from data on a 68-km (42-mile) electronic surveillance project] occurs as a result of 2000 or more capacity-reducing incidents per month on the 1086-km (675-mile) freeway system. This amounts to a delay of about 9200 vehicle-h/km (15 000 vehicle-h/mile) annually.

However, during the data-gathering phase (five years), certain travel patterns, or locations where incidents tended to happen more frequently, were observed. In addition, magnitude of congestion, or number of secondary accidents due to incidents at certain geometric locations, tended to be significantly higher than the per-kilometer norm.

This leads one to conclude that, if FIM options or solutions were examined on a total system basis only, the chosen solutions could differ from those selected for a specific problem area and might not solve the specific problems that accumulate to form the "system" problem.

For these reasons, I believe the approach taken in the demonstration project illustrates several important steps necessary in the application of material presented in the several volumes of Alternate Surveillance Concepts and Methods for Freeway Incident Management (4, 6, 7) used in this project.

1. Identification of the problem as truly a freeway-incident problem is covered very well in the report, in that capacity was adequate (other than during incidents) and numerous safety projects had been undertaken to reduce the accident problem to a low level.
2. The problem to be solved must be identified by technicians in a manner that allows system users (motorists) and operators (highway patrol, maintenance forces, emergency forces, etc.) to understand and to participate in offering workable solutions. Formation of the technical advisory committee was, in my opinion, the most important step taken in the project. This set up an easy and natural channel of communications that alerted all system operators of options and techniques of FIM available to them (via the FIM manuals). Results showing reduced incident-clearance time clearly indicate that additional options were being implemented by the system operators during the project. This has been common in California FIM experience. Knowing what is expected of them by the user and operator results in a synergistic effect by which the cooperative action has a greater total effect than the sum of the individual actions.
3. Data collected must be reasonable but do not need the proof of rigid statistical methods. The report is seriously lacking in hard data. However, FIM involves, by nature, an unpredictable event that would require unreasonable resources in equipment and manpower to gather accurate data. As evidenced in the report, the simplistic data gathered by the people involved (users and operators) was acceptable to make decisions.
4. Solutions chosen must be those agreed on by the technical advisory committee. The report notes that, of the three options chosen, one was developed and two were modified to match committee input. That the manual's options are strictly to get the thinking process going is another critical point well covered in the report.
5. Project, process, and technique implemented must be evaluated and updated as time and conditions change. The evaluations presented in the report tell the story. As time passes, the technical advisory committee, if it is still in existence, should take another look at how this FIM project is doing to determine whether any other actions are needed. I wonder if the alternate route and other options are being considered during construction operations.

Urbanek, Tignor, and Price are to be sincerely congratulated on their paper dealing with a methodology of implementing knowledge contained in the FIM guide manuals. Information presented will be of great value to traffic engineers in need of specific ideas on how to get started in solving problems by using the concept of preplanned FIM.

As W. E. Schaefer stated, "Very likely, the most difficult problem to resolve will be the coordination of the complex set of organizations that share the responsibility for the effective operations of the freeway" (8).

I believe the paper presented brings to our attention a method for moving in that direction.

REFERENCE

8. W. E. Schaefer. Effective Freeway Traffic Management System. Paper presented at Joint ASCE-ASME Transportation Engineering Meeting, Seattle, July 1971.

Publication of this paper sponsored by Committee on Freeway Operations.

High-Occupancy Vehicle Considerations on an Arterial Corridor in Pensacola, Florida

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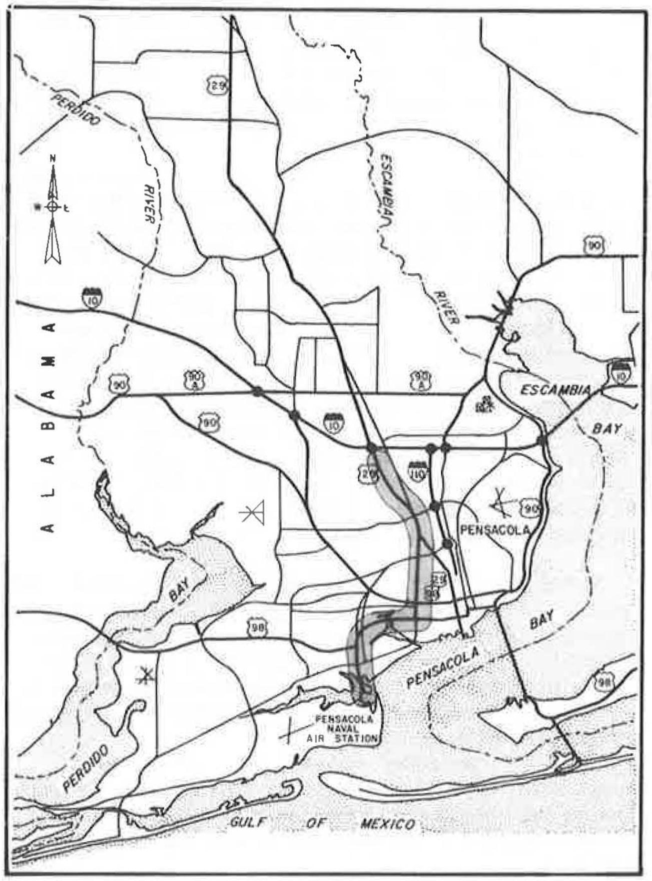
Because of the nature of the traffic using arterial corridors and the complexities of adjacent land uses, most high-occupancy vehicle (HOV) priority techniques impose restrictions on general traffic to such a degree that their implementation has met with limited success. In Pensacola, Florida, an arterial corridor was studied to determine the feasibility of implementing HOV priority techniques. The decisions made as to data

Figure 1. Corridor location in Pensacola HOV design study.



collection, data analyses, alternative selection, and the elimination of parts of the corridor from further consideration will be of general interest to others considering implementing similar projects. The final result of the study was a recommendation to implement HOV priority along parts of the corridor in combination with a lane-control system. This system permits the implementation of an HOV priority system without loss of access to the corridor and has the advantage of maintaining left-turn movements off the corridor.

