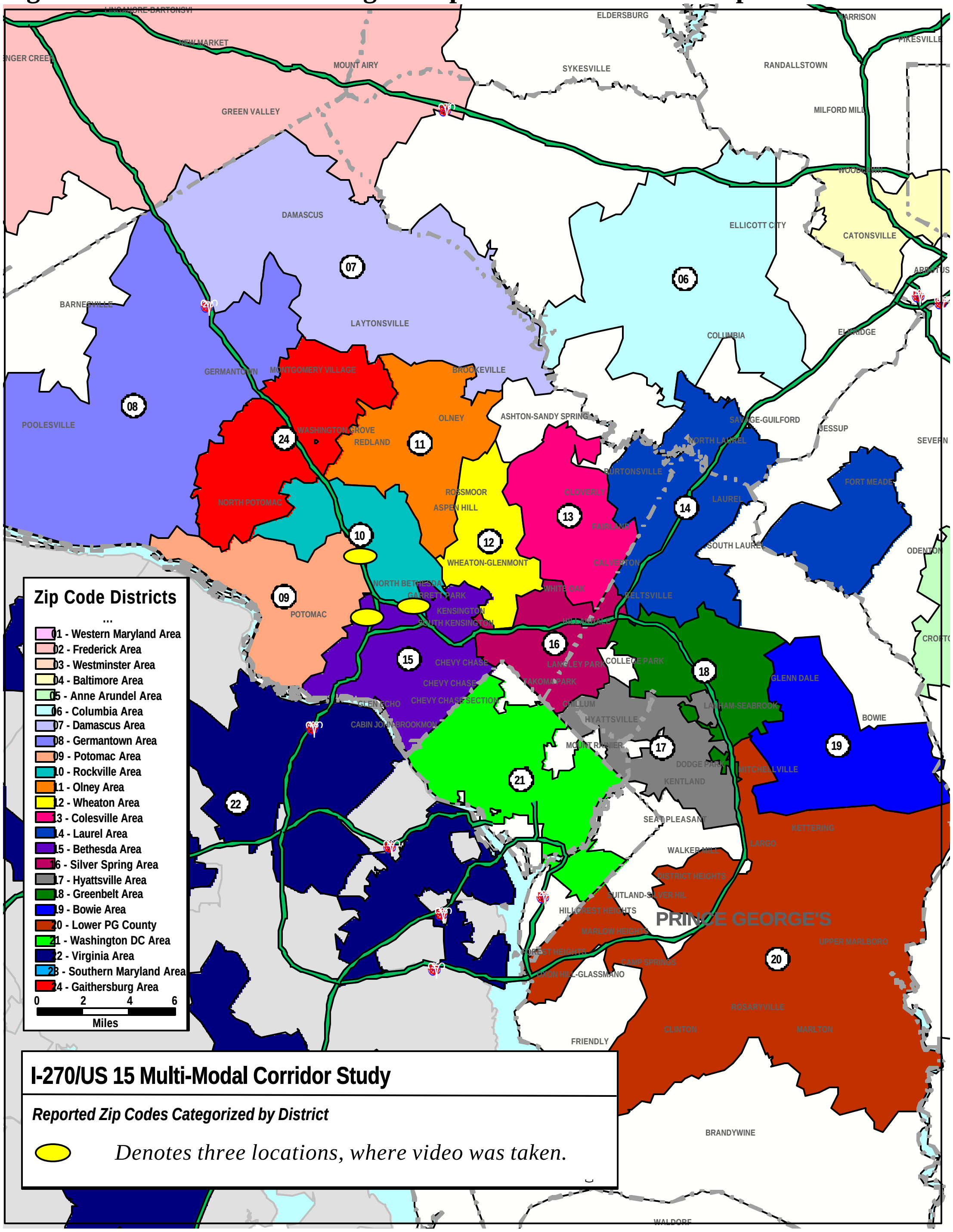
Therefore, this paper serves to report on actual relationships between mixed use general-purpose lanes and HOV lanes on I-270 to discern who is carpooling and why. It is important to understand the differences, if any, in order to pursue additional transportation infrastructure or transportation policy, not just in Maryland, but hopefully these lessons learned can be applied nationally.

1-3: Methodology

Trends on specifically who uses the HOV lanes are scarce. While there are statistics on travel demand methodology for who could use the HOV lanes, based on average automobile occupancy rates, data should be gathered on the demographics of the area, including who could and would carpool, particularly on the I-270 HOV lanes.

This data was gathered for I-270 by the Maryland State Highway Administration (MD SHA, 2000) using the following methodology. A license plate survey was conducted in October/early November, 1999 using three high speed video cameras. License plate information was collected using video play back at the following three locations: on I-270 mainline (formerly east spur) south of Montrose Road; on the I-270 spur (formerly west spur) south of Montrose Road; and on I-270 just north of I-370.

Figure 4: I-270 with Surrounding Transportation Network and Zip Codes



This captures data on three major catch points of the I-270 HOV system, as shown on Figure 4. The video taping, which was gathered over five days (October 10, 19, 21, 22 and November 11, 1999) in both the morning (6:00 – 9:00 AM) and evening (3:30 – 6:30 PM) peak period, was transcribed into a database of 20,441 readable license plates of both HOV and non-HOV users. Through coordination with the Maryland Motor Vehicle Administration (MVA), SHA received and compiled a list of corresponding addresses for these high occupancy and low (single) occupancy (LOV/SOV) vehicles.

A questionnaire was developed with 23 questions to better understand who was using the HOV lanes and the opinion of commuters, both HOV and non-HOV users, of their commute on I-270, of the HOV lanes, and on what would motivate them to carpool. This questionnaire, which was prepared by Pacific Rim Resources, Inc. for the Maryland State Highway Administration to create an unbiased survey, was distributed in November/December, 1999 to a stratified random sample of 7,002 addresses, of which 6,556, or 94 percent, were deliverable by the post office. Please refer to the Appendix to see the questionnaire. In order to ensure validity of the random sample and the 1,028 respondents (16 percent response), the following precautions were taken:

- There is no known bias in the videotape reading of license plates. Everyone traveling on the three sections of I-270 had an equal opportunity of being caught on the videotape.

- The number of surveys distributed and returned per each section of roadway, as shown in Table 1, were in proportion with the percentage of actual traffic on I-270.

Table 1: Mailed Sample Percentages vs. Actual Traffic Percentages

Road Section	Percentage of Actual Traffic	Number in Mailed Sample	Percentage in Mailed Sample
East spur	24%	1,634	23%
Main line	49%	3,363	48%
West spur	27%	2,005	29%

- There is no known significant response bias. As shown in Table 2, the number of surveys returned by road section is proportional to actual traffic count proportions.

Table 2: Returned Sample Percentages vs. Actual Traffic Percentages

Road Section	Percentage of Actual Traffic	Number of Usable Surveys	Percentage in Sample
East spur	24%	212	21%
Main line	49%	495	48%
West spur	27%	321	31%

Consequently, the margins of error were within the acceptable limits (+/-3.06 percentage points for all three sections combined) for this random sample to ensure 95 percent confidence that we would have the same results if everyone traveling the roadway would have received a survey. Please refer to Table 3.

Table 3: Sample Margin of Error by Road Section

Road Section	Number of Usable Surveys	Margin of Error
All sections combined	1,028	± 3.06
East spur	212	± 6.73
Main line	495	± 4.40
West spur	321	± 5.47

Since only one general-purpose lane (out of two or more general-purpose lanes) and the HOV lane were surveyed in each section, weighting of the data was necessary to adjust for the high percentage of HOV lane user respondents (48.2 percent). A weighting factor was applied to correlate the results with the actual percentage of HOV and non-HOV users during the peak periods (12.9 percent HOV users and 87.1 percent non-HOV users) (MD SHA, 2000). Therefore, a weighting factor of 0.267 was applied to each HOV lane respondent, while a weighting factor of 1.684 was applied to each non-HOV lane respondent.

Table 4: Trip Frequency Weighting Factor Calculations

a.	Percent of unique license plates in survey	93%
b.	Percent of duplicate plates eliminated	7%
c.	Surveys reporting multiple trips per week	935
d.	Total surveys used in the analysis	1,028
e.	Adjusted survey total (d/a)	1,105
f.	Percent of multiple trips per week (c + [e-d]/e)	92%
g.	Weighting factor (1 + [e-d]/c)	.08

Please note that, for the purposes of this report, statistical analyses were conducted with SPSS (Statistical Package for the Social Sciences) version 10. Furthermore, differences between groups are considered to be significantly different when the differences are at the .05 level of statistical significance or better (MD SHA, 2000).

The survey/questionnaire included 23 questions on the following topics to determine differences between trip and characteristics of HOV and non-HOV lane users:

- Number of vehicle occupants;
- Length and duration of the trip;
- Socio-demographic characteristics;
- Trip purposes;
- Frequency of I-270 use;
- Carpool/HOV lane motivators and detractors; and
- Origins/destinations on I-270.

The survey questionnaire used for the I-270 HOV study is presented in the Appendix. The responses were then tabulated to determine the demographics of the HOV and SOV lane users.

CHAPTER 2: COMMUTING TRENDS IN AMERICA

Commuting in America seems to follow the trends of the economy. In the Second National Report on Commuting Patterns and Trends by the Eno Transportation Foundation, Inc., *Commuting in America II*, Alan Pisarski relays past and current trends on commuting patterns based on overall growth and economic patterns in the United States (Pisarski, 1996). The 1996 Eno Report states that large increases in commuting and transportation needs in the 1970s and 1980s are due to the Worker Boom, the Private Vehicle Boom, and the Suburban Commuting Boom (Pisarski, 1996).

The surge in the work force occurred as a result of the baby boom and the soaring involvement of woman into the work force, referred to as the Worker Boom. Between 1950 and 1990, the United States experienced a doubling of workers in the nation, with an increase in female workers from 30 to 45 percent. However, even though the Worker Boom started to decline in the 1980s and followed suit in the 1990s, Pisarski (1996) believes that we will still feel the affect of the strong growth rates of the past decades for many years into the future.

During the height of the Private Vehicle Boom in the 1980s, more vehicles were added to the nation than people were added to the nation's population. The number of commuters using single occupancy vehicles (SOVs) outnumbered the total increase in commuters by approximately 3 million. In the 1980s, only one out of every ten vehicles had an occupant other than the driver. With such a large increase in SOVs, other modes of transportation began to decline, including a significant decline in walking and carpooling, and a less significant decline in transit, with one out of every twenty commuters using transit. At the close of the 1990s, the report statistics showed some decline in vehicle ownership and in the ratio of vehicles to workers (Pisarski, 1996).

