A MANUAL FOR

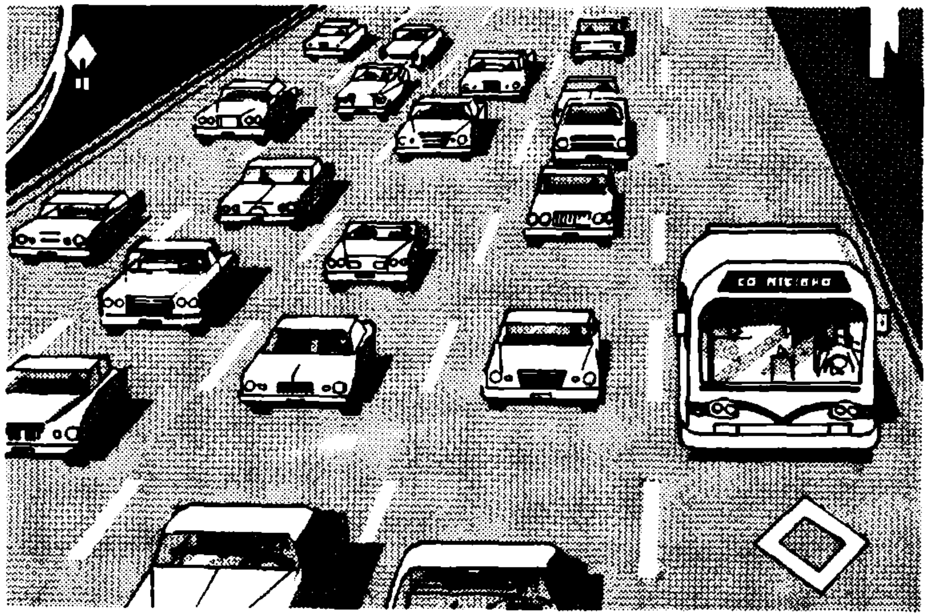
PLANNING AND IMPLEMENTING

PRIORITY TECHNIQUES

FOR

HIGH OCCUPANCY VEHICLES

TECHNICAL GUIDE



URBAN CONSORTIUM

FOR TECHNOLOGY INITIATIVES TRANSPORTATION TASK FORCE

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NOTE

Primary funding for the development of this manual was provided by the Urban Mass Transportation Administration's Service and Methods Demonstration Program.

The use of this Manual set will be demonstrated in a few cities during the next six months. This Manual set will be revised based on those demonstrations. The revised Manual set will be available in Spring of 1978.

DISCLAIMER

Manual on Planning and Implementing Priority Techniques for High Occupancy Vehicles: Technical Guide

June 30, 1977

Prepared by

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Secretariat
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PREFACE

The need to increase the level of service and capacity of an urban transportation system without substantially increasing expenditures or using up scarce land resources is a common problem for local governments. Improvements to the transportation system that are consistent with changing urban goals, particularly those relating to socio-economic, environmental and energy concerns, can be difficult to accomplish. One method available is to give preferential treatment to high occupancy vehicles.

The Urban Consortium acting through Public Technology, Inc. (PTI), has joined with the U.S. Department of Transportation (USDOT) to evaluate priority techniques for high occupancy vehicles. While these techniques are not absolute solutions readily applicable to all situations, previous studies have found that most priority techniques:

- Can help move people more efficiently;
- Can be less costly than alternatives involving new and elaborate construction;
- Can be implemented quickly (compared to most other alternatives); and
- Can be modified to meet changing conditions without involving irreversible decisions or irrevocable resource commitments.

Priority techniques are given as an alternative action to be considered in the preparation of the Transportation Systems Management (TSM) element of a Transportation Improvement Program (TIP). The TIP is a requirement if an urban area is to receive Federal capital or operating assistance for transportation projects.

This Technical Guide is one part of a Manual on Planning and Implementing Priority Techniques for High Occupancy Vehicles. The guide has been prepared for staff responsible for the detailed planning, design, and day-to-day implementatioı of a project. It is particularly appropriate for traffic engineers, transit system operators, enforcement agency personnel, transportation planners, and other related staff analysts. In addition to this guide, there are two other documents in the Manual. The Chief Executive's Report is an explanatory review for local administrators and elected officials who approve preferential treatment policies and whose continued support is essential for successful project implementation. The Program Manager's Report is an advisory document for senior personnel who staff, plan, and manage priority treatment projects.

This manual provides a comprehensive supplement to the many technical documents on the subject of priority techniques. It identifies institutional barriers and other non-technical issues which often prevent implementation of an otherwise worthwhile project.

To assist in the design of specific projects, there are certain basic technical publications which project planners or engineers should have in addition to this document. The necessary publications will vary by project type and the complexity of the vehicle or pedestrian controls needed. A list of these documents and where to obtain them is given in the annotated biblography at the end of this guide.

There are three principal parts in this Technical Guide, in addition to the Appendix (which consists of current projects and contacts, and case studies), the Glossary, and Bibliography.

Part I, the Introduction, includes a background on priority techniques and a description of the basic project approach.

Part II, General Project Considerations, includes a description of the various project development phases and details on the two initial phases, Sketch Planning and Project Planning. This part of the guide is particularly useful to agencies without an elaborate mechanism for project implementation. Ideas and guidelines are presented on how to set up a project and structure the needed activities.

Part III, Specific Project Considerations, includes a series of sections on the unique planning and design issues for (and experiences with) specific priority techniques.

Priority techniques have been successfully used in Boston, Honolulu, Los Angeles, Miami (Florida), Minneapolis, New York City, Portland (Oregon), San Francisco, and Washington, D.C. among other places. A diverse group of local officials has evaluated this body of experience for its applicability and has helped document the techniques for transfer to other jurisdictions. Since the documents are intended for practical use by local and state governments, and local circumstances vary significantly, no attempt is made to recommend a specific approach to project implementation.

A dissemination strategy is being developed which will include demonstration and technical assistance to selected local areas. Further information is available by contacting the:

- URBAN CONSORTIUM
  c/o Public Technology, Inc.
  Transportation Project
  1140 Connecticut Avenue, N.W., Suite 1100
  Washington, D.C. 20036

Local administrators, elected officials, and technical personnel are invited to contact the Urban Consortium and PTI in the event of questions or special needs.

PART I:

INTRODUCTION

BACKGROUND

This part of the technical guide presents a broad perspective on the general implementation requirements which are involved when applying priority techniques. The initial concern is for such matters as Federal requirements, costs and benefits, and possible funding sources.

Transportation Systems Management

The basic concerns related to urban transportation are changing. In recent years the need to alleviate congestion, provide mobility for transit dependents, and promote safety has been supplemented with the need to reduce air pollution, conserve energy, and improve environmental quality. As a result of these new concerns and current economic conditions, local governments have had to set new transportation goals.

One important goal is to increase the capacity and efficiency of existing transportation facilities by emphasizing the movement of people in fewer vehicles, rather than simply the better movement of vehicles. This goal is consistent with the recent Federal Transportation Improvement Program (TIP) regulations for receiving Federal financial assistance for transportation projects. The TIP contains a Transportation Systems Management (TSM) element aimed at getting the most out of the existing transportation system before looking at other, more costly alternatives.

Planners and local officials are not the only ones interested in these changing goals. Urban citizens are gradually increasing the pressure on elected officials to reduce congestion, clean up the air, provide mobility for those with no automobile access, and provide reasonable transportation choices to those who choose not to drive. These demands are increasingly difficult to meet with the limited capital and operating revenues available each year.

An appendix to the TIP regulations lists numerous Transportation Systems Management[1] actions aimed at increasing mobility with limited capital expenditure. Part of the spectrum of possible TSM actions are listed in Table 1.

A project involving priority techniques should not be implemented without a thorough analysis of the impacts it will have on the transportation system. In addition, such a project is most likely to be successful if implemented along with other consistent measures to encourage high occupancy vehicle usage.

Users of these facilities are more likely to notice cumulative system-wide time and cost savings rather than a single time and cost savings at one location. For example in Portland, Oregon, the Banfield Expressway reserved lane project was supplemented with two park-and-ride losts, new express bus services, preferential carpool parking downtown, and an improved carpool information program. A careful examination was made of the whole range of other transportation systems management actions to supplement the reserved lane project. This tended to improve the public perception of the project as being a small part of a consistent urban policy.

Costs, Benefits and Potential Problems

This Manual examines capital and operating costs by technique in Part III. Good documentation of cost data has been difficult to obtain because planning, installation, and operational costs have often not been itemized in local general budgets where Federal funds were not involved.

See page 17 for footnotes

In planning a priority treatment project, the overall costs and benefits to the community should be carefully evaluated. In addition, potential problems (e.g., enforcement, safety) should be examined critically. Table 2 is a list of some potential benefits and problems which might be expected with such projects.

Funding

As much as 90% of the capital costs for priority treatment projects can be met with funds available through the Federal Highway Administration (FHWA). In addition, Federal Aid Highway Funds are available from FHWA to defray additional enforcement costs and other operational and maintenance costs of the demonstration period of projects which test or exemplify priority techniques of general interest and applicability.

The Urban Mass Transportation Administration (UMTA) may make grants to cover up to 100 percent of the net costs during the demonstration period of projects which test or exemplify priority techniques of general interest and applicability.

Table 1

SPECTRUM OF TRANSPORTATION SYSTEMS MANAGEMENT ACTIONS

- TRAFFIC OPERATIONS MEASURES
  - Channelization
  - One-way streets
  - Better signalization and progressive timing
  - Computerized traffic control
  - Metering access to freeways
  - Other traffic engineering improvements.
- PEDESTRIAN AND BICYCLE MEASURES
  - Bicycle paths and exclusive bikeways
  - Pedestrian malls
  - Convenient and secure bicycle storage facilities
  - Other bicycle and pedestrian facilitation measures.
- PARKING MANAGEMENT AND CONTROL MEASURES
  - Elimination of on-street parking (especially in peak periods)
  - Regulation of the number and price of public and private parking spaces
  - Favoring short term over all-day commuter parking
  - Provision of fringe and transportation corridor parking to facilitate transfer to transit and other high occupancy vehicles
  - Strict enforcement of parking regulations

SOURCE: U.S. Department of Transportation, "Transportation Improvement Program, Part II", Federal Register 40, no. 181 (September 17, 1975): pp. 42976-81.

Table 1 (Cont.)

- REDUCING PEAK PERIOD DEMANDS - Changes in working schedules, fare structures, and automobile tolls to reduce peak period demands and encourage off-peak use of transportation and transit facilities
  - Staggered work hours
  - Flexible work hours
  - Reduced off-peak fares
  - Increased peak-hour commuter tolls on bridges and highways
- PRIORITY TECHNIQUES FOR HIGH-OCCUPANCY VEHICLES
  - Reserved or preferential lanes on freeways and city streets
  - Exclusive lanes to bypass congested points
  - Exclusive lanes at toll plazas with provisions for non-step toll collection
  - Exclusive access ramps to freeways
  - Bus pre-emption of traffic signals
  - Strict enforcement of reserved transit rights-of-way
  - Special turning lanes or exemption of buses from turning restrictions
- GENERAL MEASURES - Actions to reduce vehicle use in congested areas, improve transit service and increase the efficiency of internal transit management
  - Encourage carpooling and other forms of ride sharing
  - Organize employer-supported vanpool programs
  - Diversion, exclusion or metering of automobile access to specific areas
  - Area licensing, parking surcharges, and other forms of congestion pricing
  - Establishing auto-free or auto-restricted zones and closure of selected streets to through traffic
  - Restrictions on downtown truck delivery in peak hours
  - Better transit services, including route deviation and demand-responsive services in low density areas

Table 1 (Cont.)

- Greater flexibility and responsiveness in transit routing, scheduling and dispatching
- Express bus services coordinated with local collection and distribution services
- Fringe, and park-and-ride facilities
- Shuttle transit service from fringe parking areas to urban centers
- Integrating paratransit services with public transportation
- Simplified fare collection systems and policies
- Passenger amenities, including shelters
- Better passenger information services and systems
- Improved marketing
- Cost accounting and other management tools
- Maintenance policies to increase equipment reliability
- Surveillance and communications technology

Table 2

PROJECT TRADE-OFFS*

- POTENTIAL BENEFITS

  - •• Can move more people, and faster, with relatively low capital investment when compared to new highway construction, parking garages, transit systems that require exclusive rights-of-way, and similar alternatives.

  - •• Can be implemented more quickly than most other alternatives and with enough flexibility to permit easy modification or termination without major capital investment or financial losses.

  - •• Does not involve irrevocable decisions or irreversible resource commitments.

  - •• Can improve bus service operations and reliability, and result in positive environmental and energy consumption impacts.

  - •• Can improve circulation in downtown areas through reductions in the total number of vehicles to be accomodated and reduce the amount of land devoted to parking in urban centers.

  - •• Can increase employment capacity and accessability of an urban center without the usual need for new transportation facilities and without increasing vehicular congestion.

- POTENTIAL PROBLEMS

  - •• Possible complex jurisdictional and legal arrangements.

  - •• Possible adverse effects on residents or business persons as a result of diverting traffic, banning curb parking, or locating park-and-ride lots.

  - •• Possible negative public reaction due to what may be seen as an effort to force citizens out of their private cars or to deprive them of a public facility for which all have paid.

  - •• Inconvenience, which may be experienced by persons who do not use the facility and whose travel times may be increased.

  - •• Possible increased safety and enforcement requirements.

  - •• Possible increased costs, including capital and operating subsidy costs as a result of increased peak hour transit demands.

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*Staff members can use the Manual to develop a more precise understanding of the costs, benefits, and advantages and disadvantages when planning for a particular project.

Other UMTA funds are available to help meet recurring transit operating deficits, including those incurred by adding or improving service as part of a priority treatment project. Further information on funding is available in the Program Manager's Report.

HIGH OCCUPANCY VEHICLES

A high occupancy vehicle, as defined here, is any motorized vehicle carrying at least two persons, such as a carpool, vanpool, or bus. Up until a few years ago, most facilities reserved for high occupancy vehicles permitted only buses. More recently carpools and vanpools have also been allowed, indicating that they too might benefit from, and operate effectively on, such facilities.

Carpools and vanpools should be allowed on priority treatment facilities if:

- The carpools and vanpools will not adversely affect public transportation patronage;
- The facility appears to be underutilized with buses alone;
- Permitting these additional vehicle types will not undermine the opportunity of the facility for producing travel time advantages;
- Safety will not be severely jeopardized; and
- Adequate enforcement can patrol the facility so that it will not become ineffective.

If carpools and/or vanpools are allowed, then a minimum occupancy rate must be established. This number will depend on the demands made on the facility.*

PREFERENTIAL TREATMENT GOALS

The concept of reserving portions of public roadways for certain types of vehicles or persons is neither new or unusual. In the past, many parkways were

*A sample method for estimating demand is presented in Part III, Overview, later in this guide.

designed exclusively for automobiles -- trucks buses, and pedestrians were prohibited. Loading zones have been reserved for trucks in urban centers. Taxi standing zones are common near large traffic generators (such as airports, hotels, or stadiums). Malls and sidewalks have been reserved for pedestrians. More recently, exclusive bikeways have been reserved in many urban areas.

Some of the most common reasons for the installation of the preceding preferential treatment and exclusive use facilities not related to high occupancy vehicles have been:

- To efficiently and economically allocate a scarce commodity -- the public right of way;
- To improve the circulation of certain types of vehicles or pedestrians; and
- To improve safety.

Preferential treatments for high occupancy vehicles have been applied for the same reasons.

Priority techniques might be applicable whenever other approaches to transportation problems would result in:

- Unacceptable direct or indirect costs;
- Continuation or worsening of congestion;
- Unacceptably long implementation time (5 to 10 years);
- More negative environmental impacts (than a priority treatment project); and
- More negative community impacts (than a priority treatment project).

In many cases, priority treatment projects can complement high speed rail or other mass transit modes.

DESIGN CATEGORIES

One of the first applications of priority treatment occurred in Chicago in 1939 when a contraflow lane on North Sheridan Road in the central business district was reserved for buses. Since that time, numerous projects have been implemented. Four categories of techniques are described in this Guide.*

- Freeway;
- Arterial;
- Activity center; and
- Miscellaneous locations.

Freeway Applications

This category includes those techniques employed on or within freeway rights-of-way. The major types of freeway technique are: (1) separated facilities; (2) concurrent flow, and contra-flow reserved lanes; and (3) priority freeway access control, including bypass lanes on metered ramps, or exclusive use ramps. These techniques are discussed in Part III, Section 1; examples are listed in Appendix A.

Arterial Applications

These include techniques employed on heavily traveled non-freeway streets connecting urban and suburban residential areas with major commercial or industrial areas, and other major traffic generators. Concurrent and contra-flow

*For a state-of-the-art overview, and additional information about these four categories of techniques, see U.S. Department of Transportation, Priority Techniques for High Occupancy Vehicles (Cambridge, Mass.: Transportation Systems Center, 1975).

reserved lanes, and signal preemption are examples of arterial applications. See Part III, Section 2 for a discussion of these techniques, and Appendix A for a listing of current projects.

Activity Center Applications

This includes priority techniques implemented on city streets within dense urban locations such as central business districts, major commercial/industrial center or airports.* Examples of activity center applications include systematic reserved lanes for circulation systems, transit malls, and bus street terminals.

Many of the techniques which apply to arterials can be applied in activity centers. Thus, Part III, Section 2 is also relevant to activity centers. Additional options are possible within activity centers because bus and traffic densities are much higher there. Consequently, priority techniques can be applied over shorter distances or at individual intersections, as well as on an area-wide basis.[2] See Part III, Section 3 for further discussion, and Appendix A for a list of projects and contacts.

Miscellaneous Applications

In this category, priority techniques are applied on an individual problem-specific basis (which is distinct from systematic application to freeway, arterial or activity center corridors). Common alternatives include: (1) isolated signal modifications; (2) off-street transit terminals; (3) toll plaza applications; (4) carpool staging areas; (5) preferential carpool lots; and (6) transit

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*While many of the streets in this category can be labeled "arterials" in the traffic engineering sense, activity center applications generally involve shorter street portions than arterial treatments, and the surrounding land uses are more intense.

See page 17 for footnotes

operations. Part III, Section 4 includes discussion of these techniques, and Appendix A includes a list of projects.

PLANNING AND DESIGN FUNCTIONS

This Manual makes a distinction between the planning and design functions. The planning function involves setting constraints on the project designs; whereas, the design function involves developing specifications for project installation and operations within those constraints.

In practice these two functions quite frequently overlap. All appropriate individuals should be invloved in both planning and design stages of project development to ensure project continuity and smooth project implementation.

PROJECT APPROACH

As described in this Manual, a project is a formal effort to respond to a particular transportation problem by applying a priority technique(s) and any other measures which contribute to an acceptable solution. The approach suggested here is that of multi-disciplinary project team, acting under an appointed program manager. In any management environment, a project should be designed to attain specific objectives under management constraints related to resources, time, and public exceptations.

Organizational Arrangements

A project can be initiated by any public agency and executed under the auspices of an existing department, program, or other newly created authority.*

*For convenience, the discussion is based on the assumption that just one project is under consideration, but more than one are possible as part of a comprehensive program structure (depending on local requirements).

However, successful project execution probably will need the sponsorship and coordination of several agencies.* Before anything else, the agency or agencies sponsoring a project will have to determine an appropriate and acceptable mechanism for allocating policy-making responsibilities for project implementation.

Responsibility for priority treatment project may be: (1) assigned to a single existing agency, either as a separate function or as a part of its regular operations; (2) divided among several existing agencies, such as the local or State highway agencies and an enforcement agency; or (3) assigned to a newly-established agency which has been set up specifically for this purpose. Regardless of the choice, the arrangements should be fully documented and made known to all concerned.

When responsibilities for project activities are divided among two or more agencies, a means of coordination is essential. To achieve this, some form of inter-agency team structure, with representatives from major participants, may be necessary. The team should include representatives from the jurisdictions, departments, and/or agencies with a stake in the outcome. A final design will usually be more easily accepted if those affected by it participate fully from the beginning. However, a representative mix is better than an unwieldly situation where there are too many participants to make any progress. The Sketch Planning section gives more information on the issues confronted when organizing a project team.

To ensure accurate communications, each participating organization should designate someone to serve as a liaison for the control or coordination of project activities. A Program Manager should be appointed by the chief administrative

*It is evident that this can be true, regardless of the precise number of projects.

officer(s) to represent top-level concerns and direct the project in a manner which minimizes uncoordinated actions by project team members.

The precise relationship of the Program Manager to participating chief administrative officers (CAO's) can vary with local circumstances, but the discussions in each document within this Manual are independent of these variations. The tasks outlined for the manager will pertain in most cases.

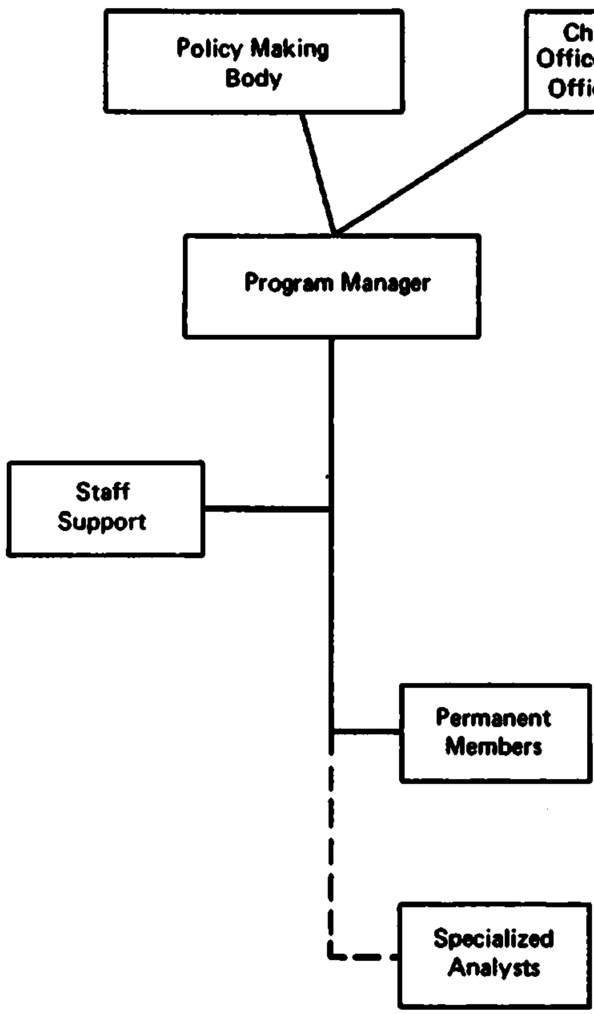
Whatever organizational arrangements are finally decided upon should be set forth specifically in the Administrative Plan described in Part II, Section 2. This may require only a sentence or two (or it may involve the preparation of an extensive description of administrative functions and interagency agreements).

Basic Program Structure

A suggested program structure is shown in Figure 1. Independent of the organizational arrangements, this structure can either be used directly or modified slightly to execute most projects. The Sketch Planning section of Part II describes the background appropriate for individual project team members.

As shown in Figure 1, the Program Manager responds directly to policy inputs and management instructions from the CAO's staff, or a department head with transportation responsibilities. The community can relate directly to the team activities. Special analysts or consultants would be used only where the involved agencies otherwise do not have the resources to execute a project-related activity.

Figure 1
SUGGESTED PROJECT STRUCTURE*



- The group selected for this work should be broadly representative of the technical specialities that are involved, and may include transportation planners, highway and traffic engineers, transit operators, and enforcement officers.

- May or may not be needed depending on project scope and available resources.

*Depending on the jurisdiction(s) involved, one or more project teams may be needed, which could involve several teams reporting to one Program Manager.

PART I NOTES:

INTRODUCTION

1. U.S. Department of Transportation, "Transportation Improvement Program, Part II", Federal Register 40, no. 181 (September 17, 1975): pp. 42976-81.

2. Wilbur Smith and Associates, Bus Rapid Transit Options for Densely Developed Areas (Washington, D.C.: U.S. Department of Transportation, February, 1975).

PART II:

GENERAL PROJECT CONSIDERATIONS

OVERVIEW

INTRODUCTION

This part of the Technical Guide consists of a general description of the priority treatment project process. The issues covered here generally apply to most projects. In contrast, Part III includes discussions of planning and design issues that are specific to particular techniques.

General Contents

This part of the Guide serves two basic purposes: First, it provides those agencies which do not have existing mechanisms for implementing priority treatment projects with ideas and guidelines for developing them. Second, it provides those agencies which do have them with a checklist of fundamental activities which should be undertaken during the project.

PROJECT DEVELOPMENT PROCESS

The initial phases of the priority treatment project process--referred to as Sketch Planning and Project Planning--are emphasized in the two sections that make up Part II. If these phases are successfully completed, those remaining--Design, Installation, Operations, and Evaluation--are more likely to be successful. Ordinarily, the latter four phases do not depart in any significant way from existing planning and engineering practices or procedures.

As depicted in Figure II-i, a project should progress through a series of at least six interrelated project phases to achieve full implementation. Such

Figure 2

PRIORITY TREATMENT PROJECT DEVELOPMENT PROCESS*

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Initiate program effort, organize team, appoint Program Manager, develop program goals, assemble data, identify problems and opportunities for projects, compare alternatives, submit recommendations to decision makers, and select one or more projects for detailed planning.
Project Planning	Set objectives, develop design criteria, conduct specific problem analysis, set constraints on the remaining phases to meet a variety of regulatory and operational requirements.
Design	Prepare detailed design specifications according to constraints set by the project plan.
Installation	Install project facilities.
Operations	Operate and monitor project facilities on a day-to-day basis.
Evaluation	Measure the project performance and modify as needed.

*The arrows indicate the general sequencing and expected activities in each project phase. However, while the phases are in sequence, they may overlap and some repetition may be necessary to refine or modify earlier results.

phasing permits administrative control of priorities, costs and timing within fixed technical, management and political constraints.

Although project phases are sequential, they may overlap and can be repeated to refine or modify earlier results. Each phase fulfills specific policy expectations and may include the major activity shown in Figure 2. Most major decisions in the project development process are made at points where significant technical and management considerations converge.

Sketch Planning

Sketch Planning, described in Part II, Section 1, consists of identifying and describing the applicability of priority techniques to specific problem situations. It can be used to select a project or to ensure that a tentatively selected project will address the purposes for which it is intended. Sketch planning also ensures that users and non-users who might be affected by the project are given input into the project development process before any significant decisions are made.

Sketch Planning should result in a list of possible projects or a documented statement that no projects of this type are feasible or currently needed. If such projects are infeasible or not needed at present, the Sketch Planning team might lay out a crisis plan which would employ one or more of these techniques in the event of unforeseen difficulties, such as an energy crisis.

The chief elected official or governing body should review the results of Sketch Planning in order to decide whether or not to proceed to Project Planning. If the results and issues are not clear, or if management is not satisfied with any of the alternatives of the Sketch Planning team, the Sketch Planning process can be refined until a decision on continuation is reached.

Project Planning

Part II, Section 2, includes a full discussion of Project Planning requirements. Fundamental to the successful implementation of priority techniques is a project plan, which forms the basis for:

- Local decisions as to whether or not to proceed further with the project;
- Funding requests and the preparation of applications for Federal and State aid;
- Activities preparatory to project design and installation; and
- Project operations and evaluation.

Project Planning can be greatly simplified by taking advantage of existing planning efforts and utilizing existing plans and data whenever possible. Often, only minor modifications of existing plans will be necessary to ensure timeliness and consistency with the priority treatment project objectives.

Design

The Design phase involves preparing detailed plans and specifications for the facilities and services. Existing practices and procedures for project design are usually adequate for the design of priority treatment projects.

Installation

The time needed for installation will vary greatly, depending on the nature and scope of each project. During this phase some persons may be inconvenienced, and in such cases adverse public reaction may be expected. Suggestions for handling such situations are given in the "Public Education and Marketing Plan" in Part II, Section 2.

Operations

The Operations phase begins when the project is placed in use and involves monitoring and maintaining project facilities on a day-to-day basis. In order to monitor performance and reduce confusion for users, it is sometimes advantageous to open the project in stages. Regardless of the approach, the success or failure of the project is not usually clear until after an adjustment period.

Evaluation

The decision to proceed with a project carries with it the commitment to give the project a chance to meet its objectives. The essential features of the approved project plan should not be sacrificed for short-term gains. Public acceptance and use of a project may depend in part on the perception that the project is permanent and that its benefits--and inconveniences--will not be experienced for only a short time.

The Evaluation phase is usually carried out simultaneously with the Operations phase and involves an on-going analysis of project performance, according to some pre-established measures of effectiveness. The Evaluation phase provides a basis for making improvements in the project or abandoning it if it does not have an overall positive impact on the urban area.

Section 1

SKETCH PLANNING

INTRODUCTION

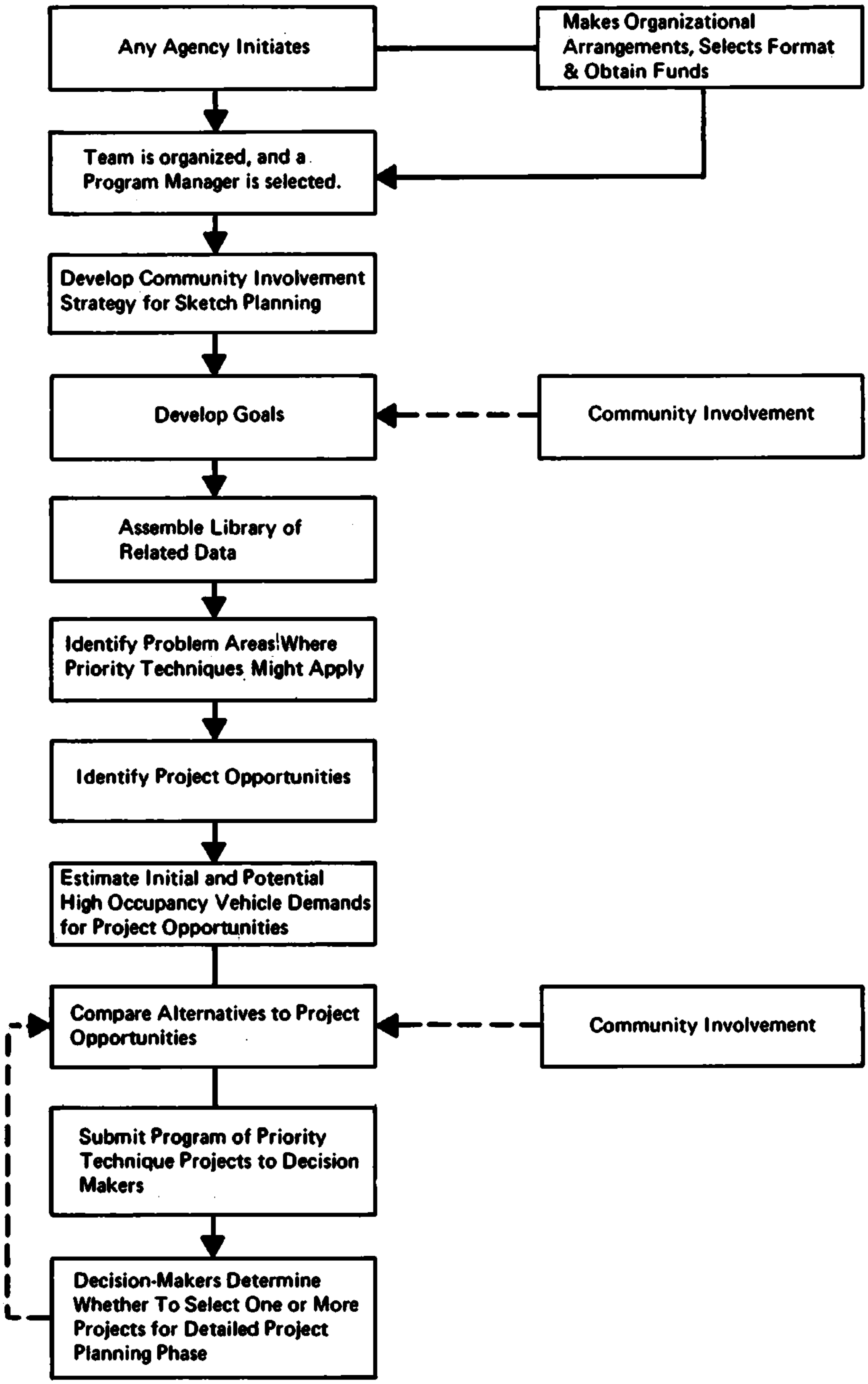
Sketch Planning can be an orderly, fast, reliable, and inexpensive means of finding out whether or not a priority treatment project will solve a specific local transportation problem. It may be conducted on a corridor, subarea, citywide or broader urban area basis. While there are many ways to do Sketch Planning, the version described herein is systematic, comprehensive, and can be objectively applied. It is intended to be used as a guide and/or an example. The general approach outlined here should be modified to fit institutional and fiscal constraints of each local area.

General Approach

Figure 3 depicts the entire Sketch Planning process. Though Sketch Planning is the first part of project development, it need not be separated from any existing planning efforts, just as the development of a priority treatment project need not be divorced from other transportation planning efforts. If a sketch planning mechanism already exists, the priority treatment effort should be integrated into it.

In order for a sketch planning process to be successful, its results must be accepted by the general public. For this to happen, the process should meet three conditions:

Figure 3
SKETCH PLANNING ACTIVITIES



(1) Both the process and its results must not be imposed on the public by an agency(cies) perceived as external to or not representative of the affected local area.

(2) The effort must be credible. The right organization must be involved, and the right people must do the work. These should include local government officials responsible to both anticipated project users and non-users.

(3) The affected community must feel that it has been allowed input into the process, and that its concerns have been sincerely taken into consideration.

INITIATE PROJECT

Any public agency involved in transportation or transportation-related activities can initiate a priority treatment project. The agencies most likely to be involved in a project include local and State planning and operating agencies, traffic enforcement agencies, and regional planning organizations with support from Federal agencies. The following discussion is a brief description of their basic roles with respect to project initiation.

State and Local Planning and Operating Agencies

Local agencies are generally responsible for the detailed planning and implementation of priority treatment projects on city streets. State agencies are usually responsible for projects on State highways and freeways. Since priority treatment projects will relate only to urban areas, most freeway and arterial projects should involve both State and local agencies in the Sketch Planning process.

Traffic Enforcement Agencies

These agencies are responsible for ensuring that the operating characteristics of a project are adhered to by users and non-users. If enforcement agencies are to accomplish this, any necessary State or local enabling legislation affecting priority treatment projects should be enacted prior to project implementation.

The project should also be designed in such a way that enforcement is physically possible. Enforcement may become expensive or impossible if enforcement agencies do not participate in Sketch Planning. Close and continual coordination is necessary between the enforcement agency and the other agencies responsible for implementing and operating the project.

Regional Planning Organizations

Regional planning organizations -- currently referred to as Metropolitan Planning Organizations (MPO's) -- are often responsible for coordinating the use of Federal funds among the planning and operating agencies which they serve, and for coordinating the development of regional transportation plans, including the Transportation Systems Management (TSM) element of the Transportation Improvement Program (TIP) under the joint UMTA/FHWA planning regulations issued September 17, 1975.

MPO's may also coordinate local applications for Federal funding and for commenting upon the relationship of the applications to regional plans under the Federal Office of Management and Budget Circular No. A-95. There organizations may serve to coordinate efforts of projects which affect two or more jurisdictions within the area they serve. However, the involvement of a regional agency to coordinate two or more agencies may be unnecessary if those agencies work well together.

Federal Transportation Agencies

These agencies have the responsibility for assisting and providing guidance to State and local agencies in implementing national policies relating to transportation. They accomplish this according to Federal legislation (such as energy conservation and air quality regulations, or mandates on consideration of transportation for the elderly and handicapped) and provide financial and technical assistance to State, regional and local planning and operating agencies.

ORGANIZE PROJECT TEAM

A team approach to Sketch Planning is suggested. It is recognized that many agencies, and even different branches of the agency may not work well together. Because of these inherent rivalries, a team may often be difficult, if not impossible, to assemble. However, the interdisciplinary team approach can ensure that the wide range of concerns invloved in the planning and implementation of a priority treatment project are addressed and the basic project objectives are at least understood and, better yet, acceptable to all agencies concerned.

The team could be comprised of representatives from agencies likely to be involved in implementing, operating and enforcing the project. The size of the project team should depend on the scope of the sketch planning effort and the number of jurisdictions invloved. Agencies which may ultimately have roles in the detailed planning of a project should either be represented on the team, be allowed to provide input throughout Sketch Planning, or be kept informed of any major decisions resulting from Sketch Planning.

The team concept will work best if the persons involved know the local situation, represent and express the views of their own organizations, and relate well to representatives of other agencies in identifying the need, or lack of need, for the project. The project team should represent the concerns listed below:

- Table 3: Project Team Concerns
  - Transportation planning;
  - Land use planning;
  - Traffic Engineering;
  - Highway Engineering (State and/or Federal)
  - Public transit and para-transit operations;
  - Traffic enforcement;
  - Other public services (fire, sanitation, postal, etc.);
  - Community issues; and
  - Environmental impacts.

ESTABLISH INSTITUTIONAL ARRANGEMENTS AND FUNDING

Two major activities in the Sketch Planning process are administrative in nature: (1) the determination of Sketch Planning responsibilities; and (2) obtaining funds. These activities are the responsibility of the agency which initiated the project, which may or may not be the appointed lead-agency. (See Part II, Section 2 under "The Administrative Plan", for more details).

ASSURE COMMUNITY INVOLVEMENT

At the Sketch Planning phase, a broad community involvement program must be outlined. The community should be involved in two important activities which occur during Sketch Planning: (1) setting program goals; and (2) analyzing project alternatives. The media should be kept accurately informed of sketch planning developments. In this way, the process can be fully documented and the public notified of important meetings and decisions. (See Part II, Section 2, for further details).

DEVELOP GOALS

A comprehensive set of goals should be developed during the Sketch Planning phase. There are two reasons why this is important. First, goal setting helps ensure that a priority treatment project will be compatible with community needs, and that each project will address the concerns for which it was conceived. Second, goals are normally the source of specific project objectives, and the latter provide the means for evaluating whether a project is a success or failure. The table below lists some sample goals which could apply to a priority treatment program.

- Table 4: Example Priority Treatment Goals
  - Increase the people-carrying capacity of the existing transportation system to make it as efficient as possible at moving people.
  - Encourage the use of public transit, vanpools, and carpools.
  - Improve bus service operations and reliability;
  - Reduce person-trip travel times for those in high-occupancy vehicles;

- Make progress towards the attainment of environmental and energy consumption goals;
- Improve access to activity centers and improve parking for those who use high occupancy vehicles.
- Improve circulation of pedestrians and certain types of vehicles in downtown areas through reductions in the total number of vehicles to be accommodated;
- Increase the employment capacity and accessability of an activity center without the usual need for new transportation facilities and without increasing vehicular congestion;
- Reduce the amount of land devoted to parking in activity centers;
- Improve safety; and
- Reduce future expenditures related to major transportation improvements.

Most cities have developed goals to cover a wide range of areas, in addition to transportation, These may include, but are not limited to, land use, housing, community design, community revitalization, public services, environmental resources management, public safety and energy conservation.

The full range of urban goals should be examined in Sketch Planning so that goals which reinforce or conflict with transportation goals can be identified along with goals which are no longer applicable.* This knowledge can be used in the decision making process to determine appropriate tradeoffs in establishing goals, policies or objectives related to priority treatment.

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*Goals are not static; they may change as circumstances do. For example, our fuel conservation goals changed radically after the energy crisis of 1973-74.

While not directly related to the Sketch Planning goal setting effort, the policy positions of key decision makers concerning priority treatment may greatly constrain goal setting and the type of projects which are ultimately selected for implementation. There are at least three basic policy positions which may be taken.

- Encourage the use of high occupancy vehicles regardless of whether major negative impacts are inflicted upon non-users. This approach reflects the premise that long-term environmental and transportation problems warrant drastic measures. It assumes that the widespread use of high occupancy vehicles is one of the best ways of resolving these problems. In effect, priority treatments are used as auto disincentives.

- Encourage the use of high occupancy vehicles only if non-users are not significantly affected. This approach implies that the use of high occupancy vehicles is important, but major or long-term ill effects resulting from priority treatment projects should not be forced upon non-users.

- Encourage the use of high occupancy vehicles only if non-users are either not affected or positively affected. This approach assumes that people should not be discouraged from using any mode of transportation. Only incentives to use high occupancy vehicles are allowed -- no auto use disincentives.

While all three of these viewpoints are exemplified in various urban areas throughout the country, the second and more moderate of the three seems to reflect the most common policy position among cities with priority treatment projects already in existence.

ASSEMBLE DATA

A library of priority treatment and related documents should be compiled and organized. Completion of this task will result in significant time savings for both the Sketch Planning and Project Planning phases. In addition to the use of the material during the planning phases of a project, it will prove to be a valuable resource throughout the project's implementation, as well as to other transportation related projects. Table 5 is an abbreviated list of topics relevant to priority treatment projects for which data should be obtained.

The whole process should take no longer than a few person-weeks to complete. If major reports exist, they should be listed by functional area. Dates of completion should also be provided. It is usually necessary to compile only the most recent versions of studies, and at this point, it is more important to obtain documents about existing conditions than about future projections.

In addition to the operational and planning documents inventory, the project team should obtain, to the extent available, the information or maps listed in Table 6. Such information can shorten the Sketch Planning phase considerably and provide common frames of reference for the project team.

The project team might also prepare a comprehensive list of future contacts, if one is not already in existence. Such a list might include:

- General purpose local governments officials;
- Local, State and regional transportation planning and operating agencies;
- Traffic law enforcement agencies;
- Major on-going city or metropolitan transportation planning and operational projects; and
- Planning, urban development and environmental agencies.

A list of contacts and agencies compiled at the beginning of the Sketch Planning phase and amended as needed can be used throughout the planning and implementation of the project.

Table 5

SUGGESTED DOCUMENT LIST

- TRAFFIC OPERATIONS STUDIES. THESE WILL HELP DEFINE THE EXISTING STREET NETWORK AND TRAFFIC SYSTEM, AS WELL AS TO OUTLINE CAPACITY, SAFETY, AND PARKING PROBLEMS AND ISSUES WHICH MAY AFFECT POTENTIAL PROJECTS.
  - Traffic Count Programs*
  - Vehicle occupancy counts*
  - Travel time studies*
  - Origin-Destination trip studies*
  - Traffic Operations Program to Increase Capacity and Safety (TOPICS)
  - City-wide studies on pavement markings, parking signalization or signing (traffic control devices)
  - Traffic assignments/projections
  - Regional and CBD traffic studies
- TRANSIT AND PARA-TRANSIT OPERATIONS STUDIES. THESE WILL HELP TO DEFINE THE DEMAND, CAPACITY AND QUALITY OF EXISTING TRANSIT AND PARA-TRANSIT SERVICES.
  - Transit Operating Data (e.g., patronage by route, service levels, fare structure, base and peak period schedules, maximum load points)*
  - Carpool or vanpool services and matching programs*
  - Transit finance studies (State and Federal assistance applications and status)
  - System inventories--equipment and facilities, staffing, organizational structure.
  - Taxi and special service operating data
  - Short and long range transit plans
  - Other transit or para-transit studies

*Most important documents.

Table 5 (Cont.)

- TRANSPORTATION PLANNING STUDIES. THESE WILL PROVIDE A COMPREHENSIVE OVERVIEW OF PAST EFFORTS IN TRANSPORTATION PLANNING. POTENTIAL PROJECTS SHOULD BE CONSISTENT WITH THESE EFFORTS.
  - Urban transportation goals*
  - Downtown transportation studies*
  - Comprehensive transportation planning studies
  - Miscellaneous regional rail, air or goods movement studies
  - Future projections of O-D patterns
  - Modal split projections, sensitivity analyses studies
- GENERAL LAND USE AND OTHER URBAN PLANNING STUDIES. THESE SHOULD PROVIDE THE BACKGROUND NEEDED TO INTEGRATE THE PROJECT EFFORT WITH GENERAL LAND USE AND TRANSPORTATION-RELATED PLANNING EFFORTS.
  - Downtown or major urban center plans*
  - General plans
  - Growth projections and trends
  - Other demographic data
- ENVIRONMENTAL STUDIES. THESE ARE NECESSARY TO ENSURE THAT THE PROJECT WILL BE SENSITIVE TO EXISTING ENVIRONMENTAL CONDITIONS AND THE ENVIRONMENTAL CONCERNS OF THE COMMUNITY.
  - Transportation Control plan
  - Air quality maintenance plan
  - Air quality implementation plan
  - Other environmental reports

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*Most important documents.

Table 6

SUGGESTED INFORMATION LIST

- Existing traffic volumes on major freeways, arterials, and in urban center areas showing capacity surpluses and deficiencies;*
- Existing street system and highway status including committed short range projects;*
- Existing curb usage in urban areas, including loading zones, taxi zones, etc.;*
- Existing transit system delineating local and express routes;*
- Existing transit terminals, major transfer points, and park-and-ride facilities;*
- Existing and/or proposed land use;
- Future projections of traffic volumes (with capacity relationship);
- Existing on-street parking restrictions and off-street parking facilities (100+ spaces) in urban centers, and on major arterials;
- Existing transit system peak period patronage and peak period bus volumes;
- Proposed transit development on exclusive rights of way, route changes, new systems;
- Sensitive ecological areas; and
- Sensitive locations such as schools, hospitals, concentrations of elderly, poor or minority groups.

*Most important information.

IDENTIFY PROBLEM AREAS

Not all problems can be solved through the installation of a priority treatment project. The table below lists some of the possible problem areas where projects might apply. Potential problem areas should be listed and described by the team.

- Table 7: Example Problem Areas

  - Corridors with recurring peak hour or off-peak congestion and traffic bottlenecks in the transportation system. Some corridors may involve more than one facility (e.g., parallel routes). If recurring congestion is found on one or more of the parallel facilities it should be noted. Non-recurring but predictable congestion due to accidents or weather may also be indicative of problem areas--particularly on freeways. These, however, may be more appropriately resolved through measures such as freeway surveillance and control systems or integrated motorist information systems.

  - Corridors with significant peak hour directional bus passenger volumes or those serving areas with a high potential for transit growth. Significant is meant to indicate a volume of high occupancy vehicle passengers or potential demand comparable to the number of auto occupants in an adjacent lane of the same facility.

  - Corridors approaching (or expected to have) peak or off-peak congestion in the short range (0-5 years) when priority techniques might be incorporated into plans for such areas.

  - Activity center streets with significant commuter traffic problems, severe vehicle-pedestrian conflicts, or severe bus circulation problems.

  - Activity center streets where congestion may not be prevelant but where a priority treatment may result in: (1) improved service for transit users; (2) reduced accidents; or (3) economic benefits for adjacent property owners; or (4) rejuvenation.

  - Access routes to special traffic generators, such as sports stadiums or major recreational facilities, where recurring congestion may be reduced through improved bus or other high occupancy vehicle access.

If there are no problem areas where projects might apply, the project team might consider developing a "crisis" plan of treatments to be implemented in emergencies such as a gasoline shortage. The Sketch Planning phase could then continue, the emphasis shifting to the identification of project opportunities which might be available in a crisis situation.

IDENTIFY PROJECT OPPORTUNITIES

Opportunities for implementing priority treatment projects are limited. There are basically two types of opportunities which are applicable: (1) those related to the physical transportation system; and (2) those related to policies and goals established at the beginning of Sketch Planning. These two types are not mutually exclusive.

Physical Opportunities

These are existing system characteristics which may allow project implementation without making major policy decisions. They are often the easiest opportunities to implement since they may not affect non-users as much as exclusive policy or goal-related opportunities might.