This paper documents the decisions made in selecting a high-occupancy vehicle (HOV) priority technique on an arterial corridor in the Pensacola, Florida, area. The nature of the traffic using the arterial system and the nature of land uses adjacent to most arterial corridors impose restrictions on the type of techniques that can be considered. Because experience in implementing such techniques is so limited, the process used in Pensacola to select the corridor for HOV improvements should prove to be of general interest to anyone considering the implementation of a similar project.

The Florida Department of Transportation (DOT), in an effort to reduce congestion and improve vehicle-occupancy rates, selected several corridors in major cities around the state for study to determine the feasibility of implementing HOV priority techniques. The objects of these studies were to increase the person-carrying capacity of the corridor, to identify locations where transit service could be improved, to increase carpooling, and to develop a cost-effective HOV priority technique that could be implemented in the near future (three to five years).

The corridor selected in Pensacola was unique in that it was the only HOV corridor in the state located entirely on the arterial system. The decisions made and the lessons learned about data collection and analysis, alternative selection, and design considerations can provide guidance to similar arterial projects in other cities.

CORRIDOR SELECTION

The corridor selected by the DOT for study in Pensacola is US-29 (Pensacola Boulevard) between I-10 and FL-292 (Pace Boulevard), then on FL-292 to the Pensacola Naval Air Station. Although this corridor's main role is as a connector between the Naval Air Station and I-10, its length and the multitude of adjacent land uses have encouraged a variety of trip purposes and trip-making patterns. The location of the corridor in the Pensacola urban area is shown in Figure 1.

Data Collection

The data-collection effort was designed to provide information about the corridor's physical, traffic, and user characteristics. The studies undertaken are described in what follows.

Roadway Characteristics

A complete study of roadway characteristics along the corridor was made to determine where these characteristics might restrict or permit HOV priority techniques. This study consisted of recording lane and median widths, number of lanes, existence of barriers such as obstructions in medians or adverse slopes, locations of structures, and other pertinent data. This information was useful in locating not only those areas where HOV priority techniques can be implemented without major construction but also those constraints along a corridor that would prevent cost-effective implementation of a priority technique.

A record of the types and intensities of land uses along the corridor was also developed. These data are particularly important on an arterial corridor because roadside developments can cause friction on the roadway that could prevent the successful implementation of an HOV priority project.

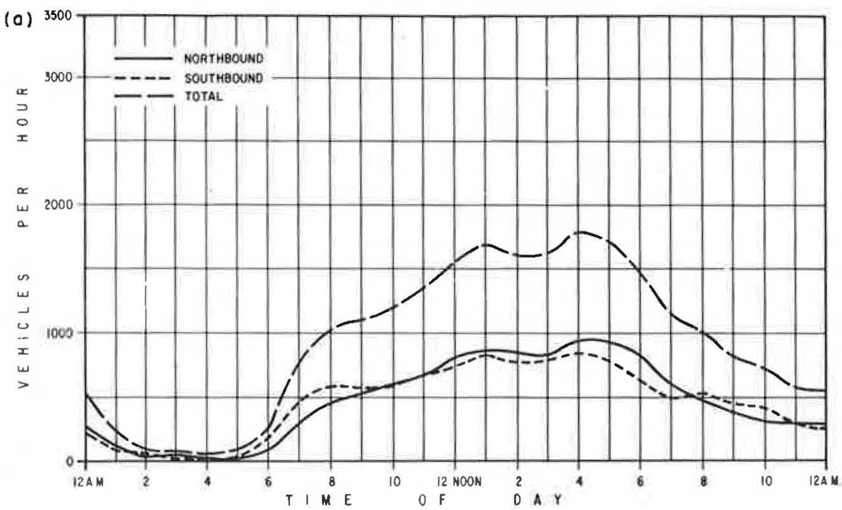
Generally along urban arterial corridors such as the one in Pensacola, the primary areas of traffic conflicts and restraints to improvements occur at intersections. For this reason, greater data-collection efforts were made at major intersections in order to gather information for intersection-capacity analyses. This also gave a more complete picture of the opportunities for and constraints on HOV priority techniques at specific intersections. Lane widths, lengths of turning lanes, median widths, and the location of obstructions such as driveways and utility poles also were determined.

An investigation of traffic-signal operations along the corridor proved useful in identifying those locations where existing equipment was inadequate and where additional equipment would be required to implement HOV priority techniques. Specifically, data collected included signal phasing, type of controllers in use, adequacy of the signal display, and condition of the signal equipment.

