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Volume I: Procedures and Conclusions

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16. Abstract

This two volume report details the findings of 256 past and present high occupancy vehicle treatments which have been implemented. Volume I contains the procedures followed and the major conclusions found concerning the 19 specific HOV treatment types which were studied. Some of these conclusions are that only five treatments (park-n-ride lots, separate roadways, contraflow freeway and arterial lanes, and preferential bypass at a metered ramp) produced the impacts which were expected. Another seven treatments either produced mixed results or had no effect on the expected impacts, while the remaining six HOV treatments had no reportable data collected or were never implemented.

Findings concerning specific HOV treatments included: it was generally found that transit malls/auto restricted zones must have an operating transit system on the street and a major pedestrian generator for it to be effective; reserved lane operations must not affect reverse flow traffic and should be physically separated from peak direction traffic to be effective;contraflow lanes usually have safety problems during off-peak hours or where major turning movements or pedestrian activity exists; concurrent flow lanes usually need major transit use or a large increase in occupancy to be effective; and finally, a much greater effort must be made by both traffic engineers, planners, and researchers to obtain pertinent information about HOV preferential treatments.

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Volume II contains a comprehensive bibliography along with a listing for each HOV treatment cited which includes the year implemented, size, priority cutoff, hours of operation, current status and any before and after data concerning the impacts which the treatments may affect.

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SUMMARY AND CONCLUSIONS

Because of such factors as competing funds for new highway construction, limited right of way, and the ever-present energy problems, mass transit and carpool use has received more emphasis in recent years. New ways of enticing commuters to get out of their autos and into a bus or carpool have been implemented and this study reviewed 19 of these high occupancy vehicle (HOV) preferential treatments. First, the treatments were grouped by the type of preference (economic, convenience, space, time) they produce, then the anticipated impacts (increased transit use, improved air quality, increased parking needs, etc.) were determined, and finally, the parameters (transit passengers, tons of emissions, parking needs, etc.) used to measure these impacts were determined.

Initially, representatives of the metropolitan planning and transit planning organizations in New Jersey were interviewed to determine their interests and views of HOV treatments. As a result of these interviews it was determined that costs, congestion, capacity, and safety are impact areas of major concern. Eighteen of the nineteen HOV treatments were judged to be applicable in our state, but very few are being considered. HOV treatments seem to be given low priority in the development of the overall transportation system. The determination of exactly what an HOV is, where to implement, and when to implement HOV preferential treatments is very unclear and more work needs to be done on what makes a certain implementation a success.

Finally, contact was made with transportation agencies in the United States to determine the number of HOV treatments implemented, to obtain before-after data, and to obtain treatment analysis which could help determine why certain treatments are successful. Two hundred and fifty-six applications of the 19 HOV treatments were found, but only about one half of them had any before - after data, while only about one-quarter of them had substantial data. One of the findings from the available data

was that the information most often collected was that which the Planning Organizations were most concerned about, namely costs, congestion, capacity, and safety. Five treatments (Park-and-Ride Lots, Separate Roadways, Contraflow Freeway and Arterial Lanes and Preferential Bypass at a Metered Ramp) produced the impacts which were expected while four treatments (Preferential Toll Charges, Exclusive Freeway Ramps, Toll Facility Preferential Lanes, and Signal Preemptions) did not produce the expected results but were simply a good way of giving HOV users a time or cost reduction. Three treatments (Transit Mall/Auto Restricted Zones, Concurrent Flow Freeway and Arterial Lanes) produced mixed results on the expected impacts while the final six treatments (Preferential Freeway Congestion Pricing, Preferential Parking Costs, Preferential Parking with or without Priority, Turning Movement Restrictions, and Exclusive Bypass Ramp) had no reportable data collected or were never implemented.

It was generally found that transit malls/auto restricted zones must have an operating transit system on the street and a major pedestrian generator for it to be effective. Reserved lane operations must not affect reverse flow traffic and should be physically separated from peak direction traffic to be effective. Contraflow lanes usually have safety problems during off-peak hours or where major turning movements or pedestrian activity exists. Concurrent flow lanes usually need major transit use or a large increase in occupancy to be effective.

A much greater effort must be made by both traffic engineers, planners, and researchers to obtain pertinent information about HOV preferential treatments. This data is needed not only to justify and defend present and future treatments, but also to determine the reason for certain negative impacts. With this knowledge, we might be able to reduce these negative impacts, making the treatments even more attractive to decision makers.

INTRODUCTION & BACKGROUND

More and more emphasis is being put on the use of mass transit and carpooling in recent years. This is due to such factors as the trend away from construction of new highways caused by fiscal constraints, limited right-of-way, and the ever-present, although not always prevalent, energy problems. However, the American love affair with the automobile continues and it is difficult to change a person's habit of driving alone to work.

One way of enticing people to form a carpool or use mass transit is to give carpools and buses some type of preferential treatment. Preferential treatments for high occupancy vehicles (HOVs) have, therefore, become popular transportation systems management tools for reaching certain objectives such as conserving our natural resources or increasing the person-carrying capability of a roadway at low cost. Examples of such treatments are reserving a lane on a freeway for HOVs, preferential toll charges for HOVs, and special park-and-ride facilities.

In the past, a location was studied for a specific HOV treatment due to the fact that no systematic approach was available to determine which HOV treatment was best suited for the location. This was due, in part, to the fact that it was not fully understood how well different preferential treatments compared in terms of meeting specific objectives. Therefore, an expensive and detailed feasibility study would have to be performed to determine if a specific HOV preferential treatment had the possibility of meeting the proposed objectives for the location.

For example, over the past several years, New Jersey has performed three different feasibility studies for a preferential HOV lane at three different locations. At one of these locations, Route 444 in Middlesex and Union Counties, it was determined that a preferential lane was feasible within 12 of the 39 mile study area. Since then, the preferential lane has been implemented and subsequently discontinued due to it not meeting the objectives. At another location (17 miles of Routes 80 and

95 in Bergen and Passaic Counties), it was determined that a preferential HOV lane of one mile was feasible for bypassing congestion associated with the George Washington Bridge toll plaza. Steps are currently under way to achieve implementation. However, a preferential lane was not recommended for the remaining sixteen miles of the study area. At the third location (six miles of Route 3 in Passaic, Bergen, and Hudson Counties), it was determined that a preferential HOV lane was not feasible.

By studying each location independently, large amounts of time and money were expended before it was determined whether the particular preferential treatment should be recommended for implementation. Also, because only one specific preferential HOV treatment was studied, another study would need to be performed to determine the feasibility of other HOV treatments.

Many preferential HOV treatments have been studied and implemented in other parts of the country. Tremendous amounts of data have been provided by these studies which can be used in identifying the potential of the different treatments in meeting certain objectives. However, no one has compiled this data by each particular parameter which is associated with HOV treatment's objectives.