The Miami I-95 concurrent flow bus/carpool lane project, described in Appendix E was implemented primarily because of a physical opportunity resulting from a widening project on I-95. Road space was not taken away from non-users. Instead, lanes were added for the benefit of high occupancy vehicles.

- Table 8: Examples of Physical Opportunities
  - Facilities with unused excess capacity or future commitments to widening, preferably the facilities should either have system continuity or serve to bypass congestion. For surface streets, information on existing signal systems, lane widths, shoulder widths, on-street parking regulations, and frequencies and volume of cross streets should be of assistance in evaluating these opportunities. In addition, certain freeways or freeway ramp configurations can also accommodate bypass lanes without new construction.

- Excess or under-utilized rights-of-way, preferably with system continuity. These may include abandoned railroad rights-of-way or freeway rights-of-way where an opportunity might exist for a separated facility;

- Signal system opportunities to accommodate a bus priority system;

- Existence of local carpool or vanpool programs in which there is high public interest;

- The facilities available for enforcement. These might include adequate pull-over space of a freeway surveillance and control system. In addition, enough personnel must be available to carry out the enforcement efforts needed for certain reserved lane facilities; and

- Availability of transit resources to accommodate additional demand.

Policy or Goal-Related Opportunities

These might be used in critical problem areas where no apparent physical expansion opportunities exist, and where other alternatives, including "Do nothing", are undesirable. Projects of this type are generally more difficult to implement than those related to physical opportunities, and may meet with negative public reaction, particularly when non-users are adversely affected.

The Santa Monica Diamond Lane project, described in Appendix B, was implemented primarily because of a policy opportunity. In that case, the opportunity occurred when the Diamond Lane project was part of a locally-adopted plan aimed at improving air quality in the Los Angeles basin. Since there was no particular physical opportunity to add a lane, a lane was taken away from the general traffic and reserved for buses and carpools.*

*This action followed a high level policy decision to use the corridor, even though some initial negative reactions were expected.

ESTIMATE HIGH OCCUPANCY VEHICLE DEMAND FOR EACH PROJECT OPPORTUNITY

For each project opportunity, three basic determinations must be made. First, the type of service now being offered on the facility must be categorized (i.e., local or express buses, carpools, other) and quantified. Second, the existing demand for each type of service on the facility must be measured. Third, a determination must be made about the anticipated project's ability to accommodate present and anticipated demands after the priority treatment project is implemented.

COMPARE HIGH PRIORITY PROJECT OPPORTUNITIES TO OTHER ALTERNATIVES

Other alternatives might include such things as widening, rapid rail, new roads, "Do Nothing", or other Transportation Systems Management measures. The feasible alternatives should be compared with priority techniques on the basis of the anticipated:

- o Planning and Implementation Time Frame;
- o Costs;
- o Impacts; and
- o Effective Life Expectancy of the Solution.

Particular attention should be given to environmental issues (See P. 49).

The alternatives comparison matrix used in Miami, Florida, to evaluate alternative South Dixie highway projects* is shown in Figure 4. In initial Sketch Planning, two types of alternative comparisons might be made. One would be an objective approach based on a qualitative technical evaluation

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*Refer to the Case Study on the Miami, Florida South Dixie Highway Project in Appendix E.

Figure 4
SOUTH DIXIE CORRIDOR ALTERNATIVES COMPARISON SHEET

Variables \ Alternatives	Express Street	Freeway	Reversible Auto Lane	Exclusive Fully Access Controlled Busway	Railbus	Railcar	Contra-flow Buslane
• Costs	Very high	–	–	high	high	high	low
• Implementation time	4-7 years	–	–	2-3 years	2-3 years	2-3 years	1-2 years
• Feasibility w/respect to public opinion/ community values	feasible	not feasible	not feasible	very feasible	very feasible	very feasible	feasible
• Public benefits	excep- tional	–	–	good	good	good	very good
• Sunk costs not retrievable at start up of Dade Area Rapid Transit system.	none	–	–	high	high	?	low

SOURCE: Marc Lopatin, Florida Department of Transportation of alternatives. The other would be an overview ranking of alternatives based on subjective preferences. At this stage a range of costs might be established for each alternative.

It is strongly suggested that the alternatives evaluation be conducted with some form of community participation. It would be logical for sketch planners to provide performance criteria for technical evaluation data while the community participants provide a subjective weighting of criteria and/or ranking of alternatives. If appropriate, the project team might present a tentative ranking of alternatives to the community, with the community providing advisory guidance on re-ranking the list. Whatever process is used, the outcome of this task should be a tentative list of priority treatment projects which survive the alternatives analysis.

SUBMIT PROGRAM RECOMMENDATIONS TO DECISION MAKERS

Submission of recommendations involves two steps: (1) justification of projects; and (2) submission of program recommendations.

Justification

Unlike typical traffic engineering projects, specific warrants such as those presented in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)[1] may be impossible to develop for priority treatment projects. There are several reasons for this.

- No two projects are alike. Projects generally involve more than one operating agency. The agencies may have to compromise to determine the most important reasons why a project may or may not be warranted. It may in a given instance be more consistent with urban goals to improve transit services rather than traffic flow. A uniform set of priority treatment warrants could not reflect this difference in philosophy.

- Policy decisions, often involving energy conservation, air quality improvements, or other environmental concerns, have often been given as the reasons for projects.

[1]See page 113 for footnotes

- Projects are often implemented to create new demand for high occupancy vehicle usage rather than accommodate existing demand like other traffic engineering projects. This created demand is difficult to estimate and can only be measured after a project is implemented.

For the above reasons, it is suggested that the alternatives analysis be used as the primary justification for projects. If decision makers are willing to initiate a project only on the basis of existing demand, a general warrant might apply for those projects involving an exclusive lane or ramp:

> If more people will be accommodated in an affected corridor by the use of the lane or ramp for high occupancy vehicles and in fewer vehicles, than by the use of the lane or ramp for general traffic, the special use lane or ramp is warranted.[2]

This warrant implies that the negative impacts on non-users shall not outweigh the positive impacts on users.

Submit Program Recommendations

The results and conclusions of Sketch Planning should be submitted to decision makers who will in turn decide whether or not one or more projects should be pursued. Such a decision may not be immediate, since decisoon makers could request further information or additional community feedback about Sketch Planning results.

SELECT PROJECT

Selection of one or more projects for a priority treatment program is the link between Sketch Planning and Project Planning. Even if all opportunities for projects are eliminated, documentation of Sketch Planning will be useful in preparing a TSM element of the area, Transportation Improvement Program, and when required in meeting Department of Transportation alternatives analysis requirements.

See page 113 for footnotes

Section 2

PROJECT PLANNING

INTRODUCTION

This section consists of discussions relating first to setting objectives and environmental impact analyses, and then the six other components of a complete project plan. Successful Project Planning depends on the Sketch Planning described in Part II, Section 1: Sketch Planning. Part III provides specific information on each priority technique. It should be used as a reference guide for analyzing the unique problems and characteristics of each technique during the project planning phase.

SET OBJECTIVES

Early in the project development process, the project effort must move from broad statements of desired results or goals to specific accomplishments or objectives. Objectives must be approved by the chief executive(s) whose responsibility is to ensure that the project achieves its intended results within the boundaries of community needs and constraints. With objectives, management will be able to determine whether the project merits its intended purposes, and should be able to set reasonable time and resource limitations for the project.

Meaningful community involvement also can play a significant part in setting objectives, since such involvement will familiarize the community, affected users and affected non-users with the project benefits and tradeoffs as well as generate support for the project.

An attempt should be made to develop objectives which are measurable. In order for their measurement to have any meaning, the parameters covered by the objectives should be based on the performance of the existing system before project installation so that the improvements (or detriments) can be evaluated in a meaningful framework. There is little value in collecting "after" data alone.

Sample objectives appear in Table 9, Table 10, and Table 11 on the following pages. The three lists group the various technical and political objectives into categories related to: (1) users; (2) non-users (but those affected); and (3) the community in general. Generalizations about non-user and community objectives are difficult to make since they depend on the individual type of project and public attitudes about public transportation and carpooling. These attitudes are affected by many factors, including the quality of current transit services, transit amenities, passenger security, the extent of local carpooling programs, ease and convenience of automobile travel, and the local image of transit.

Many of the project objectives may be reached within weeks after project operations begin. Others may not be achieved at all, or not until several months or a year has elapsed. These differences should be kept in mind when determining when evaluation should begin and how long it should last

Technical objectives may not be viewed as the most important by management. For example, when public acceptance is a primary objective (and it may be for a controversial project), then those responsible for operations and evaluation should be notified of this fact long before project installation. In such cases, public education, marketing and community involvement might have to be given more emphasis. The Santa Monica Diamond Lane project is a case in point. While some of the technical objectives were achieved, general public acceptance was not. The case study in Appendix B discusses this issue in depth.

Table 9

SAMPLE PROJECT OBJECTIVES
AND MEASURES: USERS*

PROJECT OBJECTIVE	MEASURE
1. Improve trip time for bus riders	1. Bus travel times
2. Improve trip times for carpools	2. Carpool travel times
3. Increase number of carpools	3. Carpools/facility
4. Increase average car occupancy	4. Car occupancies
5. Increase bus patronage	5. Bus passengers/time period
6. Increase average bus occupancy	6. Bus occupancies/time period
7. Increase revenue passenger/bus mile	7. Total passenger revenue/total bus miles
8. Increase bus frequency in peak period without lowered occupancies	8. Buses/time period and bus occupancies
9. Reduce bus delays	9. Bus delays/time period
10. Improve bus reliability	10. Average schedule variance/time period
11. Improve service for transit dependents	11. Transit dependent survey responses
12. Improve user convenience	12. User survey responses
13. Improve user attitudes towards high occupancy vehicles	13. User survey responses

*The term users, describes those who use and directly benefit from the service of a priority treatment (e.g., users are in high occupancy vehicles using the treatment). Each measure is a sample and not the only one for the objective given.

Table 10

SAMPLE PROJECT OBJECTIVES
AND MEASURES: NON-USERS*

	PROJECT OBJECTIVE		MEASURE
#1.1	Maintain or improve current travel times for non-users	1.1	General traffic travel times
#1.2	Minimize travel time degradations for non-users while improving overall average travel times for users and non-users	1.2	General traffic travel times
2.0	Maintain or improve pedestrian safety	2.0	Pedestrian accident patterns
#3.1	Maintain or improve current access to adjacent businesses and residences	3.1	Adjacent business and resident survey results
#3.2	Minimize disruption of access to adjacent business and residences	3.2	Adjacent business and resident survey results
4.0	Gain approval of non-users for project	4.0	Non-user survey responses
#5.1	Minimize disruption to goods movement and loading/unloading	5.1	Truck travel times
#5.2	Maintain or improve goods movement and loading/unloading	5.2	Truck travel times
6.0	Maintain or improve bicycle circulation (for non-freeway projects)	6.0	Accident records, survey responses, bike counts

*Non-users are those who may be affected by a priority treatment and do not benefit (e.g., non-high occupancy vehicle motorists and passengers, pedestrians, and nearby business operators, among others). Non-users may be using the same facility, parallel routes or cross streets. Each measure is a sample and <u>not</u> the only one for the objective given.

#A choice would have to be made between these objectives since they reflect different attitudes towards non-users.

Table 11

SAMPLE PROJECT OBJECTIVES AND MEASURES: COMMUNITY*

PROJECT OBJECTIVE	MEASURE
1. Improve center city environment and economic viability	1. Retail sales, downtown work and shopping trips, and activity hours (day and night time)
2. Maintain or improve safety	2. Accident records
3. Increase peak period person carrying efficiency of the existing transportation system	3. Vehicle volume counts multiplied by vehicle occupancies
4. Reduce the need for alternate facilities to accommodate current or future person trip demands (e.g., save future transportation costs)	4. Analyze person carrying efficiency with respect to alternative accommodation measures
5. Increase transit system productivity	5. Passengers/gallon of fuel consumed; bus trips/driver; etc.
6. Reduce overall energy consumption	6. Energy consumption in impact area minus energy used on extra trips which may occur during the day
7. Reduce air pollution	7. Vehicle miles traveled; delays and speeds; air quality measurements
8. Improve transit incentives for newly developing residential areas	8. Modal splits
9. Provide an adequate level of enforcement	9. Violation rates

*This refers to the area-wide goals of the jurisdictions involved in project planning. Each measure is a sample and not the only one for the objective given.

ENVIRONMENTAL IMPACT ANALYSIS

Although priority techniques are ordinarily designed to be environmentally beneficial (e.g., fewer vehicles improve air quality), there are problems associated with environmental review. A court decision on environmental analysis requirements terminated operation of the Diamond Lane Project, a preferential land for buses and carpools on the Santa Monica Freeway in Los Angeles.* This recent decision has highlighted the need for environmental impact analyses of priority treatment projects.

While Federal regulations may change, the intent of environmental analyses probably will not change in the foreseeable future. The major Federal legal requirements for environmental impact analyses as they might relate to priority techniques are found in the following sources:

- "Design Approval and Environmental Impact", Federal Register 39 (December 2, 1974): 41804.
- "Guidelines for Federal Agencies under the National Environmental Policy Act", Federal Register 38 (August 1, 1973): 20549.
- National Environmental Policy Act of 1969, Public Law 91-190 (NEPA)
- "Procedures for Considering Environmental Impacts: DOT Order 5610.1B", Federal Register 39 (September 30, 1974): 35232.

The following discussion is aimed at describing how the intent of such regulations might be met for priority treatment projects.

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*On August 9, 1976, the United States District Court ordered suspension of the Diamond Lane because the California Department of Transportation had failed to comply with Federal and State laws requiring an environmental impact analysis. The Environmental Planning Branch of the California Department of Transportation has made an early determination that the proposed project was "categorically exempt" under the regulations for implementation of the California Environmental Quality Act of 1970. The Department is now appealing this decision and is also preparing an Environmental Impact Statement.

A. The Approach. The approach to environmental analysis used in this Manual introduces environmental concern early in the process. This hopefully enables subsequent work efforts to focus on ways to maximize environmental benefits and mitigate environmental problems.

There is a clear distinction between an "environmental impact analysis" and an "environmental impact statement" as used in this Manual. An environmental impact analysis fulfills the spirit of the National Environmental Policy Act of 1969 (NEPA); that is, it incorporates the broad range of environmental concerns into the planning, design and installation of a project from the beginning.

Projections of environmental impacts are made along with projections of all other aspects of the project, such as costs, travel time changes, or patronage estimates. An environmental impact analysis should be completed for every priority treatment project.

- <u>Table 12</u>: Environmental Impact Analysis Components[1]
  - A description of the proposed project and any anticipated positive and negative impacts on the environment;
  - Discussion of any unavoidable adverse environmental effects of the proposed project;
  - Reasonable alternatives to any portion of a project having adverse impacts which would minimize or eliminate such impacts. Each alternative should also include a statement of financial costs and environmental benefits;
  - A comparative analysis of the short and long-term local impacts on the environment;
  - A statement of any environmental impacts which might result in an irreversible commitment of resources. This statement should include an analysis of the likelihood of adverse environmental impacts which might be caused by future developments generated by the proposed project; and
  - A discussion of the problems and objections raised by Federal agencies, State and local entities and citizens, and the disposition of the issues involved.

See page 113 for footnotes

B. The Process. Environmental issues should be discussed in the alternatives analysis step of Sketch Planning when the potential for a priority treatment program is examined. A broad evaluation of the environmental consequences of various alternatives, including "do nothing", should be undertaken. Alternatives which appear to have very positive or severe adverse environmental impacts should be noted.

The Project Planning phase should include an examination of the environmental impact requirements at Federal, State, and local levels. At this point, an attempt should be made to consolidate as many environmental analysis review efforts as possible through joint memoranda of understanding between reviewing agencies.

Other environmentally-related actions which should occur in the Project Planning phase include:

- Final detailed projection of any environmental impacts;
- Completion of the environmental impact analysis;
- Identification of mitigating measures to reduce any adverse environmental impacts; and
- A decision about whether or not to issue an Environmental Impact Statement. (If the Urban Mass Transportation Administration (UMTA), Federal Highway Administration (FHWA), or other Federal funds are involved, the reviewing agency would make this decision. Otherwise, it is a local decision).

To do these things, environmental problems identified in Sketch Planning will require detailed study. These studies will provide decision-makers with an information base from which to make tradeoffs involving environmental impacts.

Mitigating measures should then be incorporated into the project design and installation phases as needed. Measurements of environmental impacts, supplemented with other impact measurements, will provide useful data for modifying and upgrading the project during the operations and evaluation phases.

Figure 5 shows the environmental impact analysis activities during the project development process.

Figure 5
ENVIRONMENTAL IMPACT ANALYSIS ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Gather background environmental data and assess general impacts of project alternatives.
Project Plan	Determine Federal, State and local environmental impact analysis requirements. If project involves (and most will) UMTA or FHWA or other federal agencies develop a joint memorandum of understanding for review purposes to avoid duplication of efforts. Make detailed projections of project impacts and conduct environmental impact analyses. Identify mitigating measures. Issue an Environmental Impact Statement (EIS) if required.
Design	Integrate mitigating measures in project designs. Gain EIS approvals.
Installation	Install mitigating measures with project.
Operations	Measure environmental impact; note effectiveness of mitigating measures
Evaluation	Check accuracy of environmental impact analysis and/or statement conclusions on the basis of collected data.

C. Joint Agreements. When an environmental impact analysis must be reviewed by two or more Federal agencies, such as UMTA or FHWA, a joint memorandum of understanding patterned after the example shown in Table 13 on the following page could be prepared to avoid duplication of efforts. The example shown is an agreement made between UMTA and FHWA for the review of the Environmental Impact of proposed rapid transit stations for the Massachusetts Bay Transportation Authority's Redline South Shore extension.

D. Environmental Impact Statements. One of the most important decisions that a Federal, State or local agency reviewing an environmental impact analysis will have to make is whether or not to issue an Environmental Impact Statement (EIS). This decision is generally based on whether or not a project is expected to have a significant impact on the environment.

The National Environmental Policy Act of 1969 requires environmental impact statements for "...major Federal actions significantly affecting the quality of the human environment." The U.S. Department of Transportation Order 5610.1B, "Procedures for Considering Environmental Impacts"[2] and the Federal Highway Administration's "Design Approval and Environmental Impact"[3] provide guidance to reviewing agencies as to when an EIS is required. For proposed actions which are covered by these guidelines, either an EIS or a negative declaration must be issued. A negative declaration is a statement that the "...proposed action will not have a significant impact on the environment." (USDOT Order 5610.1B). The problem is that many of the actions involved in priority techniques fall into the grey area where no precise guidelines exist.

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Table 13

EXAMPLE MEMORANDUM OF UNDERSTANDING

MEMORANDUM OF UNDERSTANDING

BETWEEN

FEDERAL HIGHWAY ADMINISTRATION

AND

URBAN MASS TRANSPORTATION ADMINISTRATION

SUBJECT: Analysis of the Environmental Impact of the Rapid Transit Stations on the Massachusetts Bay Transportation Authority's Redline South Shore extension in the Quincy-Braintree area, and related access roads and fringe parking facilities.

I. Purpose: This Memorandum of Understanding establishes general principles and procedures for the coordination of efforts of the Urban Mass Transportation Administration and the Federal Highway Administration in the analysis of the environmental impact of the proposed jointly funded transportation project.

The analysis of the environmental impact of this Project is consistent with Section 102(2) (c) of the National Environmental Policy Act of 1969 (42 U.S.C. §4332(2) (c)), the Council on Environmental Quality Guidelines of April 23, 1971, UMTA Order 5610.1 dated February 1, 1972, and Federal Highway Administration requirements contained in PPM 90-1.

II. Definitions

A. Project - The proposed Project is a combined mass transit - highway facility.

B. Environmental Analysis

The analysis of the mass transit aspects of the Project and its potential environmental effect pursuant to Section 10(b) of the UMTA Order 5610.1 which addresses in part the following points:

1. the environmental impact of the proposed action;

2. any adverse environmental effects which cannot be avoided should the proposal be implemented;

3. alternatives to the proposed action;

4. the relationship between local short term use of man's environment and the maintenance and enhancement of long-term productivity; and

5. any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Table 13 (Cont.)

C. Public Hearing

1. UMTA procedures pursuant to Sections 3 and 14 of the Urban Mass Transportation Act of 1964, as amended, require an Applicant for financial assistance to hold a public hearing affording all interested parties with a significant economic, social or environmental interest in a project an opportunity to express their views.

2. FHWA procedures pursuant to PPM 20-8 require a public hearing to be held with respect to the highway aspects of a project.

D. EIS

1. UMTA Order 5610.1, pursuant to NEPA and CEQ guidelines, upon a determination by UMTA that the project will result in a significant environmental impact, requires that a Draft and Final Environmental Impact Statement (EIS) be prepared on the Project.

2. FHWA procedures, pursuant to PPM 90-1, requires that an environmental assessment be prepared on a proposed highway facility.

E. DOT - Department of Transportation

F. UMTA - Urban Mass Transportation Administration

G. FHWA - Federal Highway Administration

H. MDPW - Massachusetts Department of Public Works

I. MBTA - Massachusetts Bay Transportation Authority

J. CEQ - Council on Environmental Quality

K. NEPA - National Environmental Policy Act

L. Lead Agency - The Federal Agency primarily responsible for the implementation of procedures which comply with the NEPA. UMTA shall be the Lead Agency for this joint project.

III. General Principles and Procedures

A. The MBTA, with support as necessary by UMTA, MDPW and FHWA, shall prepare and submit to UMTA an Environmental Analysis on the mass transit elements of the proposed project. MDPW in consultation with FHWA, shall prepare an environmental analysis on the highway aspects of the proposed project.

B. A Public Hearing(s) shall be held pursuant to adequate prior notice, in accordance with UMTA procedures.

C. UMTA and FHWA shall evaluate the environmental analysis of the Applicants, public hearing transcript (held according to UMTA and FHWA procedures) and review agency comments to decide whether the mass transit and highway elements of the proposed project are likely to result in a significant environmental impact, and whether an EIS will be required.

D. UMTA, in consultation with FHWA, upon a determination that the project will result in a significant environmental impact, will prepare and circulate a joint Draft EIS on both the transit and highway elements of the proposed project in accordance with UMTA and FHWA procedures.

E. UMTA, in consultation with FHWA shall prepare the Final EIS for the proposed jointly funded project. The Final EIS shall incorporate the highway portion of the project and the mass transit elements of the proposed project.

F. Any ambiguities about format, content, procedure and/or technical matters shall be resolved by consultation between the offices of FHWA and UMTA.

IV. <u>Specific Agreements</u>

A. The data collection and development of the Draft and Final EIS for the Project shall be the joint responsibility of the MDPW and MBTA. The sharing of the costs between UMTA and FHWA for this joint effort shall be determined by the respective Federal agencies.

B. The Draft and Final EIS for this Project shall be developed and administered in accordance with the requirements of UMTA Order 5610.1.

V. <u>CEQ Coordination</u> - If in the course of implementing the above procedures, either UMTA or FHWA determines that advice is required with respect to the protection of the environment, as set forth in the NEPA, then CEQ, as the implementing agency for the NEPA, shall be consulted for the proper course of action.

DATE: ______________________________

DATE: ______________________________

The FHWA guidelines[4] list the following actions related to priority treatment as ordinarily considered non-major actions:

- Modernization of an existing highway by resurfacing, widening less than a single lane width, adding shoulders, adding auxiliary lanes for localized purposes (weaving, climbing, speed changes, etc.) and correcting substandard curves and intersections;

- Lighting, signing, pavement marking, signalization, freeway surveillance and control systems, and railroad protective devices;

- Safety projects such as pavement grooving, glare screens, safety barriers, energy attentuators, etc.; and

- Construction of bus shelters and bays.

Under FHWA guidelines, major actions include those "...likely to precipitate significant foreseeable alterations in land use; planned growth; development patterns; traffic volumes; travel patterns, transportation services, including public transportation; and natural and manmade resources...."[5]

Some of the actions involved in priority treatment could fall under either definition. Despite all that has been written about "major" and significant impacts, no clear guidance is available for many projects. The decision on whether or not to require an EIS is generally made on a project-by-project basis and is up to those responsible for reviewing the environmental impact analysis. While this decision could occur anywhere between the Sketch Planning or Design phases, it must be made while alternatives are still being considered. The process of impact projection and analysis should be the same whether or not a formal EIS is to be issued.

As suggested in the previous section, the type of project and its location are key factors in determining the potential for significant impact. There are several other factors which may affect this decision:

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- Table 14: Determining the Potential for Significant Impact

  - Type of project. Major new construction, such as an additional lane or interchange, is more likely to produce significant impacts than relatively minor new construction, such as adding a ramp at an interchange, repaving, signal installation, demolition or paving.

  - Location. A project located in a densely developed urban area, or near schools, hospitals, concentrations of elderly, poor, minorities or ecologically-sensitive areas is more likely to have significant impacts than one in a low density suburban area or one far from heavy concentrations of people. Park-and-ride lots proposed for residential neighborhoods are one exception to the general rule.

  - Permanence of potential impacts. An impact which is permanent is likely to be more significant than one which is temporary, or which can feasibly be reversed.

  - Relation to community plans and goals. A project which conforms with the plans and goals of a community is less likely to have significant adverse (and controversial) impacts than one which is at odds with such plans.

  - Effect on traffic. A project which shifts large amounts of traffic to areas previously unaffected is more likely to have a significant impact than one that doesn't.

  - Number of different impacts. A project which has many different types of impacts (e.g., air, noise, traffic and social impacts) is more likely to be significant than one which affects only a few environmental concerns.

  - Potential for public controversy. The project likely to create public controversy usually has more significant impacts than one which doesn't. Greater care in planning and design is demanded.

If there is any doubt about issuing an EIS, it is best to issue one.[6] Keeping good records of environmental analyses, their results, and the decisions based on those results is crucial and can save time over the long term. If an EIS is needed later, such records can help facilitate its production.

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COMMUNITY INVOLVEMENT PLAN

Community involvement in Project Planning is an extremely important part of the planning process, yet one which is both time-consuming and sensitive. Its importance lies in its potential for informing decision makers about the perceived needs and objections of prospective users and non-users, and in generating an understanding of, and possible support for, a project which is designed to fit into a larger--Federal, state, or local--set of goals.

Why Do It?

Community involvement may be a mixed blessing if not done properly, since a community involvement program can create more problems than it solves. A Community Involvement Plan may serve six basic purposes:

(1) Obtain ideas;

(2) Determine a community's perception of its needs;

(3) Minimize surprise and misunderstanding which create resistance;

(4) Generate support;

(5) Avoid the appearance of arbitrariness and insensitivity; and

(6) Satisfy Federal requirements.

However, agencies responsible for the design and implementation of a complex project may resent lay intrusion into the decision-making realm. Elected officials may view community involvement as competing with their election-day mandate. In such cases, they often opt for a "least is best" approach.

The determination of the appropriate level and scope of citizen involvement is difficult because many agencies and elected officials do not know what value community involvement has, or how to assure that it is representative, or how best to harness it to the purposes for which it is designed.

Doing It For Results

Productive community involvement can be realized by tailoring the force and degree of participation to the significance of the proposed project. In developing a plan, the staff person must take into account the attitudes of elected officials who will receive and act upon the products of the community involvement process. Generally, elected officials are anxious to respond to constituent interests. On the other hand, if the situation is one in which no one is going to listen--where citizen participation is a mechanical process to meet legal or political requirements--the staff effort should be minimal. To treat it otherwise wastes the time of the citizens, and, in the end, creates ill will from those whose efforts have been ignored.

As Figure 6 shows, extensive efforts are necessary in the first two steps of project development process--the Sketch Planning and Project Planning steps. For a community involvement program must be organized and defined in the beginning of this planning process, and the mechanisms set in motion for its continued input into the process, for it to be successful, and for it to produce positive rather than negative results. The latter often result from an attempt to "cram" a truncated "citizens should be seen and not heard" process into the tail end of the project planning process.

Establishing a Program

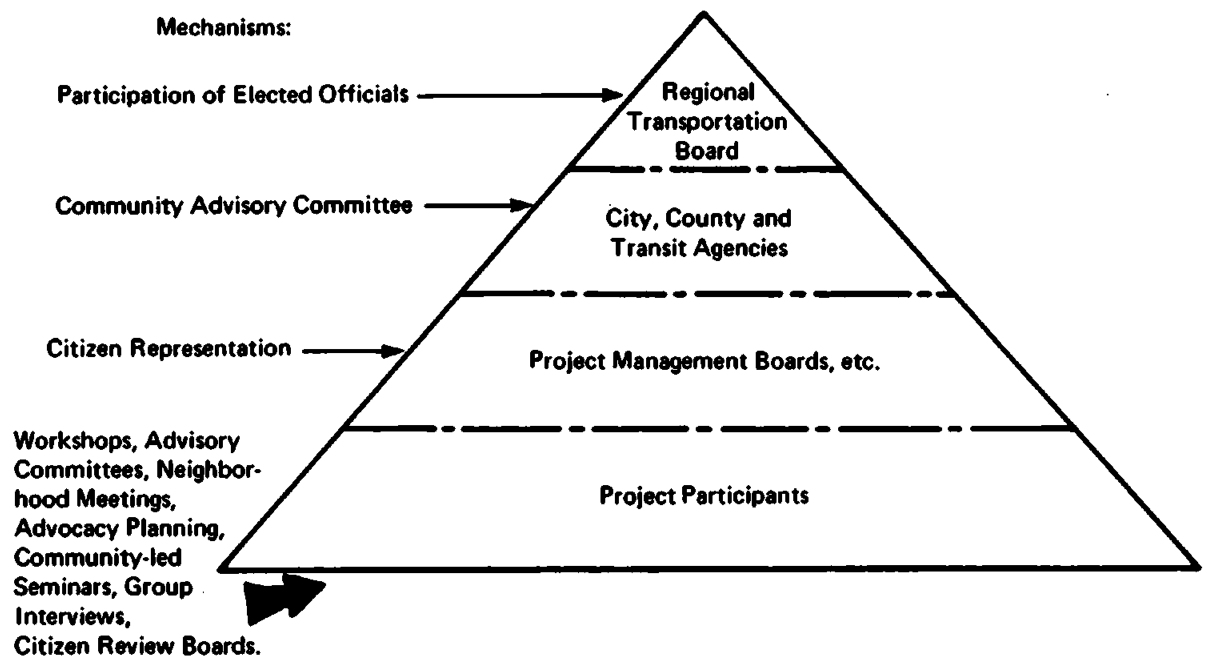
If a community already has an existing community involvement program, the community involvement portion of the project development process should, if possible, be integrated into this structure. Where no such opportunity exists, or where such a structure holds no potential for reaping the benefits necessary

Figure 6
COMMUNITY INVOLVEMENT PLANNING ACTIVITIES*

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Develop a broad plan for community involvement, based on the sketch planning area. Involve community in goal setting for program and comparison of alternatives. Keep media well informed of process.
Project Planning	Determine which elements of the community will be directly affected by the project. Refine the community involvement plan to project level. Involve affected community in objective setting and determining planning and design constraints. Continue to keep media well informed.
Design	Review final designs with media and affected community prior to installation. Prepare public for installation procedures.
Installation	Advise affected community of construction or installation schedules.
Operations	Provide a continuous mechanism for community feedback on project operations.
Evaluation	Evaluate community/media reactions to project operations.

*The arrows indicate the general sequencing and expected activities in each project phase. However, while the phases are in sequence, they overlap and some repetition may necessary to refine or modify earlier results.

Figure 7
CITIZEN PARTICIPATION AT ALL LEVELS OF GOVERNMENT



for successful project planning, the responsibility for directing and coordinating such a plan should be delegated at the very beginning of the project planning process to a member of the project team.

The first step in establishing a community involvement program is to identify the areas in which citizen participation might be useful and meaningful. This would depend primarily on what the decision makers hope to learn and gain from citizen involvement, and upon the decision makers' perceptions of the value versus constraints of citizen participation. Thus, within the six Project Phases described earlier, certain subtantive areas should be emphasized, and the information hoped to be learned from those areas outlined.

The second step in extablishing such a program is to identify those individuals who will participate in the various parts of the process and at various levels of government. Citizen participation may take several forms depending on the level of involvement. Figure 7 shows that at the regional level it may be primarily representation by elected officials. Participation can become much more specific at the project level.[7]

A third step in establishing a community involvement program is to identify the persons and groups which would likely be affected by the project, both users and non-users. Such a group should include transit riders, citizen or community organizations, representatives from business, labor, management and industry, elected or appointed officials, transit agency staff members, community institutional leaders, and citizens at large.

Running The Program

In addition to completing the three steps of the program, consideration must be given to the following five dimensions of the program's operation:

- Level of effort;
- Participatory techniques;
- Community role;
- Budgetary support; and
- Documentation.

A. Level of Effort. The primary determinant of this is the scope of the project. Yet factors such as how controversial the project is, its technical complexity, decision maker perception of community involvement, and political expediencies and legal constraints all play an integral part in this determination.

Controversy is the most sensitive of these factors. This is compounded by the severity of user and non-user impacts. In designing a program, the decision maker must take into account the neighborhood and other social impacts, the extent of inconvenience expected during the construction phase, the effects of such

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inconvenience on business and movement of people and goods, and in general, the disruption of normal patterns and habits of urban life.

Quite often, Federal agencies which contribute funds for projects demand that certain specific requirements be met. When the U.S. Department of transportation is such a sponsor, the project team should, at a minimum, review the following documents:

- The joint FHWA/UMTA planning regulations. U.S. Department of Transportation, "Transportation Improvement Program, Part II", Federal Register 40, no. 181 (September 17, 1975): 42976-81;

- The grant application guidelines (UMTA External Operating Manual and appropriate sections of the Federal Aid Highway Program Manual): and

- The requirements related to special user groups (e.g., "Transportation for Elderly and Handicapped Persons", Federal Register, April 30, 1976: 18234-18241.)

In addition, both Federal, state and local environmental protection statutes should be examined closely.

B. Participatory Techniques. There are generally four kinds of techniques, the distinction being based upon the purpose of those techniques in the community involvement process:

- Information-Gathering Techniques/Mechanisms--these include letters, memoranda, speeches, media coverage, direct mail, handouts, posters, flyers, responses to inquiries, and audio-visual presentations.

- Issue Clarification--These include public hearing, direct telephone communications, issue ranking, balloting, alternatives development, surveys, pools, public meetings.

- Problem Solving--These include formal and informal question/answer sessions, role-playing, brainstorming, etc.

- Group Process Monitoring--these include general discussions with community leaders, general feedback, etc.

As a quick perusal of these techniques illustrates, the emphasis is on developing and maintaining a two-way flow of information--finding out what the community wants and needs, and telling the community what the decision maker and her or his technical staffs would like to do about them.

C. Community Role. The success of a community involvement program is strongly related to the degree of correlation between the nature of the planning project and the role which the community plays with in that process. Quite often, various levels and types of involvement are appropriate at different stages of a process, much less from process to process.

Some roles in the planning process are normally not appropriate for community involvement such as technically-oriented judgements, etc. Others, such as helping to determine acceptable enforcement levels, are invaluable, and in fact, can probably be shaped best by community groups. Both types of information are necessary; what is most important is that the planning process has the right people and groups doing the right things.

D. Budgetary Support. The percentage of a project's total budget which should be devoted to community involvement varies both project-specifically and geographically (i.e., different decision makers perceive different levels of involvement as appropriate). Thus no rules of thumb exist for predicting far in advance how much such programs will cost. Such a determination should stem, rather, from a careful examination of what roles community involvement should play in a project, how much information must be obtained, and what difficulties might be expected, as well as a host of similar considerations.

E. Program Documentation. The extent to which citizen participation activities are to be documented should be determined at the outset of the program. Documentation may serve three purposes:

- To provide basic data for the final report on a demonstration project;
- To show what statutory requirements have been met; or
- To lay a factual basis for the defense of law suits in which due process may be an issue.

OPERATIONS PLAN

The operations plan provides guidelines and procedures for (1) actions leading to project installation and (2) project operations. The operations plan usually consists of two elements:

(1) highway operations

(2) transit operations.

Each of these elements* normally is prepared by the agency which will be responsible for carrying out the activities described in them. Figure 8 on the following page illustrates operations activities throughout the project development process.

Basic Requirements

The development of the Operations Plan should be an iterative process, work upon which must begin at the earliest possible stage of detailed project planning, and which may well have begun at the sketch planning stage.

The way in which the project is expected to perform and the results which are expected from it must be clearly understood by those who are preparing the Operations Plan. Known constraints--such as funding limitations and controlling policy determination--should also be identified.

The timing of project activities may be the most critical aspect of operational planning. If done well, few will notice it. If done poorly, it may predestine the project to failure.

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*Often para-transit is distinguishable as a separate third element. However, for reasons of simplicity, only two elements are treated in this section, para-transit operations being included in the transit element.

Figure 8
OPERATIONS PLANNING ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Determine general highway, transit, and paratransit operational responsibilities for various project alternatives. Develop preliminary service estimate costs for project alternatives.
Project Planning	Review general requirements for timing, plan revision methods and operating objectives for the project. Develop a plan for carrying out design, installation, and operations.
Design	Prepare and integrate separate designs for highways, transit (and if needed, paratransit) project components.
Installation	Install project components according to staging plans.
Operations	Conduct day-to-day operations.
Evaluation	Modify operations as needed.

In developing the time schedules contained in the plan, it is necessary to make sure that: (1) activities come on line in proper sequence and, (2) the activities of the participating agencies are timed so as to interface properly.

While it is obvious that transit operations on a reserved lane cannot start until the physical facilities are ready for use, it may not be equally obvious that a physical facility should not be completed and lie idle awaiting some other event.

It is also best to open a project involving reserved lanes by setting long hours of operation and the highest occupancy requirements. It is easier to back-off at a later date if needed than to increase hours of operation or the carpool occupancy requirement.

Experience also shows that it is better to allow enough preparation time than, for political or other reasons, to set unrealistic time schedules that either cannot be met or which result in unsatisfactory improvisations.

The operations plan is not a static document. It must be adjusted and revised as a result of routine supervisory observations, data supplied in the evaluation process, development of new concepts and techniques, unanticipated delays, and other factors. Each of the operational plans should contain procedures for its revision.

Part 1: The Highway Operations Element

The highway (freeway, street, etc.) element of the operations plan is concerned with: (1) the physical changes, including new construction, which must be made in the highway system before a preferential treatment project can begin; (2) installation of required traffic control devices; and (3) the operation and maintenance of highway-related facilities.

The highway agency responsible for the highways and streets to which the priority treatment facilities are linked normally is responsible for the preparation of this portion of the plan. When two or more highway agencies are involved, close cooperation will be necessary, both in planning the interfacing of various facilities, and in obtaining maximum system efficiency during the operational phase of the project.

A. Physical Facilities. From the project definition, the highway engineer determines how the project can operate most effectively and identifies the specific facilities that are required. The engineer then prepares preliminary design plans, outline specifications, and preliminary cost estimates for each of these facilities. These are finally brought together in an installation plan consisting of: (1) a production schedule; and (2) a capital budget for highway-related work items.

B. Operational Planning. The engineer must not only design the physical facilities for the highway and street segments of the project, but must also provide the operation instructions necessary to fit these facilities into overall project operations. The operating instructions should prescribe:

(1) The periods during which various facilities will be operated as a part of the project.

(2) The types of vehicles which will be allowed to use these facilities. This may vary on the same facility (i.e., carpools 2 or more on ramps and carpools 3 or more in reserved lanes), but the public often finds such variances confusing.

(3) The rules by which facilities will be operated (a) during their designated periods of operation and (b) if appropriate, when they are not being operated as a part of the project.

(4) Who is responsible for the operation of these facilities. This may not be necessary if the facilities require no operating attention.

(5) The maintenance program, including levels of maintenance and the designation of the agency or agencies responsible for maintenance.

(6) A designation of the traffic regulations or ordinances to back up the plan.

This part of the highway operations plan may be simple. In the case of a concurrent bus-only lane on a city street, the whole plan may take the form of statements that: (1) the lane and associated parking and turning-movement restrictions are in effect at all times; and (2) the city departments responsible for street maintenance and traffic control devices shall make routine inspections, and perform necessary maintenance as for any other part of the street system. As simple as they are, these statements contain sufficient information and fix responsibility accurately enough to reduce the possibility of later misunderstandings.*

At the other extreme, the project may provide for a traffic operations center, which receives information from an array of meters, detectors, and visual scanners and responds in terms of changes in metering rates and speed limits, changes in sign messages, and the dispatch of enforcement, maintenance, road service, and emergency units. In such a situation, the operating instructions will be equally complex.

Within this broad range of possibilities, engineers should use their knowledge and experience to establish both general and specific guidelines for the operation and maintenance of the facility.

This part of the Operations Plan should include four additional components: (1) identification of traffic regulations or ordinances which

*In addition to this set of instructions, separate instructions cover: (1) the operation of transit vehicles over the facility; and (2) enforcement activities.

should or must be changed; (2) the procedure for revising the operating instructions; (3) an installation schedule; and (4) an operating budget for this segment of project activity. The budget period and data requirements will be determined by the organization responsible for budget preparation and administration.

Part 2: The Transit Operations Element#

The transit operations element of the Operations Plan is concerned with: (1) the design of the transit services to be provided; (2) new construction; (3) bus purchases; and (4) day-to-day operations of project services.

The transit agency which provides urban mass transportation service within the project area is normally responsible for the preparation of this element. If more than one carrier is involved, each will plan the service it is to provide. However, there must be a close collaboration among the carriers in the development of their service designs to eliminate gaps and overlaps in service areas and to achieve reasonable consistency in service levels, fares, and similar matters. Consideration should be given to the coordination of service through: (1) the establishment of joint fares or the extension of transfer privileges; and (2) the development of coordinated schedules and bus stop locations at potential transfer points.

#In this manual it is assumed that transit services will be provided with transit buses. Where paratransit services are involved, that portion of the plan will follow generally the outline for transit services. Detailed reports on carpool/bus operations are available through the FHWA Office of Highway Planning--Transit and Traffic Engineering Branch, Washington, D.C., 20590, HHP-26 and UMTA Service and Methods Demonstrations, Washington, D.C. 20590, UMD-20.

If service areas are to be expanded, problems may arise in connection with territorial rights. These should be resolved as early as possible in the planning period.

A. Service Design. When new or expanded transit services are to be provided as part of a preferential treatment project, the service design is likely to be both the most difficult and the most significant phase of transit operations planning. When service changes are not contemplated, this part of the plan is unnecessary.

The service design begins with the assembly of planning and market data needed to: (1) describe the market; and (2) estimate transit demand. In many instances this data will already be available in the transit agency or from regional and local planning agencies and may actually have been assembled as part of the sketch planning process. Additional data may be available from private sources, such as Chambers of Commerce and major employers. To the extent that time and funds permit, gaps in the available data may be filled through special surveys.

The project definition should indicate the general area to be served and the kinds of trips the project should be designed to attract. With this as a base, and through the use of data regarding land use, origins and destinations, residential densities, income levels, and the locations of major traffic generators--the target market is delineated and described.

The planner then develops an estimate of the potential demand for services aimed at the target market and, in turn, refines this into what is judged to be an achievable objective for transit patronage.

The planner next puts together a service package which is believed to be sufficiently attractive to the target market that the patronage goal can be attained. The service package may include:

- Express and local service routes;
- Levels of service and schedules
- Fare structure, including transfer arrangements;
- Bus stop locations
- Transfer points
- Park-and-ride and terminal facilities; and
- Passenger amenities, such as special services, vehicle design features, bus stop shelters, distinctive bus stop signs, etc.

The final step in the process is the preparation of an operating statement for project services, by fiscal year, for the duration of the project or five years, whichever is the lesser period. The operating statement, as a minimum, should contain estimates of revenue passengers, miles of revenue service, passengers per mile, operating revenues by source, operating expenses by standard expense categories, and operating surplus or deficit.

B. Physical Facilities and New Bus Purchases. The provision of physical facilities and the purchase of new buses both require significant capital expenditures and long lead times.

The provision of major park-and-ride facilities can easily take twelve months or more. This is because of the time involved in site selection, public hearings, environmental impact statements, possible rezonings, and land acquisition procedures, as well as actual construction.* The other

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*Park-and-ride lots, particularly those located adjacent to freeways, may be the responsibility of the highway agency.

physical facilities for which the transit agency may be responsible, such as the purchase and installation of bus stop signs and shelters, are usually much less complex and will require less lead time.

The planner or engineer then prepares preliminary designs, outline specifications, and preliminary cost estimates for each of these facilities.

When a final site has not been selected for a major facility, such as a park-and-ride lot, only conceptual plans and highly tentative outline specifications and cost estimates will be possible. The plan should outline the criteria for site selection and, if possible, indicate possible alternative sites.

When facilities such as bus stop shelters are involved, the plan should outline the criteria for their placement and indicate the location of each.

The purchase of new transit buses is also a long lead-time item. Delivery, depending upon manufacturers' back-logs, average about eighteen months. Beginning with a decision on the requirement, and assuming that Federal financial assistance is sought, the whole process can require two years before the first bus arrives on the property.

In some cases, project bus requirements can be met from the existing fleet through redeployment and by postponing the sale of vehicles under the transit agency's bus replacement program. If this cannot be done, the plan should indicate:

- The number and size of buses to be purchased;
- Any special features desired because of the use in project operations;
- Estimated cost, including delivery and conditioning; and
- Estimated delivery dates.

The various capital items under this heading should be brought together in: (1) a Production Schedule; and (2) a Capital Budget for this segment of project activity.

C. Operation of Project Service. The final part of the transit element of the Operations Plan involves the operation of project service. The scope, complexity, and level of detail required here will depend upon the particular project and the number of situations which may occur in which the procedure is different from that applicable to non-project situations.

The list in Table 15 consists of items to be considered in developing the plan. Some items might be inapplicable, either because the situation does not exist for a particular project or because a standard operating procedure is available.

This part of the Operations Plan should include three additional components: (1) the procedure for revising the operating instructions, (2) an implementation schedule, and (3) an operating budget for this segment of project activity. The budget period and data requirements will be determined by the organization responsible for budget preparation and administration.

Table 15

OPERATIONS PLAN: ELEMENTS RELATED TO OPERATION OF PROJECT SERVICE

- Equipment availability, including plans for the redeployment of vehicles in the existing fleet and for the retention and use of vehicles which ordinarily would be sold under the transit agency's bus replacement program.
- Equipment assignment, in the event that project vehicles are pooled separately or where only specified vehicles may be used in project service.
- Bus operator assignments, including consideration of whether to have a special pick or operate off the extra board until the next regular pick and the need for additional recruitment.
- Bus operator training to familiarize operators with the project service and the physical and operating characteristics of the priority treatment facilities.
- Preparation of route maps and schedule cards for employee use*.
- Fare collection procedures.
- Dispatching procedures
- Communications.
- Street supervision, including supervising and assisting in the use of priority treatment facilities, schedule checks, passenger counts, complaint investigation, accident investigation, and action in the event of breakdowns, accidents, or other interruptions of service.
- Procedures for handling breakdowns.
- Special maintenance and vehicle service requirements.
- Special reporting and record-keeping requirements.
- Joint actions with highway and enforcement agencies.

*Public timetables and transit maps are covered in the Marketing Plan.

THE ENFORCEMENT PLAN

Most priority techniques involve a rearrangement of physical facilities and a revision of operating practices. As a result, users must face new situations and learn new rules. Thus, for the techniques to produce their intended effects, users must modify their behavior significantly. An effective and fair enforcement effort is a key element in this process (Figure 9 illustrates the Enforcement Planning Activities).

