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HOV LANE PERFORMANCE MONITORING REPORT 2002
VOLUME 2- TRENDS

by

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16. ABSTRACT

This report identifies and analyzes trends in HOV lane usage and performance by comparing HOV lane usage and performance in 2000 with HOV lane usage and performance in 2002.

The report highlights some of the major shifts in peak and off-peak hour HOV usage. It compares specific data including speed and reliability measures, vehicle volume measures, and person throughput measures from specific sites on the I-5, I-90, SR 520, I-405 and SR 167 freeway corridors. It also discusses the effects of seasonal factors on travel reliability.

This information is intended to serve as reliable input for transportation decision makers and planners in evaluating the impact and adequacy of the existing HOV lane system in the Puget Sound area, and in planning for other HOV facilities.

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EXECUTIVE SUMMARY

HOV LANE PERFORMANCE MONITORING REPORT 2002 VOLUME 2-TRENDS

This two-volume report documents the speed and reliability of HOV lanes located on Puget Sound freeways, and compares the person-carrying performance of specific HOV lanes to their adjacent GP lanes. This volume summarizes the performance of the HOV lanes in 2002, with emphasis on changes observed between 2000 and 2002. It covers a time period when the HOV lanes were available for use exclusively by carpoolers, transit riders, other travelers who share rides, and motorcycles 24 hours a day, 7 days a week.[1]

HOV LANE USE

Peak Period Use

Between 2000 and 2002, the Puget Sound region reversed a decade-long trend in HOV use and performance. Instead of slowly growing, peak period HOV use remained steady or declined on many HOV corridors. General purpose (GP) traffic also remained steady, and frequently declined between 2000 and 2002. Table EX-1 shows the percentage change in person and vehicle throughput for the primary study corridors and locations for both GP and HOV lanes. The table is sorted in ascending order, from the greatest growth in HOV person throughput to greatest decline in person throughput. Person and vehicle throughput generally mirror each other, however, changes in transit service availability and carpool usage do result in differences in vehicle and person throughput rates (e.g., increased transit service can generate additional HOV person throughput even when HOV vehicle volumes decline).

[1] Time of day restrictions have since changed, but the effects of these changes are not reflected in the statistics reported in this document.

Table EX-1: Percentage Change in Throughput Between 2000 and 2002

AM Peak Period (6:00-9:00)	HOV Lane Person Throughput Change 2000 - 2002	2002 HOV Lane Person Throughput	HOV Lane Vehicle Volume Change 2000 - 2002	2002 HOV Lane Vehicle Volume	GP Lane Vehicle Volume Change 2000 - 2002	2002 Vehicle Volume Per GP Lane	GP lane Person Throughput Change 2000 - 2002	2002 Person Throughput Per GP Lane
I-5 SB, South Everett	6%	4620	-2%	1780	2%	4640	-7%	5420
SR 167 NB, Kent	-1%	4830	-3%	2270	-1%	5000	-4%	5850
I-405 SB, Kirkland	-1%	7510	-1%	3040	-1%	5080	-3%	5890
SR 520 WB, Medina	-2%	4090	8%	440	-5%	4220	-12%	4690
I-90 WB, Floating Bridge	-4%	6140	-2%	2140	-3%	4580	-4%	5120
I-90 WB, Issaquah	-6%	3630	-1%	1250	-1%	4250	-2%	4810
I-405 NB, Newcastle	-6%	8740	-8%	3580	4%	4810	0%	5600
I-5 SB, Northgate	-8%	13720	-3%	4090	1%	4120	-1%	4640
I-5 NB, South of Seattle CBD	-12%	11940	-6%	3570	0%	5020	-7%	6250
I-405 SB, Southcenter	-14%	2250	-5%	1070	-1%	4110	1%	5020
I-5 NB, South of Southcenter	-14%	10300	-11%	3120	0%	5910	-1%	7180
PM Peak Period (3:00-7:00)	**HOV Lane Person Throughput Change**	**2002 HOV Lane Person Throughput**	**HOV Lane Vehicle Volume Change**	**2002 HOV Lane Vehicle Volume**	**GP Lane Vehicle Volume Change**	**2002 Vehicle Volume Per GP Lane**	**GP lane Person Throughput Change**	**2002 Person Throughput Per GP Lane**
I-405 NB, Kirkland	11%	12440	7%	5220	-3%	6170	-9%	6940
SR 167 SB @ S. 208th	6%	8460	-2%	3370	-4%	6570	-7%	7710
I-90 EB, Issaquah	5%	4980	5%	2140	0%	5800	-2%	7030
I-405 SB, Newcastle	0%	13200	-4%	5800	3%	6990	-1%	7860
I-405 NB, Southcenter	0%	9270	5%	4250	5%	5030	5%	5820
I-5 NB, South Everett	-1%	9210	-1%	3710	-1%	6110	-1%	7730
I-5 NB, Northgate	-1%	17810	-1%	5300	-2%	5900	-8%	3820
I-5 SB, South of Seattle CBD	-6%	16600	-5%	5150	-1%	6350	-5%	8010
I-90 EB, Floating Bridge	-12%	9430	0%	4360	-2%	5940	-5%	6640
I-5 SB, South of Southcenter	-13%	12720	-11%	4150	-2%	6070	-2%	7250
SR 520 WB, Medina	-15%	4390	-2%	1480	5%	5480	1%	6060

In the morning, only I-5 in the far north end showed an increase in HOV person throughput. This growth was, in large part, due to increased transit use corresponding to increased transit service in Snohomish County along the I-5 corridor. In the afternoon, three locations show increased HOV person throughput: I-405 in Kirkland, SR 167, and I-90 near Issaquah. For GP lanes, only one location shows a significant increase in person throughput: I-405 northbound, in the evening near Southcenter.

Peak period HOV use was still heavy, despite the slight volume declines on several corridors. On many corridors, vehicle volumes on the I-5 and I-405 HOV facilities approached or exceeded 1,500 vehicles per hour, and at several locations on I-5 (Northgate, NB PM, Southcenter, SB, PM) and I-405 (Newcastle NB AM, Southcenter NB, PM) HOV lane volumes still routinely exceeded GP lane volumes per lane. Most other HOV facilities carried approximately 1,000 vehicles during the peak hour. In most locations in the evening, all HOV lanes except SR 520 (which has restrictive rules) and I-90 still carried more people per lane than the adjacent GP lanes during peak commute times. In the morning peak period, GP lanes still moved more people than HOV lanes on both SR 167 and on I-5 near Everett.

Off-peak Period Use

Unlike the peak periods, most general purpose and HOV lanes showed minor increases in vehicle volumes in the middle of the day. (See Table EX-2.) In only three locations did midday GP volume grow at a faster percentage rate than HOV percentage growth. In two of the locations, exit ramp configurations made these "unusual" HOV locations. (On I-5 northbound at Albro approaching downtown Seattle, the HOV lane also led to a left-hand off-ramp. On I-405 southbound by Southcenter, a significant number of HOVs exited the HOV lane prior to the data collection point, in order to either go southbound on I-5 or west on SR 518.) These two locations were the only two data collection sites examined that lost midday HOV volume.

Table EX-2: Change in Midday GP and HOV Vehicle Volume 2000 - 2002

	Percent Change		Volume Change		2002 Average Midday GP Volume Per Lane	2002 Average Midday Hourly HOV Volume Per Lane
	GP	HOV	GP	HOV		
I-405 NB, Newcastle	0.4%	2.8%	7	20	1730	750
I-405 SB, Newcastle	0.9%	1.8%	15	13	1600	750
I-405 SB, Southcenter	-0.2%	-5.2%	-3	-15	1400	270
I-405 NB, Southcenter	-0.4%	7.4%	-6	39	1480	570
I-405 SB, Kirkland	1.1%	7.6%	15	40	1450	570
I-405 NB, Kirkland	1.1%	6.0%	15	26	1330	470
I-5 NB, Northgate	2.0%	5.3%	22	20	1110	400
I-5 SB, Northgate	1.2%	4.3%	18	28	1500	690
I-5 NB, South of Seattle CBD	0.2%	-3.5%	3	-26	1530	730
I-5 SB, South of Seattle CBD	1.0%	1.2%	14	11	1390	890
I-5 SB, South of Southcenter	2.6%	6.2%	28	32	1140	540
I-5 NB, South of Southcenter	1.4%	3.4%	21	16	1530	480
I-5 NB, South Everett	4.2%	6.2%	55	32	1360	560
I-5 SB, South Everett	3.2%	2.1%	43	10	1400	470
I-90 WB, Issaquah	6.0%	7.5%	54	17	960	240
I-90 EB, Issaquah	5.4%	8.5%	50	17	990	220
SR 167 NB, Kent	1.0%	23.3%	14	89	1440	470
SR 167 SB @ S. 208th	1.8%	6.5%	21	22	1170	360
SR 520 WB, Medina	-4.1%	8.4%	-60	10	1400	130

In terms of absolute volumes, midday HOV volume growth exceeded GP growth per lane slightly more than half the time. In general, when midday volumes were near 1,000 vehicles per lane per hour, the most significant growth occurred in the GP lanes. Where GP volumes significantly exceeded 1,000 vehicles per lane per hour, HOV growth frequently equaled or exceeded GP growth per lane. No change in volume was apparent in either GP or HOV lanes late at night.

SPEED AND RELIABILITY

The speed and reliability of travel in the HOV lanes generally improved between 2000 and 2002. By the end of 2002, 10 out of 14 HOV corridors performed above the speed and reliability standard of 45 mph at least 90% of the time. (Note: one segment, I-5 south of the Seattle CBD, southbound, did not meet the standard for the first three quarters, but did the last quarter of 2002. This is due to a freeway improvement project being completed which improved traffic flow both in the HOV lane and in the GP lanes.)

The number of corridors where HOV lane travel times measured throughout the year fell below the adopted regional performance standard dropped from eight to five. The three corridors that improved enough to meet the standard in 2002 were southbound I-405 from Swamp Creek to I-90, and both north and southbound I-405 from Tukwila to I-90. In addition, preliminary analysis shows that the southbound I-5 corridor from Downtown Seattle to Des Moines, mentioned above, began meeting the standard during the fourth quarter of 2002—after the construction project was completed—and will have met the standard throughout 2003. Table EX-3 highlights the performance of the region's freeway HOV corridors.

Table EX-3: Summary of 2002 HOV Lane Speed and Reliability Performance

Corridors	Dir	From	To	Meets Standard?	Status Change From 2000?
I-5 North of the Seattle CBD	NB	Northgate	112th St SW	N	**N**
	SB	SR 526 Interchange	Northgate	N	N
I-5 South of the Seattle CBD	NB	S 184th St	Columbian Way	N	N
	SB	S Spokane St	S 184th St	N (yes in Q4)	N (yes in Q4)
I-405 North of I-90	NB	I-90 Interchange	SR 524 Interchange	Y	N
	SB	SR 524 Interchange	I-90 Interchange	**Y**	**Y**
I-405 South of I-90	NB	W Valley Hwy	I-90 Interchange	**Y**	**Y**
	SB	I-90 Interchange	Andover Park E	**Y**	**Y**
I-90	EB	Mt. Baker Tunnel	193rd PL SE	Y	N
	WB	SR 900	23rd Ave S	Y	N
SR 520	EB	I-405 Interchange	NE 51st St	Y	N
	WB	W Lk Sammamish Pkwy	84th Ave NE	N	N
SR 167	NB	15th St NW	S 34th St	Y	N
	SB	S 23rd St	43rd St NW	Y	N

These speed and reliability improvements were the result of several factors including:

- Extending the I-5 and I-405 HOV lanes, and the resulting elimination of weaving movements at the previous ending points, which created congestion in the HOV lanes.
- A slight reduction in peak period HOV volumes mentioned above.
- Increased WSDOT emphasis on improving freeway operations through such programs as improved incident response.
- A slight reduction in HOV volumes mentioned above.

In most instances, specific sections of roadway were the cause of the majority of congestion on the HOV facilities. These congestion points were primarily associated with areas where large numbers of vehicles entered or exited the HOV lanes, and many of these points had geometric limitations that caused drivers to slow as they performed the merge/diverge movements.

VIOLATION RATES

Violation rates appeared to increase slightly on several corridors, although the total percentage of violations was still relatively modest. Most drivers tended to follow the HOV eligibility rules, and Seattle has traditionally had among the lowest measured HOV violation rates in the country. Only two locations had average annual violation rates above 6 percent, and more than half the locations had violation rates below 5 percent. (See Table EX-4)

Violation rates at most locations on most days were well below 5 percent. However, on specific days and/or at specific locations, violation rates could jump to more than 20 percent. The apparent change in overall vehicle occupancy rates that appears to be occurring seems to have been caused by an increase in the number of relatively rare "high violation" days. Violations also tended to increase just upstream of the locations where HOV lanes reverted to being GP lanes, or led to exit ramps.

Table EX-4: Summary of 2000 and 2002 HOV Lane Violation Rates

Location	2002 Violation Rates	2000 Violation Rates
I-405 NB, Newcastle AM	5%	1%
I-405 SB, Newcastle PM	5%	3%
I-405 SB, Southcenter AM	8%	3%
I-405 NB, Southcenter PM	4%	3%
I-405 SB, Kirkland AM	2%	1%
I-405 NB, Kirkland PM	1%	3%
I-5 NB, Northgate PM	1%	1%
I-5 SB, Northgate AM	6%	1%
I-5 SB, South of Seattle CBD PM	1%	1%
I-5 SB, South of Southcenter PM	1%	2%
I-5 NB, South of Southcenter AM	2%	2%
I-5 NB, South Everett PM	1%	1%
I-5 SB, South Everett AM	1%	3%
I-90 WB, Issaquah AM	4%	3%
I-90 EB, Issaquah PM	5%	4%
SR 167 NB, Kent AM	4%	2%
SR 167 SB @ S. 208th PM	4%	4%
SR 520 WB, 148th PM	6%	7%
SR 520 EB, 148th AM	6%	3%
SR 520 WB, Medina AM	6%	7%
SR 520 WB, Medina PM	8%	5%

INTRODUCTION

High occupancy vehicle (HOV) lanes exist on large portions of the I-5, I-405, I-90, SR 520, and SR 167 corridors in the Puget Sound region. The Freeway HOV system in the Puget Sound region currently totals over 200 lane miles. The intent of HOV lanes is to improve the person- moving capacity of each corridor by providing travel reliability and time savings that encourage the use of higher capacity, shared ride modes of travel. Increasing the use of shared ride transportation increases the mobility provided by the freeway system while decreasing the number of single occupant vehicles (SOV) required, subsequently decreasing congestion and environmental impacts for a given level of person-movement on HOV lane equipped roadway corridors. HOV lanes are generally considered successful when they carry more people per lane than general purpose (GP) lanes during peak periods.

Analysis of previously collected data has shown that most Puget Sound freeway HOV facilities are very successful in attracting and reliably moving large numbers of people. During peak periods,[2] the majority of the region's freeway HOV lanes typically carry more people, in fewer vehicles, at faster speeds, than their adjacent GP lanes. However, it is important to continually track the use and performance of these facilities because their usage is affected by a large number of factors, including changes in public attitude and behavior, fluctuating populations levels and employment rates, changes in public policy, changes in both HOV and GP vehicle volumes, and the interaction between geometric limitations and the roadway network.

This report documents the speed and reliability of HOV lanes, and compares the person-carrying performance of specific HOV lanes to their adjacent GP lanes. The report covers a time period when the HOV lanes were available for use exclusively by

[2] In this report, "peak period" is defined as either the 3-hour morning period from 6:00 AM to 9:00 AM or the 4-hour afternoon period from 3:00 PM to 7:00 PM.

carpoolers, transit riders, other travelers who share rides, and motorcycles 24 hours a day, 7 days a week.[3] It summarizes the performance of the HOV lanes in 2002 with emphasis on changes observed between 2000 and 2002 using the following measures:

- facility volume trends
- HOV lane performance
- seasonal effect on travel reliability

This is the second volume of a two-volume set. The first volume, titled HOV Lane Performance Monitoring: 2002 Report, provides a more detailed description and analysis of the number of people and vehicles carried by each of the Puget Sound region's freeway HOV lanes. It provides more detailed use and performance information about specific HOV corridors and locations within them. It also presents information on the public's perceptions about HOV lanes obtained from surveys distributed and returned during 2002. Unlike this report, it does not discuss how conditions have changed over time.

[3] Time of day restrictions have since changed, but the effects of these changes are not reflected in the statistics reported in this document.

FACILITY VOLUME TRENDS

This section of the report looks at two different types of volume trends: 1) vehicle volumes and 2) person throughput.

Vehicle volumes describe "how full" the HOV lanes are by time of day. This is not only a measure for describing HOV lane use, it is a reasonably good descriptor for how the public perceives the level of use of the HOV lanes, and also describes whether the HOV vehicle volumes can grow, and if that growth is likely to create or exacerbate congestion problems.

Person throughput measures how effective the HOV lanes are in meeting the public policy objective of moving an increasing number of people through a given amount of public space. Person throughput combines vehicle volumes with transit ridership and average car occupancy data. A change in any of these variables affects the number of people actually using the HOV lanes.