The Suburban Commuting Boom began in the 1960s, however the trend to live and work in the suburbs has continued at an accelerated rate. In the 1990s, the dominant commuting pattern was suburb to suburb, with 50 percent of the nation's commuters residing in the suburbs and 41 percent working in the suburbs (Pisarski, 1996). While the "traditional commute" has always been suburb to central city, the "reverse commute," where one commutes from the central city area to the suburb, has grown capturing 12 percent of the commuter share in 1990, while the traditional commute is down from 25 to 20 percent in 1990 (Pisarski, 1996). Intermetropolitan commuting from suburb to suburb of another metropolitan area ("cross-suburb commuting") has shown tremendous growth, growing twice as much as a standard suburb to suburb commute in 1990. The Washington, DC area, between 1980 and 1990, showed a 20.67 percent growth in population, a 34.51 percent growth in workers and a 41.38 percent growth in suburban workers.

Even though automobile ownership may slightly decline, it will likely not affect the carpooling, walking or transit modes. The need for the automobile flexibility are too great, stressed by America's desire to live and work outside of central cities (in suburbs), America's need to combine trips ("trip chaining") based on multi-worker household pressures on time, and the low cost to own and maintain a vehicle.

Therefore, it is important to understand the history of carpooling in America. Carpooling first appeared in the United States during the 1940's in response to oil and rubber shortages during World War II (Ferguson, 1997). However, with the War and fuel shortages no longer an issue, carpooling disappeared, only to reappear during the oil crisis of the 1970s. It was in the 1970's that a few carpool lane demonstration projects were first implemented. However, the late 1980s and into the 1990s showed a rapid decline nationally in carpooling by approximately one third, from 19.7 percent to 13.4 percent (Pisarski, 1996). Washington, DC, which has traditionally been considered a leader in carpooling, also showed signs of decline from an average vehicle occupancy rate of 1.23 to 1.21 for the region (Pisarski, 1996). The decline in carpooling can be linked to the surge in private vehicle ownership, the suburban shift in commuting patterns, and the need for multi-working households to combine trips serving the household (food shopping, dry cleaners, child care, medical, automobile repair) with trips to/from work (commuting), called "trip chaining" (Pisarski, 1996).

CHAPTER 3: CARPOOLING PATTERNS IN AMERICA (WHY & WHO)

3-1: Overview

As mentioned earlier, carpooling as a commuting mode share, has declined by approximately one third (19 million carpools in 1980 and 15.4 million carpools in 1990 nationally), while total commuting numbers have increased by over 18 million (Pisarski, 1997). More specifically defined, two person carpools decreased by ten percent and carpools with three of more people decreased by 50 percent. Alan Pisarski (1997) explains that, since carpooling has become, almost exclusively, a household activity, carpooling will decline based on the country's trend to have smaller families who have one or more vehicle per household. He further states that there are in fact three types of carpools, the Household Carpool, the Cost-Driven Carpool, and the Congestion-Driven Carpool.

The Household Carpool is typically comprised of two people, largely husbands and wives or two adult, family members, residing in one household who are able to travel together due to the fact that their jobs are convenient to one other. Pisarski (1996, p.31) states that "seventy percent of workers live in households of two or more workers." The Cost-Driven Carpool is usually comprised of a longer commuting distance, with two or more members who are not necessarily family members. This carpool or vanpool is generally formed to enable the multiple carpool members to share costs or to keep each other company for the long trip, generally between metropolitan areas or from one metropolitan suburb to the central city. The Congestion-Driven Carpool is usually a smaller, two person carpool, for the purpose of taking advantage of carpool strategies, such as HOV lanes, or supporting measures (special HOV ramps, parking advantages), on a congested facility. The Congestion-Driven Carpool could also incorporate cost savings. It is important to note that every time a carpool is formed it costs the carpoolers time and money in that, according to the 1990 Census data, about five minutes are added to the commute time per each additional carpool member (Pisarski, 1997).

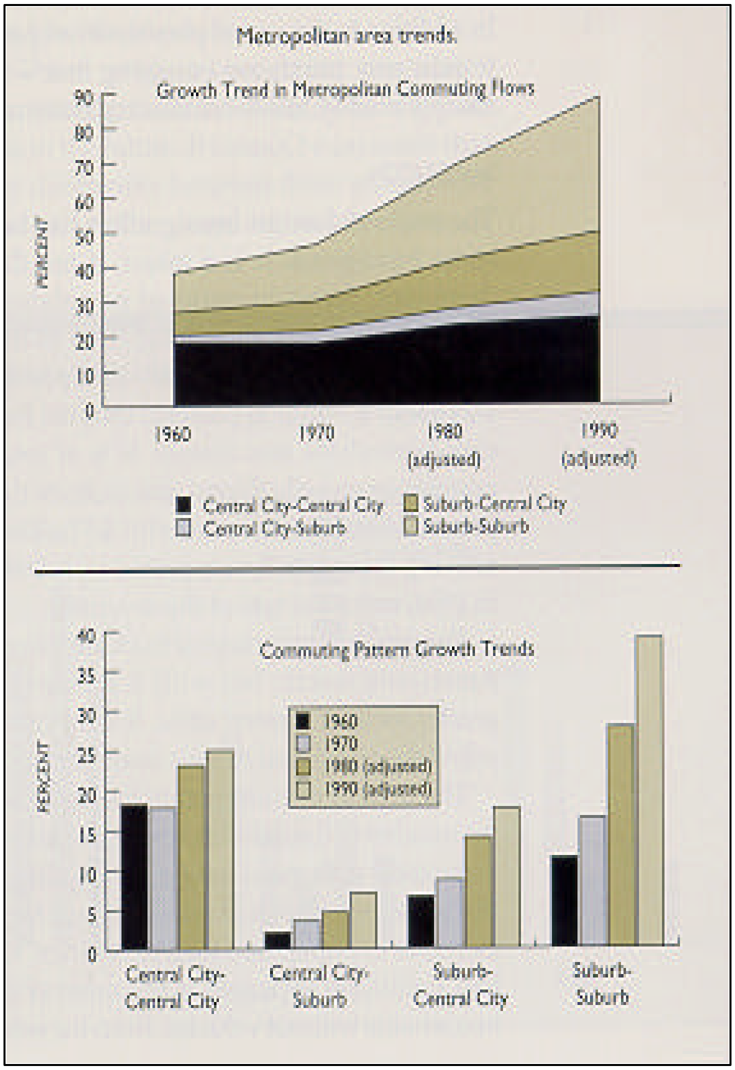
There is some debate over whether "who" is carpooling affects "why" they carpool. While researchers seem to agree that the trend is for most carpools to be comprised of household or family members, there is less statistically significant data showing that age, education, income or ethnicity factor into why individuals carpool. Erik Ferguson outlines in *The Rise and Fall of American Carpool: 1970-1990* (1997) that certain lifestyles and demographic configurations in America have made the formation of a carpool less likely, or more difficult, over the past two decades. He insists that this can be attributed to development densities, increases in family incomes, automobile availability, and women in the workforce. Others agree, as well as add other reasons for why individuals carpool.

3-2: Trip Making Characteristics

3-2-1: Development Densities

The decline in the urban development densities as development spreads throughout suburban and exurban areas makes it more difficult for the formation of carpools (Ferguson, 1997). Pisarski (1996, p.18) highlights in *Commuting in America II* that the "suburban share of total national population continues to grow – from 43% to 47% between 1980 and 1990… while the central city share of population declined to 29%," as shown in Figure 5. Therefore, the suburbs are now comprised of half of the total workforce. Consequently, carpools, as mentioned earlier, are more difficult to form when origins and destinations are widely dispersed in the suburban areas, as is the trend.

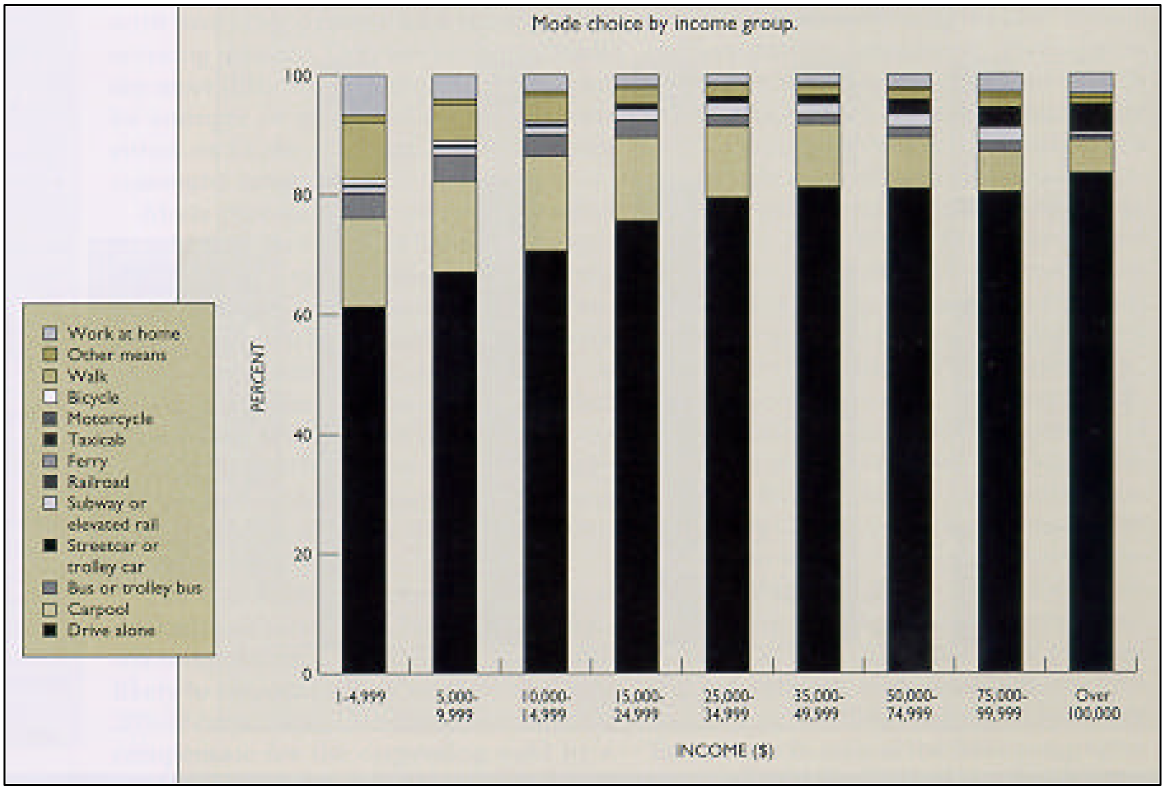
Figure 5: Metropolitan Area Commuting Trends



3-2-2: Income

Pisarski (1996) found that as the level of income increases, so does the tendency to drive alone, as shown in Figure 6. Furthermore, Roger Teal (1984, p.204) in *Carpooling: Who, How and Why*, states that researchers have shown that "lower income, lower automobile ownership levels and multiple worker households" can increase the tendency to carpool.

Figure 6: Mode Choice by Income Group[1]



3-2-3: Automobile Availability & Ownership

Pisarski (1996, p.32-33) states that "although population grew by less than ten percent and households by about 14% between 1980 and 1990, total vehicles available to households jumped by over 17%." Furthermore, he states that the "majority of one-worker households have one or more vehicles, the majority of two-worker households have two or more vehicles, and the majority of three-worker households have three or more vehicles." This shows that multiple worker households are most likely to carpool if their destinations are convenient to each other. If their destinations are not convenient, then the cost and automobile ownership is low enough to dissuade or discourage carpool formation.

