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# HOV Lane Enforcement Evaluation

Final Report

WA-RD 281.1

January 1993



**Washington State Department of Transportation**

Washington State Transportation Commission  
Transit, Research, and Intermodal Planning (TRIP) Division  
in cooperation with  
U.S. Department of Transportation  
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16. ABSTRACT <p>This study evaluated various high occupancy vehicle (HOV) lane enforcement techniques on a recently constructed section of HOV lanes along I-405 in the Seattle, Washington, area. The research included a related public opinion survey concerning HOV lanes. The enforcement techniques that were evaluated included intensive (or continuous saturation) enforcement, once a week saturation enforcement, and once a week stationary enforcement.</p> <p>This study concluded that each type of enforcement effort helped in lowering the number of HOV lane violations; however, it was not possible to determine which method was most effective. Violations decreased considerably during the first weeks of enforcement, regardless of the type of enforcement.</p> <p>The public opinion survey indicated that, in general, the public supports the concept of HOV lanes. Eighty-six percent of the respondents felt that HOV lanes were a good idea. At the same time, 55 percent indicated that existing HOV lanes were not being used enough. Almost 60 percent of the respondents believed HOV lane violations were common during the commute hours. Almost the same percentage (58 percent) believed that HOV lane violators were seldom caught by enforcement agencies. A higher percentage of the respondents (71 percent) believed HOV violations increased when the Washington State Patrol was <u>not</u> visible along the HOV lane.</p> <p>The research team recommends intensive enforcement only for the first three months (or less) of the operation of a new HOV facility. After that point, the level of effort should revert to routine enforcement.</p> <p>This study also makes recommendations concerning the design of HOV lanes related to enforcement issues. Specifically, enforcement areas alongside HOV lanes <u>must</u> be designed in cooperation with the appropriate enforcement agency. Two types of enforcement areas along freeways are suggested.</p>			
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## **Final Report**

Research Project GC 8719, Task 36  
HOV Enforcement — I-405

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## SUMMARY

This study evaluated various high occupancy vehicle (HOV) lane enforcement techniques on a recently constructed portion of HOV lanes along I-405 in the Seattle, Washington area and a related public opinion survey concerning HOV lanes. The enforcement techniques that were evaluated included intensive (or continuous saturation) enforcement, once a week saturation enforcement, and once a week stationary enforcement. The public opinion survey was sent to the registered owners of vehicles observed violating the HOV lane restrictions and a control group of non-violators. In addition, the HOV literature was reviewed and Washington State Patrol (WSP) officers responsible for HOV enforcement were interviewed.

The public opinion survey indicated that, in general, the public supports the concept of HOV lanes. Eighty-six percent of the respondents believed HOV lanes were a good idea. At the same time, 55 percent indicated that existing HOV lanes were not being used enough.

Almost 60 percent of the respondents believed HOV lane violators were common during the commute hours. Almost the same percentage (58 percent) believed that HOV lane violators were seldom caught by enforcement agencies. A higher percentage of the respondents (71 percent) believed HOV violations increased when the WSP was not visible.

Based on analysis of HOV violations and enforcement techniques in the I-405 corridor, this study recommends using intensive enforcement only for the first three months (or less) of the operation of a new HOV facility. After that time, the enforcement emphasis effort should revert to routine enforcement. This is a 50 percent reduction from the current six-month enforcement emphasis that is the policy of the Washington State Department of Transportation (WSDOT).

This study also makes recommendations concerning the design of HOV lanes related to enforcement requirements. Specifically, enforcement areas must be designed in cooperation with the appropriate enforcement agency. Two types of enforcement areas along freeways are suggested. One is an area where the WSP can safely park, observe violators, and pursue them. This area can be relatively small and short. The other is an area where violators can safely and obviously pull over and be ticketed. This second area needs to be longer and often wider than the first type. The designs of both areas must consider the deceleration, acceleration, and merging characteristics of the vehicles and drivers expected to use them.

Complete details of the study are contained in a University of Washington Master's thesis by Eldon L. Jacobson, entitled "HOV Lane Enforcement and Public Opinions About HOV Lane Enforcement on I-405 in the Seattle, Washington, Area." This report summarizes research activities, research findings, and recommendations of that study.

## CONCLUSIONS AND RECOMMENDATIONS

### CONCLUSIONS

#### 1. Public support for HOV lanes

In general, the traveling public supports the concept of HOV lanes. The public opinion survey indicated that 86 percent of the respondents believed HOV lanes were a good idea. At the same time, 55 percent of the respondents indicated that existing HOV lanes were not being used enough.

#### 2. Public opinions on HOV lane enforcement related issues

Almost 60 percent of the respondents believed HOV lane violators were common during the commute hours. Almost the same percentage (58 percent) indicated their belief that HOV lane violators were seldom caught by enforcement agencies. An even higher percentage (71 percent) believed HOV violations increased when the State Patrol was not visible. Surprisingly, just over half (56 percent) of the respondents agreed that the current \$47 penalty for HOV violations is adequate.

#### 3. HOV lane enforcement

As the general purpose lane volumes increased, so did the number of violations. The number of observed violations was consistently greater in the northbound direction than in the southbound direction of the study area. Each type of enforcement effort helped in lowering the number of HOV lane violations, but it was not possible to determine which method was most effective. Violations decreased considerably during the first weeks of enforcement, regardless of the type of enforcement.

### RECOMMENDATIONS

Some of the following recommendations are a result of the quantitative research conducted for this project. Other recommendations are based on conversations the

researchers had with Washington State Patrol officers. All the recommendations would make enforcement of HOV lanes more effective and more efficient.

1. **Reduce intensive enforcement period to three months (or less)**

The six-month intensive enforcement conducted immediately after the opening of HOV lane(s) should be reduced to a three-month period, with options for extension if observations indicate the violation rate has not dropped to acceptable levels during the third month. The three-month period could even be less if violation rates declined considerably.

2. **Modify the WSDOT Design Manual**

High occupancy vehicle (HOV) lanes need to be designed from their initial stages with enforcement in mind. This includes consideration at the prospectus stage. To avoid a lack of continuity, the WSDOT Design Manual (M22-01) should be modified to require that all design reports covering HOV lanes address locations and shoulder widenings where enforcement will occur. These locations should be coordinated with the applicable law enforcement agency. The coordination effort should be documented as part of the design report. This would help to avoid the apparent lack of continuity that occurred on the I-405 project. The WSP indicated that they met with the project's designers early in the design process, and plans for building enforcement areas were made, but these areas were not incorporated into the contract plans. This was probably because the design and construction of the lanes were delayed several times because of funding problems, which led to a lack of continuity in the project's design process. The WSDOT design manual currently recommends that enforcement areas be a minimum shoulder width of 6 feet, but no ideal shoulder width is mentioned. A commonly accepted ideal shoulder width for enforcement is 14 feet (1, 2).

3. **Provide a turnaround and enforcement area on I-405**

The precast concrete barrier in the median of I-405 should be modified as shown in Figure 1. This would provide both an enforcement area where motorcycle troopers

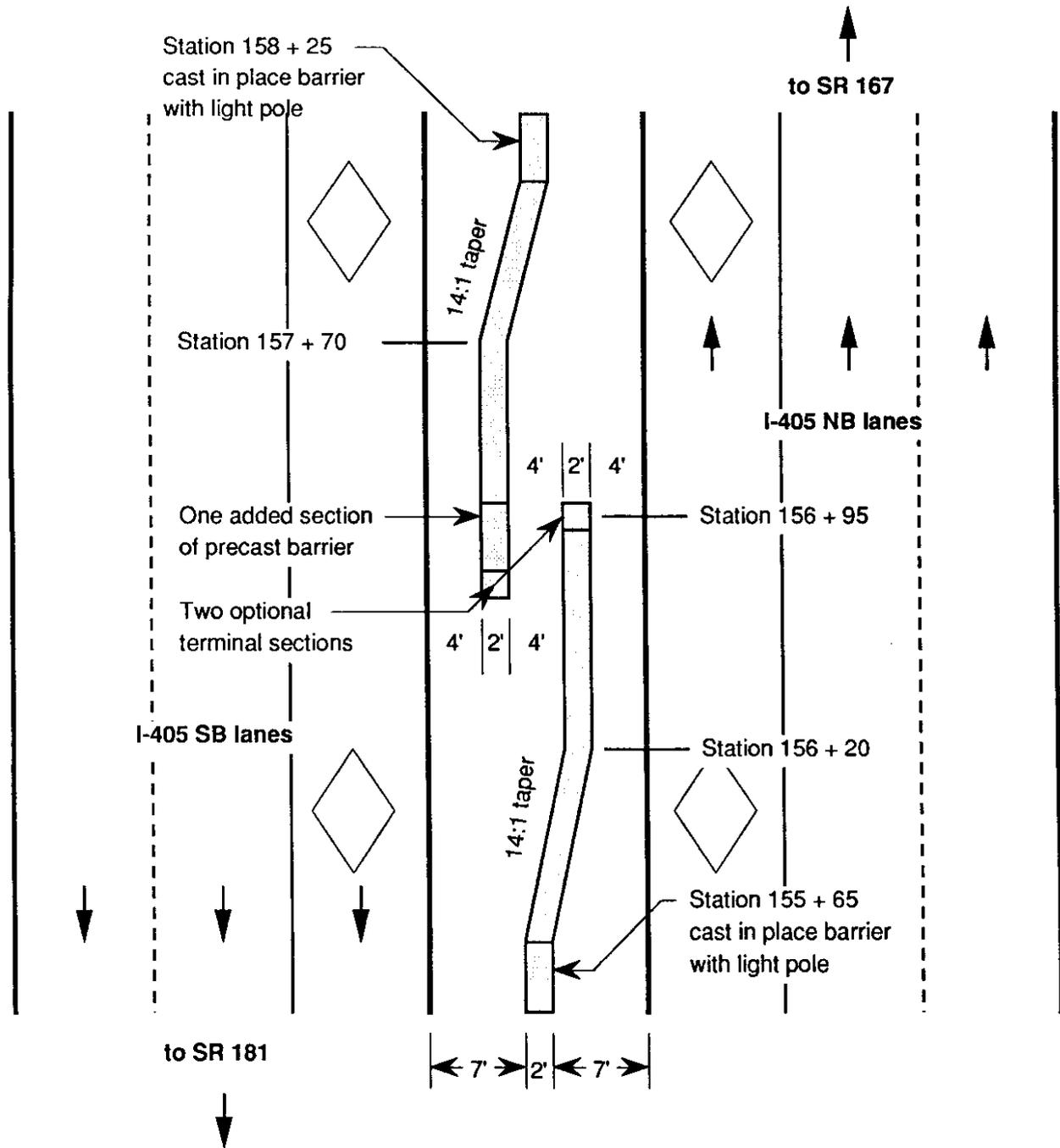


Figure 1. SR 405 Precast Barrier Relocation for Trooper Waiting Area (Plan View)  
 (Note: Stationing from Contract 3354 plans)  
 (All stationing approximate)

could safely pull off the road, and an emergency turnaround (designated for motorcycle troopers only).

**4. Install bridge pier enforcement areas**

Whenever a freeway is built or modified that has a median narrow enough to require barrier separation, the barrier around bridge piers in the median should be constructed to provide an enforcement area downstream of the bridge pier (see Figure 2). This configuration is less expensive to construct than continuous barriers around bridge piers. One potential problem, however, is the accumulation of dirt and debris in the enforcement pocket.

**5. Consider barrier-separated HOV lanes**

To simplify enforcement and to increase safety, HOV lanes with barrier separation between the HOV lane and the general purpose lanes are preferred (see Figure 3). Then, only one enforcement area along each section of barrier separated HOV lane is needed. In addition, the barrier separation eliminates the concerns about the different vehicle speeds in two adjacent, unseparated lanes.