Vehicle Volumes

The report details measured changes in vehicle volume throughput that occurs in GP and HOV lanes during the morning and afternoon peak periods. (See Table 1.) Until this analysis, growth in HOV lane use had been fairly consistent in the Puget Sound region for much of the last two decades. However, between 2000 and 2002, a slight reduction in HOV lane use occurs on most of the monitored corridors. GP lane volumes also decline on many of the same corridors. The change from increasing volumes to decreasing volumes is not surprising given the downturn in the local economy between 2000 and 2002.

The largest measured losses in HOV vehicle volume are on I-5 in the south end, both northbound in the morning—11% of AM peak period volumes, or almost 400 vehicles—and southbound in the evening. While some of the loss of HOV traffic is undoubtedly due to the slowing of the economy (GP volumes are also down slightly on

this corridor), a portion of the reduction in is likely due to the introduction of Sounder commuter rail service between Tacoma and Seattle, through the Kent Valley.

Sounder service started in the fourth quarter of 2000, and has expanded to include station stops in Puyallup, Sumner, Auburn, Kent, and Tukwila. By the end of 2002, Sounder carried nearly 1,500 passengers in the peak-period-peak-direction each weekday. Some of Sounder riders were probably previously in carpools or on buses on the monitored sections of the I-5 HOV facility during 2000. This conclusion is further supported by examining time-of-day volume curve for I-5, near Tukwila. Comparisons between 2000 and 2002 vehicle per lane volumes for both HOV and GP lanes show that HOV lane volumes decline only in the early AM commute period, during the time period that Sounder service is provided. (See Figure 1.) Meanwhile, 2002 HOV lane volumes equal or exceed 2000 HOV lane volumes by 7:30 AM, fifteen minutes prior to the last Sounder train's arrival into downtown Seattle.

Table 1. Change in Number of Vehicles Carried in (2002 vs. 2000)

AM Peak Period (6:00-9:00)	HOV				GP			
	2002	2000	Number Change	% Change	2002	2000	Number Change	% Change
I-5 SB, South Everett	1784	1828	-44	-2%	13907	13686	221	2%
I-5 SB, Northgate	4087	4197	-110	-3%	16468	16246	222	1%
I-5 NB, South of Seattle CBD	3572	3812	-240	-6%	20058	19960	98	0%
I-5 NB, South of Southcenter	3120	3515	-395	-11%	23630	23722	-92	0%
I-405 SB, Kirkland	3039	3069	-30	-1%	15245	15415	-170	-1%
I-405 NB, New Castle	3578	3907	-329	-8%	9617	9263	354	4%
I-405 SB, Southcenter	1065	1117	-52	-5%	12339	12407	-68	-1%
I-90 WB, Floating Bridge	2136	2189	-53	-2%	13745	14201	-456	-3%
I-90 WB, Issaquah	1351	1368	-17	-1%	12745	12842	-97	-1%
SR 520 WB, Medina	443	412	31	8%	8431	8873	-442	-5%
SR 167 NB, Kent	2268	2348	-80	-3%	10004	10108	-104	-1%
PM Peak Period (3:00-7:00)	**HOV**				**GP**			
	2002	**2000**	**Number Change**	**% Change**	**2002**	**2000**	**Number Change**	**% Change**
I-5 NB, South Everett	3710	3738	-28	-1%	18321	18486	-165	-1%
I-5 NB, Northgate	5299	5356	-57	-1%	23605	24150	-545	-2%
I-5 SB, South of Seattle CBD	5149	5400	-251	-5%	25385	25596	-211	-1%
I-5 SB, South of Southcenter	4145	4663	-518	-11%	30343	30979	-636	-2%
I-405 NB, Kirkland	5217	4890	327	7%	18516	19005	-489	-3%
I-405 SB, New Castle	5797	6039	-242	-4%	13986	13640	346	3%
I-405 NB, Southcenter	4252	4040	212	5%	15103	14376	727	5%
I-90 EB, Floating Bridge	4362	4375	-13	0%	17830	18133	-303	-2%
I-90 EB, Issaquah	2138	2029	109	5%	17401	17418	-17	0%
SR 520 WB, Medina	1481	1513	-32	-2%	10968	10460	508	5%
SR 167 SB @ S. 208th	3691	3772	-81	-2%	13139	13683	-544	-4%

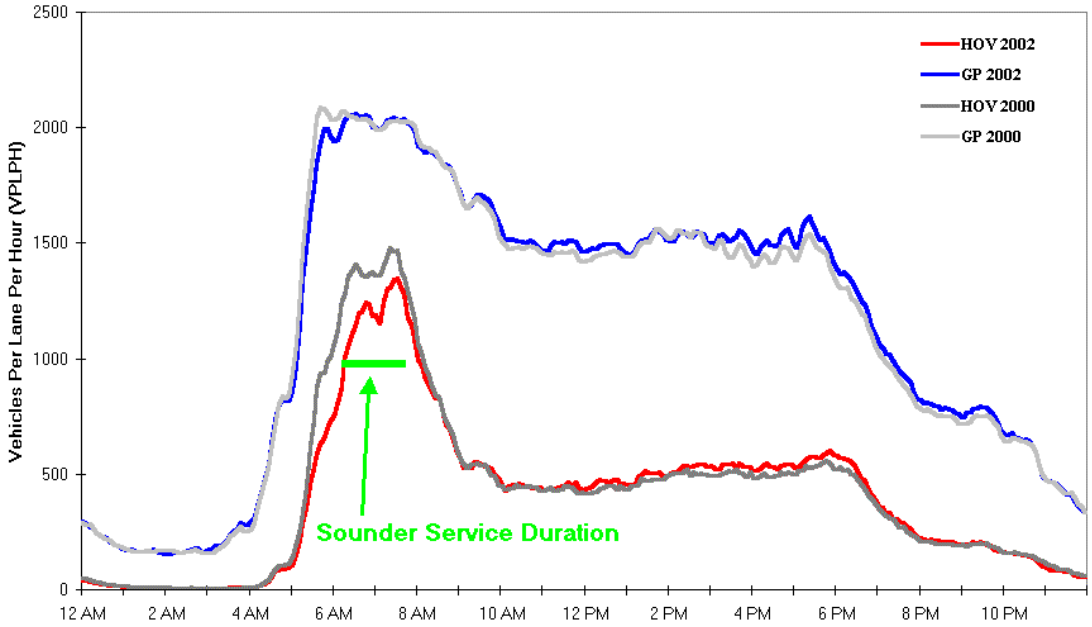

Figure 1: Volume Comparison, I-5 Northbound, South of Southcenter (S. 184th St)

However, not all Sounder passengers are likely to have been former HOV lane users. The decline in HOV lane volume on I-5 starts at 5:45 AM, much earlier in the day than Sounder service begins. Further, the size of the HOV volume decline is much smaller just south of downtown Seattle than it is near Southcenter. This would indicate that at least some of the "lost" carpool volumes were destined for either the Tukwila and Renton employment areas, or those employment centers further north on I-405, rather than towards downtown Seattle. Commuters to these destinations are probably not Sounder passengers, so the HOV losses are likely to be the result of the employment declines on the Eastside and south of Lake Washington.

I-5 southbound in the evening experiences a loss in HOV volumes similar in size and scope to the losses found northbound in the morning. (See Figure 2.)

Interestingly, for both directions at this location, both HOV and GP volumes increase marginally during the midday, while peak period volumes decrease.

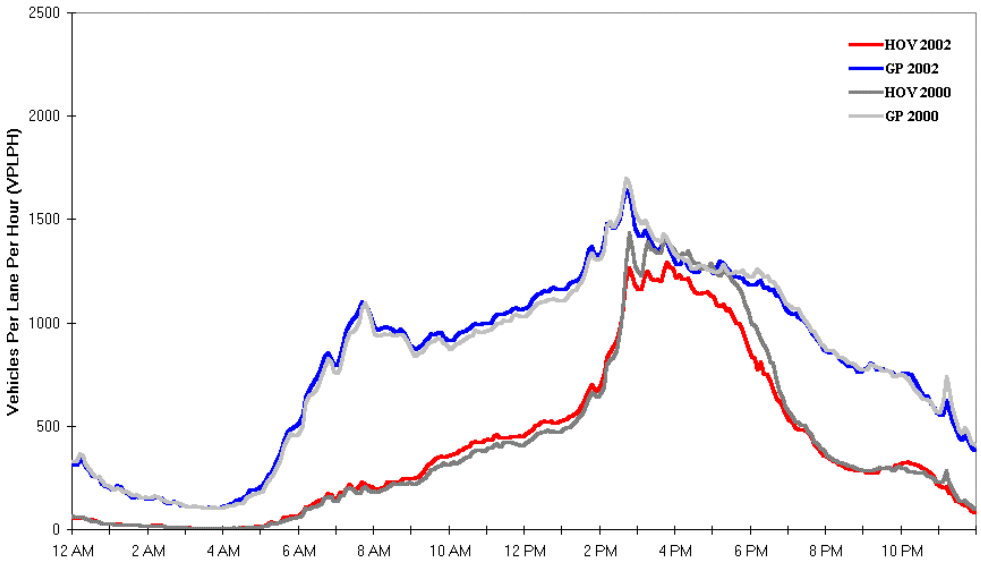

Figure 2: Volume Comparison, I-5 Southbound, South of Southcenter (S. 184th St)

The second largest loss of HOV volume is on the I-405 corridor between Renton and Bellevue. On this section of road, HOV volumes decrease slightly northbound in the morning and southbound in the evening, reflecting the decline in jobs and business activity in the eastside DOT.COM businesses. (See Table 1, and Figures 3 and 4.)

Interestingly, GP lane volumes increase during the peak period on this corridor. The increase probably isn't because there are fewer multi-passenger vehicles or more single passenger vehicles—there is simply less congestion, so more single occupant vehicles actually pass the data collection point during the peak periods. This conclusion is supported by the fact that there is a decline in the frequency of service F congestion (stop and go traffic) at this location. (See Figure 5.)

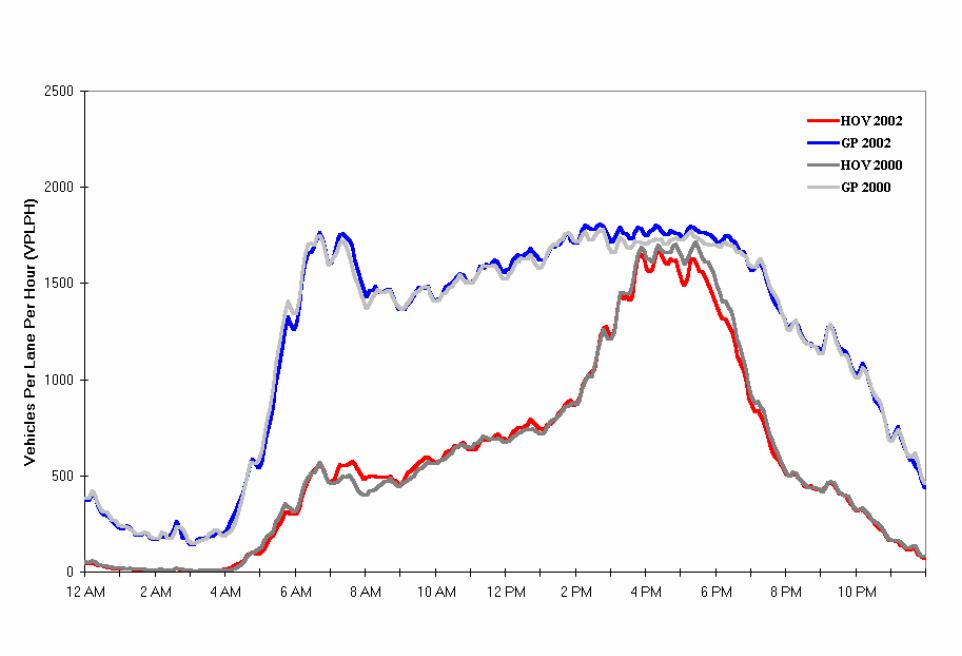

Figure 3: (above) Volume Comparison, I-405 Southbound, Newcastle (SE 52nd St)

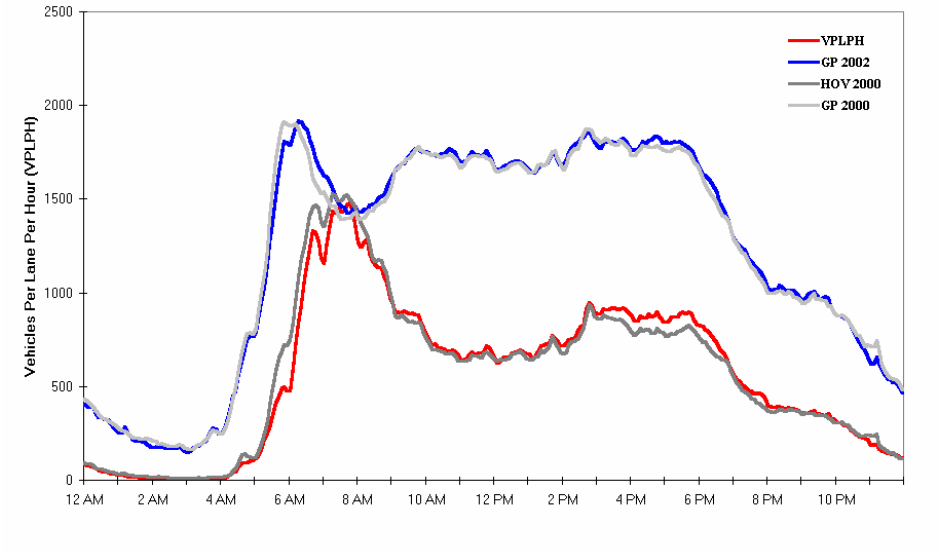

Figure 4: Volume comparison, I-405 Northbound, Newcastle (SE 52nd Street)

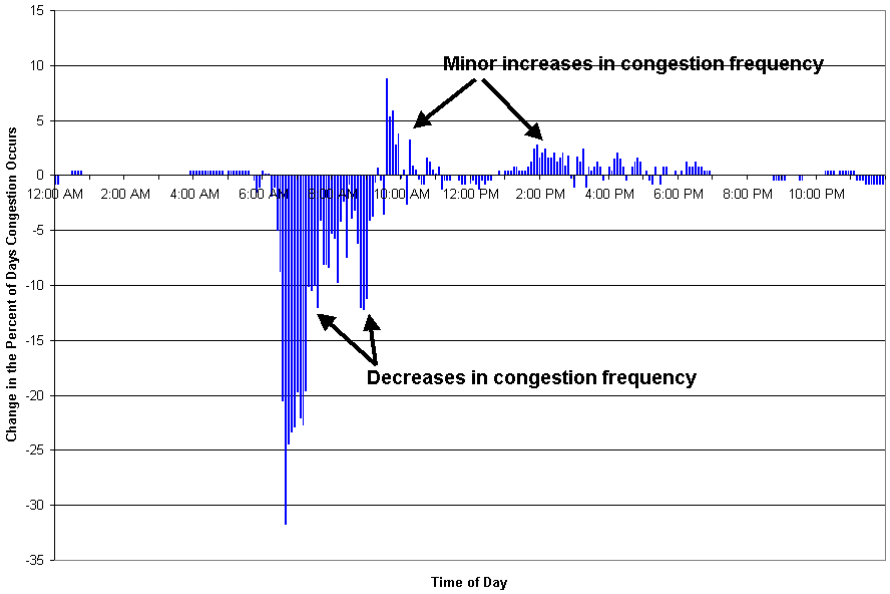

Figure 5: Change in Northbound I-405 GP Lane Congestion Frequency at 52nd Street, 2000-2002

The other interesting trend for this corridor is an increase in afternoon HOV use northbound—the "off-peak" direction—while GP lane use stayed constant. (See Figure 4.) This illustrates one historic HOV trend in the Seattle area that has continued despite the economic slowdown: an increase in HOV volumes on roadways where GP volumes are constrained by capacity.

This pattern of HOV growth in association with GP volume stagnation or decline is also apparent in the evening peak period on I-405 northbound leaving Bellevue. This corridor, the northern section of I-405, is one of three that experience continued peak-period-peak-direction HOV growth. (See Figure 6.)