Therefore, this study had two main objectives. First, to identify the objectives associated with each high occupancy vehicle preferential treatment and from the data of past research determine how the parameters associated to these objectives were affected by both successful and unsuccessful HOV treatments. Second, to put this information into an easy to access manual for project engineers to use in assessing how a specific objective might be affected by implementing a specific preferential treatment.

PROCEDURE

The project was set up in three steps. First was an extensive literature review of past work concerning HOV preferential treatments. This was geared to compile the material available on those objectives associated with each HOV treatment. Also considered were the parameters used to measure if the objectives were being reached. Examples of these parameters are travel time, auto occupancy, transit ridership and accident rates. These preferential treatments, objectives, and parameters were then grouped in tabular form.

After these groupings were made, the next step was to determine New Jersey's local and state officials' opinions of these HOV preferential treatments. In the past, HOV treatments had only been studied with engineering concerns considered. Further along it was found .that local officials were not as enthusiastic about the treatment and its attributes as the engineering staff was. Thus, the main purposes of this step of the project were to determine the objectives which the respondents thought were the most important for their jurisdiction, if the respondents thought HOV preferential treatments or more conventional transportation methods best addressed these objectives, and which HOV treatments are supported by the respondents and should be studied for implementation in the future.

First, a mailout questionnaire was prepared to obtain this data. However, most of the local officials would be unfamiliar with HOV preferential treatments. Therefore, it was decided that personal interviews would be more appropriate. The HOV treatments, which are relatively new techniques of traffic management, could be better explained and understood at face-to-face meetings. But the list of local officials had grown to over 700 which caused another problem, i.e., the large amount of time needed to conduct these interviews. Therefore, plans were again changed to interview representatives of the metropolitan planning organizations within the state. In this way, the number of interviews could be greatly reduced while still obtaining the

local area's point of view since these organizations deal regularly with the elected officials. Also, these representatives would be more familiar with the use of preferential treatments.

The final step of this study was the preparation of a user's manual dealing with past experiences of HOV preferential treatments. From the earlier literature search, an association was made between the preferential treatments, the impacts which were affected by each treatment, and the parameters used to measure whether the objectives were being met. The information on the effect which the implementation of HOV preferential treatments had on these parameters had not previously been gathered and compiled for easy reference. By doing this, an engineer proposing a preferential treatment can take the parameters associated with the specific location and compare them to both successful and unsuccessful treatments of the past. The comparison will help the engineer in determining the feasibility and possible success of the proposed preferential treatment.

RESULTS

A. TREATMENTS, IMPACTS AND PARAMETERS

The first item to be determined was the nature of an HOV preferential treatment. HOV preferential treatments were generally considered as any improvement designed to give people who carpool, vanpool, or use public transportation preference during their trip over a person who does not. These treatments are generally installed for the peak periods of the day when congestion exists and require only minimal cost outlay and a relatively short time to implement. Using this definition produced nineteen preferential treatments. These treatments were then grouped by the four types of preference they provided:

1. Economic-Treatments which primarily make a specific trip less expensive for the HOV user.
2. Convenience-Treatments which primarily make a specific trip more convenient for the HOV user.
3. Space-Treatments which primarily reserve an area for HOV users only and require low occupancy vehicle users to change their route.
4. Time-Treatments which primarily reduce the travel time for HOV users for a specific trip without requiring non-HOV users to change their route.

Table A-1 in Appendix A groups the nineteen preferential treatments by type and gives the definition for each.

Once the HOV preferential treatments were determined, the impacts associated to these treatments were needed. A study (180) performed by J.H.K. and Associates and Peat, Marwick, Mitchell and Company for the Federal Highway Administration had compiled a list of goals and impacts which could be used for all Transportation Systems Management strategies and was very helpful in the determination of the final list of objectives. Table A-2a in Appendix A shows the 18 positive impacts which were chosen as dealing with HOV preferential treatments.

After going through the literature, however, it was found that although some HOV preferential treatments met their stated objectives, they were still determined to be unsuccessful for other reasons. Because of this, a list of negative impacts was compiled. These impacts shown in Table A-2b in Appendix A may be caused by the preferential treatments and are very derisive to the successful presentation of the treatments to the public.

The next step was the determination of which preferential treatments and impacts should be grouped together; that is, which preferential treatments can be used to meet the positive objectives or cause the negative impacts to occur. After a review of the literature, a matrix was constructed showing these relationships.

Finally, the parameters which are used to monitor whether the impacts are being affected had to be selected. Thus, Table A-3 in Appendix A was compiled which gives parameters for each of the 35 impacts in Tables A-2a and A-2b. The effect an HOV preferential treatment has on these parameters was used in the third part of this study to determine its success or failure in meeting its objectives.

B. QUESTIONNAIRE AND PERSONAL INTERVIEWS

Mailback questionnaire packages were to be sent to politicians to obtain their views on HOV treatments. (Appendix B contains a copy of the questionnaire.) However, a decision was made that because of the unfamiliarity of the HOV preferential treatments, personal interviews would be more appropriate in determining the data needed. In this way, the HOV preferential treatments could be better explained to the respondents making for more informed and applicable responses.

It was later decided that due to the large number of politicians, it would be impossible to personally interview all of them. Therefore, the approach changed from interviewing mayors who govern small sections of the state to interviewing representatives of planning organizations, who have responsibility for much larger sections of the state. In this way, it was hoped that the same coverage of the state could be obtained while decreasing the number of personal interviews.

Twelve interviews were held with personnel from the following groups:

Atlantic City Urban Area Transportation Council

Wilmington Metroplitan Area Planning Coordinating Committee (Salem-WILMAPCO)

Warren County Planning Department (Phillipsburg)

Cumberland County Planning Deparmtent (Vineland)

Delaware Valley Regional Planning Commission (DVRPC)

Salem County Planning Board (Salem-WILMAPCO)

North Jersey Transportation Coordinating Committee (NJTCC)

New Jersey Department of Transportation's Planning Division

New Jersey Transit Corporation

Atlantic County Transportation Authority

Port Authority of New York and New Jersey

Delaware River Port Authority

The first eight organizations were included as representatives of the six metropolitan planning organizations in the state. These organizations do the planning for approximately 75 percent of the state's land area as shown in Figure A-1 in Appendix A. Approximately 90 percent of the population lives in these areas. These areas include the large urban areas where HOV preferential treatments are most likely to be implemented. The areas in New Jersey represented by the Wilmington, Warren, Cumberland, and Salem organizations are smaller metropolitan areas and are actually somewhat rural in comparison to the two larger metropolitan areas of North Jersey, bordering New York City, and the Delaware Valley, bordering Philadelphia. The Atlantic City area is unique because of its attraction power caused by the gambling casinos which were legalized in 1978. Eleven casinos have been built and are now open for business and the Atlantic City representatives stated that a large increase in traffic, including charter bus service into the city, has occurred mainly due to the casinos' operations.

The Department of Transportation's Planning Division does the transportation modeling for all the urban areas except the Delaware Valley but is mainly concerned with the smaller metropolitan areas. The next two listed organizations are transit operators, one with responsibility for the planning and operation of the transit service in Atlantic City, whose interest in transit has also peaked with its new growth, and the other with the responsibility for the transit system of the entire state. The final two organizations are authorities responsible for the major river crossings into New York City and into Philadelphia.