There are a few locations along I-5 where constructing barrier-separated HOV lanes might actually be less expensive than placing HOV lanes adjacent to the general purpose lanes. These locations are along I-5 in Federal Way (south of Seattle) and perhaps the area along I-5 in Lynnwood (north of Seattle). These areas have wide medians that do not require barrier separation except where there is an unsafe slope between the two independent vertical alignments. These wide medians have required that some bridges crossing over I-5 be supported by two bridge piers in the median, with each pier at the edge of the inside shoulder. Building an adjacent HOV lane would require the complete replacement of the bridge. On the other hand, building barrier-separated HOV lanes would allow the HOV lanes to be routed between the existing bridge piers, eliminating the need for the bridge replacement. Installing the barrier-separated HOV lanes in areas of independent mainline alignment might require constructing retaining

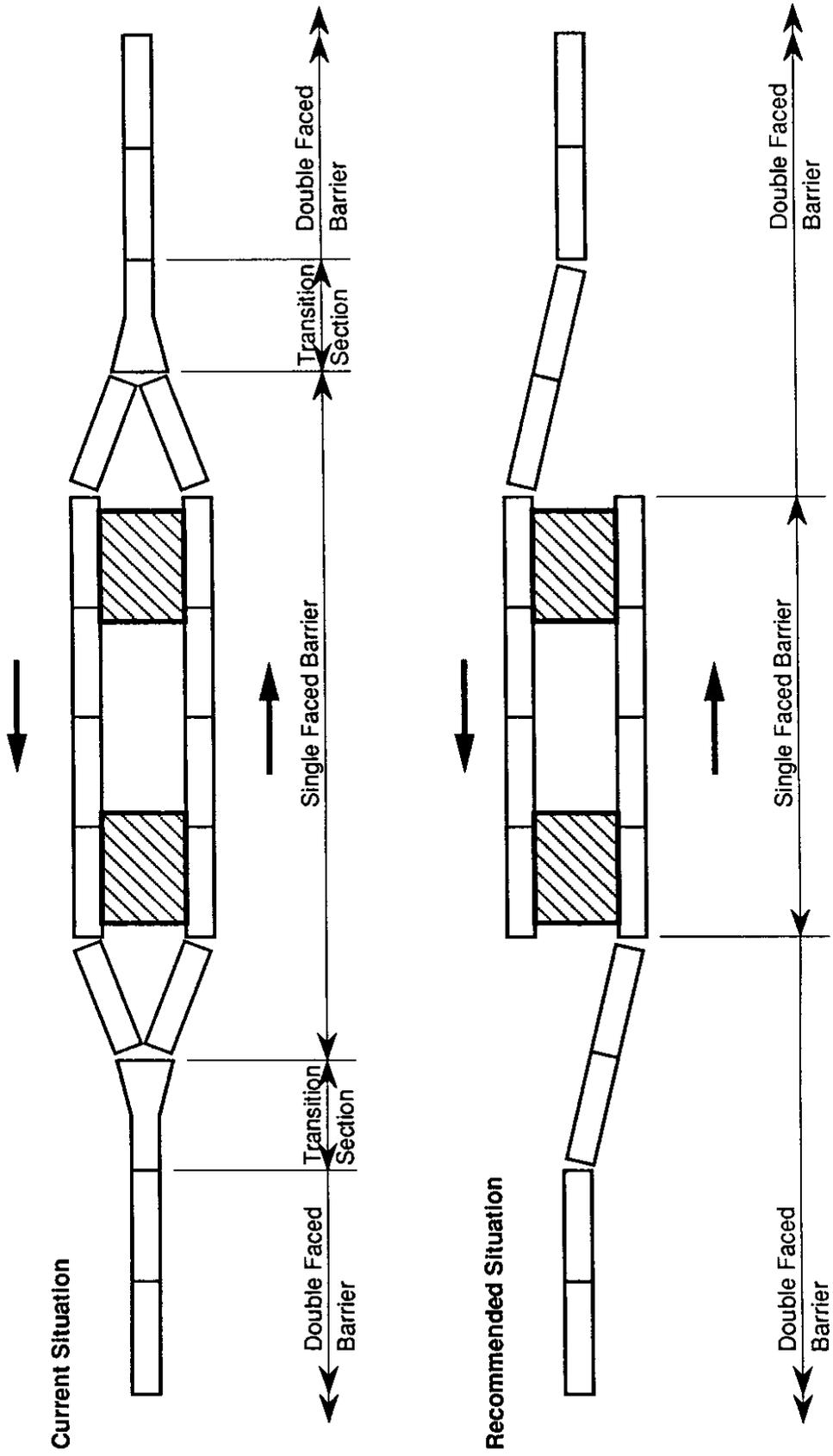


Figure 2. Median Bridge Pier Law Enforcement Waiting Area (Plan View)  
 (Use when HOV lane is on inside and bridge piers are located in the median)

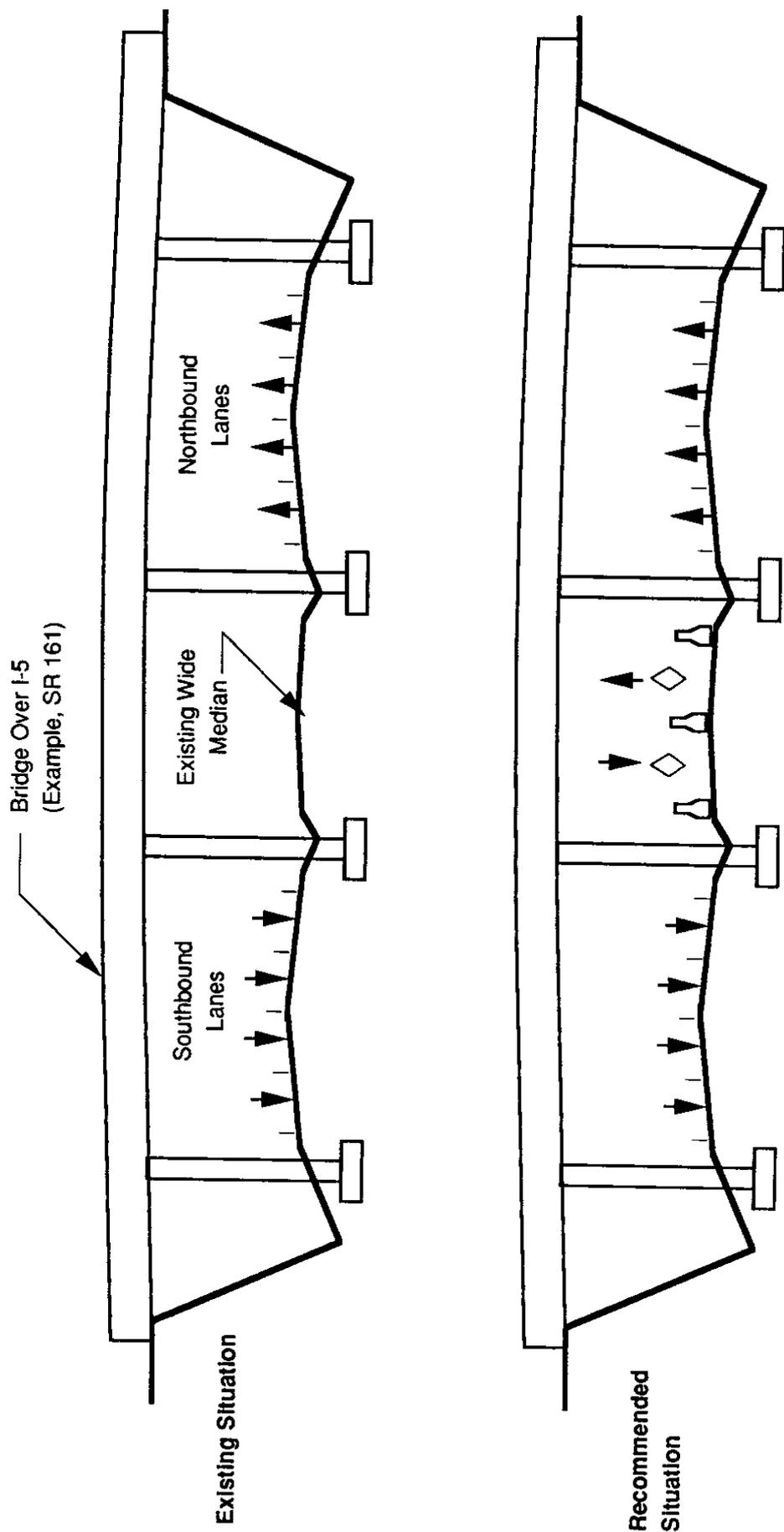


Figure 3. I-5 Barrier Separated HOV Lanes (Cross Section)  
View Looking North (No bridge replacement needed)

walls, but from an operational, enforcement, and safety standpoint, separation is still recommended, and would probably be less expensive than complete bridge replacement. Note that barrier separation is ideally suited to inside HOV lanes, where the HOV users are traveling long distances and, thus, do not need to change lanes.

**6. Increase HOV violation fine**

In California, a drastic increase in the level of fines for HOV lanes was implemented. The impact was a substantial reduction in HOV violations. The Washington State Legislature should consider increasing the HOV violation fine. Second and third HOV violations in a twelve-month period should incur higher fines. This consideration should take into account an expected lack of wide public support for the change.

**7. Allow ticketing by mail**

Washington state law should be investigated and modified so that violators can be ticketed by mail. If enforcement officers had the option of standing by the side of the road (in a safe location), observing violators, and mailing a ticket, then much of the time that they currently spend in pursuing and stopping violators could be minimized or eliminated. This option would also enhance safety for both motorists and troopers, and eliminate the need to construct HOV enforcement pullover areas (though enforcement areas can also serve a dual function by also providing vehicle breakdown areas).

There are three possible problems with ticketing by mail. First, the ticket would be mailed to the registered owner, not the person driving the vehicle. Ticketing the registered owner raises concerns about constitutional issues of fairness and equity. Second, a small but significant percentage of registered owners have not recorded their current mailing address with the Department of Licensing. In this study, six percent of the public opinion surveys mailed out were returned by the post office. Third, when ticket by mail was used in Virginia, there was a substantial negative public reaction to the

policy. Some public relations staff people of the Virginia DOT believe that it contributed to an erosion of public support for HOV lanes.

A similar ticketing by mail method would require the enforcement officer to stop the violator vehicle only long enough to verify the vehicle driver's name. The ticket could then be mailed to the offender. This method would save 2 to 5 minutes of a typical HOV lane enforcement stop. While the time savings would not be great, the less time an officer and a violator are stopped along the side of the road, the smaller the probability of their being involved in an accident. Also, traffic disruption is decreased.

The use of video cameras is a possible way to aid the observation of violators. However, a test in California two years ago determined that video cameras were not successful by themselves in determining vehicle occupancies. Suggested improvements included video cameras used in conjunction with enforcement officers, and the use of infrared video cameras (3).

**8. Add additional enforcement personnel**

WSDOT should request additional troopers dedicated primarily to HOV enforcement. As the HOV network expands, the existing motorcycle squads will have to cover larger areas. A possible further research project could investigate the optimum number of troopers per HOV lane-mile.

**9. Develop a publicity program about the purpose and rules of HOV lanes**

Public awareness of the purpose of the HOV lane system needs to be improved. A program apprising citizens of the benefits of the HOV lane system should be developed. In addition, the HERO program in the Seattle area needs to be publicized. It was well-publicized when it was implemented in 1984, but apparently it has received minimal publicity since that time. (The HERO program encourages people to call in and report HOV lane violators). The publicity program should also include personal contacts with judges involved with HOV lane violators.

## **INTRODUCTION**

Traffic congestion continues to increase in the urban areas of Washington state. The Washington State Department of Transportation (WSDOT) and the state's cities and counties have a minimal opportunity to build new freeways or arterials to help alleviate this congestion. Consequently, a growing emphasis is being placed on increasing the person-carrying capacity of existing roads, rather than on the construction of new facilities.

One way to increase the person-carrying capacity of existing roadways is the institution of high occupancy vehicle (HOV) lanes. Motorists traveling roadways with HOV lanes are frustrated because they perceive that many drivers violate the HOV lane rules. A high percentage of lane violators compromises users' incentives for taking the bus, or joining or forming carpools and vanpools. To maintain the viability of HOV facilities, the number of violators must be minimized.

## **RESEARCH APPROACH**

WSDOT constructed new HOV lanes, between I-5 in Tukwila and the south Renton area, as part of the reconstruction of I-405. WSDOT obtained funds from the Federal Highway Administration for what was originally planned to be a six-month intensive enforcement period for these new HOV lanes shortly after they were opened to traffic. WSDOT and the Washington State Patrol (WSP) agreed that WSP would provide this intensive enforcement. The WSP provides routine enforcement on all state highways in Washington state.

After the WSP began the intensive enforcement effort, a decision was made to modify the research project's evaluation procedures. Two major changes took place: the enforcement effort was changed to investigate the effects of three types of enforcement of the HOV lane violators, and a survey about HOV lane enforcement issues was designed to obtain public opinion.

The enforcement study examined HOV lane violations during intensive enforcement (continuous saturation enforcement), once-a-week saturation enforcement, once-a-week stationary enforcement, and normal (or routine) enforcement before and after each enforcement period. The public opinion survey was sent to registered owners of vehicles observed violating the HOV carpool lane and a control group of non-violating single occupant owners of registered vehicles. In addition, interviews were conducted with WSP officers responsible for HOV lane enforcement.