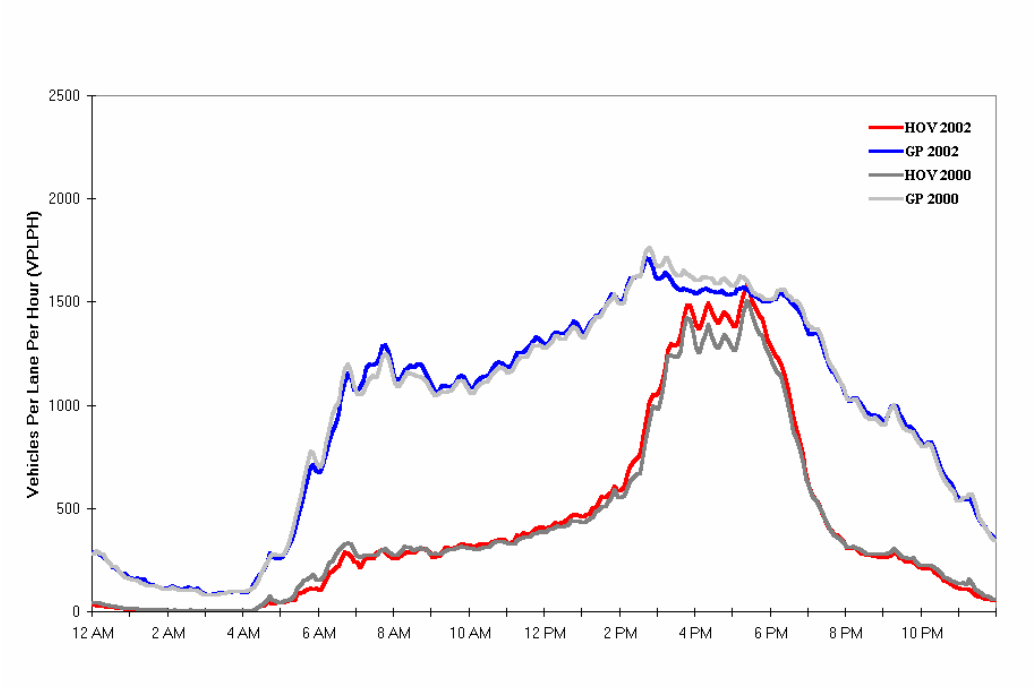

Figure 6: Volume Comparison, I-405 Northbound, Kirkland (NE 85th St)

The slight decline in GP volumes at this location is not the result of lowering single-occupant vehicle demand. Instead it appears to be the result of very high levels of congestion at this location, which limit the number of cars this section of freeway can serve during the afternoon peak period. The increase in the frequency of congestion at this location which causes this decrease in vehicle throughput is illustrated in Figure 7.

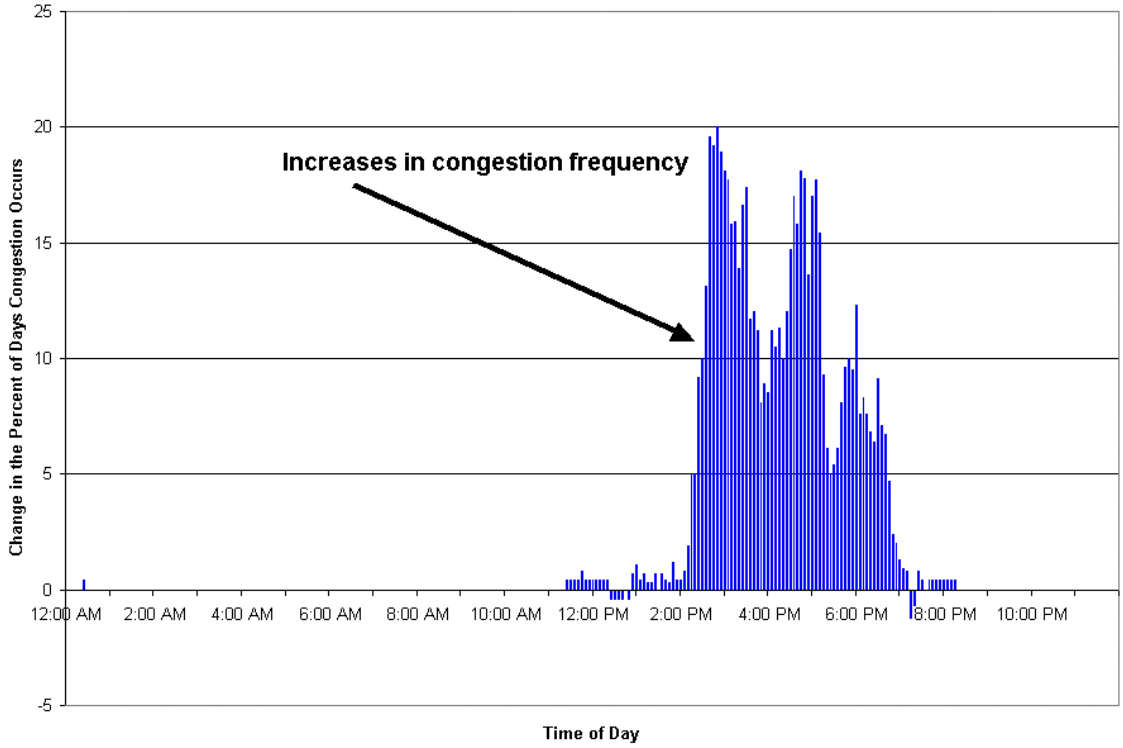

Figure 7: Change in Congestion Frequency from 2000 – 2002
Northbound I-405 GP Lanes, Near Kirkland

The southbound direction of this section of I-405 shows almost no change in GP or HOV traffic volumes. (See Figure 8.) This would imply that the growth in HOV volumes northbound in the evening, are not commuters, but afternoon travelers making non-work trips who are carpooling in order to take advantage of the travel time savings provided by the HOV lanes.

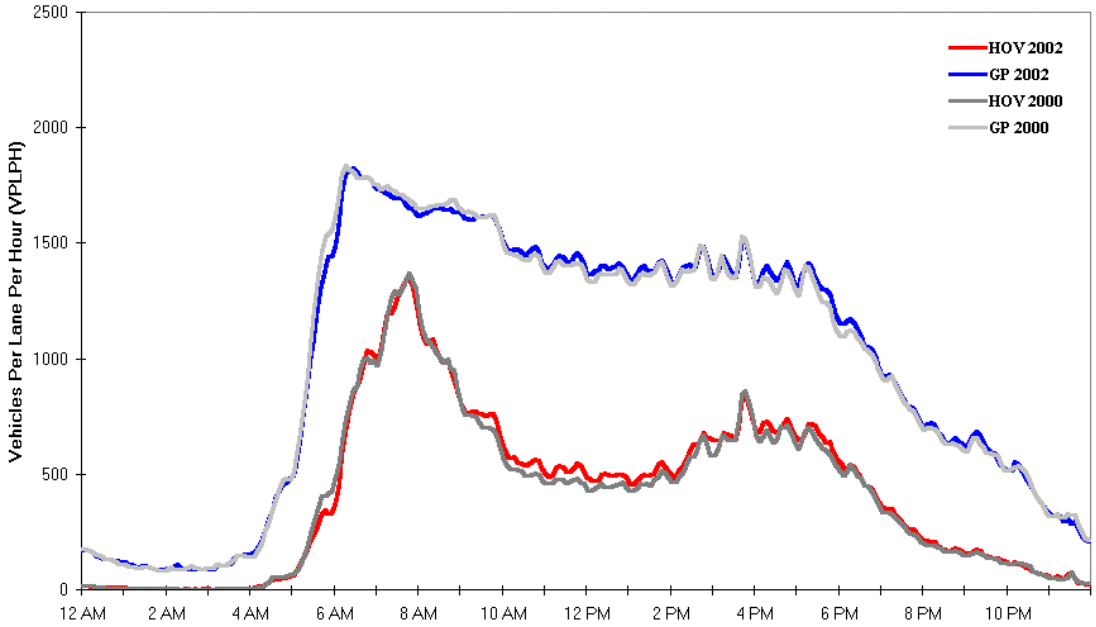

Figure 8: Volume Comparison, I-405 Southbound, Kirkland (NE 85th St)

The other two corridors that experience peak-period-peak- direction increases in HOV volumes are eastbound on I-90 heading towards Issaquah in the evening, and westbound on SR 520 approaching the Evergreen Point Floating Bridge in the morning.

On I-90, HOV morning volume increases do not match the increases in afternoon HOV volumes. (See Figures 9 and 10.) I-90 experiences significant off-peak growth in GP lanes midday, both eastbound and westbound. This growth generally does not continue across Mercer Island and onto the I-90 Floating Bridge. (See Figures 11 and 12.) The conclusion is that the increased HOV lane use on I-90 eastbound towards Issaquah is caused by the lack of general purpose capacity which results in an increase in non-work related carpooling, and/or an increase in HOV lane use by carpools that had previously used the GP lanes.

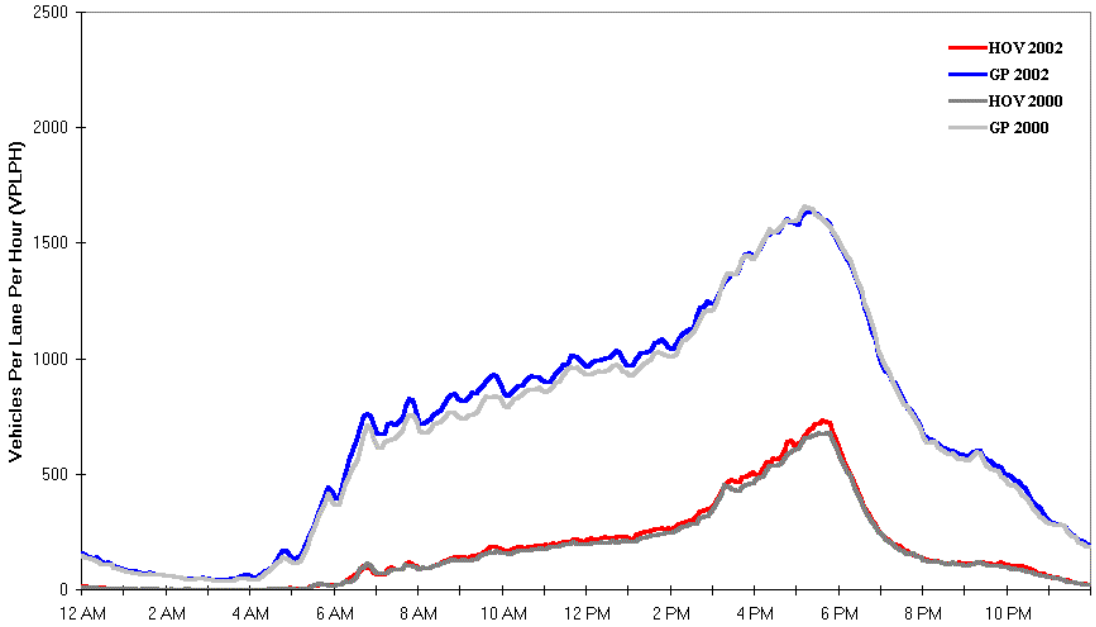

Figure 9: (above) I-90 Eastbound, Issaquah (W Lake Sammamish Pkwy)

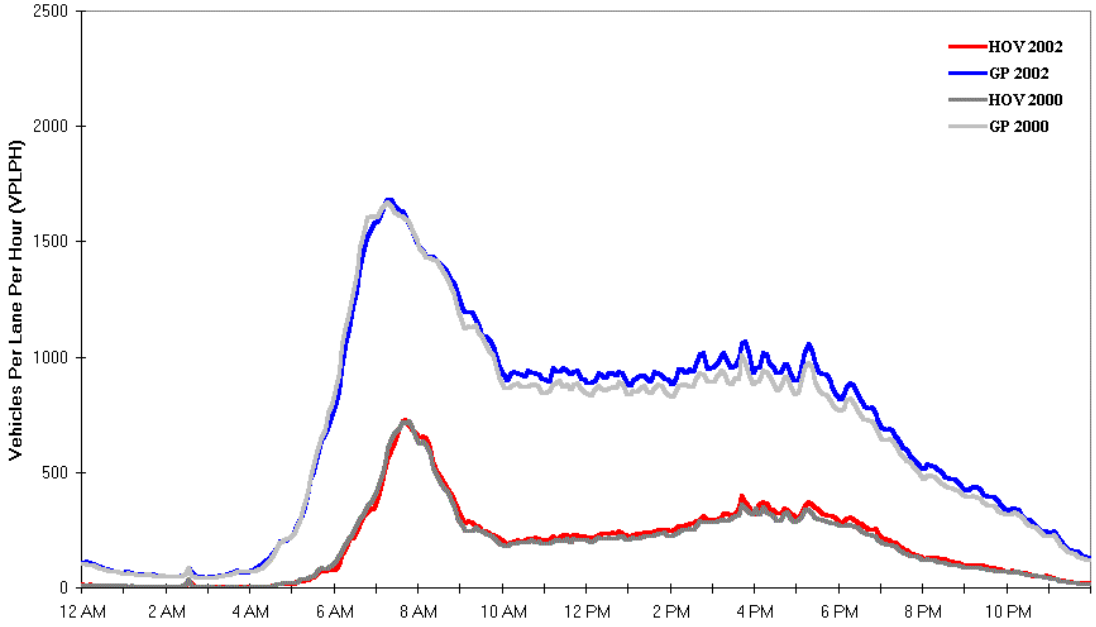

Figure 10: I-90 Westbound, Issaquah (W Lake Sammamish Pkwy)

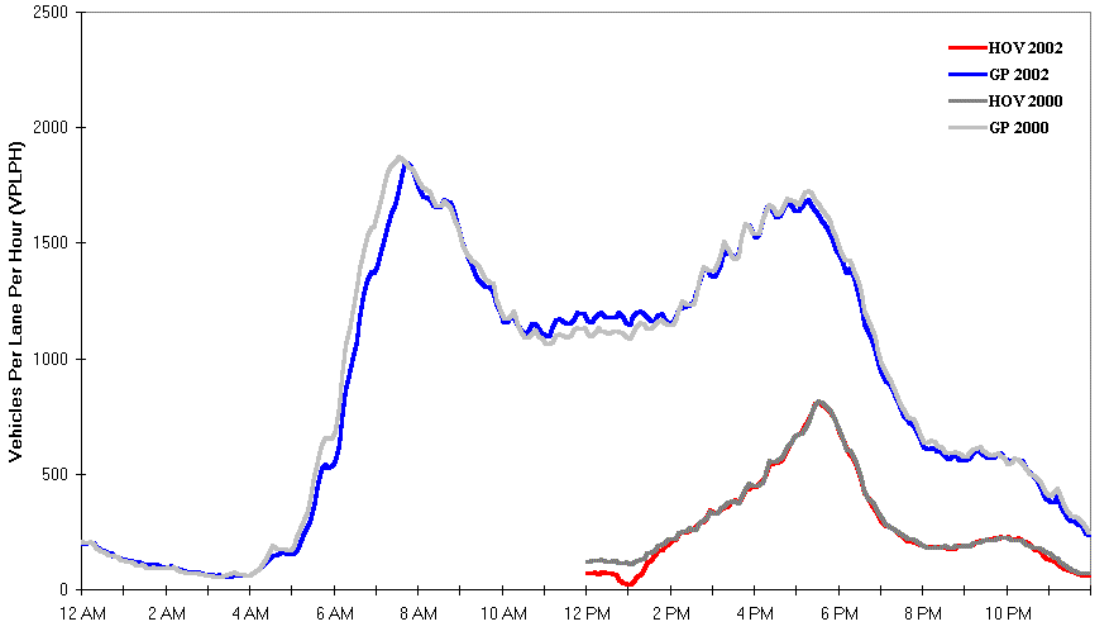

Figure 11: (above) I-90 Eastbound, Floating Bridge (Midspan)

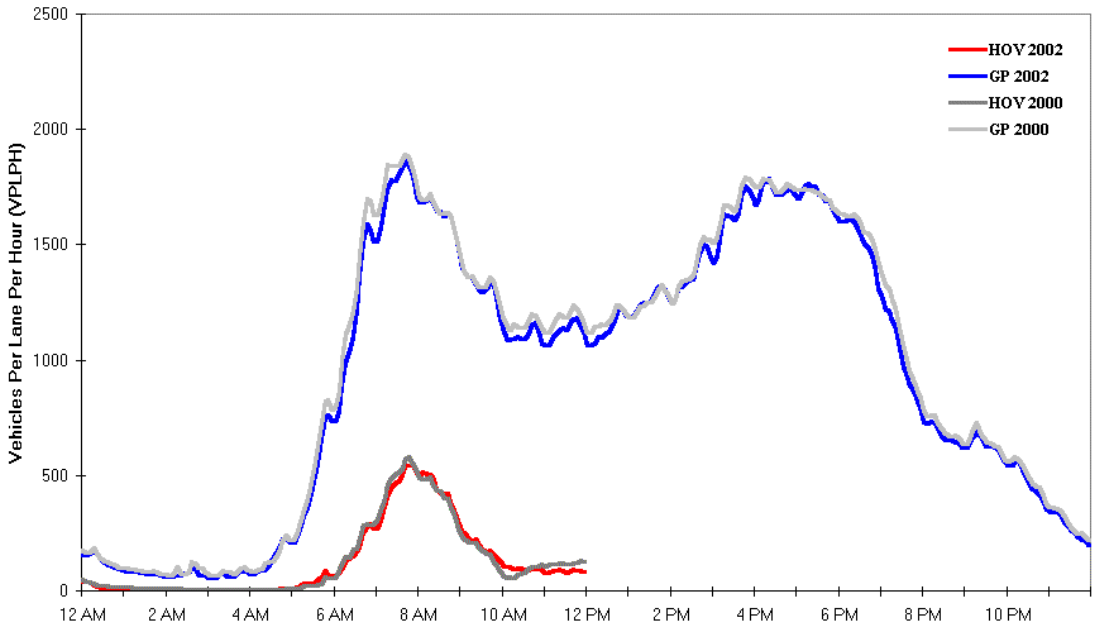

Figure 12: I-90 Westbound, Floating Bridge (Midspan)

On SR 520, the change in peak period morning vehicle volumes is fairly high on a percentage basis (8 percent), but quite small on an absolute basis (roughly 30 vehicles). The afternoon "decline" is similarly sized. Both changes are too small to represent significant changes in HOV use.