Prior to the interview, a package was sent to each representative. This package included the definitions for the four types of HOV preferential treatments and the nineteen treatments themselves (Table A-1). This was done so that the representatives would be familiar with the terms used during the interview.

Because of the change to interviews, the questionnaire was revised to a more concise form. The result was a five question interview as shown in Figure A-2 in Appendix A. The first two questions were related to the objectives associated first with the organization itself and second with the HOV treatments. The next two questions dealt with whether priority should be given and which treatments are applicable in the organization's area. The final question dealt with the negative impacts associated with HOV treatments.

The answers to the first question dealing with the organization's objectives were predictable. The representatives of the smaller, more rural, urban areas reported that no real congestion existed and that their main objectives were to maintain the present transportation facilities and provide the funding for it. The larger metropolitan urban area representatives, although also having these two objectives, were more concerned with reducing present congestion and improving the productivity of the present transportation facilities. The Atlantic City representatives, which have the unique situation of legalized gambling in their city, stated that improving the transit system's

service and efficiency and reducing the number of passenger cars entering Atlantic City were their main objectives. The Port Authorities' representatives asserted that their primary objective is the efficient operation of their facilities which includes reducing congestion and increasing traffic flow. Finally, the transit agencies' representatives explained that improving transit's service and efficiency were their main objectives.

The second question of the interview tried to determine how important each of the attributes associated to HOV treatments are in the organizations' planning process. Table A-4 in Appendix A shows the responses to this question. These responses can be broken up into three groups. The first and most important group contains six attributes. This group had at least two thirds of the respondents say that the attribute was of "great importance" or higher and a minimum of five say it was of "absolute importance." These attributes included both capital and operational costs, congestion, roadway capacity, safety, and transit use. These match many of the answers given to Question 1 of the interview. The only attribute which appears in this group that didn't get mentioned in response to Question 1 was safety. This may be because safety is taken for granted. For example, no one would build a road or make an improvement without considering the safety aspect.

The second or less important set of attributes included such factors as the user's travel time and cost, reduction in auto use, bus reliability, and comfort and convenience. These attributes are more relatable to the user of the roadway rather than the cost and roadway capacity in the first group which are the major concern of the transportation system's provider.

The third or least important set had at least two thirds of the respondents say that the attribute was of "some, little, or no importance." They included such factors as energy impacts, and air and noise quality. These factors can be considered "special interest" factors which don't cause any major concerns unless a specific group of people have a problem or a major crisis arises.

The third question specifically asked if HOVs should be given preference and to define the HOV which should receive this preference. Three of the representatives stated that the answers to these questions depended on the situation of when, where, and how the preference is being given. The remaining representatives declared that HOVs should be given preference but were not so positive on the definition of an HOV. Six respondents stated that it depends on the situation. Two claimed that 3+ occupant vehicles, vanpools, and buses should be given the preference, but one of these said reserving a travelled lane for them should not be done. The final respondent stated that buses should be given preference with vanpools and carpools being added only if their use of the preferential treatment is needed to justify the presence of the treatment.

The next question pertained to the applicability of the 19 HOV preferential treatments in the representatives' area. Table A-5 in Appendix A lists the number of positive responses for applicability of each of the HOV preferential treatments. Eighteen of the nineteen treatments were thought to be applicable in New Jersey by at least one respondent. The other treatment had no applicability simply because there are no metered ramps in the state. Also shown in the table is the treatments which are now or have been in operation. These include park-and-ride lots, preferential toll charges, toll facility preferential lanes, and concurrent flow freeway preferential lanes. Appendix C gives the list of these treatments and also a list of specific sites which the representatives stated could be examined for their future applicability to HOV treatments.

These responses were again predictable. Almost two-thirds of the positive responses came from the representatives of the two largest metropolitan areas, Philadelphia and New York. These are the areas where congestion is worse and space for transportation facility expansion is limited. Therefore, HOV preferential treatments could play a major role in increasing the person-carrying capabilities in

these areas. Atlantic City representatives, with their expanding traffic problems, also are showing a cautious interest in preferential treatments. Finally, the representatives from the three smaller urban areas showed very little interest in HOV treatments with two of them stating that park-and-ride lots would be the only treatment applicable in their area. This is due to the fact that no real congestion problems exist in their area.

The final question pertained to negative impacts which may cause a project to be dropped from consideration. All the negative impacts listed could be caused by at least one of the HOV preferential treatments. Table A-6 in Appendix A displays the number of positive responses for each of the impacts. Out of the six negative impacts with the most responses, two deal with safety, two with governmental costs and one with congestion. These responses match the responses given for Question 2 concerning the most important attributes. The other negative impact in the top six, inconvenience to residents of the affected area, seems appropriate since without public support of the people in the immediate vicinity of a project it will definitely have approval problems.

From the results of the interviews with the planning organization representatives, the following conclusions can be made:

1) Keeping costs down, decreasing congestion, improving the productivity (capacity) of the transportation system, and improving safety are the main objectives and pose the largest problems to the planning organizations.
2) It is generally agreed that high occupancy vehicles should be given preference, but the specific situation should determine the definition of HOV.
3) All but one of the nineteen HOV preferential treatments were judged to be applicable by at least one planning organization. The two larger metropolitan areas have many more occasions for these treatments because these are the areas where congestion is greatest.

4) Even though there seems to be support for HOV preferential treatments, very few are being considered for implementation. Preferential treatments are not given a top priority in the development of the overall transportation system.

5) The determination of exactly what an HOV is, where to implement, and when to implement HOV preferential treatments is still very abstract. More work needs to be done to determine what makes the implementation of a treatment a success.

This last conclusion leads into the final step of the project which was to determine if there is a common link between the HOV preferential treatments which have succeeded in the past.

C. IMPLEMENTED HOV TREATMENTS AND DATA

An extensive phone survey was performed in which state and city transportation agencies across the country were contacted to determine the treatments which had been implemented and where, and also to obtain any before and after implementation data that might have been collected.

Two hundred and fifty-six specific applications of preferential treatments were pinpointed through this survey. Less than half of these treatments had any before or after data collected to determine their effectiveness, while about one half of these had very little data collected. Appendix E contains all the collected data. It first presents the specific locations, year implemented, and other general information for a specific preferential treatment. Then for this type of preferential treatment, it presents any before-after data which was available for each specific impact.

Table 1 presents the impacts which each preferential treatment is expected to affect. The numbers after the treatment's name are the total number of treatments found in the United States. The shaded blocks are the expected impact areas. The number in the block states how many teatments had before-after data for that impact.