## **VIOLATION RATES AND ENFORCEMENT TYPES**

The high occupancy vehicle (HOV) lanes involved in this project extend along Interstate 405 from the intersection of I-5 and I-405 in Tukwila to the intersection of I-405 and SR-167 (the Valley Freeway) (see Figures 4 and 5). This portion of I-405 was rebuilt between 1987 and 1990 from a four-lane freeway to a six-lane freeway. The two new lanes are HOV lanes located on the inside of the roadway. The HOV lanes have a separate connection to I-5 north at the intersection of I-405 and I-5 (see Figure 6). Currently, they merge back into the two general purpose lanes at the other end (see Figure 7). Eventually, after the completion in 1994 of a reconstruction project, these HOV lanes will continue through the Renton S-curves. The HOV lanes are currently about 2.5 miles long in each direction.

The HOV lanes covered by this project are designated for vehicles with a minimum of two people. Single person motorcycles are also allowed. Single occupant vehicles and trucks over 10,000 pounds (4,500 kilograms) gross weight are not allowed. Other HOV lanes in the Seattle area are similarly set up to allow a minimum of either two people or three people per vehicle.

The HOV lanes covered in this report are separated from the remaining general purpose lanes by an eight-inch wide, white, paint stripe. The HOV lanes were opened to traffic at the end of 1990: the northbound HOV lane opened to traffic on Monday, November 26, 1990, and the southbound HOV lane opened to traffic on Saturday, December 1, 1990.

### **PROCEDURES**

During December 1990, the Seattle area experienced an unusually long cold spell that included snow and freezing temperatures. Consequently, the WSP was asked to delay the start of intensive enforcement until January 7, 1991. This delay allowed the collection of some auto occupancy and violation rate data before the start of the intensive

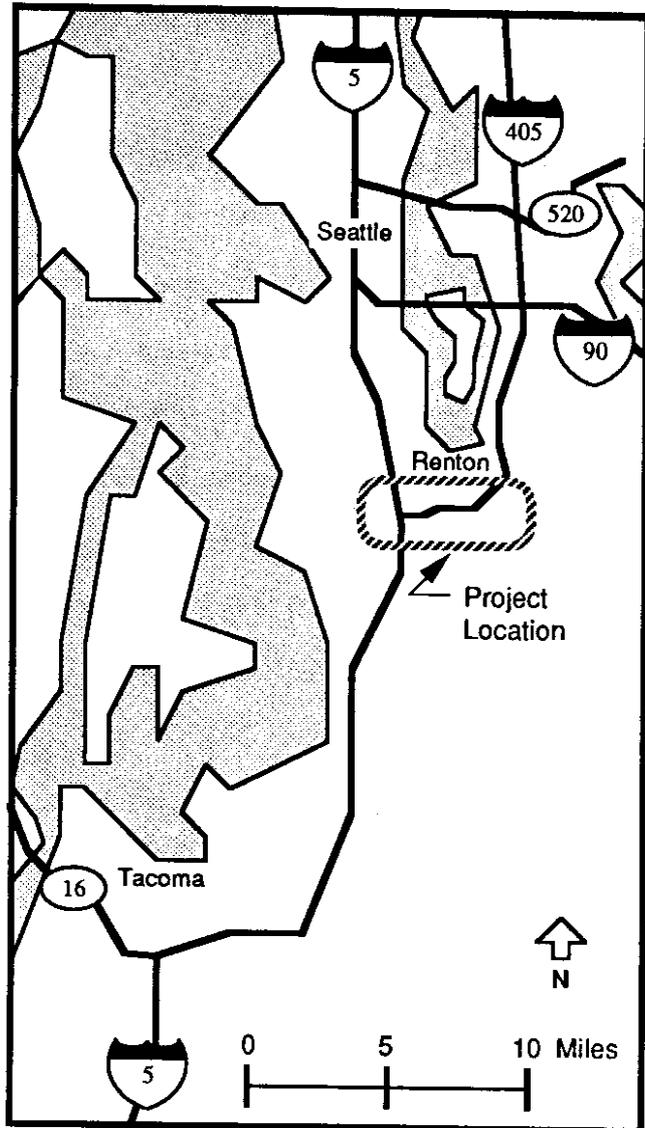


Figure 4. Project Location

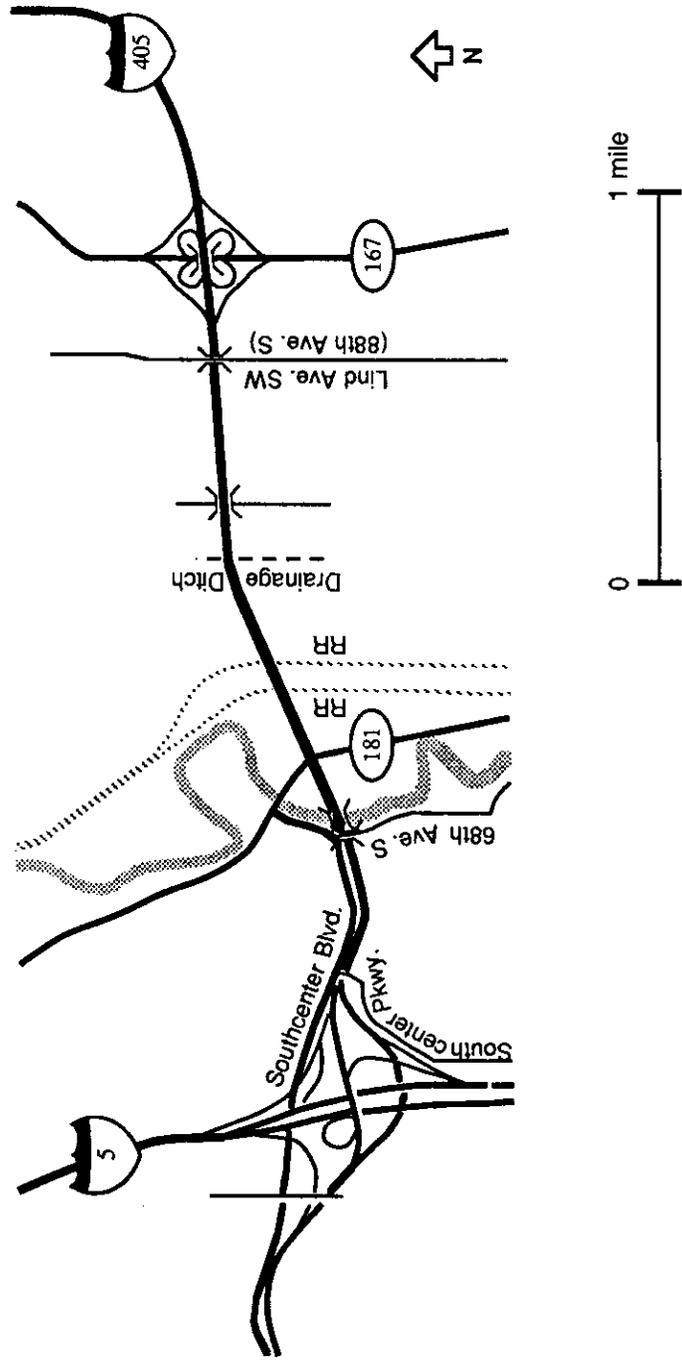


Figure 5. Overall Site Plan

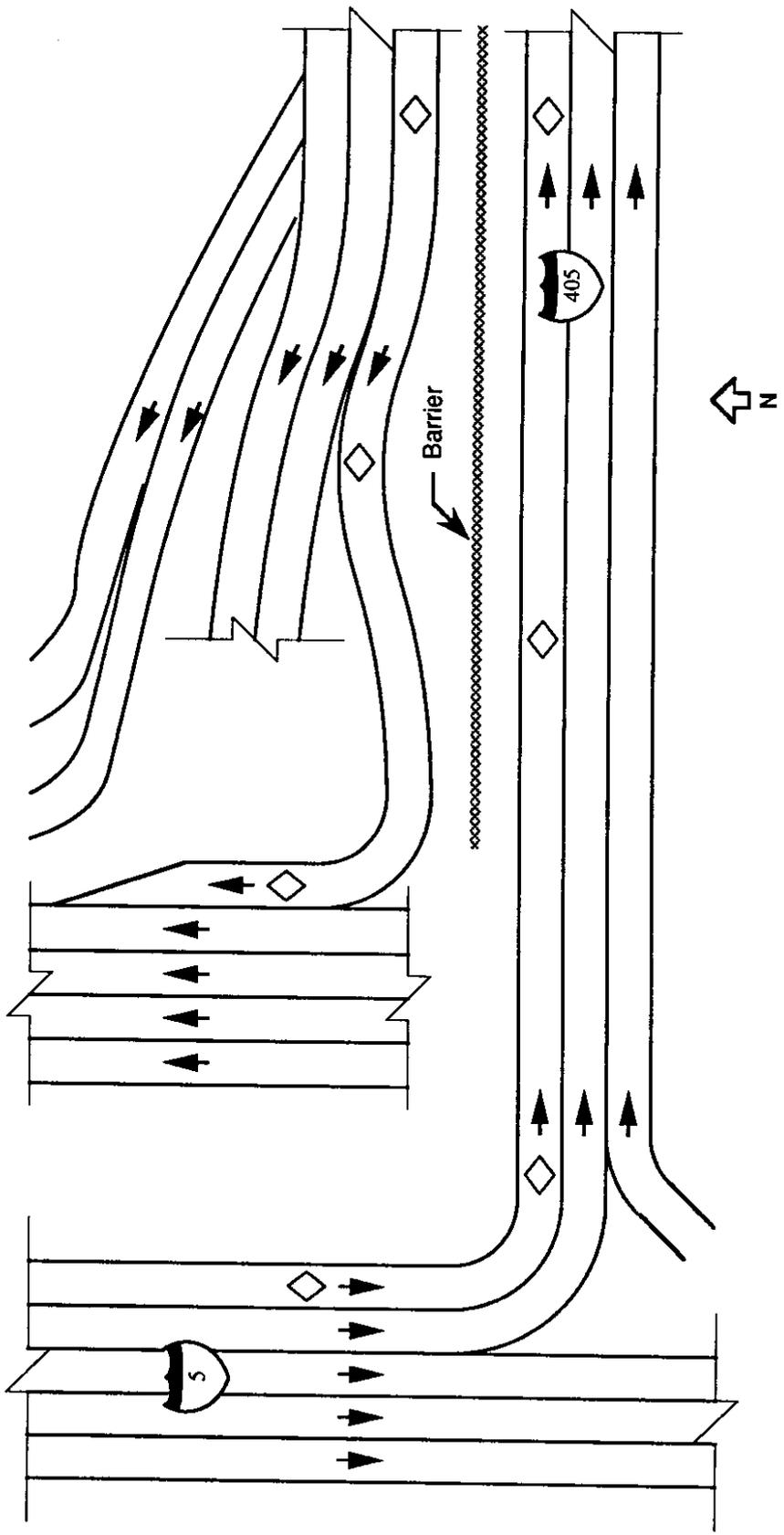


Figure 6. Site Schematic (West End)  
 (Showing how HOV lanes connect to I-5)

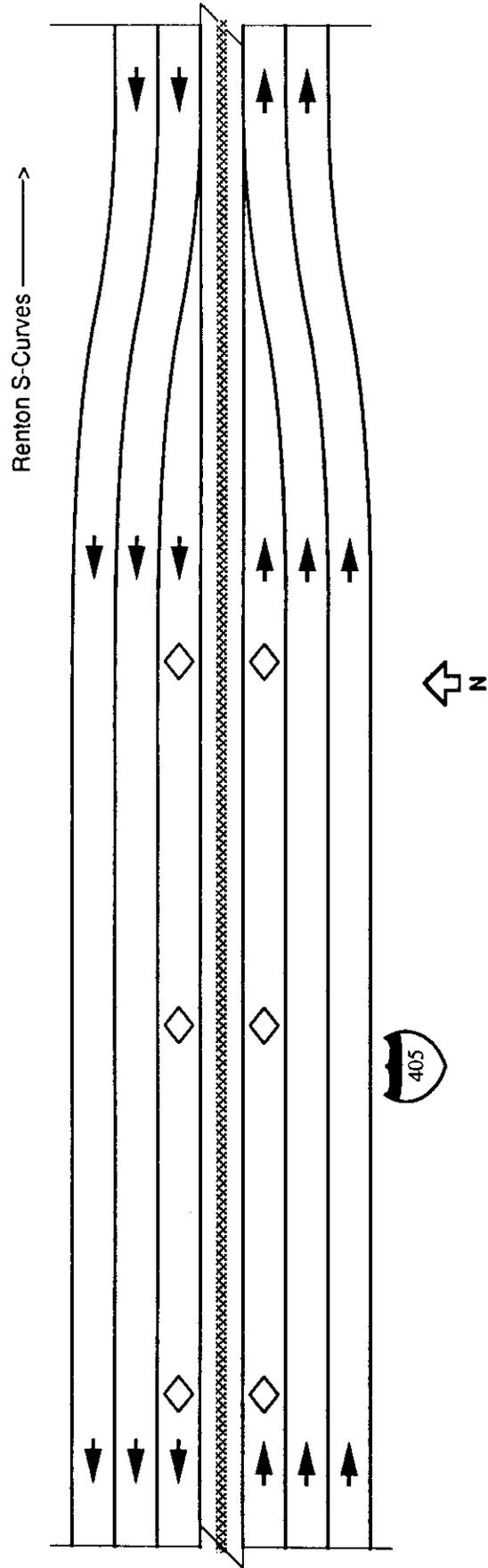


Figure 7. Site Schematic (East End)  
 (Showing how HOV lanes merge)

enforcement. These initial data were collected on January 2, 3, and 4, 1991 (enforcement period 1). The remaining data were collected during the last two weeks of each of the phases. Each enforcement phase is defined below:

### **Definitions**

- **Normal enforcement**  
Period 3 — 3/11 - 4/7  
Period 5 — 5/6 - 6/2  
Period 7 — 7/8 - 7/25  
The type of routine enforcement WSP normally does, with no special written agreement with WSDOT. During this normal enforcement, the motorcycle squad is spread throughout the Seattle area on a somewhat random basis, concentrating on known violation spots that have acceptable enforcement areas. These troopers are frequently assigned to more urgent tasks, such as accidents, court appearances, and dignitary escort.
- **Intensive enforcement (or continuous saturation enforcement)**  
Period 2 — 1/7 - 3/10  
Saturation enforcement (see third definition below) that is done five days a week, Monday through Friday.
- **Saturation enforcement**  
Period 4 — 4/8 - 5/5  
The majority of the motorcycle squad covers the site at the same time, primarily during the peak hours.
- **Stationary enforcement**  
Period 6 — 6/3 - 7/7  
A trooper sits at the entrance to each HOV lane (one in each direction) as a visible deterrent, primarily during the peak hours. Normally, they do not pursue violators.

The AVO data collected included the vehicle types and number of people inside each vehicle passing the observation point. Each peak period included three 30-minute data collection periods. The 30-minute period was chosen as the time best suited for such an intense task based on previous experience (4). A short (five- to ten-minute) break to rest the eyes and stretch sore muscles was allowed and encouraged. Because of the steepness of the site, the data collectors had to sit on the ground, rather than in a comfortable chair or vehicle.

Vehicle codes were entered into laptop computers. The codes were as follows:

<u>Code</u>	<u>Description</u>
1	One person car or pickup truck
2	Two person car or pickup truck
3	Three person car or pickup truck
4	Four or more person car or pickup truck or unlabeled vanpool
5	Designated vanpool
6	Public transit bus, with option for bus route number
7	Other bus
8	Truck-two axle (UPS delivery truck and larger)
9	Truck- three axle or more
0	Motorcycle

Codes 5, 6, 7, 8, 9, and 0 did not fully indicate the occupancy of the vehicle: sometimes trucks (code 8 or 9) have two or more occupants, motorcycles (code 0) sometimes have passengers. The public buses (code 6) never carried passengers on this particular roadway. The "other" buses (code 7) had a widely varying number of passengers. The same was true for the unmarked vans (code 4) or for the designated vans (code 5). Occasionally, more than four people were in code 4 vehicles. Sometimes vehicles did not clearly fit any of the listed categories; for example, a motor home, a pickup towing a boat, or an airport shuttle express. The counters coded motor homes and pickups towing boats as codes 1-4 (cars or pickups), and airport shuttle buses as code 7 (other buses). Because the number of these types of vehicles was so small, their statistical effect was minimal.

The data collection effort took place along I-405 by the 68th Ave S. (formerly Christensen Road) bridge that crosses over I-405. The data collectors were located about 30 feet above I-405 near the bridge's end piers. To minimize the number of drivers who would see them, the data collectors sat downstream of the bridge, so the bridge end pier hid them. Essentially, then, no vehicle drivers were able to see the counters. The part of I-405 evaluated in this project only has two locations where people can sit high enough above the roadway to see down into vehicles. It is important that auto occupancy counters sit above the roadside level, especially when a busy three-lane roadway is being observed.

Even though the counters were high on the bank, large trucks in the two outside lanes would occasionally block the view of vehicles behind them. Hidden vehicles were counted (often one could see just a portion of a car's tires), and coded as the most common occupancy noted for that lane. For a vehicle hidden in the HOV lane, a two-person vehicle was coded. If a vehicle was hidden in the middle (general purpose) lane, then it was coded as a one-person vehicle. The counters reported that these hidden vehicles accounted for less than 10 vehicles for any one 30-minute count of 1,000 vehicles, which is less than 1 percent. Usually, there were less than ten hidden vehicles.

## **DISCUSSION**

The raw data are summarized as average vehicle occupancies (AVOs) in Tables 1, 2, and 3. The general purpose lane volumes were compared to the HOV lane volume during each enforcement phase. This was originally done to see whether missing lane-volume data could be generated, given some of the other lane volumes. The overall trend was that as the traffic volumes increased in the general purpose lanes, so did the HOV traffic volumes.

The general purpose lane volumes were compared to the HOV lane violation rate during each enforcement phase. It was hypothesized that high volumes in general purpose lanes (indicating congestion) would be related to HOV violations. This correlation was statistically insignificant.

The average violation rate and individual violation rates during each enforcement phase were graphed using bar graphs (see Figure 8, 9, and 10). The before-enforcement period and the intensive enforcement period had higher average violation rates than the following enforcement periods. In fact, the average violation rate went up during the intensive enforcement period. A possible explanation is that the before-enforcement data collection occurred on January 2, 3, and 4, 1991, right after the New Year holiday. Traffic volumes were low, the roadway was just beginning to dry after a month-long cold spell of snow and ice, and people were not using the HOV lane yet.

Table 1. Average Vehicle Occupancies (All Three Lanes Together)

ENFORCEMENT PERIOD	SOUTHBOUND		NORTHBOUND	
	AVO**	STD.DEV.	AVO**	STD.DEV
1	1.189	0.026	1.263	0.039
2	1.160	0.002	1.246	0.030
3	1.167	0.020	1.271	0.039
4	1.149	0.014	1.260	0.033
5	1.166	0.018	1.261	0.026
6	1.175	0.019	1.300	0.049
7	1.187	0.014	1.325	0.046
Total*	1.171	0.021	1.256	0.162

\* Totals based on average of data, not on averages listed above.

\*\* AVO = total persons/total vehicles. Total persons computed using 4.1 persons for each vehicle coded as four or more, 6 persons for each vanpool, 1 person for each transit bus, and 5 persons for each other bus. Note that each transit bus only counted one person (the driver) because the portion of I-405 being observed does not carry any Metro bus routes. All observed Metro buses were empty.

Table 2. Average Vehicle Occupancies Southbound (General Purpose Lanes and HOV Lanes Separately)

ENFORCEMENT PERIOD	SOUTHBOUND			
	GENERAL PURPOSE LANES		HOV LANE	
	AVO**	STD.DEV.	AVO**	STD.DEV
1	1.163	0.028	2.258	0.118
2	1.115	0.021	2.078	0.013
3	1.115	0.024	2.243	0.191
4	1.103	0.012	2.053	0.100
5	1.105	0.011	2.245	0.095
6	1.117	0.015	1.388	0.322
7	1.132	0.015	1.816	0.424
Total*	1.119	0.025	1.979	0.399

\* Totals based on average of data, not on averages listed above.

\*\* AVO = total persons/total vehicles. Total persons computed as described in note under first table in this section.

Table 3. Average Vehicle Occupancies Northbound  
(General Purpose Lanes and HOV Lanes Separately)

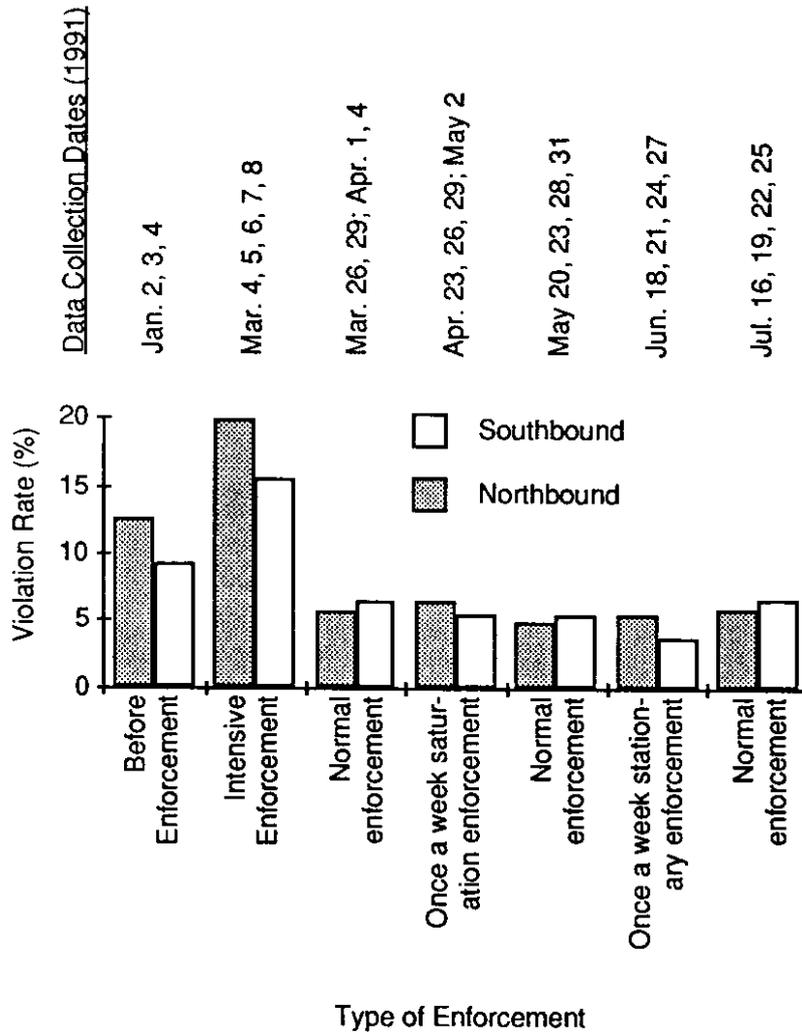
ENFORCEMENT PERIOD	NORTHBOUND			
	GENERAL PURPOSE LANES		HOV LANE	
	AVO**	STD.DEV.	AVO**	STD.DEV
1	1.138	0.022	2.107	0.070
2	1.157	0.033	2.264	0.340
3	1.176	0.038	2.158	0.074
4	1.169	0.041	2.133	0.071
5	1.169	0.017	2.191	0.064
6	1.183	0.054	2.228	0.053
7	1.223	0.048	2.240	0.062
Total*	1.176	0.044	2.193	0.142

\* Totals based on average of data, not on averages listed above.

\*\* AVO = total persons/total vehicles. Total persons computed as described in note under first table in this section.

The general purpose lane volumes were compared to the HOV lane violation count. Again, the data appeared scattered, with no obvious trends. The average violation count and individual violation counts for each enforcement period were graphed using bar graphs (see Figure 11, 12, and 13). These graphs showed that the violation counts dropped to an acceptable uniform level by the end of the third month of enforcement.

Various regression analysis computer runs were made with SPSS (statistical package for the social sciences) Release 4.0 for the Macintosh. Both the individual violation rates and violation counts were analyzed as separate dependent variables in relation to the independent variables of different enforcement periods, direction on I-405, general purpose lane volumes, and combinations of the enforcement periods. Regression analysis was used to control for traffic volumes (congestion), direction, and other factors. The resulting coefficients of three of the computer regression models are listed in Table 4.