All other monitored HOV corridors show similar, inconsequential changes in vehicle volumes in the HOV lanes. Additional graphics that illustrate the time-of-day volumes on other study corridors are shown at the end of this report.

It is possible to observe the overall change in the share of vehicles with more than one person by comparing changes in HOV and SOV vehicle volumes: These are the change in the percentage of vehicles occupying the HOV lanes during the peak periods on each of the monitored corridors. (See Table 2.)

- Three corridors show HOV vehicle volume increases relative to single occupant volumes.
- Eight corridors show a relative decline in HOV vehicles.
- Eleven corridors showed no change.

Table 2. Change in HOV Lane Share of Vehicle Throughput (2002 vs. 2000)

AM Peak Period (6:00-9:00)	2002	2000	Change
I-5 SB, South Everett	11%	12%	0%
I-5 SB, Northgate	20%	21%	-1%
I-5 NB, South of Seattle CBD	15%	16%	-1%
I-5 NB, South of Southcenter	12%	13%	-1%
I-405 SB, Kirkland	17%	17%	0%
I-405 NB, New Castle	27%	30%	-3%
I-405 SB, Southcenter	8%	8%	0%
I-90 WB, Floating Bridge	13%	13%	0%
I-90 WB, Issaquah	10%	10%	0%
SR 520 WB, Medina	5%	4%	1%
SR 167 NB, Kent	18%	19%	0%
PM Peak Period (3:00-7:00)	**2002**	**2000**	**Change**
I-5 NB, South Everett	17%	17%	0%
I-5 NB, Northgate	18%	18%	0%
I-5 SB, South of Seattle CBD	17%	17%	-1%
I-5 SB, South of Southcenter	12%	13%	-1%
I-405 NB, Kirkland	22%	20%	2%
I-405 SB, New Castle	29%	31%	-1%
I-405 NB, Southcenter	22%	22%	0%
I-90 EB, Floating Bridge	20%	19%	0%
I-90 EB, Issaquah	11%	10%	1%
SR 520 WB, Medina	12%	13%	-1%
SR 167 SB @ S. 208th	22%	22%	0%

Person Throughput

Person-throughput for a specific corridor is a measure of transit ridership plus the number of people in cars and trucks. The number of people in cars is the car volume times the number of people in each car (average car occupancy or ACO). Changes in ACO and transit ridership are, in theory, independent of changes in vehicle volumes. However, between 2000 and 2002, all three variables frequently follow similar trends. When this happens, changes in person-throughput are more significant than changes in vehicle volume alone.

In general, most corridors show a slight decline in peak-period person throughput in the HOV lanes with a few corridors showing more significant declines. (See Table 3.) Person throughput also tends to decline in the GP lanes.

In most cases, the decline is smaller than the statistical precision of the measurement process can accurately measure, and is thus considered insignificant. However, in a few corridors, the combined changes in transit ridership,[4] the declines in HOV vehicle use, and an increase in HOV lane violation rates results in a statistically significant decline in person throughput.

Here are some key observations:

I-5 in the south end experiences the greatest reduction in person throughput between 2000 and 2002. The economic slowdown and the introduction of Sounder Commuter train service combine to reduce both bus ridership and carpooling. Significant reductions in person throughput occur both northbound during the morning commute period and southbound during the evening commute period. There are also declines in person throughput in the general purpose lanes, but on a smaller scale.

Three other corridors experience significant losses in person throughput. These corridors are I-405 southbound in the morning near Southcenter, SR 520 westbound in the afternoon, and the I-90 eastbound reversible lanes in the evening. None of these corridors experience equally significant losses in HOV vehicle throughput. Reduced person throughput is caused by losses in transit ridership and a decline in average car occupancy.

[4] This report uses transit ridership numbers provided by the various transit service providers. A detailed review of transit ridership is beyond the scope of this study.

Table 3. Person Throughput 2002 vs. 2000

AM Peak Period (6:00-9:00)	HOV				GP			
	2002	2000	Number Change	% Change	2002	2000	Number Change	% Change
I-5 SB, South Everett	4551	4276	276	6%	16247	17407	-1160	-7%
I-5 SB, Northgate	13721	14924	-1203	-8%	18560	18813	-253	-1%
I-5 NB, South of Seattle CBD	11943	13503	-1560	-12%	24994	26850	-1856	-7%
I-5 NB, South of Southcenter	10301	12020	-1719	-14%	28701	28868	-167	-1%
I-405 SB, Kirkland	7295	7376	-81	-1%	17588	18048	-460	-3%
I-405 NB, New Castle	8377	8889	-512	-6%	11110	11131	-21	0%
I-405 SB, Southcenter	2251	2617	-366	-14%	15056	14931	125	1%
I-90 WB, Floating Bridge	6141	6416	-275	-4%	15368	15957	-589	-4%
I-90 WB, Issaquah	3400	3604	-204	-6%	14202	14539	-337	-2%
SR 520 WB, Medina	4087	4169	-82	-2%	9294	10505	-1212	-12%
SR 167 NB, Kent	4926	4966	-41	-1%	11699	12226	-527	-4%
PM Peak Period (3:00-7:00)	**HOV**				**GP**			
	2002	2000	Number Change	% Change	2002	2000	Number Change	% Change
I-5 NB, South Everett	9213	9293	-80	-1%	23193	23464	-271	-1%
I-5 NB, Northgate	17807	18011	-205	-1%	27284	29638	-2354	-8%
I-5 SB, South of Seattle CBD	16599	17590	-991	-6%	32049	33884	-1835	-5%
I-5 SB, South of Southcenter	12717	14571	-1854	-13%	36263	37073	-810	-2%
I-405 NB, Kirkland	12443	11255	1188	11%	20809	22777	-1968	-9%
I-405 SB, New Castle	13200	13226	-26	0%	15714	15848	-133	-1%
I-405 NB, Southcenter	9265	9297	-32	0%	17462	16559	902	5%
I-90 EB, Floating Bridge	9429	10775	-1346	-12%	19927	21071	-1144	-5%
I-90 EB, Issaquah	4916	4700	216	5%	20767	21101	-334	-2%
SR 520 WB, Medina	4482	5274	-792	-15%	12120	12055	65	1%
SR 167 SB @ S. 208th	8456	8006	450	6%	15411	16626	-1215	-7%

Several corridors do, however, experience an increase in person throughput in the HOV lanes. These corridors include I-90 eastbound approaching Issaquah in the evening, I-5 southbound leaving the Everett area in the morning, I-405 northbound in the evening through Kirkland, and SR 167 southbound in the evening.

Of these, only I-405 northbound through Kirkland show more than a 10 percent increase in overall corridor throughput: HOV vehicle volume grows by 7 percent, transit ridership increases, and the number of non-passenger car users of the HOV lanes increases. (Non-passenger cars in the HOV lanes are mostly small commercial trucks with two or more passengers.) SR 167 southbound in the evening also experiences a significant increase in the number of two-person commercial, light duty trucks using the HOV lanes.

It is notable that the I-90 reversible lanes eastbound crossing Mercer Island shows a decrease in person throughput in the evening while the eastbound I-90 HOV lanes approaching Issaquah experience an increase in person throughput. This is partly because the reversible lanes portion of I-90 has no change in vehicle volume, while volumes increase near Issaquah by 5 percent. Transit ridership also increases near Issaquah, but declined slightly over the I-90 floating bridge.

Finally, average car occupancy drops considerably in the reversible lanes on I-90, while changing only slightly approaching Issaquah. It is not known how many of the increasing percentage of single occupant vehicles on the reversible lanes are violating the HOV lane restrictions, and how many are legitimately destined for Mercer Island.

Table 4 shows the relative change in the percentage of person throughput occurring in the HOV lanes at each of the monitored locations. Of all 22 monitored locations, seven show an increase in the HOV lane use by comparison to GP lanes, while twelve locations showe a decline, and five show no change.

A key contributor to changes in person throughput on the HOV lanes is the change observed in the average car occupancy (ACO) for each corridor. Car occupancy statistics describe how frequently people are choosing to carpool, as well as how often they are violating the HOV rules set by the Department of Transportation.

Unfortunately, average car occupancy is a volatile statistic, and fluctuations captured in this statistical measurement can create “artificial” changes in estimated person throughput that vacillate to the point of unreliability. Consequently, minor changes in measured ACO, and subsequent minor changes in estimated person throughput, are considered statistically insignificant. However, major changes in ACO are usually a reliable description of significant changes in public behavior.

Table 4. Change in HOV's Share on Person Throughput (2002 vs. 2000)

AM Peak Period (6:00-9:00)	2002	2000	Change
I-5 SB, South Everett	22%	20%	2%
I-5 SB, Northgate	43%	44%	-2%
I-5 NB, South of Seattle CBD	32%	33%	-1%
I-5 NB, South of Southcenter	26%	29%	-3%
I-405 SB, Kirkland	29%	29%	0%
I-405 NB, New Castle	43%	44%	-1%
I-405 SB, Southcenter	13%	15%	-2%
I-90 WB, Floating Bridge	29%	29%	0%
I-90 WB, Issaquah	19%	20%	-1%
SR 520 WB, Medina	31%	28%	2%
SR 167 NB, Kent	30%	29%	1%
PM Peak Period (3:00-7:00)	**2002**	**2000**	**Change**
I-5 NB, South Everett	28%	28%	0%
I-5 NB, Northgate	39%	38%	2%
I-5 SB, South of Seattle CBD	34%	34%	0%
I-5 SB, South of Southcenter	26%	28%	-2%
I-405 NB, Kirkland	37%	33%	4%
I-405 SB, New Castle	46%	45%	0%
I-405 NB, Southcenter	35%	36%	-1%
I-90 EB, Floating Bridge	32%	34%	-2%
I-90 EB, Issaquah	19%	18%	1%
SR 520 WB, Medina	27%	30%	-3%
SR 167 SB @ S. 208th	35%	33%	3%

Table 5 shows the ACO value as measured between 1999 and 2002 for each of the monitored corridors. This is an excellent illustration of the volatility of the ACO statistic. Comparing the 2002 ACO values against both 1999 and 2000 statistics shows that ten of the 22 entries[5] have 2002 ACO values that are lower than all of the available 1999 and 2000 ACO entries for that location. In only one case is the 2002 value higher than all of the available 1999 and 2000 data for that location. At the remaining eleven sites, the 2002 data is equal to, or below, the 1999 and 2000 ACO values.

[5] Note that five of these entries have data for either 1999 or 2000, but not both years.

Table 5. Changes in Measured ACO Over Time

AM Peak Period (6:00-9:00)	1999	2000	2001	2002
I-5 SB, South Everett	2.06	2.01	2.02	2.06
I-5 SB, Northgate	2.13	1.86	2.04	2.00
I-5 NB, South of Seattle CBD	1.79	2.02	1.61	1.77
I-5 NB, South of Southcenter	2.1	2.01	2.16	na
I-405 SB, Kirkland	2.12	na	na	2.01
I-405 NB, New Castle	2.07	2.04	2.20	1.98
I-405 SB, Southcenter	2.08	1.95	na	1.99
I-90 WB, Floating Bridge	1.52	1.63	1.48	1.49
I-90 WB, Issaquah	2.08	na	na	1.90
SR 520 WB, Medina	2.63	na	2.38	2.53
SR 167 NB, Kent	2.04	1.99	na	2.03
PM Peak Period (3:00-7:00)				
I-5 NB, South Everett	2.17	2.15	2.08	2.12
I-5 NB, Northgate	2.16	2.08	2.08	2.10
I-5 SB, South of Seattle CBD	2.11	2.20	na	2.14
I-5 SB, South of Southcenter	2.16	2.14	2.06	na
I-405 NB, Kirkland	2.09	2.01	2.10	2.07
I-405 SB, New Castle	2.03	2.16	2.04	2.01
I-405 NB, Southcenter	2.09	2.15	na	2.04
I-90 EB, Floating Bridge	1.80	1.82	1.64	1.51
I-90 EB, Issaquah	2.12	na	na	2.09
SR 520 WB, Medina	2.63	na	2.79	2.35
SR 167 SB @ S. 208th	2.02	na	na	2.07

na = data not available during that year

The conclusion is that ACO declines slightly from 1999/2000 to 2002, reflecting a change in carpooling frequency or, more commonly, a change in violation rates. A closer examination of data shows that the majority of this decline is due to an increase in the frequency of HOV lane violations, even though the total percentage of those violations is still relatively modest. Violation rates for each corridor are shown in Table 6.

Table 6. HOV Lane Violation Rates By Corridor and Location

AM Peak Period (6:00-9:00)	Violation Rate 2002
I-5 SB, South Everett	1%
I-5 SB, Northgate	6%
I-5 NB, South of Seattle CBD	N.A.
I-5 NB, South of Southcenter	2%
I-405 SB, Kirkland	2%
I-405 NB, New Castle	5%
I-405 SB, Southcenter	8%
I-90 WB, Floating Bridge	N.A.
I-90 WB, Issaquah	4%
SR 520 WB, Medina	6%
SR 167 NB, Kent	4%
PM Peak Period (3:00-7:00)	**Violation Rate 2002**
I-5 NB, South Everett	1%
I-5 NB, Northgate	1%
I-5 SB, South of Seattle CBD	1%
I-5 SB, South of Southcenter	1%
I-405 NB, Kirkland	3%
I-405 SB, New Castle	5%
I-405 NB, Southcenter	4%
I-90 EB, Floating Bridge	N.A.
I-90 EB, Issaquah	5%
SR 520 WB, Medina	8%
SR 167 SB @ S. 208th	4%

Violation rates themselves are a volatile statistic. Individual behavior tends to be very different than group behavior. Most drivers tend to follow the HOV eligibility rules, and traditionally Seattle has among the lowest HOV violation rates in the country. However, if drivers observe other motorists violating the HOV lane restrictions without being caught by law enforcement, violation rates tend to increase quickly. These increases are location and day specific.

Violation rates are location specific, and can vary considerably along a corridor. However, they tend to increase at the very end of an HOV lane since many drivers apparently think that it isn't "a real violation" if they jump into the HOV lane during the last one-half mile of the facility. Violation rates at most locations on most days are well

below 5 percent. On the unusual days when violations soar, violation rates routinely reach 10 percent. However near the end of an HOV facility, especially where the HOV lane becomes a GP lane, as on southbound SR 167, violation rates are routinely near 5 percent and can go above 20 percent on a "high violation rate" day.

Violations are "day specific" in that violation rates at almost all locations tend to be quite low for most of the days data are being collected, but relatively high on one or two days. Insufficient data are available to determine why violation rates for some days are so much higher than on other days.

A single day at a single location with a high violation rate can significantly alter ACO values, but this may be statistically insignificant since peak period ACO measurements are only taken five to eight times per year, per location. However, if many locations show similar increases in violations, there's a trend. And that's what appears to be happening now, in the Puget Sound Region.

HOV LANE PERFORMANCE

Puget Sound Region's adopted public policy is that HOV lanes are intended to operate at 45 mph or faster, 90 percent of the time. In 2002, five of the 14 corridors monitored[6] fell below this standard, and one of those five began to meet the standard after completion of latest HOV lane extension on I-5 approaching Federal Way. This is a significant improvement over 2000 when more than half of the corridors did not meet the standard. This improvement appears to be the result of the minor decline in HOV lane vehicle volumes plus operational improvements, such as the increased emphasis on incident response, implemented by WSDOT. In addition, it must be pointed out that while the results are reported here for entire corridors, it is a small number of spot locations where performance fails to meet the adopted standard. Thus, out of the 205 miles of freeway HOV lanes, all but a few miles achieve the performance standard.

The HOV lanes in the I-90 and SR 167 corridors still routinely travel at free flow speeds throughout the day in both directions.

The HOV lanes in the I-405 corridor show enough improvement that three previously failed facilities now achieve the standard. Of the five corridors that still fail to meet standards, four are on I-5 and one is on SR 520. Performance of all HOV corridors on I-5 fall below the adopted policy standard in the peak directions in 2002. (See Figures 13-16.) However, three of the four corridors did show performance improvements in 2002, with the southbound, southern corridor meeting the standard in the evening peak after the extension of the HOV lane to Federal Way was completed. The lone exception to the improvement trend was the corridor north of the Seattle CBD, northbound, when the PM peak period showed a slight decline in performance.