TABLE 1

HOV PREFERENTIAL TREATMENTS AND IMPACTS
AVAILABLE BEFORE-AFTER DATA

PREFERENTIAL TREATMENTS		IMPACTS	Incr. Person Carry. Cap. of Rdwy.	Incr. Bus Use	Incr. Bus Reliability	Incr. Car and Vanpools	Incr. Safety	Red. Future Road Needs	Red. Congestion	Red. Capital Costs	Red. Auto Use	Red. Travel Time	Red. Travel Cost	Red. Energy Use	Imp. Air Quality	Imp. Noise Quality	Imp. HOV Comfort and Conv.	Imp. Ped. and Bicycle Traffic	Enh. Comm. Activity	Min. Oper. Costs	Incr. Non-HOV Oper. Costs	Incr. Non-HOV Delays	Incr. Transit Oper. Costs	Incr. Gov. Oper. Costs	Incr. Weaving Movements	Incr. Enforcement Costs	Incr. Parking Needs	Incr. Energy Use Initially	Incr. Acc. Init.	Decr. Non-HOV Comfort and Conv.	Decr. Air Quality Init.	Decr. Noise Quality Init.	Div. to Other Routes	Inconv. Area's Residents	Hamper Comm. Deliveries	Neg. Media Cov.	Court Actions Initiated
Pref. Toll Charges	7		1			1		1		1	1		7											2												2
Pref. Fwy. Cong. Pricing	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0					0	0	0	0	0		0			0	0	0		0	0	0
Pref. Parking Costs	2					0					0		2								0			0											0	0
Park-and-Ride Lots	10			0		0						1	8	4	0	0	0						0	1												
Pref. Parking	5					0					0	0					0			0										0						0	0
Exclusive Fwy. Ramps	4				0	1	0	0		0	0	3	0	0	0	0	0				0	0		0		0		0		0	0	0	0		0	0
Transit Malls	18			2	0						2			0	2	2	3	2	2	1	1	0	2			3	0		0	1	1	2	0	5	0	0
Auto Restr. Zones																																				
Red. Parking w/Prior.	1			0		0					0	0					0			0	0	0	0			0	0		0	0	0	0	0			0
Turning Movement Restr.	5				0	0	0					0								0	0	0					0		0	0	0	0	0			0
Separate Roadway	15		7	4	4	1		7	9	7	7	9	0	3	3	0							5	0	0									3		4
Contraflow Fwy. Pref. Lane	4		3	3	0			3	3	3		3	2	1	1	0							0	5	0				3							0
Contraflow Art. Pref. Lane	26		2	3	4			2	9	2		9	2	0	0	0							4	5	0		0		7							2
Concur. Flow Fwy. Pref. Lane	18		8	6	2	9		8	10	8	8	10	2	4	3	0							1	1	1	5		0	9		0	0		5		2
Concur. Flow Art. Pref. Lane	95		19	20	5	7		19	30	19	19	30	2	1	1	0							1	0	0	14	3	0	10		0	0		15		15
Exclusive Bypass Ramp	8				0	0		0		0	0	1	0	0	0	0	0			0						0									0	0
Pref. Bypass at a Metered Ramp	16		7		0	5		7		7	7	8	0	0	0	0	0			0					0	1			1							2
Toll Fac. Pref. Lane	5		4	2	1	1		4		4	4	4	0	0	0	0				0		1	0	3	0	0		0	1		0	0				0
Signal Preemption	16			3	4							7	0								0	5	2	2												

What this table shows is that the main data usually collected or calculable deals with reduction in congestion or travel time improvements, increasing capacity, capital cost reductions, and safety. Data not usually collected dealt with energy, air and noise quality, comfort and convenience, and commerical activity. This closely matches the results of the state's planning and transit organizations interviews as to which impacts are considered important and which are not.

The following will be a short review by each preferential treatment of the number cited, whether the expected impacts occurred and why or why not, if possible.

- Preferential Toll Charges - Seven of these treatments were cited, all of which are still operational. From data available (seven sites), this preferential treatment really has no effect on increasing the number of carpools and thus improving the capacity. However, it does not increase operating costs or cause court actions either. Therefore, it seems to simply be a way to reward HOV users for being just that.
- Preferential Freeway Congestion Pricing - No present or past implementations of this treatment were found in the United States.
- Preferential Parking Costs - Two of these treatments were cited, with one being suspended due to a construction project removing the parking area. No real data was collected, therefore, no conclusions can be made.
- Park-and-Ride Lots - New Jersey performed a study in which the 50 states were surveyed for before and after data concerning this preferential treatment. The report entitled, "An Analysis of the Response to New Jersey Department of Transportation's Survey of Statewide Park-and-Ride Development Programs" summarized the results of this study and was used as the data base of this project for this treatment. Ten sites were evaluated. Very little concrete data was available, but a few assumptions can be made. Park-and-Ride lots do

decrease energy use, vehicle miles travelled and operating costs, but probably also cause the commuter additional travel time.

- Preferential Parking - Five of these treatments were cited, with one being suspended due to a construction project removing the parking area. No data was collected, therefore, no conclusions can be made.
- Exclusive Freeway Ramps - Four of these treatments were cited, with one being suspended due to the opening of a separate roadway for buses. From the small amount of data available (three sites), this treatment seems to have no effect on increasing carpools or bus users but does give a travel time savings to those who use it.
- Transit Malls/Auto Restricted Zones - Eighteen of these treatments were cited, with one being suspended because it was in a wholesale commercial district and did not attract bus riders and pedestrians. From the small amount of data collected (three sites), most of the impacts that were expected occurred. However, some data was contradictory. For example, air and noise quality, pedestrian activity, commercial activity, and transit costs showed a change in the expected direction for one treatment while they stayed the same or changed in the other direction for another. No explanation for this was found. Another factor concerning this treatment is that it usually reduces the travel time for transit.
- Reduced Parking with Priority - One of these treatments was found and is still operational. No data was collected, therefore, no conclusions could be made.
- Turning Movement Restrictions - Five of these treatments were cited, but they were all in conjunction with another preferential treatment, usually a preferential lane. Therefore, the effects of this treatment could not be separated from the effects of the other, more influential treatment.

- Separate Roadway - Fifteen of these treatments were found and all are still operational. From the available data (nine sites), these treatments performed exactly as expected. They increased both bus and carpool use, thereby reducing congestion and the need to expand the roadway. They increased bus reliability by reducing travel time and also reduced emissions and energy use. Media coverage was generally good and no court challenges were found. This treatment did increase the transit company's operating costs because of the additional service that was usually needed to satisfy demand.
- Contraflow Freeway Preferential Lane - Four of these treatments were cited. One was suspended because a separate roadway was opened for HOVs while another was closed in the evening peak because the operating costs outweighed the benefits. From the available data (three sites), these treatments also performed as expected. Bus ridership increased, reducing congestion and the need to expand the roadway. Travel time and cost for HOV users as well as energy use and emissions were reduced. The operating costs for this treatment are high. However, accidents, a major concern for this treatment, showed no signs of increasing during the peak period. During the off-peak, accidents did increase because it is thought that traffic is light and vehicles mistake the priority lane for a general use lane.
- Contraflow Arterial Preferential Lane - Twenty-six of these treatments were found. Eight have been suspended for the following reasons: high operating costs (1), low utilization (1), converted to bicycle lane (1), construction along roadway (2), safety problems (3). Two others will be suspended in the near future because of safety problems. For the number of treatments, very little data was obtainable. The available data (11 sites) does show an increase in bus use, thus reducing congestion and the need to expand the roadway. Travel times and costs are reduced for HOV users. Because of the travel time reduction, one transit

company reported a reduction in operating costs. This treatment has two major drawbacks, government operating costs are high and safety is a major problem.