**Figure 8. Average HOV Lane Violation Rates (Northbound and Southbound)**

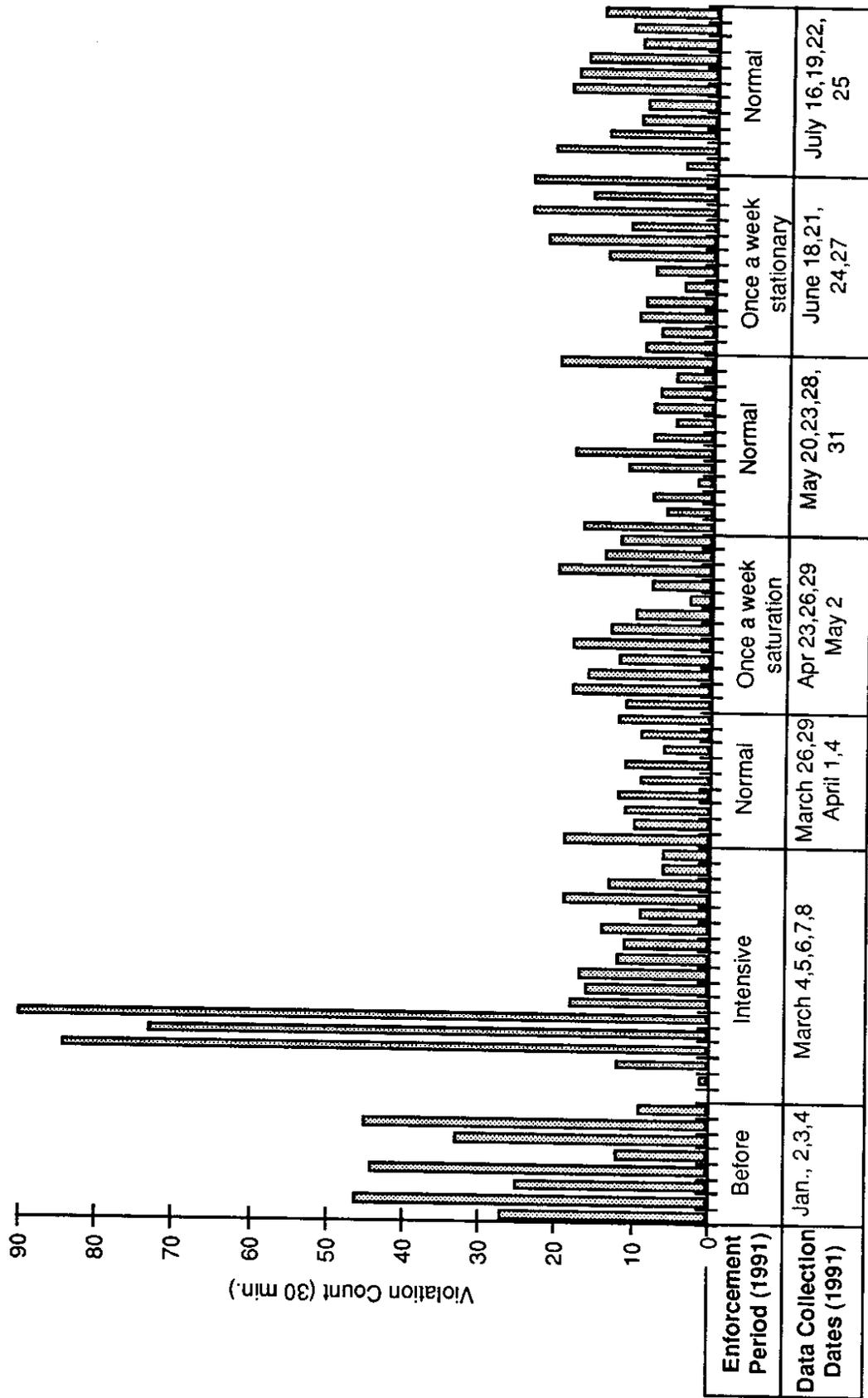


Figure 9. Individual HOV Lane Violation Rates (Northbound).  
Each bar from 30 minute counts.)

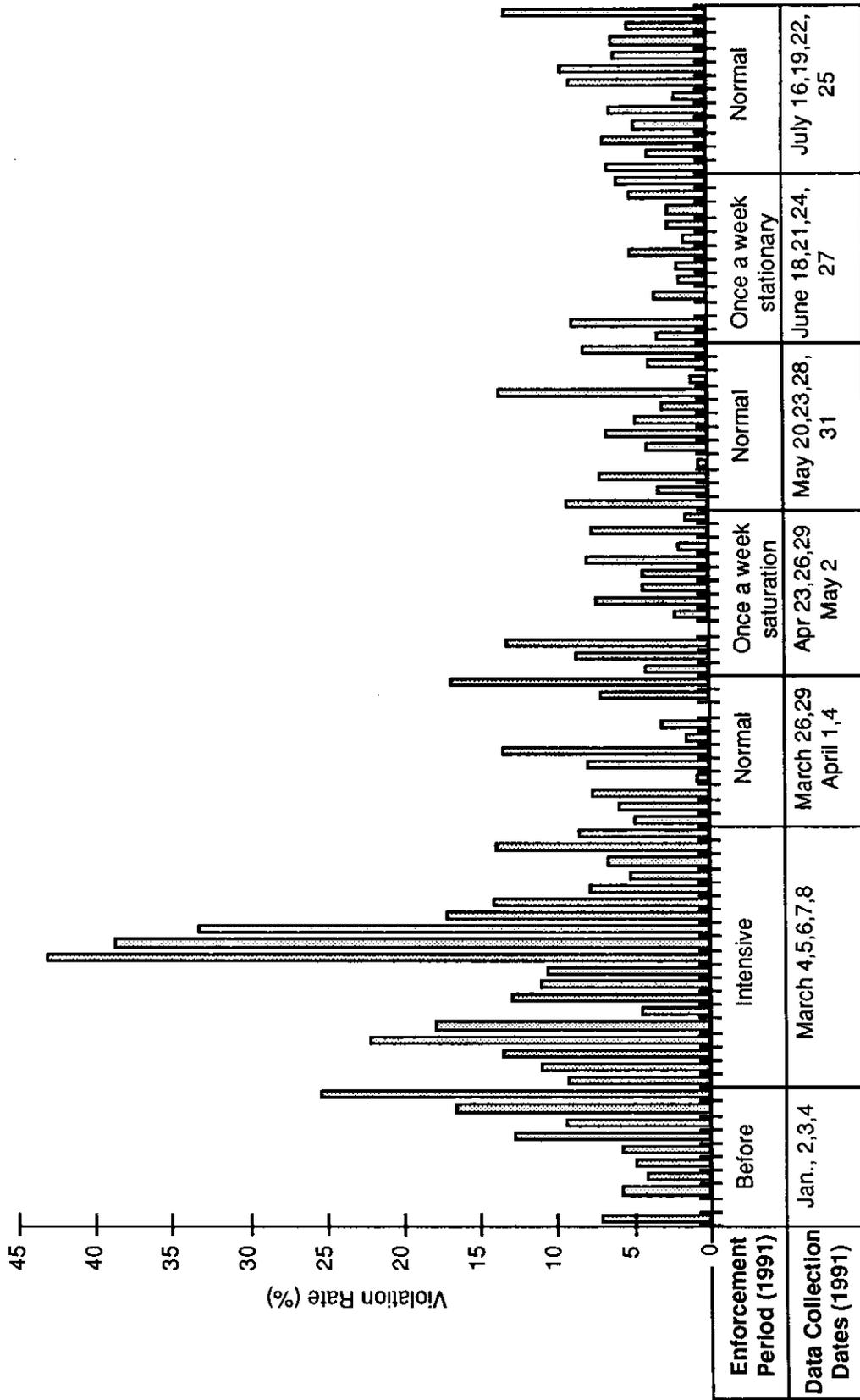


Figure 10. HOV Lane Violation Rates (Southbound).  
Each bar from 30 minute counts.)

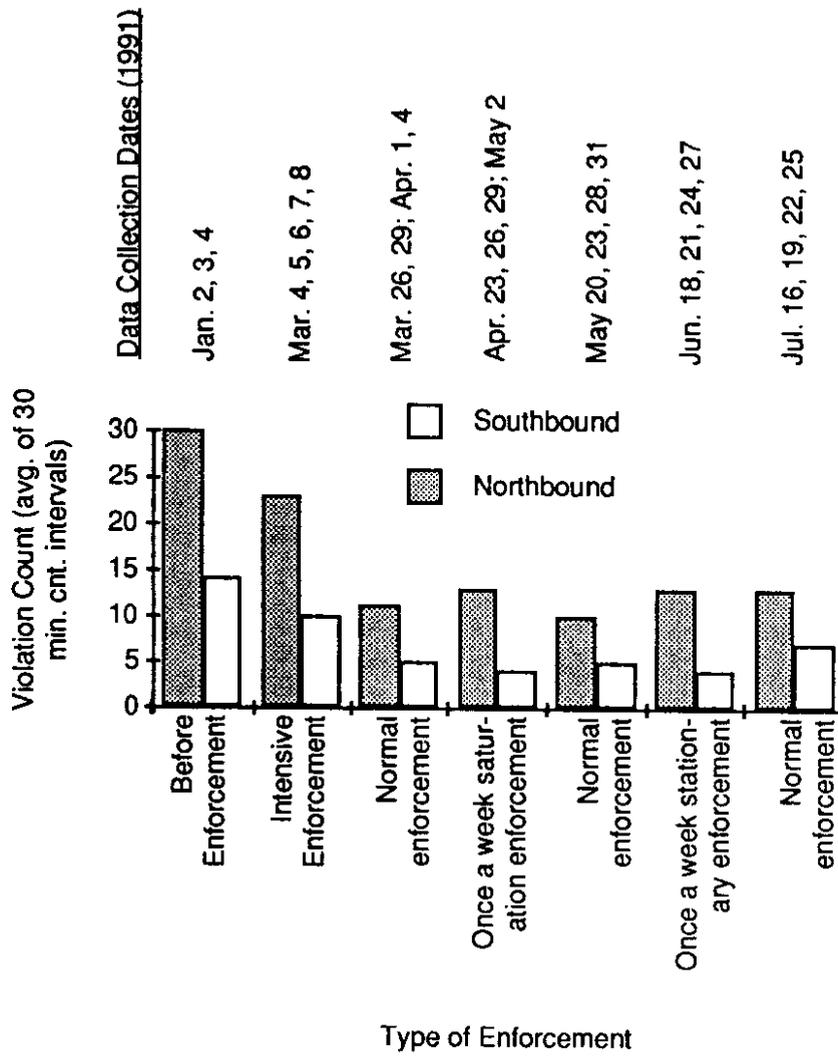


Figure 11. Average HOV Lane Violation Counts (Northbound and Southbound)

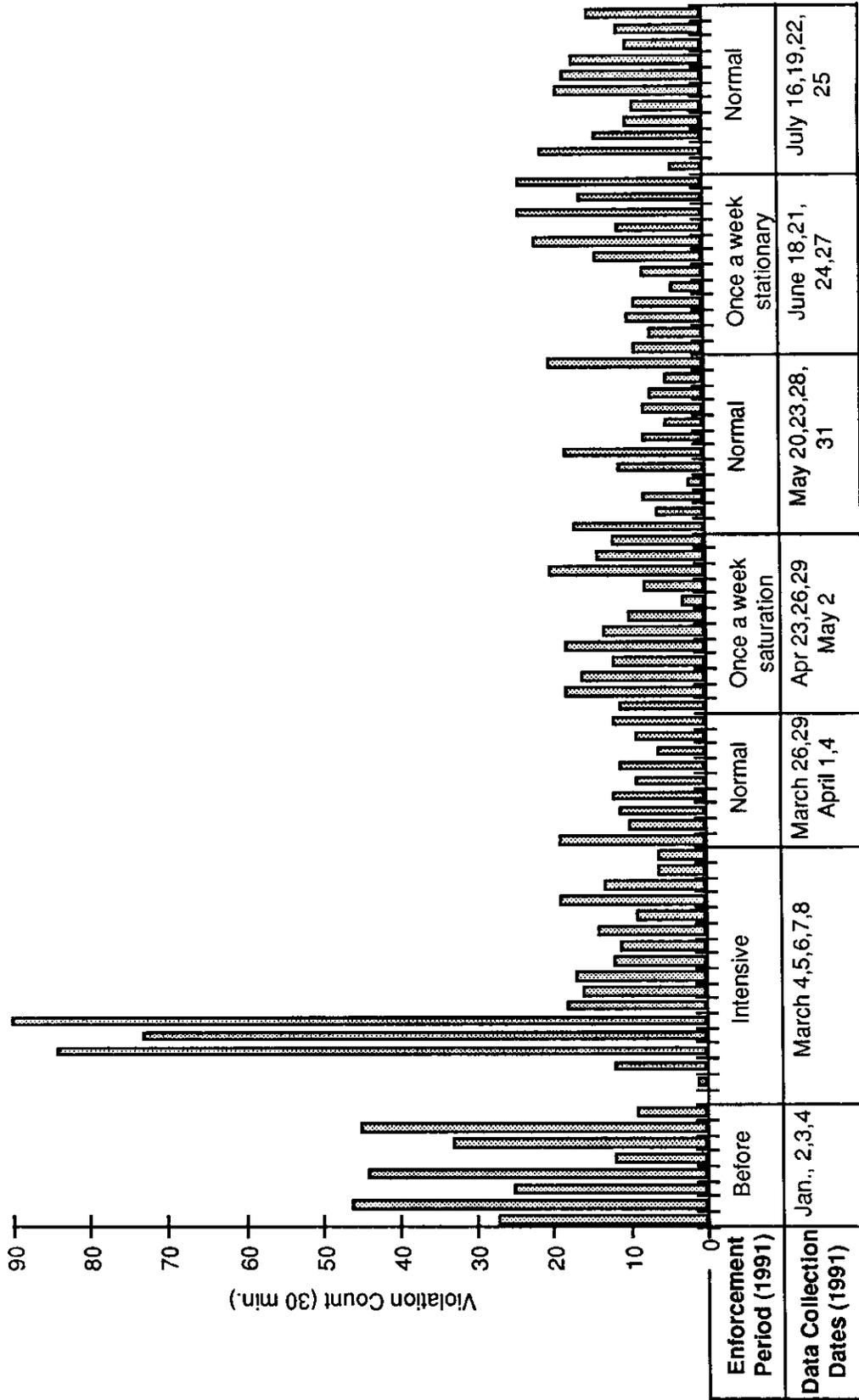


Figure 12. Individual HOV Lane Violation Counts (Northbound. Each bar from 30 minute counts.)