Factors In Achieving A Successful Enforcement Plan

The most significant factor in achieving a successful enforcement program appears to be early involvement in the planning process by representatives of the enforcement agencies affected. Such early involvement will ensure consideration of five key elements of a sound enforcement plan.

A. Good Enforcement Design. One of the most serious requirements of good enforcement requires not just a good enforcement design but also a good safety design. In project planning, enforcement officers, who possess a wealth of knowledge and practical experience in traffic regulation and enforcement and safety-related matters, can make an important contribution.

B. Promotion of Cooperative Relationships. Early involvement in the initial planning "...gives each agency a feeling of importance and proprietorship in the project and thereby provides each agency with an impetus for the development of a successful project."[8] Ideally, all projects should be designed to maximize ease of enforcement. Though that is not always possible, if enforcement personnel play a meaningful role in the planning process, they will more likely understand and accept project team design decisions which compromise enforcement. Conversely, the enforcement agency can educate the rest of the

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Figure 9
ENFORCEMENT PLANNING ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Involve potential enforcement agents early in the planning process. Determine enforcement feasibility implications for various project alternatives.
Project Planning	Determine specific enforcement agency requirements. Resolve any legal problems associated with the project. Develop an enforcement plan and integrate into project plan.
Design	Provide for an enforcement agency review of project design plans.
Installation	Prepare for initial enforcement efforts.
Operations	Determine the level of continuing enforcement efforts.
Evaluation	Collect enforcement data on violation rates, safety and costs.

project design team to the true costs involved in design elements which adversely affect enforcement, long before the final design decisions are made.

C. Provision of Technical Advice. Because of the police officer's familiarity with motorists and pedestrian behavior, enforcement personnel can provide valuable advice on signing and striping schemes.

D. Personnel Planning. Since enforcement activities may require more manpower than is already available, early involvement of the enforcement agency allows time for the recognition of this need in its budget proposals or in plans for the redeployment of existing staff.

E. Investigation of Legal Restrictions. Police officers and local government attorneys are quite knowledgeable about "...possible judicial tendencies regarding various traffic operational schemes."[9] It would be pointless to design a detailed enforcement procedure if the judicial system will fail to uphold citations issued by patrolling officers. Project team personnel must determine if there is legal authorization for project activities, inform judges about the project, if necessary, and secure changes in legislation necessary for successful operation.

Reasons For An Enforcement Plan

The scope and level of detail of the Enforcement Plan should be related to the complexity and specific characteristics of the project. Yet even for relatively minor treatments, the development of a written set of enforcement procedures is advisable, for four reasons:

(1) Field officers responsible for day to day enforcement are often not the same officers who have been directly involved in the planning effort;

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(2) A well-documented, comprehensive Enforcement Plan may assist in the defense of the project aganist legal challenges;*

(3) The Enforcement Plan lets other project operating personnel know what to expect from enforcement officers; and

(4) The activity of developing the plan may in itself highlight previously unanticipated problems which can then be resolved by the project team before project installation. (The Manual should also be revised as appropriate once operations have begun).

Authorship/Participation In Plan Development

Much of the information to be contained in the Enforcement Plan (see outline of plan below) has either already been collected during the Sketch Planning phase (maps of project area) or decided upon by the project team which includes enforcement officers (operating policies, evaluation reporting procedures).

Writing the enforcement procedures should not be difficult, since they are based upon standard enforcement tactics. Pulling all this information together into an Enforcement Plan can be the responsibility of a subcommittee of the planning team, the team itself, or an individual. Unless the project is extremely complex, one or two person-weeks should suffice.

Writing The Enforcement Plan

There are no uniform guidelines for the content of the enforcement plan. The plan must be tailored to the individual project. As more projects using the same techniques are implemented in an urban area, it will not be necessary to repeat the entire process. The original plan can serve as a basis

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*A suit against the Blue Dash project in Dade County was dismissed largely because the enforcement manual, along with the accompanying project documents showed to the judge's satisfaction that the County and State acted responsibly.

for subsequent plans. Table 16 provides suggested components.

General Enforcement Considerations

First, the experience of those who have already implemented priority techniques seems to clearly indicate that it is much better to have strict enforcement at the outset of project operations than to under-enforce. If there is concern that the public may need time to become accustomed to project operations, then violators should be issued warnings. A two-week period of warning citations has been sufficient in most instances to educate regular users.

When enforcement has been "soft" during initial project operations, violation rates have remained quite high, with enforcement being more difficult than in cases when it was highly visible from project commencement.

Second, during project design, attention should be paid to the provision of vehicle storage areas easily accessible from points of possible violation. Even though this cannot always be done, project design personnel should recognize the difficulty of an enforcement officer having to pull a violator over from an inside lane to the right shoulder. This maneuver can itself cause an accident.

Third, several areas have statutes which allow only the officer witnessing a violation to issue a citation. Since such statutes have serious impacts on enforcement schemes, they should be investigated by the project design team. If no such statutes exist or apply, then local jurisdictions may contemplate some unusual enforcement techniques that have been applied elsewhere.

Table 16

SUGGESTED ENFORCEMENT PLAN OUTLINE

I. DESCRIPTION OF PROJECT

A. Brief statement of objectives of project and purposes of project elements. List participating agencies and outline their responsibilities.

B. Physical Features
   1. Cross-sectional diagrams showing lane configuration
   2. Map of project area
      a) Show clearly geographic boundaries and jurisdictional limits if more than one enforcement agency is involved.
      b) Show location of special traffic procedures and/or restrictions (e.g. no left turns or special cross-over signals for buses to enter contra-flow lane).

II. SYSTEM OPERATIONS

A. Operating Policies--This section should clearly and concisely deal with operating regulations. These might include:
   1. How many vehicle occupants constitute a carpool?
   2. What types of vehicles will be granted priority? (municipal buses, inter-city buses, emergency vehicles, taxis, trucks, etc.).
   3. Restrictions should be clearly defined, for example, only passenger vehicles with no more than 2 axles and 6 tires, having 3 or more occupants will be allowed to use priority lanes.

B. Operating Hours--Specify times of project operation, distinguishing between various elements if necessary. State policy on holidays and define procedures for individual officers to be apprised of special circumstances, for example, "project operates during State holidays, but not on National holidays".

C. Personnel Levels--Briefly specify nature of agreement between enforcement agency and project sponsoring agency.
   1. Are there a certain number of officers to be assigned specially to the project or is this to be included in routine patrol duty?
   2. If specially assigned, are any officers to remain at particular intersections throughout project hours?
   3. If special services such as police helicopters will be used, instruct enforcement personnel on how to contact these services.

Table 16 (Cont.)

III. ENFORCEMENT PROCEDURES

Project sponsors should understand that no matter how specifically procedures are spelled out, individual officers will often have to rely upon their own judgement, particularly in emergencies. However, in order to maximize the effectiveness of those officers, certain guidelines should be established.

A. Routine enforcement procedures--Detail specific procedures for enforcement, relating them to various project elements.
   1. Violations--Outline general categories of violations to be expected and the penalties for each.
   2. Standard operating tactics--This section should cover routine enforcement procedures, such as:
      a) Whether violators are to be pulled off the roadway or reports of violators radioed ahead to officers "downstream" (depends on average speeds, level of congestion, level of enforcement manpower, etc.);
      b) If project involves priority lanes with special entry/exit points, the role of the officer assigned to each location; and
      c) Special activities related to beginning or ending daily project operations, e.g. special escort for signing crews or "flushing" the lane.

B. Procedures for possible malfunctions--This section should cover malfunctions of various project elements. Information should include:
   1. Bus breakdown
      a) Removal of disabled buses (whether next bus should push immobile vehicle to storage area or towing company or emergency crew should be called, Phone Number________________).
      b) Notification of transit agency (Phone Number, whether extra bus available)
      c) Procedures for transfer of passengers
      d) Rerouting of following buses
   2. Other vehicle breakdown
      a) Removal of disabled vehicle
      b) Traffic rerouting
   3. Equipment malfunction or damage
      a) List proper agency and phone number for major types of malfunction or damage.
      b) List any special interim procedures to be followed until malfunction corrected.

C. Emergency situation guide
   1. List any departures from normal policy for dealing with accidents and other emergencies
   2. Give guidelines for determining if project operations must be temporarily halted due to accident or other emergency.

D. Reporting procedures--Coordinate with evaluation team to see if special reports are to be filed by enforcement officers regarding accidents, vehicle breakdowns, signal malfunctions or other problems and the subsequent action taken by the officer. Explain the purpose for such reports. If a special form is to be used, it should be developed during the planning phase in conjunction with enforcement officials. Include copy of form and any special instructions in enforcement manual.

E. Special intersection considerations--If there are significant changes in operating policy planned for particular intersections (rerouting of traffic due to turn prohibitions, changes in signal operations, etc.) small maps of those intersections indicating the new procedures should be provided.

IV. REFERENCE INFORMATION

Even if phone numbers related to various questions or problems are given elsewhere in the text, it is a good idea to have a special section that can be referred to quickly. It should list the situation, person to be contacted and the phone number. For example:

A. <u>Signal malfunction</u>

   - Mr. Jones - Traffic Engineering Department
     Phone number:

B. <u>Public inquiries</u>

   - Ms. Smith - Project Coordinator
     Phone number:

In Singapore, police officers cite violators of the congestion pricing program by simply dictating a description of the violation and violator's license plate into a small tape recorder. Citations are mailed later. Other jurisdictions have used automatic surveillance cameras which snap pictures of violators. Techniques of this kind not only improve the labor productivity of enforcement personnel, but serve to apprehend violators at considerably less risk to police officers.

PUBLIC EDUCATION AND MARKETING PLAN

The installation of a priority treatment project--particularly one involving reserved lanes--is not an everyday occurrence. It can easily be misunderstood by an uninformed or misinformed public. The potential users of project services must be made aware of those services and how to use them. Thus, there are two reasons for preparing a public education and marketing plan:

- To disseminate information on project objectives, facilities and services to the general public; and
- To market the bus and carpool services of a project.

Basic Requirements

There is an important distinction between the community involvement plan and the public education and marketing plan. While the community involvement plan is aimed at getting the representatives of the affected public involved in planning activities, the public education and marketing plan is aimed at informing the rest of the public about project activities and encouraging use of project services and facilities.

Figure 10
PUBLIC EDUCATION AND MARKETING PLANNING ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Collect market research data for various project service alternatives.
Project Planning	Identify target audience(s) for public education and marketing project activities. Determine public education and marketing objectives. Conduct market research for developing project services. Establish a unified strategy for marketing project services.
Design	Review and develop public education and marketing action plan as designs become final. Develop transit maps and schedules.
Installation	Conduct pre-installation public education and marketing activities. If necessary, collect pre-installation information on public attitudes toward project.
Operations	Continue public education and marketing efforts throughout project operation to achieve objectives. Revise action plan as service or other changes are made. Collect post-installation marketing data (surveys, customer service requests, etc.)
Evaluation	Analyze post-installation marketing data and revise project services as data evaluation indicates.

Project public education and marketing activities might be integrated with general transit and carpool marketing programs for the area involved. These programs vary from jurisdiction to jurisdiction, and even within the same jurisdiction. Figure 10 includes a summary of suggested public education and market research activities during project development.

What Should a Public Education and Marketing Plan Do?

Public education should be oriented towards providing facts. Facts which the public needs to be aware of include:

- The objectives of a project and its context within regional/city plans and programs;
- The location of project facilities;
- How to use the project facilities (e.g., what constitutes a legal carpool, what lanes to use, turning or access restricted locations);
- The operating hours of project facilities;
- Who or what agency to contact in the event of questions concerning the project; and
- What new traffic regulations will be enacted.

Press releases, public service announcements, posters at public places, and (if aesthetically acceptable to the community) billboards along heavily traveled streets are just a few examples of the many ways to bring these facts to the attention of the public. In addition, making presentations to special interest organizations (PTA groups, Chambers of Commerce, downtown business groups, and so forth) can be an effective means of disseminating facts about project operations with the added benefit of getting immediate feedback.

Marketing takes public education one step further. In addition to providing information, its primary purpose is to encourage the use of the project facilities and services. Marketing is also more than advertising and promotion. As the Urban Mass Transit Administration (UMTA) Transit Marketing Management Handbook: Marketing Plan points out, marketing includes four major functions:[10]

- Market Research*--This entails gathering the information needed to identify the travel needs and demographic characteristics of the user group(s) of a project. This should be collected prior to defining the user services. If the user group primarily includes people who will be riding in buses or carpools by choice rather than by necessity, or vice versa, the approach to developing project services should reflect this fact. Much of the raw data needed for market research can be collected in the Sketch Planning phase.

- Service Development*--On the basis of market research, it should be possible to develop project services which address the needs of potential users.

- Advertising and Promotion--Having defined project services tailored to the potential users, the next step is to let the users know the details about the services to be provided. This activity can be accomplished using some of the same methods cited previously for public education.

- Customer Service--This involves setting up the mechanism(s) whereby project users will be able to request information on or changes in project services and facilities.

The preceding four elements are applicable to the marketing effort for a priority treatment project, though not all will necessarily be of equal weight.

Until recently, transit marketing programs were usually oriented toward existing rather than new riders. The marketing effort rarely went beyond publishing route and schedule information. Carpool promotion, which is not generally handled by the transit agency, also was usually left to individual employers, with occasional public service announcements in the media.

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*Both market research and service development overlap with activities which are described in the "Operations Plan".

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The changes in transit service and carpooling brought about by most priority treatment projects make it necessary that a more aggressive approach to marketing be developed.

Before the marketing portion of the public education and marketing plan can be prepared, service development decisions should be made covering:

- Project objectives;
- The type of priority technique to be utilized;
- The types of vehicles to use the project;
- Operating hours;
- Target market auxiliary services such as carpool matching and park-and-ride lots; and
- Destinations served.

Representatives from marketing programs for transit and carpooling should be able to provide input on the marketing consequences of such decisions before they are made.

During the Project Evaluation phase, the analysis of marketing data should be one of the factors considered in making adjustments to project services.

Expected Benefits

The UMTA marketing handbook identifies various benefits which can be derived from a marketing plan, including:[11]

(1) The marketing unit can coordinate, focus, and set priorities for each of its activities through the plan;

(2) The plan can provide the marketing unit with an excellent means of communicating its analyses, goals, strategies, and resource requirements to top management;

(3) The plan, upon approval, can become the formal management tool for marketing management (i.e., the program can be directly translated to an implementation or action plan); and

(4) The plan can serve as the basis upon which the performance of the marketing unit is evaluated.

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While the document referred to is oriented more to general transit marketing programs, the benefits could also apply to a marketing plan prepared for a priority treatment project. In addition, a project marketing plan can:

- Document marketing resources, particularly important if Federal or State money is being used;
- Highlight areas in the general transit and carpool marketing program which dovetail with specific project activities, maximizing coordination and the effectiveness of each; and
- Inform other project participants of what to expect from the marketing program.

Preparing a Public Education and Marketing Plan

A formal document outlining the public education and marketing plan should be prepared when the design of project facilities and services is completed and approved by decision makers. Table 17 shows the possible contents of a public education and marketing plan for a complex project. Figure 11 shows a sample marketing brochure developed for the Portland, Oregon Banfield Project.

Since no two projects are alike, the level of effort applied to preparing a public education and marketing plan will vary significantly with the type and complexity of a project. For example, a project consisting only of a reserved concurrent flow curb lane along a short street section in an urban center will not require the marketing effort of a contra-flow freeway project supplemented with carpool staging areas, park-and-ride lots, and new bus services.

Table 17

SUGGESTED PUBLIC EDUCATION
AND MARKETING PLAN OUTLINE

- OBJECTIVES

  These are based on project objectives and should be quantified, time specific and attainable. (e.g. provide carpool matching, bus route schedules and fare information in 50 percent of the retail businesses in the market areas served by the project by Sept. 30, 1977.)

- SUMMARY OF MARKET RESEARCH FINDINGS

  - who the users are (e.g. choice vs. transit dependent)

  - where they are located

  - what their travel needs are

  - data sources used (e.g., origin-destination surveys of market audience; census or other socio-economic data sources; on board transit surveys; and attitude surveys of market audience.

- ALLOCATION OF RESPONSIBILITIES

  - determining who or what agency will coordinate the traffic/bus/carpool public education efforts.

  - determining whether or not buses and carpools should be marketed together. In the past buses and carpools have been viewed as competitive. However, there are four compelling reasons why buses and carpools might be marketed together for priority treatment projects:

    1) Both modes contribute to the attainment of air quality and energy conservation goals.

    2) Carpools are more cost effective at serving low density areas than buses.

    3) Bus service can complement and add more flexibility to carpooling as an alternative when carpoolers must work late or a regular driver is unavailable.

    4) Carpooling can be an incremental step to regular transit usage.

Some of the individual elements of the project marketing plan will relate only to carpools or only to transit, and these should be assigned to the appropriate agency. However, in the view of the public, a priority treatment project which features both carpools and transit is still a single project. Advertising and promotion efforts to make the public aware of the project and its goals should be appropriately coordinated. Figure 11 shows a marketing brochure developed for the Portland Banfield project which markets buses and carpools together.

- SUMMARY OF THE BUDGET AND SOURCES OF FUNDS OR FREE SERVICES

  - How much should be spent. This can be done by three methods:

    1) subjective budgeting based on management judgment

    2) percent of sales budgeting based on a percent of fare box revenues (service firms average 2 to 4 percent, while manufacturers average 10 to 20 percent of marketing budget to sales)

    3) task budgeting (the approach recommended by UMTA) which is done by estimating the resources needed to meet each objective

    Even if the over-all marketing budget is determined by one of the first two means, a marketing plan budget for priority treatment proejcts is quite amenable to task budgeting. The marketing objectives of a particular priority treatment project should be quite specific and measurable. Marketing professionals in the transit and carpool agencies should be asked to provide estimates of the resources required to meet those objectives.

  - Private sources (e.g. downtown businessmen, other local interests)

  - Public sources (e.g. Federal, state and local sources)

  - Media public service obligations for public education and marketing*

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*There is free public service announcement time, subject to Federal Communications Commission regulations, which radio and television stations must allocate to qualified public agencies. This should be thoroughly explored for priority treatment projects since it may reduce the costs of the marketing and public education effort substantially. The Deleware Valley Regional Planning Commission, Penn Towers Building, 1819 J.F. Kennedy Blvd., Philadelphia, Pa., Phone (215) 567-3000 has developed several public service announcements related to computer-based vanpool services. The City of Houston has also developed ride-sharing announcements through the Office of Public Transportation, #1 Allen Center, Suite 1845, 500 Dallas St., Houston, Texas 77002, Phone (713) 222-5217.

Table 17 (Cont.)

- •• Press releases.

- A CONTINUING MECHANISM FOR MEDIA RELATIONS

  The media--which may include newspapers, radio and television--are the primary vehicles of public education and may have a significant impact on the public acceptability of projects.* If a project is good the media can serve to generate support for it. Vice versa, if a project is bad, or perceived as bad, then the media can serve to stimulate public outcry against a project. The best way to deal with the media is to develop an open and positive relationship with its representatives. Keep the media well informed of all noteworthy project developments, including the bad news, if there is any. If this is done well, things should work out in the best interests of the public.

- PRE-INSTALLATION ACTION PLAN

  - a description of the specific public education and marketing actions by agency and the timing of each activity.

- CONTINUING POST-INSTALLATION ACTION PLAN

  - a description of the continuing public education and marketing activities.

  - a description of the mechanism for answering public questions on facilities and services and requests for changes in facilities and service.

  - a description of marketing and public education evaluation procedures not covered in the project "Evaluation Plan".

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*See the Santa Monica Diamond Lane Case Study.

Figure 11
PORTLAND-BANFIELD MARKETING BROCHURE

Your tax dollars are building a better Banfield.

As you can see, the Banfield is going to be an entirely new place to drive when this project is completed . . . but all good things take time. So, we hope you'll all bear with us during the next three months and be as patient as you can through any delays or inconveniences you may experience. We promise to get the work done just as fast as we can and to keep at least two lanes open during the day and one at night.

TRI-MET
TELEPHONE
233-3511

OREGON STATE HIGHWAY
OFFICE OF
METROPOLITAN
ENGINEER

CARPOOL
TELEPHONE
227-7665

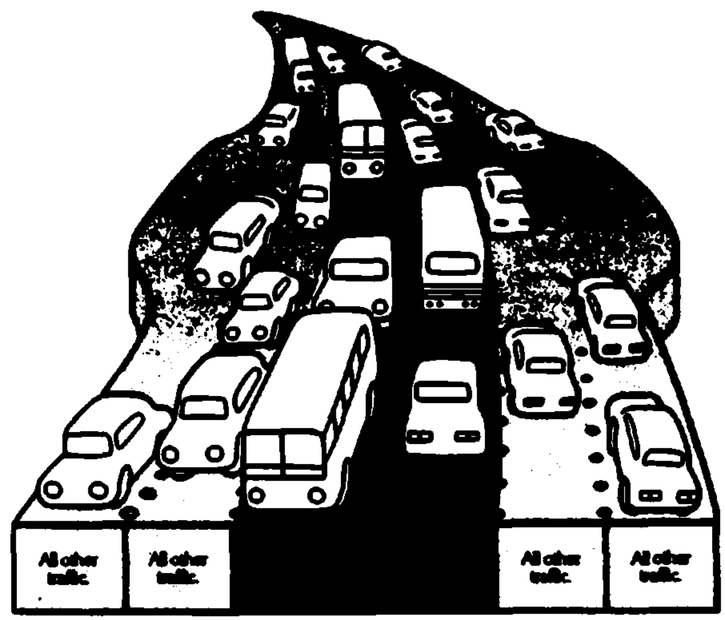
We're going to make it easier and faster for you to drive the Banfield.

If you drive the Banfield, you're aware of all its problems . . . congestion, ruts in the road, deep pools of standing water during rainstorms, washed out white lines that make it hard to see where the lanes are . . . and more.

When the people who plan freeways are faced with a situation such as this, there are several options Doing nothing obviously would solve nothing. Building a totally new freeway would take too long to implement. Adding a conventional third lane would only fill to capacity, further increasing congestion.

Since the Banfield has been scheduled for total resurfacing, we've decided to take advantage of this construction to exercise another option. We're going to conduct an experiment which hopefully will solve many of the problems at a relatively low cost in a short amount of time.

The most noticeable improvement that will be part of the new program is an experimental express lane, reserved exclusively for buses and carpools with at least three people to a car. Since the express lanes will operate all day, ▶



EVALUATION PLAN

Figure 12 illustrates evaluation activities which should occur during the project development process. The Evaluation Plan process has often been overlooked in the design and implementation of a priority treatment project.

Basic Justifications

There are three basic reasons why evaluation is an important component which should be developed as an integral part of any priority treatment project.

A. "Fine-tuning" the Project. The data gathered for the evaluation can be valuable indicators of adjustments that need to be made in on-going project operations. There may be a number of options available to the project planner during project design, including changes to service levels (e.g., bus headways, feeder bus vs. park and ride), physical configurations (e.g., lane separators vs. overhead signing), and user definition (e.g., how many people constitute a carpool?). When more than one option seems possible, a staged implementation, with careful assessments of each phase, can make "fine-tuning" the project an easier task.

B. Project Assessment. A careful evaluation is the only sure method of determining whether or not the project meets its stated objectives. Public officials need information upon which to base a decision of whether or not to continue the project. Because such projects entail giving priority to a certain class of users, there are often criticisms from other users of the project facility who are not given priority. A good evaluation will enable transportation officials to assess those criticisms intelligently, and either refute the objections, dismiss them, modify the project, or cancel it.

Figure 12
EVALUATION PLANNING ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	Relate sketch planning goals to evaluation requirements.
Project Planning	Identify technical and non-technical (political and social) evaluation requirements on the basis of project objectives. Relate evaluation requirements to specific project objectives. Specify a time-table for evaluation.
Design	Modify evaluation plan if required by design changes.
Installation	Collect pre-project data as needed.
Operations	Collect post-project installation evaluation data. Make project modifications as evaluation analysis indicates.
Evaluation	After the specified evaluation period expires, determine whether project is to continue. If so, set evaluation intervals and continue to collect data and evaluate it if needed.

C. Project Documentation. The whole field of priority treatments for high occupancy vehicles, while not new, is still experimental. Local governments contemplating such treatments face a large number of unanswered questions concerning the best ways to design and implement priority techniques. More precise design standards, warrants and justifications can only be developed through assessment of projects that have already been implemented. Both the Urban Mass Transportation Administration and the Federal Highway Administration have made funds available to assist local governments in the evaluation of priority treatments.

Local governments today face severe budgetary constraints. Good documentation of new projects (successes and failures), properly disseminated, will enable each succeeding project to profit by the experience of others. Hopefully, the end result will be reduced implementation and operating costs with increased effectiveness for later applications.

Designing An Evaluation Plan

To be sure that all participants in the priority treatment project understand evaluation requirements, a plan containing several steps may be needed.

Step 1: List Goals, Objectives and Possible Impacts. By now, there should be a set of goals and objectives agreed upon by project participants.* Both technical and non-technical (e.g., political and social) objectives should be clearly identified. In addition, the project team should attempt to enumerate all the project impacts that can be anticipated, both favorable and unfavorable.

*The establishment of general sketch planning goals has been dealt with earlier in Part II, Section 1.

This should include items such as diversion of traffic to alternate routes, air pollution, safety, and impacts upon businesses adjacent to the project. An exhaustive list will allow the project to be evaluated thoroughly, and objections which may surface after project operations commence to be addressed in an informed manner.

Step 2: Determine Evaluation Timetable. The success of many priority treatment projects depends on the behavioral changes they induce. Desired changes will not be likely if the public perceives the project as a temporary experiment. It generally takes several months for traffic patterns to stabilize following the implementation of a priority treatment project. The evaluation timetable should reflect this point.

As a general rule, no less than six months should be allowed before a judgement can be made on the success or failure of a project. However, for major projects, because of weekly, monthly and seasonal variations, a year of project operations should be allowed before a final evaluation report is done. In the interim, evaluation data should be provided quickly to the operators or implementation team, political decision makers, and the public.

Step 3: Decide on Evaluation Reporting Scheme. The plan should call for a decision to be made on procedures to assure that the data gathered will be quickly recycled back to the project participants. Depending upon project scope and the stage of implementation, full reports prepared for team meetings may or may not be necessary; charts indicating selected indices, such as lane occupancy, travel time, and accidents may well suffice. Significant project data should be made available to policy makers on a regular basis so that incipient problems can be identified and dealt with in the early stages of implementation.

Step 4: List and Explain the Individual Data Collection Elements. Step 1 was to list goals, objectives and possible impacts with which the project is concerned. This step anticipates collection of more detailed data. The following information should be provided for each objective/impact:

- What data is to be collected;
- Why this data is necessary (sample size);
- Specific procedures to be followed;
- Agency responsible (estimate person-hours required);
- When "before" data is to be collected;
- Duration and frequency of collection period following project start-up (e.g., travel times will be tested during morning and afternoon peaks each day for one week, second week of every month for one year); and
- Estimated cost of each work item.

Step 5: Determine Evaluation Budget. Determining the evaluation budget can be difficult. On the one hand, there is pressure to trim evaluation costs and spend the money on project operations. However, changes in travel behavior are often subtle, and there are many factors exogenous to the project that also influence behavior. It is important, therefore, to devise a comprehensive program, taking care to draw the boundaries of the study areas broadly enough to include all that area that is impacted by the project. Probably the best way to determine the evaluation budget is to examine all the impacts and objectives, decide which are important enough to monitor, determine the measurements to be taken for each, and cost them out roughly.

It is not practical to provide a rule-of-thumb percentage of total budget that should be devoted to evaluation. Evaluation costs in the same metropolitan area have exhibited wide variation. The scope of the evaluation may depend on the impacts the project will have on users and non-users. For example, the evaluation effort for one bus and carpool bypass ramp might have a considerably narrower focus than a concurrent flow exclusive lane for carpools and buses coupled with an area-wide carpool matching program. The level of detail might also relate to whether the project involves new approaches, or uses some of the better-documented techniques.

ADMINISTRATIVE PLAN

The purpose of the Administrative Plan is to assure that necessary administrative functions are performed adequately and the time and effort expended on them are minimized. The principal administrative functions are:

- The making of organizational arrangements;
- Budget preparation and administration;
- Personnel management;
- Accounting; and
- Procurement.

Many projects will require no special administrative arrangements beyond an understanding of the assignment of responsibilities and some more or less formal means of coordinating project activities. At the other extreme is the project for which a separate special purpose agency is established to perform all or most of the project activities. The Administrative Plan must reflect these differences.

This section identifies specific administrative items which should be considered when the plan is first outlined. Those items which are not applicable in a specific situation should then be eliminated and need not receive further consideration.

Program managers and technical staff need to know that there are a wide array of administrative and legal points that must be dealt with. Depending on the project desired, any of the following questions may have to be resolved:

- Table 18: Typical Administrative/Legal Questions*

  - It is better to have a general purpose government, public corporation or authority administer the program or project?
  - What level of government should be responsible for implementing the project?
  - Should planning and implementation be handled by the same staff?
  - If a city is the lead agency, can the city operate outside city limits -- a state outside of state rights-of-way?
  - Which agencies can most easily execute inter-local agreements?
  - What Public Utility Commission regulations apply?
  - What practices and perogatives need to be acted upon in the provate sector? Who can do this best?
  - Is credit lending an issue? (e.g., vanpool abort costs)
  - Where can local funding of projects come from? If more than one jurisdiction is involved, what is the proper split of funding?
  - Do any carpool insurance programs need to be resloved (e.g., local cooperative of carpool insurance or self-coverage)?
  - Is there any special enabling legislation required at the State or local levels?

Basic Requirements

As a general rule, it is far simpler to have the necessary administrative functions handled by organizations which already exist than to create new ones. Existing agencies have established procedures which fulfill the requirements of any grantor agencies.

In cases where all of the project functions are assigned to one or more existing agencies, no special arrangements may be necessary to perform budget, personnel, accounting and procurement functions. The Administrative Plan need merely reflect that fact.

At the outset, the person responsible for preparing the Administrative Plan should secure copies of the application instructions and operating regulations of each prospective grantor agency. This will enable specific provision to be made for these requirements and avoid later duplication of effort. Figure 13 illustrates the administrative activities which will occur during the project development process.

Organizational Arrangements

The activities which comprise a project may be the responsibility of a single existing agency, either as a special function or as a part of its regular operations. They may be divided among existing agencies, such as a local or state highway agency, one or more transit operators, and an enforcement agency. Or they may be assigned to a newly-established agency set up for this purpose.

It is impractical to try to suggest all of the many possible organizational alternatives. The main point is that the allocation of responsibilities must be made consciously, must be as clear-cut as possible, and must be made known to everyone concerned.

Figure 13
ADMINISTRATIVE PLANNING ACTIVITIES

PROJECT PHASE	MAJOR ACTIVITIES
Sketch Planning	NONE
Project Planning	Allocate project responsibilities. Obtain funds for project planning and operations. Determine whether project administration can be accomplished through an existing agency or whether a new agency must be formed. Establish administrative arrangements.
Design	Obtain funds for design. Identify procurement needs, obtain funds for any capital requirements. Begin procurement activities.
Installation	Complete procurement activities for installation.
Operations	Administer day-to-day project activities
Evaluation	NONE

When responsibilities for project activities are divided among two or more agencies, a means of coordination is essential. Commonly, this is done through some form of committee structure within which each project participant is represented. There may or may not be a lead agency.

The coordinating group, whatever its structure and name, may actually control and direct project activities--or some of them, say those financed through a specific Federal grant--or it may be only advisory to the participating agencies. There may, of course, be more than one committee. In addition to an overall coordinating group, there may be, for example, a marketing committee.

Each project participant should designate a person within its organization to serve as the focal point for the control or coordination of project activities. The participants may also agree to designate an overall project manager to control or coordinate the project on a day-to-day basis.

The organizational arrangements for the project should be set forth specifically in the Administrative Plan. This may require only one or two sentences, or it may involve the preparation of a detailed description of the allocation of functions and of levels and lines of authority, both among agencies and within the agencies themselves.

Budget

The budget element of the Administrative Plan consists of: (1) a description of the budgetary process; and (2) the project budget. In some instances, there may not have to be a project budget, but only a statement of funds or other resources each participant expects to use in project-associated activities. Decisions on appropriation requests or funding levels within available funds, budget preparation and justification, and budgetary administration and controls are the responsibility of the participating agency and are a part of its usual functions.*

At the other extreme, all project activities may be specially funded and carried out under the control of a coordinating committee or Program Manager. In this instance the manager will be responsible for the performance of a full array of budgetary functions, even though essentially clerical or ministerial functions may be performed by another organization under agreement.

As with the other Administrative Plan elements, those items which are inapplicable in a specific situation are to be ignored.

<u>Budget Preparation</u>--This describes the budget preparation process, including:

- schedule
- responsibility for preparation, review and approval
- data and degree of detail needed
- supporting documentation required

<u>Budget Administration</u>--This describes the budget administration process, including:

- periodic reviews of budget status and accomplishments
- controls to keep project costs within authorized amounts and purposes
- budget amendments

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*Examples of this would be the use of already available highway funds for pavement marking and signs, the operation of existing bus service over an exclusive lane on a downtown street, or even the provision of new service over a metered freeway when the net operating loss will be met from general transit subsidy funds.

Project Budget Plan--This is a budget plan covering the entire life of the project when the project is of definite duration. This will be most likely in the case of an experimental or demonstration project. The Project Budget Plan may include:

- estimates of operating income and expense (including administrative expenses) by project activity and fiscal year
- estimates of capital requirements by project activity and fiscal year
- anticipated cash drawdown by fiscal year
- anticipated sources of funds to meet administrative expenses, operating deficits, and capital costs

Where Federal grant funds will be used, the budget to be submitted with the grant application and the Project Budget Plan may be the same document. When the Federal grant covers only one phase of the project, the activity so financed will in most instances appear as a single line item in the Project Budget Plan.

Annual Project Budget--This is the budget for the fiscal year during which costs are first charged against the project or revenues credited to the project; budgets for subsequent fiscal years will be prepared as prescribed in the budget preparation procedures. It consists of:

- estimates of operating income and expenses (including administrative expenses) by project activity for the fiscal year. This may be in substantially finer detail than in the Project Budget Plan and should provide information and supporting data sufficient to (1) describe the activities to be carried out and (2) support the levels of expenditure requested and the revenue estimates.
- estimates of capital requirements by project activity for the fiscal year. The budget justification should be in enough detail to (1) describe each line item, (2) explain the need for each expenditure in terms of project requirements and objectives, and (3) support the unit cost estimates.

- sources of funds, including an evaluation of the probability that funds will be available to meet expenses as they are incurred.

- a staffing schedule showing, by organizational unit:
  1) Positions (title and rate of pay) to be occupied during any part of the fiscal year, showing man-years occupied and the estimated cost of salary or wages, without fringe benefits
  2) Positions (title and rate of pay) to be established at any time during the fiscal year, showing the date each appointee should enter on duty
  3) Positions (title and rate of pay) to be abolished at any time during the fiscal year, showing the date each such action will be taken

  This schedule is derived from the estimates by project activity. It becomes a major budget document in itself, useful particularly in budget administration, and provides the basis for planning many of the activities of the personnel management organization.

Personnel

The personnel element of the Administrative Plan can be very simple or very complex, depending largely upon whether or not this service can be provided by an existing agency, that agency's personnel policies, regulations, and procedures can usually be adopted with little or no change. When a personnel organization has to be established, it will be necessary to devise personnel policies, regulations, and procedures, and set them forth in detail.

At a minimum, the personnel element should consist of:

- designation of the administering agency and identification of the persons to whom appointing authority will be delegated

- identification of the personnel policies, regulations, and procedures to be adopted and specification of any modifications of them applicable to the project

- a recruitment program for the fiscal year during which the project begins. This program is based upon the staffing schedule developed as a part of the Annual Project Budget.

Projects financially assisted under the Urban Mass Transportation Act of 1964 must satisfy the requirement of Section 13(c) of that Act that"...fair and equitable arrangements are made, as determined by the Secretary of Labor, to protect the interests of employees affected by such assistence."*

When employees who may be affected by a project are members of a labor organization, the determination of the Secretary of Labor ordinarily is made on the basis of an agreement negotiated between the project sponsor and the union. When there is no labor organization, the protective provisions are prescribed by the Secretary of Labor.

Accounting

Accounting is another area in which administrative planning and operations can be greatly simplified by obtaining services from an already-established organization. When this is the case, the minimum accounting element in the Administrative Plan consist of:

- designation of the administering agency and identification of persons to whom authority to authorize payments will be delegated
- identification of the accounting policies and procedures to be adopted and any modifications which will be required to adapt them to the project
- identification of any special financial reports which will be required in the administration of project activities

If a system of accounting and internal control must be devised for the project, the assistance of an accounting systems analyst will be needed.

Grantor agencies may have minimum criteria by which they will evaluate the adequacy of the system of accounting and internal controls. They may also specify

*Information concerning Section 13(c) can be obtained from the Assistant Secretary of Labor for Labor-Management Relations, Washington, D.C. 20210.

the accounts and records to be maintained, define the eligibility of project costs, indicate the documentation needed to support such costs, and give financial reporting and audit requirements.*

An established accounting organization should have no difficulty complying with the financial management requirements of a grantor agency. However, it should review such requirements as a part of the administrative planning process to determine if this is so, and to develop solutions to any problems which may appear.

Procurement

The term "procurement", in the context of an Administrative Plan, includes:

- contracting for profesional and consulting services
- purchasing and leasing supplies, equipment, and utility services
- purchasing or renting land, building, and rights-of-way or easements
- construction by contract or force account
- such associated functions as inspection, warehousing and storage, property accounting, and the disposal of surplus property of all kinds

This is a third major administrative area in which it is easier to use an established organization than to organize, staff, and develop policies and procedures for a new organization.

Assuming that procurement will be handled by an established organization, the minimum content of the procurement element of the Administrative Plan includes:

- designation of the administering agency and identification of persons to whom procurement authority will be delegated

*Uniform Federal cost standards applicable to projects with State and local public agencies are prescribed in Office of Budget and Management Circular #A-87.

- identification of the procurement policies and procedures to be adopted, and any modifications which will be required to adapt them to the project

- identification and scheduling of major procurement actions to be initiated in the fiscal year during which project activities begin, or, if the project is of definite duration, the entire project period

When procurement responsibility is to be assigned to a newly-established organization, policies and procedures should be developed for each of the procurement functions which is applicable to the project. The easiest way to do this is to adapt procedures used by another public agency subject to the same statutory and other controls as the newly-established organization.

The depth of treatment and extent of procedural detail should be related to the job to be accomplished. One or two relatively minor procurement actions in any one of the areas mentioned above will not justify spending time on policies and procedures relating to that area. Even so, it will be necessary to identify and adhere to any requirements which may be imposed by State or other statutes or which may be prescribed by grantor agencies.

In developing the procurement element of the Administrative Plan, particular attention should be given to the need for, and the content of, policies in such areas as:

- competitive procurement through formal advertising

- competitive procurement through informal price solicitation

- competitive procurement with price negotiation

- sole source procurement

- use and selection of individuals and firms to provide professional and consulting services

- use of the project sponsor's own employees (force account) or those of another public agency (cooperation agreement)

- methods of payment under contracts, such as fixed price, cost plus fixed fee, or some form of incentive pricing

- bid guarantees, bonding and insurance requirments, liquidated damages
- land selection and acquisition
- disposition of surplus property
- standards of conduct for persons engaged in procurement activities

The regulations of grantor agencies usually contain detailed requirements with respect to procurement when grant funds are involved. These should be reviewed and provision for them made in the procurement policies and procedures. In some instances, an inadvertent failure to follow a requirement can be remedied retroactively or can be forborne. In other instances, the defect cannot be remedied, and may result in a loss of grant funds and possibly other mandatory sanctions.

Other Administrative Functions and Services

There are a number of additional administrative functions and services for which provision may have to be made during the life of a project. In most priority treatment projects, these are not of sufficient importance to include them in the Administrative Plan, if indeed, the need for them exists at all.

The following is provided solely as a checklist:

- Building services
- Central files
- Communications management
- Data processing
- Duplicating services
- Graphic services
- Health services
- Identification cards and passes
- Library services
- Mail room
- Messenger service

- Motor pool
- Office equipment loan pool
- Parking management
- Photographic services
- Public document inspection
- Records disposal
- Security
- Space management
- Stenographic-typing pool
- Supply room
- Travel services

PART II NOTES:

GENERAL PROJECT CONSIDERATIONS

Section 1: GENERAL PROJECT CONSIDERATIONS

1. Federal Highway Administration, Manual on Uniform Traffic Control Devices for Streets and Highways (Washington, D.C.: U.S. Department of Transportation, 1971).

2. Institute of Transportation Engineers, Traffic and Transportation Engineering Handbook, J.E. Bearwald, Editor. (Edgewood Cliffs, N.J., 1976).

Section 2: PROJECT PLANNING

1. Personal communication, Barry Goodman, "UMTA and Environmental Protection", as interpreted pursuant to the NEPA Section 102(2)(c), 1974.

2. U.S. Department of Transportation, "Procedures for Considering Environmental Impacts", Federal Register 39, no. 190 (September 30, 1974): 35232-35249.

3. U.S. Department of Transportation, Federal Highway Administration, "Design Approval and Environmental Impact", Federal Register 39, no. 232 (December 2, 1974): 41804-41821.

4. Ibid., p. 41808.

5. Ibid.

6. If a decision is made to issue an EIS, then two how-to-do-it documents are available: (1) U.S. Department of Housing and Urban Development, Interim Guide for Environmental Assessment: HUD Field Office Edition, GPO No. 023-000-90151-0 (Washington, D.C.: Government Printing Office, 1975); and (2) U.S. Department of Transportation, Environmental Assessment Notebook Series: Highways, Notebook 6 - Environmental Assessment Reference Book, GPO Stock No. 050-000-00109 (Washington, D.C.: U.S. Government Printing Office, 1975); $21.00 for a seven-part set, sold in sets only.

7. John Jamieson, Continuing Transportation Planning Operations Plan for the Twin Cities Metropolitan Area: Proposed Draft of March 11, 1974, Metropolitan Transit Commission staff proposed addition to the interim Operations Plan of September 5, 1973.

8. Craig Miller and Robert Deuser, "Issues in Busway and Bus/Carpool Lane Enforcement", (Paper prepared for the 55th Annual Meeting of the Transportation Research Board, Washington, D.C.; January 1976), p. 2.

9. Ibid., p. 3.

10. Office of Transit Management, Urban Mass Transportation Administration, Transit Marketing Management Handbook: Marketing Plan, (Washington, D.C.: U.S. Department of Transportation, April, 1976), p. 3.

11. Ibid.

PART III

SPECIFIC PROJECT CONSIDERATIONS

OVERVIEW

INTRODUCTION

This part of the Technical Guide consists of an Overview and four sections that describe planning and design considerations for separate categories of priority techniques--freeway, arterial, activity center, and miscellaneous. Each section includes an identification of the different technical concerns of the various implementing and operating disciplines which must work together to develop a successful project. Each section begins with the general issues, applications and problems common to all the techniques within the category and relates the issues back to the project planning effort.

General Contents

While technical information has been published and is available on arterial, activity center, and miscellaneous techniques, these have not been as well documented as freeway techniques.* Actual project design efforts require more specific how-to do-it information that is provided in this part of the guide. However, enough information is provided to permit one to identify and discuss the unique planning and design issues and experiences pertinent to each type of priority technique.

Most project designs can be developed directly from accepted transportation engineering standards on traffic control devices and highway designs.# It is

*Major reports and studies in each category are cited in the Annotated Bibliography in the Appendix.

#Such standards include the Federal Highway Administration Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), supplemented with the annual "Official Rulings on Requests" volumes (1971, 72-76) or similar state adopted versions. A complete listing of major design documents is given in the annotated bibliography.

intended that the framework presented in this Manual be supplemented with sound engineering judgement and creativity.

How to Determine Users*

Not all projects have been designed to serve all possible types of users. For example, a reserved lane project might be designed to serve only buses, only carpools, or both. The issue is further complicated because a carpool may be defined as a vehicle with 2, 3 or 4 or more occupants. While most previous projects were designed to serve buses only, the trend lately has been to allow carpools when:

- A reserved facility or lane has plenty of excess capacity (i.e., the lane or facility will be perceived by the public as greatly underutilized otherwise);
- The travel time advantage to buses will not be lost with the addition of carpools;
- Safety will not be jeopardized;
- Adequate enforcement can be accomplished, and;
- There are insufficient buses to make the exclusive facility cost effective.

The selection of an appropriate number of occupants to define a carpool is a policy issue which should be resolved early in the planning process. From a technical standpoint, the resolution of this issue should be based on project demand for that facility or reserved lane.

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*The term users is used here to describe those who use and directly benefit from the service of a priority treatment project. That is, users are in the high occupancy vehicles using the treatment. Conversely, non-users are those whose circulation and/or access needs may be affected by a priority treatment project but who do not directly benefit from it (i.e., non-high occupancy vehicle motorists and passengers, pedestrians, or adjacent property owners). Non-users may be using the same facility, parallel routes or cross streets.

It has been found that existing forecast methods often leave considerable discretion (for example, carpool demand forecasts) in project management decisions regarding the initial operating features of the project. Decisions about other operating features such as the exact hours of operation, and the range of vehicles allowed entry are also not always clear at the outset.

Where such discretion exists, particularly where the project appears to be controversial, it is wise to establish the initial operating features of the project at a "maximum" rather than a "minimum." For example, if it is unclear whether the facility should be operated during a three hour peak period or a two hour peak period, a number of considerations suggest that the three-hour period is appropriate. These include the following:

- It is much easier to diminish the operational features of priority treatment facilities than to expand such operations. This is particularly true because of the usual public suspicion, if not opposition, to projects which appear to encroach upon the rights of the majority of the driving public.

- If there are continuing public protests against the project after it is implemented, maximum operating features allow a response to such protests through various modifications to the operations - without necessitating a complete abandonment of the project.

- The evaluation of the project will be partially aimed at providing a basis for decisions to modify the project or to modify concemitant support services and facilities. Therefore, the initial "maximum" operating characteristics will allow more latitude in the evaluation process, in terms of actual modifications to the project operations.

To some extent, there appears to be a correlation between the level of public protests and the objective technical evaluation of a project's usefullness. For example, Portland Oregon, public clamor for modifications to the Banfield project operations was clearly supported by technical evaluation, both with respect to direct operating features of the project (hours of operation) and to related support efforts (additional express buses).

Estimating User Demand

Transit or carpool demand for freeway or arterial priority techniques can be simulated by using any of a number of previously developed computer travel demand models which project modal splits, car occupancies and ridership usage levels based on existing car occupancies, land use, and socio-economic data.* The costs of applying these models versus the accuracy of their findings limits their application to complex situations where there are several alternatives for freeway or arterial configurations which must be evaluated.

Activity center user demand is even more difficult to estimate. The most sophisticated urban travel demand models may be able to approximate passenger demand on a large or regional scale, but to date they do not have the flexibility to accommodate all the variables which might be needed to predict small scale urban center transit demand. Factors such as paratransit use, human factors, complex land uses, parking access points, parking pricing and goods movement are too complex to be reflected by these demand estimates. Projected demand estimates for activity centers might best be made manually until small scale travel demand computer models have been perfected.

One of the best models for predicting carpool demand for various preferential lane configurations on a corridor basis was recently developed by Riley for the I-90 corridor. The accuracy of the model has been verified at two other locations -- the San Francisco Oakland Bay Bridge and Washington State Route 520. It could be applied to other corridor locations if total existing person trips, mode split, and average vehicle occupancy are known, Its accuracy is, however, limited to predicting single occupant vehicles and 2 or 3 occupant carpools.