All four of the I-5 corridors suffer from significant geometric limitations that, when combined with high vehicle volumes, cause congestion. The most significant

[6] A "corridor" is defined both geographically and directionally. So that I-405 from its southern terminus to I-90 is considered two corridors, one southbound and one northbound.

geometric bottlenecks are located at one or both end points of the HOV facilities. The most significant bottlenecks are the entrances and exits to the reversible express lanes, and the former end point of the HOV lane southbound near Des Moines, where there is considerable lane changing when many vehicles enter and leave the HOV lanes to and from the GP lanes.

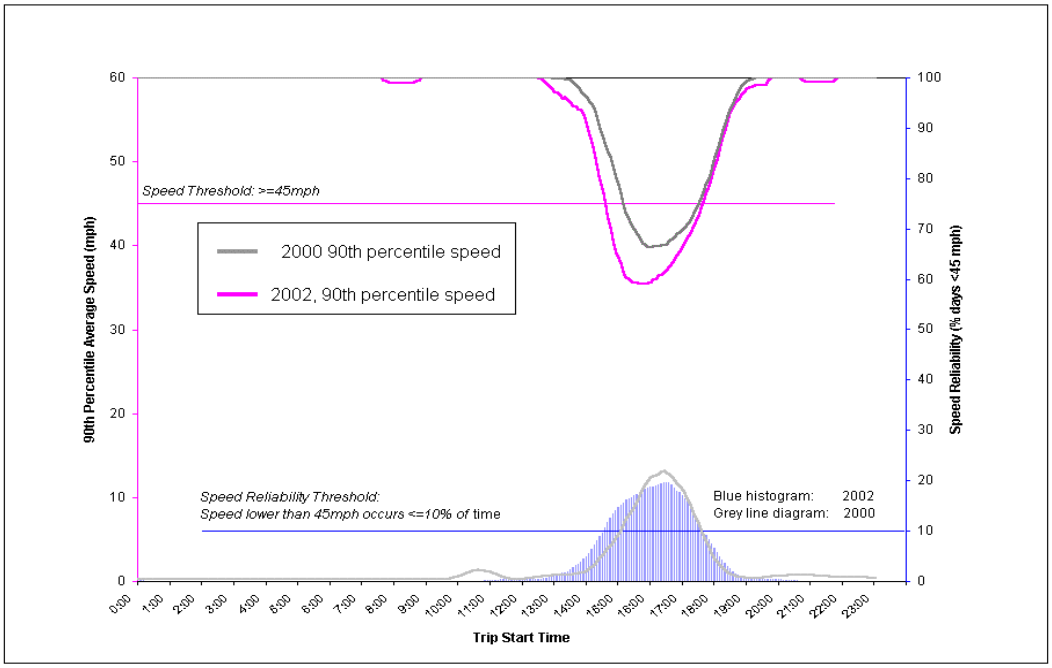

Figure 13.[7] Change in HOV Speed and Reliability: I-5 Northbound, North of the Seattle CBD, Northgate to 112th St SW

[7] This figure illustrates the 90th percentile travel speed for the named corridor (the pink and gray lines at the top of the graphic, read off of the left hand axis.) It also illustrates the frequency (percent of time) with which the HOV lane fails the 45 mph standard. This is shown at the bottom of the graphic as the blue histogram (and accompanying gray line), and is read using the axis on the right side of the graphic

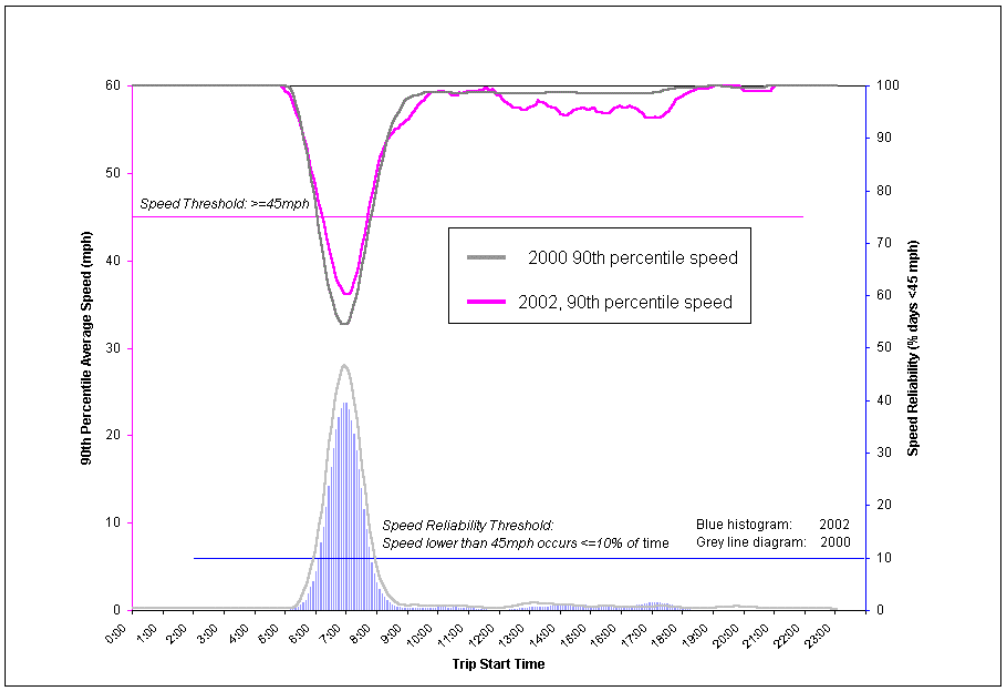

Figure 14. (above) Change in HOV Speed and Reliability: I-5 Southbound, North of the Seattle CBD, SR 526 Interchange to Northgate

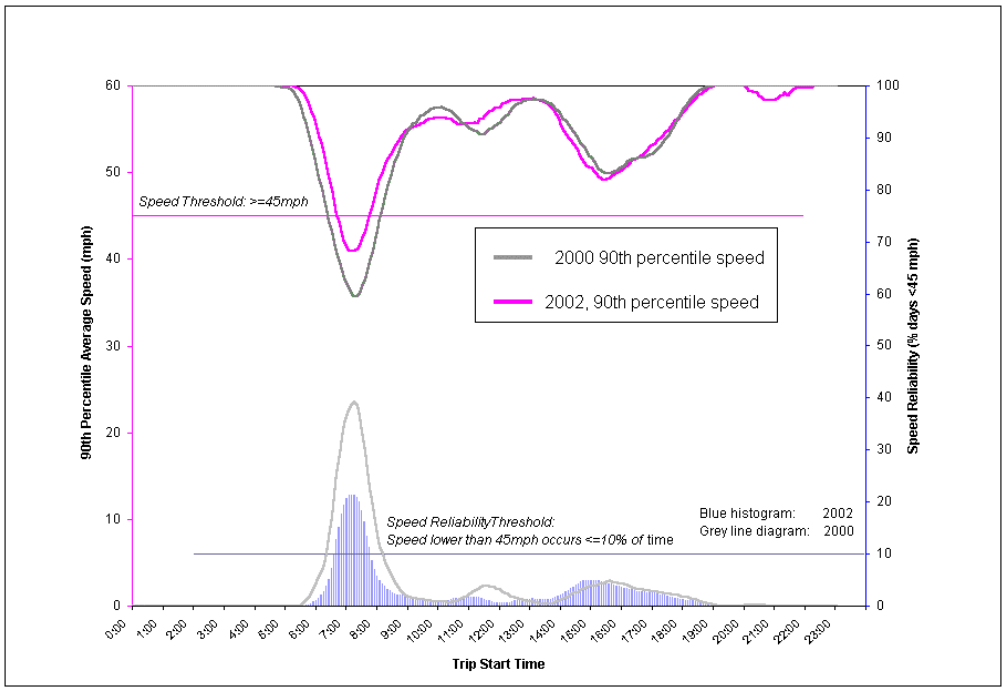

Figure 15. Change in HOV Speed and Reliability: I-5 Northbound, South of the Seattle CBD, S 184th St to Columbian Way

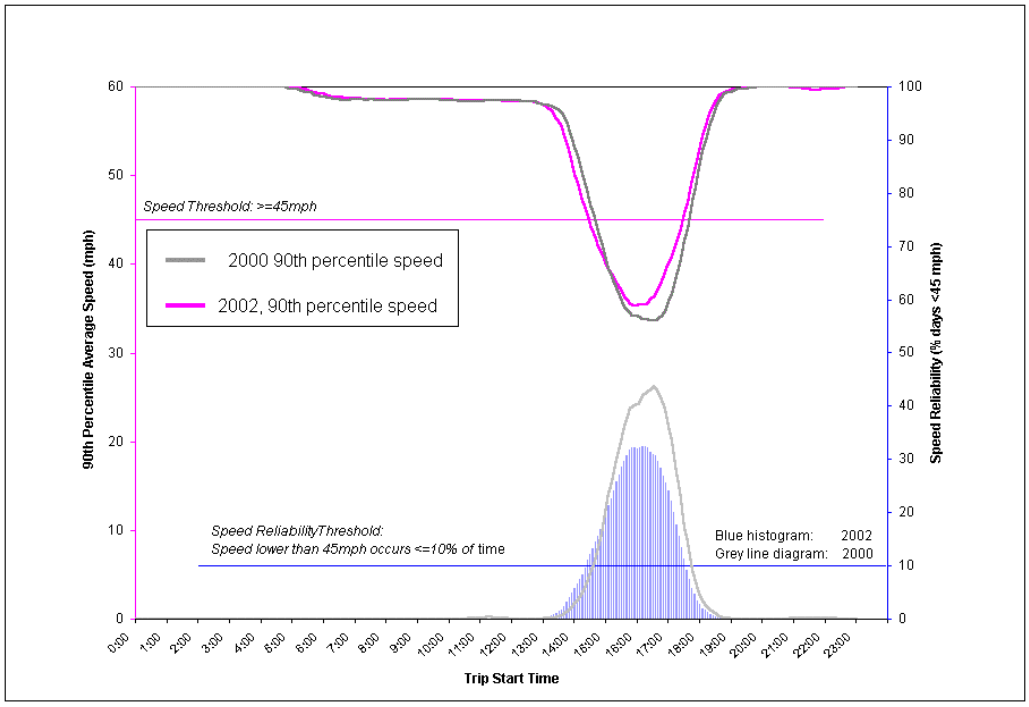

Figure 16. Change in HOV Speed and Reliability: I-5 Southbound, South of the Seattle CBD, S Spokane St to S 184th St

The resulting congestion from merging causes frequent slowdowns in both the HOV and GP lanes, and is one of the primary causes of failure to meet performance standards. However, since October 2002, the southbound end point of the HOV lane near Des Moines has been extended southwards resulting in a significant improvement in HOV lane performance. This improvement is discussed later in this report.

The fifth segment that does not meet the HOV lane performance standard is the westbound HOV lane on SR 520. Here, frequent slowing is the result of two conditions: 1) friction between the narrow HOV lane and the adjacent, heavily congested GP lanes, and 2) merge congestion associated with the HOV lane drop at the eastern end of the Evergreen Point floating bridge. While still falling below the performance standard, it does improve over 2001. (See Figure 17.) No data is available from 2000 because construction occurs east of the SR 520/I-405 interchange during much of that year.

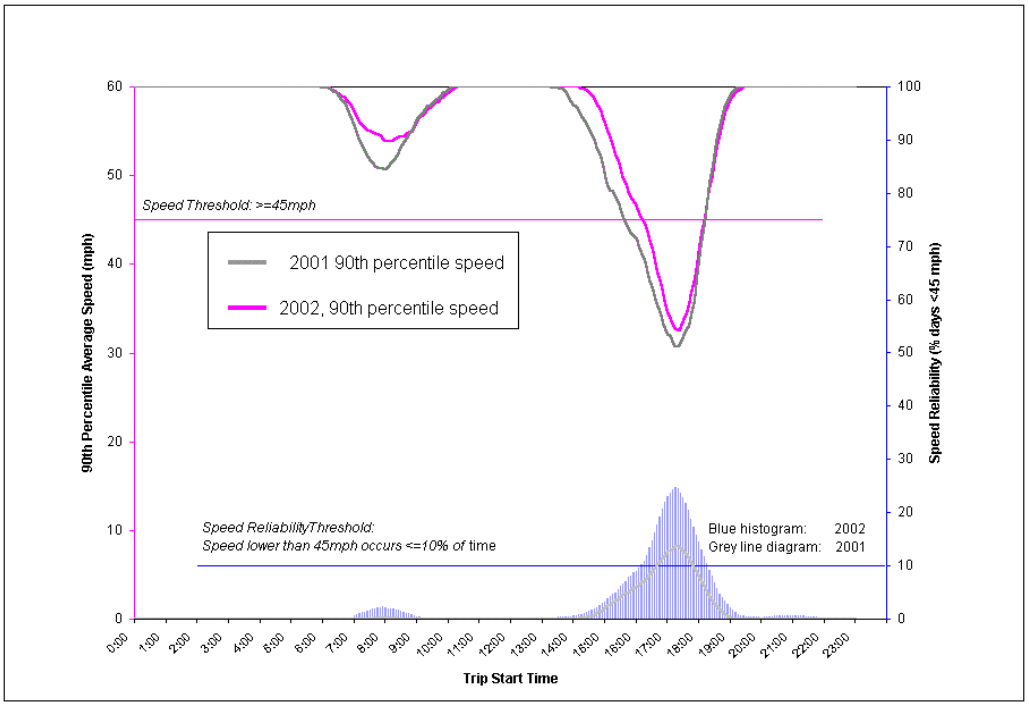

Figure 17. Change in HOV Speed and Reliability: Westbound SR 520, W Lake Sammamish Parkway to 84th Ave NE, 2002 versus 2001

Along the I-5 corridor, the southern and northern most termini of the HOV lanes can be extended by building additional roadway lanes; these improvements are currently planned. But the north and southbound end points at Northgate and the southern entrance to the Express lanes will require extensive redesign and reconstruction to achieve operational improvements. SR 520 improvement is tied to the replacement of the aging Evergreen Point Floating bridge.

Meanwhile, HOV lanes on I-405 operate better in 2002 than in 2000. All three segments on I-405 that had previously failed the performance standard in 2000, meet the standard in 2002. (See Figure 18.)

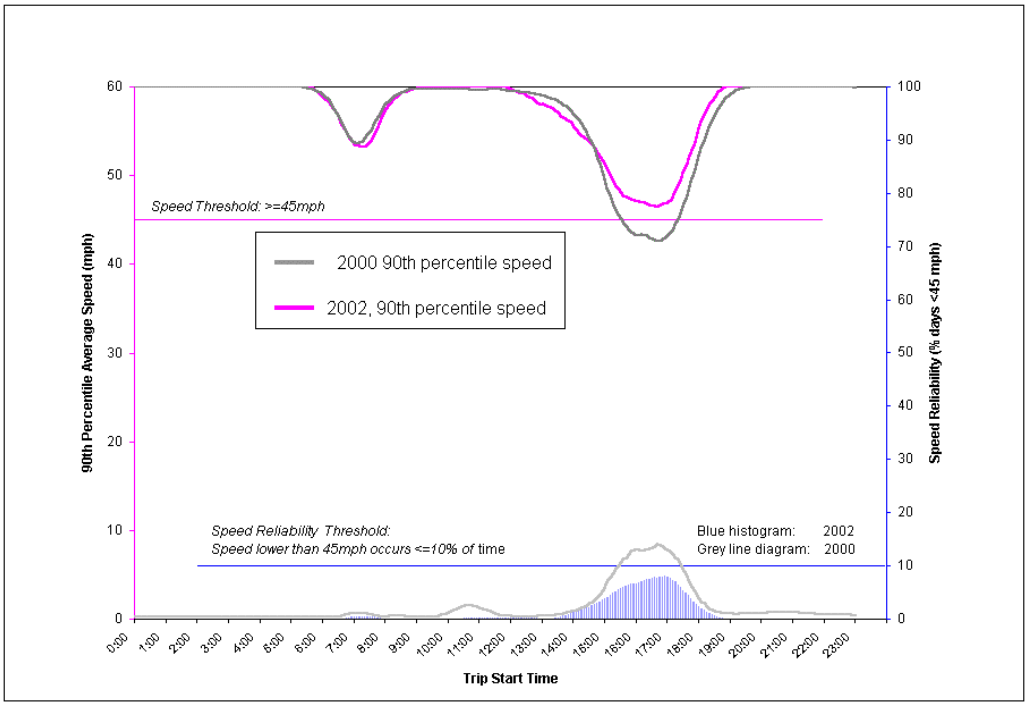

Figure 18. Change in HOV Speed and Reliability: Northern I-405 Corridor, Southbound Direction, 231st St SE to I-90 Interchange, 2002 versus 2000