3-2-4: Travel Times and Trip Lengths

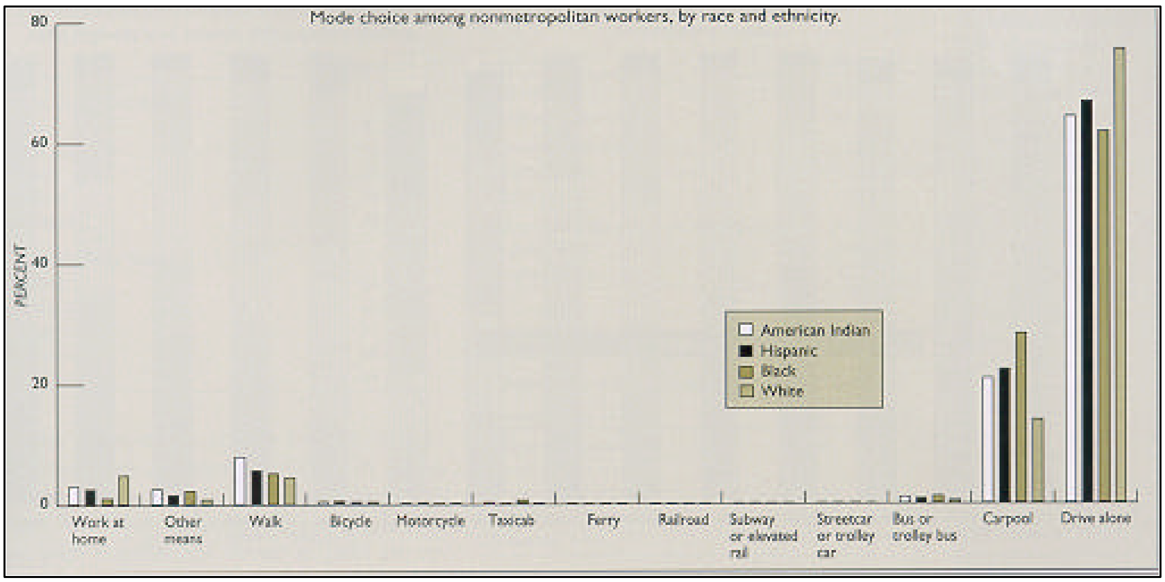
Pisarski (1996, p. 91) states that "contrary to conventional wisdom, travel times have not changed much, despite large increases in commuting, particularly with private vehicles." Between 1980 and 1990, the average travel time for the Washington metropolitan area changed from approximately 27 (+/-) minutes to 29 (+/-) minutes, which is consistent with the national average travel time increase of 40 seconds (from 21.7 minutes to 22.4 minutes). Washington, DC was one of only three areas (the other two being Chicago and New York City) that had a rate in 1990 of ten percent or more commuters traveling for more than an hour (the national average for commutes over an hour was 6 percent). Therefore, those individuals with longer travel times might be more likely to carpool, based on the cost-driven carpool, or possibly on I-270, the congestion-driven carpool, due to the existing HOV lane incentives.

3-3: Socio-Demographic Characteristics

3-3-1: Race and Ethnicity

Any variations in carpool formations based on race and ethnicity, according to Ferguson (1997), can only be attributed to factors, such as family income, automobile ownership, household size and composition, and development densities. Travel preferences are not based on race and ethnicity. Ferguson (1997) did find, as was reflected in *Commuting in America II* (Pisarski, 1996), that Black and Hispanic commuters had very low rates of automobile ownership nationally (30 percent and 19 percent, respectively), particularly in metropolitan areas. Washington, DC, specifically, has a high rate of Black households who do not own vehicles (43 percent). This could also correlate with Pisarski's findings (1996) that Black nonmetropolitan residents showed a stronger tendency to carpool, as shown in Figure 7.

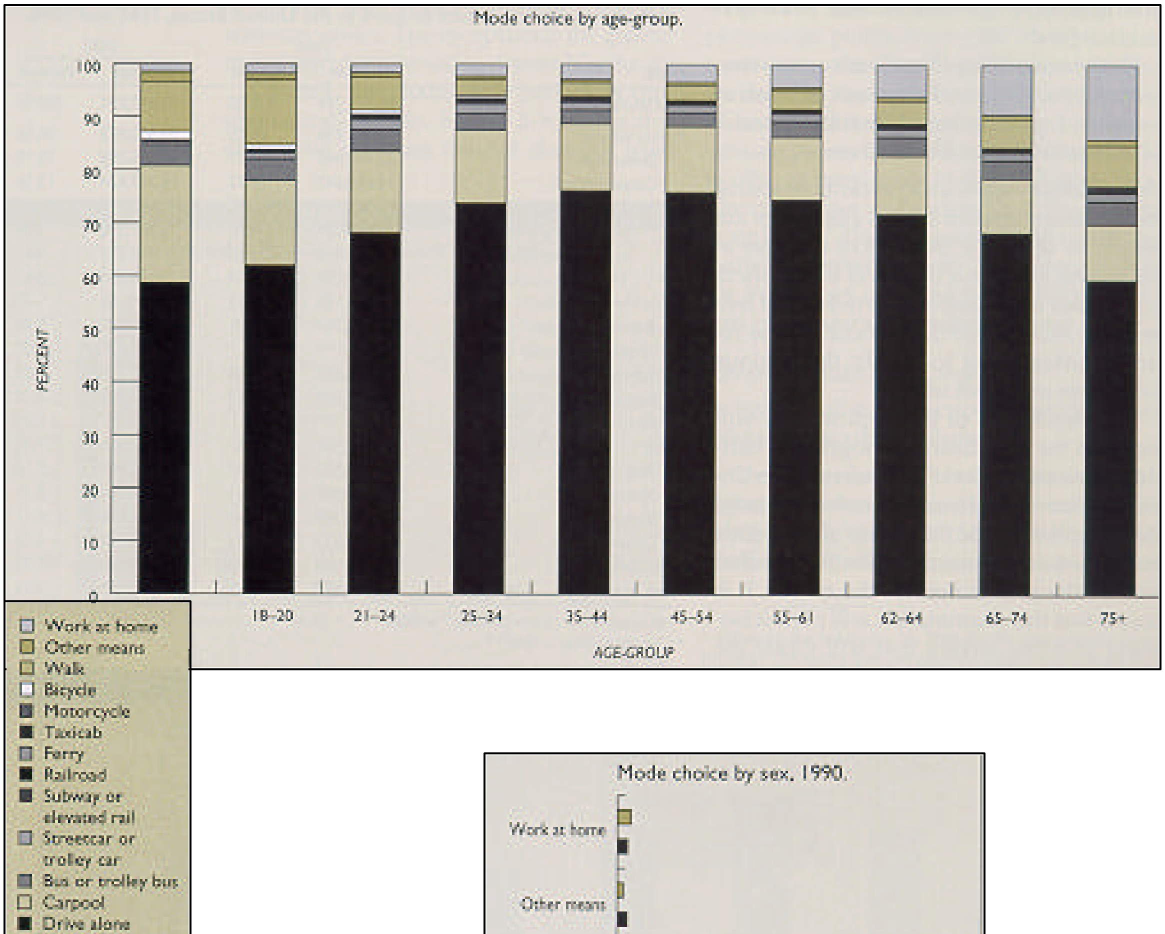
Figure 7: Mode Choice By Race and Ethnicity[2] (nonmetropolitan areas)



3-3-2: Age and Education

Age and education should also not have an effect on carpool formation, according to Ferguson (1997). Pisarski (1996) states that as people age, they are less likely to drive, preferring to walk or work at home, when available to them. Figure 8 reflects the national tendency to drive alone (1990) for most workers, age 25-61.

Figure 8: Mode Choice by Age-Group[3]



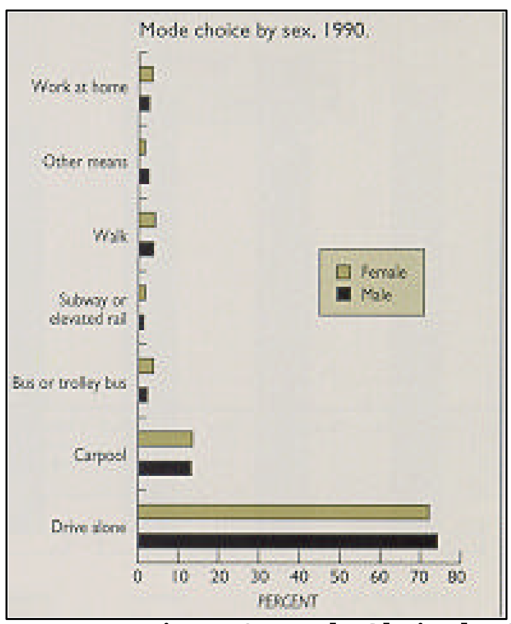


Figure 9: Mode Choice by Sex, 1990[4]

3-3-3: Women and Men in the Work Force - Gender

Female workers help to increase family incomes, automobile ownership, and foster the lifestyle necessary to include "trip chaining" in daily commuting patterns. The rate of women in the workforce in 1990 continued to increase, whereas the rate of men joining the workforce showed some decline (Pisarski, 1996). In 1990, women's share of total employment had increased to 45 percent (from 30 percent in 1950). Of married women in the workforce, the majority have children (Pisarski, 1996). With less flexibility and greater demands on their time, working women with children are unlikely to form carpools unless with a family member due to the need to combine house and work related trips. It appears that both men and women share complex commutes and "trip chaining," since Pisarski (1996) found that men and women have virtually no statistical difference between their tendencies to carpool or drive alone, as shown in Figure 9.

CHAPTER 4: HIGH OCCUPANCY VEHICLE, OR CARPOOL, LANES

Figure 10: I-405 HOV Lanes in California

A High Occupancy Vehicle (HOV), or carpool, lane is a transportation demand management strategy, which converts an existing lane or adds a lane for the exclusive, restricted use of high occupancy vehicles (HOV) or vehicles carrying two or more people. Please refer to Figure 10 of the I-405 HOV lanes in Orange County, California. HOV lanes, also known as carpool, commuter and express lanes, are reserved for carpools, vanpools, buses and motorcycles during designated time periods, typically during the peak commuting period, although some HOV lanes enforce their occupancy restrictions all day.

The goal of an HOV lane is to provide buses, carpools, and vanpools with a travel time savings, as well as a more predictable commute, thereby increasing the person throughput of a transportation facility and enabling single or low occupancy vehicles with an incentive to change their commuting patterns. Many carpools, as mentioned in the previous section, are formed by family members and co-workers. In Houston, Texas, a survey showed that family members comprised between 56 and 65 percent of the carpools, co-workers comprised 25 to 32 percent of the carpools, and neighbors or other individuals comprised the remaining eight to thirteen percent (Pratt, 1999).