- Concurrent Flow Freeway Preferential Lane - Eighteen of these treatments were cited. One has been suspended due to the construction of a light rail system while three others and one direction of another were suspended because of low utilization of the lane. From the available data (ten sites), most of the expected impacts occurred. Travel time and costs were reduced and bus reliability was improved. However, at a few sites, very little or no increase in carpool use occurred. This was the reason for two sites closing where there was also no bus use. Accidents were expected to be a problem for this treatment, but none of them reported an extended increase in accidents.
- Concurrent Flow Arterial Preferential Lane - Ninety-five of these treatments were cited, by far the most of any treatment. However, twenty-two of these have been suspended for the following reasons: opening of concurrent flow freeway lane (1), safety problems (1), transit strike (1), high operating costs (1), opening of light rail system (2), enforcement problems (4), reconstruction of the roadway (5), low utilization (6), and unknown (1). Eleven others have stated that lack of or inability to enforce the treatment may cause their suspension. However, none of the treatments suspended for low utilization had any before-after lane use data and almost none of the treatments with enforcement problems had reported violation rates. It is, therefore, impossible to determine how these treatments differ from those that succeeded.

From the available data (33 sites), the results were somewhat mixed. Most treatments increased carpool and transit use, thus reducing congestion and the need to expand the roadway. Travel time and costs were reduced for HOV users, thus improving bus reliability. The biggest problems with this treatment are enforcement and the possibility of increased accidents although seven of ten

treatments showed no increase in accidents. Two areas that were thought to be problems, negative media coverage and court actions, were shown not to be.

- Exclusive Bypass Ramp - Eight of these treatments were cited, with one being suspended due to a light rail line being opened. No real data was collected, therefore, no conclusions could be made.
- Preferential Bypass at a Metered Ramp - Seventeen locations with 294 bypasses were cited. Only three bypasses were suspended, two because of volume problems on the roadway and one because of lack of storage on the ramp. From the available data (nine sites - 81 bypasses), most of the expected impacts occurred. Carpool and bus use increased causing reduced congestion and reduced need to expand the roadway. But at a few sites, the other ramps without bypasses were not studied to determine if these trips were new HOV trips or HOV trips diverted from these other ramps. Travel times were reduced while the expected problem areas of increasing accidents and court actions did not occur. The largest problem that surfaced was the violation problem which was reported as high as 50 percent at some locations. The inability to enforce without being too visible was also stated as a problem here.
- Toll Facility Preferential Lane - Five of these treatments were cited and all are still operational. From the data available (four sites), this treatment does not seem to increase bus ridership, but is merely another way of giving HOV users a time savings which improves bus reliability without adversely affecting the general traffic. When the lane runs contraflow, the operating costs are quite high, but no increase in accidents occurred.
- Signal Preemption - Sixteen of these treatments were cited. Nine of these were suspended for the following reasons: new signal system (1), congestion caused large delays to buses and system ineffective (1), freeway preferential lane opened (1), bus service was stopped (1), high maintenance costs (1), large delays to side

street traffic (4). Again, for these treatments no before-after data was presented to justify the suspensions. From the small amount of available data (nine sites), the treatment seemed to have no effect on ridership but did improve travel time and, therefore, improved reliability and lowered the transit company's operating costs. It had mixed effects on non-HOV travel times. At some locations not affecting them at all, while at others increasing them, causing delays for both side street and preemptive street traffic. Government operating costs appeared to increase.

Table 2 reports the number of applications of each treatment and the reason for suspension of any of them. Table 3 summarizes the effect each preferential treatment had on the expected impacts. For each preferential treatment, the numbers added across equal the number of impacts (shaded blocks in Table 1) which were expected to be affected by that treatment.

There were six treatments (B, C, E, I, J, P) which had no data available or no applications implemented. Therefore, nothing could be said about the 84 impacts which were thought to be affected by these treatments. For the remaining 13 treatments, there was still 79 out of 210 impacts which could not be discussed due to no data being available. Out of the 131 remaining impacts, where some data was available, 71 of them were affected as expected while 24 impacts had mixed effects. Finally, 36 impacts were affected the exact opposite or not at all. Most of these were negative impacts which did not materialize.

Table 4 is again the matrix showing the preferential treatments and the impacts. It shows individually how each impact was affected by each specific treatment. The folowing summarizes the results of Tables 2, 3, and 4 after reviewing the preferential treatment data as a whole:

1) A much larger effort must be made to collect the pertinent data when HOV treatments are implemented. It is hard enough to justify reserving a lane or

TABLE 2

HOV TREATMENTS IMPLEMENTED AND REASONS FOR SUSPENDING

TREATMENTS	Number Implemented	New Construction	Enforcement Problem	Low Utilization	Caused Delay	Other Pref. Treat. Opened or Rail Service Initiated	High Op. Costs	Other	Safety Problem
Preferential Toll Charges	7								
Preferential Freeway Congestion Pricing	0								
Preferential Parking Costs	2	1							
Park-and-Ride Lots	Numerous								
Preferential Parking	5	1							
Exclusive Freeway Ramps	4					1			
Transit Malls/Auto Restricted Zones	18			1					
Reduced Parking with Priority	1								
Turning Movement Restrictions	5								
Separate Roadway	15								
Contraflow Freeway Preferential Lane	4					1			
Contraflow Arterial Preferential Lane	26	2		1		1	1		3
Concurrent Flow Freeway Preferential Lane	18			4		1			
Concurrent Flow Arterial Preferential Lane	95	5	4	6		3	1	2	1
Exclusive Bypass Ramp	8					1			
Preferential Bypass at a Metered Ramp	17(294)								
Toll Facility Preferential Lane	5								
Signal Preemption	16				4	2	1	2	