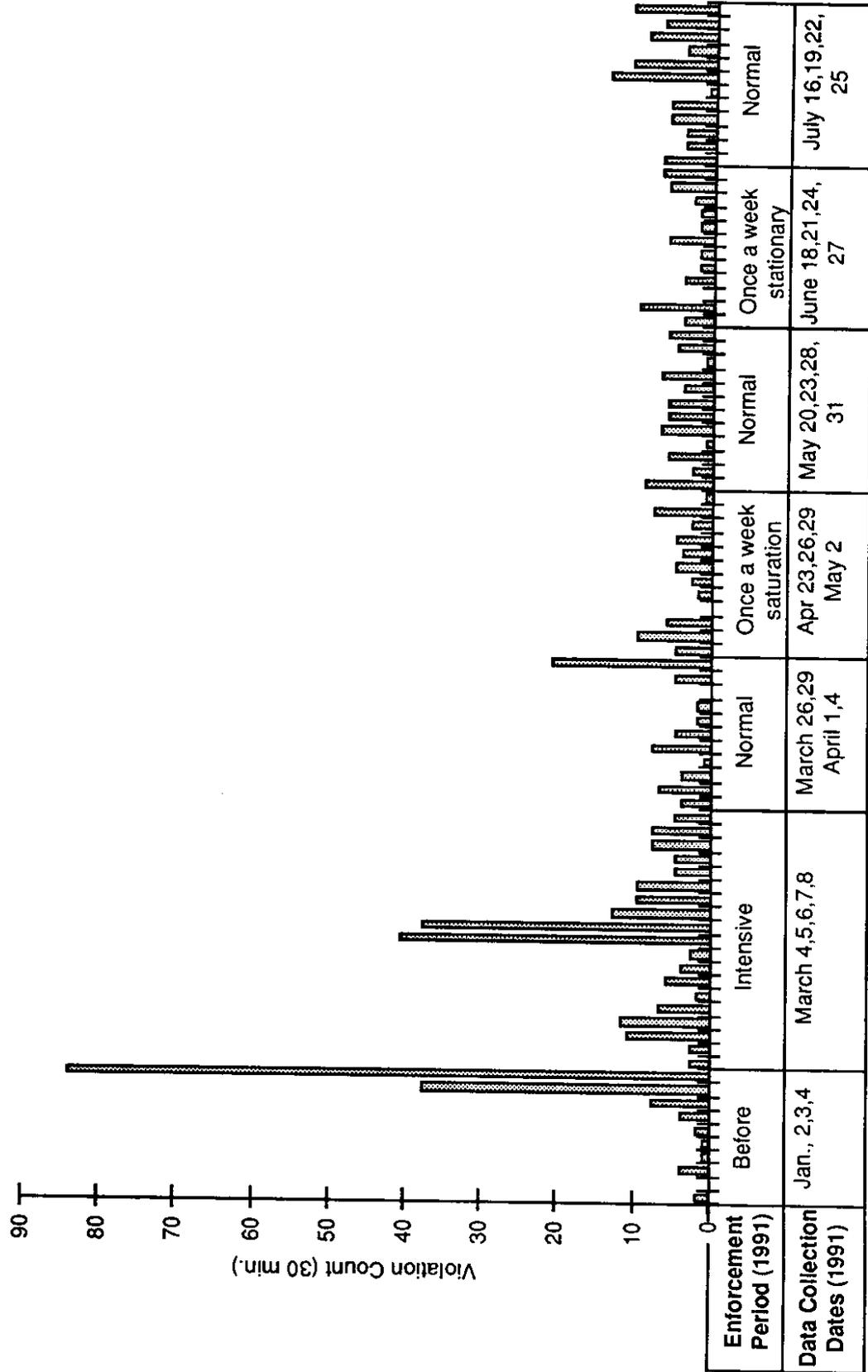


Figure 13. Individual HOV Lane Violation Counts (Southbound).  
Each bar from 30 minute counts.)

Table 4. Coefficients (B Values) Used in Some Specific Regression Models

Independent Variables	Model 1		Model 2		Model 3	
	Violation Count	Sig.T	Violation Count	Sig.T	Violation Count	Sig.T
Intensive enforcement	-2.596	0.23	-11.29	0.00	-----	-----
Once a week saturation enforcement	-1.050	0.51	-0.19	0.90	-----	-----
Once a week stationary enforcement	-1.102	0.48	-0.41	0.78	-----	-----
Direction (1=northbound and 0= southbound)	8.082	0.00	6.70	0.00	6.885	0.00
Traffic volumes in general purpose lanes	0.003	0.47	0.013	0.00	0.008	0.05
Before enforcement and intensive enforcement combined	-----	-----	10.28	0.00	4.211	0.01
All three enforcement emphasis periods combined	-----	-----	-----	-----	-1.830	0.12
Constant	-7.511	0.22	-25.61	0.00	-16.15	0.02

The "Sig.T" value is usually considered significant when smaller than 0.05.

Three conclusions obtained from the regression runs are as follows:

1. **As the general purpose lane volumes increased, so did the number of violations (so enforcement effort should primarily be done during peak traffic periods).**

The coefficients for general purpose traffic volumes indicate that an increase in lane volumes corresponded to an increase in the number of violations. The relationship is strong and statistically significant.

2. **The number of observed violations was consistently greater in the northbound direction than in the southbound direction.**

This is probably explained by the observation site used. The observation site was located close to the south end of the corridor (about half a mile). Many violators traveling southbound would have already changed lanes back to the general purpose lanes. Observers occasionally noted this lane changing phenomenon. Both violators and non-violators continually changed lanes from the HOV and general purpose lanes. Because of the configuration of the southbound HOV lane, all vehicles that remain in the

HOV lane can only head north on I-5. Most of the traffic in the afternoon travel period is headed for locations across I-5, or headed south on I-5. In contrast, the observation site on I-405 for the northbound direction was at the beginning of the HOV lane. This presented a greater incentive for violators to use the lane, since the end of the lane was about two miles away.

- 3. Each type of enforcement effort helped in lowering the number of HOV lane violations, but it was impossible to determine which method was most effective.**

Model 3 indicates that all the enforcement periods were significant in reducing violations. However, Model 1 indicates no differences in effectiveness among the types of enforcement. Model 2 results show a possible significant effect for intensive enforcement; however, with the overwhelming influence of high violation rates early in the project, it would be erroneous to state that the intensive enforcement method is better than the other methods.

Another regression run that included an independent variable that combined the three enforcement periods indicated a beneficial effect on the number of violations. Thus, enforcement does lead to a decrease in the number of violations (the T value of 0.12 approaches significance).

### **ADDITIONAL COMMENTS**

Counters noticed that a large number of law enforcement vehicles seemed to travel this particular corridor. Not only were WSP vehicles seen here, but King County police and municipal police from various nearby jurisdictions were also seen. This increased visibility may have deterred potential violators.

The amount of time allocated for the normal enforcement period (4 weeks), between the special enforcement periods, was probably not enough time for people to be aware that the enforcement effort had changed. This is especially true considering the large enforcement presence in the corridor.

The HOV lanes covered in this report, and most of the other major HOV lanes in Washington state, are separated from the general purpose lanes by only an 8-inch-wide, white, paint stripe, so in Washington state, drivers are free to move in and out of the HOV lane. In some states the HOV lane is separated from the other lanes either with a wider buffer area or with concrete barriers. While conducting the auto occupancy counts, researchers noticed that some single occupant vehicles used the HOV lane for passing slower vehicles in the general purpose lanes. Because these passers were in the HOV lane for such a short distance, enforcement of the violation would have been difficult unless a trooper had been driving alongside the violator.

## **PUBLIC OPINION SURVEY ON ENFORCEMENT**

A public opinion survey was sent to registered vehicle owners to obtain their opinions on HOV enforcement. The survey was sent to two groups: observed HOV violators, and a control group of non-violators also observed at the site. In addition to their opinions of HOV lanes and HOV enforcement, general demographic data were also collected.

### **PROCEDURE**

Field observers discretely noted the license plates of vehicles seen violating the HOV lane requirements (henceforth called the "violator" group). As soon as a violating vehicle was observed, a control vehicle was observed in one of the two general purpose lanes. The control vehicles were easy to observe when traffic conditions were stop-and-go. When traffic was wide open, the vehicles moved too fast to observe the license plates before disappearing in the distance or going around the corner. The researchers determined that the violator vehicles were easiest to observe in the southbound direction, perhaps because the observation point was close to the end of the HOV lane, and violator vehicles were often slowing down to merge into the general purpose lanes at this point. In the northbound direction, the observer was only able to obtain about one in ten of the violator license plates, primarily because the violators were traveling so fast. Initially, the control group of license plates was a group of legal vehicles traveling in the HOV lane (henceforth called the "control HOV" group). This control group was then changed to single occupant vehicles (SOVs) traveling in the general purpose lanes (henceforth called the "control SOV" group).

The license plate numbers were coded in a special format and then sent to the Washington State Department of Licensing (DOL). A signed commitment that the researchers would keep the registered owners' names and addresses confidential, and an assurance to destroy the list after the completion of the research was included. DOL sent

the registered owners' names and addresses, and vehicle descriptions to the researchers. The lists were analyzed for duplication, and vehicle descriptions were verified. Addresses located outside of the Puget Sound area were eliminated from the survey, mainly because the researchers reasoned that the out-of-area addresses were probably out of date, or the driver was visiting the Seattle area.

The survey was mailed to the name and address of the owner of the observed license plate on file at DOL. The survey cover letter requested that the survey be given to the driver who commuted most often. While the researchers hoped that the vehicle driver observed violating the HOV rules would fill out the survey, the results indicated that this was not always the case.

The public opinion survey was sent to 485 registered vehicle owners. As an incentive to improve the survey return rate, a one dollar bill was included with each survey.

## **DISCUSSION**

Of the 485 surveys mailed out, 27 were returned undeliverable (and unopened) by the Post Office. One survey was returned uncompleted by a person who said he was retired, and hence ineligible since we had requested that only commuters complete the survey (he even returned the dollar bill). The revised total of surveys mailed and delivered was 457. Two months after mailing the surveys, 55 percent of the 457 surveys had been returned. Twelve surveys were received too late for processing (bringing the total response rate to 58 percent). Of the 252 returned surveys, 29 were received from the control HOV group, 140 from the control SOV group, and 83 from the violator group. This high return rate was probably a result of the one dollar bill incentive that was placed in each survey. (In the past when similar surveys have been mailed out without any incentive, the return rate was often in the 10 to 20 percent range.)

For the analysis, the two control groups (control HOV and control SOV) were combined into one control group for reporting the results of the first three questions on

commute trip patterns. For the remainder of the questions, the control HOV group was dropped from the analysis because of the concern that HOV drivers would differ from SOV drivers on important attributes. All remaining violators and controls were SOV drivers.

Each survey was coded and entered into a personal computer spreadsheet (Microsoft Excel Release 2.2a for the Macintosh) and analyzed with a statistics package (SPSS Release 4.0 for the Macintosh). In the vast majority of the questions, there was no statistical difference in rates of agreement or disagreement between the groups. The few questions that did reveal a statistical difference between the two major groups are described below with the applicable question (see Tables 14 through 19, which correspond to survey questions 4h, 4i, 4j, 4k, and 4l in the Appendix). The results of each question are discussed individually.