*Many are found in the book, Urban Travel Demand Forecasting, Highway Research Board, 1973.

UMTA is in the process of trying to adapt the widely used Urban Transportation Planning System (UTPS) series of computer travel models for short range modeling efforts. This effort may be completed sometime in 1978.

There is some controversy concerning how to take auto occupancy counts. The Manual on Traffic Engineering Studies gives a brief description of how to take auto occupancy counts:

> "Vehicle occupancy counts are summarized by directions. The number of occupants counted (including drivers) is determined by multiplying each occupancy group times the number of occupants in each group (1,2,3, etc.). The total number of occupants counted in the study period is divided by the total number of cars counted. This yields the average occupancy per vehicle. The average may be calculated by selected time period provided that a sample of at least 500 vehicles is available for the shortest time interval and direction of travel that is selected."

Some transportation engineers feel this is not clear enough guidance.

The city of Seattle is undertaking a study on auto occupancy to prove that A.M. peak period auto occupancy is relatively constant with season, and that a semi-annual midweek auto occupancy count program will be sufficient to determine (with a reasonable level of confidence) the regional and corridor auto occupancy rates.

The research is expected to produce a method of sampling auto occupancy which will reduce the total cost of data collection. This will also make data available for Transportation Systems Management planning and help identify those corridors transit or carpool incentives are needed.

In a recent study to predict the effects of opening bus only ramps to 4 or more person carpools on the Shirley Highway bus/carpool lanes, the following percentages were used to estimate changes in auto occupancies (or diversion factors):

- five percent of the bus passengers (for the identified zonal pairs) will be diverted to four person carpools at an average occupancy of 4.45.

- fifteen percent of the two occupant vehicle (for the same zone) will be diverted to four person carpools at an average occupancy of 4.45.

- fifteen percent of the two occupant vehicles will be diverted to four person carpools at an average occupancy of 4.45; and

- seven and one-half percent of the single occupant vehicles will be diverted to four person carpools at an average occupancy of 4.45.

After one year of operation, the predictions made were close to the actual counts. There was also an untested prediction made for the Shirley Highway with regard to changing the definition of a carpool from 4 persons to 3 persons. It was assumed that:

- all three person carpools on the Shirley Highway that could reasonably use the express lanes would be diverted to them;

- a portion of three person carpools using other highways in the corridor would be diverted to the Shirley express lanes based on a travel time ratio and a diversion curve.

- Twenty-five percent of the two person carpools would be converted to three person carpools at an average occupancy of 3.25; and

- seven and one-half percent of the single occupant vehicles would be diverted to three person carpools at an average occupancy of 3.25.

SYSTEM CONSIDERATIONS

The discussion that follows covers the interrelated project issues which need to be examined systematically. Issues such as policy changes, support services and facilities, project side effects, project operating hours, and safety implications are included.

Balancing Urban Policy

Local transportation policies related to priority techniques may have major implications for non-transportation aspects of an urban area. More importantly, in order to change a transportation policy, interrelationships between transportation and other urban policies have to be understood and balanced to achieve an overall improvement to the urban area. For instance, an activity center parking policy which promotes inexpensive and plentiful public parking in activity centers may be acceptable to activity center business since business perceive parking as related to business success. However, if extreme congestion is a by-product of this policy, such congestion may deter new business. A new circulation policy which discourages long-term parking without providing any positive incentives to improve affected businesses would likely be unacceptable to those businesses. If, however, a new policy is accompanied with proposals which will result in better bus service, preferential parking for carpools, and an extensive marketing campaign which would benefit the activity center businesses, the whole policy package might be acceptable. Balancing policy in this way would be consistent with the goal that the urban area--not just the transportation system--should benefit from priority techniques.

Support Services and Facilities

Support services connected with a priority treatment project include bus feeder and distribution services, and/or carpool matching programs for project users. Support facilities, on the other hand, are the non-roadway stationary facilities which accommodate transferring and parking operations for vehicles using a priority treatment facility. These may include park and ride lots, preferential fringe parking lots, urban center preferential parking facilities, carpool staging areas, transit terminals and other designated modal transfer points.

Before project planners can determine what support services or support facilities are needed, they should resolve the crucial questions (listed in Table 18 on the following page) that relate to type of users and their trip needs. The "Operations Plan" discussion in Part II, Section 2 provides further information on support services and facilities needed for project operations.

There are many situations where support services and facilities are provided simultaneously. However, it is sometimes necessary to make a decision between one or the other. For example, a choice might have to be made between building a park and ride lot or providing feeder service to an express bus terminal. An appendix to the previously cited Levinson report on Bus Use of Highways, Planning and Design Guidelines provides guidance on how to resolve such a problem through a cost effectiveness analysis.

Project Side Effects

There are often side effects related to project operations which may not reflect priority treatment objectives. These vary widely by technique, both in magnitude and public acceptability. Figure 14 is a summary of some of these side effects by technique. This is not an exhaustive list and most of these side effects can be reduced or eliminated by addressing them during project planning efforts. The sections on individual techniques which follow provide further information on each of these side effects and how to deal with them.

Project Operation Hours

Some techniques will be applied all day long, others during business hours only, in both peak periods, on weekends or for special events. The project type, expected demand and the level of effort needed to enforce a project will determine the most appropriate operational hours of each project component. The "Enforcement Plan" and "Operations Plan" in Part II, Section 2 includes further information on selecting project operating hours.

Table 19

SUPPORT SERVICES AND FACILITIES

- Will the primary users of the project services be captive (transit dependent) or choice riders? The answer to this question will indicate whether to orient project services towards local, express or both types of needs. This type of information is not only useful in determining the type of services to be provided, but the hours it will be in operation. For example, a freeway reserved lane project might be aimed at providing "choice users" with express service in peak hours, while an urban center reserved lane project might be aimed at providing "choice" and "captive" users with local service in peak and off-peak hours.

- What will be the total trip needs of the potential users? A project designed to serve carpools and/or buses must also consider the full trip needs of potential users. The users of the project must get from a specific origin to a specific destination. If they cannot do this, any advantages of priority treatment may be lost. A series of questions concerning each user mode must be addressed by those responsible for providing the services:

  (1) Carpools or vanpools. How would carpoolers meet? Are there local matching programs, or employer/employee support for such programs?

  - Would carpool drivers have to pick-up passengers at home or at carpool staging areas?

  - Would carpoolers have alternate means of getting to and from work or home? (e.g., bus service)

  - Are there preferential parking facilities for carpoolers at major destination points?

  (2) Buses. How would patrons get to the bus system using the priority treatment facility? Would they walk, ride in or drive a car, ride a bicycle, or transfer from another bus?

  - After using the facility, how would passengers continue on to their destinations? Would they stay on the same bus, transfer at a terminal, or walk?

Figure 14
POSSIBLE PROJECT SIDE EFFECTS

TECHNIQUE / SIDE EFFECTS	May increase traffic on parallel facilities	May increase traffic in parallel lanes	May affect safety (whether positive or negative)	May create a need to make signalization adjustments in the affected area	May require elimination of parking	May affect goods movement	May affect pedestrian circulation (whether positive or negative)	May cause delays in non-user traffic	May be difficult to enforce	May cause queues on cross streets	May impair access to adjacent properties	May impact land use of adjacent properties
Freeway												
Separated Facility			X	X								
Concurrent Flow Lanes	X	X	X	X					X			
Contra-Flow Lanes		X	X	X								
Priority Access		X	X	X						X		
Arterial												
Concurrent Flow Lanes	X	X	X	X	X	X	X	X	X		X	
Contra-Flow Lanes	X	X	X	X	X	X	X	X			X	
Median Lane	X	X	X	X			X	X	X		X	
Signal Pre-emption				X				X		X		
Urban Center												
Concurrent Flow Lanes	X	X	X	X	X	X	X	X	X		X	
Contra-Flow Lanes	X	X	X	X	X	X	X	X			X	
Bus Street	X		X		X	X	X	X			X	X
Transit Malls	X		X		X	X	X	X			X	X
Miscellaneous												
Off-Street Terminals												X
Toll Plaza Treatments		X		X				X				
Transit Operational Improvements				X	X							
Park 'n' Ride				X								X
Carpool Staging										X		

Safety Implications

General safety implications of priority techniques are discussed in the sections which follow. No single piece of research has drawn firm conclusions about the safety aspects of priority techniques. Because of this, the Federal Highway Administration (FHWA) has funded a comprehensive study entitled "Safety Evaluation of Priority Techniques for High Occupancy Vehicles" (Beiswenger, Hoch and Associates). This study is expected to be completed early in 1978.

Section 1

FREEWAY-RELATED PRIORITY TECHNIQUES

INTRODUCTION

Freeway applications commonly are designed to reduce vehicle trips without reducing person trips--in other wor ds, to move a given number of people to specific destinations in fewer vehicles. Freeway techniques are particularly appropriate for recurring long distance trips (5+ miles) and low occupancy trips that are primarily peak period, home-based work trips.

In 1968, average work trips in major U.S. urbanized areas ranged from 5.1 to 8.7 miles in length.[1] Today such trips are probably even longer. While there are many reasons for this, improvements in transportation facilities--especially freeway development--tended to encourage this trend.

Also, the nation's force has been increasing at a significant rate. As a result, there has been a steady increase in the number of work trips, mostly in peak periods.

The construction of freeways to serve these additional and increasingly longer trips has been curtailed in recent years because of community opposition, economic, energy, environmental, and other concerns. During the same period, ridership in high occupancy vehicles has not increased enough to offset this trend. The result of all this is that greater numbers of vehicles must compete for a limited amount of space on the existing freeways.

See page 240 for footnotes

As shown in the table below, there are five basic approaches which can address the issue of relieving freeway congestion.

- Table 20: Approaches to Relieving Freeway Congestion

  (1) Build more freeways. This approach is becoming less and less feasible.

  (2) Do nothing. With this approach, traffic will build up until it reaches a point where congestion becomes intolerable and discourages new trips.

  (3) Implement operational improvements to improve vehicle flow. Include widening, ramp metering, reversible median lanes, or freeway surveillance and control systems. Where applicable, express bus service could be initiated or its frequency and/or coverage increased, and possibly be supplemented with park and ride lots or other transit feeder/distribution services.

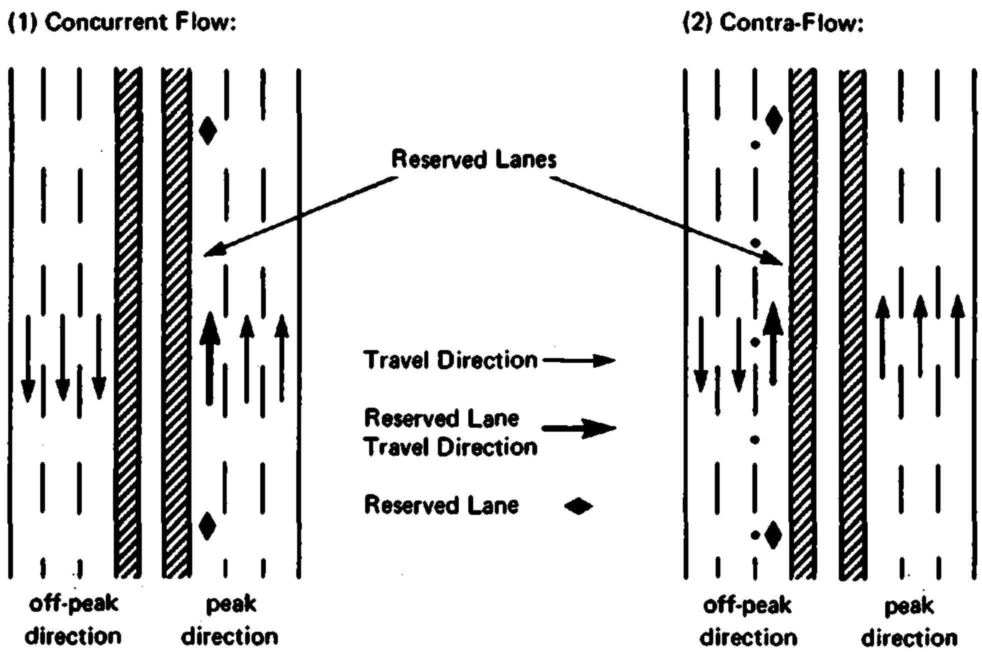
  (4) Implement freeway priority treatment projects for high occupancy vehicles. This approach would improve person movement without increasing vehicle movement.

  (5) Implement a combination of priority treatment techniques and operational improvements. This would improve both person and vehicle movement.

The most sensible and equitable approach depends upon the specific dimensions of each problem as well as the particular goals and objectives of the urbanized areas involved.

If either of the last two choices are found desirable, in most cases, the state highway agency or regional transportation authority will be responsible for the design and implementation of freeway-related priority techniques. However, a cooperative planning and design effort involving affected transit operators, adjacent local jurisdictions, and the appropriate enforcement personnel will yield a project which is most responsive to local needs and which has adequate support services and facilities, in addition to being acceptable to the affected community.

Figure 15
CONCURRENT AND CONTRA-FLOW FREEWAY RESERVED LANES CONCEPTS



All of the freeway techniques described in this guide have been implemented in this country and generally fall into three broad categories. A brief description of each category follows, with more complete discussions of each presented later in this section.

A. Exclusive or Separated Facilities. A separate roadway facility is constructed for carpools and buses. Access to these facilities is limited and special connecting ramps are generally required.

B. Reserved Freeway Lanes. An exclusive ramp can be used to by-pass a metered ramp or a congested freeway link. It may or may not invlove construction. As shown below, two kinds of lanes can be involved: (1) concurrent flow and (2) contra-flow. Both types as, shown in Figure 15, are defined with respect to the flow of traffic (i.e., direction) from which the special lane is taken.

Access to concurrent flow lanes can be unlimited, while limited access is required for contra-flow lanes.

C. Priority Freeway Access. An exclusive ramp can be used to by-pass a metered ramp or a congested freeway link. On a separate facility with changing directional flows, an exclusive ramp may be reversible. A by-pass lane on a non-exclusive ramp can be applied where a ramp is wide enough for two lanes of traffic. A by-pass lane may involve construction, generally is not reversible, and often is used in conjunction with freeway ramp metering.

The specific criteria used to evaluate any priority treatment/freeway project should depend somewhat on the nature and characteristics of the physical facility itself, and the purposes for which it was designed. Examples of some basic technical criteria which might be evaluated on any freeway project include the items listed in Table 20 on the following page. Non-technical issues such as community acceptance are just as important, if not more so, than technical evaluation criteria. These criteria are covered in the "Evaluation Plan" and "Public Education and Marketing Plan" of Part II, Section 2.

SEPARATED FACILITIES

Separated facilities are limited access roadways specifically constructed or designated for the exclusive use of high occupancy vehicles. They are often used to provide express transit and carpool service between outlying areas and activity centers, for short by-passes at major freeway bottleneck/congestion points, or as a feeder service to rail transit lines.[2]

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Table 21

FREEWAY PROJECT TECHNICAL EVALUATION CRITERIA

- IMPACT ON PERSON TRIP MOVEMENTS
  - Are the number of persons carried in a corridor less than, equal to, or greater than pre-project levels? Has person through-put leveled off at a particular point? If so, at which point? After how long?
  - Are the average over-all travel times for users and non-users better or worse than pre-project travel times for those groups?
  - What are the average auto occupancies in the corridor now as compared to before the project was implemented?
- IMPACT ON BUS OPERATIONS
  - Have bus travel times been reduced?
  - Have bus occupancy rates increased?
  - Has schedule reliability improved?
- IMPACT ON SAFETY
  - Are there more or fewer accidents on the overall facility? Has the general trend been downward? Has it leveled off at any particular point?
  - Has there been a change in accident patterns after the project started? (e.g., per cent rear end, per cent side swipe--before compared to after)?
  - Are accidents of the same severity?
- IMPACT ON THE ENVIRONMENT
  - Is less energy being consumed?
  - Has there been a positive or negative impact on the project area's air quality? Is the difference significant?
  - What has been the effect of the project on noise levels?

Only two such facilities have been implemented in the U.S. to date--the Shirley Highway (I-95) Project serving the Washington, D.C. area, and the San Bernardino Freeway (I-10) Busway Project serving the Los Angeles, California area. Both are currently open to carpool usage (Figure 16 shows both facilities). In addition, another separated facility is now being constructed to serve the Pittsburgh, Pennsylvania Metropolitan Area. The South section of the Pittsburgh facility scheduled for opening in the Fall of 1977--has been designed for exclusive bus use only. Other facilities also are being considered in major U.S. cities, including Atlanta and Dallas.

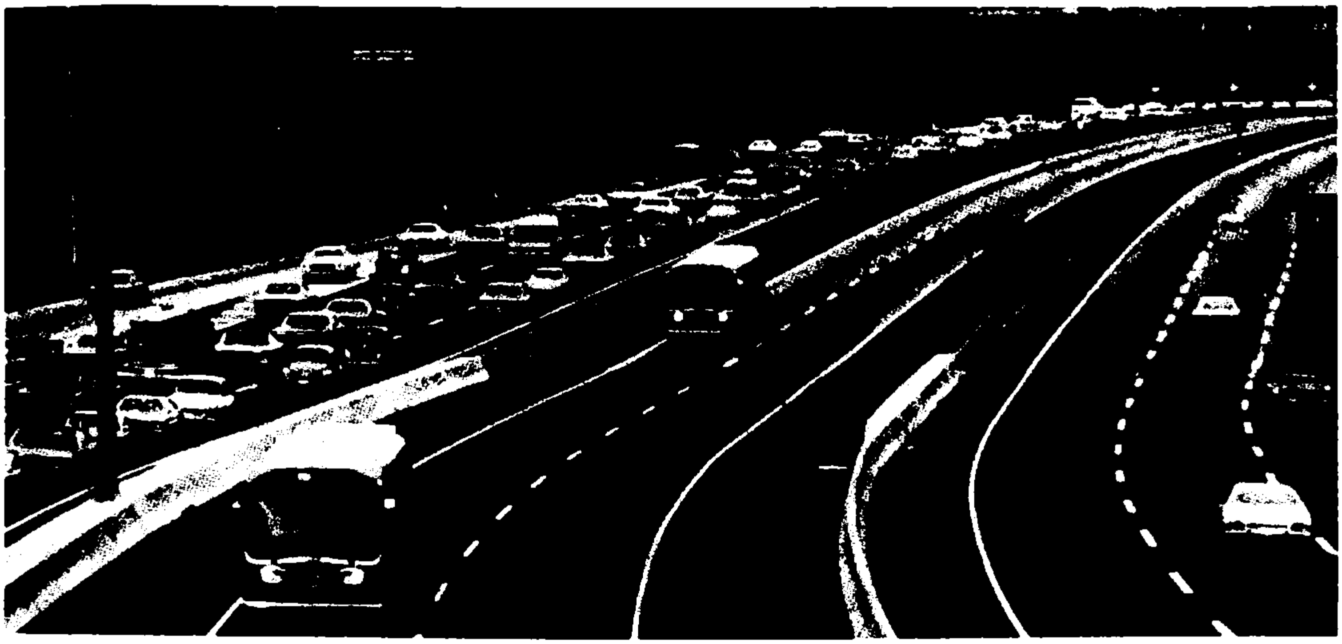
The two projects currently in operation in the U.S. have several characteristics in common:

- Both connect outer residential areas to a CBD;
- Both are located in dense urban areas having well-established transit service, though express service had not been provided in the San Bernardino Freeway Corridor prior to this project;
- Both required high capital investment and extensive federal assistance.
- The right-of-way was already available in connection with an existing freeway;
- Despite their high costs, both projects are widely perceived favorably by the general public and are considered to be successful by most users as well as non-users;
- Both had multi-year implementation time frames from inception to completion; and
- Enforcement has been relatively easy in both instances.

The major differences between the two projects was in the way they were developed. The San Bernardino project was originally conceived and designed as a busway while the Shirley Highway project was originally intended to serve mixed traffic in reversible median lanes. This latter facility was later converted to an exclusive busway and finally, to joint carpool/bus usage.

Figure 16
SEPARATED FREEWAY FACILITIES

(A) Shirley Highway (I-95) Project -Washington, D.C. Area.



(B) San Bernardino Freeway (I-10) Project-Los Angeles, California Area.

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

Rigid generalizations about separated facilities should not be drawn from these two projects. Nationally accepted traffic engineering warrants for these facilities do not exist, although a recent edition of the Traffic and Transportation Engineering Handbook cites three advantages of their applications:[3]

- They can provide for express bus service between areas that cannot otherwise be served by new or existing roadways;
- They can be fitted into the urban landscape with a minimum of disruption and land taking, and often into corridors too confined for a full expressway, by taking advantage of abandoned or underutilized railroad or other narrow rights-of way; and
- The facilities and rights-of-way can be converted to rapid rail facilities in the future if the demand warrants such a conversion.

To ensure safety, adequate enforcement, and continuity of operation, a separated facility should include a minimum of two lanes or one lane and a shoulder. Since these facilities involve a major capital investment, they should be justified on the basis of potential demand. That demand must be carefully estimated during the preliminary design phase.* This should then be communicated to decision makers and the general public lest resistance to the project arise.#

Capacity is defined as the maximum number of vehicles (or persons) which can be accommodated in a travel lane of a particular facility under prevailing conditions for a given time period, for a given mixture of vehicles (autos, buses, trucks, etc.), and at a given level of service. Adjusting any one of the preceding variables will affect the upper limit of capacity.[4] Demand, on the other hand, is defined as the actual number of vehicles (or persons) that want to use the lane.

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*Estimating user demand is discussed in the Overview to Part III of this Manual.

#Refer to the Community Involvement Plan described in Part II, Section 2, of this guide.

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A freeway lane operating at a poor level of service (e.g., 15 to 20 mph) with an average vehicle occupancy of 1.3 persons is capable of carrying 2000 vehicles at 2,600 persons per hour. The same freeway lane reserved for buses and carpools of 4 or more persons need carry only 40 full fifty-passenger buses and 150 carpools (4 persons each) per hour to move the same number of people at a much higher level of service (e.g., 50 to 55 mph.), not to mention the savings in energy and the improvement in air quality. While there is an almost infinite number of combinations for carrying the same number of persons in fewer vehicles, the more persons per vehicle, the more efficient the system is in accommocating person-trip demands.

It has been suggested that demand in the range of 40 to 60 buses per hour, carrying from 1,600 to 2,400 passengers per hour (assuming 40 passengers per vehicle) might justify the construction of a separated facility.[5] Yet with only one bus every minute or so, the public may perceive these demands as being inadequate, since the facilities may appear empty except at the ingress and egress points. Because of this, where safe conditions exist, carpools should be allowed on such facilities.

The passenger-carrying capacity of the facility depends upon the occupancy rates of the vehicles using it, the vehicle capacity and the vehicle mix. The vehicle capacity is affected by the vehicle mix as well as many other factors (number of on-line stops horizontal and vertical alignments, access points, access point signal controls, etc.). In general terms, the vehicle capacity of an exclusive use busway is roughly 1,200 buses per lane per hour for busways less than 1/2 mile long and 800 to 1,000 buses per lane per hour for busways more than 1/2 mile long.[6] If carpools are also included, as suggested, the available capacity depends

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upon the ratio of carpools to buses. For example, at low speeds and a poor level of service vehicle capacity would range from 800 (all buses) to 2,000 (all carpools) vehicles per hour. Facility designers should try to design a facility to keep the mixture of vehicles on the facility running at a level of service which is at least competitive with parallel, non-priority highways or freeways. With flexible designs (e.g., inclusion of shoulders on both sides), the facility's capacity in the future can be adjusted to meet changes in demand.

It is better to justify separated facilities on the basis of demand than capacity, because the likelihood that the facility will reach capacity--particularly with buses alone--may be remote. When carpools are allowed, however, the facility may reach capacity. Thus, the consideration of capacity should not be ignored altogether.*

Planning Considerations

A. Support Services and Facilities. As discussed in Part I, the Introduction, the type and quality of support services and facilities may, more than anything else, determine the success or failure of a priority treatment project. This is particularly true for separated facility and reserved lane freeway projects, because they don't extend to the origins and destinations of any of the trips they serve.

*The Shirley Highway project in Washington, D.C., with its current lane configuration, is approaching capacity in the peak periods.

B. Operations and Maintenance. For the most part, specific operations and maintenance considerations related to separated facilities are no different than those for the operation and maintenance of any other freeway facilities.* There are, however, a few differences which stem from the unique characteristics of a separated freeway facility.

When plastic posts or cones are used to separate exclusive use facilities from regular freeway traffic lanes, they are likely to require frequent replacement. On the seven mile section of the San Bernardino Busway separated from regular freeway traffic by a buffer lane, about half of the pylon barriers had to be replaced in a single year. The reasons for these replacements are not totally clear, although most of the pylons replaced were those adjacent to the regular traffic lanes, and traffic in the regular lanes, not buses in the exclusive lane, were primarily responsible for this damage.[7]

Traffic control delineation should be planned to minimize maintenance costs. Urban areas have used various delineation devices in other applications for traffic control and have had first-hand experience in the maintenance problems associated with certain traffic delineation techniques. Such knowledge should be utilized and applied in the early planning stages for exclusive use facilities.

*The Operations Plan in Part II of this Technical Guide identifies and describes common operating procedures and requirements for priority treatment projects in general.

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Bus operations for exclusive use facilities can be greatly facilitated by preparing a short, 10-15 page, operating manual and a training course for prospective drivers. Such a manual might include, but not necessarily be limited to, information on:[8]

- Applicable laws and ordinances;
- Speed limits and following distances;
- Lane operations;
- Special merging and weaving instructions;
- Bus breakdowns;
- Other emergency situations;
- Project map showing access and ramp configurations; and
- Special gate or ramp operations.

C. Enforcement. Exclusive busways do not present major enforcement problems, compared to other priority techniques, because they are highly self-enforcing. Once carpools are introduced, however, enforcement problems may occur.

Experience has shown that violation rates are relatively low on exclusive carpool/busway facilities (less than 5 percent, which is normal for a typical traffic control device such as a stop sign or signal).[9] As such, all that is normally needed is the periodic placement of enforcement personnel at entrances or exits of the facility (entrances are suggested, because the officers would act as a deterrent as well as an enforcement mechanism).

D. Evaluation. Because separated facilities affect the regular traffic stream only at entrance and exit points, they are not subject to the safety and enforcement problems of projects which operate adjacent to and/or in conjunction with mixed traffic. As a result, other evaluation factors gain importance, including:*

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*This list is not all inclusive.

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- Priority vehicle usage;
- Travel times;
- Transit efficiency and productivity;
- User and non-user reaction;
- Energy savings;
- Air quality improvement (or decline); and
- Changes in traffic conditions on parallel or cross facilities.

Design Considerations

Much research has already been done on the design of separated facilities, particularly exclusive busways.[10] These designs are generally more than adequate for joint carpool/bus usage. Figure 17 and Figure 18 show suggested cross-sections for separated facilities. This portion of Section 1 includes a summary of a few of the most important points about these designs.

A. Signing and Marking. The operation, safety and enforcement of separated facilities are facilitated by clear, vivid, and accurate marking--both on the facility itself, and at entry and exit points. (Examples of typical markings and signs are provided by Figure 19 on the third page following). The need for uniform signing has been responded to by continual revisions to the Manual on Uniform Traffic Control Devices, which illustrates marking and signing standards for priority treatment projects, including access points.[11]

If a separated facility is to have varying operational characteristics, or is to be constructed in conjunction with a freeway surveillance and control equipment, variable message signs can be installed, such as the ones illustrated in Figure 20. These may either be manually or electronically operated.[12]

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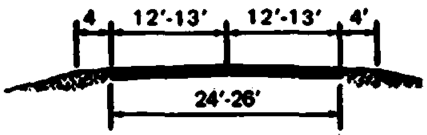
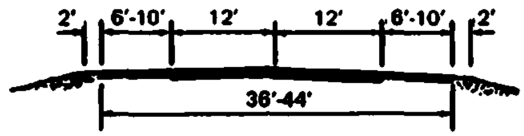
Figure 17
SEPARATED FACILITY TYPICAL CROSS SECTIONS– CONCURRENT FLOW

(1) Special Right-Of-Way: Class "A" Busways - 13' Lanes and 8'-10' Shoulders, Class "B" Busways - 12' Lanes and 6'-8' Shoulders

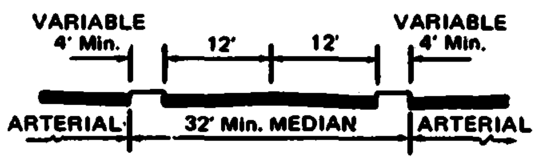


(a) Minimum Design

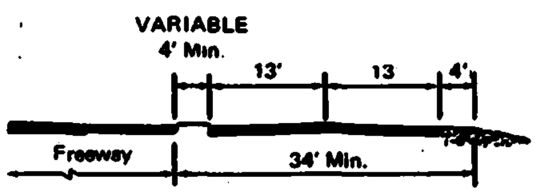


(b) Full Shoulder Design

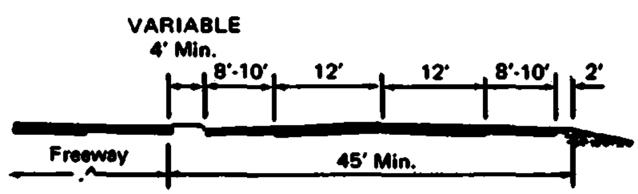
(2) Special Right-Of-Way Arterial Median: Class "B" Busway



(3) Alongside Freeway: Class "A" Busway

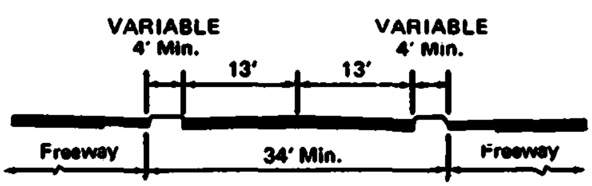


(a) Minimum Design

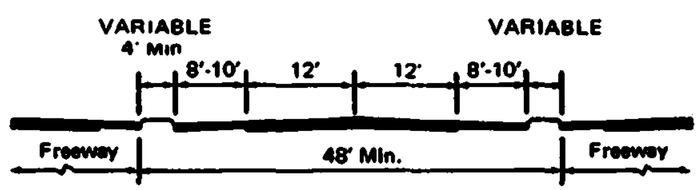


(b) Full Shoulder Design

(4) Freeway Median: Class "A" Busway



(a) Minimum Design



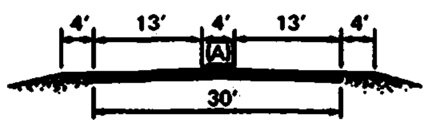
(b) Full Shoulder Design

SOURCE: Levinson, *Bus Use of Highways: Planning and Design Guidelines*. NCHRP Report 155, p.84.

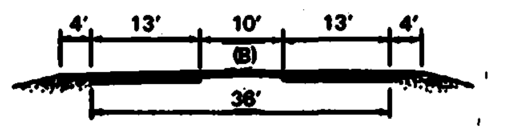
NOTES: (1) Lane widths may be increased on curves. (2) Add 1 foot to lane width where non-mountable curbs are utilized adjacent to lane.

Figure 18
SEPARATED FACILITY TYPICAL CROSS SECTIONS—CONTRA-FLOW AND SPECIAL FLOW

(1) Special Right-Of-Way

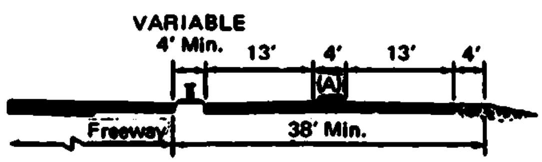


(a) Minimum Design

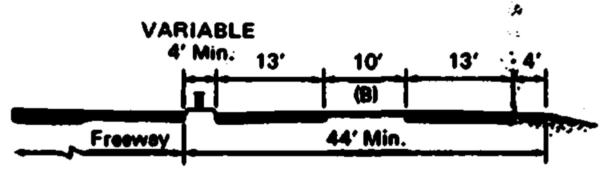


(b) Full Shoulder Design

(2) Alongside Freeway

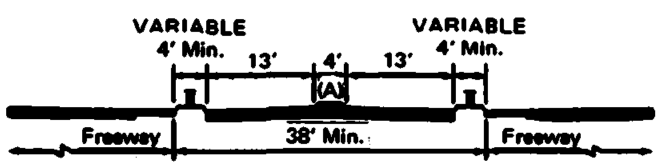


(a) Minimum Design

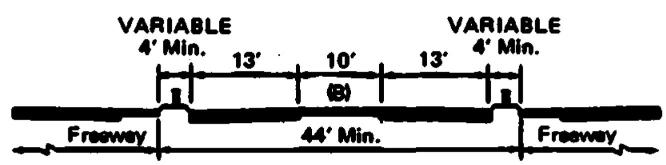


(b) Full Shoulder Design

(3) Freeway Median



(a) Mimimun Desiqn: Raised mountable median tor contra-flow; flush median for special-flow



(b) Full Shoulder Design: Flush Median

SOURCE: Levinson, *Bus Use of Highways: Planning and Design Guidelines,* NCHRP Report 155, p. 65.
NOTES: (1) Lane widths may be increased on curves. (2) Add 1 foot to lane width where non-mountable curbs are utilized adjacent to lane.

Figure 19
EXAMPLE SIGNS AND MARKINGS – FREEWAY PROJECTS

(1) S.F. BAY AREA; APPROACH TO EXCLUSIVE LANES

(2) MIAMI; I-95

(3) PORTLAND, OREGON: BANFIELD EXPRESSWAY

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

Figure 20
VARIABLE MESSAGE SIGN – SEATTLE I-5
EXCLUSIVE BUS ACCESS RAMP

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

In developing the most successful marking and signing schemes, traffic engineers should consider the opinions and concerns of local traffic enforcement officials. Practical knowledge and experience gained through enforcement and accident investigation could be useful in determining potential user and non-user reactions to signing.

B. Safety. Separated facilities have proven to be very safe. However entry and exit points, on-line bus stops, and points where the high occupancy vehicles merge back into regular traffic or connect with other priority treatment facilities should be monitored.

To date, mixed bus/carpool use on the Shirley Highway and San Bernardino projects have posed no significant safety problems. The excellent safety records of these two facilities thus far may be due to a combination of factors. Those postulated include:

- High priority of safety during the design stage of project planning;
- Limited access controls which have been properly designed and which are adequately enforced; and
- The absence of pedestrian conflicts.

Close adherence to design standards should keep safety problems to a minimum.[13]

C. Access. Access points act as physical constraints to the future flexibility and utility of a separated facility. They must be carefully chosen and designed to ensure this flexibility and to maximize convenience and service within budget limitations. Often, construction of access points will have to be staged. In such cases, priority for early installation should be given to those on which the heaviest use is anticipated.

While ramps to separated facilities normally serve both buses and carpools, it may be appropriate to limit certain ramps to buses only if bus volumes are high, or if merging or other operational problems occur with joint use. "Carpool only" ramps should generally not be considered unless physical design constraints prevent bus use.

D. Signalization. Ramps to or from separated facilities may be signalized. Engineering warrants for the signalization of intersection are outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways published by the Federal Highway Administration in 1971. A bus priority feature might be applicable to off-ramp intersections in dense activity centers (see Part III, Section 4: Miscellaneous Treatments).

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E. Installation Costs. High capital costs are a major inhibiting factor associated with the installation of carpool/busway projects. The cost of a separated facility should be considered, however, in relation to the cost of implementing an alternative project to accommodate the same demands, assuming those demands must be met, not compromised. Separated facilities have the potential for delivering long term benefits which might justify high initial capital costs.

RESERVED FREEWAY LANES

Reserved freeway lanes may be placed in several positions on either side of the freeway,* as shown previously in Figure 15. Reserved lanes on which the buses and carpools flow in the same direction as the rest of the traffic on the same side of the median are called concurrent flow reserved lanes. Those on the opposite side of the median from traffic flow in the same direction are called contra-flow reserved lanes. Buses and carpools in a contra-flow lane travel against the traffic on their side of the median.

Concurrent flow lanes are usually located on the inside or median lane, although outside lanes are employed on occasion. Priority vehicles may have exclusive access to the lane, but generally have the option of using all other normal freeway access points and lanes.# To date, limited access designs have not been employed to separate concurrent flow lanes from regular traffic lanes. Figure 21 shows a possible limited access slip ramp design for a concurrent lane.**

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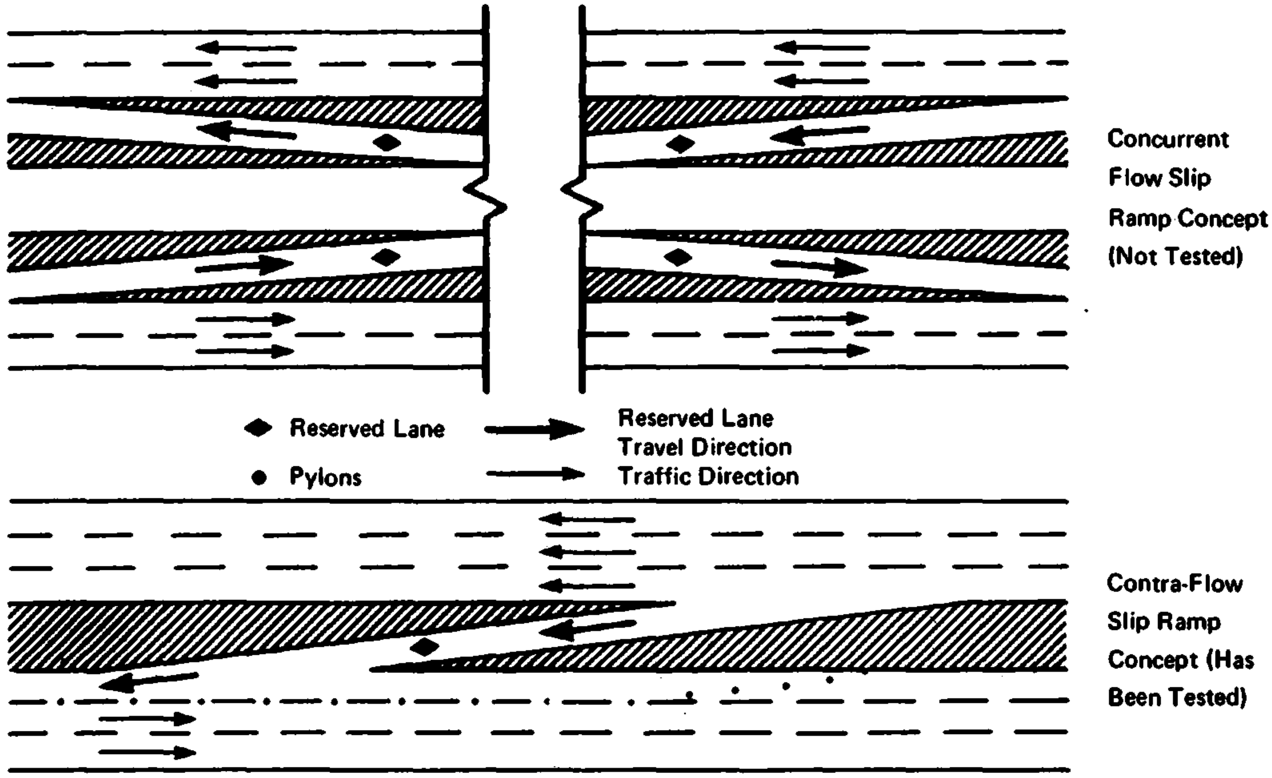
*A report funded by the Federal Highway Administration (FHWA) permits the computer simulation of freeway priority strategies within an urban area. The model, designated FREQ3CP, is described later in this section, under "Priority Freeway Access".

#Six concurrent flow freeway projects are listed in the Appendix. One of them, the Santa Monica Diamond Lane experiment, is described in detail.

**This design would limit access to the lane and may have the benefit of reducing accidents and easing enforcement. This was a problem of the Santa Monica Diamond Lane project.

Figure 21
SLIP RAMP DESIGN CONCEPTS: CONCURRENT FLOW AND CONTRA-FLOW



Contra-flow lanes are placed only along the median, so that they are not surrounded on both sides by traffic moving in the opposite direction. Access is limited to specific "slip" ramps or cross-over points, and removable barriers are normally used to delineate the lanes, as shown on the following page. A buffer lane may or may not be used to separate the traffic on the contra-flow facility from opposing freeway traffic. To date, only buses have been allowed to use contra-flow facilities.

The implementation of contra-flow usually relies on having highly directional peak period traffic flow with excess capacity in the off-peak direction. However, even when such excess capacity exists, a contra-flow lane should not be installed if it would severly impede traffic flow in the off-peak direction, while only slightly improving traffic in the peak direction. The only exception to this would occur when the overall effect of doing nothing would be much worse.

A reserved lane project should normally be considered for a freeway with less than three lanes (or two lanes and a shoulder) in each direction because freeways cannot function correctly with less than two lanes open for regular traffic in each direction.

Planning Considerations

Reserved freeway lanes are generally used for the same purposes as separated facilities. Usually, reserved lanes are not high capital-intensive facilities, generally permit greater access than separated facilities, and are thus more flexible. On the other hand, enforcement and safety are more of a problem on reserved lanes.

Given these basic characteristics, the choice of facility would depend upon the relative importance these factors (cost, access, flexibility, enforcement and safety) to the particular urban area. All things being equal, if flexibility and cost are not major issues, a separated facility is probably a better choice; if they are major issues, a reserved lane may be better.

Of course, on a project-specific basis, many other physical and political considerations (such as urban area objectives, existing freeway capacity, terrain, availability of rights-of-way, etc.) affect the decision. This decision should be addressed at the Sketch Planning stage (See Part II, Section 2).

Freeway reserved lanes are the most controversial of all freeway priority techniques. First of all, reserved lanes may be perceived by the public as subtractions from the existing roadway system, rather than additions to it (like separate facilities). This may be true even when a lane is physically added to the freeway. Secondly, reserved lanes are perceived as part of the normal roadway intended for general traffic use, whereas separated facilities are viewed as separate facilities, designed specifically for special vehicles. For these reasons, reserved lane projects are generally not as acceptable to the public as separate facilities, and thus require a more intensive marketing and public education program.

A. Operations.

(1) Concurrent flow lanes. There are no unusual maintenance considerations except for the need to maintain required pavement markings and additional signing.

(2) Contra-flow lanes. These will require a regular maintenance crew when the lane involved is delineated by set-up and take-down posts or cones (see Part III, Section 3, for discussion on spacing of pylons). Special vehicles may have to be purchased for this operation. While a minimum spacing of these pylons is necessary to maintain a certain safety standard, the cost of operation must be considered in designing these standards; obviously, the further apart the spacing, the lower the operational costs. Costs of daily operations will vary from project to project. Typically, a range of $1,000 to $3,000 per mile per month can be expected. Maintenance costs are difficult to itemize since most implementing agencies do not separate out added costs of maintenance for each operational change.

B. Enforcement.

(1) Concurrent flow lanes. Enforcement of concurrent flow lanes is more difficult than contra-flow lanes. Non-priority drivers can see priority vehicles as they approach from behind, since drivers are used to looking for traffic in parallel lanes in the same direction. Since they perceive no unusual hazards involved in entering the priority lane, they are tempted to use it. The danger caused by this violation, plus the speeding, weaving, merging, and high volumes of traffic generally found on the freeway, create a strong need for enforcement.

It is preferable to have a shoulder located adjacent to a reserved freeway lane in order to simplify enfocement. If this is not done, it becomes necessary for both the police officer and the cited driver to weave across several lanes of traffic, from the priority lane, for the citation. This is not only hazardous, but can create additional congestion on the freeway.

While enforcement techniques for concurrent lanes vary widely from area to area, it has generally been found that a high degree of initial enforcement is necessary to generate public respect for the project and any projects that may follow. Enforcement officials, however, must avoid over-enforcement, as the mere visibility of enforcement can create traffic congestion in peak hours.[14]

Capital-intensive, as opposed to labor-intensive, enforcement measures (e.g., allowing ticketing by mail for peak period offenders, use of freeway surveillance cameras for closed-circuit television monitoring, etc.) might reduce enforcement costs and improve effectiveness. However, most of these measures would require authorizing legislation before they could be applied by any enforcement programs.

(2) Contra-flow lanes. These are generally self-enforcing. Traffic in the off-peak direction is aware of high speed priority traffic coming in the opposite direction. This, by itself, is an adequate deterent.

C. Evaluation. Unlike separated facilities, reserved lanes may not be physically separated from the general traffic. Therefore, safety and enforcement are more likely to become problems in reserved lane projects.

For reasons mentioned earlier, public opposition is more likely to arise with reserved lane projects. Therefore, non-user impacts should be given more attention in reserved lane projects than with separated facilities.

Design Considerations

(1) Concurrent flow lanes. As shown earlier in Figure 15, the design for concurrent flow lanes are considerably less complicated than those for separated facilities. In most cases the lane already exists; it need only be marked and signed. Some of the factors which should be taken into account in the design of these facilities are listed on the following page.

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Table 22: Design Considerations, Concurrent Flow Lanes

- Exclusive ingress/egress ramps to and from urban center areas. Proper placement and design will eliminate difficult merging and weaving problems.

- Types of vehicles to be allowed (i.e., buses, carpools, or both).

- Bypass lanes on metered freeway ramps for users of the facility.*

- Variable message signing. This could inform motorists when the priority use lane is and is not in operation (if it is not intended to operate constantly, as is usually the case), or of changes in speed limits.

- Speed limits. Previous studies indicate that merging and weaving operations become more dangerous with high speed differentials in adjacent lanes. The maximum speed limit in the priority lane should depend, therefore, on the speed of the traffic in the regular lanes.

- Presence of left-side off ramps. If there are left-side off ramps for general traffic, a concurrent flow project becomes much more difficult to implement, because non-priority traffic must cross over the special lane to exit.

(2) Contra-flow lanes. From a design standpoint, these lanes are more complex than concurrent flow lanes. Proper design requires a critical examination of peak period traffic characteristics in both directions.

Most contra-flow projects implemented to date have included priority lanes in one direction only, and often, only in the morning peak period. Identical directional splits rarely exist in both the morning and evening peak periods since, among other things, a greater percentage of non-work trips use freeways in the evenings.

The primary factors to be taken into consideration in the design of contra-flow lane projects are signing and marking, and safety. Many other factors also play important parts in the design, including those listed on the following page.

*Refer to "Priority Freeway Access" later in this section.

- Table 23: Design Considerations, Contra-Flow Lanes
  - Entry/exit points. Both placement and signing are important.
  - Exclusive entry/exit ramps. These might be considered where contra-flow crossover operations are extremely difficult or when there are physical opportunities to construct such structures.
  - Daily operational needs. These include periods of use, operational manpower and equipment requirements of alternative lane separation schemes, and so forth.
  - Shoulders, for both enforcement and breakdown.
  - Variable message signing (see concurrent flow characteristics above).
  - Speed limits. These should be adjusted, using engineering judgement, according to: (1) the speed of opposing traffic during operation; and (2) the presence or absence of a buffer lane.
  - Types of vehicles to be allowed.
  - Left-side off ramps. Just as with concurrent flow projects, if these exist for general traffic, the project cannot be implemented.

A. Signing and Marking

(1) Concurrent flow lanes. Since access to a concurrent flow lane is virtually unlimited, signing to alert users and non-users should be spaced to make both groups constantly aware of the distinction between the reserved lane and the other freeway lanes. Post-mounted signs should be located directly adjacent to the reserved lane. Overhead signs indicating a reserved lane should be placed directly above the reserved lane, not merely over the general highway.