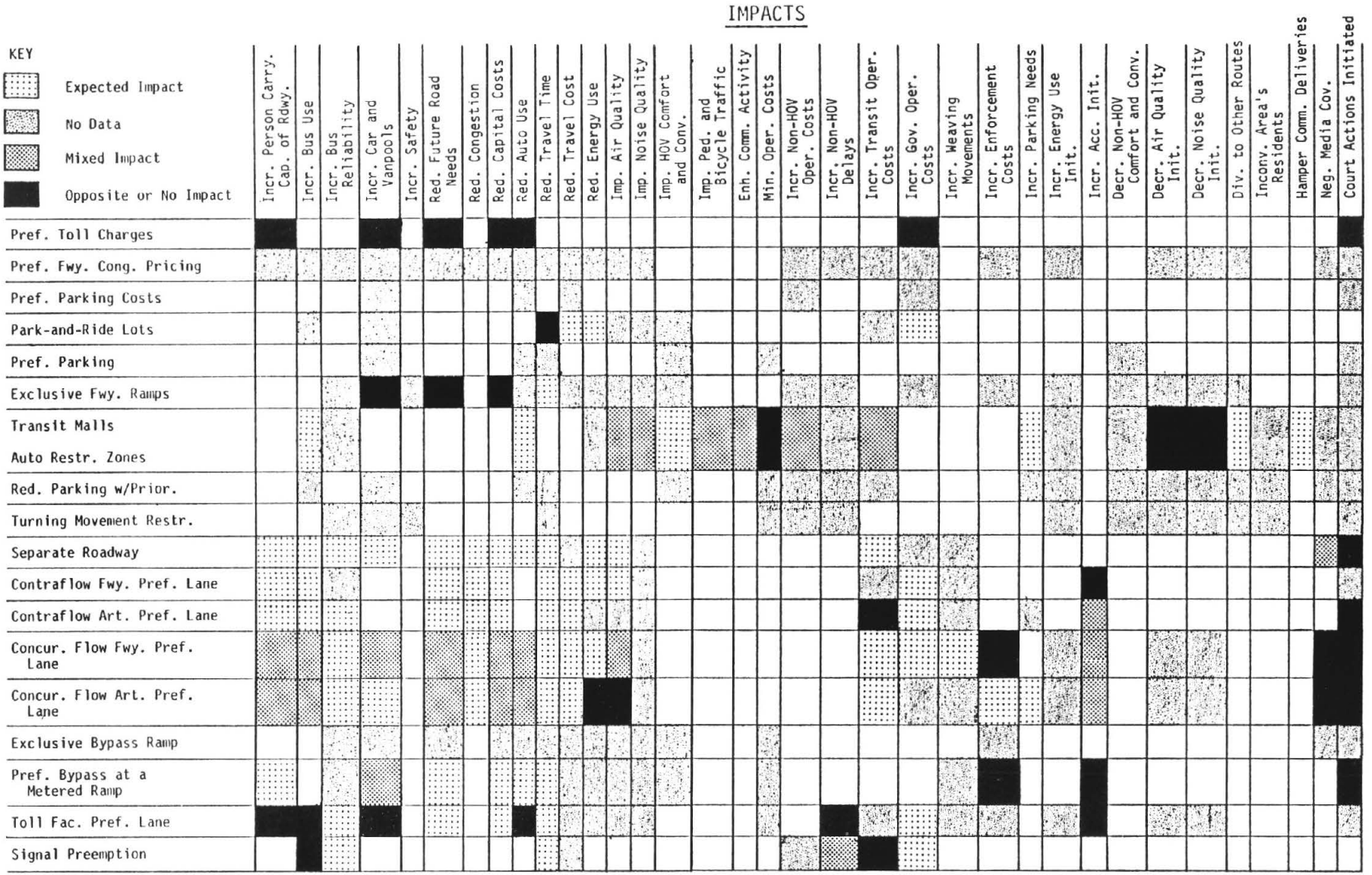
TABLE 3

SUMMARIZED RESULTS

	No Data	Expected Impact	Mixed Impact	Opposite or No Impact
A - Preferential Toll Charges		1		7
B - Preferential Freeway Congestion Pricing	25			
C - Preferential Parking Costs	6			
D - Park-and-Ride Lots	6	3		1
E - Preferential Parking	7			
F - Exclusive Freeway Ramps	19	1		3
G-H - Transit Malls/Auto Restricted Zones	8	6	6	3
I - Reduced Parking with Priority	17			
J - Turning Movement Restrictions	14			
K - Separate Roadways	4	12	1	1
L - Contraflow Freeway Preferential Lane	5	10		1
M - Contraflow Arterial Preferential Lane	5	9	1	2
N - Concurrent Flow Freeway Preferential Lane	4	8	8	3
O - Concurrent Flow Freeway Preferential Lane	6	8	6	4
P - Exclusive Bypass Ramp	15			
Q - Preferential Bypass at a Metered Ramp	8	5	1	3
R - Toll Facility Preferential Lane	12	5		6
S - Signal Preemption	2	3	1	2
TOTAL	163	71	24	36

TABLE 4

HOV PREFERENTIAL TREATMENTS AND IMPACTS
RESULTS



roadway even when justifying data is available, much less when it isn't even known if the number of carpools increased. Also, the collection and comparison of more data will help us in determining why certain negative impacts occur and how we might reduce them.

2) Nothing can be said about six treatments (B, C, E, I, J, P), because no data was available.

3) Four treatments (A, F, R, S) did not seem to increase bus and carpool ridership but were simply a good way of giving HOV users a time or cost reduction. The first two have relatively no cost to the governing agency while the last two do. Only the last one could have a negative effect on non-HOV users.

4) Five treatments (D, K, L, M, Q) produced the impacts which were expected from them.

5) Three treatments (G-H, N, O) produced mixed results on the expected impacts.

6) Transit Malls/Auto Restricted Zones must have an operating transit system on the street and a major pedestrian generator, such as a commerical business area or a college, for them to be effective.

7) For reserved lane operations to be effective, the treatment usually must not affect the reverse flow traffic, while at the same time it should be physically separated from the peak direction traffic.

8) Contraflow lanes usually have safety problems during off-peak hours or where major turning movements or pedestrian activity exists.

9) Concurrent flow lanes usually have either major transit use or a large increase in occupancy for them to be successful.

APPENDIX A

TABLES

AND

FIGURES

TABLE A-1

HIGH OCCUPANCY VEHICLE (HOV) PREFERENTIAL TREATMENTS

A. Economic Preferential Treatments

1. Preferential Toll Charges - Increasing the toll on a facility for low occupancy vehicle users or reducing the toll for HOV users.

2. Preferential Freeway Congestion Pricing - Charging a fee to low occupancy vehicle users to travel a congested section of freeway which before was free to use. HOV users would continue to travel free of charge.

3. Preferential Parking Pricing - Increasing the fee a low occupancy vehicle user pays to park his car off the street or reducing the parking fee for HOV users.

B. Convenience Preferential Treatments

1. Park & Ride Lots - Centralized parking lots where HOV users may park and transit service is available.

2. Preferential Parking - Setting aside of the most desirable parking spaces for HOV users. Applicable at large employers, transit station parking areas, and shopping malls.

C. Space Preferential Treatments

1. Exclusive Freeway Ramps - Reserving an existing freeway ramp to only HOV users.

2. Transit Malls - Reserving a street for transit and HOV vehicles only. Principally used within a CBD shopping area or a heavy transit transfer area.

3. Auto Restricted Zone - Restricting all auto traffic within a defined area of a city, with public transit, and sometimes HOV vehicles excepted. Much larger area restricted than a transit mall.