Planned improvements along an urban corridor have often had a drastic impact on traffic patterns. Therefore, an effort was made to determine all scheduled or planned improvements along the corridor that might affect the feasibility of HOV priority techniques. The Pensacola urban area transportation study generated several documents that were useful in identifying these projects (1). Projects that are important to identify include intersection improvements, minor widening projects, signal upgrading, and projects improving access to

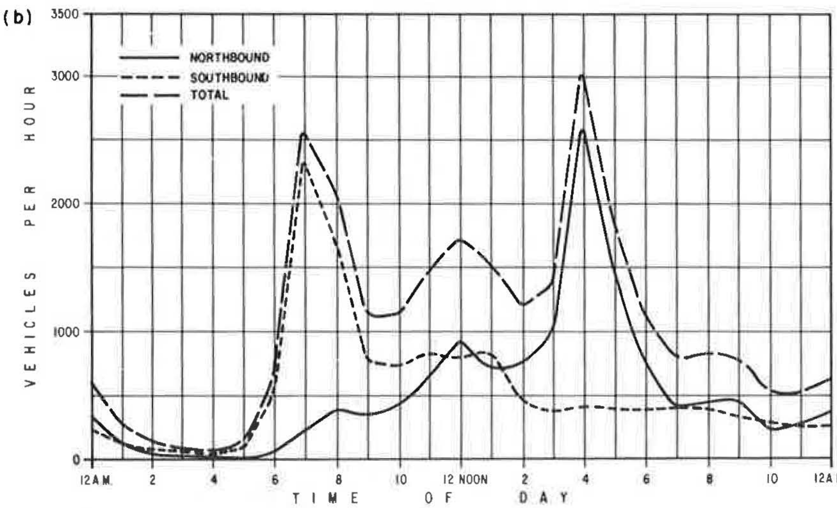
Figure 2. Hourly traffic variations.

(a)



TYPICAL TRAFFIC VARIATIONS NORTH PART OF CORRIDOR
PACE BLVD. NORTH OF CERVANTES ST.

(b)



TYPICAL TRAFFIC VARIATIONS SOUTH PART OF CORRIDOR
NAVY BLVD. NORTH OF NAVY GATE

property adjacent to the corridor. Some of these may be difficult to identify in a work program, but it is important that their impact on a proposed HOV priority technique be considered.

Traffic Characteristics

An extensive traffic-counting program was undertaken to reveal traffic variations on a daily and an hourly basis, which would give us necessary data for capacity analyses. Two counting programs were used. The first involved identifying locations that were representative of the various traffic patterns on the corridors. At these locations traffic counts were taken hourly for one week. The data obtained are useful in determining existing traffic patterns. Typical results are shown in Figure 2.

Turning-movement counts were also taken at 15-min intervals during the peak 2.5- to 3-h periods during the morning and afternoon at eight intersections along the corridor.

Observations of existing vehicle-occupancy trends were made in two locations on the corridor. The purpose of this study was to determine the effectiveness of any recommendations that might be implemented. The vehicle-occupancy studies were also used to verify the existence of current positive attitudes toward carpooling and vanpooling.

Observations were made by noting each vehicle as it passed a checkpoint and recording the number of occupants. Our experience showed that one observer per lane could record each vehicle that passed the checkpoint. The checkpoints chosen were at signalized intersections and, in the case of the Naval Air Station, at the guardhouse. The relatively slow speeds of the vehicles as they passed these points permitted 100 percent coverage.

Travel-time and delay studies were conducted along the entire length of the corridor to gather data on the locations and causes of delays and to provide information about travel speeds along the various portions. The method used to collect these data was a test-vehicle method using the maximum-car technique.

Travel-time runs were made during the morning and afternoon peak hours in good weather. No fewer than 6 runs were made in each direction of travel for each of the two time periods. Studies have shown that from 6 to 12 runs in each direction must be made to achieve an accuracy of the order of 10 percent and to estimate average travel time (2, p. 429). The amount, cause, location, and duration of delays due to traffic controls and operational restraints were obtained.

Data on past accident experience along the corridor were collected to help identify problem locations and to provide a base for measuring the effectiveness of any implemented HOV priority improvement. Data were collected by segments determined after observing traffic patterns along the corridor. The intent was to identify portions of the corridor where varying traffic patterns might indicate different trends in accident experience.

The location of each traffic characteristics study is shown in Figure 3. Those studies identified by arrows in the figure indicate that data were obtained in the direction of the arrow. Data on southbound traffic were obtained in the morning peak hours, and data on northbound traffic were gathered in the afternoon.