Figure 11: I-66 HOV Lane in Virginia

HOV lanes move more people because of their higher vehicle occupancies. HOV lanes in Maryland are designated as HOV 2, meaning motorists, other than motorcyclists, must carpool with at least one other person to use the HOV lane (MD SHA, 1996). Another HOV 2 facility, I-66 in Virginia, is shown in Figure 11 above. Where the traffic demand is projected to increase beyond the capacity of the existing general-purpose lanes, HOV lanes are important to move more people in fewer vehicles. They also provide a reduced and more predictable travel time.

California and Virginia were two of the first states to implement these restricted HOV lanes in the 1970s – California as an HOV 3+ facility and Virginia as an HOV 4+, or bus, facility. In order to initiate a high occupancy vehicle or carpool, individuals must be able to creatively find someone with similar origins (home) and destinations (work), similar work hours, as well as similar dispositions (especially for longer journeys) (Pedersen, 1999).

Now that HOV lanes have been in effect and under evaluation for almost two decades, several individuals and organizations have begun to question whether HOV lanes are in fact achieving their goal. Conceptually, HOV lanes would encourage ridesharing, increase vehicle occupancies, and promote the objectives of reducing travel delays and air pollution (Poole, Jr., & Orski, 1999). Complaints include "empty" HOV lanes next to overly congested general-purpose lanes. Carpools are now more frequently made up of family members with similar destinations due to the ever-growing complexities of travel patterns (Poole, Jr., & Orski, 1999). An HOV lane is considered underutilized or "empty" when it "fails to carry at least an equal number of people as an adjoining general-purpose or mixed-flow lane" (Poole, Jr., & Orski, 1999, p. 11). An HOV lane needs to have a minimum of 700-800 vehicles per lane per hour or 30-45 bus vehicles per lane per hour (in order to carry the same number of people as the adjoining general-purpose lane carrying 1,500-1,800 vehicles per lane per hour). This assumes an average automobile occupancy rate for the carpools of 2.1-2.2 (persons per vehicle). It must be noted that if the adjoining general-purpose lanes are significantly congested with over 2,000 vehicles per lane per hour, the HOV lane could be perceived as a failure or "empty" even if it is carrying 1,200 vehicles per lane per hour (Poole, Jr., & Orski, 1999, p. 11). Therefore, the HOV lanes only offer an incentive if the HOV lanes are uncongested, but not "empty," and the adjoining general-purpose lanes are congested. Please refer to Figure 12 above of the evening peak period of the I-270 Corridor, including the HOV lanes.

Figure 12: I-270 Corridor in Maryland

Robert Cervero (1999) states that carpooling appeals ideologically to almost everyone, including environmentalists who agree with moving more people, not vehicles, and economists who agree with marketing and using the empty vehicle capacity. However, HOV lanes have been implemented throughout the nation to some protestation. Currently, there is close to 1,200 lane miles designated for the exclusive use of High Occupancy Vehicles nationwide (Cervero, 1999). Some may argue that HOV lanes provide a more efficient use of the existing transportation system, while others may argue that HOV lanes are only "stealing" carpoolers and transit users from other facilities or different times of the day (Giuliano, 1990). Regardless of whether the HOV lanes are effectively converting new carpools, it is important to understand "who" is using these lanes and "why," particularly if the goal is to maintain and improve these existing HOV lanes in order to achieve the overall transportation goal of moving people effectively.

CHAPTER 5: I-270 HOV LANES

Figure 13: I-270 HOV Lanes Looking North

High Occupancy Vehicle (HOV) lanes currently exist on I-270 mainline and spurs in Montgomery County, Maryland. Along I-270, special signs noting “HOV-2”, as well as special striping and diamond markings, are evident along the northbound and southbound left lanes. Please refer to Figure 13 above of HOV lanes on I-270 in Maryland. “The Maryland State Highway Administration (SHA) opened its first High Occupancy Vehicle (HOV) lane along the northbound I-270 east spur (mainline) in Montgomery County in September 1993. In July 1994, SHA opened an HOV lane along the southbound I-270 east spur (mainline). Effective December 1996, SHA provided a continuous 19-mile HOV lane along northbound I-270 from I-495 (Capital Beltway) to MD 121 (Clarksburg Road), and a continuous, 12-mile HOV lane along southbound I-270 from I-370 to I-495.

These I-270 HOV lanes are operational along southbound I-270 during the morning rush hours, 6:00 to 9:00 AM, and along northbound I-270 during the evening rush hours, 3:30 to 6:30 PM. Hours for HOV use are clearly posted on signs along the highway. General-purpose traffic may use these lanes all other times” (MD SHA, 1996).

Residential and employment development within the project area is expected to increase significantly over the next 20 years. Round 5.1 (and more recently Round 6A) Cooperative Forecasts of demographics produced by MWCOG indicate that considerable growth is expected in both Frederick and Montgomery counties between 1990 and 2020, including a 32 percent increase in population in Montgomery County and a 65 percent increase in population in Frederick County (Pedersen, 1999). In both counties, employment is expected to increase at an even faster percentage rate than population. Fifty percent growth is expected in Montgomery County and 110 percent growth is expected in Frederick County (Pedersen, 1999).

Land uses throughout the project area are quite variable. The southern portion of I-270, generally south of MD 121 (Clarksburg), consists of residential (a mixture of single-family homes, townhomes, and condominiums) and commercial with office/industrial development along both sides of I-270. North of MD 121 (Clarksburg), most of the anticipated development is concentrated east of I-270, mainly consisting of office/light industrial uses. Most of the land use west of I-270 is expected to remain agricultural/conservation. Residential and some commercial land uses exist in Clarksburg and Urbana. Land uses in the vicinity of the Frederick area contain a mixture of residential and commercial, with some agricultural and industrial designations north of the City of

Frederick limits. Parks and woodlands also exist throughout the corridor. Please note that within the I-270 Corridor, transportation services are also provided by Metrorail, Maryland Area Commuter Rail (MARC) and local (Ride On) and express (MTA #991) bus services.

Much of the anticipated development is planned to occur in identified activity centers, such as Gaithersburg, Germantown, Clarksburg, Urbana and Frederick. However, even these activity centers represent a further dispersion of population and employment throughout the corridor than currently exists. Especially noteworthy are the projected increases in households and employment in Clarksburg and Urbana. Only residential development is expected in Clarksburg, while residential, commercial and planned unit development (PUD) is expected in Urbana. The City of Frederick also anticipates a substantial increase in residential development, causing the projected number of households to almost double (Pedersen, 1999).

Traffic along the corridor has increased over 50 percent in the last fifteen years, and is forecasted to increase an additional 35 percent in the next fifteen years. This corridor provides a critical link for local and long distance trips between the Washington, DC area, and central and western Maryland. The 1998 existing average daily traffic (ADT) volumes along the I-270 Corridor vary greatly depending upon location, with traffic volumes generally increasing as one approaches Washington, D.C. In addition, peak hour Levels of Service show many links within the corridor failing (see Figure 14) (Pedersen, 1999).

Figure 14: I-270 HOV Lanes Looking North

A six month evaluation of the I-270 HOV lanes in 1997 showed that they were carrying more HOVs than originally anticipated. The six month review showed the HOV lane usage to average 700 HOVs per hour with a range of 600 to 1,100 vehicles per hour. In addition, there was an increase in the number of carpools using I-270, growing from an average of approximately 600 to around 1,000 carpools during the peak hour. The HOV lanes were, in fact, moving more people in fewer vehicles. As an example, 1997 data for the morning peak period along the I-270 East Spur showed that the HOV lane was carrying 1,772 people in 746 vehicles, while the general-purpose lanes were carrying 4,354 people in 4,081 vehicles. The HOV lane was, therefore, carrying 30 percent of the people in 15 percent of the vehicles. Finally, the travel time savings was averaged at four minutes, a value which is often perceived higher than its actual value (Walton, 1999).

Data on the traffic volumes, automobile occupancy rates and violation rates have been collected semiannually since early 1997. This semiannual data on the I-270 HOV lanes show that this system is meeting national performance criteria and is considered a success. Nationally accepted performance criteria for HOV lanes include a travel time savings of four minutes or approximately one minute per mile, a vehicle demand of 400-800 vehicles per lane per hour or 30-45 bus vehicles per lane per hour, a person demand that exceeds the adjacent general-purpose lanes, and an average violation rate of less than ten percent, based on the type of facility (Walton, 1999). As shown on the table below (MD SHA, 1998), the automobile occupancy rate has been, and continues to, gradually increase, as do the number of carpools.

Table 5: I-270 Semi-Annual Evaluation

Measure	July 1997	Sept. 1997	Jan. 1998	Sept. 1998	Mar./ May 1999	Sept. 1999	Mar. 2000	Meeting National Criteria (Y/N)
Average Vehicle Occupancy	1.23	1.25	1.34	1.37	1.23/ 1.20	1.32	1.37	Y
Average Percentage of HOVs (2+)	16%	18%	19%	17%	14%	18%	19%	Y
Average Percentage of People traveling in HOVs (2+)	20%	22%	26%	24%	20%/ 21%	24%	22%	Y
Average Travel Time Savings (Capital Beltway to MD 121 in minutes)	4	4	N/A	7.5	5	3.5	5	Y
Average Violation Rate	19%	13%	12%	11%	13%/ 14%	13%	15%	Somewhat high relative to other national experience.
Number of Carpoolers (Number of People/Lane/Hour)	2,300 (1,895)			4,630 (1,995)				

CHAPTER 6: SURVEY RESULTS

6-1: Overview

Of the 6,556 individuals who traveled one or more times during the videotaping period in the Fall of 1999 and received a survey, 1,028 surveys were returned, providing a response rate of 16 percent. The following tables reflect the Socio-Demographic responses and Travel Behavior/Travel Making Characteristic responses (MD SHA, 2000).

6-2: Travel Behavior/Trip Making Characteristics

6-2-1: Development Densities

The I-270 Corridor is considered the "technology" corridor for the Washington region, with many medical research and high technology businesses along the corridor, including the National Institute of Standards and Technology, the National Institute of Health, the Department of Energy, COMSAT and local colleges, to name a few. I-270 terminates to the south at the Washington (Capital) Beltway, Interstate 495, and to the north at the City of Frederick, approximately 40 miles north of the nation's capital. The land use densities vary along the corridor with the highest densities to the south and lowest in the middle and to the north end of the corridor. It can be assumed that anyone commuting along I-270 is likely involved in a suburb to suburb commute or a suburb to central city commute (traditional commute), with very little commuters on the corridor participating in a "central city to central city" commute or a "reverse" commute.

Table 6: Major Origins

Germantown area	(26.2%)
Frederick area	(12.7%)
Virginia area	(10.7%)
Rockville area	(9.8%)

Table 6 highlights the four most popular origins for commuters in the I-270 corridor. Germantown (26.2 percent) and Frederick (12.7 percent), which make up approximately 40 percent of the commuter origins, are considered lower density, suburban areas. In addition, Virginia (10.7 percent) and Rockville (9.8 percent), which constitutes 20 percent of the origins, are metropolitan fringe areas. These four origins consist of 60 percent of the I-270 commuters and are spread throughout the 30 – 40 mile corridor.