Signs used to reserve lanes for freeway projects should be simple and clear. Violations resulting from complex sign regulations may be thrown out in court. This makes enforcement much more difficult.*

*This happened when the San Bernardino Busway in Los Angeles was opened to carpools. Violating motorists claimed they could not read the complex signs and judges upheld their arguments.

Pavement markings for concurrent lanes are provided in the Manual on Uniform Traffic Control Devices for Streets and Highways.[15] The diamond symbol is the official designation for an exclusive use lane. (See Appendix G for sign and markings standards.)

(1) Contra-flow lanes. Delineation must be more vivid and pronounced than with concurrent lanes. Signing must compliment and reinforce the more physical markers such as posts, cones, or overhead signals. At a minimum, signs should be used to warn motorists well in advance of a contra-flow lane or section, and at freeway entry points along the contra-flow section. Variable message signs, whether manually or electronically controlled, are the most flexible means of signing for such cases. (Examples of signing for existing concurrent flow and contra-flow freeway projects are shown in Figure 22 and Figure 23.)

Equally as important as signing is the placement of physical barriers, primarily pylons (the use of a buffer lane will be treated in the next segment on Safety). As shown in Figure 24, plastic posts are the most commonly employed of these. The posts are commonly inserted into holes drilled in the pavement. The operational costs associated with this type of pylon are high, as they require daily set-up and take-down. Cones are also expensive to use, but are less stable than posts. Set-up and take-down are easier than with posts, and placement is obviously more flexible.

Mechanical "pop-up" separations have been used in reversible lane projects, but not in priority treatment projects to date. They are expensive to install and are currently being studied. The concept seems to require further research and development before its application to priority treatment facilities can be considered.

Definitive spacing guidelines have not been developed for contra-flow projects. A recent study has suggested that a one-to-one spacing ratio in feet per miles per hour of the opposing traffic, is adequate, with a minimum necessary distance of

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Figure 22
EXAMPLE SIGNS FOR CONCURRENT FLOW FREEWAY PROJECTS

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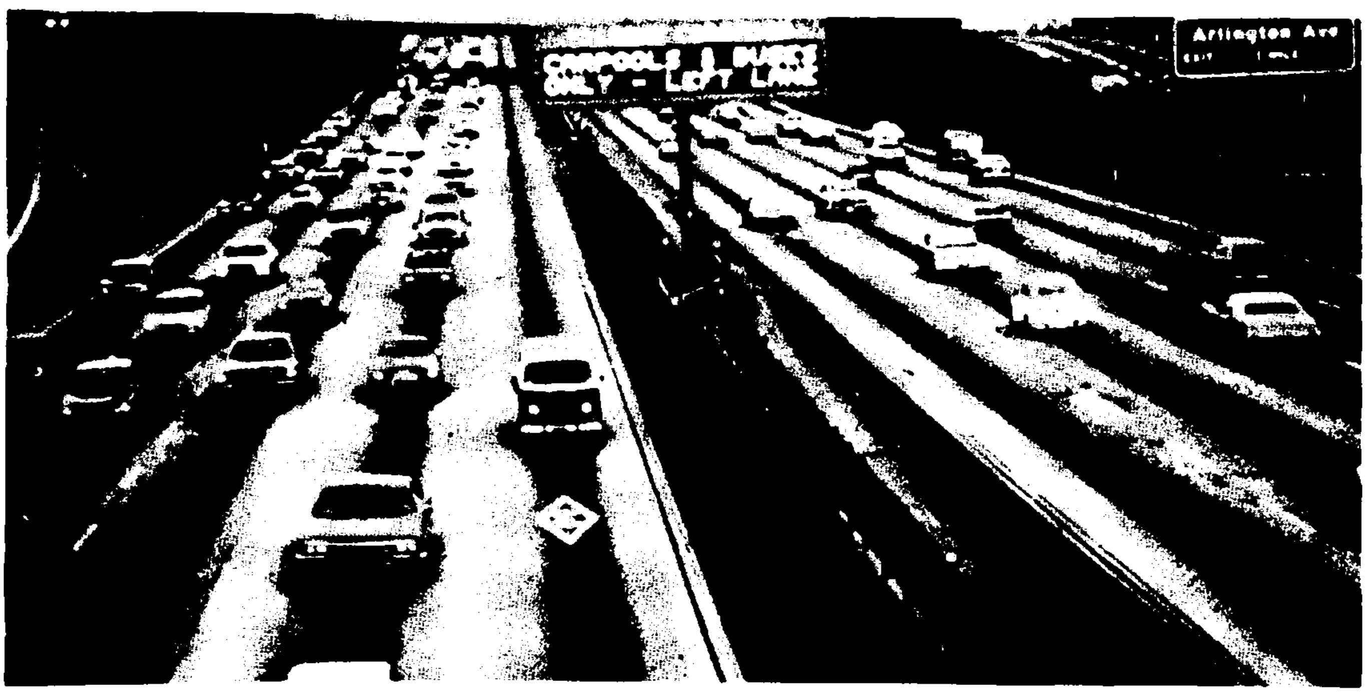
(1) MIAMI, FLORIDA: I-95

(2) LOS ANGELES, CALIFORNIA: Santa Monica Freeway Diamond Lane



SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

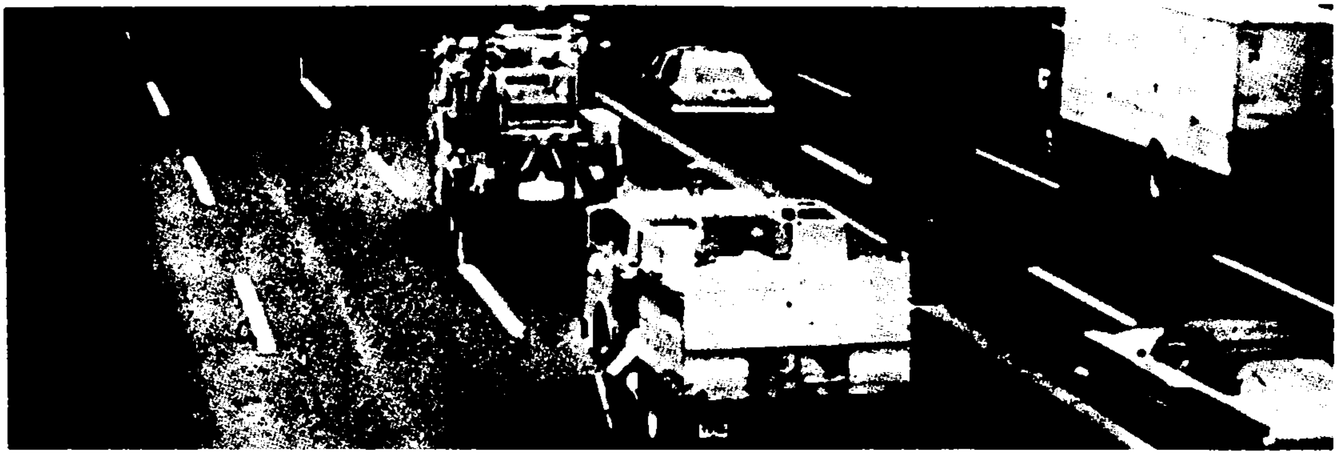
Figure 23
EXAMPLE SIGNS FOR CONTRA-FLOW FREEWAY PROJECTS

(1) NEW JERSEY: Lincoln Tunnel Approach

(2) MARIN COUNTY, CALIFORNIA: State Highway 101

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

Figure 24
LINCOLN TUNNEL APPROACH, NEW JERSEY;
CONTRA-FLOW LANE SET UP/TAKE DOWN OPERATIONS



SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

40 feet.[16] However, tests for the Boston Southeast Expressway indicate that 80 foot spacing may be adequate.[17] Further study is needed to develop definitive spacing guidelines.

As with concurrent flow lanes, the diamond symbol is the official designation suggested to delineate this lane from the others on the freeway.

B. Safety

(1) Concurrent flow lanes. Because non-priority drivers are tempted to enter concurrent flow lanes (see earlier portion on enforcement), accidents can become a serious problem. In the Santa Monica Freeway project, where carpools were allowed to use the reserved lane, the rate of accidents increased during the initial period of operation, then leveled off at roughly twice pre-project levels.[18] The reasons for these accidents are not totally clear. However, most of these were "rear-enders", and were non-injury. This was due primarily to the low speed differential between colliding vehicles moving in the same direction.

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One reason postulated for these accidents is curiosity. Drivers in the lane adjacent to the reserved lane sometimes tend to count occupants of autos in the reserved lanes, and speed up and slow down unevenly to do so. This unevenness often causes drivers behind to suddenly bunch up. Somewhere behind, in the "chain reaction", a mild accident occurs.* In addition, normal distractions, such as enforcement personnel, other accidents, and stopped vehicles, can lead to this buckling effect, which adds to the problem. Another reason suggested for these accidents involves the reaction of violators merging back into the regular traffic stream after spotting an enforcement officer or vehicle.

It is expected that much will be learned about the safety aspects of concurrent flow freeway projects when a Federal Highway Administration-sponsored study called "Safety Evaluation of Priority Techniques for High Occupancy Vehicles" is completed in late 1977.

(2) <u>Contra-flow lanes</u>. Violations have been less of a problem in contra-flow projects because the obvious fear of head-on collisions at high speeds is a significant deterrent. Thus the accident rates on contra-flow lanes tend to be low, though the severity index (injuries/accident) tends to be high. Clear and extensive signing and marking implemented on these projects may contribute to the low accident rates. Finally, contra-flow projects thus far have only permitted buses to use the exclusive lanes. These professional drivers are trained to avoid accidents. The massive appearence of buses whizzing by are a constant reminder to avoid using the lane.

A major safety issue is whether or not to have a buffer lane. Fear of head-on collisions has deterred many project designers from implementing a project of this

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*According to the California Highway Patrol, this behavior may account for the unusually high accident rate in the Number 2 lane of the Santa Monica Diamond Lane project.

type where a buffer lane could not be provided. Yet, of the four existing U.S. projects, only the contra-flow lane north of the San Francisco Golden Bridge on on Highway 101 has a buffer lane.* Since accident rates on the others appear to be no higher, it is suggested that the need for a buffer lane be considered on an individual project basis. Taken together, factors such as speed of opposing traffic, length of the reserved lane, sight distance, whether or not carpools are allowed, and directional splits should indicate whether or not a buffer lane is needed.

Some claims have been made that contra-flow lanes have resulted in lower overall accident rates; others claim minor increases. In no case to date, however, has safety been an insurmountable problem in the use of a contra-flow freeway project.

C. Access

(1) Concurrent flow lanes. Access is generally unlimited to concurrent flow lanes. Because of the expensive operational costs of employing removable posts or cones, signing and limited marking have been used almost exclusively to identify and delineate the lanes. This may be the reason for some of the safety problems cited earlier.

It has been suggested that safety might be improved if access to concurrent lanes were limited in a manner similar to that used for contra-flow facilities.[19] For instance, by placing the shoulder to the right of the concurrent lane (i.e., between it and the adjacent lane) instead of to the left, accidents might be reduced. Access could hypothetically be provided via slip ramps (illustrated earlier in Figure 21). Such concepts suggest that further experimentation with access designs might prove worthwhile.

*This buffer lane was installed primarily because the off-peak traffic was so light that the lane was available (the highway is an eight-lane freeway, and only two lanes were needed in the off-peak direction).

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(2) Contra-flow lanes. Contra-flow freeway lanes require specially designed access points at terminal or at any intermediate points where access may be desired. To get to a contra-flow lane, priority vehicles normally must cross the freeway median. Access ramps (generally slip ramps) should be clearly signed for the priority vehicles only, and should be able to accommodate buses traveling at freeway speeds. Horizontal and vertical curvatures should conform to the American Association of State Highway and Transportation Officials (AASHTO) standards for urban highway design.*

It is difficult to implement a contra-flow lane on a freeway with an extra-wide median strip or a median strip where both sides of the freeway are not at the same vertical alignment.

Access points should be clearly signed to warn non-priority motorists when a merge to the right is required, or to warn priority vehicle drivers of a required merge to the right or left. When the priority lane is being placed into or taken out of operation, a procedure must be developed for closing and opening access points, and "flushing" the lane of either priority or non-priority vehicles (depending upon whether the lane is being opened or closed).

D. Signalization. The only signalization equipment which might be applicable would be overhead reversible lane signals for contra-flow lanes. Most transportation engineers feel that because of the high speeds involved, these signals should be used to supplement other lane separators. However, such signalization might further reduce the need for a buffer lane, since it would provide a clearly visible reminder of the contra-flow operation.

E. Installation Costs. Costs depend primarily upon the amount of construction, if any, that is needed, and upon the type and amount of supplemental structures needed for signing, marking and enforcement.

*See the Annotated Bibliography for information on how to obtain this document.

Concurrent flow projects may involve construction of additional lanes and costs must include supplemental traffic control devices. Contra-flow projects, however, require special access. Thus most projects have involved at least minor construction, in addition to signing, marking and enforcement efforts. Costs for both types of facilities have ranged from $10,000 to $30,000 per mile.

PRIORITY FREEWAY ACCESS

Giving high occupancy vehicles priority access to freeways has been the least controversial and most common of freeway priority techniques implemented so far. The table below is an enumeration of the general reasons for this successful record, along with the common purposes of priority freeway access.

- Table 24: Priority Freeway Access

  (1) General Reasons for Project Successes

  - •• Access ramps affect a relatively smaller proportion of the total freeway trip than do reserved lanes-- thus non-user motorists are less inclined to perceive such measures as having significant detrimental impacts on them.
  - •• In places where it has been implemented, the public has generally perceived priority freeway access as a reasonable and acceptable measure to encourage the use of high occupancy vehicles.
  - •• Projects either have a positive or very little impact on freeway safety.
  - •• The costs involved with priority freeway access projects are generally less than those related to other freeway alternatives.
  - •• The implementation time frame associated with providing priority access is generally shorter than for the other types of freeway priority techniques.

  (2) Common Purposes of Priority Freeway Access

  - •• To provide high occupancy vehicles exclusive and easy access to a freeway within a congested activity center.

- To improve the travel times of high occupancy vehicles in a freeway corridor where reserved lanes or separated facilities are unfeasible.

- To improve the travel times of high occupancy vehicles in a freeway corridor where high occupancy vehicles would not be impeded by traffic congestion on the freeway (i.e., on a metered freeway where peak hour traffic is running smoothly becuase of an on-going ramp metering project).

- To improve the travel times of high occupancy vehicles in a freeway corridor where reserved lanes have been or are being implemented.

Two types of priority freeway access are covered in this section: (1) bus and/or carpool bypass lanes at metered ramps; and (2) exclusive bus and/or carpool ramps. Bypass lanes are used on a ramp which is shared by low occupancy vehicles while an exclusive use ramp is used only by high occupancy vehicles.

Planning Considerations

A. Applicability

(1) Bus and Carpool Bypass Lanes at Metered Ramp. Ramp metering has been used since the late 1960's to maximize the capacity of urban freeways. It is now used daily in more than 20 American cities. The installation of high occupancy vehicle bypass lanes in conjunction with ramp metering is a newer concept.

A state-of-the-art report describing various forms of ramp metering and other freeway surveillance and control measures was compiled and documented by Everall in 1972.[20] This report is useful to any highway agency considering ramp metering as a technique to control freeway operations. Many options of freeway traffic control not discussed in this manual are provided in the Everall study.

Freeway volumes, densities and speeds are related parabolically as shown in Figure 25 on the following page. Various capacity studies have shown that if

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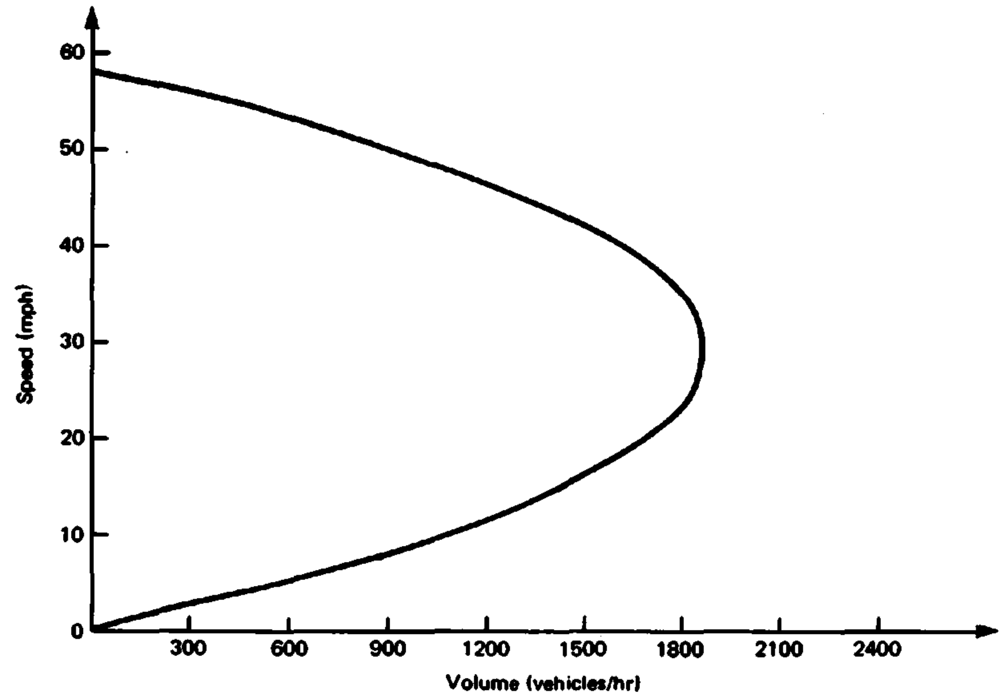
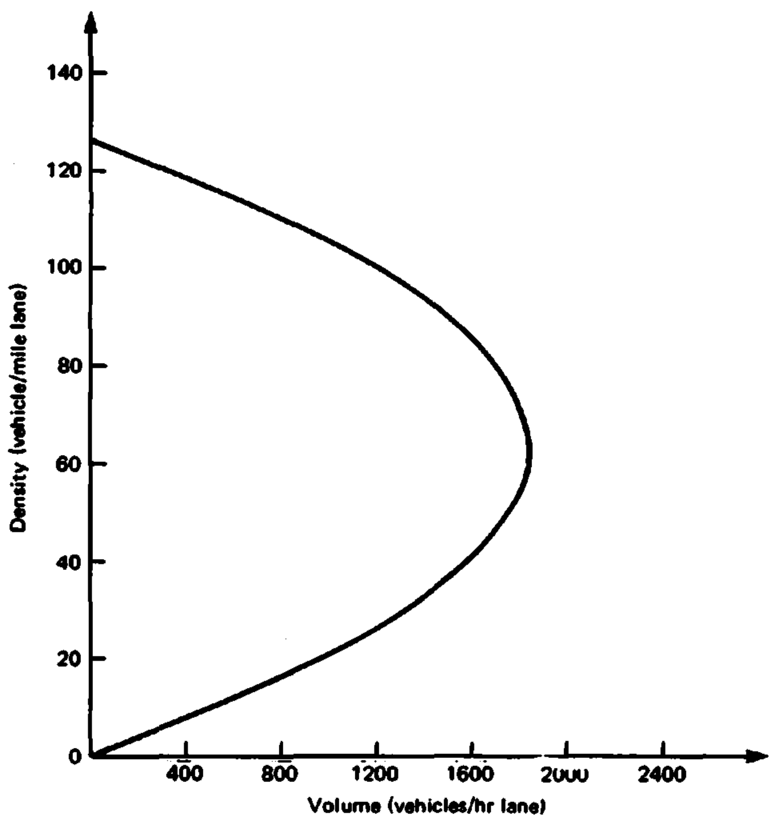
Figure 25
RELATIONSHIPS BETWEEN VOLUMES, SPEEDS, AND DENSITIES

(1) Speed Volume Relationship: Greenshield's Hypothesis



(2) Density Volume Relationship: Greenshield's Hypothesis



SOURCE: Paul F. Everall, *Urban Freeway Surveillance and Control: The State of the Art* (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, November, 1972), pp. 6 and XX.

the volume of on-ramp traffic entering a freeway section could be controlled according to the on-freeway volume densities, the freeway could serve an optimal volume of traffic without becoming congested.

Metering applies these concepts by allowing a freeway to operate at the highest vehicle volume possible within a given level of service (e.g., 30 to 40 mph). A successful ramp metering project will eliminate stop and go conditions on a freeway without overburdening the parallel street system or causing excessive ramp delays.

In addition to improving vehicle flow, a metered freeway ramp can move people more efficiently if a priority bypass lane is also provided for high occupancy vehicles. Metering concepts with and without a priority bypass lane are illustrated in Figure 26. As the figure shows, the bypass lane on a metered ramp can either be metered or unmetered. It is usually unnecessary to meter a bypass lane unless the volume of high occupancy vehicles becomes so great that an uncontrolled bypass lane will create congestion on the freeway.

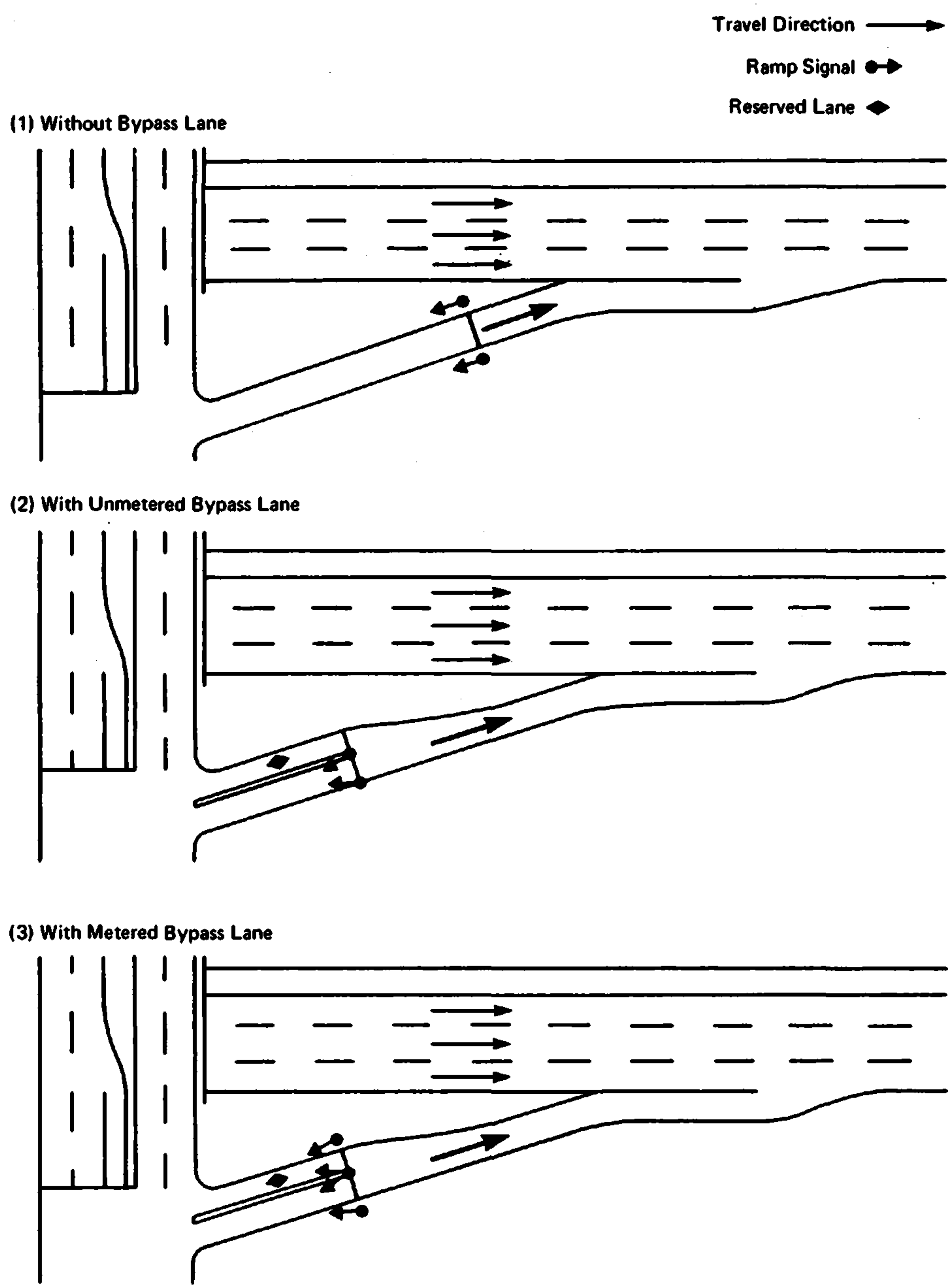
The bypass lane for high occupancy vehicles can be reserved on the right or left side of the non-priority lane. Generally, left side lanes are reserved because:

- Passing on the right might cause potential safety problems; and
- Queues might form on the cross street blocking entry to a right side priority lane.

Metered freeway ramps are controlled by signals displaying alternating red and green indications. The signals usually operate only during peak periods or when warranted by freeway conditions. Typically, only one vehicle is allowed per green indication.

While not directly related to priority bypass lanes, some inter-agency

Figure 26
RAMP METERING CONCEPTS: WITH AND WITHOUT PRIORITY ACCESS LANES



conflicts may occur when ramp metering is proposed. Ramp metering normally diverts some freeway traffic to parallel local street systems resulting in traffic delays on those streets. Thus, if two different agencies are responsible for traffic control on the parallel streets and freeway, respectively, they should come to some agreement over the trade-offs involved in ramp metering.

A ramp metering project may be justified if delays on parallel and cross streets do not exceed the delay savings encountered as a result of the ramp metering project. Nonetheless, the local traffic engineer should be prepared to accommodate increased traffic on local parallel routes and potential delay problems on freeway cross streets with interchanges.

Two types of ramp metering control devices can be employed--fixed time or demand responsive.

Fixed time control is obtained by pre-setting metering rates according to the time of day. These rates are estimated on the basis of past traffic counts taken on the freeway and on the ramp. Fixed time control is ramp specific and can be used without detectors. The number of metering rate possibilities are limited by the capabilities of the on-site controller. Fixed time metering is usually applied in situations where hourly freeway conditions are very predictable (or demand responsive metering is too expensive to be applied).

Demand responsive control is obtained by using vehicle detectors on the ramp and freeway to optimize metering rates. Demand responsive control adjusts metering rates according to real-time traffic conditions. The detectors feed information on freeway and ramp volumes, speeds and densities into a computer which analyzes the information and adjusts metering rates accordingly. While it costs more than fixed time metering, demand responsive control:

- Is responsive to unpredictable congestion created by freeway incidents such as accidents.

- Is more efficient than fixed time control--i.e., it can result in less delay per vehicle.

- Can optimize ramp metering over a section of freeway served by several ramps. It does this by treating the freeway section as a system, where as fixed time metering would treat the same section on a ramp by ramp basis.

The discussions which follow provide information on how to use priority freeway access with demand responsive or a fixed time metering control.

(1a) Demand Responsive Ramp Metering. Selection and evaluation of the many alternative ramp metering strategies, including those which give priority to high occupancy vehicles, is a complicated procedure. Consequently, several computer models have been developed to help evaluate and apply demand responsive metering strategies. One of the better ones is FREQ3CP.[21]

The FREQ3CP model can be applied to determine an optimal demand responsive metering strategy and can be used to control demand responsive ramp metering. It has proven effective on three actual freeway sections (Santa Monica Freeway, Los Angeles; Long Island Expressway, New York; East Bayshore Freeway, San Francisco). The maximum freeway section which the FREQ3CP model can accommodate is a section with 20 on and 20 off ramps in one direction.[22]

By using FREQ3CP, demand responsive ramp metering can accomplish any one of the following:*

- Maximize the number of vehicles served by a ramp in peak periods.

- Maximize the number of vehicle-miles generated by the vehicles using the ramp over the metered section of freeway in peak periods. Metering rates are reduced to allow slightly fewer vehicles by diverting shorter vehicle trips to parallel streets. Thus longer vehicle trips will be served by the ramp.

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*Enhancements to the model are forthcoming and the Federal Highway Administration should be contacted for current information.

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- Maximize the number of persons served by the ramp in peak periods. This incorporates a priority lane in addition to a non-priority lane.

- Maximize the number of person-miles generated by the passengers using the ramp over the metered section of freeway in peak periods. The metering rate for the non-priority lane is reduced to allow slightly fewer persons by diverting shorter person trips to parallel streets. Thus longer person trips will be served by the ramp.

For the last two options, metering rates will reflect the occupancies of the vehicle using the ramp.

One advantage of FREQ3CP is its flexibility of application. Its submodels--FREQ3, which stimulates freeway conditions, and PREFO, which optimizes freeway entry strategies--can be used independently as well. The FREQ3CP model integrates these two submodels and has the characteristics noted on Table 24 on the following page. In applying the FREQ3CP model, the user must be particularly satisfied that the data requirements described in the User Documentation Report can be obtained and will be of satisfactory quality. If input data is poor, the model should not be applied.

When the origin-destination tables are prepared for FREQ3CP, a minimum time interval for data input must be selected. Generally, 15 minutes is a useful time interval. If demand fluctuates often, a 10 minute interval may be more appropriate. While a smaller time interval is more accurate, it will increase the costs of both data collection and computer processing time. Metering rates resulting from application of the FREQ3CP model must be "fine-tuned" according to actual data measurements during the project operations phase.

(1b) Fixed Time Ramp Metering. Two 1975 reports--Guidelines for Design and Operation of Ramp Control Systems,[23] and the U.S. Department of Transportation UMTA Office of Transit Planning's Final Report for the I-35W Corridor Demonstration

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Table 25

FREQ3CP MODEL CHARACTERISTICS[22]

- OPERATING MODES
  - FREQ3, which evaluates freeway design alternatives and the consequences of changes in traffic demand;
  - FREQ3C which selects a vehicle entry control strategy (freeway metering rates) and evaluates traffic performance; and
  - FREQ3CP which selects a high occupancy vehicle priority entry control strategy and evaluates traffic performance with and without priority control.
- INPUT DATA REQUIREMENTS
  - Origin-Destination Tables. Each table must give the number of vehicles for every combination of entry and exit points along the freeway analysis section, for the time interval being considered. Tables for one to six time intervals are allowed.
  - Passenger Car and Bus Occupancies. Passenger car occupancies must be expressed as X% single passenger vehicles, Y% two passenger vehicles, etc. Vehicles with 6 or more passengers are considered to be buses.
  - Freeway Characteristics. Freeway capacity, weaving, speed flow, and ramp characteristics are needed.
  - Control Parameters. As described previously, four options are available: maximization of vehicles, vehicle-miles, passengers or passenger-miles.
  - Maximum and Minimum Metering Rates. There are two options available: input rates for the full ramp or input rates for the non-priority lane only.

Project[24] (currently available)--can provide guidance in selecting an appropriate fixed time ramp metering strategy involving priority bypass lanes. Some of the ramp metering strategies covered in the above documents do not require the use of computers.

(2) Exclusive Bus and/or Carpool Ramp. There are several different design concepts for exclusive use ramps. Three of these concepts, involving one-way operation with direct freeway access, one-way operation with indirect freeway access, and reversible ramp* operation with direct freeway access, are shown in Figure 27. Exclusive use ramps may be applicable under certain circumstances as shown below.

- Table 26: Appicability of Exclusive Use Ramps
  - When there is a physical opportunity to construct a new ramp or to designate an existing ramp for exclusive use by high occupancy vehicles;
  - When freeway merging and weaving can be accommodated (i.e., spacing between the exclusive ramp and other ramps is adequate) during peak hours (or all day long);
  - When there is peak period or all day congestion on entrance/exit ramps serving an urban center;
  - When the exclusive ramp could bypass significant congestion and thus save travel time in an urban center;
  - When there would be more passengers carried on the priority ramp at a better level of service than without it; and
  - When there are support services and facilities available for express buses or carpoolers using the ramp.

B. Enforcement

(1) Bus and/or Carpool Lanes at Metered Ramps. Compliance rates at ramp metering bypass projects have been surprisingly good. Periodic enforcement at

*One notable case where a reversible ramp has been effectively implemented occurs in the Seattle, Washington, I-5 Blue Streak Project. The ramp in that project was used to provide exclusive access for buses to a special downtown circulation loop.

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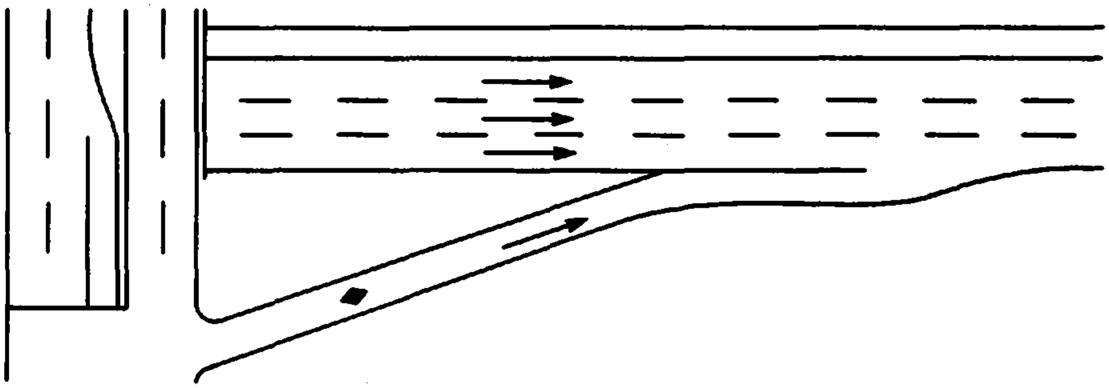
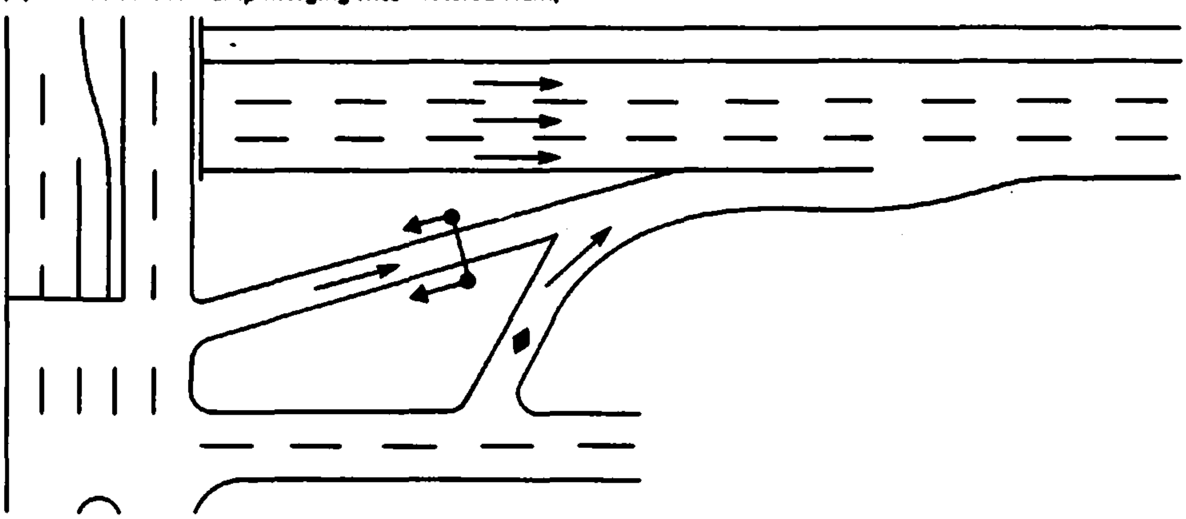
Figure 27
EXCLUSIVE USE RAMP DESIGN CONCEPTS

Travel Direction ⟶ Pylons • • • • •
Reserved Lane ◆ Ramp Signal ●⟶

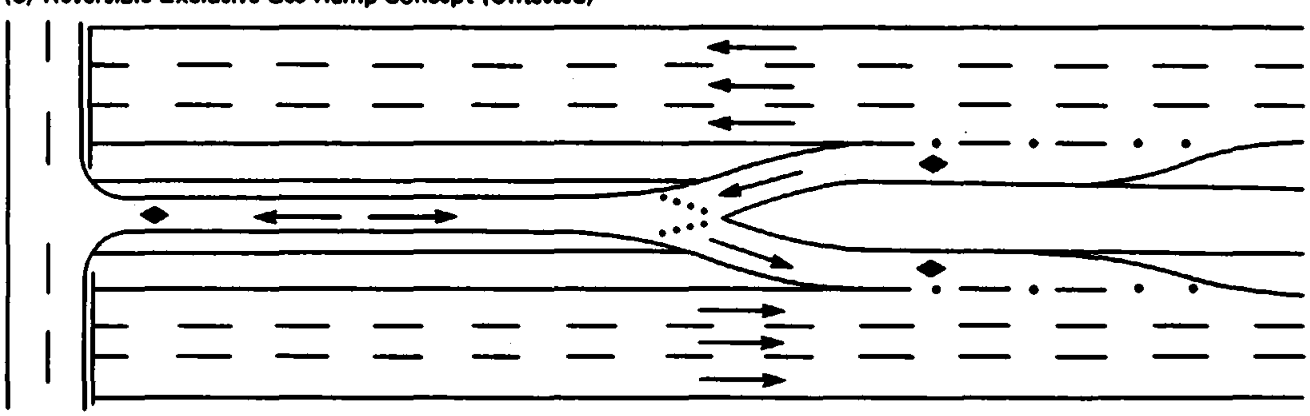
(1) One-Way Exclusive Use Ramp Concept



(2) Exclusive Use Ramp Merging Into Metered Ramp



(3) Reversible Exclusive Use Ramp Concept (Untested)



bypass ramps is necessary though "...each location has its own enforcement characteristics."[25] Average compliance for 13 priority bypass metered ramps in Los Angeles, California is 87.6%. According to Goodell, a bypass ramp is adequately enforced if it has 85 to 90% compliance.[26]

(2) Exclusive Bus and/or Carpool Ramps. Enforcement compliance has also been excellent for exclusive use ramps, though again periodic enforcement campaigns may be required. Installing a gate actuated by specially issued plastic cards is one enforcement measure that can be taken.

For exclusive bus-only ramps, however, a gate causes a delay in bus operations which may outwiegh its enforcement benefits. Due to lack of control, carpools should not be allowed to use gated ramps.*

C. Evaluation.

(1) Bus and/or Carpool Lanes at Metered Ramps. The minimal evaluation data gathered and used in the Los Angeles area may be used as a model for most bypass lane evaluations. Figure 28 shows a typical evaluation data sheet compiled by the California Department of Transportation for Los Angeles area bypass metered ramps. It should be noted that accidents are not shown on this sheet since they did not occur on any of the ramps.[27] Where they occur, accident statistics should be included. In addition, attitudinal surveys of users and non-users can provide insight into the human factors associated with priority bypass lanes.

(2) Exclusive Bus and/or Carpool Ramps. Exclusive use ramps might be evaluated using similar types of data including:

- Number of buses and/or number of carpools used daily and during peak periods--after opening (and, if applicable, before);

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*Mechanical gates have been installed on the Dulles airport access road to give buses access to Reston, Virginia.

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Figure 28
EVALUATION DATA SHEET: BYPASS LANES

DATA ON CARPOOL BY-PASS RAMPS LOS ANGELES AREA Date: Oct. 1, 1975		L.A.-405		L.A.-10 W/B					L.A.-10 E/B				L.A.-5		
		Lakewood	Hawthorne	Hoover	Vermont*	Western	Crenshaw	Fairfax	Manning	Venice	Western	Vermont	Los Feliz	Western	Stadium Way
Months in Operation		27	17	11	7*	11	11	11	4	4	4	4	10	4	3
Peak Hour Operation		P.M.	A.M.	P.M.	P.M.	P.M.	P.M.	P.M.	A.M.	A.M.	A.M.	A.M.	P.M.	A.M.	P.M.
No. of Carpools (Daily)	Before	125	150	230	283	194	142	183	233	115	335	273	360	67	125
	Max.	471	443	294	246	191	185	210	322	312	382	285	587	130	147
	Latest	351	422	258	–	191	185	192	322	312	382	285	495	129	147
% Increase in No. of Carpools	Max.	277	195	28	-22	-2	30	15	38	171	14	4	68	94	18
	Latest	180	181	12	–	-2	30	5	38	171	14	4	41	93	18
Time Savings by Carpools (minutes)	Max.	7½	6½	6	–	2¾	5	2	5½	6	1½	1	5½	5	1
	Min.	1½	1	1½	–	1	1¾	½	½	1	¼	¼	½	¼	0
	Avg.	5	4½	3½	–	2	3	1¼	3½	4½	½	½	3¾	2½	½
% Carpools Using Ramp	Before	17	15	20	24	27	22	22	13	13	18	22	16	17	25
	Max.	50	34	24	19	27	24	23	19	32	21	23	27	24	26
	Latest	39	31	24	–	27	24	21	19	31	21	23	25	23	26
Total Ramp Occupancy Persons/Vehicle	Before	1.23	1.18	1.28	1.35	1.31	1.29	1.33	1.16	1.16	1.21	1.28	1.20	1.22	1.28
	Max.	1.79	1.47	1.31	1.24	1.31	1.30	1.30	1.24	1.40	1.27	1.31	1.34	1.29	1.37
	Latest	1.56	1.38	1.31	–	1.31	1.29	1.30	1.24	1.39	1.27	1.30	1.30	1.26	1.35
Number of Violators (Daily)	Max.	63	147	156	456	285	315	239	55	119	81	67	349	45	27
	Min.	11	35	80	328	144	165	64	18	52	46	47	137	22	11
	Latest	72	137	104	–	144	165	69	44	119	81	67	137	45	11
% of Violators Violators/Single Occ. Veh.	Max.	13.3	16.7	14.6	44.3	50.7	47.2	31.3	2.3	17.3	5.7	7	19.6	10.6	7
	Min.	1.6	3.6	6.3	34.3	27.6	27.7	8.9	1.3	7.3	3.2	5	9.0	5.4	2.6
	Latest	13.3	14.4	12.9	–	27.6	27.7	9.6	3.3	17.3	5.7	7	9.4	10.6	2.6
Carpool Size (latest)	% 2 pers.	72	82	80	83	85	75	73	87	81	92	77	84	92	78
	% 3 pers.	18	13	15	11	12	15	16	10	14	6	16	13	6	14
	% 4 pers.	10	5	5	6	3	10	11	3	5	2	7	3	2	8
Buses Per Peak Period		8	1	0	12	1	1	1	3	16	61	10	12	13	–

*Discontinued May 10th, 1975

SOURCE: Goodell, "Experience with Carpool Bypass Lanes in the L.A. Area", *Proceedings of the Transpo L.A. (1975).*

- Total ramp person volume, and average carpool and bus occupancies;
- Time savings in minutes; priority vehicle or non-priority vehicles;
- Percentage splits between various carpool sizes using ramp; and
- Accidents after opening.

D. Staging.

(1) Bus and/or Carpool Lanes at Metered Ramps. If a ramp metering priority treatment project is to be used in conjunction with supporting transit or other priority treatment services, the provision of these other services and treatments should, coincide with ramp metering implementation.

(2) Exclusive Bus and/or Carpool Ramps. These do not involve any staging considerations other than the above.

E. Operations and Maintenance.

(1) Bus and/or Carpool Lanes at Metered Ramps. Bypass lanes on a metered ramp do not require any unusual operations and maintenance considerations beyond maintaining the marking and signing needed to designate the lane.

(2) Exclusive Bus and/or Carpool Ramp. Operations and maintenance for these ramps is not much different for a normal mixed traffic ramp unless reversible operation is used. With reversible operation, variable message signing and/or set-up and take-down operations for removable barriers may be necessary and can add considerably to operations and maintenance costs.

Design Considerations

Priority freeway access planning and design considerations overlap significantly. This discussion is limited to short descriptions of only those aspects

Figure 29
CARPOOL BYPASS LANE: LOS ANGELES I-405

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

of signs and markings, safety, signalization and cost which have not been discussed in the General Planning Considerations section.

A. Signings and Markings. The signing standards are given in an amendement to the Manual on Uniform Traffic Control Devices.[28] signs for bypass or metered ramps should be placed on the reversed lane side of the ramp entrance. The ramp should be delineated with the standard diamond symbol.[29] Figure 29 shows a typical metered ramp.

A left turn prohibition sign may be needed if queues caused by vehicles turning left into a non-priority lane block traffic on the cross street serving an entrance ramp as shown in Figure 30. The sign could be mounted directly across from the left turn pocket to prohibit all but high occupancy vehicles from turning left in peak

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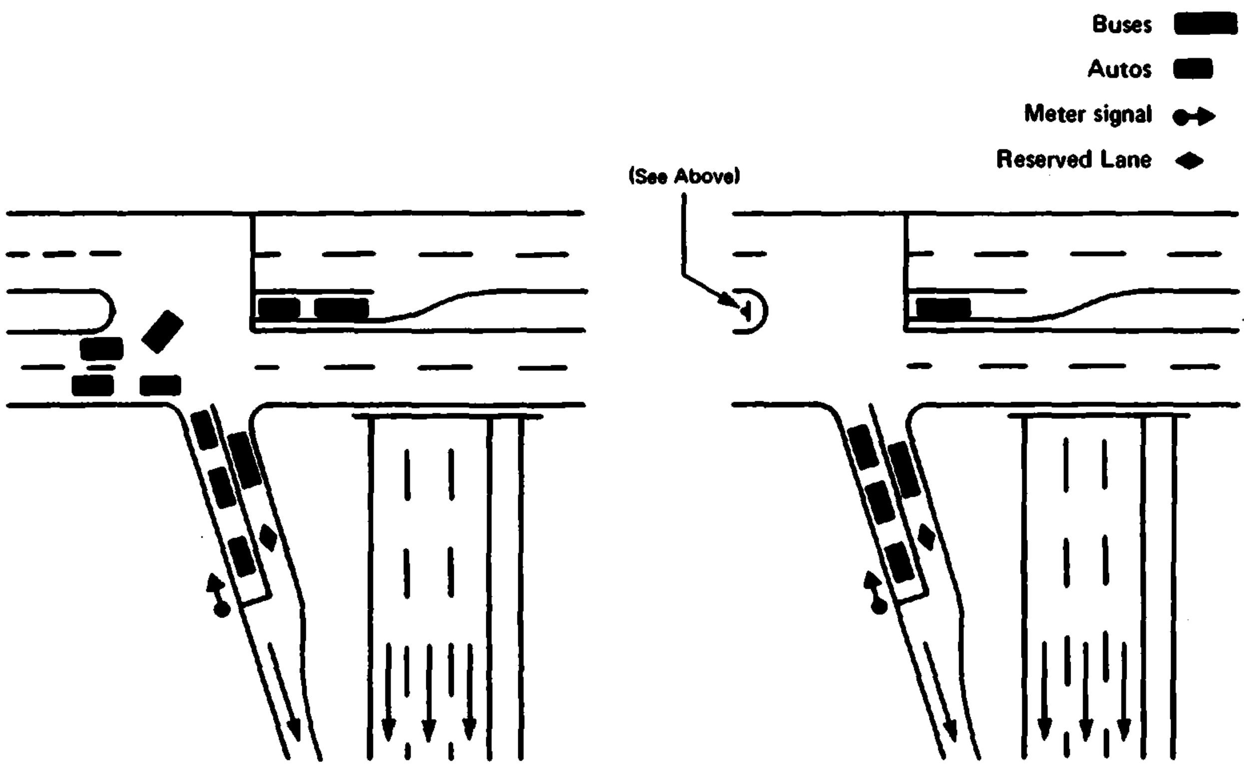
Figure 30
LEFT TURN PROHIBITION AT METERED BYPASS RAMPS: PREVENTING QUEUES ON CROSS STREETS

(1) Typical Left Turn Prohibition Sign

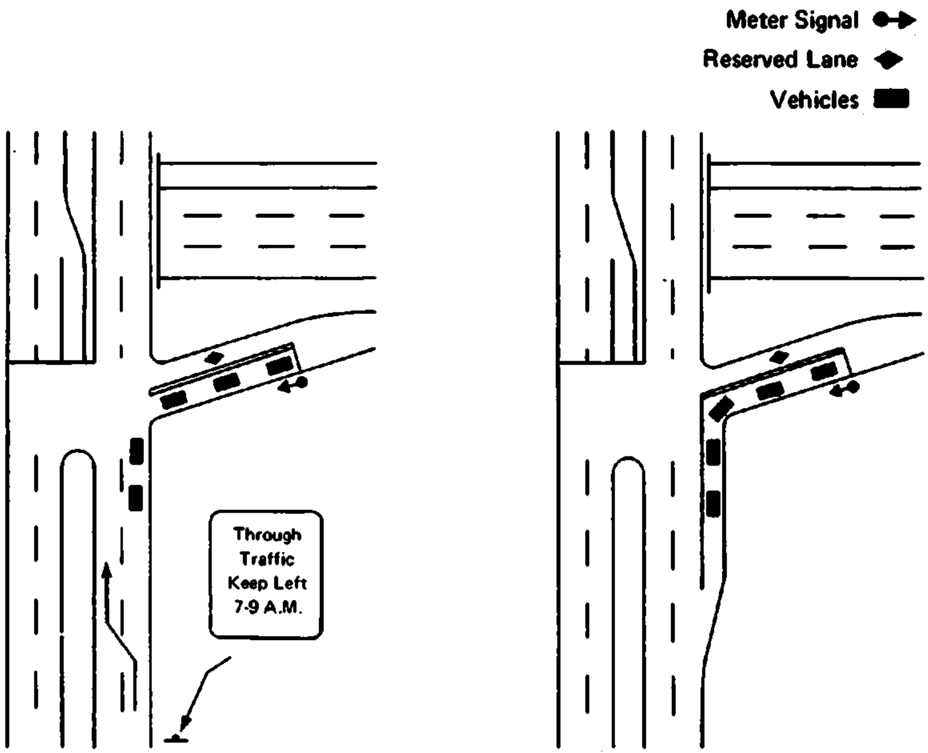
SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.