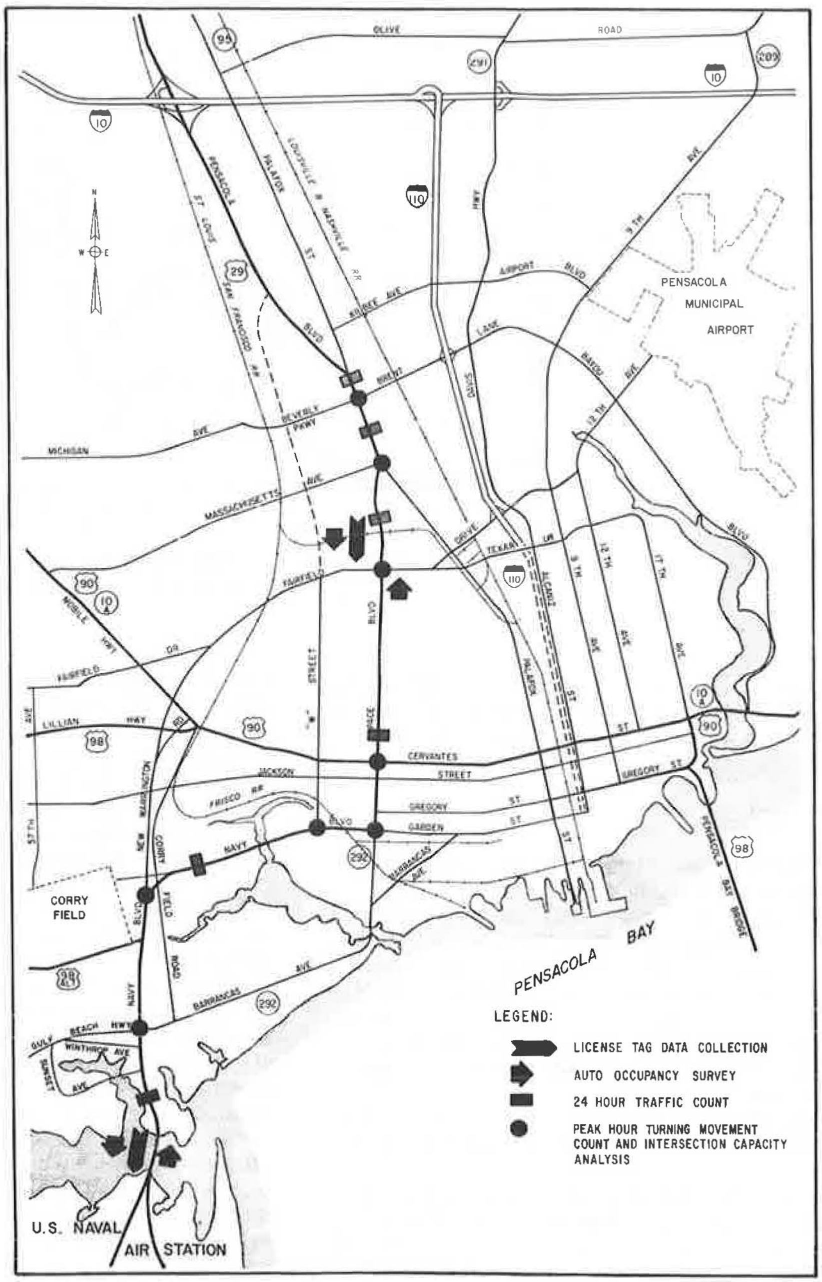
Transit Characteristics

Data on existing transit use in the Pensacola corridor were collected and used to locate areas where a potential for improving transit service existed. Data were obtained on ridership figures for all of the routes using any portion of the corridor. The existing route map was also studied to determine if there were routes that paralleled the Pensacola corridor or that provided service that could, in the future, be provided on the corridor. The ridership figures were collected for the same period as the data on the highway users were gathered. This provided a complete picture of all the users of the corridor during this period.

User Characteristics

A telephone survey was conducted to determine the attitudes of the users of the corridor toward bus and car-

Figure 3. Data-collection locations.



pooling and also to determine existing travel characteristics on the corridor. Only those respondents who indicated that they used the corridor three times or more during the week for their home-to-work trip were considered. Telephone numbers of the interviewees were obtained by matching license-plate numbers to addresses with the cooperation of the Florida Department of Motor Vehicles.

License-plate data were collected at two locations on the corridor during the morning peak hours as shown in Figure 3. These data were collected by observers who read license-plate numbers into a tape recorder as vehicles passed. The numbers were then keypunched and placed in the proper format for further data manipulation. The sites of the data collection were carefully chosen so that vehicle speeds would be sufficiently slow to allow the tag numbers to be read. Observers were instructed to record as many numbers as possible at 15-min intervals during the morning peak hours.

DATA ANALYSIS

The data-collection effort described above represented a thorough compilation of the existing characteristics of the Pensacola study corridor. These data then had to be interpreted in light of the requirements for an HOV priority improvement. This analysis was designed both to determine the feasibility of using HOV priority techniques and to determine the proper HOV priority technique to be used on the corridor.

Roadway Characteristics

The types of HOV priority techniques that are appropriate for arterial roadways are somewhat limited. Generally, on arterials HOV priority techniques involve either reserved lanes or special techniques such as signal preemptions or turn restrictions (3). Restricting turning movements for non-HOV vehicles was deemed inappropriate for the Pensacola area because of the disruption of the normal traffic flow that would occur. For this reason only reserved lanes and signal preemption techniques were considered.

The Pensacola study corridor has several different cross-section types. Some portions of the corridor are four-lane undivided roadway, some are five-lane undivided roadway, and others are four-lane divided cross sections or six-lane divided cross sections.

On the four-lane divided cross sections of the corridor, the reserved-lane techniques that were available would have involved new construction either in the median or on the outside lanes. It was felt that removing one lane of this roadway from general use and reserving it for HOV use would not work in the Pensacola area. The other option of providing a contra-flow lane in the off-peak direction on four-lane divided roadways was only briefly considered. This was because of the lack of a clear peaking trend on most of the corridor segments that had a four-lane divided cross section.

On the four-lane undivided sections of the corridor, the options that were available included adding lanes, eliminating the left-turn lane and providing a reversible HOV lane in the center of the roadway, and remarking pavement or adding lanes to provide a lane-control and HOV system with three lanes in the peak direction, two lanes in the nonpeak direction, and a dual-use left-turn lane. The other options of removing parking to gain an extra lane for HOV use generally were not available along the corridor in Pensacola.