Table 7: Major Destinations

Bethesda area	(17.1%)
Rockville area	(16.9%)
Virginia area	(8.8%)
Washington, D.C. area	(8.0%)

Table 7 highlights the four most popular destinations for commuters in the I-270 Corridor. Bethesda (17.1 percent), Rockville (16.9 percent) and Virginia (8.8 percent), which make up approximately 43 percent of commuters, are considered metropolitan fringe areas. Only eight percent of the commuters are destined for Washington, DC, historically the major destination in the Washington metropolitan area for both the corridor and the region. (Please note that the majority of I-270 commuters destined for Washington, DC may be taking advantage of transit, which was not a part of this survey). Therefore, both origins and destinations are spread out throughout the corridor, making carpooling more challenging.

6-2-2: Income

Figure 15 depicts the Annual Household Income for 1998. The majority of the commuters (75 percent) earn between $50,000 and over $100,000 annually. This shows that the I-270 Corridor provides transportation to a fairly affluent area. When evaluating the Annual Household Incomes between HOV users and those in general-purpose lanes, you can see in Table 8 that there is virtually no difference between the two groups. There is a minor difference in the $50,000-74,999 range, with the HOVs earning approximately four percent less of the share, and in the over $100,000 category, with the SOVs earning approximately six percent more of the share of income. These differences are not statistically significant.

Figure 15: Household Income of I-270 Commuters (1998)

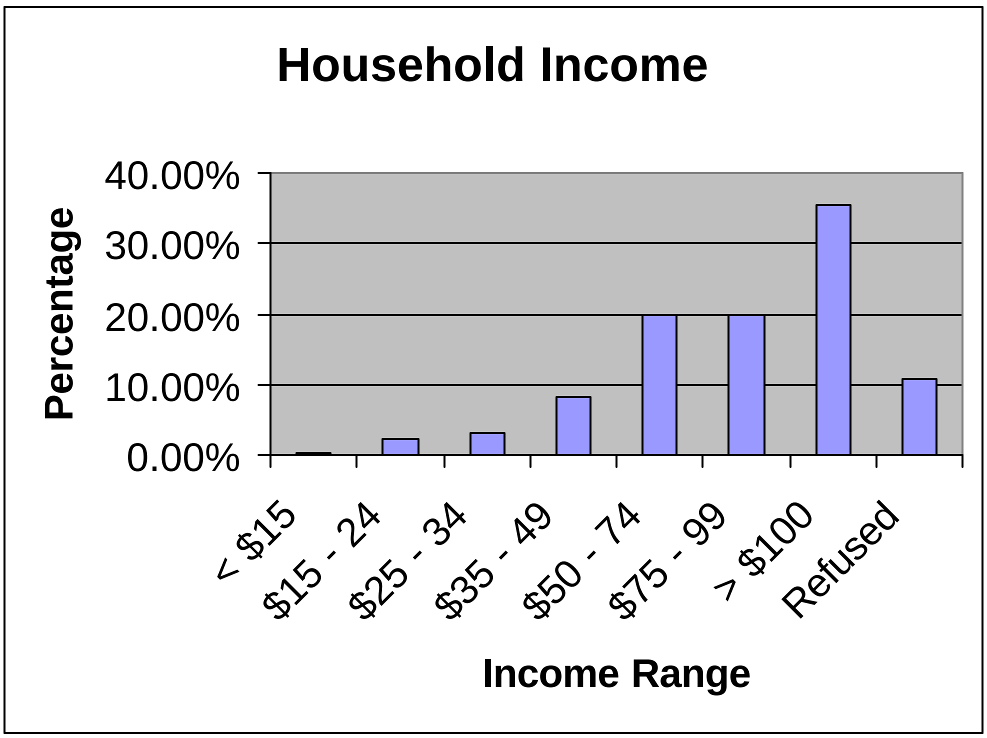


Table 8: 1998 Annual Household Income

			Lane		Total
			HOV	Regular	
Considering the 1998 annual income of all members of your household, which of the following categories best represents your household income?	Under $15,000	Count	1	3	4
		% within Lane	.8%	.4%	.4%
	$15,000 - $24,999	Count	3	20	23
		% within Lane	2.5%	2.5%	2.5%
	$25,000 - $34,999	Count	5	27	32
		% within Lane	4.1%	3.4%	3.5%
	$35,000 - $49,999	Count	13	71	84
		% within Lane	10.7%	8.9%	9.1%
	$50,000 - $74,999	Count	31	175	206
		% within Lane	25.6%	21.9%	22.4%
	$75,000 - $99,999	Count	27	179	206
		% within Lane	22.3%	22.4%	22.4%
	$100,000 and over	Count	41	323	364
		% within Lane	33.9%	40.5%	39.6%
Total		Count	121	798	919
		% within Lane	100.0%	100.0%	100.0%

Efforts to increase carpooling have often focused on determining what it would take to motivate motorists out of their single occupancy vehicles and into carpools. An Annual Survey in 1992 was conducted in Orange County, California of over 1,000 adults to determine what motivation was needed to convert SOVs to HOVs (Baldassare, 1997). This survey found that the most significant motivator was the concept of employers giving a cash bonus to anyone carpooling, accounting for 28 percent. In addition, the survey results showed that people would be more likely to use HOV lanes if more transit were available (33 percent) and if there were more carpools formed at work (35 percent). Congestion (16 percent), parking fees (20 percent) and environmental considerations, such as reductions to smog (17 percent), were not significant factors to motivate the SOVs into carpools. This California Survey shows that traditionally, money and income can provide motivation nationally in forming carpools, thus creating Cost Driven Carpools. Cost Driven Carpools do not seem widespread along I-270.

6-2-3: Automobile Availability & Ownership

The I-270 Survey did not investigate any information to determine if Automobile Availability & Ownership factors in utilizing the HOV lanes in this corridor. However, a 1987 Survey on carpool behavior on Route 55 in Orange County, California (Guiliano, 1990) reports that carpoolers who took advantage of the 13.5 mile HOV facility had a lower automobile ownership, longer trips and increased travel times. Income factors on Route 55, which serves a relatively affluent area, was not a factor in carpooling.

The I-270 Survey did investigate both the mode frequencies and the automobile occupancies to understand some of the trip characteristics. Table 9 shows that commuters traveling along I-270 do so repetitively, with over 75 percent of the commuters traveling along I-270 more than five times per week.

Table 9: Number of Days Per Week Use I-270

Less Than 1 day	(4.9%)
1 day	(3.5%)
2 days	(4%)
3 days	(6.4%)
4 days	(3.2%)
5 days	(59.4%)
6 days	(9.3%)
7 days	(2.1%)
8 or more	(6.4%)
Refused	(.9%)

In addition, Table 10 illustrates that the majority of people who travel along I-270 frequently (10+ times per month) do so alone in their vehicle (more than 86 percent). In fact, 80 percent of commuters on I-270 travel alone (SOVs), while 14.6 percent travel with another person (HOV 2), 2.5 percent travel with two other people (HOV 3) and 1.4 percent travel with three of more people (HOV 4+).

Table 10: Frequency of Travel Mode Use

	Never	Once/month or less	2 – 4 times/ month	5 – 9 times/ month	10+ times/ month
Walk (n=910)	54.16%	11.42%	13.35%	7.81%	13.26%
Bike (n=898)	83.02%	8.82%	5.18%	1.33%	1.65%
Drive alone on highway (n=1004)	0.41%	1.89%	4.47%	6.98%	86.26%
Drive alone, non-highway (n=962)	4.58%	1.46%	5.61%	8.26%	80.09%
Carpool on-highway (n=936)	68.11%	11.32%	5.34%	4.10%	11.13%
Carpool, non-highway (n=939)	73.10%	10.30%	4.05%	5.30%	7.25%
Carpool in HOV lanes (n=943)	69.48%	12.03%	5. %	2.85%	10.43%
Bus, not a school bus (n=943)	89.99%	7.66%	1.26%	0.68%	0.41%
Metro (n=957)	46.25%	34.78%	12.26%	3.69%	3.02%
School bus (n=941)	99.59%	0.21%	0.03%	0.00%	0.18%
MARC (n=945)	98.04%	1.88%	0.00%	0.00%	0.08%
Vanpool on highway (n= 953)	97.93%	0.23%	0.23%	0.59%	1.02%
Vanpool, non-highway (n=949)	98.34%	0.06%	0.23%	0.41%	0.96%
Vanpool in HOV lanes (n=936)	99.15%	0.24%	0.06%	0.21%	0.35%
Taxi (n=942)	81.41%	14.67%	3.38%	0.36%	0.18%
Motorcycle (n=931)	97.74%	0.69%	0.35%	0.51%	0.71%

In general, those who use I-270 more frequently have less favorable attitudes toward HOV lanes, while those who use the I-270 HOV lanes more frequently have more favorable attitudes toward HOV lanes.

6-2-4: Travel Times and Trip Lengths

Overall, the perception among this sample of I-270 motorists is that the HOV lanes have *not* been very effective. Eighty percent of regular lane respondents believe that they have not been effective (with 43 percent reporting that they have been not effective at all). Even among HOV lane respondents, more than half report that they have not been effective (MD SHA, 2000). (Please note that increased overall traffic congestion in the I-270 Corridor could participate in the perception of the HOV lanes.)

The perception among some respondents (55.11 percent of regular lane respondents and 38.54 percent among HOV lane respondents) is that the I-270 HOV lanes have actually *increased* trip time. The estimated median increase in trip time is 15 minutes for both groups. However, more than a third (35.42 percent) of HOV lane respondents report that their trip time has been decreased by the introduction of the HOV lanes (by a median amount of 15 minutes) (MD SHA, 2000).

Regardless of the HOV lanes, congestion has increased in the corridor over the last five years. Some SOVs may blame the HOV lane for the increased travel time due to the fact that some of the HOV lanes appear “empty,” even though the HOV lane may be carrying the same number of people as a general-purpose lane. This can be frustrating to those who are unable to use the restricted lanes. However, it is encouraging that, despite overall increased corridor congestion, some motorists have experienced a decrease in travel time due to the HOV lanes.

Table 11: Average One-Way Trip (Minutes) Along I-270

			Lane		
			HOV	Regular	Total
What is your average one-way trip (in minutes) along I-270?	1 – 5	Count	2	13	15
		% within Lane	1.6%	1.5%	1.5%
	6 – 10	Count	5	61	66
		% within Lane	3.9%	6.9%	6.5%
	11 – 15	Count	13	130	143
		% within Lane	10.1%	14.7%	14.1%
	16 – 20	Count	13	74	87
		% within Lane	10.1%	8.4%	8.6%
	21 – 30	Count	26	184	210
		% within Lane	20.2%	20.8%	20.8%
	31 – 40	Count	22	123	145
		% within Lane	17.1%	13.9%	14.3%
	41 – 50	Count	19	141	160
		% within Lane	14.7%	16.0%	15.8%
	51+	Count	29	157	186
		% within Lane	22.5%	17.8%	18.4%
Total		Count	129	883	1012
		% within Lane	100.0%	100.0%	100.0%

Table 11 shows the average trip duration in minutes. It should be noted that the majority of motorists are traveling for work trips (83.8 percent), however there is no statistical difference between the trip time on either the HOV lanes or regular lanes (MD SHA, 2000).