(a) To prevent this . . .

(b) . . . do this.

Figure 31
PREVENTING RAMP-METERING QUEUES FROM BLOCKING TRAFFIC



*Ramp metering signalization was covered previously.

hours. Queues may occur if the ramp vehicle storage area is not long enough. The problem of long queues may be solved by lengthening the ramp or reducing metering rates to allow fewer vehicles on the facility in peak hours--thus diverting more shorter trips. In this instance the left turn prohibition would not be needed.

B. Safety. Previous priority freeway access projects have had excellent safety records. Merge points of the priority and non-priority lanes are the major concerns.

C. Signalization.* If possible, ramp signals should not be placed so close to the ramp entrance that queues will back up into a cross street. Bus operators may

*Ramp metering signalization was covered previously.

otherwise complain that ramp queues prevent good bus service in the curb lane. If a ramp is too short, and if it is desirable to keep through-traffic out of those ramp queues, appropriate advisory signing for cross street through traffic during ramp metering operations (e.g., "through traffic keep left 7-9a.m.") might be helpful, if placed back far enough to give through motorists adequate warning. Another way of solving this might be to provide a right turn bay for ramp traffic (see Figure 31).

D. Costs. The extent of additional construction required for priority vehicle bypass lanes at ramps already metered is a key factor in determining costs. In Los Angeles, implementation costs not involving construction have ranged from \$3,000 - \$6,000 per ramp in addition to the cost of metering.[30] Costs with widening and/or provision of signal equipment ranged from \$10,000 - \$66,000 per ramp.

Likewise, capital costs for an exclusive bus and/or carpool ramp will also vary according to whether or not construction is involved. State agencies responsible for freeway planning should be able to estimate exclusive use ramp costs. Actual operations and maintenance costs associated with a priority bypass lane at a metered ramp are negligible if the costs associated with the ramp metering are not included.

Maintenance costs for exclusive use ramps are similar to those required for normal freeway entrance or exit ramps.

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Section 2

ARTERIAL-RELATED PRIORITY TECHNIQUES

INTRODUCTION

The term, arterial, as used here, applies to any heavily-traveled non-freeway street that connects urban residential areas with major commercial, industrial, or other employment areas.

Two categories of priority techniques are possible for implementation on arterials: (1) the reservation of an entire lane for special use by high occupancy vehicles, and (2) special privileges--not involving lane reservations--for high occupancy vehicles. The former may be only in peak periods or all day. The latter category is exemplified by signal preemption and special turning privileges, although both of these techniques can be employed with or without reserved lane facilities. Arterial techniques might be applied to fulfill one or more objectives.

- Table 27: Possible Objectives for Arterial Techniques
  - Increasing the person carrying capacity of the corridor (e.g., any reserved lane project), while reducing the quantity of recurring low occupancy vehicle trips during peak periods.
  - Expedite local transit service during peak periods or throughout the day (e.g., reserved curb lanes, signal preemption);
  - Expedite express transit services during peak periods or throughout the day (e.g., any non-curb reserved lanes, curb reserved lanes with signal preemption, signal preemption alone, or signal progression with a contra-flow reserved lane);
  - Expedite local and express transit service during peak periods or throughout the day (e.g., reserved curb flow lanes with signal preemption and/or room for passing;
  - Encourage peak period carpool usage (e.g., concurrent flow non-curb lanes); and

- Improve circulation for high occupancy vehicles (e.g., left turn restrictions for low occupancy vehicles).

An arterial priority technique also might be applied to improve general traffic flow and/or safety. If so, it would have to compare favorably with several other common traffic alternatives which include, but are not limited to:

- Widening;
- Installation of one-way street pairs;
- Provision of vehicular channelization, including right or left turn bays;
- Signalization improvements, including phasing, interconnection, and actuation; and
- On-street parking restrictions.

Some of these measures--and most of the measures in the Transportation Systems Management (TSM) spectrum[1]--are much easier to implement than priority treatment projects because they are less costly and politically feasible, since most of them offer equal improvements to all drivers. However, priority treatment projects, when properly combined with other measures, and when transit service is available to complement them, can be among the most effective means of achieving improvement in people movement and traffic flow. The key to the degree of improvement lies in how well the chosen combination of measures work togehter.

Evaluation

Because priority and non-priority vehicles affect one another so strongly on arterials, an evaluation of the priority treatment project's success or failure should include a wide array of considerations and indicators.

- Table 28: Arterial Techniques, Evaluation Considerations
  - Accident statistics (number, type and severity, lane in which most accidents occur, time of day, etc.);

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- Travel times, by lane;
- Speed and delays;
- Special delay studies on turn restrictions (if any);
- Vehicle occupancy counts and comparisons (pre- vs. post-project);
- Volume counts for facility and parallel routes;
- Bus schedule and ridership checks;
- Off-street bus service needs (loading areas, shelters, etc.);
- On-board transit surveys (origin and destination, former mode of travel for this trip, trip purpose, attitudes, mode of access to transit, etc.);
- Carpool lane user's survey;
- Non-priority user's survey;
- Business impact survey;
- Parking facility user counts; and
- Operator costs.

Marketing

Arterial techniques generally affect a broader spectrum of non-users than do freeway techniques. These non-users may include adjacent property owners, taxi operators, pedestrians, bicycle riders, and goods movement operators. Therefore, the marketing effort is extremely complex, and should be directed to many different audiences.

Through an aggressive marketing program, project objectives and transit and traffic operational changes should be understood by, if not convincing to, non-users as well as potential users. The Marketing Plan described in Part II of this manual should be closely followed, and a special emphasis should be placed on public education and establishing two-way communications between affected non-users and project implementing and operating agencies.

Responsibilities

It would be impossible, in this guide, to suggest guidelines uniformly appropriate to the diverse governmental bodies across the nation. In general, though, the following agencies would be represented from each jurisdiction:

- Agency with operating responsibility for the facility;
- Chief Administrative/Elective Officer;
- Planning Department;
- Police Department;
- Public Works Department;
- Traffic Engineering Office; and
- Transit Agency.

Urban areas in the United States are often composed of numerous local government jurisdictions. A major arterial may pass through more than one local jurisdiction, making interagency coordination and determination of the agency responsible for various tasks an important and often complicated task. Specific guidelines for setting up the coordinative mechanisms are contained in Part II, Section 2: "Administrative Plan".

If more than one jurisdiction is involved, counterpart agencies at the county or township level, or the Metropolitan Planning Organization (MPO), might be included, particularly if they could serve a coordinating role. (Refer to Part III, Section 2: "Sketch Planning", for a discussion of the role of MPO's).

Opinions have been mixed on the possible applicability of reserved lanes for arterials. A recent feasibility study of bus and carpool lanes on arterials indicated that the use of reserved lanes generally was not appropriate to most arterial corridors in the Pittsburgh and Philadelphia urban areas.[2] Some of the reasons given for the inapplicability of arterial techniques included:

- The removal of peak period or all-day parking along arterials may be difficult to accomplish, and may result in opposition from abutting businesses and residents;
- Accidents may increase if the densities of non-user vehicles is increased;
- Non-users may initially experience significant increases in travel time;
- Non-user turning movements may become more difficult to negotiate due to the increased densities of traffic in the non-priority lanes;
- Enforcement may become difficult and expensive;
- Goods movement in non-user vehicles can be adversely affected during periods of lane operation; and
- The improvement in air quality in the overall urban area can be negligible--carbon monoxide levels may actually increase in corridors where overall vehicle travel times are degraded.

Such problems do not preclude the use of reserved lanes but, taken together, do suggest several ideas that could aid in their practical implementation. First, an extensive public education program should be implemented. Potential benefits to user and non-user groups impacted by the project should be clearly demonstrated. Second, opposition can be expected if a project involves the removal of a parking lane, impedes goods loading and unloading, or degrades travel time for non-users. Third, the priority treatment project may need to be combined with

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other measures to improve goods movement or traffic flow--especially the provision of support services and facilities, and additional transit vehicles. Fourth, an extensive and active marketing campaign to attract ridership should be undertaken. Fifth, operations and enforcement for arterial projects deserve close attention in planning to minimize the costs of each.

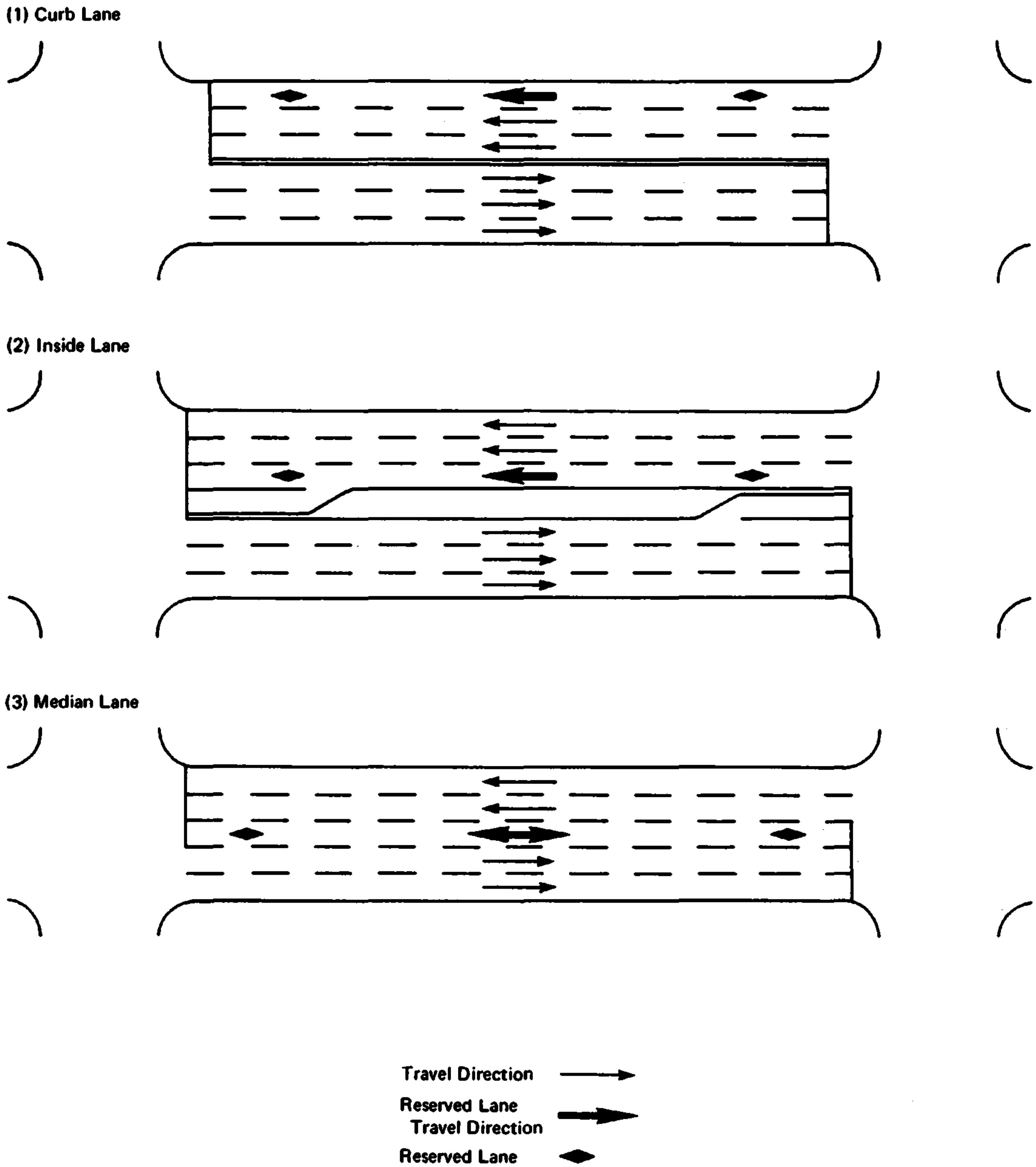
Planning Considerations

A. Roadway Constraints and User Requirements. Because of the complexity of traffic movement on arterials, reserved lanes have certain requirements which should be satisfied before they can be implemented. In addition, only certain classes of users can be allowed. Since these differ for the two types of reserved lanes, Concurrent Flow and Contra-Flow, they will be discussed separately.

(1) Concurrent Flow. The minimum lane requirements for a concurrent flow arterial project are the provision of either three lanes in each direction, or two lanes in each direction plus a median lane (which reverses with the peak period). While these requirements are not as strict as with contra-flow projects, in order to implement a project with less than five lanes, certain other unusual roadway conditions, such as extremely light non-peak-directional traffic should be present. In any event, key determinants are the level of congestion in the peak and non-peak directions, the estimated number or priority users and vehicles, and the availability of transit vehicles and their intended usage on the proposed facility (i.e., shall both express and local buses and/or carpools be permitted?).

Reserved concurrent flow lanes are generally placed in one of three positions on the roadway: (1) the curb lane; (2) the inside lane (i.e., closest to the median); or (3) in the median lane--this should reverse with the peak. Figure 32 illustrates these three types of placement.

Figure 32
ARTERIAL CONCURRENT FLOW LANE PLACEMENTS



When a concurrent flow reserved lane project is applied to improve express bus operations, or the flow of carpools along an arterial, the placement of the priority lane next to the median would be more appropriate than a curbside placement. A curb lane might improve express bus operations if it were wide enough to allow vehicles to pass loading and unloading buses or if bus bays were provided. On the other hand, if a project is implemented to improve local bus service, a curb lane would be most appropriate, because local buses cannot make stops from inside or median lanes.

If the project involves taking away an existing traffic lane from the peak direction on a congested facility, then the estimated number of people to be carried in the corridor should exceed those carried prior to the project's implementation. In addition, the project should not bring about a substantial reduction in the level of service in non-priority lanes after traffic conditions in response to the project have stabilized.

As with contra-flow lanes, if only one lane is available for low occupancy vehicles, and the lane becomes blocked for any reason, intrusions into the priority lane may occur. The safety hazard in this case is not as severe as it would be for contra-flow lanes, since drivers are used to merging into other lanes going in the same direction, and since there is normally no speed differential between lanes. When the differential is significant (e.g., 10mph+), safety can become a problem. The major problem, however, is that this merging can cause serious bottlenecks by impeding traffic flow in both the priority and non-priority lanes.

One technique which can be employed to mitigate this problem is to lower the speed limit in the priority lane. The speed differential is then decreased and merging is facilitated.

The determination of which types of vehicles will be allowed to use a concurrent flow arterial facility is important, because there are special problems associated with each type. It is considerably less difficult to allow both buses and carpools in a concurrent flow lane than in a contra-flow lane, providing the buses are either express or have bus bays to allow off-line loading and unloading. provisions. This latter amenity will only work if the priority lane volume is light enough to allow buses to re-enter the traffic stream easily. If buses make frequent stops in the priority lane, the travel time savings benefit to carpoolers will be lost and they will have little incentive to use it, and thus, to carpool. In addition, weaving in and out of such lanes increases the likelihood of vehicle conflicts and adds to congestion on the overall facility.

There are problems with concurrent lanes even when no carpools are allowed. If buses are running on close headways and make frequent stops while in the priority lane, this can present a problem if there are less than three lanes in the peak direction. The reserved lane on York Road, a four-lane arterial in Baltimore, resulted in a net travel-time increase because local buses had to stop in the lane to pick up and discharge passengers. The density of vehicles in the one remaining lane was such that it was extremely difficult for express buses to pass these stopped vehicles.[3] Bus pull-outs, wide shoulders, or off-street loading facilities can remedy this situation. In addition, if bus headways are no closer than two to three minutes, this mitigates the stopping problem, though buses still may tend to form platoons, particularly in peak periods.

If it is decided to allow carpools on the facility, the minimum number of occupants in each vehicle must be determined. The general rule in making this decision should be to allow the smallest number of persons per vehicle which will not forfeit the travel time savings incentive to form carpools in the first place. The Overview to Part III describes how to calculate this.

As with most other priority treatment facilities of any type, bus-only

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facilities are much more easily enforced. As such, when carpools are allowed, careful consideration must be given to the design of carpool ingress/egress points and vehicle pull-over areas for enforcement.* Because the visibility of violators is greatly reduced in carpool cases, non-priority drivers are much more willing to violate their restrictions.

(2) Contra-Flow. This type of project involves reserving a lane in the off-peak direction for buses (and/or carpools) traveling in the peak direction. Typical arterial contra-flow project concepts are shown in Figure 33.

A six lane two-way arterial or three lane one-way arterial is commonly a prerequisite when considering the design of a contra-flow project. When one lane of a facility which provides only two lanes in the off-peak direction is reserved for high occupancy vehicles, an accident or other serious tie-up in the one remaining lane may tempt drivers in that lane to intrude into the priority lane to avoid the cause of the congestion. This could become a serious safety problem. If there is a sufficiently wide shoulder and/or if a high enforcement level is planned, a two-way, four lane facility could be considered.

Kalanianeole Boulevard in Honolulu, shown in Figure 34, is an example of a four-lane arterial with a contra-flow bus lane which has been in operation since August, 1973. As shown on the following page, this contra-flow lane, in reality

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*This point illustrates a subtle but extremely significant dilemma in the planning of reserved lanes: the determination of facility users locks the design of the facility into a few limited alternatives. For example, if no thought is given to the possibility of converting a reserved bus lane to carpool use as well at a later date, such a wish may be frustrated because the design of the facility didn't allow for the enforcement of carpool priority treatment. The relationship of planning and design functions is extremely important and may be strained if a different set of experts commandeers each phase (planning and design). This illustrates the importance of having certain responsible actors present during the entire process.

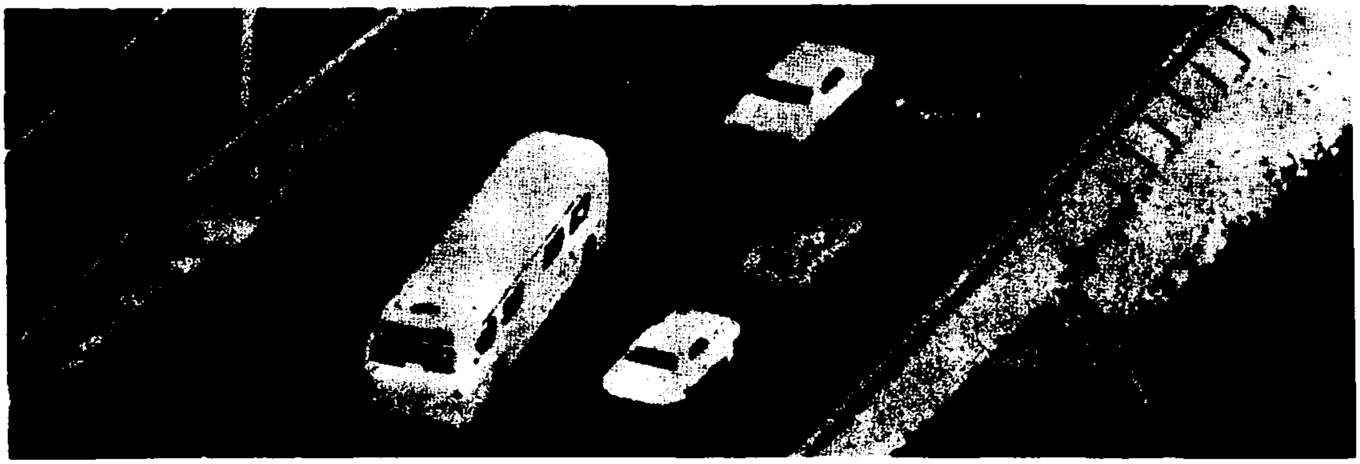
Figure 33
EXAMPLE ARTERIAL CONTRA-FLOW PROJECTS

(1) SAN JUAN, PUERTO RICO: Ponce de Leon

(2) MIAMI, FLORIDA: South Dixie Highway

SOURCES: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

Figure 34
KALANIANEOLE BOULEVARD CONTRA-FLOW BUS LANE



SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

could be considered an imbalanced concurrent flow lane. Carpools were allowed in the lane in 1975. It is called a contra-flow lane because the reserved lane is left of the roadway center line.

A strongly directional traffic flow is also a prerequisite. A ratio of sixty percent of vehicles traveling in the peak direction to forty percent in the non-peak direction is usually considered an absolute minimum, with a 65/35 split preferred. The main consideration is whether the non-reserved lanes in the off-peak direction provide sufficient capacity to handle the demand.

Also important in terms of available road space is the provision of either a breakdown lane, a wide median (either at-grade or with numerous cuts) or unused left-hand turn bays. With safety being an important issue in contra-flow projects, such facilities are needed for vehicle storage in the event of a breakdown, for police to stop a violator, or for a bus to evade any vehicles intruding into the contra-flow lane.

If excess capacity exists on a non-peak side of the roadway, then the level of usage (or demand) for this type of reserved lane is not as important a factor in justifying the project as it is for concurrent flow ones, where the lane is taken from the peak side. However, for reasons of safety, enforcement, and public acceptance, it is important that the number of vehicles not be <u>too</u> small. If a contra-flow lane is too sparsely used, non-priority drivers may violate it. For bus only contra-flow lanes, a minimum of twenty-one buses per hour has been suggested during the peak hour.*

Most arterial contra-flow projects to date have been designed for buses only, just as with freeway projects. However, there has been considerable discussion about allowing other vehicles with professional drivers, such as taxis and trucks, on contra-flow lanes installed on previously one-way streets. Serious reservations about safety have thus far prevented such experiments from being implemented on two-way arterials.

There are two major traffic operational situations which occur frequently along arterials which may make the inclusion of carpools as users of a contra-flow lane hazardous:

- When a left-turn prohibition violator from the non-peak direction makes a turn across the contra-flow lane without looking in that direction far in advance, he or she may be involved in a serious collision. This may occur because non-professional carpool drivers are not, trained to anticipate such movements on the part of other cars.

- When an accident or stalled vehicle blocks the contra-flow lane, non-professional drivers may not have the patience to wait for police to remove the bottleneck or implement emergency traffic movement measures. Rather, they may attempt to bypass the problem and encroach into the non-priority lanes. This can create safety problems (compounded with the tendency of motorists to stare at the distraction) and further congest the entire system.

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*Although minimally acceptable, such a low figure might create its own unique set of problems, such as public pressure to open the facility up to carpool use, or the constant pressure to eliminate it entirely. One must remember that the public will not respond to the same justifications for a project as a traffic engineer. With the public, perception of usage, as contrasted to actual usage, is of primary concern.

B. Operations and Maintenance. Maintenance costs for a concurrent flow lane separated by striping and signing, rather than a physical barrier (such as a median strip), will be minimal. Such costs will involve only maintenance of signs and pavement markings. Contra-flow lanes operating throughout the day will have minimal costs, involving signing and marking and the replacement of damaged barriers.

Arterial contra-flow projects which operate only in peak periods will probably involve twice-a-day set up and take down operations. These are not only costly, but often quite disruptive and congestion-producing. One way of mitigating this effect involves the installation of overhead reversible lane-type signals supplemented with special pavement markings and signing. This approach is highly capital-intensive, and to date, has not been tested.

Another approach involves the installation of signal preemption equipment. But this requires monitoring and periodic maintenance, and, to date, little data are available about these costs.

Other operating costs related to the provision of new or additional bus service on reserved lanes are discussed in the "Operations Plan" section (Part II, Section 2).

C. Enforcement. There are several planning issues related to the enforcement of arterial reserved lane projects. They include:

- Legal considerations of enforcement;
- Identification and determination of the likelihood of enforcement problems; and
- Determination of financial and physical problems of enforcement, and their solutions.

Most of these issues overlap with the design considerations and thus are treated extensively in the following portion of this section.

Design Considerations

Designing an arterial priority treatment project can be complicated process due to the nature of arterials and their impacts on such a diverse spectrum of people and businesses. Because arterials normally have unlimited access, design issues related to enforcement, signing, signalization, and other miscellaneous traffic control considerations should be carefully balanced and completely thought out in order for the project to meet its objectives.

While the primary constraints on the design of an arterial include the amount of roadway available, the feasibility of widening or modifying existing arterial geometrics, and safety considerations, many other subtle characteristics of arterial streets should be taken into account. Arterials are often lined with extensive strip commercial and multi-unit, multi-purpose developments. A large portion of the trips along this facility will therefore not be work trips (this is more true in the evening than in the morning peak period). As such, many users may enter and exit at any access point along the roadway. This must be recognized in the design of such special facilities.

While most typical carpool arterial lanes in existence have unlimited access, when they do not, facility designers might consider providing intermediate access at main generators other than intersections. The percentage of local versus express bus users should be estimated, because a project could be designed to accommodate both if this would be necessary. In addition, reserved lane project designers should strive to develop a project alternative that will minimize inconvenience and other adverse impacts to people living and working adjacent to the project.

A. Turning Restrictions. There are distinct problems and peculiarities related to turning movements on arterials where reserved lane projects are being contemplated. Often, turning restrictions must be imposed on non-priority vehicles to resolve these problems. Since these restrictions are different for concurrent than for contra-flow projects, each will be discussed separately.

(1) Concurrent Flow. Turn restrictions, present different types of problems for each of the three types of concurrent flow reserved lanes--reserve, inside, and median.

Regular traffic is generally allowed to make right turns from reserved curb lanes. The prohibition of these turns could seriously affect access, and could create dangerous situations where drivers might try to make illegal right turns from center lanes. Yet, allowing general traffic to utilize the lane for right turns creates a serious enforcement dilemma. On one hand, a curb lane is easy to enforce: violators can easily be flagged over and off the main roadway onto cross streets for citation. Unfortunately, since it is impossible to determine whether or not a driver intends to turn right at the first opportunity, violators can only be detected when they pass through an intersection in the curb lane. Thus, only one intersection can be enforced by each officer.

This already complex problem is compounded by the fact that certain idiosyncrasies in driver behavior are generally tolerated, such as a driver unfamiliar with the area cruising in the right hand lane in search of a particular street at which he or she will turn right. These peculiarities combined with the virtual freedom from detection may encourage violators. To further compound the problem, if right-turning vehicles cannot clear the intersection, they may impede the flow of buses in the priority lane.

Because of these potential problems, project designers should be prepared to monitor a concurrent flow reserved curb lane project carefully to see what level of enforcement is necessary. A project may still operate successfully within a range of turning restriction violations.

Median lanes are really a separate arterial category (i.e., neither concurrent nor contra-flow). The issue in this case is whether or not to allow left turns. Left turning vehicles can impede the flow of priority vehicles by blocking the lane. On the other hand, to ban left turns might generate strong objections from adjacent business owners whose access has been impaired. In many urban areas, left turns have been prohibited along major arterials in peak hours. Such restrictions often result in reduced congestion and fewer accidents. Therefore, a stronger precedent seems to exist to exclude left turns from median lanes than right turns from curb lanes (see Figure 35).*

There are also certain compromise solutions which can address this problem. As shown in Figure 36, one of these invloves the designation of right turn "ground loops", so that the vehicles can turn right and go around a block to turn left. However, they increase travel time for persons who use them and may increase traffic on affected streets.

Another compromise involves a special signal for left turns only within the light cycle at appropriate intersections. But this solution too has its shortcomings. Usually only a small amount of green time can be allotted for this type of signal phase. As a result, traffic may back up in the priority lane in loaded signal cycles. To escape the left-turn queues, drivers of priority vehicles will be tempted to merge into the normal lanes, which in turn are usually more congested because of the inclusion of the priority lane on the facility.

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*The N.W. Seventh Avenue Project--a reversible median lane in Miami--did allow left turns, in two different configurations, at certain intersections. Though for the most part they worked smoothly, there were some auto-bus accidents. Violations of the lane and the left turn ban at other intersections ran high. Certain enforcement officials have expressed their belief that the lack of a uniform policy at every intersection confused motorists and contributed to the high violation rate.

Figure 35
ARTERIAL MEDIAN LANE CONCEPT

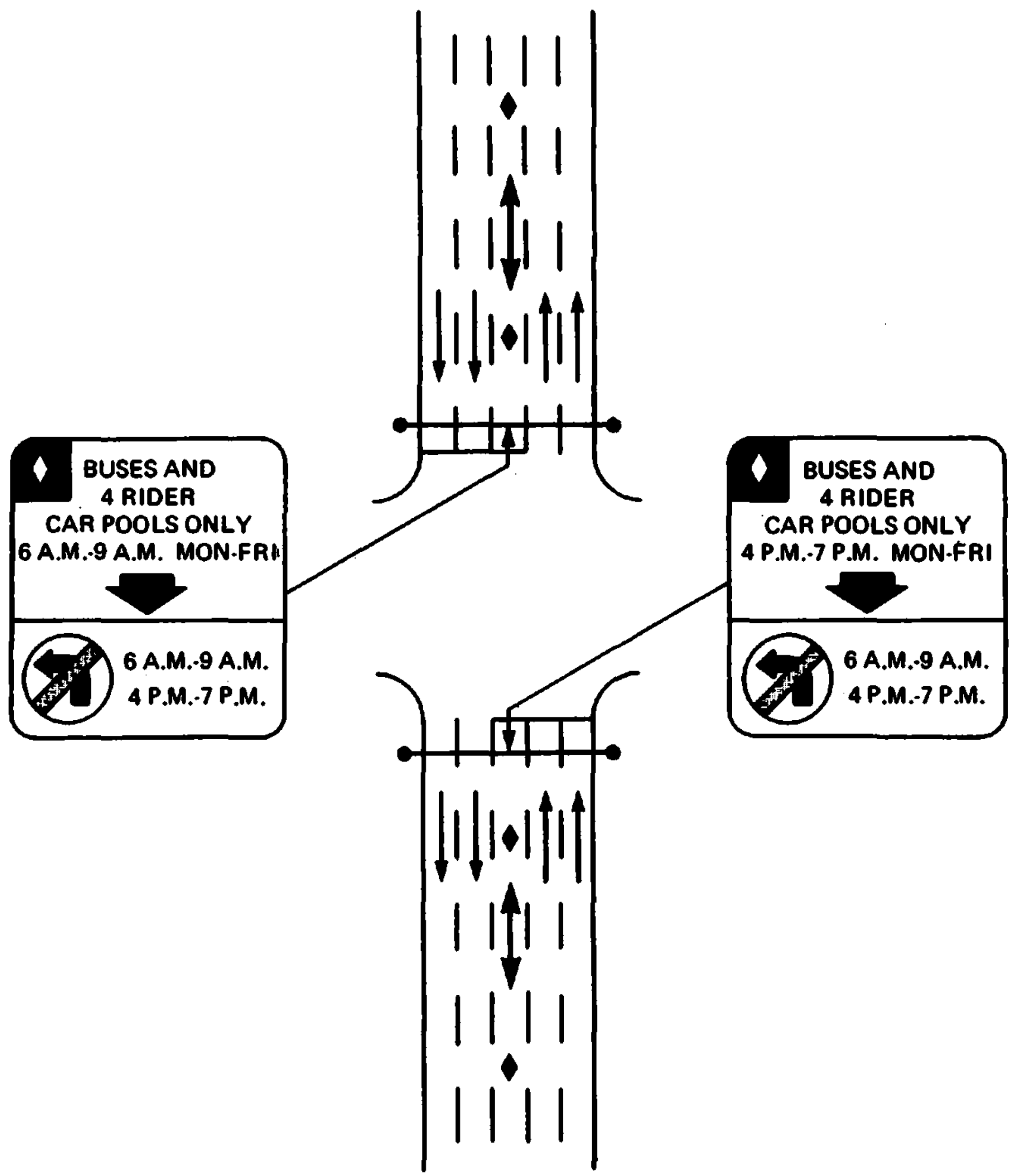
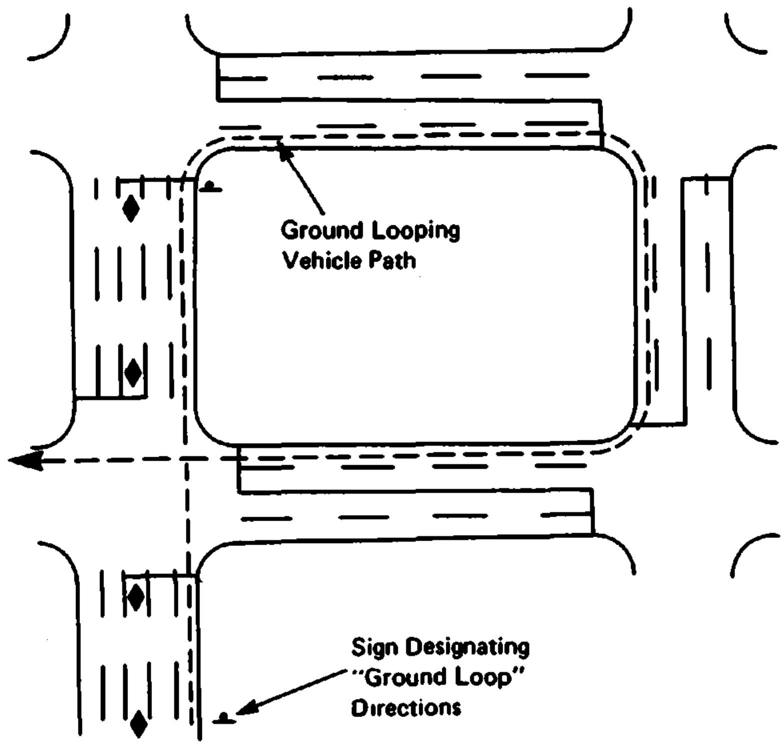


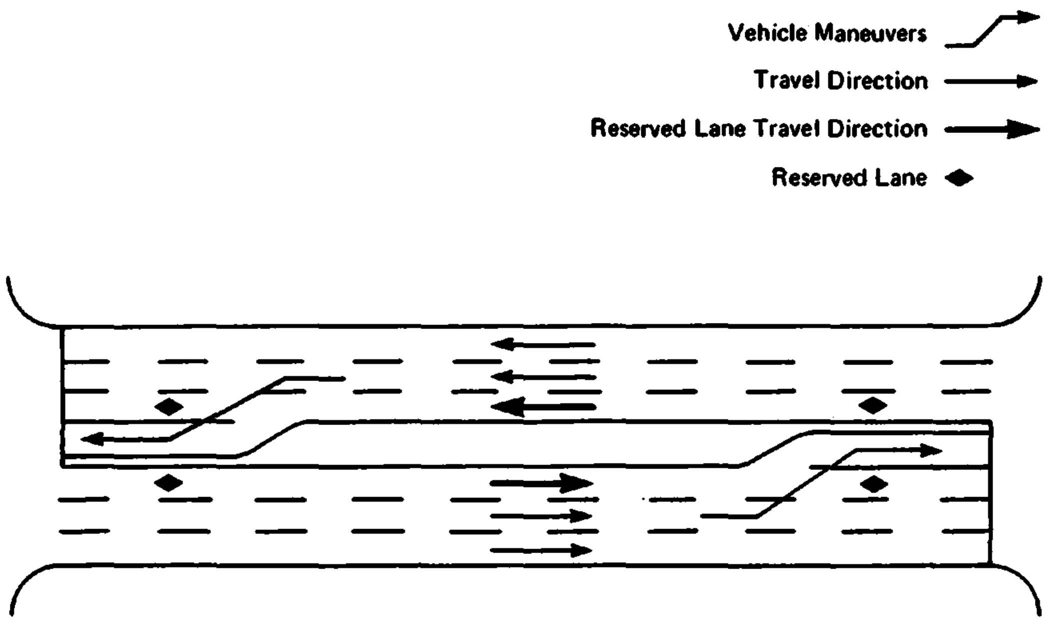
Figure 36
GROUND LOOP CONCEPT



Left turn restrictions (see Figure 37 on the following page) may not be needed with inside lanes when left turn bays are available. Motorists expect traffic in the concurrent flow lane, and can easily maneuver through it to make left turns. Any delay due to the queuing of left turning vehicles is usually not a problem if left turn bays of adequate length are provided.

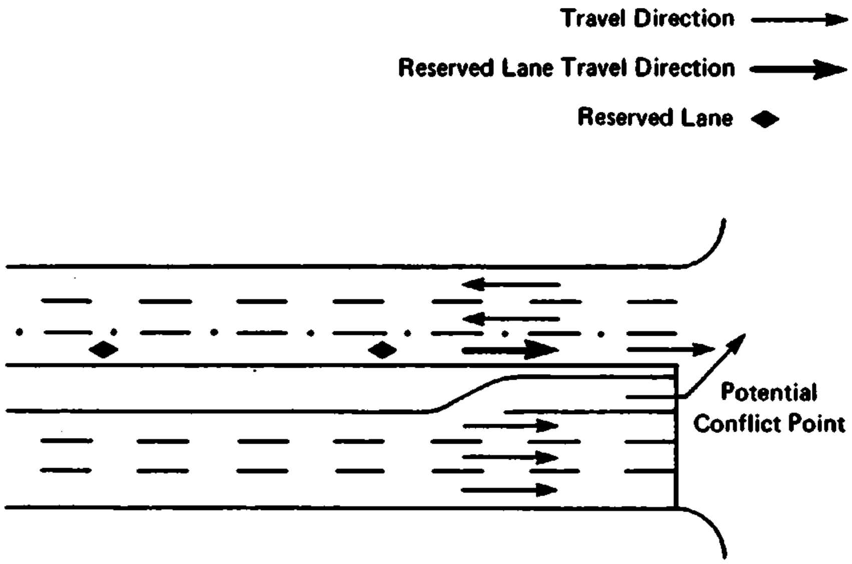
(2) Contra-flow. Most traffic engineers advocate the prohibition of left turns from the main roadway during the hours of operation for contra-flow lane projects on two-way arterials. Left turn prohibitions are not necessary on a one-way arterial contra-flow project because making a left turn from such a facility would be no more complicated than a normal left turn from a typical two-way street.

Figure 37
LEFT-TURN MANEUVER THROUGH INSIDE CONCURRENT FLOW LANES



The reason for concern over two-way arterial projects is that autos would be turning in front of the bus lane, and drivers are not used to checking for traffic coming from this direction before turning left. This will cause some inconvenience to non-priority motorists, and may raise strong objections from local businesspersons whos access has been impaired. One solution to this problem might be to provide a special left turn phase of the light cycle, with an arrow, at the major intersections along the facility. Traffic in the contra-flow lane would have to have a simultaneous red indication. Even that can be hazardous, since many motorists still turn left even after the green arrow switches to red. Provision of extra clearance time for these vehicles may be warranted. (See Figure 38 on the following page).

Figure 38
LEFT TURN HAZARD OF CONTRA-FLOW ARTERIAL PROJECT



B. Signing and Marking. A federal standard on signing for priority treatment projects has been published in the June, 1975, Official Rulings on Requests, the annual supplement to the Manual on Uniform Traffic Control Devices. The supplement furnished recommended designs and sizes for signs and markings designating priority bus and carpool lanes.*

*Persons contemplating a priority treatment project, particularly if they anticipate federal funding assistance, refer to Appendix G.

Engineering judgement should be exercised in determining the placement of signs. Because of the many access points on an arterial, careful attention should be paid to notifying anyone entering the arterial at intermediate points, including pedestrians, about any restricted lanes in operation. Some traffic engineers who have implemented priority treatment projects advise it is best to over-sign at the outset of the project and selectively remove some signs after users become accustomed to the new arrangement.

Particularly troublesome are inside (next to the median) restricted lanes when there is no physical separation between opposing lanes of traffic. Overhead signs in that instance are probably preferable to signing on the right hand shoulder, but the overhead standards are often aesthetically offensive to some of the public. Again, an attempt should be made to exercise good judgement in striking a balance between technical and social issues for a particular situation or project.

If the project requires signing using heavy standards or posts, some thought might be given to the purchase and installation of impact attenuators, especially if speeds above 35 mph are expected.

All projects involving peak hour contra-flow lanes on two-way arterials have used either safety posts or traffic cones, in addition to signing, for lane delineation. While the capital costs of these physical barriers is not exhorbitant ($5.00 a piece for posts, plus the labor cost of cutting holes in the pavement), operating costs can be quite high. A crew must set-up and take-down all the posts as well as change all the variable-message signing.

For a three mile freeway lane in San Francisco utilizing one crew per peak, the cost came to $6,700 a month. A five and a half mile contra-flow project in Miami utilizing 2 to 4 crews per peak averaged $19,000 per month. This expense represented salaries for 18 crew members, 8 hours per day. Slightly more than half of their time was actually spent on the project; the remainder of the time, they performed miscellaneous traffic-related tasks. Traffic officials felt that the high level of personnel was necessary to minimize disruption of the traffic from post placement/removal on the heavily-used arterial. Each operation took thirty to forty minutes to complete.

An interesting point about arterial projects is that they have, on occasion, been implemented specifically to improve safety. College Avenue, in Indianapolis, was one such case. Originally a four lane, two-directional arterial, it was converted into a one-way street in 1959. As a result of public opposition, it was changed to three lanes northbound, and one lane southbound, in 1965. This contra-flow-like configuration resulted in a very high accident rate. At that point in time, returning it to a one-way street was impossible because there was no southbound arterial nearby capable of handling the heavy transit service (100 buses/day). As a compromise solution, the southbound lane was made into a 2.9 mile contra-flow lane restricted to buses, bicycles and other designated vehicles. Despite only minimal signing, this transformation reduced the accident rate dramatically.[5]

D. Signalization. Special attention must be paid to entry and exit points from contra-flow, and inside and median lane concurrent flow projects, particularly on two-way arterials. Since such maneuvers generally involve a bus weaving across several lanes of traffic, a special advanced green indication for buses only may be required. Special pedestrian "walk/don't walk" signals may also be desirable for contra-flow projects where pedestrian volumes are high enough, or where engineering judgement indicates a problem might occur (e.g., near a school).

For experimental or demonstration projects where the project sponsors are trying to avoid non-recoverable capital investments by not installing permanent support equipment on "temporary" project facilities, a police officer stationed

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at the entry and exit points may suffice. However, if the entry/exit maneuver involves turning across several lanes of traffic, a police officer will probably not suffice, and special signalization may be necessary, regardless of cost.

In addition, designers of contra-flow projects have the option of providing signal progression favoring contra-flow lane users. This should be done if it can be shown that overall delays would be reduced by such measures. Signals on reserved lane arterials may need to be retimed. This should not be done, however, until after the project has been operating for a reasonable amount of time, and bus frequencies and operating characteristics are known. Then, if advantageous, the signals can be retimed to account for the peculiarities brought about by the priority treatment facility. Other signalization changes are not usually necessary for reserved lanes.

Careful attention paid to signalization improvements should pay off in overall improvements in travel flow for both priority and non-priority vehicles. Improvements in travel time to non-priority facility users will also be a positive step in convincing the public that a project is valuable to all those affected by it, not just its immediate users.

SIGNAL PREEMPTION

Signal preemption is a technique which allows a certain class of vehicles (in this case high occupancy vehicles) to alter a given signal cycle to its advantage--i.e., so that a special vehicle's passage through the intersection is facilitated. The equipment installed for this purpose "senses" when a bus or other priority vehicle is approaching and, under given constraints, gives or extends the green indication for that vehicle, allowing it to go through the intersection with a minimum of delay. Although signal preemption can be used to supplement the

the effects of reserved lanes, it can also be used effectively as a priority treatment by itself. The success of signal preemption is not as related to roadway capacity as it is to how well it reduces the amount of person-delay caused to traffic using the affected cross streets.*

There are several different types of signal preemption equipment. The main differences between the types lie in the way the priority vehicles activate the signal controls.# The Miami and Louisville systems transmit optical signals which flash from a strobe light device mounted on top of the bus. The Urban Traffic Control/Bus Priority System used in the District of Columbia (until mid-1976) utilized loop detectors embedded in the pavement which picked up radio signals transmitted by the priority vehicles as they passed over the dectors. In both systems, if a signal is red, it advances to green after giving time for cross street traffic and pedestrians to clear the intersection If the signal is green, the equipment will extend the green time to allow the bus to pass through. Once the bus has passed through the intersection, the signal reverts to its normal cycle.

Safety has become a major concern related to bus signal pre-emption. Automobiles tend to follow buses too closely to try to benefit from the green light extension. As a result, following cars tend to run yellow and red lights and can be caught in the intersection or rear-end the bus. This problem led to a higher than normal accident rate on N.W. 7th Avenue during a signal pre-emption projects there.

Another signal preemption issue which should be addressed is how to treat emergency vehicles and the possible problem of two buses actuating the equipment

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*One such project, the Orange Streaker project in Miami (described in Appendix D) caused only a minimal delays to cross street traffic.

#Only buses have been given such devices thus far. It is highly unlikely that any other modes smaller than buses will be or should be allowed such priority because the overall person-delay may otherwise increase.

at once. Designers may wish to incorporate features which give emergency vehicles priority over buses. If signal pre-emption is to be given to emergency vehicles, the designer should seek the advice of safety agencies before incorporating the feature in buses. Also, if two buses approach from different directions, a feature might be incorporated which affords each direction priority treatment in a sequential order. Again, safety agencies should be involved in the planning of signal pre-emption.

According to a recent study by the MITRE Corporation, the following conclusions can be drawn concerning the Bus Priority System (BPS) form of signal pre-emption:[6]

- If traffic signal priority treatment is to be successful, then bus stops must be located on the far side (downstream) of the intersections involved;
- Local buses on arterials with poor signal coordination have the greatest potential for improvement;
- The existing level of signal coordination if of particular importance when assessing potential improvement for express bus service (though some arterials could not be used regardless of the level of signal coordination);
- The potential for improvement increases when a greater proportion of signalized intersections are instrumented for BPS;
- The most promising BPS algorithm provides a green signal for every bus but limits the maximum additional duration to 10 seconds (with only 7% delay to cross street traffic; and
- Detection reliability might be a problem. Currently available technologies--such as low power High Frequency transmitters, low frequency inductor loops, optical beacons (as in Miami), and magnetic signature detection--have been tried, but no comparative reliability data is available.