On the six-lane divided portion of the corridor, the options of providing an HOV priority technique included adding a lane in each direction and removing a lane from general use to provide one lane for HOV priority use and two lanes for non-HOV use in each direction. Because of the extreme width of the median on this section, many of the techniques for creating a separated reversible HOV lane in the median of the roadway were inappropriate.

A portion of the Pensacola corridor operates on a five-lane undivided roadway. The options for this portion were similar to those for the four-lane undivided sections of the corridor. The exception was the option of removing parking that would provide six lanes of travel service on this portion of the corridor without additional construction.

The HOV priority techniques that involve signal preemptions were available all along the HOV corridor, but it was felt that these techniques, because of the small demand for buses, would not be very effective in meeting the objectives of the study. While these techniques were considered, they were considered only in conjunction with reserved-lane improvements. Thus, a system wherein a reserved HOV lane would have separate actuaters at signalized intersections along the corridor was considered as an additional means of improving the attractiveness of the HOV lane.

The data study revealed that there were several physical restraints on low-capital HOV priority techniques. For example, there are three bridges along the corridor, two of which are on the east-west portion of Navy Boulevard between Pace Boulevard and New Warrington Road. The third bridge is the structure over Bayou Grande leading directly to the Naval Air Station gate.

Existing traffic on the last of these three bridges is now handled by a lane-use control system put into operation by placing cones along the bridge. This provides three lanes of movement in the peak direction on the bridge and one lane in the off-peak direction. Navy personnel place these cones before the peak hour and remove them after the peak. This technique is very effective in moving vehicles during the peak hour at this location because of the highly directional and repetitive loading patterns near the Naval Air Station during those hours.

Traffic Characteristics

The information on the characteristics of the traffic on the Pensacola corridor was analyzed with a view to locating areas where improvements through use of HOV priority techniques were possible. Figure 2 shows hourly variation of traffic at two of these locations along the corridor. The Pace Boulevard graph (Figure 2a) shows a location that is typical of the traffic variation that occurs throughout most of the corridor. This pattern is characterized by the lack of a true morning peak and by the lack of a discernible directional peak in the afternoon. This traffic pattern developed because the corridor serves a variety of trip purposes and, during the peak hour, serves the home-to-work trips in both directions. In other words, there were as many people commuting into the downtown area of the corridor from the suburbs as were commuting in the opposite direction. This is due in part to large employment centers north of the limits of the corridor.

The traffic pattern shown in Figure 2a does not lend itself very well to the type of HOV priority techniques that can be implemented on the arterial system. Since there is no clear direction of movement during the peak hours on most of the corridor, HOV priority techniques that involve lane control or removing a lane from the nonpeak direction for HOV service would not work. The HOV priority techniques available on this part of the corridor would require the addition of a separate lane in each direction.

The Navy Boulevard graph in Figure 2b is representative of the other traffic pattern that was observed on the Pensacola corridor. This figure identifies a portion of the corridor where very definite morning and afternoon peaks with extremely heavy directional loading occur. This type of traffic pattern was observed on the portion of Navy Boulevard from the Pensacola Naval Air Station's main gate north to the intersection with New Warrington Road. Because of the highly directional peaking characteristics of this traffic pattern, the HOV priority techniques discussed earlier would be appropriate here.

The data on traffic service were also analyzed to determine the location of problem areas. This analysis indicated that the primary source of delay occurred on the section just discussed where delays at the signalized intersections averaged more than 3 min in the morning. Delays on the northern portions of the corridor were noticed only in the afternoons, and these delays were not of the magnitude noticed on the southern portion of the corridor near the Naval Air Station.

The accident data collected also were analyzed to determine whether certain portions of the corridor experienced higher accident rates than others and, if so, whether they could experience a reduction through the application of appropriate HOV priority techniques. The data, however, showed no discernible differences in the accident experiences. It was noticed that the accident rate on that portion of the corridor just north of the Naval Air Station was somewhat lower than on other portions of the corridor. This was a surprise because traffic volumes on this portion were a little higher than on other portions of the corridor. It was felt that the uniformity of the trip purposes and the fact that the same drivers use this portion of the corridor every work day at the same times help hold traffic accident rates down in this portion of the corridor.

Transit Use

As noted before, the existing transit service along the Pensacola corridor was limited. A review of the routes using the corridor indicated that major modifications in route structures would be required to improve transit service, because all of the transit routes in service use the downtown terminal. This is in direct conflict with the desires of most of the users of the corridor, who desire to travel to the Naval Air Station.

User Characteristics

The telephone survey provided valuable information both on the attitudes of the people using the corridor and on their desires for improved traffic service along it. The analysis of the results of the telephone survey proved extremely valuable in the selection of an appropriate HOV priority technique for the Pensacola corridor.

Respondents to the telephone survey were asked questions that revealed two interesting facts. First, the users of the northern portions of the corridor tend to have a variety of destinations, and those whose ultimate destination is the Naval Air Station tend to leave the corridor and use parallel routes to make their approach. Those users of the corridor who are approaching the Naval Air Station generally are only on the corridor in large numbers for a short duration, namely between the intersection of Navy Boulevard with New Warrington Road and the main gate of the Naval Air Station. The other interesting fact noticed in these responses to the telephone survey was that a large number of respondents go several kilometers out of their way to avoid the existing delay at the intersection of Navy Boulevard with Barrancas Avenue and Gulf Beach Highway.