Respondents of the I-270 survey were presented with a series of potential motivators similar to the California study and asked how likely they would be to carpool if these things were available. HOV lane respondents found these things more motivating than regular lane respondents. However, with the exception of *guaranteed ride home* and *improved trip time reliability*, none of the other motivators would appear to have much of an impact on increasing carpooling (MD SHA, 2000).

Trip time saved is often thought of as an important issue for motorists. When asked how much time their trip time would have to be reduced to make using buses, carpools or vanpools more appealing, nearly half (49.34 percent) of regular lane respondents report that they would not use HOV lanes regardless of trip time saved. For the remainder, in order for trip time saved to have an impact, the amount of time would have to be somewhere between six and 30 minutes (see Table 12) (MD SHA, 2000).

Another potential motivator for using buses, carpools and vanpools is the increased cost of parking. Respondents indicated that increased parking costs would not have an appreciable impact. Most respondents (46.4 percent) expect to have free parking indefinitely and a large percentage of others (especially regular lane respondents [34.1 percent]) indicated that they would not use these transportation alternatives regardless of how much parking costs increased (MD SHA, 2000).

Table 12: Trip Time Savings (Minutes) on the HOV Lanes Along I-270

			Lane		
			HOV	Regular	Total
How many minutes would you need to save by using the I-270 HOV lanes, to make using buses, carpools or vanpools appealing or more appealing to you?	5 minutes or less	Count	3	20	23
		% within Lane	2.4%	2.4%	2.4%
	6 to 10 minutes	Count	18	88	106
		% within Lane	14.6%	10.5%	11.0%
	11 to 20 minutes	Count	37	158	195
		% within Lane	30.1%	18.8%	20.3%
	21 to 30 minutes	Count	19	108	127
		% within Lane	15.4%	12.9%	13.2%
	31 to 40 minutes	Count	6	34	40
		% within Lane	4.9%	4.1%	4.2%
	Over 40 minutes	Count	3	17	20
		% within Lane	2.4%	2.0%	2.1%
	I would not use regardless of	Count	37	414	451
		% within Lane	30.1%	49.3%	46.9%
Total		Count	123	839	962
		% within Lane	100.0%	100.0%	100.0%

Table 13 depicts the average trip length in miles on I-270. The I-270 motorists are traveling similar distances regardless of their use of the HOV lanes. It makes sense that shorter trips (under ten minutes) were less utilized (by half) by HOV lane respondents since there are less opportunities to benefit from use of these lanes (i.e., no travel time savings). Each time you pick up a rider or need to merge through congested lanes, travel time savings is lost (approximately five minutes per rider, as stated earlier). Using the same logic, it makes sense that the longer trips would have more use by the HOV lane respondents. It should be noted, however, that trip length did not show a statistically significant difference between HOV users and non-HOV users (MD SHA, 2000).

In looking at the attitudes of the commuters, the survey found that those, whose average trips (in minutes) are longer, have less favorable attitudes toward HOV lanes. In addition, those whose average trip time has decreased since the introduction of the I-270 HOV lanes have more favorable attitudes toward HOV lanes (MD SHA, 2000).

Table 13: Average One-Way Trip Length (Miles) Along I-270

\

			Lane		Total
			HOV	Regular	
What is your average one-way trip length (in miles) along I-270?	1 – 5	Count	5	57	62
		% within Lane	3.9%	6.5%	6.2%
	6 – 10	Count	14	179	193
		% within Lane	11.0%	20.6%	19.3%
	11 – 15	Count	32	199	231
		% within Lane	25.2%	22.8%	23.1%
	16 – 20	Count	21	96	117
		% within Lane	16.5%	11.0%	11.7%
	21 – 30	Count	20	143	163
		% within Lane	15.7%	16.4%	16.3%
	31 – 40	Count	18	116	134
		% within Lane	14.2%	13.3%	13.4%
	41 – 50	Count	10	54	64
		% within Lane	7.9%	6.2%	6.4%
	51+	Count	7	27	34
		% within Lane	5.5%	3.1%	3.4%
Total		Count	127	871	998
		% within Lane	100.0%	100.0%	100.0%

6-3: Socio-Demographic Characteristics

6-3-1: Race and Ethnicity

The I-270 Survey did not investigate any information to determine if race and ethnicity was a factor in utilizing the HOV lanes **in this corridor.**

6-3-2: Age and Education

The age range of commuters on I-270, as illustrated in Figure 16, is 25-64, with the heaviest concentration of commuters between the age ranges of 35-54 (30 percent) and 45-54 (27 percent). When comparing the age ranges of motorists using the HOV lanes, Table 14 shows that the there are statistically no differences in carpoolers based on age (MD SHA, 2000).

Figure 16: Age of I-270 Commuters

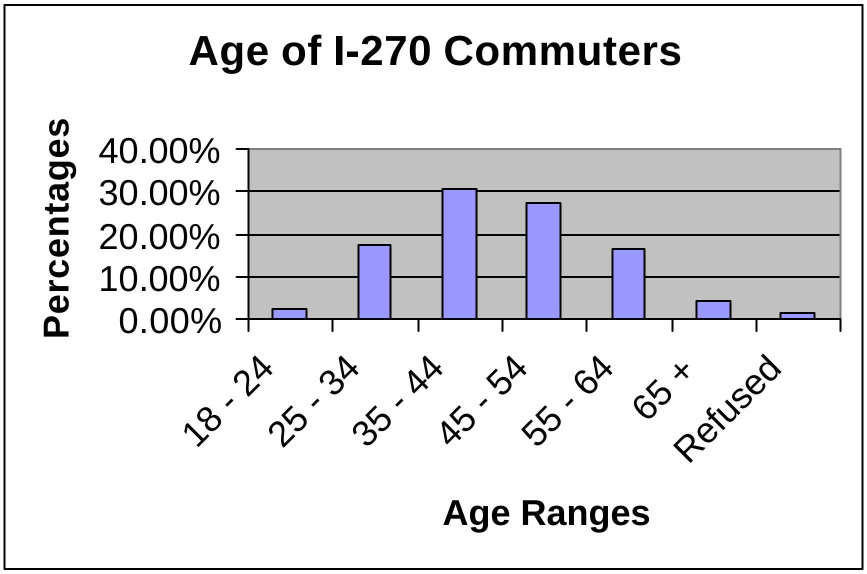
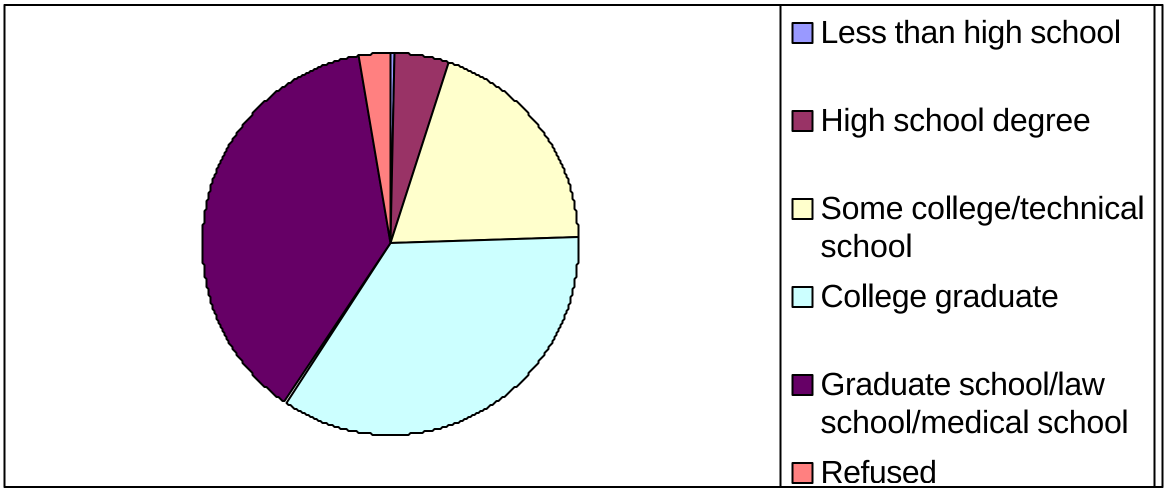


Table 14: Age Using the HOV Lanes vs. the Regular Lane Along I-270

			Lane		
			HOV	Regular	Total
What is your age?	18 – 24	Count	2	25	27
		% within Lane	1.6%	2.8%	2.7%
	25 – 34	Count	28	147	175
		% within Lane	21.9%	16.7%	17.3%
	35 – 44	Count	42	271	313
		% within Lane	32.8%	30.8%	31.0%
	45 – 54	Count	32	246	278
		% within Lane	25.0%	27.9%	27.6%
	55 – 64	Count	19	153	172
		% within Lane	14.8%	17.4%	17.0%
	65+	Count	5	39	44
		% within Lane	3.9%	4.4%	4.4%
Total		Count	128	881	1009
		% within Lane	100.0%	100.0%	100.0%

The I-270 Corridor has fairly well educated commuters, with 50 percent of the motorist achieving some college or a college degree and just under 40 percent completing graduate school, law school or medical school (see Figure 17) (MD SHA, 2000).

Figure 17: Education Level of I-270 Commuters



In evaluating the effect of education on carpooling, Table 15 outlines that there is virtually no difference in who is carpooling based on education level.

Table 15: Education Based on HOV Lanes vs. Regular Lanes Along I-270

			Lane		Total
			HOV	Regular	
What is the last year of schooling you completed?	Less than High School	Count	1	2	3
		% within Lane	.8%	.2%	.3%
	High School	Count	9	42	51
		% within Lane	7.0%	4.8%	5.1%
	Some college/technical school	Count	26	172	198
		% within Lane	20.2%	19.7%	19.8%
	College graduate	Count	44	317	361
		% within Lane	34.1%	36.3%	36.0%
	Graduate school/Law school/Med school	Count	49	340	389
		% within Lane	38.0%	38.9%	38.8%
Total		Count	129	873	1002
		% within Lane	100.0%	100.0%	100.0%

It was important for the I-270 Study to determine whether carpooling was made easier based on employers, such as the federal government, particularly since just over 90 percent of commuters on I-270 are full time employees. Table 16 highlights similar percentages for all motorists, regardless of their employer, including state and local government, private companies and health care facilities. Federal government employees did seem to have a slightly higher share of motorists carpooling, 27 percent versus 21 percent, but it is not a significant enough difference to claim that federal government employees have an unfair advantage to use the HOV lanes. This slight increase in federal government workers who use HOV can be tied into the fact that Washington, DC is the center for the federal government offices and could present a few more opportunities to carpool based on a central destination.