4. Reduced Parking With Priority - Reduction in available parking spaces with priority given to HOV users.

5. Turning Movement Restrictions - Restricting a turning movement to only HOV users.

D. Time Preferential Treatments

1. Separate Roadway - Building a roadway, usually in the median of an existing freeway, for the exclusive use of HOV users.

D. Time Preferential Treatments (Continued)

2. Contraflow Freeway Preferential Lane - Reserving a freeway traffic lane of the off-peak direction of travel for the exclusive use of HOV users.

3. Contraflow Arterial Preferential Lane - Same as above except on an arterial street.

4. Concurrent Flow Freeway Preferential Lane - Reserving a freeway traffic lane of the peak direction of travel for the exclusive use of HOV users.

5. Concurrent Flow Arterial Preferential Lane - Same as above except on an arterial street.

6. Exclusive Bypass Ramp - A ramp built exclusively for HOV users to bypass a congested ramp. Usually done in conjunction with a Preferential Lane.

7. Preferential Bypass at a Metered Ramp - Reserving the shoulder of a ramp which meters traffic onto a freeway for HOV users to bypass the queue on the ramp.

8. Toll Facility Preferential Lane - Reserving a toll booth for the exclusive use of HOV users to bypass the queue at the toll plaza.

9. Signal Preemption - Traffic signal controls which are actuated by transmitters located on transit vehicles. Extends the green phase for the transit vehicles, thus reducing their delay.

TABLE A-2a

OBJECTIVES OF HOV PRIORITY TREATMENTS
(POSITIVE IMPACTS)

1. Increase person carrying capability of roadway
2. Increase bus transit use
3. Increase bus transit reliability
4. Increase carpooling and vanpooling
5. Increase safety
6. Reduce the need for future expansion of the roadway
7. Reduce congestion on the roadway
8. Reduce future capital costs for new construction
9. Reduce auto use on the roadway
10. Reduce travel time for HOV users and overall
11. Reduce travel cost for HOV users
12. Reduce energy use
13. Improve air quality
14. Improve noise quality
15. Improve comfort and convenience for HOVs
16. Increase pedestrian and bicycle traffic
17. Enhance local commercial access and activity
18. Minimize operating costs for roadway administration

TABLE A-2b

NEGATIVE IMPACTS OF HOV PRIORITY TREATMENTS

19. Increase non-HOV operational costs

20. Increase delays for non-HOVs

21. Increase transit operating costs

22. Increase government's operating costs

23. Increase the amount of weaving on the roadway

24. Increase enforcement costs

25. Increase parking needs

26. Increase energy use initially

27. Increase accidents initially

28. Decrease in comfort and convenience to non-HOVs

29. Decrease air quality initially

30. Decrease noise quality initially

31. Diversion to other routes

32. Inconvenience to residents of affected area

33. Hamper commercial deliveries

34. Negative media coverage

35. Court actions initiated against priority treatments

TABLE A-3

PARAMETERS USED TO MEASURE EFFECTIVENESS
OF HOV TREATMENTS' IMPACTS

	Impacts	Parameters
1.	Increase person carrying capability of roadway	Persons carried, Volume to capability comparison
2.	Increase buse transit use	Transit passengers, Transit passenger-miles of travel
3.	Increase bus transit reliability	Schedule adherence, Bus breakdown, Travel time variance
4.	Increase carpooling and vanpooling	Number of carpools and vanpools, Auto occupancy
5.	Increase safety	Number of accidents, Accident rates in both vehicle and passenger-miles travelled
6.	Reduce the need for future expansion of the roadway	Difference between person moving capability with and without the improvement
7.	Reduce congestion on the roadway	Total vehicle delay, Total person delay
8.	Reduce future capital costs for new construction	Costs saved from Objective 6
9.	Reduce auto use on the roadway	Number of vehicles, Vehicle-miles travelled, Auto occupancy, Person-miles of travel
10.	Reduce travel time for HOV users and overall	Person-hours of travel, Vehicle-hours of travel, Point-to-point travel times, Vehicle delay
11.	Reduce travel costs for HOV users	Parking cost, Point-to-point travel cost, Point-to-point transit fare
12.	Reduce energy use	Energy consumption

TABLE A-3 (Continued)

	Impacts	Parameters
13.	Improve air quality	Tons of emissions, Concentrations of pollutants
14.	Improve noise quality	Noise levels
15.	Improve comfort and convenience for HOVs	Perceived comfort and convenience, Transit load factor, Walking distance from parking location to destination
16.	Increase pedestrian and bicycle traffic	Bicycle and pedestrian counts
17.	Enhance local commercial access and activity	Dollar sales, Employment
18.	Minimize operating costs for roadway administration	Operating and maintenance costs, Operating revenue, Operating deficits
19.	Increase non-HOV operational costs	Parking costs, Point-to-point travel costs
20.	Increase delays for non-HOVs	Person-hours of travel, Vehicle-hours of travel, Vehicle delay, Point-to-point travel time, Person delay
21.	Increase transit operating costs	Operating costs, Operating revenues, Operating deficits
22.	Increase government's operating cost	Operating and maintenance cost
23.	Increase the amount of weaving on the roadway	Weaving maneuvers, Accidents, Accident rates in both vehicle and passenger miles travelled
24.	Increase enforcement costs	Enforcement costs
25.	Increase parking needs	Parking reductions, Parking needs, Parking accumulations

TABLE A-3 (Continued)

	Impacts	Parameters
26.	Increase energy use initially	Energy consumption
27.	Increase accidents initially	Number of accidents, Accident rates in both vehicle and passenger miles travelled
28.	Decrease in comfort and convenience to non-HOVs	Perceived comfort and convenience, Walking distance from parking location to destination
29.	Decrease air quality initially	Concentration of pollutants, Tons of emissions
30.	Decrease noise quality initially	Noise levels
31.	Diversion to other routes	Traffic volumes
32.	Inconvenience to residents of affected area	Parking needs, Walking distance from parking location to destination
33.	Hamper commercial deliveries	Shop owner complaints
34.	Negative media coverage	Press articles, Editorials
35.	Court actions initiated against priority treatments	Court cases

TABLE A-4

IMPORTANCE OF EACH ATTRIBUTE TO THE INTERVIEWED PLANNERS

Attribute	Absolute Importance	Great Importance	Some, Little or No Importance
Capital Costs	9	2	1
Congestion	9	1	2
Safety	7	4	1
Government Operational Costs	7	2	3
Transit Use	5	6	1
Roadway Capacity	6	2	4
User Travel Time	3	6	3
Future Need to Expand Roadway	4	3	5
Comfort and Convenience	2	7	3
Carpool Use	3	4	5
Bus Reliability	3	3	6
Local Commercial Activity	3	3	6
User Travel Costs	0	8	4
Reduce Auto Use	1	6	5
Air Quality Impacts	1	3	8
Pedestrian and Bicycle Travel	1	2	9
Energy Impact	0	3	9
Noise Impacts	0	0	12