Survey questions concerning existing carpool habits showed a very close relation to the observed vehicle-occupancy rates, particularly those at the Naval Air Station's main gate. This survey also showed that, of those people who do not now carpool, a majority have either considered it in the past or have carpooled in the past. The survey also indicated a positive attitude toward carpooling if these carpools could avoid the congestion on the Pensacola corridor.

Survey respondents also indicated that they would be favorably inclined toward two-block bus service and park-and-ride bus service. In this instance, the two-block service was preferred to carpooling and carpooling slightly preferred to park-and-ride bus service.

Questions inserted in the survey to provide an indication of those people who would or could actually use carpooling and bus service indicated that only about half of those who indicated positive reactions to carpooling and bus service would actually use them. The responses to carpooling and bus-use questions were used to provide a maximum possible bus use and carpool use that would occur on the corridor. The results of the telephone survey indicated that there was a strong potential for an HOV priority lane, at least within that portion of Navy Boulevard between New Warrington Road and the Naval Air Station (4).

SELECTION OF THE HOV PRIORITY CORRIDOR

The results of the data analyses all indicated that portions of the Pensacola corridor were not appropriate for HOV priority techniques. The physical constraints of the two bridges on the east-west portion of Navy Boulevard and of the intersections on the northern portions of the corridor indicated that such techniques would not be particularly low-capital-intensive in these areas. These factors, combined with the traffic service analysis results, indicated that HOV priority techniques would not be successful in the northern portions of the corridor.

The traffic-service indicators that led to this conclusion included the lack of definite peaking characteristics on the northern portions of the corridor and the tendency of the traffic using the northern portions of the corridor to have several destination points including the Naval Air Station, the Pensacola central business district, the various employment centers along the Pensacola corridor itself, and the destinations north of the corridor. The lack of definite traffic-service problems that could be solved by HOV priority techniques discouraged their use.

Therefore Navy Boulevard from New Warrington Road south to the Pensacola Naval Air Station was selected as the only portion of the Pensacola corridor that would be appropriate for the implementation of HOV priority techniques. Along this portion, referred to hereafter as the improvement corridor, the common destination of the traffic, the extreme peaking characteristics, and the positive attitudes toward carpooling and bus use all indicated that HOV priority techniques could be implemented successfully.

SELECTION OF THE APPROPRIATE HOV PRIORITY TECHNIQUE

The improvement corridor has four different cross sections along its length. The first, from New Warrington Road to Alternate US-98, is where the corridor operates on a six-lane divided cross section and has a median width of approximately 12 m (40 ft). South of this section the corridor becomes a four-lane divided roadway with four 3.35-m (11-ft) lanes. The median width in this section is 6.40 m (21 ft). From the intersection with Barrancas Avenue and Gulf Beach Highway south to the bridge over the Bayou Grande, the roadway is undivided and marked for five lanes of service with parking on the southbound side of the road. This section provides three lanes northbound and two lanes southbound. The last of the four cross sections is the bridge over the Bayou Grande, a four-lane bridge that is 12.8 m (42 ft) wide.

There were several alternate methods available to select from to provide a lane for HOV priority uses on the improvement corridor. Generally, these alternatives broke down to the following:

1. Remove a lane from general use, both northbound and southbound;
2. Provide HOV priority only northbound from the Pensacola Naval Air Station's main gate to the intersection of Barrancas and Gulf Beach Highway (this would also involve removing a lane from general use);
3. Use lane control to provide three traffic lanes in the peak direction, one of which is reserved for HOV traffic; and
4. Provide new construction along the entire length of the improvement corridor to provide three lanes in each direction, one of which would be reserved for HOV priority use.

These various options led to the selection of six alternatives to be considered in the selection of an HOV priority technique. The first of these concepts was the "do-nothing" alternative, which meant that there would be no new construction and that only projects already scheduled for improvements on the corridor would be implemented. No priority techniques for HOV vehicles would be used.

The next choice also involved a "no-construction" solution, but for this alternative one lane of general use would be taken away and reserved for HOV vehicles. This alternative is similar to the do-nothing alternative but with the provision for HOV priority. This is alternative 1.

Alternative 2 would involve the installation of lane control along the corridor with no provision for HOV. This alternative would require widening the roadway in the four-lane divided section to six lanes of traffic along the entire improvement corridor from New Warrington Road to the Naval Air Station. Lane control would be needed to provide three lanes in the peak direction plus dual-use left-turn lanes and two lanes in the off-peak direction. All lanes would be available for use to general traffic.

Alternative 3 would be identical in concept to alternative 2, except that one of the lanes in the peak direction would be reserved for HOV use. These two alternatives would also require improvements of the signal systems at signalized intersections.

Alternative 4 would provide for six lanes of traffic plus left-turn lanes as needed. This would be accomplished by widening the existing roadway to provide three travel lanes in each direction plus left-turn lanes. The four-lane divided portion of the corridor would be widened by an additional lane in each direction. South of the intersection of Barrancas Avenue and Gulf Beach Highway, the roadway would be widened to 25.6 m (84 ft).

Alternative 5 would use the same concept as alternative 4, but one of the lanes would be reserved for exclusive use by HOV. Both alternative 4 and alternative 5 would require right-of-way purchase and major construction of drainage facilities and curb and gutter along at least portions of the corridor. In addition, alternatives 4 and 5 would require the construction of a new bridge across Bayou Grande.