The table on the following page indicates expected potentials for improvement in bus travel time given the various ways in which BPS might be applied.

While evaluation of such treatment has been sparse thus far, a study of the Orange Streak project in Miami yielded favorable results. Buses equipped with signal preemption devices, traveling in general traffic on N.W. 7th Avenue,

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• Table 29: Potential for Bus Priority System Improvement[7]

PROPORTION OF INTERSECTIONS EQUIPPED FOR BPS	TYPE OF SERVICE	COORDINATION OF TRAFFIC SIGNALS PRIOR TO BPS INSTALLATION	
		Poor	Good
Most	Local	Very Good	Good
	Express	Good	Fair
	Local and Express	Good	Fair
Few	Local	Fair	Poor
	Express	Fair	Very Poor
	Local and Express	Fair	Very Poor

experienced a 25.3% reduction in travel time. When a 10 mile reversible median bus lane was implemented in addition to the signal preemption, bus travel time was further reduced by 8.1%, and schedule reliability was noticeably improved. The relatively small incremental improvement in travel time with the bus lane "...is due to the fact that the average speed (29 mph.) in this stage was very close to the desired speed. Thus a smaller potential existed for improvement."[8]

On the basis of the Ludwich analysis cited above,[9] it would appear that many non-urban center arterials with 10 to 30 local service buses per hour could benefit greatly from a continuous Bus Priority System if far side stops were provided. Far side stops work well only if buses do not arrive simultaneously or if there is enough space for the buses to arrive simultaneously. Otherwise, buses could block an intersection. A situation where 30 buses per hour maximum would be present would not seem to have this problem, if buses are well spaced and the far side stop has adequate storage for two or more buses, if needed. Express buses, while benefiting somewhat from such a system, would appear to benefit more from improved signal coordination.

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Section 3

ACTIVITY CENTER PRIORITY TECHNIQUES

INTRODUCTION

An activity center is a major aggregation of commercial, industrial, institutional and/or dense residential development. It may include not only Central Business Districts (CBD's), but any area with enough traffic generators to require concentrated bus service, and which can be delineated as a significant planning entity. Non-CBD activity centers might include major commercial/industrial parks, airport commercial/industrial areas, university/commercial areas, and medical center/commercial complexes. Isolated regional shopping centers are not normally large enough to be considered activity centers, and often generate little transit demand.

Many forms of priority techniques for high occupancy vehicles have been applied within activity centers.* They are:

- Reserved lanes;#
- Bus street terminals and transit malls;#
- Turning restrictions for low occupancy vehicles;
- Exclusive bus bays;
- Fringe parking lots;
- Transit terminals;
- Toll plaza treatments;

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*These activity center techniques are covered in the Freeway, Arterial, and Miscellaneous Sections of this Guide. Appendix A lists 32 urban center projects which have been implemented.

#These techniques, reserved lanes and bus streets and transit malls, are covered in depth in this section; all other are treated in Section 4 of Part III.

- Signal preemption; and
- Priority freeway access.

This section includes a description of the general planning considerations for most of these techniques, along with specific planning considerations for reserved lanes.* In addition, design considerations specific to three of these techniques --reserved lanes, bus streets and transit malls--will be examined in detail.

Most of the discussion which follows is directed toward CBD's, since they are the most complex activity centers, and present the widest range of possibilities for implementing priority techniques. It is recognized that not all of the priority techniques listed and discussed here will be applicable to the other types of activity centers, and that many will probably apply only to a CBD. In addition, as smaller activity centers develop, jurisdictions might consider a policy to incorporate priority techniques into their general plans to improve circulation.

General Planning Considerations

The circulation issues within activity centers are often complex and require that several alternatives be considered, along with an analysis of the affected traffic areas, when trying to resolve them. In fact, there are many cases for which several alternatives may be combined to form a single solution (e.g., a downtown taxi/bus circulation system incorporating contra-flow reserved lanes and bus bays). The analysis should address not only traffic movement, but also parking, access, pedestrian movement, taxis, goods movement, and the traffic implications of these techniques on other potential activity center projects (e.g., new buildings, street closures, changes in land use, and so forth). To develop a successful activity center project, those responsible for it should:

*Reserved lanes are discussed further in Part III, Section 2 on "Arterial Techniques".

- Identify businesses, institutions, and residents who will be directly affected by the project (i.e., whom or which are located adjacent to the project), and early in the process# reasonable efforts should be made to actively involve those persons in the planning and alternatives analysis processes. If this is not possible, they should at least be kept informed of development.

- Try to obtain the cooperation and support of a large majority of those directly affected by the project.

- Ensure that the specific project objectives are consistent with other goals, objectives, policies, plans, and proposals of the activity center.

A. Activity Center Characteristics. There are two significant factors which may affect the need for or usefulness of activity center priority treatment projects: (1) general activity center circulation, and (2) economic status of the center.

(1) General Circulation. In order to determine the hours of operation for certain activity center projects (e.g., reserved lanes), one must know whether traffic congestion occurs all day or only during peak periods. Also, a reserved lane or street project can be more difficult to implement if no excess capacity is available in the activity center street system to accomodate resulting shifts in low occupancy vehicles to other lanes and facilities. At the other extreme, if there is no congestion, and if high occupancy vehicles can circulate freely mixed with other traffic, there may be no need or justification for such a project.

#Refer to Part III, Section 2: "Arterial-Related Priority Techniques".

*Project planners might begin by exploring project alternatives with representatives of the people and businesses directly affected by a project. These might include independent businessmen, business groups, cab operators, transit operators, residents, civic and labor organizations, and enforcement personnel. This will ideally provide an opportunity for many of those directly affected to become advocates of a proposed project, with the project planners supplying coordination and technical assistance. (Issues related to community involvement and institutional arrangements are discussed in Part II, Section 2 of this guide).

(2) Economic Status. An urban area may reap economic benefits from the In tegration of both internal and external transit services with priority treatment projects. A downward trend in business and economic growth may indicate that a priority treatment project, such as a pedestrian or transit mall, could fit well into a plan to revitalize the activity center by helping it to compete with suburban shopping centers.

B. Transit Demand. It is often easy to determine the initial bus demand of a potential project. It is usually more difficult to determine the ultimate person-demand such a project will generate. There are presently no accurate methods for calculating latent or hidden person-demand for priority treatment projects in an activity center.

Sophisticated computer models are able to approximate transit passenger demand on a large scale and synthesize impacts related to a broad range of potential demand. However, these models do not have the flexibility to accomodate the factors needed to predict small-scale short range activity center transit demand. Variables such as paratransit use, socio-economic factors, land use, non-intersection access points, parking pricing and availability, and movement of goods are difficult, if not impossible, to input into these models.

Until good short range modeling techniques have been developed, estimates of initial project applicability and feasibility might be based on broader planning considerations, such as improvements in personal mobility, bus availability, and the attainment of other urban goals.

C. Project Impacts. The most important impacts of priority treatment projects are those which affect pedestrians and property owners.

Pedestrians should be taken into account during the planning and design of these projects. contra-flow projects, in particular may increase pedestrian/vehicle conflicts. For example, pedestrian signals may be needed at previously unsignalized locations, or where pedestrians previously had to look only in one direction before crossing. It may be helpful to place temporary signs warning pedestrians about a contra-flow lane at unsignalized intersections. Transit mall designers may also wish to consider incorporating second level pedestrian overpasses to increase the commercial capacity of the mall and to separate and reduce on-street pedestrian/vehicle conflicts, thus improving bus movement, goods movement, and the rest of the at-grade traffic.*

Adjacent property owners will be affected by any priority treatment project with the exception of signal preemption. Projects should be designed with an awareness of the attitudes and needs of adjacent property owners. A design which considers goods movement and customer access needs may increase support for a project.

There are several ways of considering goods movement in project design. One of the best is to ensure that representatives of goods movement are involved in the project planning and design phases--not merely asked to comment after the fact. If problems do arise, a typical design solution might be to provide an extra-wide (18+ feet) curb lane for a concurrent or contra-flow project and allow goods movement vehicles to use the lane for loading and unloading. A variation of this alternative might be to provide goods movement bays (similar to bus bays) along reserved lanes, if this can be done without severely impacting pedestrians. In some projects it might be possible to allow trucks to use a reserved lane for circulation in off-peak hours.

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*Refer to Appendix F for case study on Nicollet Mall in Minneapolis, Minnesota, where overpasses over nearby streets improve access to the mall.

Customer access and, pick-up and drop-off problems, are classic issues almost always raised when a two-way street is changed to one-way operation, or when on-street parking is removed. Business-persons often feel threatened when such operational traffic changes occur. Even though these changes may improve traffic circulation and often may prove economically beneficial to them, businesses are reluctant to support such measures without extensive justification. Similar issues will likely arise when a reserved lane is proposed in an activity center. If the lane appears to impair customer access or requires the removal of some on-street parking, affected businesses will have to be convinced of its worth. Again, active participation and two-way communication is probably the best approach. Design compromises can be made as long as project objectives are not abandoned.

RESERVED LANES

A. Operations and Manitenance. One of the most important issues concerning operations involves the allowance vs. prohibition of carpools in activity center reserved lanes. It may be best to prohibit carpools because: (1) it is difficult to identify violators, and thus, enforcement is complicated; as a result the lane may be rendered ineffective; and (2) carpools would normally not save much time where local buses make frequent stops.

If a reserved lane is underutilized by buses, then taxis might be allowed access--even if only during off-peak hours. For one, taxis are highly visible and would not complicate enforcement as much as carpools. Taxis also reduce the need for automobiles in activity centers. Given that issues on bus travel and pedestrian safety are resolved, allowing taxis in reserved lanes (either concurrent flow, or contra-flow) may enhance circulation in an activity center.

Contra-flow projects may require special operational signal designs. Some form of bus actuation or bus priority system might be appropriate if a contra-flow lane is to operate smoothly. Biasing signals in favor of the contra-flow traffic during operation may result in potential time savings for persons in the contra-flow lane. This can be particularly effective when cross street and opposing traffic are light. Conversely, biasing signals in favor of buses in a contra-flow lane may be detrimental if opposing or cross-street traffic is heavy.

Reversible lane overhead signals might be used for contra-flow projects when:

- Signing and marking alone are ineffective or result in high accident rates attributable to the contra-flow lane;
- A contra-flow lane is operational only in one peak period and is used primarily for express high occupancy vehicles; and
- Average peak period speeds on the street are greater than 30 miles per hour and physical separation is not desirable or possible.

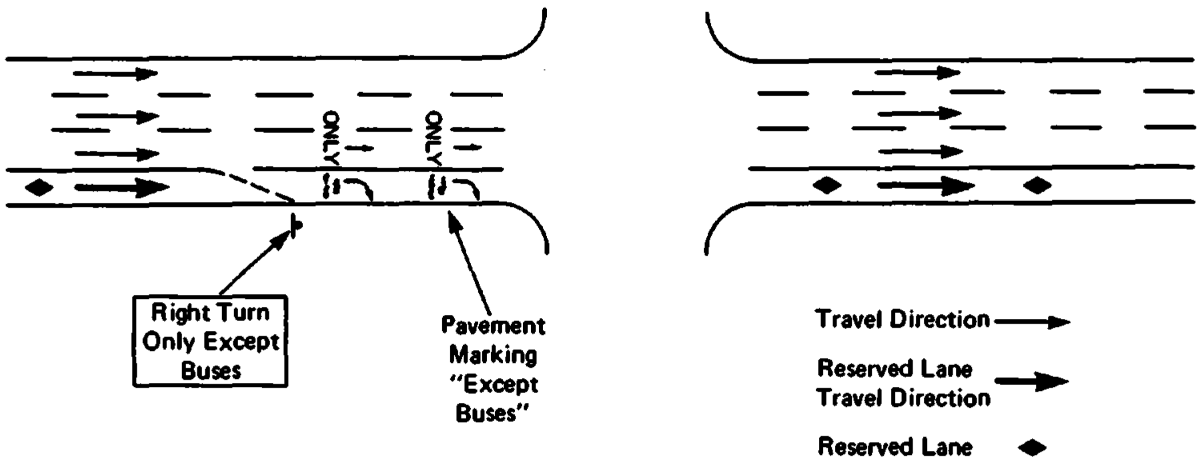
Plastic posts, cones, or other removable barriers should be used to separate a contra-flow lane in an activity center street only if the lane is to be in operation 24 hours a day. Their aesthetic appearance and the extremely disruptive nature of set-up and take-down operations are generally incompatible with the activity center environment.

B. Enforcement. Enforcement is a major planning consideration in urban center projects for both concurrent and contra-flow lanes, especially when they involve limited hours of operation. Enforcement is more difficult on concurrent projects.

As discussed in the Enforcement Plan of this Guide (See Part II, Section 2), the responsible enforcement agency can provide valuable input about the enforcement implications of various alternative project schemes. Generally, the severity of enforcement problems which may be encountered will depend upon two factors:

- The existing level of traffic enforcement--including parking regulations. If enforcement is already good, chances are the reserved lane project will be easily enforced.

Figure 39
ONE METHOD OF ACCOMMODATING RIGHT TURNS FOR CONCURRENT FLOW CURB LANE PROJECTS



- The attitude and capibility of the responsible enforcement agency to enforce the project in relation to other enforcement needs (i.e., willingness to enforce the project and availability of personnel to do so).

Enforcement may be particularly difficult in concurrent flow curb lane projects if right turns by all vehicles are allowed. For this reason, some of those jurisdictions using curb reserved lanes have prohibited right turns.

Another way commonly employed in Europe to accomodate right turns is to terminate the concurrent flow lane a considerable distance bofore the approach to each intersection in order to create a bay for right turns.* This distance could be calculated on the basis of the number of right turning vehicles in the peak hour. As shown in Figure 39, the reserved lane could then be continued through the intersection. This method has the disadvantage of allowing only right turn access to intersections and can be difficult for drivers unfamilar with where they want to turn (See "Arterials" for a discussion of this problem).

*This technique was cited in the NATO/CCMS Report No. 45 entitled Bus Priority Systems published by the United Kingdom Transport and Road Research Laboratory Department of the Environment in 1976.

If such a right turn bay is not provided, a right turn prohibition might not be advisable. This would be especially true if a decision were made to tolerate high violation rates, (i.e., as long as violators do not interfere with safety and bus operations).

Strict enforcement of parking prohibition is needed in all reserved lane activity center projects, even if some illegal lane usage by non-priority vehicles is to be tolerated. Tow-away zones might have to be established in reserved lanes during hours of operation.

Though contra-flow reserved lane projects are generally self-enforcing, intensified peak period enforcement may be needed if, in addition to buses, carpools or other vehicles are to be allowed in the lane, or if the priority lane is operative only during a peak period.

Design Considerations

Three specific types of activity center priority techniques are discussed in this section: (1) reserved lanes; (2) bus street terminals; and (3) transit malls.

Much of the material included in Part II, Section 2, on the subject of arterial-related priority techniques overlaps this area (item 1, above). As a consequence, this section will only discuss those features of activity center areas which are unique to activity centers, and which have not been covered in the previous section.

Recently, many publications have provided detailed design concepts and specifications for various activity center project types related exclusively to buses. Three of particualr value are:

- Herbert Levinson et al., Bus Rapid Transit Options for Denseley Developed Areas (Washington, D.C.: U.S. Department of Transportation, 1975).
- Herbert Levinson et al., Bus Use of Highways: State-of-the-Art, National Cooperative Highway Research Program Report 143 (Washington D.E.: National Research Council, Transportation Research Board, 1973).

- Herbert Levinson et al., Bus Use of Highways: Planning and Design Guidelines, National Cooperative Highway Research Program Report 155 (Washington, D.C.: National Research Council, Transportation Research Board, 1975).

In addition, the annotated bibliography at the end of this guide includes a comprehensive list of documents related to activity center projects.

Reserved lanes in activity centers are the most common forms of priority treatment techniques to be found across the country. Since they generally do not involve roadway construction, they are easier to apply than techniques like transit malls and are more flexible in their application.*

A. Usage. The volume of buses carried on each reserved lane has varied from 20 to 100 buses in the peak hour. Typically, only buses, or buses and taxis, have been allowed to use these facilities, though other vehicles have been allowed to make right turns from concurrent flow lanes to keep intersections from becoming saturated.[1]

Reserved lanes in activity centers increase the people-carrying capacity, but typically do not reduce bus travel times substantially (they may even increase travel times for express buses). They may, however, improve schedule reliability.

(1) Concurrent Flow Projects. These projects usually operate in one or both peak periods, rather than all day long.

- Table 30: Applicability of Activity Center Concurrent Flow Projects
  - When two-way or one-way streets have at least two lanes available for traffic in the same direction;[10]
  - When on-street parking is, or can be, prohibited in the lane during hours of operation;
  - When access to adjacent land uses can be accommodated; and

*Part III, Section 2: "Arterial-Related Priority Techniques" includes additional information on enforcement and the general operational characteristics of reserved lanes.

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- •• When goods loading can be restricted during hours of use, and the amount of people carried in the priority lane equals or exceeds that which was carried in the lane prior to implementation after the project adjustment period.

(2) Contra-Flow Projects. In activity centers, these usually operate either in one peak period only, or all day long.

- Table 31: Applicability of Activity Center Contra-Flow Projects

  - •• When a one-way (preferred) or divided two way street has low traffic volume, and diverting buses from parallel routes to the contra-flow lane would not be an unreasonable inconvenience to passengers;

  - •• When at least two lanes remain available for traffic in the opposing direction;

  - •• When on-street parking is or can be prohibited during hours of operation;

  - •• When loading of goods can be restricted in the lane during hours of operation;

  - •• When access to adjacent land uses can be accommodated; and

  - •• When the amount of people carried in the lane equals or exceeds that which was carried in the lane prior to implementation after the project adjustment period.

The above lists of prerequisites for both concurrent and contra-flow projects illustrates the similarities between them. Project planners might explore the possibility of developing a systematic network of contra-flow lanes with other techniques in an activity center.*

B. Signing and Marking. Signing and marking for reserved lane projects should conform to the standards in the previously cited revisions to the Manual on Traffic Control Devices for Streets and Highways.** Figure 40 shows typical signing and

*This is presently being done in the Chicago Loop area of its Central Business District.
**See Appendix G for these standards.

markings for activity center concurrent flow lanes. Typical signs and markings for contra-flow lanes are illustrated in Figure 41. Note particularly the special cross-street signing which should be used with contra-flow lanes.*

C. Safety. Though little accident data are available, it is felt that activity center reserved lane projects have few safety problems. This is probably due to the low operating speeds used in activity centers and the extensive safety precautions usually taken during the design stage of the project planning process.

D. Installation Costs. Any necessary construction would usually be related to amenities and support facilities such as bus shelters, information systems and benches. However, it may be necessary to strengthen the roadway for frequent bus operations.

Because of the generally low capital costs (of reserved lanes, not the services), most cities with such projects have implemented them as part of their regular street operations and maintenance programs. As a result, specific installation costs for these priority projects have often not been separated out. For the few agencies that did separate out these costs, the costs were well under $50,000 per mile, most of this entailing signs and other markings.

E. Staging. Reserved lane projects, which generally involve little or no construction, can be installed in a very short period of time. Staging can therefore be handled easily in the design of such projects.

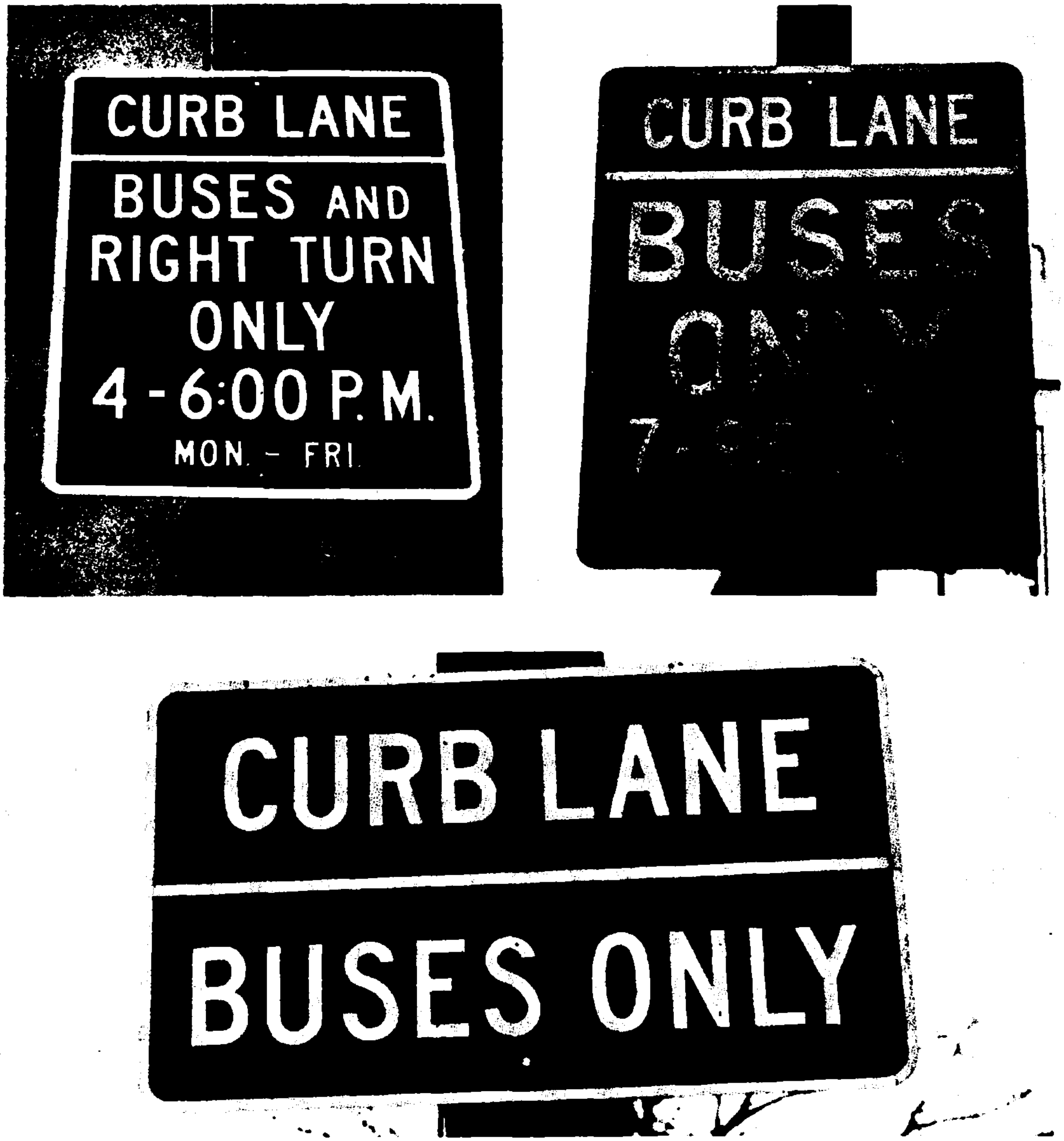
BUS STREET TERMINALS

Bus street terminals are open air terminals or turn around points where several bus routes may converge near a major employment area. They are a rare

*FHWA has a project underway concerning signs and markings of priority treatment projects. This is cited in the annotated bibliography of the Appendix.

Figure 40
EXAMPLE ACTIVITY CENTER CONCURRENT FLOW RESERVED LANE SIGNING: WASHINGTON, D.C.

(1) (2)



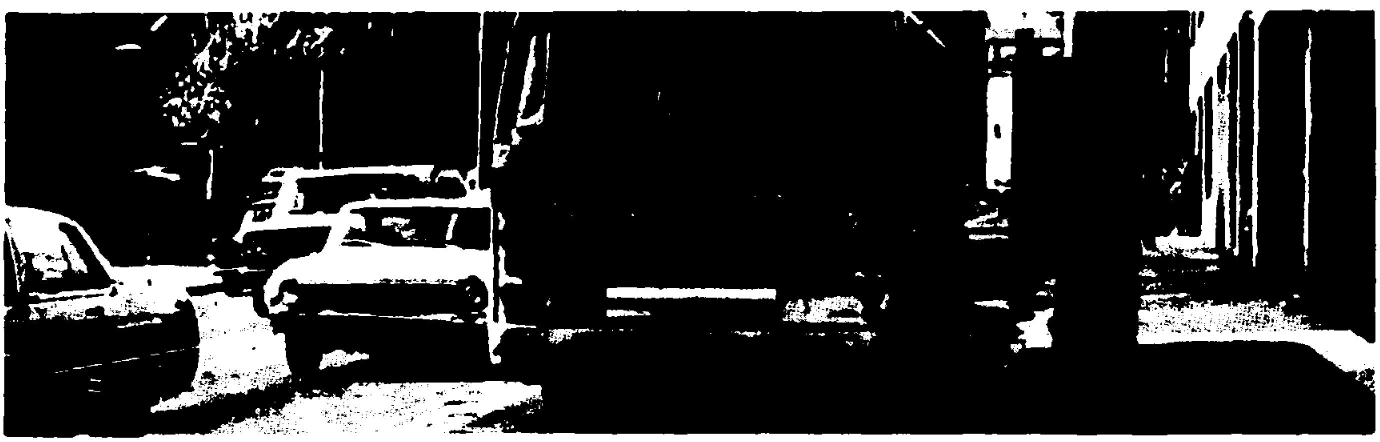
(3)

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

Figure 41
EXAMPLE ACTIVITY CENTER CONTRA-FLOW
RESERVED LANE SIGNING

(1) HARRISBURG, PENNSYLVANIA

(2) SEATTLE, WASHINGTON



(3) LOS ANGELES, CALIFORNIA

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

form of activity center priority technique which should only be applied under the special circumstances outlined here. Surface treatments and street furniture are different for bus street terminals than for transit malls. Trucks, taxis, or special-use vehicle might be allowed, in addition to buses often, streets least essential general circulation are selected for use as bus streets.

Bus street terminals are usually not longer than a single block, or larger than a one block loop. Neither on-street parking nor access to off-street parking should be allowed on bus streets during hours of operation. Carpools normally would not be allowed on such streets, since bus street terminals are aimed at improving transfer operations between bus routes, or providing a bus turn around point.*

A. Usage and Capacity. Since implementation of a bus priority street may involve the removal of an entire block, or blocks, from normal use, whether or not to implement a project should be determined by cost/benefit analysis: would the benefits of this special project offset its alternate use for general traffic?

Assuming that the traffic formerly using the street can be comfortably accommodated by alternative facilities, a bus street might be warranted when:

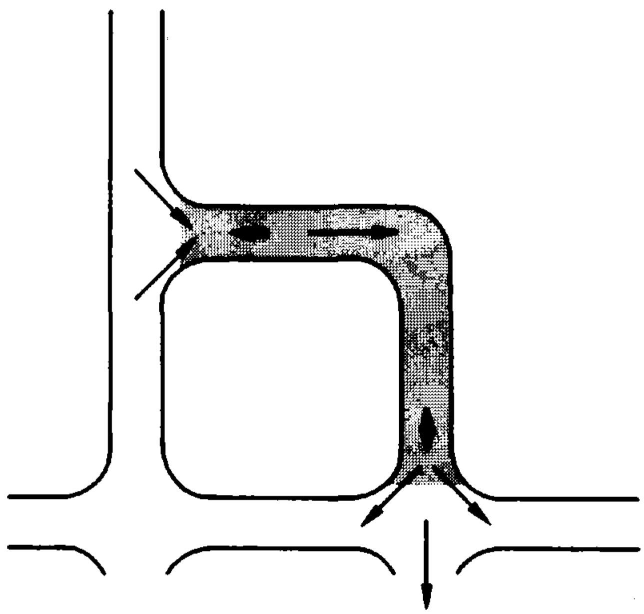
- General traffic significantly interfers with bus transfer operations, or vice versa;
- An analysis or activity center transit service indicates such a terminal would be desirable; and
- Adjacent property owners do not object to being withoug automobile access for themselves or their customers. This implies that a bus street would normally not be located at the main frontage of a commercial establishment.

The capacity of a bus street terminal will be affected by the same variables as for a transit mall (discussed in the next subsection).

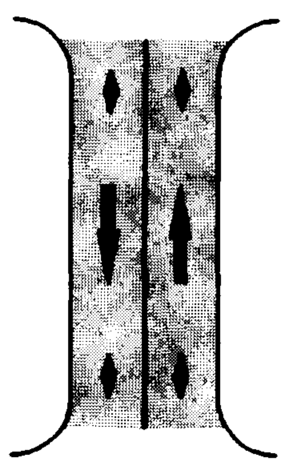
*Figure 42 on the following page illustrates two bus street terminal concepts.

Figure 42
BUS STREET TERMINAL CONCEPTS

(1) Bus Loop



(2) Bus Block



SOURCE: Adapted from Levinson, *Bus Use of Highways: Planning and Design Guidelines*, NCHRP Report 155 (1975).

Figure 43
WASHINGTON, D.C. BUS STREET TERMINAL

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

B. Signing, Delineation and Aesthetics. The national standard for exclusive facilities can be applied to the signing of bus street terminals.[2] Except for street furniture, bus street terminals and loops often look like regular streets (see Figure 43). All entrances need only be signed "Do Not Enter", with regulatory information concerning the types of vehicles allowed. Delineation should include the nationally recognized diamond symbol.

Aesthetics are normally not a major design issue on bus street terminals. If the terminal is deisgned along commercial frontage, however, street furniture might be used to reflect a theme common to adjacent businesses.

C. Safety. Existing bus street terminals have been shown to be safe facilities. Safety should, however, be evaluated on any nearby traffic facilities which are affected by traffic diverted from the bus street. Traffic engineers should be prepared

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to monitor these facilities and adjust traffic control devices, or install new ones, should there by significant changes in traffic volumes or accident patterns.

D. Costs. If construction is required, it would normally include bus shelters, transit information systems or bus loading platforms. Costs for these imporvements will vary widely between urban areas. Most cities have included non-construction costs related to the additional signs and markings with regular street operations and maintenance programs.

E. Staging. Since bus streets involve little or no construction staging would not be a major problem.

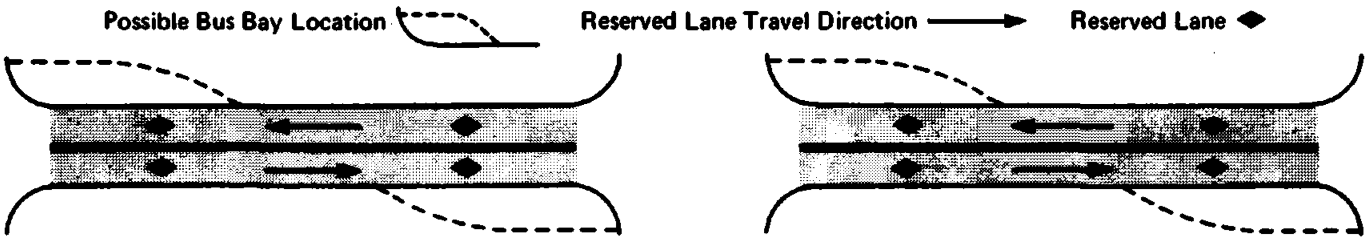
TRANSIT MALLS

Transit malls are specially designed commercial areas where street portions are reserved for the exclusive use of buses, pedestrians, and on occasion, other high occupancy vehicles or service trucks. Transit malls have been created for specific purposes, such as:

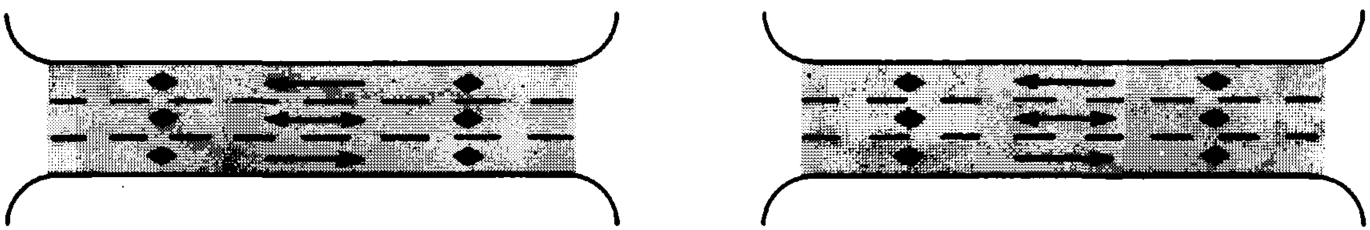
- To improve circulation for pedestrians and buses within a commercial area;
- To improve the image of activity center business through common design features;
- To create new opportunities for promotion of retail area businesses;
- To improve access to the commerical area for special vehicles; and
- To encourage private investment by creating a stable business environment.

Malls work best when planned in conjunction with downtown revitalization programs and when goods movement to affected businesses is improved or adequately accommodated in the design (e.g., when rear entry access service bays or loading platforms are available).and when traffic diversions to other streets are adequately accommodated. Figure 44 on the following page, illustrates some typical transit mall concepts.

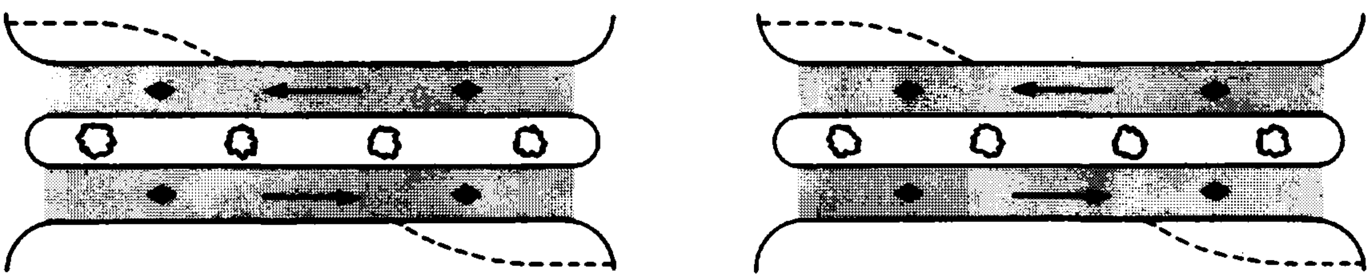
Figure 44
TYPICAL TRANSIT MALL - CONCEPTS



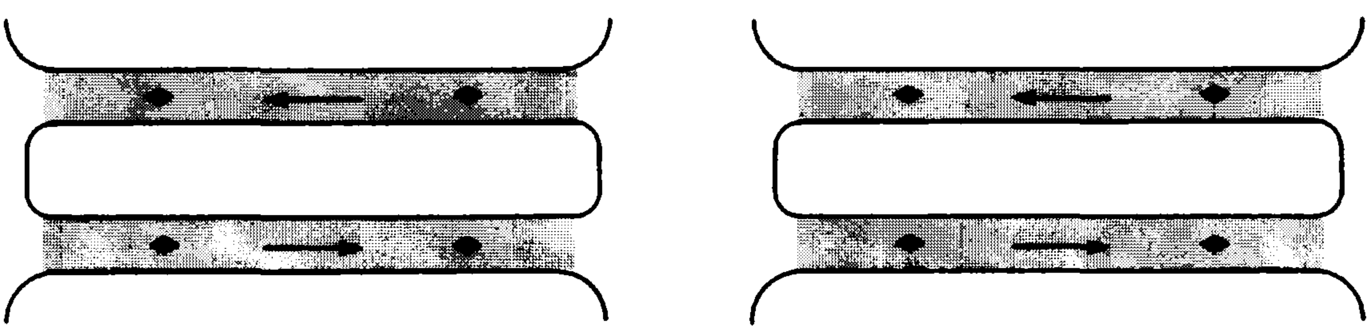
1. Two-way street with 1 lane in each direction with extra-wide lanes (20-24') for bypass or bus bays at stops.



2. Two-way street with 1 lane in each direction and a reversible middle lane depending on time of day



3. Two-way street with extra-wide lanes for bypass or bus bays and a landscaped median



4. Parallel one-way streets with one extra-wide lane in each direction.

A. Usage and Capacity. An estimate of the initial number of buses likely to use a transit mall should be made on the basis of existing transit service. The effects of moving transit routes from parallel streets to the mall or rerouting other traffic away from a transit mall should be examined.

The capacity of a transit mall, while secondary to demand in importance, is largely dependent upon the following:

- The types of vehicles being used;
- The number of bus stops;
- On-off loads at bus stops;
- Cross street spacing and/or signalization;
- Interference from right and left turning buses;
- Whether or not local and express buses are separated;
- Whether or not bus bays or passing lanes are provided at stops;
- Volume and control of pedestrian conflicts; and
- Horizontal and vertical street alignments.

Because of the complexity of these factors, transit mall capacity must be determined on a project-by-project basis.

On-site observations and discussions with the transit operators may lead to the most accurate estimates of capacity. Well-designed transit malls in most urban centers will have more than enough capacity to accommodate potential vehicle demand as long as allowances are made for passing vehicles at loading points.

B. Signing, Delineation and Aesthetics. Signs designating a mall should be placed at all entry points. Cross streets, if there are any, should be signed to prohibit turning movements by all but priority vehicles.

A transit mall is often designed to appear markedly different from a regular street. This may mean a different travel surface, gently curving horizontal

Figure 45
NICOLLET MALL: MINNEAPOLIS, MINNESOTA

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

street alignment, extensive landscaping, distinctive lighting, and/or pedestrian and bus loading amentities. A unique design can help make a transit mall self-enforcing and present a unified them for activity center businesses.

Transit mall designers should not ignore the pedestrian aspects of the mall. Noise and diesel fumes from buses can create a poor environment for pedestrian circulation. Research efforts are being focussed on this problem and it is expected that it will be resolved within the next decade.

C. Safety. Pedestrian and bicycle safety should be closely monitored on transit malls. The Chestnut Street Mall in Philadelphia had a couple of pedestrian fatalities during the first few months of operation. This followed conversion from one-way operation to two-way bus operations. To avoid such problems at other malls, extra precautions should be taken by both operators and police during the first few months after opening a transit mall. Pedestrians tend to forget the presence of buses if there are long gaps between them. Like bus street terminals, the safety impacts related to traffic diversions on other facilities should also be monitored.

D. Costs. Transit malls are expensive. They generally represent a heavy capital investment in addition to the transit services which must be provided. These costs primarily are aesthetical and pedestrian oriented since benefits related to transit malls can be economic as well as transportation-related, adjacent businesses may feel the results are worth the expense.

To date, very little information has been gathered concerning business or economic benefits related to transit malls. The Nicollet Mall case study in Appendix E provides an example of a completed transit mall that achieved its economic objectives in the eyes of adjacent businessmen.

E. Staging. Staging is relevant to the discussion in this portion of Section 3 because the construciton of a transit mall project demands the design and inclusion of many different types of barriers, signs, and other amenities at various stages of construction. These design problems must be worked out in detail by project engineers and safety experts, both of whom must work with representatives of the directly affected community, in order to minimize the adverse impacts in implementing the project.

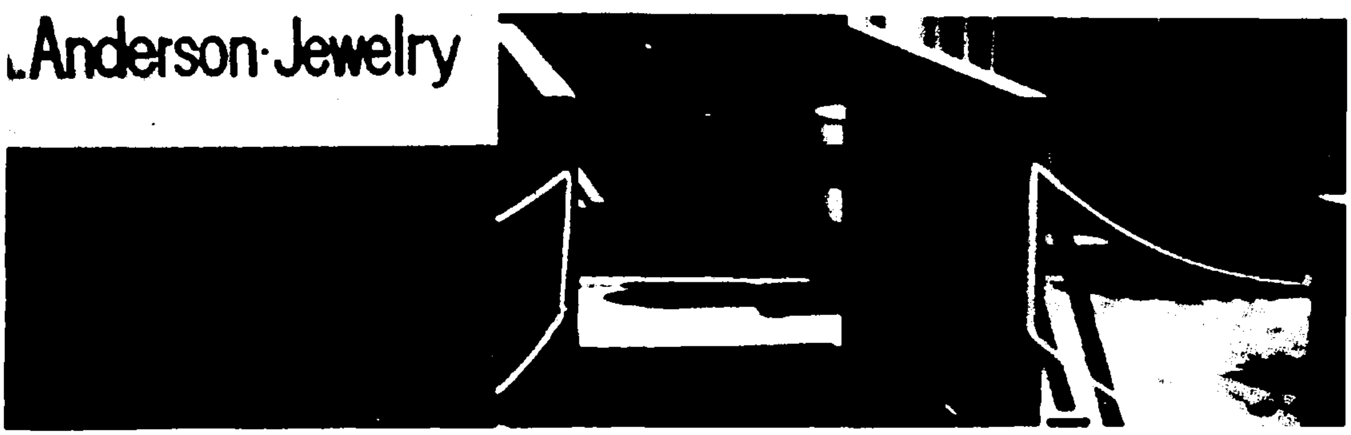
During the project's construction stage special interim measures should be taken to ensure access to adjacent businesses and to minimize the disruption to pedestrian or vehicle traffic caused by the construction. Special detours and barricade/signing schemes should be carefully planned to minimize activity center ocnfusion. Innovative ideas, such as the use of decorative signing to guide potential patrons to businesses, might minimize the adverse aesthetic impacts and traffic disruption during this period. Figure 46 illustrates some of the staging measures being used in Portland, Oregon.

Figure 46
TRANSIT MALL STAGING MEASURES:
PORTLAND, OREGON

(1)

(2)

(3)



SOURCE: U.S. Department of Transportation, Federal Highway Adminstration, Transit and Traffic Engineering Branch.

Section 4

MISCELLANEOUS PRIORITY TECHNIQUES

INTRODUCTION

There are a broad spectrum of miscellaneous techniques, ranging from access improvements to amenities, and from high to low capital costs, which can facilitate the movement of high occupancy vehicles. These techniques can be implemented wherever bottlenecks exist, safety problems, or opportunities for improved high occupancy vehicle movement exist. They can be aimed at either reducing travel time or improving safety and reliability. They are another step in making preferential treatment a systemwide consistent policy.

Miscellaneous techniques can not only effect changes in traffic movement by themselves, but more important, they can be used in combination with one another, and with other major preferential treatment facilities (see <u>Part III</u>; <u>Section 1, 2 and 3</u>). The success of such combinations will depend largely upon the creativity and imagination exercised in their conceptualization and planning.

ISOLATED SIGNAL MODIFICATIONS

The examples given below illustrate special priority techniques which aid transit vehicles to cross several lanes of traffic. A transit-only or transit priority signal will allow a bus or street car to do this within minimum time and distance, and without dangerous conflicting movements.

<u>Examples</u>

A. Arlington, Virginia: Wilson Boulevard at Key Bridge. Buses preparing to cross into Washington, D.C. from the Rosslyn, Virginia, area enter the intersection from the left-hand side but must cross to the right to serve a bus stop. An optically programmed signal (visible only to the bus) gives an advance green to the bus to allow it to cross to the right side before other traffic.

B. Philadelphia, Pennsylvania: 40th Street Portal. Surface trolley cars emerging from the subway at 40th Street actuate a signal phase which allows each one to cross the street.

C. Chicago, Illinois: Cermak Road. A special bus signal allows buses to make a U-turn at the end of the bus line.[1]

OFF-STREET TERMINALS AND PARKING FACILITIES

The provision of off-street terminals, and accommodations for access to them, greatly enhance the ability to use transit. The techniques involved here accommodate both buses and private automobiles (which drop off and pick up bus riders using that transit system). Four types of off-street terminal techniques are described in this section:

- Mini-Terminals;
- Bus Access to Terminals;
- Park and Ride Lots; and
- Carpool Staging Areas.

Mini-Terminals

Off-street mini-terminals at major transit route convergence points can provide a protected area for bus loading and unloading, with minimal traffic interference, and at relatively low cost. They may also serve as an exchange point between bus operators. If the area is large enough, space can be provided for buses to pass one another without having to wait for those ahead, as often happens on congested urban streets.

See page 240 for footnotes

Off-street mini-terminals at major transit route convergence points can provide a protected area for bus loading and unloading, with minimal traffic interference, and at relatively low cost. If the area is large enough, space can be provided for buses to pass one another without each bus in a platoon having to wait for those ahead, as often happens on congested urban streets.

Where transit fleets are not equipped with two-way communications devices, a supervisor using a radio car can notify the garage about a late bus, or a breakdown. Important passenger services can be provided such as an easier transfer connection, a sheltered waiting area, and route and schedule information.

A. Washington, D.C.: S.W. Terminal. Space is reserved for off-line loading and unloading near a major employment/hotel/commercial center. Three separate aisles with 3 bays each are provided, accommodating a total of 9 buses at a time, with room for them to pass one another. A 24-hour, automatic postal service kiosk was also included.

B. Miami, Florida. Mini-terminal near the fringe of the Central Business District includes 3 aisles.

Bus Access to Terminals*

Exclusive bus ramps, while more costly than most spot priority treatments, may provide significant travel time savings by allowing the bus to bypass local street congestion surrounding a terminal. (Design considerations for exclusive bus ramps are covered in Part III, Section 1: "Freeway-Related Priority Techniques"). Before and after travel time comparisons for most ramps are not currently available.

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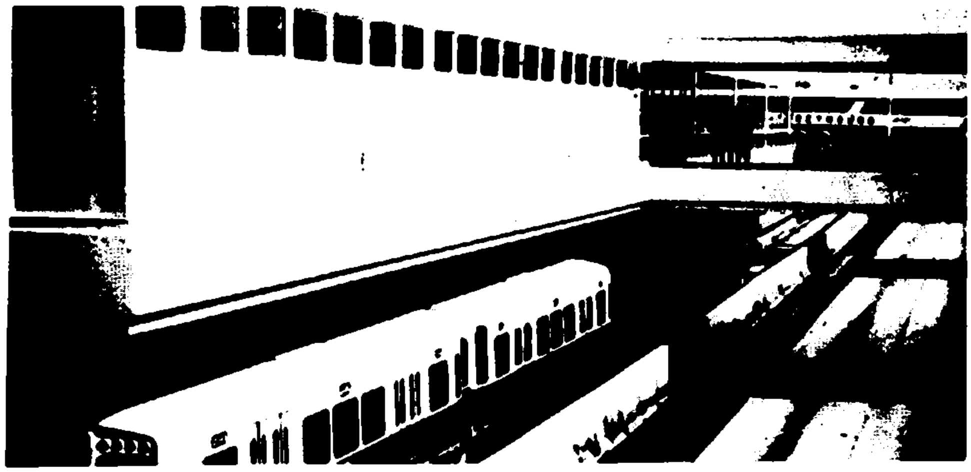
*This discussion draws heavily from Levinson, Bus Use of Highways: A State of the Art, NCHRP Report 143 (1975).

Figure 47
CTA DAN RYAN TRANSIT LINE TERMINAL ACCESS



SOURCE: U.S. Department of Transportation, Office of Public Affairs.

A. Boston-Cambridge, Massachusetts. The Massachusetts Bay Transportation Authority provides a variety of special treatment facilities to give buses direct access to rapid transit stations. These range from an exclusive bus tunnel into the Harvard Square station to special bus signals or bus streets at other locations.

B. Chicago, Illinois: 69th Street/Dan Ryan Expressway Bus Bridge. The Bridge, built over the depressed expressway for $550,000 in 1969, provides space for four buses. The terminal provides a direct connection with the CTA Dan Ryan rapid transit line (see Figure 47).

C. New York, N.Y.: George Washington Bridge Bus Terminal. Heated access ramps directly connect the bridge and the terminal.