Table 16: Employer Type by HOV or Regular Lane Along I-270[5]

			Lane		
			HOV	Regular	Total
Employer Type	Federal government	Count	33	173	207
		Column %	26.90%	20.60%	21.40%
	State government	Count	6	45	51
		Column %	4.77%	5.40%	5.32%
	Local government	Count	15	109	125
		Column %	12.36%	13.00%	12.92%
	Private sector	Count	70	502	572
		Column %	56.62%	59.60%	59.22%
	Health care	Count	7	64	71
		Column %	6.07%	7.60%	7.41%
	None of the above	Count	10	64	74
		Column %	8.24%	7.60%	7.68%
Total	Count		123	842	965
	Column %		100.00%	100.00%	100.00%

6-3-3: Women and Men in the Work Force - Gender

A study was conducted in Southern California of 15 vanpool programs (Ferguson, 1993). The study reported that "carpool satisfaction varies with respect to carpool size, acquaintanceship and gender composition." Women rated all five benefits of reliability, social aspects, relaxation, economic factors, and environmental benefits higher than men.

For the I-270 Corridor, the gender breakdown of motorists is two-thirds male (62.7 percent) and one-third female (34.6 percent). Gender was not a significant factor in forming carpools in the I-270 Corridor, as shown in Table 17. As stated earlier in this report, women have developed a similar commuting pattern to men, which are now more complex, making carpooling appealing only when convenient, such as with family members.

Table 17: Gender Based on HOV Lanes vs. Regular Lanes Along I-270

			Lane		
			HOV	Regular	Total
Your gender:	Male	Count	78	568	646
		% within Lane	60.5%	65.1%	64.5%
	Female	Count	51	305	356
		% within Lane	39.5%	34.9%	35.5%
Total		Count	129	873	1002
		% within Lane	100.0%	100.0%	100.0%

6-4: General Attitudes

There was not much support for allowing certain classes of single occupancy drivers, such as Inherently Low Emission Vehicles (ILEVs) or emergency staff, to use the HOV lanes. Perhaps this is due to the public not realizing how few vehicles this actually could be. This was the case regardless of whether they were HOV lane or regular lane respondents.

The vast majority of respondents, regardless of whether they were HOV lane (73.08 percent) or regular lane respondents (71.18 percent), were in favor of the option of enabling SOVs to pay a fee to use the HOV Lanes. The amount the respondents would be willing to pay for this option is relatively small, with about three-quarters indicating that they would not be willing to pay more than $1.00 for each one-way trip. About another fifth would be willing to pay as much as $2.00.

CHAPTER 7: CONCLUSIONS

The I-270 Survey has helped to better understand who is utilizing the I-270 Corridor. Socio-demographically, the survey results have outlined that gender, education, age, and employment characteristics do not impact carpool decisions on I-270, since men and women are using the I-270 facility equally, regardless of their employer, education level or age. While federal government employees might be more inclined to carpool, this did not show enough differentiation to statistically factor into why motorists are carpooling on I-270.

Data on the I-270 HOV lanes reflect that people are carpooling, but *who* is carpooling? The I-270 Survey shows that the same people, socio-demographically, who are driving in the general-purpose lanes are carpooling and vice versa. No special groups, as claimed by many, are carpooling based on increased pre-dispositions (government workers, age, sex or income) or ability. It would be useful to conduct additional research relating to the race or ethnicity of carpoolers, and whether carpoolers have children and include children as part of their carpool routine, all of which were not covered by this survey.

Data from the I-270 Survey illustrated that dispersion of households and employment in the region have made carpooling a challenge, with origins and destinations spread throughout the I-270 Corridor and into Virginia. In fact, Washington, DC, once the major employment center for the region, attracts only eight percent of the destinations. This dispersion of households and jobs is evident in the survey results with most motorists traveling I-270 alone (86 percent) more than five days per week (75 percent). The survey displayed that commuters on I-270 were not encouraged to carpool based on trip time, trip length, travel time savings, or income, with over half of the respondents not willing to convert to a carpool regardless of any travel time savings.

The survey also helped to highlight the motivation of motorists to carpool and their attitudes towards HOV lanes. Motivating factors, as indicated from HOV lane respondents, only included the guaranteed ride home program and improved trip time reliability, and did not include increased parking costs. In general, those who use I-270 more frequently, have less favorable attitudes toward HOV lanes, while those who use the I-270 HOV lanes more frequently, have more favorable attitudes toward HOV lanes. In looking at the attitudes of the commuters, the survey found that those whose average trips are longer (in minutes) have less favorable attitudes toward HOV lanes (this could be due to the overall length of the HOV lanes not covering the entire I-270 Corridor). Overall, the perception among this sample of I-270 motorists is that the HOV lanes have not been very effective in reducing traffic congestion. Eighty percent of regular lane respondents believe that they have not been effective. Even among HOV lane respondents, more than half report that they believe the HOV lanes have not been effective.

There was not much support, regardless of lane use, for allowing certain classes of single occupancy drivers, such as Inherently Low Emission Vehicles (ILEVs) or emergency staff, to use the HOV lanes. However, the vast majority of respondents were in favor of the option of enabling SOVs to pay a fee to use the HOV Lanes. The amount the respondents would be willing to pay for this option is relatively small, with about three-quarters indicating that they would not be willing to pay more than $1.00 for each one-way trip. About another fifth would be willing to pay as much as $2.00.

If, in fact, carpools are not being formed for any of the reasons above, then *why* are people on I-270 carpooling? While the I-270 survey data does not clearly tell us why, it can be hypothesized, using both national commuting patterns and the fact that I-270, like many suburban corridors, is enjoying a suburban to suburban commuting pattern, that carpools are being formed by multiple worker households who have convenient destinations. Another factor to back the family carpooling trend is the complex commuting patterns driven by the need for commuters to "trip chain," or combine household and work related trips, which is clearly more convenient if carpoolers share the same household needs and convenient origins and destinations. Another reason for people to carpool, as shown with the HOV respondents, is increased trip time reliability and the possibility of providing a guaranteed ride home. It would be useful to conduct additional research to identify, more directly, why people are carpooling. Perhaps additional questions could be asked as to relationships with carpoolers (to identify family members), whether employers provide a guaranteed ride home and whether carpoolers combine house and work related trips together.

Lessons learned from this survey on user characteristics and motivating factors to carpool have been informative and hopefully can be used to further education on who is carpooling nationally and why. It is the intent of this report to share this information with other transportation planners to further develop knowledge on who is carpooling on the nation's HOV lanes. Lessons learned on I-270 specifically, can help State transportation officials to plan and implement improvements in response to the I-270 needs. For example, it is apparent that respondents do not realize who is carpooling, the effect of special vehicles if allowed on the HOV lanes and that there is interest in allowing SOVs, not based on special classifications, onto the HOV lanes. Therefore, it is recommended to State transportation officials to consider, based on this survey, the following transportation improvements and policies:

- Education to the general public on who is carpooling to assuage general public concerns that some individuals may be given an advantage to carpool.
- Understanding to the general public on the size and affect of allowing special vehicles, such as ILEVs or emergency vehicles, into the HOV lanes (this could be a very low amount, particularly during the HOV functioning peak periods).
- Evaluation of the affect of enabling SOVs to "buy" their way onto HOV, or High Occupancy/Toll (HOT), lanes for a fee (likely more than $1.00) to achieve a premium, more reliable trip. I-270 may be an excellent corridor for testing HOT lanes in Maryland, based on survey results, particularly if some feel that HOV lanes alone are ineffective.
- Continuation of HOV or HOT lanes further north on I-270 to I-70 in Frederick in order to respond to the origins and destination throughout the I-270 Corridor, since not all of the suburbs can currently access the HOV lanes for a full travel time savings (particularly north of Germantown/Clarksburg).
- The long term consideration of HOV or HOT lanes on I-270 to operate in both directions during the peak period due to origins and destinations spread throughout various suburbs, including Virginia.
- Provision of a guaranteed ride home program more universally by employers and/or government agencies.
- A lot of emphasis is placed on transportation and its interaction with the local land use; therefore additional research on the impact of the recent transportation improvements

(including Metrorail extensions, MARC stations, and enhanced bus services) on the local land use would be useful.

- Montgomery County planners are extremely proficient in ensuring that the transportation improvements are consistent with planned land use, therefore, it would be useful to historically evaluate the effect of land use and transportation decisions on the surrounding area.
- It is important to note that the I-270 Corridor has been an effective "technology corridor" due to the fact that it does have multi-modal transportation infrastructure (transit, highway and travel demand management strategies) and well thought out and mixed density land use. Other areas could learn from the lessons identified in the development of the I-270 Corridor.

BIBLIOGRAPHY

Baldassare, Mark, Sherry Ryan, and Cheryl Katz. (1998). Suburban Attitudes Toward Policies Aimed at Reducing Solo Driving. *Transportation.* 25 (1), 99-117.

Bonsall, P. W., A.H. Spencer, and W.-S. Tang. (1984). What Makes A Car-Sharer? *Transportation.* 12, 117-45.

Cervero, Robert. (1999). Reviving HOV Lanes. *Transportation Quarterly*. 53 (4), 67-81.

Dahlgren, Joy. (1998). High Occupancy Vehicle Lanes: Not Always More Effective Than General Purpose Lanes. *Transportation Research. Part A.* 32, 99-114.

Ferguson, Erik. (1990). The Influence of Employer Ridesharing Programs on Employee Mode Choice. *Transportation.* 17 (2), 179-207.

Ferguson, Erik. (1997). The Rise and Fall of the American Carpool: 1970 - 1990. *Transportation*. 24, 349-76.

Ferguson, Erik, Kevin Hodge, and Kathryn Berkovsky. (1994). Psychological Benefits from Vanpooling and Group Composition. *Transportation.* 21, 47-69.

Giuliano, Genevieve, Douglas W. Levine, and Roger F. Teal. (1990). Impact of High Occupancy Vehicle Lanes on Carpooling Behavior. *Transportation.* 17 (2), 159-77.

Koppelman, Frank S., Chandra R. Bhat, and Joseph Schofer. (1993). Market Research Evaluation of Actions to Reduce Suburban Traffic Congestion: Commuter Travel Behavior and Response to Demand Reduction Actions. *Transportation Research. Part A.2*7, 383-93.

Mannering, Fred L, and Mohammad M. Hamed. (1990). Commuter Welfare Approach to High Occupancy Vehicle Lane Evaluation: An Exploratory Analysis. *Transportation Research. Part A.* 24, 371-9.

Maryland State Highway Administration (SHA). (2000, February). *Maryland I-270 HOV lanes and Origin & Destination Survey Summary Report*. Baltimore: Maryland Department of Transportation.

Maryland State Highway Administration (SHA). (1998, October). *I-270 HOV Usage Report Update.* Baltimore: Maryland Department of Transportation.

Maryland State Highway Administration (SHA). (1996, Fall). In a JAM? Use HOV. *I-270 High Occupancy Vehicle Lanes Pamphlet.* Baltimore: Maryland Department of Transportation.

Mattill, John. (1983). Games Carpoolers Play. *Technology Review.* 86, 86+.