ALTERNATIVES EVALUATION

An evaluation matrix was devised to provide a means of evaluating each of the alternatives. This matrix showed how the alternatives compared in nine areas of concern. Qualitative assessments of each of the major evaluation points were made for each of the alternatives. The results of these evaluations are shown in Table 1. The qualitative measurements of the various evaluation points were based to a considerable degree on a quantitative evaluation of the traffic service provided by each of the alternatives. To a certain degree, each evaluation consideration depends on traffic service. The traffic-service evaluation was made by using the intersection-capacity analysis concept and projected traffic demands for each of the alternatives at the intersection of Navy Boulevard with Barrancas Avenue and Gulf Beach Highway.

For the alternatives that did not involve an HOV priority technique, capacity analyses were conducted based on the lane arrangement provided for each of the alternatives. For those alternatives that did involve an HOV improvement, traffic analyses at the intersection were conducted for various probable lane uses that would occur based on the results of the telephone interviews. In general, these optional concepts involved a restriction on the HOV priority lane to vehicles with three or more people or two or more people.

This method provided a quantitative assessment of the traffic service along the improvement corridor for the total range of improvements. This measurement of traffic flow in turn provided a base on which to make qualitative judgments of other impacts of the various alternatives.

SELECTION

The alternative recommended for implementation on the Pensacola improvement corridor was alternative 3, a lane-control and HOV priority concept where three lanes travel in the peak direction and one of them is for HOV priority use. This alternative provided adequate traffic service at a much lower cost than alternatives 4 or 5. The alternative also satisfied the objectives of this study by improving automobile-occupancy rates and reducing the number of vehicle trips on the corridor.

The alternatives that offered HOV priority use would provide the opportunity for implementing limited bus service to the Naval Air Station. Based on responses from the telephone survey, two areas of potential bus use were identified. By servicing these areas with the appropriate bus service, the person-carrying capability of the corridor will be further improved. This bus service is made more attractive because of the time savings on the HOV priority lane.

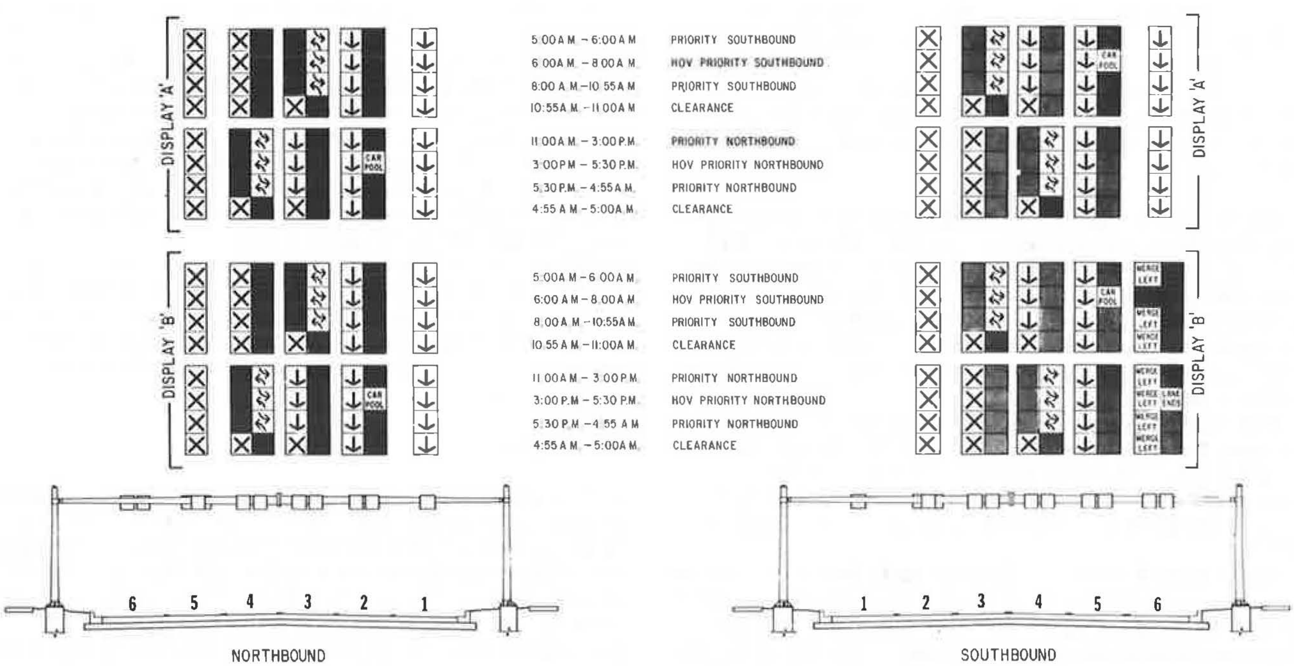
DESIGN CONSIDERATIONS

The alternative selected in the Pensacola corridor incorporates features not found on other arterial HOV priority projects in the country. The most important of these features is the use of a lane-control system with the HOV priority lane. A unique feature of this recommendation is the fact that the left-turn lanes are left in operation along the corridor, which improves access to it. The left-turn lanes also provide a buffer between traffic moving in opposite directions. Because of the nature of the land uses along the improvement corridor, it was desirable to maintain this left-turn capability.

Table 1. Results of evaluation of alternatives for improvements in corridor.