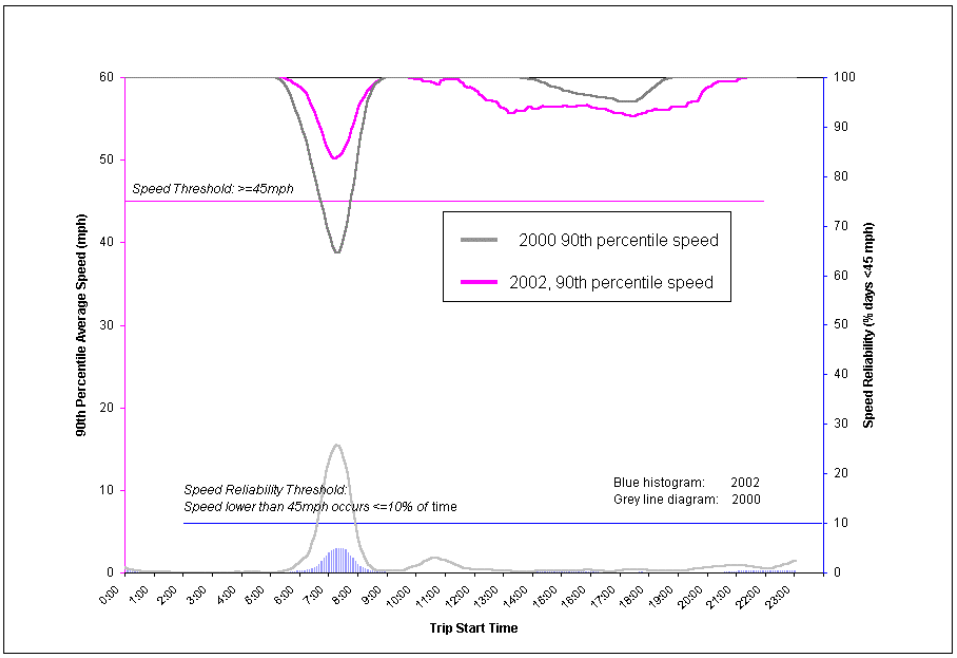

Figure 19. (above) Change in HOV Speed and Reliability: Southern I-405, Northbound Direction, W Valley Hwy to I-90 Interchange, 2002 versus 2000

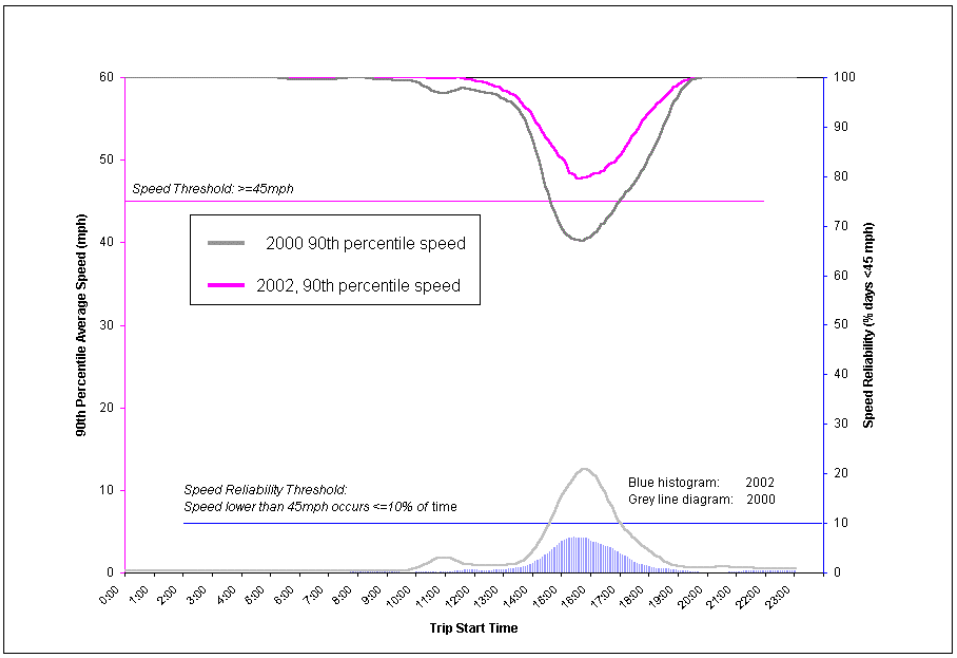

Figure 20. Change in HOV Speed and Reliability: Southern I-405, Southbound Direction, I-90 Interchange to Andover Park E, 2002 versus 2000

SEASONAL EFFECT ON TRAVEL RELIABILITY

In this section, the seasonal effects on roadways are examined. The decision to examine this aspect of travel reliability came as a result of evidence gained while monitoring the results of a major WSDOT construction project: the extension of the HOV lanes southbound on I-5 near Federal Way, completed in October 2002. During the analysis to determine how the extension affected HOV lane performance, it became apparent that roadway performance often varied as a result of seasonal changes in weather patterns, recreational travel patterns, and commute behavior. It was decided that a study of seasonal conditions should factor into monitoring studies. The results of that investigation, along with the effects of the HOV lane extension, are presented below.

I-5 NORTH OF THE SEATTLE CBD

Northbound

A comparison of quarterly HOV Lane Performance Northbound I-5, Northgate to Everett, (see Figure 21) provides an excellent example of the diversity of performance found in the HOV lanes. In this case, HOV lanes met the regional performance goal of 45 mph 90 percent of the time during winter quarter. This was the corridor's best quarter in 2002. Meanwhile summer quarter performance failed the standard, dropping to almost 30 mph 90 percent of the time, the corridor's worst performance for the year 2000.

August was a particularly bad month for congestion. (See Figure 22.) It was also a month when the number of vehicles using the HOV lane increased significantly in the afternoons. One possibility is that these increases are caused by recreational travelers (which frequently qualify as carpools) heading out-of-town on Thursday and Friday, creating increased congestion in the HOV lanes.

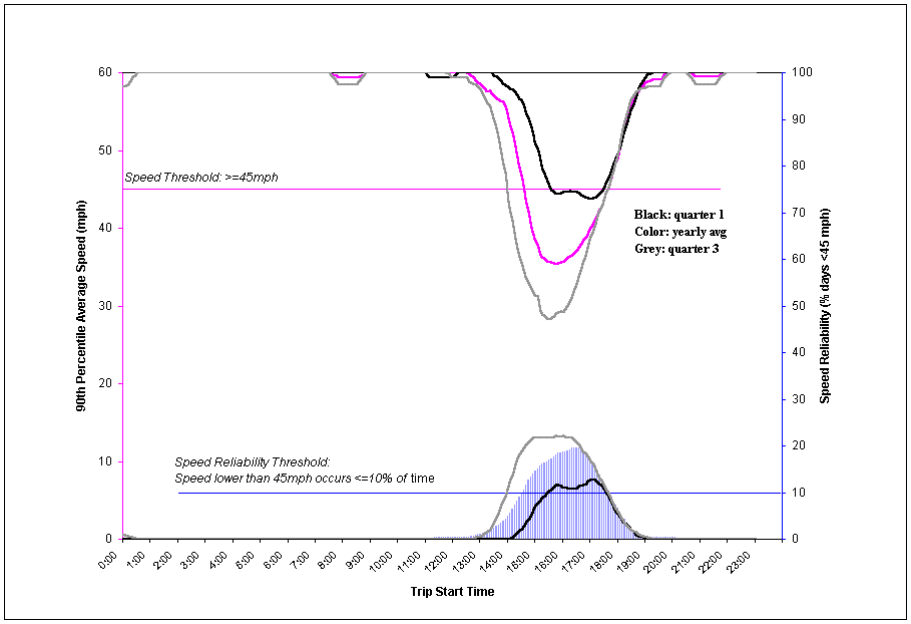

Figure 21. (above) Comparison of Quarterly HOV Lane Performance, Northbound I-5, Northgate to Everett

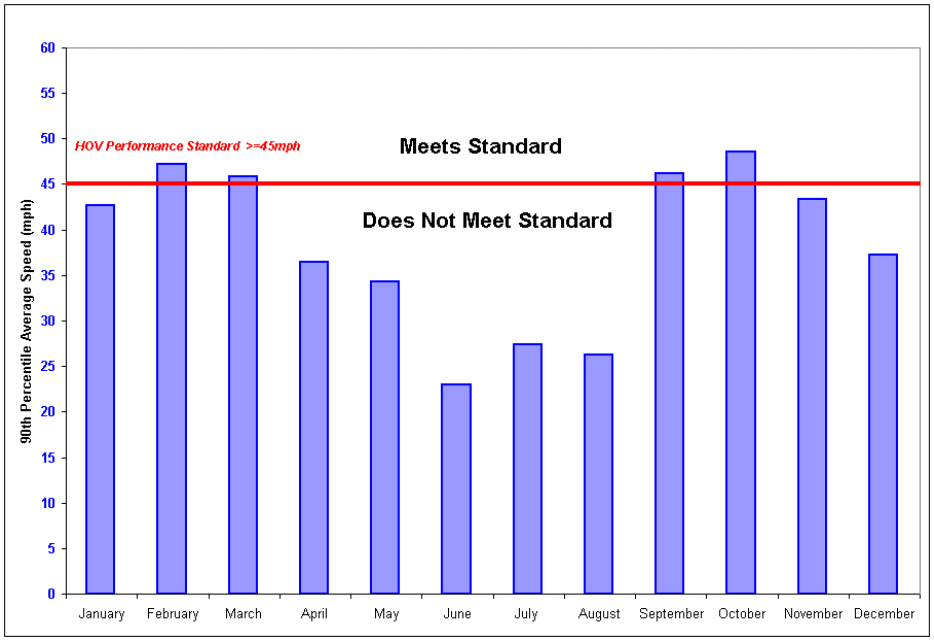

Figure 22.[8] Monthly HOV Lane Performance, Northbound I-5, 3:30 – 4:30 PM, Northgate to Everett

[8] This graph shows the average 90th percentile speed for the slowest hour of the peak period for each month of the year as a blue line.

To examine the relationship between changing HOV lane volumes and congestion, a comparison of the average PM-peak period volumes against the frequency with which the HOV lanes fail the performance standard was performed. (See Figure 23.) Only a modest correlation of increasing volume with increasing congestion frequency is apparent. Thus, while volume may have an effect on HOV lane performance, other factors, such as weather and darkness, are clearly affecting corridor performance.

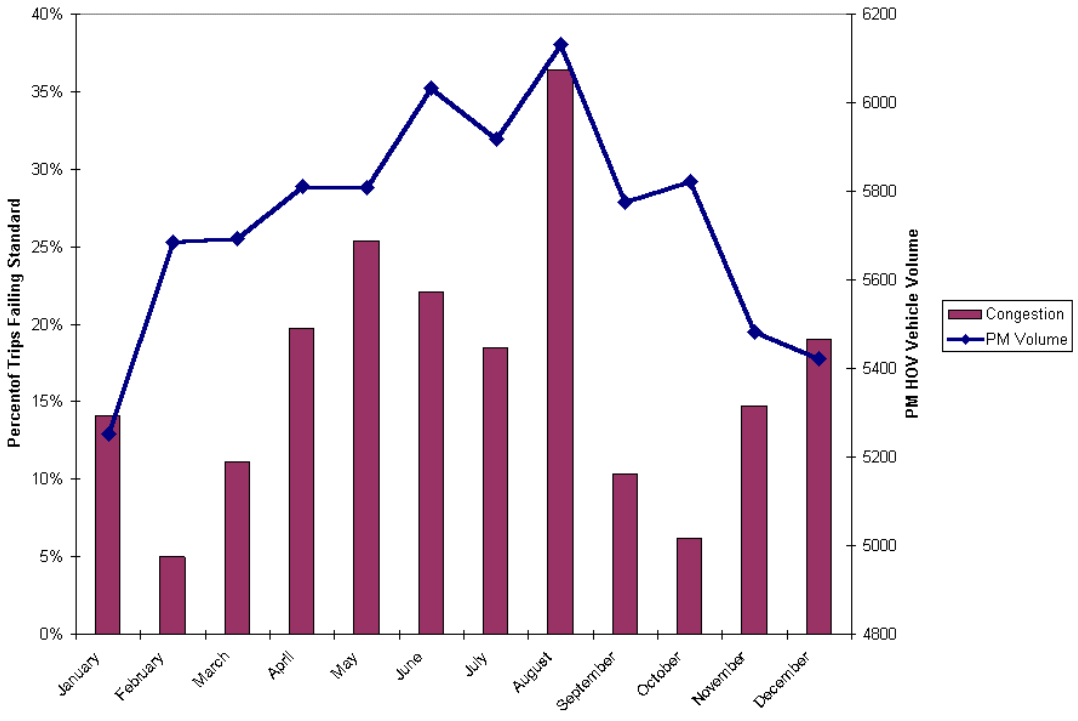

Figure 23.[9] Monthly HOV Lane Performance Compared to PM Peak HOV Lane Volumes by Month, Northbound I-5, Northgate to Everett

Southbound

The seasonal congestion patterns southbound in the morning are quite different than those northbound. While northbound HOV lane congestion on this section of I-5

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[9] This graph shows the average 90th percentile speed for the slowest hour of the peak period for each month of the year as a blue line. The frequency of failure of the HOV standard for that hour during that month is then shown by the histogram at the bottom of the graphic (and is read off the right-hand axis.)

generally increases in the summer, southbound congestion decreases in the spring and summer. Congestion is far more likely to occur southbound in the fall and winter. (See Figures 24 and 25.) The HOV lane almost meets the performance goal during spring months, while falling below the standard more than half the time in the fall. This is likely because southbound HOV travel in the morning peak is almost exclusively comprised of commuters. Significant increases in recreational volumes do not occur, and consequently do not have an effect on HOV lane performance .

On the other hand, winter and fall weather and light conditions seem to have a measurable impact on HOV lane performance in this corridor.

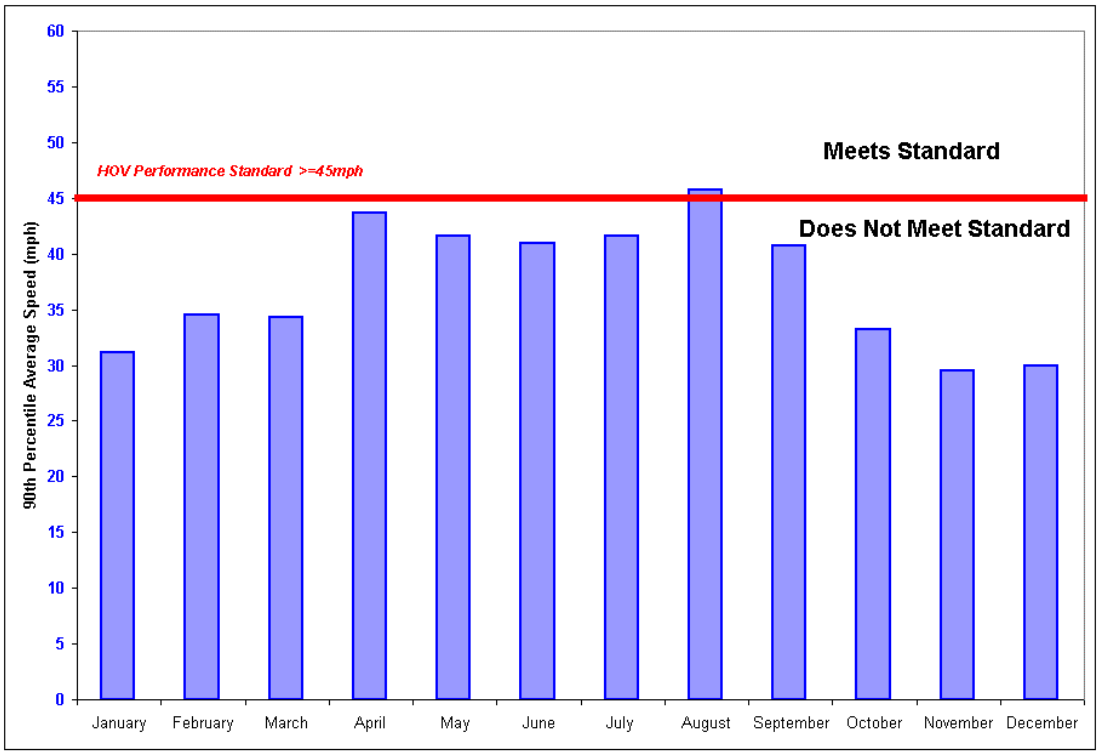


Figure 24. Monthly HOV Lane Performance, Southbound I-5, 7:00 – 8:00 AM,, Everett to Northgate