### **The Commute Trip**

The first page of the survey asked questions about the person's commute trip.

Table 5 shows the normal mode used by the respondents to commute to work (Question #1). The percentages are not statistically different between the two subgroups.

Table 5. Please place a mark by one of the following that indicates how you normally get to and from work.

ANSWERS	SUBGROUP		Total
	Control	Violator	
	(column percentages)		
Drive alone	85.8	91.6	<b>87.7</b>
Carpool - you and 1 other person	5.3	6.0	5.6
Carpool - you and 2 or more other people	1.2	0.0	0.8
Vanpool	0.6	0.0	0.4
Bus	3.0	1.2	2.4
Bicycle, Walk	0.6	0.0	0.4
Motorcycle	0.0	0.0	0.0
Other	2.4	1.2	2.0
No answer	1.2	0.0	0.8
<b>Total</b>	100.1	100.0	100.0

Of the 29 presumed "control HOV," 15 said they drove alone. This indicates that the people the researchers had hoped would fill out the survey were probably not the people who did complete the survey.

The large percentage of people who reported driving alone (87.7 percent) compared favorably to the figure reported by Mehyar (5). Mehyar reported a range of 81.2 to 96.2 percent single occupant vehicles along other portions of I-405 between October 1989 and September 1990.

Table 6 shows the results for Question #2, which asked if and how the respondents used the HOV lanes on their commute trip. Of the total, 37.3 percent said they used the HOV lane while alone for turning. Because the HOV lane in this project is on the inside, the answer needs explanation. One possible explanation is that many of the drivers had used the HOV lanes located farther north on I-405, where the HOV lane is on the outside. This outside HOV lane requires drivers to use the HOV lane when exiting or entering the freeway general purpose lanes.

Question #3 asked if respondents ever have enough people in their vehicle to use the HOV lanes, but don't. Of the total sample, 71.0 percent said "no," 27.0 percent said "yes," and 2.0 percent gave no answer. Of those who answered "yes," 16 respondents when asked "Why?" checked "slower than regular lanes," 18 checked "too much trouble to change lanes," 10 checked "not safe," 6 checked "traffic moves too fast," 27 checked "forget," and 26 checked "other."

### **Opinions**

The next series of questions asked people's opinions about various HOV issues. The response categories were "agree strongly," "agree," "neutral," "disagree," and "disagree strongly." The five possible responses have been combined into three (or less) responses in the results presented here. If responses had less than five check marks, then the response was deleted to obtain a valid chi-square value.

Table 6. Have you ever used the HOV lanes while traveling to and from work... (check yes or no for each one).

ANSWER GROUP	ANSWERS	SUBGROUP		Total
		Control	Violator	
		(column percentages)		
on a bus	no	45.6	22.2	67.9
	yes	8.3	4.0	12.3
	no answer	13.1	6.7	19.8
	total	67.1	32.9	100.0
in a carpool	no	33.7	17.1	50.8
	yes	24.6	12.7	37.3
	no answer	8.7	3.2	11.9
	total	67.1	32.9	100.0
in a vanpool	no	50.4	24.2	74.6
	yes	2.8	0.4	3.2
	no answer	13.9	8.3	22.2
	total	67.1	32.9	100.0
on a motorcycle	no	51.6	23.8	75.4
	yes	1.2	1.2	2.4
	no answer	14.3	7.9	22.2
	total	67.1	32.9	100.0
alone	no	53.2	22.6	75.8
	yes	3.2	4.0	7.1
	no answer	10.7	6.3	17.1
	total	67.1	32.9	100.0
alone for turning	no	30.6	15.1	45.6
	yes	25.4	11.9	37.3
	no answer	11.1	6.0	17.1
	total	67.1	32.9	100.0

Table 7. HOV lanes are a good idea.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	83.7	89.9	<b>86.0</b>
Disagree	16.3	10.1	14.0
Total	100.0	100.0	100.0

Table 8. HOV lanes help decrease traffic congestion for all commuters.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	59.0	59.8	59.3
Neutral	12.2	11.0	11.8
Disagree	28.8	29.3	29.0
Total	100.0	100.0	100.0

Table 7 shows the responses to the statement "HOV lanes are a good idea." The 86.0 percent that approved of HOV lanes compares favorably with the 85 percent reported in an earlier, similar survey (6).

The next statement requesting a response was "HOV lanes help decrease traffic congestion for all commuters." Table 8 shows the responses. Some people believed that HOV lanes cause congestion in the general purpose lanes. Their comments relate that backups are created in the general purpose lanes when HOV lane traffic has to merge back into the general purpose lanes when HOV lanes end. The Seattle area is in the process of building an HOV lane network, but currently most of the HOV lanes are relatively short and disconnected. In a few years, as more and more of the HOV lane segments become connected, the bottlenecks caused by ending lanes should decrease.

The I-405 HOV lane studied in this report also has a design problem at its connection with I-5. HOV lane traffic headed southbound on I-405 has a relatively good connection with north I-5 (mostly used during the morning commute). However, HOV lane traffic desiring to head south on I-5, or west on SR 518, has to merge back into the two general purpose lanes, causing almost daily backups during the afternoon commute. The backups might also be due to traffic congestion on I-5 that affects I-405.

Table 9 shows the responses to the statement "Adding lanes to existing freeways and arterials for regular traffic would eliminate traffic congestion." Almost 60 percent of

**Table 9. Adding lanes to existing freeways and arterials for regular traffic would eliminate traffic congestion.**

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	56.4	63.9	59.2
Neutral	17.1	15.7	16.6
Disagree	26.4	20.5	24.2
Total	99.9	100.1	100.0

the respondents agreed with this statement. While the addition of lanes to the freeways would expand capacity, it would not eliminate congestion over time. Experience shows that after a new road has been built or an existing road widened, traffic use grows until the area becomes just as crowded as before. The widened roadways and new roads are less congested only until the traffic use increases to congestion levels.

In Table 10, one can see that respondents, in general, disagreed with the statement "Constructing HOV lanes is unfair to taxpayers who choose to drive alone." Apparently, vehicle owners do not mind subsidizing HOV lane construction.

For the most part, respondents did not agree with the statement that "HOV lanes should be opened to all traffic." Table 11 shows that almost 65 percent of the respondents disagreed, meaning that they strongly supported keeping HOV lanes restricted to HOV use.

Table 12 shows that respondents tended to disagree with the statement "Existing HOV lanes are being adequately used." Over half of the respondents believed the HOV lanes were underutilized. Because the highest usage is only during the peak commute hours, the HOV lanes are almost empty during the rest of the day.

Table 10. Constructing HOV lanes is unfair to taxpayers who choose to drive alone.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	17.1	23.2	19.4
Neutral	17.9	13.4	16.2
Disagree	65.0	63.4	<b>64.4</b>
Total	100.0	100.0	100.0

Table 11. HOV lanes should be opened to all traffic.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	21.6	24.1	22.5
Neutral	12.9	13.3	13.1
Disagree	65.5	62.7	<b>64.4</b>
Total	100.0	100.1	100.0

Table 12. Existing HOV lanes are being adequately used.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	24.5	31.7	27.1
Neutral	20.1	14.6	18.1
Disagree	55.4	53.7	<b>54.8</b>
Total	100.0	100.0	100.0

Table 13. HOV lane violators commit a serious traffic violation.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	54.3	45.8	51.1
Neutral	21.0	24.1	22.2
Disagree	24.6	30.1	26.7
Total	99.9	100.0	100.0

The next part of the survey contained questions specifically about violations and enforcement issues. Respondents tended to agree that "HOV lane violators commit a serious traffic violation." According to Table 13, half of the respondents believed an HOV lane violation is a serious traffic offense, while only one fourth disagreed, and the remainder were neutral. If the question had labeled an HOV violation a "crime," rather than a "violation," the people's responses might have been milder.

In Washington state, an HOV lane violator is currently fined \$47, and the offense is defined as a moving violation, which can affect the driver's car insurance rates. Some other states have much higher fines, but generally the ticket is not considered a moving violation. Table 14 shows the results when respondents were presented with the statement "Fines for people who violate HOV lanes are adequate (currently \$47 per ticket)." A chi-square test indicated with a high statistical significance that the control SOV group disagreed with the question more strongly than the violator group. The responses to this question appeared to conflict with the responses to the previous question. If people believed HOV lane violations were a serious traffic offense, they should support higher fines. Perhaps the public considers the \$47 fine enough of a deterrent.

Table 14. Fines for people who violate HOV lanes are adequate (currently \$47 per ticket).

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	54.3	60.2	56.6
Neutral	13.0	22.9	16.7
Disagree	32.6	16.9	26.7
Total	99.9	100.0	100.0

Table 15. HOV lane violators are common during the commute hours.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	68.8	45.1	<b>60.0</b>
Neutral	21.7	35.4	26.8
Disagree	9.4	19.5	13.2
Total	99.9	100.0	100.0

Table 16. HOV lane violators are seldom caught by the State Patrol or local police.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	65.2	46.3	<b>58.2</b>
Neutral	23.9	36.6	28.6
Disagree	10.9	17.1	13.2
Total	100.0	100.0	100.0

As shown in Table 15, 60 percent of the respondents agreed with the statement "HOV lane violators are common during the commute hours." This percentage compares favorably with a statement in the California HOV design manual that "over three fourths of the drivers surveyed in a recent California HOV study felt that the illegal use of HOV lanes was a problem" (2). A chi-square test indicates with a high statistical significance that the control SOV group agreed with the question more strongly than the violator group.

Table 16 shows the responses to the statement "HOV lane violators are seldom caught by the State Patrol or local police." A chi-square test indicates with a high statistical significance that the control SOV group agreed with the question more strongly than the violator group.

Billheimer reported that California has an apprehension rate of about 2.5 percent of all drivers who use mainline HOV lanes illegally (7).

"With an apprehension rate of 2.5 percent, the typical violator could expect to use mainline HOV lanes illegally 40 times before being caught, so that a daily commuter using mainline lanes illegally morning and evening would expect to be caught within a month."

One of the survey respondents wrote that she got caught the first time she violated the rules. She used the HOV lane out of habit, because the person with whom she usually carpooled was not with her that day.

People believe that the presence of enforcement is an effective way to reduce the number of violations. As shown in Table 17, responses to the statement "When the presence of the State Patrol is not visible, HOV violations increase" indicate confidence in the effectiveness of enforcement. In addition, the cross-tabulation indicated that the control SOV group agreed with the statement more strongly than the violator group.

People were more neutral about the effectiveness of the HERO program. When people call in and report an HOV lane violator, the violator is sent an informational brochure for the first reported violation. The second and third reported violations

Table 17. When the presence of the State Patrol is not visible, HOV violations increase.

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	72.7	64.6	69.7
Neutral	23.0	22.0	22.6
Disagree	4.3	13.4	7.7
Total	100.0	100.0	100.0

Table 18. HOV lane violators are minimized by the HERO program (this program encourages people to call in and report HOV violators at phone number 764-HERO).

ANSWER	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
Agree	11.0	23.2	15.6
Neutral	45.6	41.5	44.0
Disagree	43.4	35.4	40.4
Total	100.0	100.1	100.0

Table 19. How much does HERO reduce the illegal use of HOV lanes? (6).

POSSIBLE ANSWER	ANSWER PERCENTAGES
not at all	24%
don't know	11%
somewhat,	29%
not very much	31%
a great deal	6%
Total	101%

generate increasingly firm letters from WSDOT and WSP, respectively. The WSP targets occasional repeat offenders for watching and possible ticketing. The HERO program itself does not ticket anyone since the evidence is only hearsay and not admissible in court.

When presented with the statement "HOV lane violators are minimized by the HERO program," only a small group agreed. Table 18 shows a large block of neutral answers. This may indicate that people were either not aware of the HERO program, or were not aware of the affects of the HERO program. A chi-square test indicates that the control SOV group disagreed with the statement more strongly than the violator group.

An earlier survey by Rutherford posed similar questions about the HERO program (6). Because the questions asked earlier were not identical to the above single question, one can only look at similarities. One question was, "How much does HERO reduce the illegal use of HOV lanes?" The answers are shown in Table 19. The report stated:

"Apparently, even though many people feel the HERO hotline does not significantly reduce the illegal use of HOV lanes by unqualified vehicles, the majority of people are nonetheless in favor of the HERO program. Perhaps many people are in favor of the program because it gives them the ability to 'do something' about HOV lane violators."

### **Personal Data**

The final series of questions requested personal information about each respondent. Table 20 shows the response to a question about gender. When collecting the license plates for the survey, the field observer thought he noticed that the majority of the observed drivers were female (but no records were kept). Perhaps it was the males who filled out the survey at home for almost 60 percent of the respondents were male.