	Alternative					
Area of Concern	Do-Nothing	1	2	3	4	5
Traffic service	Poor	Fair to poor	Good	Good to poor	Excellent	Good to poor
Cost	None	Low	Mid	Mid	High	High
Environmental impact	Poor air, diversions	Poor air, diversions	Improved air, less diversion, noise	Improved air, less diversion, noise	Improved air, neighborhood encroachment, noise	Improved air, neighborhood encroachment, noise
Energy impact	Poor	Poor	Fair	Good	Fair	Good
Compatibility with planning effort	No	No	Yes	Yes	Yes	Yes
Safety	Poor	Poor	Fair	Fair	Excellent	Excellent
Ease of implementation	NA	Good	Good	Good	Poor	Poor
Enforcement	NA	Good	NA	Good	NA	Good
Compatibility with survey	Good	Questionable	Good	Questionable	Good	Questionable

Figure 4. Recommended lane-control signal indications and HOV priority system.



The recommended system operates on a six-lane undivided roadway. To make this system work, three lanes for movement in the peak direction, one lane for left turns in both directions, and two lanes for movement in the nonpeak direction are provided. During the peak traffic hours in the morning and in the afternoon, one lane in the peak direction is reserved exclusively for HOV, or, in this case, vehicles with two or more people.

Details of the recommended concept are shown in Figure 4. This figure also provides a schematic of the type of signal installations required for the proper signalization of the recommended system. Along most of the corridor, display A is used. In the southernmost part of the corridor just north of the Naval Air Station, display B is required to provide a smooth transition from the six-lane undivided roadway to the four-lane bridge over Bayou Grande. It is recommended that the existing system of cone placement on this bridge be continued. This system is recommended to be in place during the hours the HOV priority lane is in use.

CONCLUSIONS

The HOV priority system recommended for Pensacola is unique in its application of lane-control techniques with HOV priority use. This system provides a method for greatly improving traffic flow along the corridor and is cost effective because it uses the existing roadway to the maximum extent. The system also fulfills the objectives of increasing automobile occupancy along the corridor and of moving greater numbers of people with improved traffic service.

Although some of the characteristics of the Pensacola corridor are unique, particularly the extreme homogeneity of the traffic using the corridor during the peak hours, the system recommended has potential application in other urban areas as well. The combination of a lane-use control system with HOV priority use provides a system of implementing HOV priority techniques in a cost-effective manner on arterials. Access along the corridor is not adversely affected because left turns are not prohibited. This type of system has potential in other areas where the following characteristics are observed:

1. Homogeneity of traffic in terms of trip purpose and destination,
2. Distinctive peak periods that are highly directional,
3. Positive attitudes toward carpooling or bus use,
4. Extreme delays for existing travel, and
5. Available roadway widths or right-of-way for additional lanes.

While the Pensacola corridor is unique in that the corridor was a direct feeder to the Pensacola Naval Air Station, other corridors in other urban areas have the five characteristics noted above, and a system such as the one designed for Pensacola could be successfully implemented in these areas as well.

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Planning Rail Station Parking: Approach and Application

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The efforts of the Northeast Corridor Improvement Project to revitalize passenger railroad service have entailed planning numerous station improvements such as accommodating increased passenger parking requirements. Results of studies of 3 of the 11 stations along the corridor that are being upgraded to high-speed rail requirements are reported in this paper. A compendium of parking characteristics to enable planning officials to better assess the needs of rail passenger parkers is included. Topics covered are parking demand estimates, passenger trip characteristics, and fiscal considerations of providing parking at rail stations. Planning guidelines of 0.28 spaces/daily boarding Amtrak passenger and 0.32/commuter passenger are suggested. The need for subsidization to make planned parking facilities economically feasible is also emphasized.

The railroad network in the Northeast Corridor is being upgraded to offer reliable high-speed rail passenger service as an alternative to congested East Coast highways and airports. The corridor, as shown in Figure 1, extends from Washington, D.C., to Boston and includes 15 high-speed rail stations.

Every railroad station, whether located in the corridor or elsewhere, will have different factors influencing passenger parking requirements. Parking studies conducted under the auspices of the Northeast Corridor Improvement Project (NECIP) offer an opportunity to examine general relations that can help determine total parking requirements of the respective stations.

Rail station activity entails the three elements of parking demand conceptually presented in Figure 2—passenger demand for both long- and short-term spaces and nonpassenger (station employee, station visitor) demand. This paper focuses primarily on the passenger demand for long-term parking space. It addresses approaches used in determining passenger parking demand and application of the findings to define economic feasibility, as illustrated in the flowchart in Figure 3.

ESTIMATING PASSENGER PARKING DEMANDS

Parking studies were conducted at the Wilmington, New Haven, and Providence stations as part of NECIP. All cities have Amtrak (high-speed rail) as well as commuter (non-Amtrak) train service. Commuter service is provided in Wilmington by the Southeastern Pennsylvania Transportation Authority (SEPTA), in New Haven by Consolidated Rail Corporation (Conrail), and in Providence by the Boston and Maine Corporation (B&M).

Rail Passengers

Wilmington, the most centrally located of the corridor stations surveyed, has the most train activity: More than 75 trains depart daily. Only 26 trains leave from Providence, as detailed in Table 1. New Haven, however, has the most passenger activity of the three stations, primarily because of commuter trips to New York. An average of 1650 passengers depart from New Haven daily. Average daily boarding passenger volumes are 1335 and 760 at Wilmington and Providence, respectively.

New Haven is principally a commuter station; two-