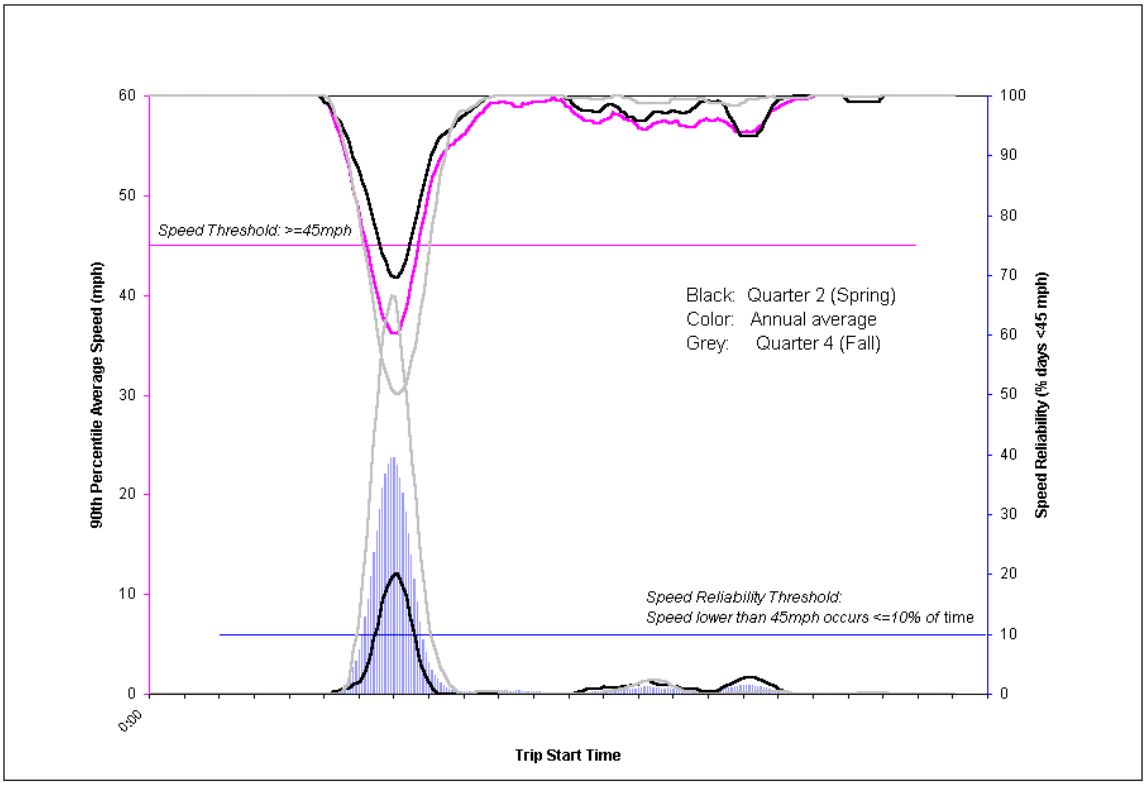


Figure 25. Comparison of Quarterly HOV Lane Performance, Southbound I-5, Everett to Northgate

I-5 SOUTH OF THE SEATTLE CBD

The southern half of the I-5 corridor is, in many ways, the mirror opposite of the northern corridor: The morning peak is almost exclusively northbound commuters. Conversely, the PM peak southbound movement is primarily commuters, but during the summer, it also serves substantial number of recreational travelers as residents leave the city.

Northbound

Spring congestion, the lightest quarter, is considerably smaller than fall congestion, the worst quarter, on this corridor. Fall congestion fails the performance standard, but the spring months meet it. (See Figure 26.)

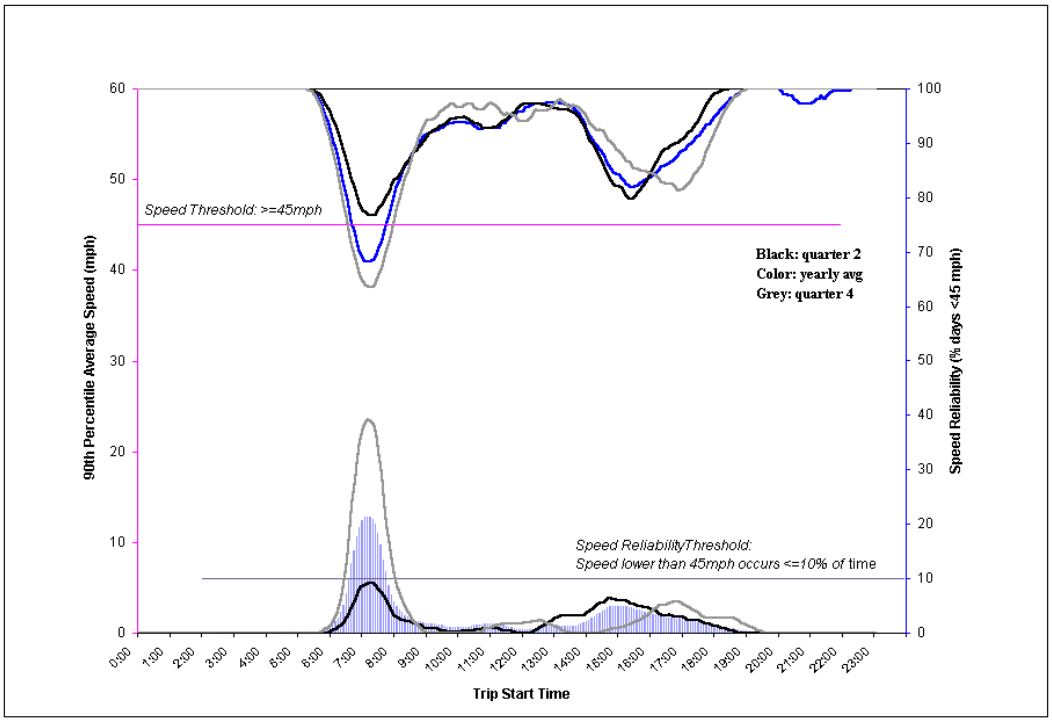


Figure 26. Comparison of Quarterly HOV Lane Performance, Southbound I-5, Everett to Northgate

A major difference in the northbound movement on this section of I-5 and its mirror image southbound movement is that there is significant late afternoon and evening use of the HOV lane in the south end, causing moderate congestion. (See Figure 26.) Afternoon congestion is roughly the same in the fall and spring, but that the timing of the congestion changes slightly. In the spring the worst of the HOV lane congestion occurs around 3:30 PM, while in the fall, the peak slowing occurs closer to 5:00 PM. The cause of this shift is not currently understood.

Southbound

Slower travel speeds and higher congestion tend to occur in the summer and late spring in the evening, southbound. During 2002, 90th percentile speeds frequently dropped below 40 mph, and the HOV lane failed to maintain 45 mph roughly half the

time between 3:30 and 4:30 PM. Winter conditions in 2002 were not quite as bad as during the summer, but still substantially below the established performance standard.

Unlike the northern corridor, however, southbound movement dramatically improved during fall 2002. This improvement was a direct result of the extension of the HOV lanes in October from SR 516 in Des Moines to S. 320th in Federal Way, a distance of roughly six miles. This change not only extended the HOV corridor, it significantly reduced the merge congestion that occurred at the former terminus of the HOV lane. That congestion, combined with difficulties some transit busses have in maintaining speed up the Southcenter Hill, had been responsible for much of the delay in the HOV lanes southbound on I-5. Performance in the fourth quarter—after construction—is markedly better than in the previous three quarters. (Figure 27.)

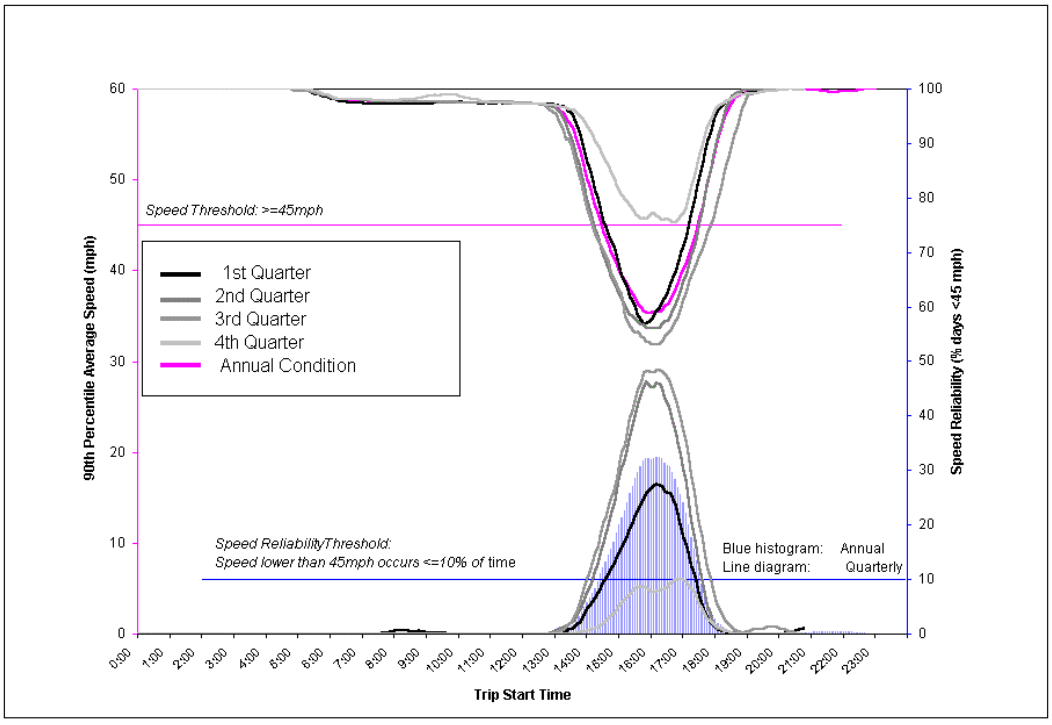


Figure 27. Comparison of Quarterly HOV Lane Performance, Southbound I-5, S. Spokane St. to S. 184th St.

To ensure that seasonal effects are not reflected in the measurement of the performance improvements caused by this construction, a comparison was made of HOV lane performance between the first quarter of 2003 against the same quarter for 2002, and again for fourth quarter of 2001 against the post-construction fourth quarter of 2002. The data shows that the HOV lane extension resulted in significant travel time reliability improvements. (See Figure 28.)

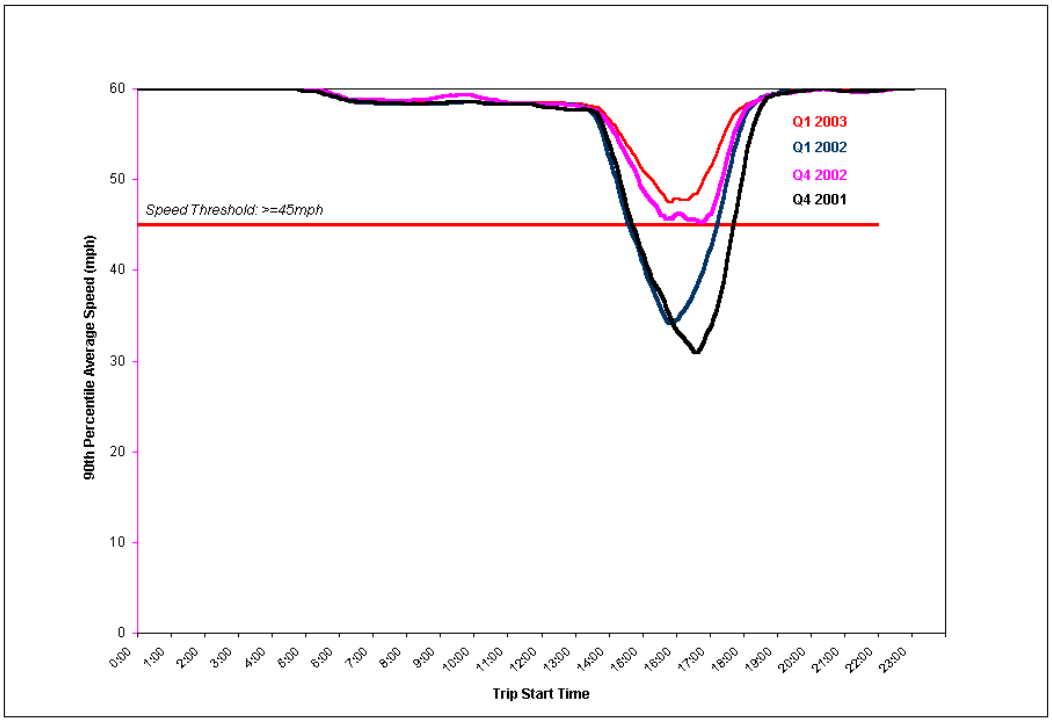


Figure 28. Effects of HOV Lane Extension, Southbound I-5, S. Spokane St. to S. 184th St.

SR 520

Westbound SR 520 is primarily a commuter route, although evening HOV congestion can be affected by evening recreational movements as Eastside residents and office workers use the 3+ carpool facility to reach downtown Seattle and other event destinations. This corridor is somewhat unique because it serves substantial westbound

HOV volumes in both the morning and evening peak periods. Only the afternoon movement fails the performance standard. (See Figure 29.)

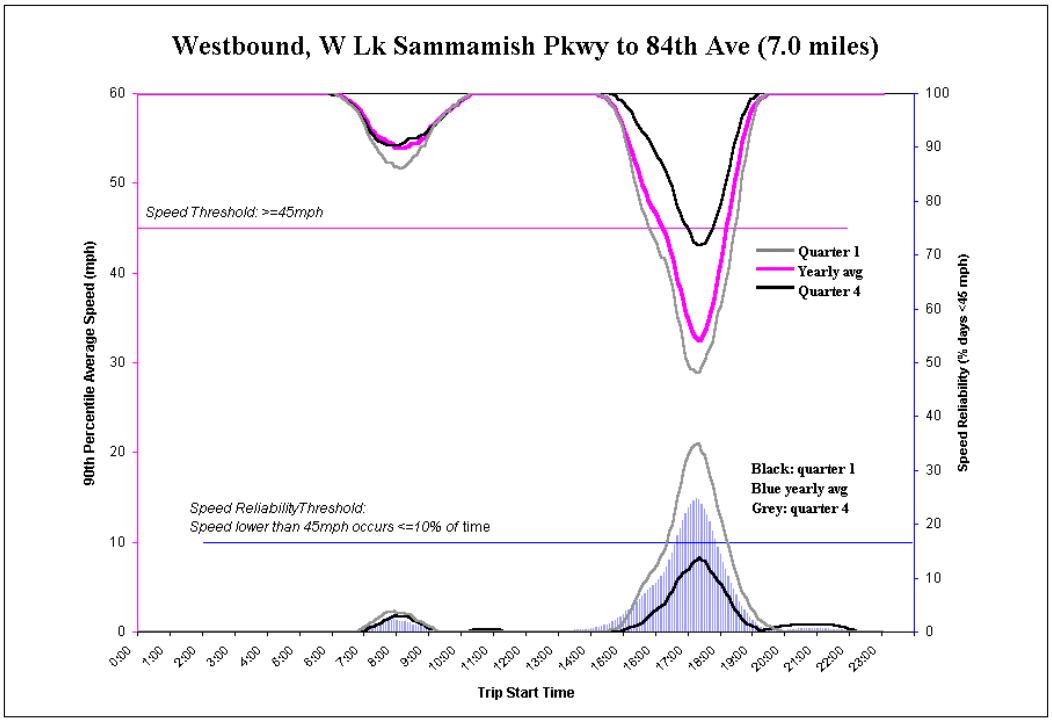


Figure 29. Quarterly Travel Reliability: SR 520, Westbound

The effect of adding evening recreational traffic to the routine commuter traffic on SR 520's HOV facility can be seen by separating Friday's performance from Tuesday through Thursday's performance (See Figure 30.) Friday mornings are traditionally the lightest commute periods, and consequently show the least congestion. On the other hand, Friday evenings have the greatest recreational travel among weekdays, a fact that has a significant detrimental effect on HOV lane performance. On SR 520, even a modest increase in volume can have a significant effect on performance because of the lane drop, which occurs at the Floating Bridge approach.