Table 21 shows the age ranges of the respondents. Interestingly, most of the violators were in the 31-40 age range, while most of the members of the control group (non-violator SOV commuters) were under 31 years old.

Table 20. Are you?... \_\_\_ Male \_\_\_ Female.

	SUBGROUP		Total
	Control SOV	Violator	
SEX	(column percentages)		
Male	56.4	62.7	58.7
Female	42.9	34.9	39.9
No Answer	0.7	2.4	1.3
Total	100.0	100.0	100.0

Table 21. What is your age?

AGE RANGE	SUBGROUP		Total
	Control SOV	Violator	
AGE RANGE	(column percentages)		
Under 31	29.3	20.5	26.0
31-40	26.4	37.3	30.5
41-50	25.7	24.1	25.1
51-64	15.0	16.9	15.7
65+	2.9	0.0	1.8
No answer	0.7	1.2	0.9
Total	100.0	100.0	100.0

Table 22. What is your highest level of education?

EDUCATION	SUBGROUP		Total
	Control SOV	Violator	
EDUCATION	(column percentages)		
did not finish high school	0.0	2.4	0.9
high school	13.6	18.1	15.2
community college or trade school	22.1	26.5	23.8
college/university	45.7	38.6	43.0
post graduate	17.9	13.3	16.1
no answer	0.7	1.2	0.9
total	100.0	100.1	99.9

The respondents tended to be highly educated. Table 22 shows the distribution of respondents by education. Only two respondents admitted to not finishing high school. The differences in education between violators and non-violators was not significant.

As shown in Table 23, the largest category for the control SOV group was a household size of two, while the largest category for the violator group was a household size of four. Could it be that people in larger households have busier lives and therefore have a higher motivation to violate HOV laws? The results shown in Table 24 tend to corroborate this speculation. In most households, two people worked outside the home, followed by one person working outside the home. However, there are more two-working-person households among the violators than among the non-violators.

Table 25 shows the distribution of people over 15 among the survey respondents. The number of people over age 15 was an indication of the number of people in each household who were old enough to drive, even though some people over the age of 15 do not drive.

Violators and non-violators tended to have about the same number of vehicles per household. Table 26 shows the distribution.

### **Written Comments**

The respondents were allowed (and encouraged) to make additional written comments. Of the total 252 surveys analyzed, 105 (41.7 percent) contained some written comments. There was no significant difference in written response rates between the two subgroups; 39.8 percent of the violator group and 41.4 percent of the control SOV group wrote comments. This high volume of written comments is an indication that many people have opinions about traffic.

All the written comments were categorized by type, and the result of the tabulation are shown in Table 27. While most of the written comments were only a few sentences long, one person typed a separate, one-page comment.

Table 23. Including yourself, how many people live in your household?

HOUSEHOLD SIZE	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
1 person in household	13.6	8.4	11.7
2 people in household	<b>40.0</b>	24.1	34.1
3 people in household	15.7	22.9	18.4
4 people in household	20.0	<b>26.5</b>	22.4
5 people in household	7.9	10.8	9.0
6 people in household	0.7	4.8	2.2
7 people in household	0.7	1.2	0.9
no answer	1.4	1.2	1.3
total	100.0	99.9	100.0

Table 24. How many people living in your household work outside the home?

WORK OUTSIDE HOME	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
no people work outside home	1.4	3.6	2.2
1 person works outside home	35.0	27.7	32.3
2 people work outside home	47.9	57.8	<b>51.6</b>
3 people work outside home	9.3	3.6	7.2
4 people work outside home	5.0	3.6	4.5
5 people work outside home	0.7	1.2	0.9
6 people work outside home	0.0	1.2	0.4
no answer	0.7	1.2	0.9
total	100.0	99.9	100.0

Table 25. How many people living in your household are over age 15?

NUMBER OF PEOPLE OVER AGE 15	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
1 person over age 15	17.9	12.0	15.7
2 people over age 15	57.9	57.8	57.8
3 people over age 15	11.4	19.3	14.3
4 people over age 15	7.9	4.8	6.7
5 people over age 15	2.9	3.6	3.1
6 people over age 15	0.0	1.2	0.4
no answer	2.1	1.2	1.8
total	100.1	99.9	99.8

Table 26. How many vehicles (in working order) do you have?

OPERATING VEHICLES	SUBGROUP		Total
	Control SOV	Violator	
	(column percentages)		
1 working vehicle	20.7	20.5	20.6
2 working vehicles	45.0	49.4	46.6
3 working vehicles	24.3	19.3	22.4
4 working vehicles	7.1	7.2	7.2
5 working vehicles	1.4	2.4	1.8
6 working vehicles	0.7	0.0	0.4
no answer	0.7	1.2	0.9
total	99.9	100.0	99.9

Table 27. A summary of the types and numbers of written comments:

GENERAL TYPE OF COMMENT	COUNT
Support HOV lanes	28
Support rail (light rail generally)	24
Prefer 2+ rather than 3+ carpool definition	21
Design problems with HOV lanes (outside vs. inside, beginning and ending points, unconnected network, etc.)	21
Dislike HOV lanes	19
Supports increased enforcement (or need more enforcement)	13
HOV lanes should be opened to all traffic outside peak hours	10
Support public transit (like Metro)	10
Trucks are a problem	4
Construct more general purpose lanes	3
Safety concerns of HOV lanes	3
Miscellaneous	25
TOTAL*	181

\*Total count (181) exceeds number of written comments (105) because most respondents covered more than one topic. Additionally, classification of the type of comment was very subjective.

While both the survey cover letter and the survey itself included phone numbers to call if people wanted to discuss the survey, only one telephone call was received. This call was from a man who said he had already sealed the survey and had forgotten one comment that he still wanted to record. His comment was that some people might think they need a special "carpool" permit to use the HOV lanes, since the signs along the roadside say "carpools only." Thus people might avoid using the lane even when they were eligible.

## SUGGESTIONS FOR FURTHER RESEARCH

The researchers' findings indicate that if similar research is performed in the future, a few changes could make this research more effective. For instance, while the HOV lane violation rate dropped to a reasonable level sometime during the third month of the enforcement period, it is unclear how the effects of the initial two-month intensive enforcement period compared to the third month of normal enforcement. A better method might be to use only one type of enforcement until monitoring indicates that the violation rate is leveling off (to a steady state condition).

Another concern is the possible "halo" effect that one type of enforcement effort might have on subsequent enforcement efforts. While statistical analysis packages can eliminate some of the variables, two possible improvements could be made. First, the normal enforcement period could be extended between each special enforcement period. The one month (four weeks) allowed between each special enforcement period may not have allowed enough time for drivers to realize that the enforcement effort had changed, and thus to allow violation rates to possibly climb.

Another method that could eliminate the "halo" effect would be to use different locations for each type of enforcement effort. The locations should be in different corridors so most of the drivers would not be influenced by the enforcement effort being conducted elsewhere.

Public opinion surveys should be more specific about who should respond. The survey instructions for this project asked that the driver who commuted the most fill out the survey. Perhaps a better approach would be to ask that the survey be completed by whomever commuted to work on a particular road segment.

Research on HOV lane enforcement should involve close coordination with enforcement officers. The researchers suggest contacting the appropriate enforcement supervisors on a weekly basis. While all contacts the researchers had with the WSP were

positive and productive, there was some miscommunication. For example, one sergeant indicated that when the once-a-week stationary enforcement effort began, his troopers went out for 3 successive days and then, because of negative public comments about the lack of pursuit, decided to abandon that type of enforcement. Because the researchers were not in weekly contact with the WSP, they were not able to intervene in the decision.

Any future research related to HOV lane enforcement should also monitor how many enforcement vehicles are using the corridor. While the I-405 corridor by Tukwila appeared to have a higher than normal number of police vehicles on the roadway, this supposition could not be substantiated. Does the presence of so many marked police vehicles correspond to reduced HOV lane violations? The public opinion survey responses suggested that people do tend to better obey the regulations when police vehicles are seen.

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**APPENDIX A**

**HIGH OCCUPANCY VEHICLE LANE ANALYSIS  
PUBLIC OPINION SURVEY**

(similar to what was mailed out, printed both sides on  
one piece of 11 X 17 inch (28 X 43 cm.) paper)



Washington State  
Department of  
Transportation



University of  
Washington



Washington State  
Transportation  
Center

## HIGH OCCUPANCY VEHICLE LANE ANALYSIS PUBLIC OPINION SURVEY

The Washington State Department of Transportation and the Washington State Transportation Center at the University of Washington are working together to study the high occupancy vehicle (HOV) lanes in the region (HOV lanes are sometimes called "carpool" lanes). We need to understand your perception of HOV lanes and HOV lane use and why you choose to commute the way that you do.

Please give this survey to the driver in your household who most often commutes to work. Ask him or her to fill out the survey and return it by mail. No postage is necessary.

While this survey is intended to be anonymous, feel free to call us if you want to discuss this survey. Contact Eldon L. Jacobson at 685-3187, during normal business hours.

### Section A: Your Commute Trip

1. Please place a mark by one of the following that indicates how you normally get to and from work.

- Drive alone
- Carpool - you and 1 other person
- Carpool - you and 2 or more other people
- Vanpool
- Bus
- Bicycle, Walk
- Motorcycle
- Other: \_\_\_\_\_

2. Have you ever used the HOV lanes while traveling to and from work ... (check yes or no for each one)

- | YES                      | NO                       |              | YES                      | NO                       |                   |
|--------------------------|--------------------------|--------------|--------------------------|--------------------------|-------------------|
| <input type="checkbox"/> | <input type="checkbox"/> | on a bus     | <input type="checkbox"/> | <input type="checkbox"/> | on a motorcycle   |
| <input type="checkbox"/> | <input type="checkbox"/> | in a carpool | <input type="checkbox"/> | <input type="checkbox"/> | alone             |
| <input type="checkbox"/> | <input type="checkbox"/> | in a vanpool | <input type="checkbox"/> | <input type="checkbox"/> | alone for turning |

3. Do you ever have enough people in your vehicle to use the HOV lanes but don't?  
 Yes\_\_\_ No\_\_\_ If yes, why? (check all applicable)
- \_\_\_ slower than regular lanes                      \_\_\_ traffic moves too fast  
 \_\_\_ too much trouble to change lanes            \_\_\_ forget  
 \_\_\_ not safe    \_\_\_ other

**Section B: Your Opinions**

4. Please indicate to what extent you agree or disagree with the following statements. "1" means you agree strongly, and "5" means you disagree strongly.

	1	2	3	4	5
	Agree Strongly	Agree	Neutral	Disagree	Disagree Strongly
a. HOV lanes are a good idea.	—	—	—	—	—
b. HOV lanes help decrease traffic congestion for all commuters.	—	—	—	—	—
c. Adding lanes to existing freeways and arterials for regular traffic would eliminate traffic congestion.	—	—	—	—	—
d. Constructing HOV lanes is unfair to taxpayers who choose to drive alone.	—	—	—	—	—
e. HOV lanes should be opened to all traffic.	—	—	—	—	—
f. Existing HOV lanes are being adequately used.	—	—	—	—	—
g. HOV lane violators commit a serious traffic violation.	—	—	—	—	—
h. Fines for people who violate HOV lanes are adequate (currently \$47.00 per ticket).	—	—	—	—	—
i. HOV lane violators are common during the commute hours.	—	—	—	—	—
j. HOV lane violators are seldom caught by the State Patrol or local police.	—	—	—	—	—
k. When the presence of the State Patrol is <u>not</u> visible, HOV violations increase.	—	—	—	—	—
l. HOV lane violators are minimized by the HERO program (this program encourages people to call in and report HOV lane violators at phone number 764-HERO).	—	—	—	—	—

**Section C: About Yourself**

5. Are you? ...  Male  Female
6. What is your age?  under 31  31-40  41-50  51-64  65+
7. What is your highest level of education?  
 did not finish high school  
 high school  
 community college or trade school  
 college/university  
 post graduate
8. Including yourself, how many people live in your household? \_\_\_\_\_
9. How many people living in your household work outside the home? \_\_\_\_\_
10. How many people living in your household are over age 15? \_\_\_\_\_
11. How many vehicles (in working order) do you have? \_\_\_\_\_

PLEASE USE THIS SPACE FOR ANY COMMENTS:

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THANK YOU FOR COMPLETING THIS SURVEY

The enclosed dollar is yours to keep as our way of saying thanks. Please return this by mail as shown on the back of this page.

When completed, fold along the dotted line and secure with tape or a staple, then drop in a mailbox. Thank you!

TRAC Form HOVA

65-1054

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⇐ *Mailing info goes here* ⇒  
(to be supplied by department of printing)