TABLE A-5

APPLICABILITY OF THE HOV PREFERENTIAL TREATMENTS IN THE REPRESENTATIVES' AREAS

	Positive Responses
Park and Ride Lots	10 (4)
Preferential Toll Charges	7 (2)
Preferential Parking	7 (1)
Toll Facility Preferential Lane	6 (1)
Auto Restricted Zone	6 (1)
Concurrent Flow Arterial Preferential Lane	6 (3)
Preferential Parking Costs	5
Contraflow Arterial Preferential Lane	5
Transit malls	5
Exclusive Bypass Ramps	4
Contraflow Freeway Preferential Lane	3
Signal Preemption	3
Reduced Parking with Priority	2
Turning Movement Restrictions	2
Separate Roadway	2
Concurrent Flow Freeway Preferential Lane	2 (2)
Preferential Freeway Congestion Pricing	2
Exclusive Freeway Ramps	1
Preferential Bypass at a Metered Ramp	0

( ) - Responses where preferential treatments are now or have been in operation

TABLE A-6

NEGATIVE IMPACTS WHICH MAY CAUSE A PROJECT TO BE DROPPED FROM CONSIDERATION

Impact	Number of Responses
Increase accidents initially	6
Inconvenience to residents of affected area	6
Increase government's operating costs	6
Increase delays for non-HOVs	5
Increase the amount of weaving on the roadway	4
Increase transit operating costs	4
Diversion to other routes	3
Hamper commercial deliveries	3
Decrease in comfort and convenience to non-HOVs	2
Negative media coverage	2
Increase parking needs	1
Decrease air quality initially	1
Court actions initiated against project	1
Increase non-HOV operational cost	0
Increase enforcement costs	0
Increase energy use initially	0
Decrease noise quality initially	0

FIGURE A-1

AREAS COVERED BY THE METROPOLITAN PLANNING ORGANIZATIONS

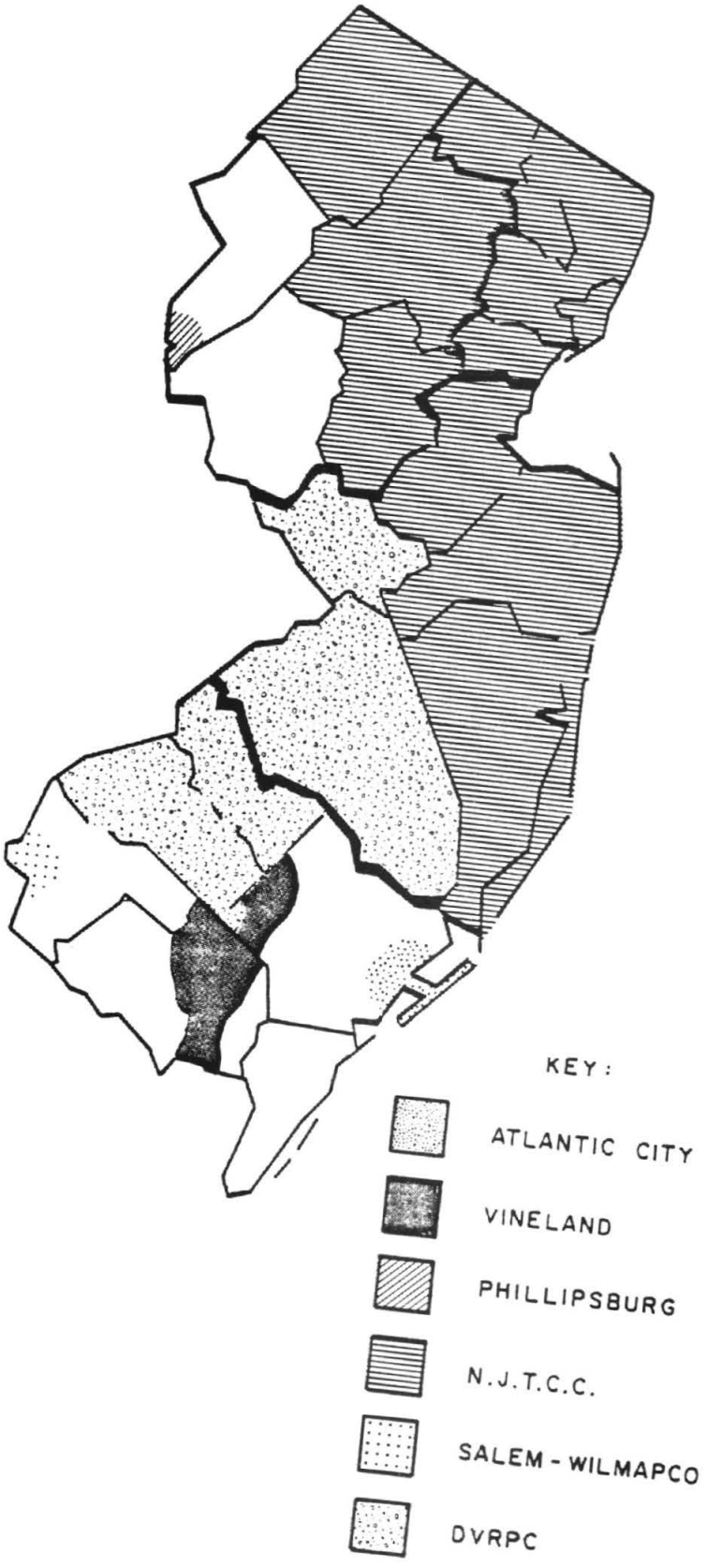


FIGURE A-2

INTERVIEW QUESTIONS

Question 1 - What are the primary objectives of your agency?

Question 2 - How important are the following attributes associated to HOV treatments, in your planning process?

	Absolute Importance	Great Importance	Some, Little or No Importance
Energy Impact			
Bus Reliability			
User Travel Time			
Capital Costs			
Noise Impacts			
Comfort and Convenience			
Government Operational Costs			
Roadway Capacity			
Local Commercial Activity			
Air Quality Impacts			
Pedestrian and Bicycle Travel			
Safety			
User Travel Cost			
Transit Use			
Carpool Use			
Reduce Auto Use			
Congestion			
Future Need to Expand the Roadway			

FIGURE A-2 (CONTINUED)

Question 3 - Should HOVs be given preference and who should be given this preference?

Question 4 - Which of the HOV treatments do you feel could be applied in your area?

Question 5 - Would any of the following negative impacts cause a project to be automatically rejected?

Increase Non-HOV Operational Costs

Increase Delays for NON-HOVs

Increase Transit Operating Costs

Increase Government's Operating Costs

Increase the Amount of Weaving on the Roadway

Increase Enforcement Costs

Increase Parking Needs

Increase Energy Use Initially

Increase Accidents Initially

Decrease in Comfort and Convenience to NON-HOVs

Decrease Air Quality Initially

Decrease Noise Quality Initially

Diversion to Other Routes

Inconvenience to Residents of Affected Area

Hamper Commercial Deliveries

Negative Media Coverage

Court Actions Initiated Against Project

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