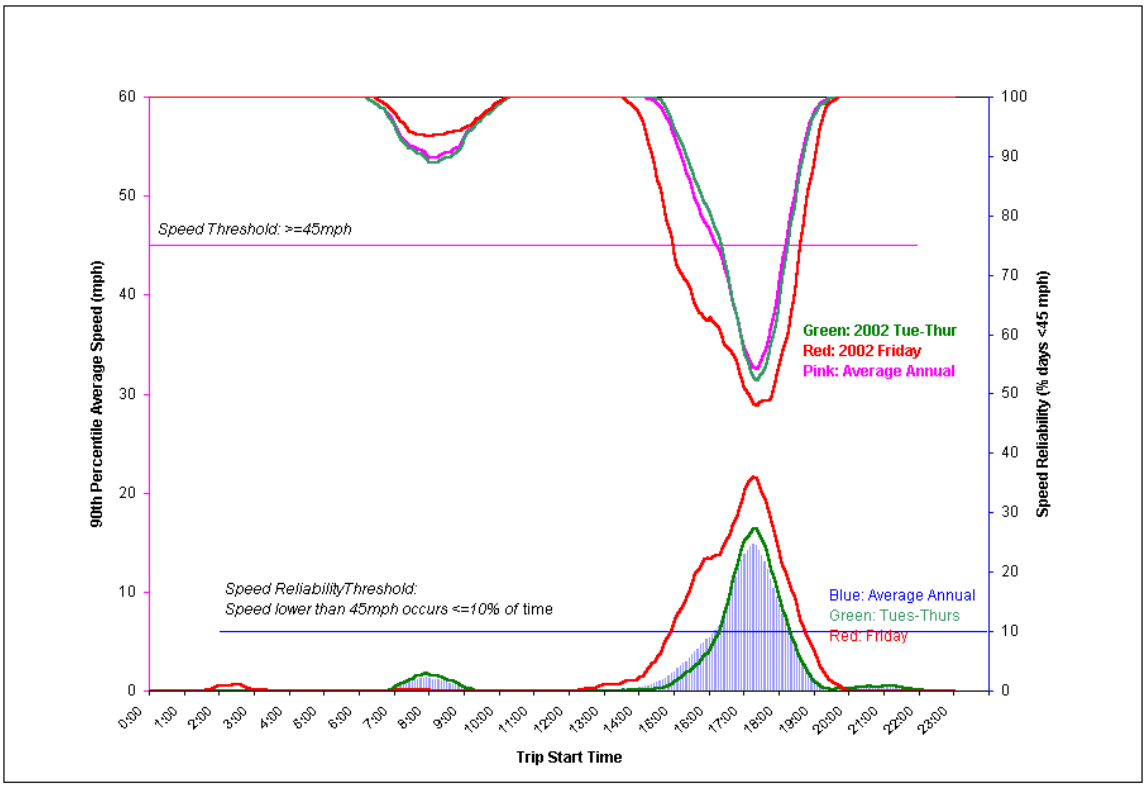


Figure 30. Effect of Recreational Traffic on SR 520 Westbound

An investigation of the general impact of HOV volumes on SR 520 resulted in findings similar to those shown earlier for I-5. While volume is important, it alone does not appear to have an overriding impact on HOV lane performance. Volume is only one of many factors which affect HOV lane performance. All other factors, including weather and incident occurrences being equal, however, increasing volume increases the likelihood of delay. So on SR 520, evening HOV volume tends to be highest in the summer, and consequently, HOV lane performance is generally worse in the summer. However, December performance is also poor, while HOV volumes are relatively low. (See Figure 31.) The added December delays are likely the result of higher incident occurrences and other congestion causes.

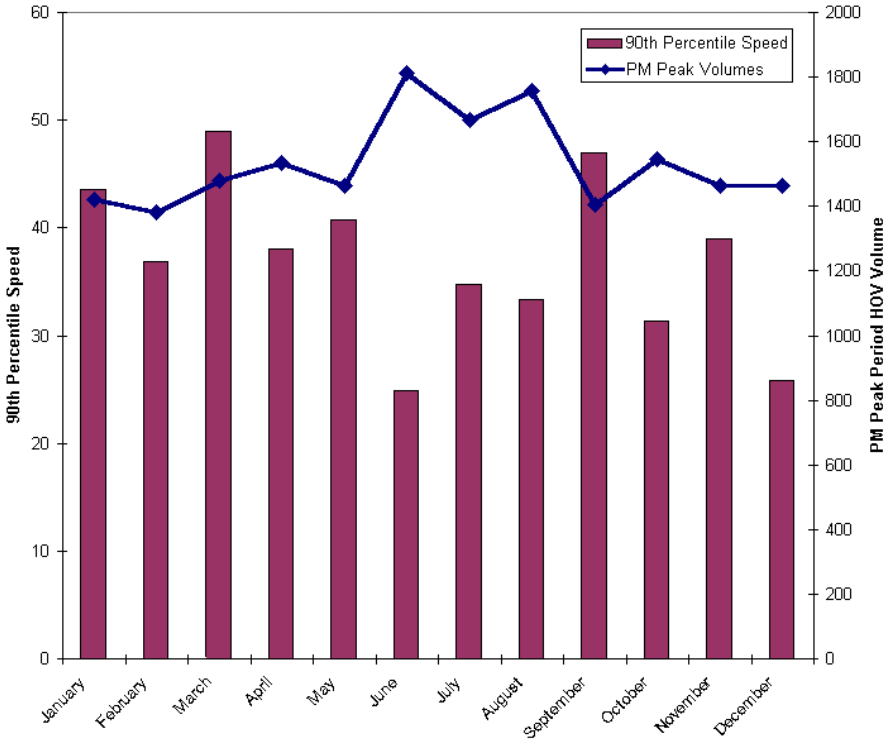


Figure 31. Volume and 90th Percentile Speed on SR 520 Westbound

INTERSTATE 405

Interstate 405 appears to be less influenced by seasonal recreational volumes than I-5, but many of the same basic trends are apparent. On I-405, morning peak period performance is generally worse during the darker, rainier months in the first and fourth quarters, and better in the sunnier, drier months, in the second and third quarters.

Evening peak period performance is somewhat different. Summer traffic volumes appear to increase the chance of congestion during the third quarter. Unlike the morning peak, the winter quarter is generally not as congested as the other times of the year.

Figure 32 presents the 90th percentile travel patterns by quarter on Southbound I-405 between I-90 and the southern I-405/I-5 interchange. This pattern of seasonal differences is fairly representative of I-405 in general, although specific incidents and

other non-recurring problems cause each corridor to vary somewhat in their performance patterns.

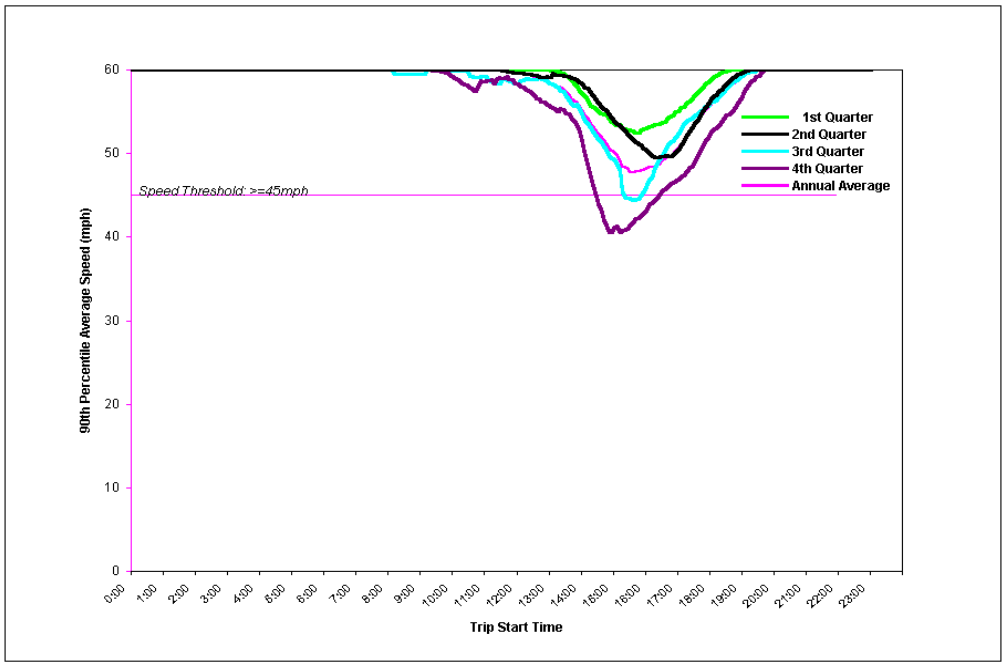


Figure 32. Quarterly Travel Reliability: Southbound I-405, South of I-90

STATE ROUTE 167 AND INTERSTATE 90

These two corridors have the lowest level of HOV lane congestion of all corridors in the metropolitan region. Both experience minor slowdowns in evening peak periods, but neither experiences significant performance problems. A review of seasonal patterns shows no significant difference in the reliability of the morning peak period from season to season. In the afternoon, eastbound I-90 and southbound SR 167 are slightly less reliable with slower movement during the spring and summer quarters than during the fall and winter and quarters.

REPORT SUMMARY

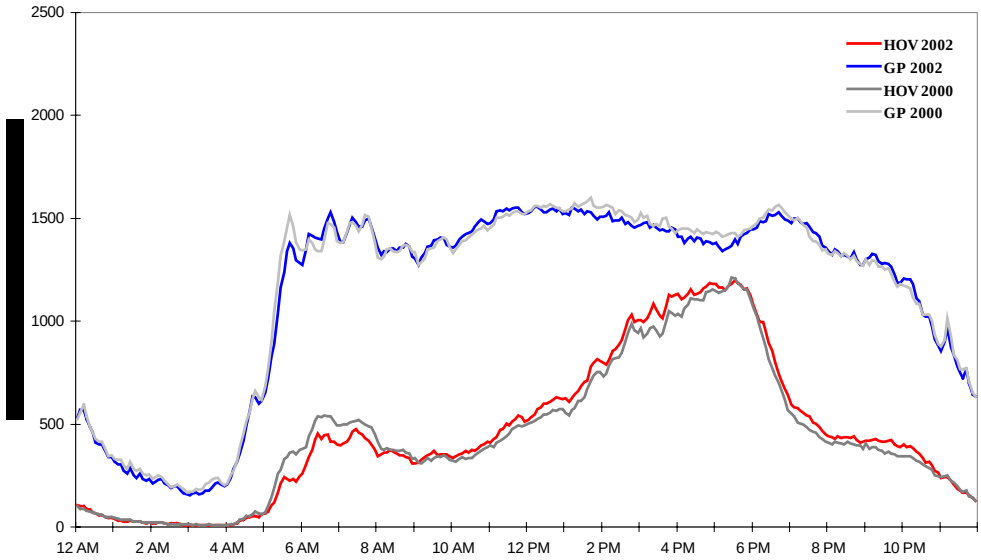
Between 2000 and 2002, the Puget Sound region reversed trends in HOV use and performance that had been ongoing for most of the past decade. Instead of slowly growing, peak period HOV use stagnated or declined on many HOV corridors. Slightly lower HOV volumes, increased WSDOT emphasis on improving freeway operations, and the extension of the I-5 HOV lanes southward to Federal Way, provided measurable improvements in HOV lane travel time reliability. In 2002, the number of corridors where HOV lane travel times fell below the adopted regional HOV lane performance standard dropped from eight to five, and one of the remaining five began meeting the standard during the fourth quarter of 2002, after completion of a construction project extending the HOV lane.

HOV peak period use was still heavy, despite slight declines on several corridors. On many corridors, vehicle volumes on HOV facilities approached 1,500 vehicles per hour, and, on several corridors, exceeded general purpose lane volumes on a lane-to-lane basis. In most locations, HOV lanes still carried more people per lane than the adjacent GP lanes during peak commute times.

APPENDIX

ADDITIONAL VOLUME TREND GRAPHS

I-405 Northbound, Southcenter (W Valley Hwy)



I-405 Southbound, Southcenter (Andover Park)

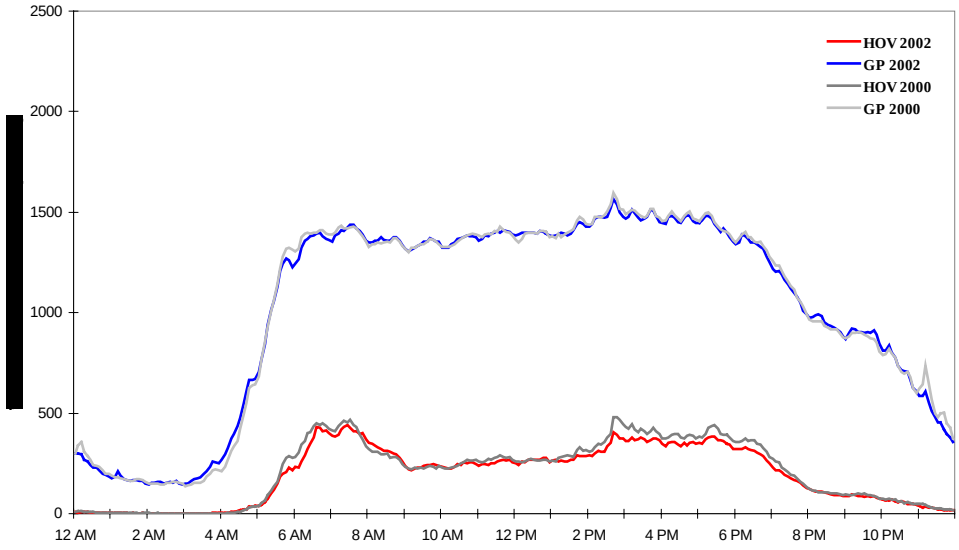
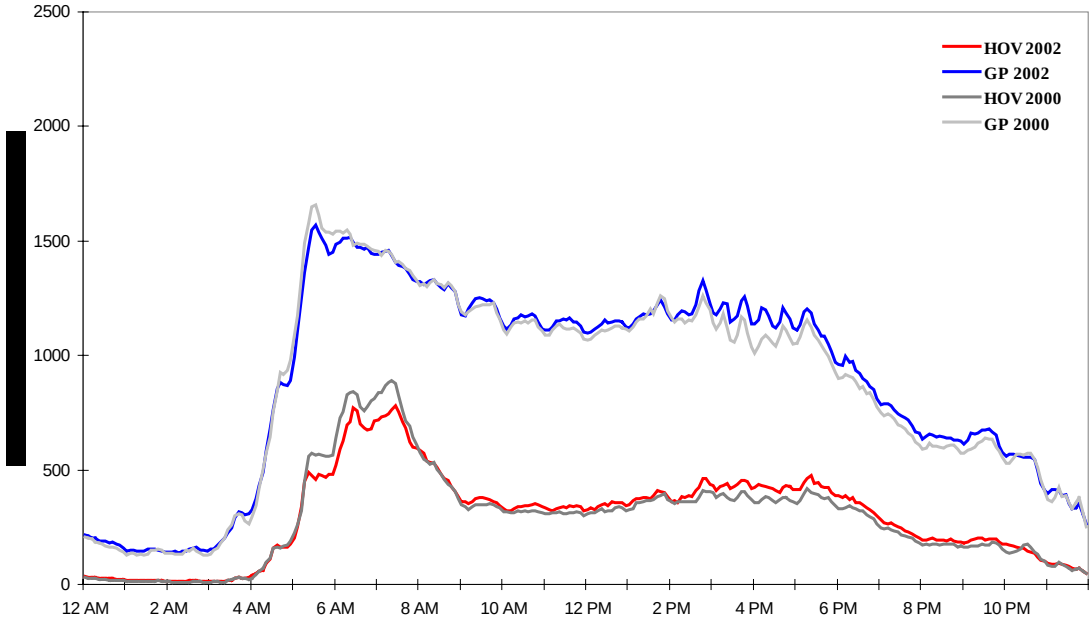


Figure A-1. GP vs. HOV Volume Profile (2002 vs.2000): I-405 @ Southcenter

SR 167 Northbound, Kent (S 208th St)



SR 167 Southbound, Kent (S 208th St)

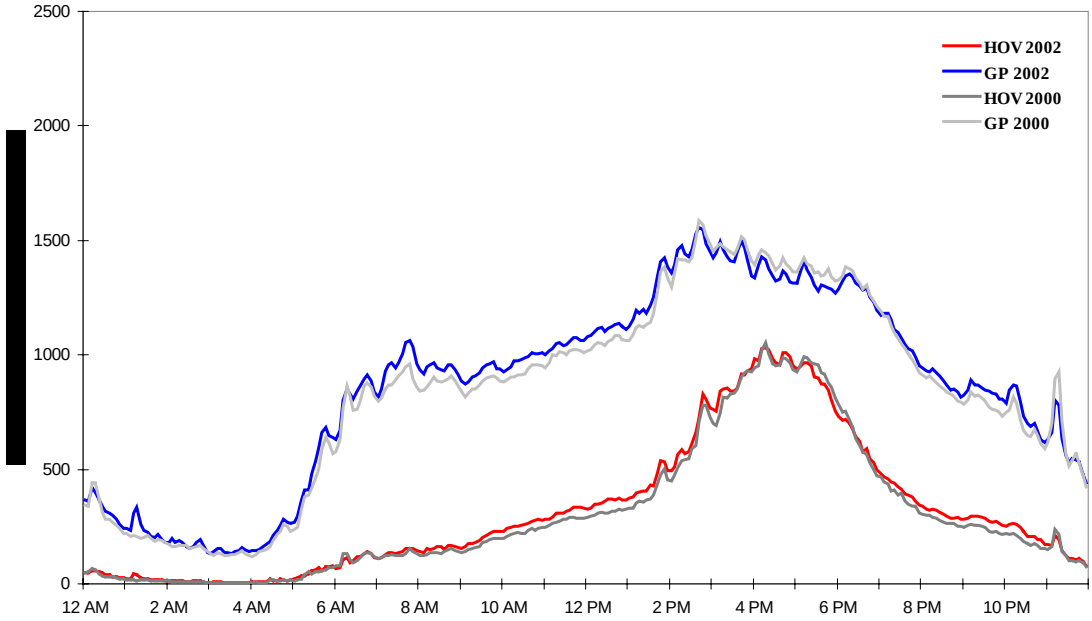


Figure A-2. GP vs. HOV Volume Profile (2002 vs.2000): SR 167 @ Kent