Orski, C. Kenneth. (2000, January/February). Carpool Lanes – The Debate Continues. *Innovation Briefs.* 11 (1).

Pedersen, Neil (1999). Interview. March 5, 1999.

Pisarski, Alan E. (1997, Spring). Carpooling: Past Trends and Future Prospects. *Transportation Quarterly.* 51, 6-8.

Pisarski, Alan E. (1996). *Commuting in America II: The Second National Report on Commuting Patterns and Trends*. Lansdowne, VA: Eno Transportation Foundation, Inc.

Poole, Jr., Robert W., and C. Kenneth Orski. (1999). *Building a Case for HOT Lanes: A New Approach to Reducing Urban Highway Congestion.* Policy Study No. 257. Los Angeles: Reason Public Policy Institute.

Pratt, Richard H. (1999). *Traveler Response Handbook.* (Working Paper). Washington, D.C.: U.S. Department of Transportation.

Reid, Alice. (1998). Area's Changing Economy Takes Toll on Car-Pooling. *Washington Post*. May 18. METRO B1.

Teal, Roger F. (1987, May). Carpooling: Who, How and Why. *Transportation Research. Part A*. 21, 203-14.

Turnbull, Katherine F., and Dennis Christiansen. (1992) HOV Lessons. *Civil Engineering (ASCE)*. 62, 74-5.

Virginia Department of Transportation. (1977, July). *Evaluation of Alternative Traffic Operation Plans for the Commuter Lanes on the Shirley Highway in Virginia*. Report Number FHWA-RD-77-114. Washington, D.C.: Federal Highway Administration.

Walton, George. (1999). Interview. April 13, May 13, and July 12, 1999.

Weisman, Jonathan. (1998). Life in the HOV Lane. *Washington Post*. January 11. MAGAZINE, W5.

Yang, Hai, and Hai-Jun Huang. (1999). Carpooling and Congestion Pricing on a Multilane Highway with High Occupancy Vehicle Lanes. *Transportation Research. Part A*. 33 (2), 139-55.

GLOSSARY

Carpool – a group of people sharing a ride.

High Occupancy Vehicle (HOV) Lane – a lane designated for carpools, vanpools, and buses during designated time periods, typically the peak commuting periods.

High Occupancy Toll (HOT) Lane – a lane designated for high occupancy vehicles, which allow other vehicles use the lane by paying a fee or toll.

Low Occupancy Vehicle (LOV) – a vehicle with, typically, one passenger, the driver.

Single Occupancy Vehicle (SOV) – a vehicle with only one passenger, the driver.

Socio-Demographic Characteristics – human population characteristics defined by one's social status, including age, gender, married status.

Trip Chaining – the process of combining trips serving the household (food shopping, dry cleaners, child care, medical, automobile repair) with trip to and from work.

LIST OF ABBREVIATIONS

AVO	Automobile Occupancy Rate
HOT Lane	High Occupancy Toll Lane
HOV 2+	High Occupancy Vehicle (2 or more passengers)
HOV 3+	High Occupancy Vehicle (3 or more passengers)
HOV	High Occupancy Vehicle
ILEV	Inherently Low Emission Vehicle (ILEV)
ISTEA	Intermodal Surface Transportation Efficiency Act
LOV	Low Occupancy Vehicle
SHA	State Highway Administration
SOV	Single Occupancy Vehicle
TEA-21	Transportation Equity Act for the 21st Century

APPENDIX

Maryland I-270 HOV Lane Use Survey

Dear Motorist:

Your vehicle was randomly selected while traveling on Interstate Route 270 on the date, time, section, lane, and direction shown in the trip information box on the back of this page. We realize that it has been some time since that particular trip, but we're assuming that most people travel along I-270 for the same reasons regardless of the actual day of travel. The questions in this survey refer to your use of I-270 in the *one-way* direction in the trip information box. Your answers will help us assess HOV lanes' usage and their effectiveness.

To ensure your anonymity, you may remove the panel with your name and address before mailing. After completing the survey, please refold with the *Pacific Rim Resources'* address on the outside and all of the questions on the inside, tape closed, and mail back to us. The postage is already paid.

Thank you.

1. What is the typical purpose of your trip(s) along I-270: (Mark just one)

   Work ☐ Business appointment ☐
   School/College ☐ Personal appt/shopping/errands ☐
   Social/recreational activity (visiting, restaurant, etc.) ☐
   Other ________________ ☐
   (please specify)

2. Using the *trip direction* information on the back of this page, what is the city/town and zip code where you *start* your I-270 trips (for the trip purpose identified above)?

   City/Town

   Zip Code

3. Using the *trip direction* information on the back of this page, what is the city/town and zip code where you *end* your I-270 trips (for the trip purpose identified above)?

   City/Town

   Zip Code

4. How many times per week do you normally use I-270 in this *one-way* direction? (Mark just one.)

   Less than 1 ☐
   1 ☐ 3 ☐ 5 ☐ 7 ☐
   2 ☐ 4 ☐ 6 ☐ 8+ ☐

5. Including yourself, how many people are usually in your vehicle when you use I-270? (Mark just one)

   1 ☐ 3 ☐ 5 ☐ 7 ☐
   2 ☐ 4 ☐ 6 ☐ 8+ ☐

6. What is your average *one-way* trip length (in miles) along I-270?

   1-5 ☐ 11-15 ☐ 21-30 ☐ 41-50 ☐
   6–10 ☐ 16–20 ☐ 31–40 ☐ 51+ ☐

7. What is your average *one-way* trip (in minutes) along I-270?

   1-5 ☐ 11-15 ☐ 21-30 ☐ 41-50 ☐
   6–10 ☐ 16–20 ☐ 31–40 ☐ 51+ ☐

8. Has your average trip time on I-270 decreased, remained the same, or increased since the I-270 HOV lanes were completed in December 1997? (*if you did not use I-270 before December 1997, please mark Doesn't Apply*)

   Remained the same ☐ Doesn't Apply ☐
   Decreased ☐ Increased ☐
   ↓ ↓
   By how many minutes? By how many minutes?

9. Here are some statements people have made both in favor of and against HOV lanes. Please mark the appropriate box to indicate your opinion:

	Strongly Agree				Strongly Disagree	Don't Know
HOV lanes make buses, carpools & vanpools more attractive because travel is faster & more reliable...	☐	☐	☐	☐	☐	☐
HOV lanes only help a few people...	☐	☐	☐	☐	☐	☐
HOV lanes relieve traffic congestion for everybody...	☐	☐	☐	☐	☐	☐
Travel time is reduced because of HOV lanes...	☐	☐	☐	☐	☐	☐
Very few people use HOV lanes...	☐	☐	☐	☐	☐	☐
The average commute time has been reduced for most commuters since installing the HOV lanes...	☐	☐	☐	☐	☐	☐
HOV lanes increase traffic congestion because they tie up a lane that could be used by everyone...	☐	☐	☐	☐	☐	☐
It's dangerous to get off the freeway when using an HOV lane because you have to cross several lanes of traffic to do so...	☐	☐	☐	☐	☐	☐
The overall goal of moving more people has not been achieved with HOV lanes...	☐	☐	☐	☐	☐	☐
Now that HOV lanes have been implemented, traffic is worse than ever...	☐	☐	☐	☐	☐	☐
Extra express lanes would be better, serving all taxpayers rather than the few who can carpool...	☐	☐	☐	☐	☐	☐
There should be more enforcement of HOV lanes...	☐	☐	☐	☐	☐	☐

10. How strongly do you agree or disagree with allowing the following types of individuals to use I-270 HOV lanes even if they are driving alone? Please mark the appropriate box to indicate your opinion.

	Strongly Agree				Strongly Disagree	Don't Know
Inherently low emission vehicles...	☐	☐	☐	☐	☐	☐
Disabled drivers...	☐	☐	☐	☐	☐	☐
Off-duty police...	☐	☐	☐	☐	☐	☐
Firefighters...	☐	☐	☐	☐	☐	☐
Doctors...	☐	☐	☐	☐	☐	☐
Clergy...	☐	☐	☐	☐	☐	☐
Judges...	☐	☐	☐	☐	☐	☐
Military personnel...	☐	☐	☐	☐	☐	☐
Motorcycles...	☐	☐	☐	☐	☐	☐

11. Please mark the appropriate box to indicate how likely you would be to carpool if the following were available or occurred.

	Very Likely				Very Unlikely	N/A
Assistance in finding a carpool partner who lives near you ...	☐	☐	☐	☐	☐	☐
More convenient park and ride locations ...	☐	☐	☐	☐	☐	☐
Free HOV parking at premium/ priority locations at work/ downtown facilities ...	☐	☐	☐	☐	☐	☐
Guaranteed ride home ...	☐	☐	☐	☐	☐	☐
Increase cost of driving alone or parking ...	☐	☐	☐	☐	☐	☐
Improved trip time reliability ...	☐	☐	☐	☐	☐	☐
Additional HOV lane miles on I-270 ...	☐	☐	☐	☐	☐	☐
Exclusive arterial HOV lanes ...	☐	☐	☐	☐	☐	☐

12. How often have you personally used HOV lanes in the past year, either in carpools, vanpools, or buses?

2 or more times/week ☐ 1 or fewer times/month ☐
2 - 4 times/month ☐ Never ☐

13. Overall, how effective do you think the I-270 HOV lanes have been in reducing traffic congestion?

Very effective ☐ Not very effective ☐
Fairly effective ☐ Not effective at all ☐

14. How many minutes would you need to save by using the I-270 HOV lanes, to make using buses, carpools or vanpools appealing or more appealing to you?

5 minutes or less ☐ 21 to 30 minutes ☐
6 to 10 minutes ☐ 31-40 minutes ☐
11 to 20 minutes ☐ Over 40 minutes ☐
I would not use regardless of trip-time saved ☐

15. How much MORE money per month would parking costs need to increase for buses, carpools or vanpools to become appealing or more appealing to you?

\$5 or less ☐ \$11 - \$20 ☐ \$31 - \$50 ☐
\$6 - \$10 ☐ \$21 - \$30 ☐ \$51 - \$100 ☐
I would not use regardless of parking cost increases ☐
I expect to have free parking indefinitely ☐

16. Would you be willing to pay a fee to use the HOV lanes on I-270 if you drive alone?

Yes ☐ No ☐

If YES, how much would you be willing to spend for each one-way trip?

50¢-\$1.00 ☐ \$2.01-\$3.00 ☐ \$4.01-\$5.00 ☐
\$1.01-\$2.00 ☐ \$3.01-\$4.00 ☐ Over \$5.00 ☐

SURVEY CONTINUED ON OTHER SIDE

To access an electronic version of this publication
and other Operations related publications visit the
ITS Electronic Document Library (EDL):
www.its.dot.gov/welcome.htm
EDL Document Number 13482

Visit Our Operations Web Site:
http://www.ops.fhwa.dot.gov
Publication No. FHWA-OP-01-041

Note to Printer: This is the spine title.

10TH International Conference on High-Occupancy Vehicle Systems FHWA-OP-01-041