D. New York, N.Y.: Port of New York Authority and New Jersey Mid-Town Bus

Terminal. Exclusive entrance/exit ramps (heated in winter) are provided from the I-495 Lincoln Tunnel bus lane to the terminal (as shown earlier in Figure 24).

E. San Francisco, California: Trans-Bay Terminal. Exclusive bus ramps connect the terminal with the San Francisco-Oakland Bay Bridge. The ramps were created by paving over former railroad tracks in 1958.

Park and Ride Lots

Many jurisdictions have park and ride lots. These facilities enable potential patrons in low-density suburban areas to utilize transit without costly feeder services. Park and ride lots can also be used as carpool staging areas. A report prepared by the University of Washington for the Urban Mass Transportion Administration (UMTA) has given some general guidelines for locating and designing park-and-ride lots. Some of these have been incorporated into Table 31 on the following page.[2]

Carpool Staging Areas

Carpool staging can take place at virtually any location convenient to the poolers. Off-street lots can be very small. Some areas have even been informally located on-street. Others have had success by allowing carpool staging in public rights-of-way immediately adjacent to freeway clover-leafs or on roads leading to freeway ramps. (See Figure 48).

TOLL PLAZA TECHNIQUES

Reserved Approach Lanes

A prominent example of this technique exists on the Oakland Bay Bridge in San Francisco. In 1971, preferential lanes were established on both sides of

See page 240 for footnotes

Table 32

PARK-AND-RIDE DESIGN CONSIDERATIONS*

- Time and cost are important parameters in determining whether park-and-ride lots are applicable. If it is easy and inexpensive to park at an activity center, park-and-ride lots will be less effective.

- Lots to capture long-distance commuters should be located either near the potential service area or at a point close to the urban center where congestion increases significantly. A lot would normally be located where a bus can equal or improve auto travel time for that section of the trip.

- Bus headways should be short and set according to the needs of the park-and-ride clientele.

- Larger lots (300+ cars) are often more economical to operate and can be located so as to draw from a side area. However, small lots are often the only way park-and-ride services can be provided and may help make services more personal. More intensive marketing efforts have to be made to reach the potential users of small lots.

- Internal circulation should be planned for the user as a pedestrian. Walking distances to bus boarding areas should be no greater than 500-900 feet, depending upon the climate.

- Lots should be easily accessible from major freeways or arterials. Optimally, the lot should be visible from the roadway.

- The total cost of parking and transit must be kept below out of pocket auto commuting costs (parking and tolls), and/or a significant time savings must be provided to transit patrons.

- A protected waiting area should be provided if the climate is not mild, but if bus shelters are not available, every attempt should be made to have a bus at the boarding stop so that patrons can board immediately.

- The parking lot should be secure. If conditions warrant it, a guard should be provided to protect parked vehicles and patrons.

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*SOURCE: University of Washington, Locating and Operating Bus Rapid Transit Park-Ride Lots: A Synthesis of Experience and Some Preliminary Planning Guidelines, UMTA Report No. UTM-20 (August, 1973).

Figure 48
CARPOOL STAGING AREA: ST. LOUIS COUNTY - 72ND STREET

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

the toll plaza on the Bay Bridge (see Figure 49). One lane was reserved for buses and two for carpools with 3 or more occupants. Early violation rates were high. In March 1974, an overhead metering system was installed for all 14 toll plaza lanes with lights over the preferential lanes providing a constant green indication for high occupancy vehicles. This has significantly reduced violations.

Toll Reduction

The reduction or elimination of tolls and/or parking fees for high occupancy vehicles are strong incentives for high occupancy vehicle use. A good illustration involves the San Francisco/Oakland Bay Bridge mentioned above and pictured in Figure 49. In March, 1975, tolls for high-occupancy vehicles were eliminated. Even though the BART Trans-bay tube was opened, the number of bus patrons has remained

Figure 49
Reserved Lanes on Oakland Bay Bridge

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

the same. Actually, latent demand created additional transit trips across the bay. At the same time, the number of carpools using the bridge has increased from, 1,000 to 2,050 daily, with a concurrent increase in non-transit vehicle occupancy from 1.33 persons per vehicle to 1.43. Carpools save an estimated five minutes travel time and fifty cents per vehicle in tolls.[3]

TRANSIT OPERATIONAL TREATMENTS

Turning Restrictions

Many U.S. Cities have a number of intersections where left turns are prohibited except for buses. These include Washington, D.C., Los Angeles, Phoenix, Lansing, New Orleans and Houston.[4] One element of the Portland Mall currently under construction is a series of mandatory right turn signals, at specified intersections, for all vehicles except buses. Albuquerque also has such treatments in effect.[5]

See page 240 for footnotes

Transit Lane Channelization

A. Philadelphia: Henry Avenue and Walnut Lane. Henry Avenue narrows from six lanes to four with one parking lane at Walnut Lane (see Figure 50). The far-right lane is marked so that autos are channeled into right turns. Buses are allowed to continue through the intersection, putting them in line for the far-side bus stop which has been delineated before the parking lane begins. This treatment was intended as a way to minimize weaving movements.

B. Philadelphia: Passynuk Avenue. At the drawbridge over the Schuylkill River, Passynuk Avenue narrows from six lanes to four (see Figure 51). The right lane was striped and signed for buses and right-turing autos only. When the drawbridge is up, buses are allowed to enter at the head of the queue.

While travel time savings are not that significant, Southeast Pennsylvania Transportation Authority personnel felt that this simple treatment -- implemented by the City of Philadelphia Department of Streets personnel as part of their routine maintenance operations -- improved schedule reliability.

Exclusive Bus Zones/Parking Prohibitions

If buses queue at stops, exclusive bus zones capable of accommodating several buses simultaneously can minimize traffic disruption from the loading and unloading of passengers (e.g., peak hour exclusive bus zones are used in San Francisco).

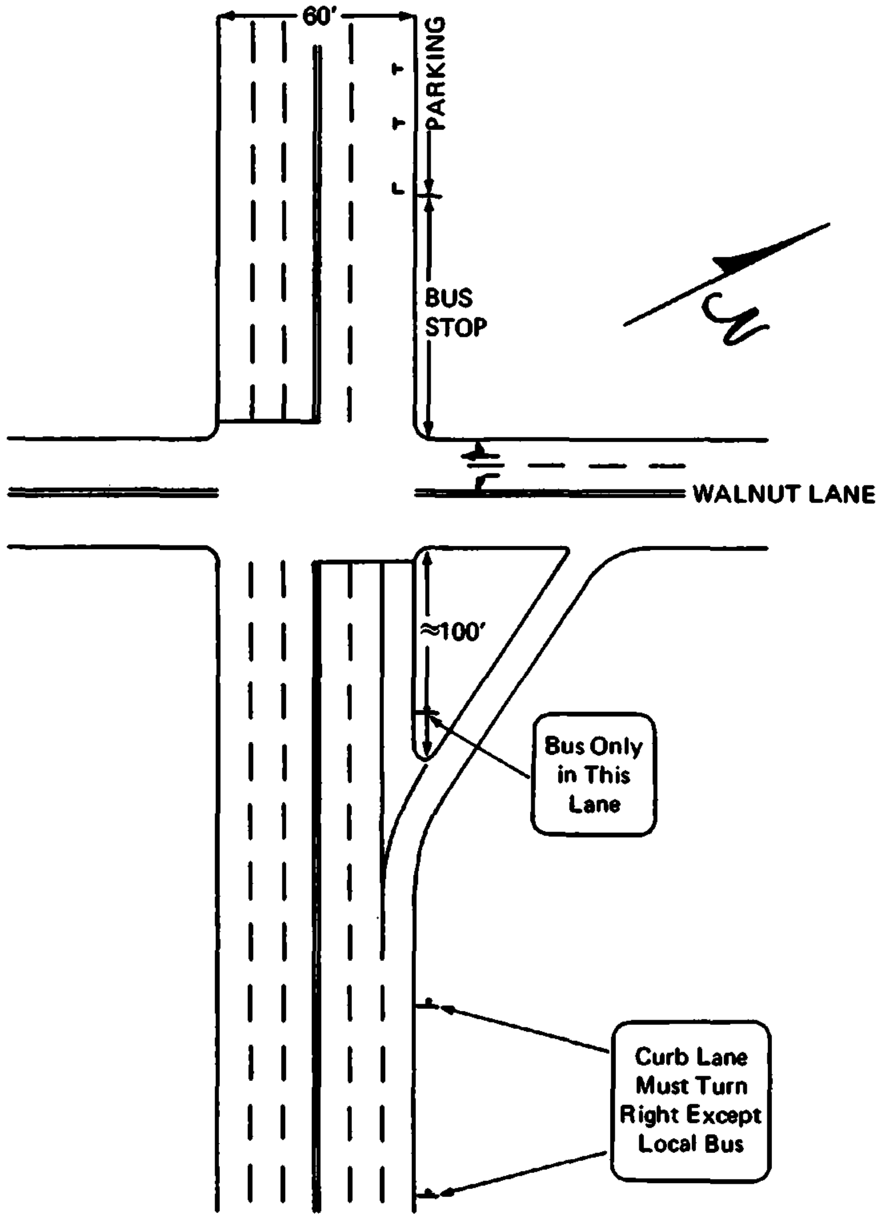
In addition to signs and markings, parking prohibitions should be aggressively enforced. When parking prohibitions are not enforced, it is often difficult for bus drivers to see bus stops. Also, poor enforcement leads to traffic congestion, particularly in peak periods.

Extended Bus Loading Platforms[6]

Soon, the City of Portland will have formally adopted policies concerning the

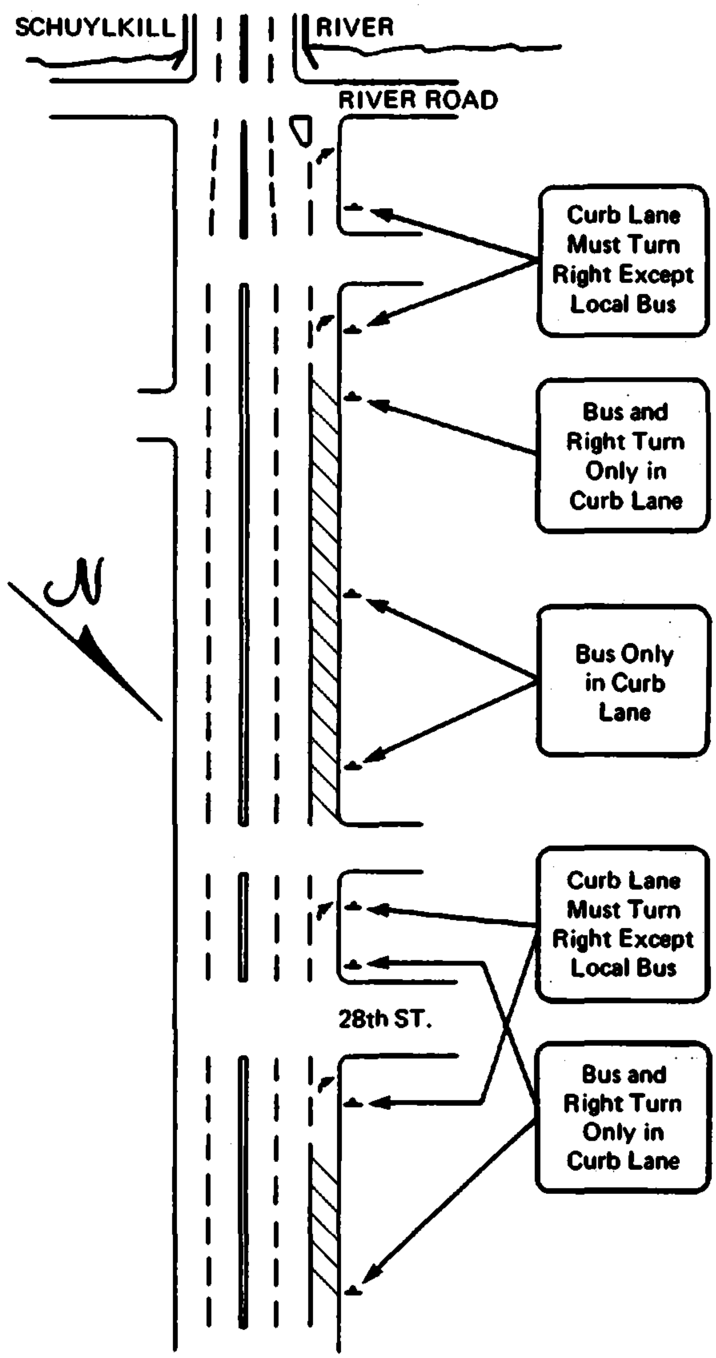
See page 240 for footnotes

Figure 50
PHILADELPHIA: HENRY AVENUE BUS LANE



NOTE: Henry Avenue, south of Walnut Lane; Route A local, northbound; not drawn to scale.

Figure 51
PHILADELPHIA: PASSYUNK AVENUE BUS LANE



NOTE: Routes G and 37, westbound; not drawn to scale.

intended use of all streets within the City. These policies will assist in guiding future decisions on transportation capital investments and operational changes, as well as other matters such as land use decisions. A good number of the streets are denoted as "transit streets" and the basic objectives with respect to use will be to increase most types of transit service and to diminish many types of non-transit use. Accordingly, Portland is currently planning for construction a number of priority lane techniques, including several examined in this manual. However, on a number of streets, a slightly different approach will be tested.

To improve the level of transit service and the transit operating speed, curb extensions are proposed at transit stops along many blocks of various "transit streets." The purpose of the curb extensions (or street necking where two occur on opposite sides of the street) will be to keep the bus in the lane of traffic flow so the bus does not have to wait for an opening in traffic to resume its movement. Thus, the curb extension will provide easier transit movement. In direct proportion to the level of transit service it will also provide a disincentive to use that street for auto trips, particularly longer, through trips. This technique is already in use in the City of San Francisco.

However, Portland has found that this particular technique is not applicable for near-side stops at intersections where there is a heavy (and desirable) right turning movement, since the curb extension would preclude the possibility of a right-turn lane at the intersection. However, the bus stop still requires the bus to move into the right-turn lane. It then faces the same difficulty of moving back into the traffic lane.

To address this problem, i.e., to allow the bus a priority movement from the curbside stop back into the traffic lane, Portland has proposed that the bus be provided a special signal pre-emption control. This actuated signal would affect only the right-turn lane and then only when the bus is occupying the lane at a position at the head of any other traffic. The signal would not alter the general signal phasing, except when the green phase is approaching. At that time, the bus in the right-turn lane would have a separate signal which would turn green several seconds before that of the regular lanes. This would allow it to move forward through the intersection and into the through traffic lane before the other traffic. In short, the intersection would have an additional signal face, visible only in right-turn lane and actuated only by the bus. The right-turn lane would have to be limited to buses and right-turning vehicles only. The technology to be used for this treatment has not been finalized as of April, 1977.

PART III NOTES:

SPECIFIC PROJECT CONSIDERATIONS

Section 1: FREEWAY-RELATED PRIORITY TECHNIQUES

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2. Herbert Levinson et al., Bus Use of Highways: Planning and Design Guidelines, National Cooperative Highway Research Program Report 155 (Washington, D.C.: National Research Council, Transportation Research Board, 1975), p. 52.

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4. Highway Research Board, Highway Capacity Manual 1965, Highway Research Board Special Report 87 (Washington, D.C.: National Academy of Sciences - National Research Council, 1965), p. 5.

5. Levinson, Bus Use of Highways: Planning and Design Guidelines. NCHRP Report 155.

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7. Personal communication from W. Myray, Maintenance Department, California Highway Patrol, August, 1976.

8. Southern California Rapid Transit District, San Bernardino Busway Operating Manual (Los Angeles: Southern California Rapid Transit District, 1976).

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11. U.S. Department of Transportation, Federal Highway Administration, "Amendment Ln-6", Manual on Uniform Traffic Control Devices for Streets and Highways, Official Rulings on Requests, GPO Stock No. 5001-0021 (Washington, D.C.: Government Printing Office, 1975), pp. 7-8.

12. Ibid., "Amendment M-26", pp. 41-42.

13. Levinson, Bus Use of Highways: Planning and Design Guidelines, NCHRP Report 155.

14. Personal interview with Lieutenant W. B. Russell, California Highway Patrol, June, 1976.

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19. Personal communication with Joseph Goodman, November, 1976.

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3. John W. Erdman and Edward J. Panuska, Jr. "Exclusive Bus Lane Experiment", Traffic Engineering 46, no. 7, July, 1976): pp. 28-33.

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5. R. H. Pratt Associaties, Inc. Low Cost Urban Transportation Alternatives: Vol. 1, Results of Case Studies and Analysis of Busway Applications in the United States (Kensington, Md.: R.H. Pratt Associates, Inc., January, 1973), pp. 63-68.

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9. See note 6.

Section 3: ACTIVITY CENTER PRIORITY TECHNIQUES

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APPENDICES

APPENDIX A

CONTACTS AND CURRENT PROJECTS

Contacts

Research and development efforts related to priority techniques for high occupancy vehicles are divided among several federal agencies. The U.S. Department of Transportation (DOT) and its two branches--the Urban Mass Transportation Administration (UMTA) and the Federal Highway Administration (FHWA) staff are housed in three offices:

- DOT Headquarters
  Nassif Building
  400-7th Street, S.W.
  Washington, D.C. 20590

- Transpoint Building (TRPT)
  2100-2nd Street, S.W.
  Washington, D.C. 20590

- Fairbank Highway Research Station (FHRS)
  6300 Georgetown Pike
  McLean, Va. 22101

In addition to the DOT, the Environmental Protection Agency and the Federal Energy Administration also have programs concerning the energy and environment aspects of priority technqiues. Their offices are located at:

- Environmental Protection Agency*
  401 M Street, S.W.
  Washington, D.C. 20410

- Federal Energy Administration*
  Washington, D.C. 20461

Activities and contact persons are listed below:

DEPARTMENT OF TRANSPORTATION

- Office of the Secretary, R&D Policy Analysis Division
  Can answer questions on general DOT research and development efforts and policy issues. Contact: Norm Paulhus or Kathy O'Leary, OST-TST-12, DOT, (202) 426-4208.

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*The change in the national administration may result in some changes in titles, structure and responsibilities of these agencies in the near future. Public Technology, Inc. will monitor these events and should be contacted if problems arise in the efforts to contact any individuals or agencies listed.

FEDERAL HIGHWAY ADMINISTRATION

- Office of Research
  Can answer questions on FHWA research efforts on priority techniques. Contact: Howard Bissell or C.J. MacGowan or Dan Rosen, HRS-33, FHRS, (202) 557-5231.

- Office of Development
  Can answer questions on FHWA publications and FHWA information dissemination efforts on priority techniques. Contact: Juri Raus, HDV-21, TRPT, (202) 426-9205.

- Transit and Traffic Engineering Branch
  Can answer questions on funding and FHWA transit and traffic operational studies related to priority techniques. Contact: Don Morin or Stephen Baluch, HHP-26, DOT, (202) 462-0210.

- National Highway Institute
  Can answer questions on training courses in all aspects of highway transportation including bus priority systems and public transportation courses which includes discussions of priority techniques. Contact: George Shrieves, HHI-2, DOT, (202) 426-9141.

URBAN MASS TRANSPORTATION ADMINISTRATION

- Service and Methods Demonstration Program
  Can answer questions on potential funding of significant research efforts and on-going projects on priority techniques. Contact: Ronald Fisher, UMD-20, TRPT, (202) 426-4984, or Joseph Goodman, UMD-20, TRPT, (202) 426-4984.

FEDERAL ENERGY ADMINISTRATION

- Can answer questions on carpool incentive policies and other energy conservation efforts related to ride-sharing programs. Contact: Anne Marie Zerega, Conservation and Environment, (202) 566-7317, or Lew Pratsch, Conservation and Environment, FEA, (202) 566-9093.

ENVIRONMENTAL PROTECTION AGENCY

- Can answer questions on transit requirements for vehicle miles travelled reductions (for sketch planning analysis) and EPA research related to priority techniques. Contact: Joel Horowitz, AW-444, EPA, (202) 426-2484.

TRANSPORTATION RESEARCH BOARD

- For information on the latest Transportation Research Board publications concerning priority techniques. Contact: David Witheford, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418, (202) 389-7641.

HIGHWAY USER'S FEDERATION

- For information on latest Highway User's Federation publications on priority techniques. Contact: Carlton Robinson, 1776 Mass. Avenue, N.W., Washington, D.C. 20036, (202) 833-5816.

AMERICAN PUBLIC TRANSIT ASSOCIATION

- For information on bus operations measures related to priority techniques. Contact: Phil Braum, 1100 17th Street N.W., Washington, D.C. 20036, (202) 331-1100.

INSTITUTE OF TRANSPORTATION ENGINEERS (ITE)

- For information on the latest I.T.E. publications and committee reports on the subject of priority techniques. Contact: Director, Technical Affairs, 1815 N. Fort Myers Dr., Suite 905, Arlington, VA, (703) 527-5277.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

- For information on design standard publications of streets and highways. Contact: AASHTO, 444 No. Capital St. N.W., Suite 225, Washington, D.C. 20001.

CURRENT PROJECTS

Tables A-1 to A-3 list examples of major current projects which have been implemented around the U.S. Information on these projects can be obtained by contacting the cities where the projects were implemented.

Table A-1

SELECTED FREEWAY PREFERENTIAL TREATMENT PROJECTS

U.S. CITY	FACILITY	TECHNIQUE
Los Angeles, CA	I-10, San Bernardino Fwy	Exclusive Carpool/Busway
Philadelphia, PA	Ardmore Busway	Exclusive Busway
Washington, D.C.	I-95, Shirley Highway	Exclusive Carpool/Busway
Boston, MA	I-93	Concurrent flow reserved lanes for buses and carpools
Honolulu, HI	Moanalua Freeway	Concurrent flow reserved lanes for buses and carpools
Los Angeles, CA	I-10, Santa Monica Fwy*	Concurrent flow reserved lanes for buses and carpools with ramp metering priority access ramps
Miami, FL	I-95	Concurrent flow reserved lanes
Marin Cty., CA	U.S. 101	Concurrent flow bus lanes and contra-flow bus lane (1 direction) in two segments of same freeway. Elimination of tolls for carpools on Golden Gate Bridge
Boston, MA	Southeast Expressway	Contra-flow bus lane (1 direction)
New York, NY	Long Island Expressway	Contra-flow bus lane (1 direction)
New York, NY	I-495, Lincoln Tunnel	Contra-flow bus lane (1 direction)
Pittsburgh, PA	Braddock Ave-Pkwy East	Exclusive bus ramp
Seattle, WA	I-5	Exclusive reversible bus ramp

* Case study provided in Appendix

U.S. CITY	FACILITY	TECHNIQUE
Dallas, TX	North Central Expressway	Freeway ramp entry gates and exclusive bus bypass ramp
Los Angeles, CA	I-405 San Diego Freeway	Priority access ramps
Minneapolis, MN	I-35W	Bus bypasses at metered ramps
San Francisco, CA	San Francisco/Oakland Bay Bridge	Concurrent flow bus and carpool approach lanes to toll booths.

Table A-2

SELECTED ARTERIAL PREFERENTIAL TREATMENT PROJECTS

U.S. CITY	FACILITY	TECHNIQUE
Arlington, VA	Wilson, Arlington Blvds.	Concurrent flow curb bus lanes
Baltimore, MD	York Road/Greenmount St.	Concurrent flow curb bus lane
Miami, FL	South Dixie Highway*	Concurrent flow bus and carpool lane
Washington, D.C.	Several arterials	Concurrent flow bus lanes (bicycles, taxis permitted)
Honolulu, HI	Kalanianaole Blvd.	Contra-flow bus lane
Indianapolis, IN	College Avenue	Contra-flow bus lane
San Juan, P.R.	Ponce deLeon, Fernandez Juncos	Contra-flow bus lanes on one-way couplet
Miami, FL	N.W. 7th Avenue*	Reversible median bus lane

* Case study provided in Appendix.

Table A-3

SELECTED ACTIVITY CENTER PREFERENTIAL TREATMENT PROJECTS

U.S. CITY	FACILITY	TECHNIQUE
Birmingham, AL	19th Street North	Concurrent flow curb bus lane
Buffalo, NY	Church, Main Sts.	Concurrent flow curb bus lane
Chicago, IL	Washington St., Canal St., Lake Shore Drive, N. Sheridan Rd., State St.	Concurrent flow, contra-flow and median bus lanes
Dallas, TX	Elm, Commerce Sts.	Concurrent flow curb bus lanes on 1-way couplet
Denver, CO	16th, 17th, Larimer and Lawrence Sts.	Concurrent flow curb bus lanes, reserved lane for carpools
Houston, TX	Main St.	Concurrent flow curb bus lane
Nashville, TN	4th Avenue	Concurrent flow curb bus lane
New York, NY	Numerous locations	Concurrent flow bus lanes and bus zones
Newark, NJ	Market St.	Concurrent flow curb bus lane
Philadelphia, PA	Broad Street Vine Street	Concurrent flow curb bus lanes, exclusive bus street
Providence, RI	Washington-Weybosset Streets	Concurrent flow curb bus lanes

U.S. CITY	FACILITY	TECHNIQUE
Rochester, NY	Main St., & Lake Ave.	Concurrent flow curb bus lanes
San Francisco, CA	Geary-O'Farrell, Judah Sts., Sutter-Post	Concurrent flow curb bus lanes on one-way couplets, several spot improvements
Washington, D.C.	Several locations	Concurrent flow bus lanes, (both CBD and arterial applications)
Cleveland, OH	Public Square	Contra-flow bus zone at major transfer/terminal point
Harrisburg, PA	Market St.	Contra-flow bus lane
Honolulu, HI	Kalakua	Contra-flow bus lane
Los Angeles, CA	Spring St.*	Contra-flow bus lane
Madison, WI	University Ave.	Contra-flow limited use lane (also used by bicycles)
Minneapolis, MN	Marquette, 2nd Aves.	Contra-flow bus lanes on one-way couplet
San Antonio, TX	Alamo Plaza	Contra-flow bus lane
Seattle, WA	CBD	Contra-flow bus lane
New Orleans, LA	Canal St.	Median bus lane
Dallas, TX	Three arterials and Frontage Rd. in North Central Expwy corridor	Bus signal preemption
Louisville, KY	8 intersections	Bus signal preemption
Washington, D.C.	Part of CBD, Wisconsin Ave.	Bus signal preemption
Chicago, IL	63rd, Halsted Sts.	Reserved pedestrian/bus sts.
Minneapolis, MN	Nicollet Mall*	Pedestrian Mall with transitway
Philadelphia, PA	Chestnut St.	Exclusive transit mall
Cambridge, MA	n.a.	Two-level exclusive trolley and diesel bus tunnel
Providence, RI	East Side Tunnel	Exclusive bus tunnel

*Case study provided in Appendix.

Appendix B

CASE STUDY: LOS ANGELES, CALIFORNIA/ SANTA MONICA FREEWAY DIAMOND LANE

INTRODUCTION

The Santa Monica Freeway Diamond Lanes project was the most extensive effort yet made in the United States to test the utility of exclusive lanes for high occupancy vehicles in achieving air quality and energy conservation goals. It may also be the most controversial.

This is a report on the project as it appeared on August 9, 1976, when it was suspended--after 21 weeks of operation--by the United States District Court on the basis that the procedure requirements of the California Environmental Quality Act and the National Environmental Protection Act had not been met during project planning. Data on the project were assembled, and many of the persons participating in the project were interviewed, during the weeks of June 22 and October 17.

The Diamond Lanes project was an experiment which was to have been completed in March 1977. The project will not be resumed. More important, the local plan developed in 1974 to supercede the Environmental Protection Agency's Transportation Control Plan may now be defunct.

Because of its early end, little of value about the long-range effects of the project can be learned. However, a great deal was learned about the planning and early operation of a major project which involves both incentive and disincentive measures.

Project Description

The No. 1 lanes in both directions on the Santa Monica Freeway (I-10) between Lincoln Boulevard in the City of Santa Monica and the Harbor Freeway in downtown Los Angeles, a distance of 12.6 miles, were reserved for the exclusive use of buses and carpools of three or more persons between 6:30-9:30 a.m. (originally 6-10 a.m.) and 3-7 p.m., Monday through Friday. The project, called locally the Santa Monica Freeway Diamond Lanes, began operation on March 15, 1976. The lane reservations were discontinued on August 13, 1976. Figure B-1 shows the lanes in operation

The Santa Monica Freeway is basically an eight-lane highway, with inside and outside breakdown lanes and a 22-foot median. In some areas, additional lanes have been provided by reducing lane widths and eliminating the right shoulder.

Lanes are delineated by pavement striping and raised pavement markers. The reserved lanes were designated by large diamonds painted within the lane--alternate diamonds having within them a numeral indicating the number of persons who constituted a legal carpool--and by signs. No physical barriers were used and vehicles were permitted to enter and leave the reserved lanes at any point.

Figure B1
SANTA MONICA DIAMOND LANES IN OPERATION

Associated features, which remained in operation after the exclusive lanes were discontinued, include:

- Thirty metered on-ramps, which controlled access to the freeway during peak periods;
- By-pass lanes at twelve of the metered on-ramps, which gave preferential access to the freeway to buses and carpools of two or more persons;
- Use of existing Commuter Computer services in securing information about possible carpool participants;
- New express bus services to and from the Los Angeles central business district and expanded feeder service; and
- Two new park-and-ride lots, located in Santa Monica and Fox Hills (a third park-and-ride lot, at Century City was closed during the project).

Project Objectives

The overall purpose of the Santa Monica Freeway Diamond Lanes project was to test one set of concepts aimed at increasing vehicle occupancy on heavily travelled urban freeways. This was to be done through the creation of incentives to form carpools and to use transit bus service. The specific objectives were to:

1. Improve air quality;
2. Contribute to the attainment of national energy conservation goals;
3. Reduce overall travel times; and
4. Increase the efficiency of existing freeway facilities.

Project Participants

The project participants were:

- The California Department of Transportation, which was responsible for establishing and maintaining the freeway facilities;
- The California Highway Patrol, which was responsible for enforcement and safety;

- The Santa Monica Municipal Bus Line, which was responsible for operating freeway express bus service, and certain local and feeder services; and

- The Southern California Rapid Transit District, which was responsible for the park-and-ride lots, operating freeway express bus service, and certain feeder services.

Organizational Arrangements

In general, each project participant was responsible for planning and carrying out a discrete part of the project. The lead agency was the California Department of Transportation, which controls the Santa Monica Freeway and whose District Director of Transportation (District 7, Los Angeles) was designated as Project Manager.

Overall policy management and operating decisions were made by a Joint Project Board of Control, consisting of representatives of the California Department of Highways, California Highway Patrol, Santa Monica Municipal Bus Line, and Southern California Rapid Transit District.

The Joint Board was conceived originally as a means of providing general direction to the Federally-funded demonstration grant project, which dealt solely with marketing and data collection. The Joint Board subsequently took on the broader responsibilities indicated in the above discussion.

As requested by the City of Los Angeles, a Project Operating Committee (consisting of representatives of the four participants and the City), was set up to manage the project and deal with citizen concerns. This committee became essentially a technical group which functioned on an informal basis without stated meetings.

PROJECT AREA

The focus of the Santa Monica Freeway project was the relatively mature residential area between the Los Angeles central business district and the northern section of Santa Monica Bay commonly known as Westside.

Description of Westside

The Westside project area contains approximately 100 square miles and had a 1970 population of about 560,000 persons. The average density is 5,640 persons per square mile, but reaches as high as 10,600 persons per square mile in the City of Santa Monica. Land uses are predominately residential--both single family and multi-family--with extensive high rise development in recent years. Considerable land area is in commercial and industrial uses.

In general, the residents of the Westside area are of above average income. While a substantial proportion of them work in the area itself, approximately 12,300 daily work trips are made to the Los Angeles central business district.

Westside is served by the Santa Monica and San Diego Freeways. The Santa Monica Freeway (I-10) runs from the City of Santa Monica to downtown Los Angeles. The San Diego Freeway (I-405) is an urban circumferential and by-pass route. Both are heavily used.

Average daily traffic on the Santa Monica Freeway in the spring of 1975 ranged from 100,000 vehicles at its western end to 240,000 vehicles at the Harbor Freeway in downtown Los Angeles. About 82 percent of the automobiles using the freeway carried a single occupant; only 3 percent carried three or more occupants. Average vehicle occupancy in the eastbound a.m. peak was 1.18 while the westbound p.m. peak was 1.25. West of the San Diego Freeway, the Santa Monica Freeway was relatively free flowing at all times, while light to heavy congestion occurred east of that point during peak periods.

Public Transportation in Westside

Transit service in the Westside area is provided by the Southern California Rapid Transit District, Santa Monica Municipal Bus Lines, and Culver City Municipal Bus Lines.

The Southern California Rapid Transit District is a regional transit agency and by far the largest transit operator in the Los Angeles area. It operates more than 2,300 buses and serves a population estimated at 7 million persons, In the pre-project period, the district operated five routes in the project area, carrying an estimated 1,600 revenue passengers daily.

The Santa Monica Municipal Bus Lines is owned by the City of Santa Monica. The Santa Monica Municipal Bus Lines operates about 100 vehicles and carries approximately 10.5 million revenue passengers annually. Considerable service is provided in the project area, but prior to the project the lines did not extend into downtown Los Angeles.

The Culver City Municipal Bus Lines (24 buses, 1.1 million revenue passengers annually) was not a project participant. However, it did then (and does now) provide a feeder service to Southern California Rapid Transit District routes.

The Board of Directors of the Southern California Rapid Transit District may authorize new routes and service which are not in violation of the State Public Utility Code. Similar authority, with respect to the Santa Monica Municipal Bus Lines, is exercised by the Santa Monica City Council. The Southern California Association of Governments is the planning agency and arbiter of jurisdictional disputes under the Public Utility Code.

The County of Los Angeles, through a special funding program, has supported a 25¢ base fare, with 25¢ zones, within Los Angeles county. The basic fare and zone charge were increased to 35¢ during the project period.

PROJECT BACKGROUND

Under the Federal Clean Air Act of 1970, each State is responsible for adopting plans which will achieve Federal air quality standards. Lacking a State plan for the Los Angeles Air Quality Control Region, the U.S. Environmental Protection Agency (EPA) on November 12, 1973, promulgated a Transportation Control Plan which would have curtailed severely the use of automobiles within the region.

The Federal plan met strong local opposition. As a counter-proposal, the Southern California Association of Governments (SCAG) adopted the SCAG Short-Range Transportation Plan on April 11, 1974. This plan included a program for the preferential treatment of high occupancy vehicles which was designed to achieve maximum person mobility through changes in trip character instead of forced reductions in mobility due to trip restrictions.

The short-range plan became the regional input to the State Transportation Control Plan then being prepared by the California Department of Transportation. The State plan was subsequently approved by the U.S. Environmental Protection Agency as a substitute for its own plan.

The California Department of Transportation, under the approved Transportation Control Plan, was assigned responsibility for developing and implementing a two-phase preferential treatment program:

- Phase I involved the implementation by 1977 of selected pilot projects, identified originally in the SCAG Short-Range Transportation Plan, to permit testing and evaluation of basic preferential treatment techniques applicable to freeway situations.

- Phase II involved the application of preferential treatment to eight selected freeway locations on a continuing basis.

Phase I projects described in the plan included:

- A contra-flow for buses only on a section of the Hollywood Freeway;

- Concurrent flow lanes for buses and carpools on a section of the Santa Monica Freeway;

- Concurrent flow lane for buses and carpools, using an improved median shoulder on sections of the San Diego, Long Beach, and Artesia Freeway; and

- Preferential ramp metering for buses and carpools on a section of the Golden State Freeway.

The Santa Monica Freeway was selected by the California Department of Transportation in the spring of 1975 as the site of the first Phase I project. The reasons for its selection were:

- Early action under the Transportation Control Plan was considered necessary and it was believed that the Santa Monica Freeway project could be implemented quickly since it involved no major physical modifications or construction.

- At a time when highway funds were tight, this project was the least capital-intensive of the Phase I projects.

- Changeable electronic message signs were already in place.

- Highway surveillance equipment involving the San Diego, Santa Monica, and Harbor Freeways was already in operation.

- There were good parallel alternative routes for diverted traffic.

- The Santa Monica Freeway had the greatest percentage of trips oriented to the Los Angeles central business district and appeared to have the greatest potential for an increase in capacity, in terms of persons using the facility, as a result of the application of preferential treatment techniques.

Project Planning

Project planning was primarily the responsibility of the California Department of Transportation, acting through its District 7 office at Los Angeles. The District office worked closely, and largely on an informal basis, with the other agencies involved in operational planning: the California Highway Patrol, the Santa Monica Municipal Bus Lines, and the Southern California Rapid Transit District. There appear also to have been satisfactory informal working relationshops at the professional staff level with various city and county agencies.

The California Department of Transportation's district office had been working on a comprehensive program for updating freeway conditions. The data collected in connection with this program, during concurrent studies of carpooling, and from routine continuing sources, provided most of the planning data needed by the district office.

The California Highway Patrol was responsible for planning enforcement tactics and the redeployment of patrol units. The California Highway Patrol also worked closely with the California Department of Transportation on enforcement and safety related aspects of overall project design.

The Southern California Rapid Transit District established criteria for the park-and-ride lots and identified alternative locations for these facilities. The district was also responsible for land purchase or leasing and the planning of site improvements.

The Southern California Rapid Transit District and the Santa Monica Municipal Bus Lines were responsible for planning their respective bus services. Route selection and patronage estimates were based on origin and destination from the Los Angeles Regional Transportation Study. Service levels designed to provide attractive frequencies were established on a policy basis that was independent of patronage estimates. Schedules were constructed on the basis of anticipated freeway speeds and experience in surface operations.

Delays In Getting The Project Started

It soon became apparent that the expectation of an early start of the Santa Monica Freeway project would not be realized. The original schedule allowed six weeks for project planning and another six weeks to get ready for the project to go into operation. In actuality, these processes took more than a year.

In retrospect, the schedule was unrealistic. Yet, even a more realistic schedule would not have anticipated some of the events which combined to delay this project. The most significant among them were:

- An unusual amount of time was required to obtain project planning approval from the Sacramento office of the California Department of Transportation.
- A jurisdictional dispute, between the Southern California Rapid Transit District and the Santa Monica Municipal Bus Lines involving territorial operating rights. The dispute was finally settled by negotiation of a cooperative agreement for joint participation in the project.
- A change in the general method of financing transit operations in Los Angeles County raised questions on the part of the Board of County Supervisors relative to project control.
- There was an essentially unrelated issue involving acceptance by the Southern California Rapid Transit District of the so-called "National Agreement" which set out labor protective arrangements for operating projects assisted under Section 5 of the Urban Mass Transportation Act of 1964.
- And, finally, a decision was made to wait for several months to avoid the winter holidays, the rainy season, and seasonal darkness during the peak traffic periods.

Changes In Concept During The Planning Period

Some changes occurred in the preliminary project concept during the planning period. The most significant of these were:

- Bus and carpool lanes were reserved during peak periods, five days a week, instead of the previous 24 hours a day, seven days a week. The California Highway Patrol considered a reserved lane virtually unenforceable during the night hours and weekends and recommended against a situation in which posted lane restrictions were not enforced for part of the time.

- The definition of carpool, as it applied to the reserved lane, was changed to apply only to vehicles carrying three or more persons. Computations indicated that the original definition, which applied to any vehicle carrying two or more persons, would overload the reserved lane. However, the original definition (two or more persons) was retained in connection with the use of the ramp meter by-pass lanes.

The original plan called for the bus and carpool lanes to be reserved first, and followed by ramp metering. Because of delays in the reserved lane project, the ramp meters--a separate freeway improvement project--were installed first. This adversely affected the public reaction to the reserved lanes because: (1) the metered ramps had freed up traffic noticeably; and (2) this fact magnified the effect of lane reservation when it finally occurred.

PROJECT OPERATIONS

The reserved lanes were placed in operation in the morning of Monday, March 15, 1976. The critics of the project--and many of its friends--refer to this day as "Mad Monday".

Although delays occurred at a number of on-ramp locations because the metering rates had been lowered to compensate for the reserved lane, the major cause of the massive tie-up which occurred on the Santa Monica Freeway itself was a multiple vehicle rear-end accident at 6:35 a.m. in the unreserved eastbound lanes at La Brea Avenue. This accident is not officially attributed to the reserved lane project. The congestion caused by this event was made worse by the failure of a meter on the Lincoln Boulevard ramp, which displayed a green signal from 6 a.m. to 7 a.m.

Peak period traffic on Monday afternoon was affected by a spilled load on the Harbor Freeway, which delayed vehicles using the connector to the westbound Santa Monica freeway. The use of the connector was also adversely affected by the barricades that had been placed to channel entry to the Santa Monica Freeway. It was impractical to remove the barricades because this would have severely congested the main lanes and probably would have made it impossible to flush the reserved lane at 3 p.m.

Accidents on the first day were at about four times the normal rate. They all occurred in the unreserved lanes and are attributed to the heavy congestion and unfamiliarity with the new configuration of the freeway.

The second day's operation showed substantial improvement. However, in the opinion of many observers, the Santa Monica Freeway Diamond Lanes never recovered from the effects of Mad Monday.

On the second day there was little congestion on the freeway itself during either peak period. Ramp delays, however, were equal to those of the preceding day and traffic volumes increased on parallel streets. The accident rate remained above normal.

Changes After March 15, 1976

There were several changes in project and associated operations after March 15. The principal changes were:

- Adjustments in metering rates to permit increased flows onto the freeway;
- Signal timing modifications to maximize the operations of parallel streets;
- Replacement of the barricades by metering devices;
- Unilateral discontinuance by the City of Los Angeles of a number of preferential left-turn pockets at on-ramps;
- Reduction of the morning peak operating period by one hour (from 6 to 10 a.m. to 6:30 to 9:30 a.m.);
- Adjustments in transit services and schedules to reflect experienced demands which involved both increases and decreases. Further decreases in the service provided by the Southern California Rapid Transit District were required because of system-wide budgetary restrictions.
- Discontinuance of the Century City park-and-ride lot because of lack of patronage.

OPERATING RESULTS

The data summaries which follow relate to a 21-week period from March 15 through August 9, 1976. However, the project operating results cannot be judged strictly on the basis of data alone, since public and professional perceptions of these results involve a variety of other factors, such as those discussed later in this appendix.

Average Daily Travel in Peak Periods

The data for average daily travel in peak periods can be summarized in four different categories: (1) all lanes; (2) reserved lanes; (3) bus patronage; and (4) car pools. In each category, data is presented below for three periods: (1) pre-projects; (2) 1st week; and (3) 21st week.

- Table B1: Average Daily Travel--All Lanes. The number of persons using the Santa Monica Freeway during peak periods each day was 7 percent below the pre-project average. The average number of persons using the Santa Monica Freeway during peak periods each day reached the pre-project level during the 21st week.

	Persons	Vehicles	Persons/Vehicle
Pre-project	118,750	96,950	1.23
1st week	98,330	76,176	1.29
21st week	122,225	89,750	1.36

- Table B2: Average Daily Travel--Reserved Lanes. The 21st week showed an increase of 41 percent over the first week in the number of persons carried in the reserved lanes. The total using the reserved lanes was about 13 percent over the pre-project level. The vehicle count dropped to about 450 per hour per lane or about 50 percent of normal capacity.

	Persons	Vehicles	Persons/Vehicle
Pre-project	19,792	16,158	1.23
1st week	15,900	4,760	3.34
21st week	22,400	6,300	3.56

- Table B3: Average Daily Travel--Bus Patronage. Although bus patronage increased 300 percent over the pre-project level, the aggregate number of daily riders at the end of the 21st week was only 3.1 percent of the total number of persons using the freeway.

	Bus Riders	% of Riders Using Freeway
Pre-project	1,260	1.1
1st week	2,483	2.5
21st week	3,807	3.1

- Table B4: The number of carpool riders increased over the pre-project level. At the end of the 21st week, 13.8 percent of the freeway users were riding in carpools.

	Car Pool Riders	% of Riders Using Freeway
(1) Pre-project	6,248	5.3
1st week	11,168	11.4
21st week	16,807	13.8

	Car Pools	% of Carpools Using Freeway
(2) Pre-project	1,785	1.8
1st week	3,191	4.2
21st week	4,802	5.4

- Table B5: Other Performance Indicators. The average ramp delay shown below is for the 5 busiest ramps, with the final figure a report for the 20th week (instead of the 21st). The range in the 20th week for the 5 ramps was: (1) average delay - 2.25 to 7.50 minutes; and (2) maximum delay - 6.75 to 14.75 minutes.

	Average Time On Project (min)			
	Non-Priority		Priority	
	am	pm	am	pm
(1) Pre-project	20	21		
1st week	23	27	15.5	15.5
21st week	19	17	15.5	15.5

	Average Ramp delay (min)	Total Vehicles parallel streets (peak periods)
(2) Pre-project	4.4	42,099
1st week	7.9	49,183 (Data for 4th week)
21st week	5.0	40,970 (Data for 18th week)

- Table B6: Total Weekly Accidents. The total number of accidents involving both personal injury (PI) accidents and property damage only (PDO) increased sharply over the pre-project level.

	PDO	PI	Total
Pre-project	9	2.5	11.5
1st week	36	18	54
21st week	14	2	16
Avg. for 21 weeks	18.9	5.5	24.4

Park-And-Ride Lots

Considerable delays were experienced in obtaining use of the three park-and-ride lots that had been included in the project plan. The lot planned for Westwood had to be relocated to what one official refers to as the sixth choice of a location at Century City. The Century City lot was eventually discontinued because of lack of patronage, which is attributed to the lot being too close to downtown Los Angeles for it to be attractive to potential transit riders. Data for the Park-And-Ride lots is presented in Table B7, at the beginning of the following page.

- Table B7: Park-And-Ride Lots

	Santa Monica	Century City	Fox Hills
Capacity (vehicles)	220	300	200
3/15/76	83	33	25
6/16/76 (weekly average)*	103	---	89

*Latest data reported

Fuel Savings

Based upon estimates of vehicle miles traveled during an eight-hour daily peak period in the entire corridor, the California Department of Transportation reports that the project saved a daily average of 11,345 gallons of fuel by the end of the 18th week. This represents a 7.6 percent savings over the period immediately prior to the project.

Air Quality

Any interpretation of the data with respect to the effect of the project on air quality is inconclusive. Within the South Coast Basin there was little change in the concentrations of vehicle-related pollutants.

- Table B8: Project Impact on Air Quality

	Tons/Day Carbon Monoxide	Tons/Day Nitrogen Oxides	Tons/Day Reactive Hydrocarbons
Pre-project	8,400	1,617	1,829
4th week	8,203	1,617	1,829
13th week	8,198	1,616	1,828

Transit Operations

No significant or unusual problems have been identified in connection with the provision of project transit services. The most serious operating problem, experienced by the Southern California Rapid Transit District (SCRTD), was that of maintaining schedules. The SCRTD was in an expansion period--during which it increased the number of bus drivers by 20 percent in one year--when project service began. The result was an exceptional number of inexperienced drivers. The problem was intensified because, during a major portion of the project, the Santa Monica Freeway service drivers had to be rotated off the extra board.

Prior to the opening of the reserved lane, only the Southern California Rapid Transit District operated over the Santa Monica Freeway, using 18 buses and carrying some 6,300 passengers a week. As a part of the agreement reached on territorial rights, to which an earlier reference has been made, the Santa Monica Municipal Bus Lines (SMMBL) gained direct access to the Los Angeles central business district.

As reflected in the table below, both carriers experienced substantial increases in patronage after project operations began on March 15, 1976. At no time, however, did bus patronage constitute a substantial proportion of the total number of persons using the Santa Monica Freeway during peak periods.

- Table B9: Average Daily Peak Period Bus Riders

	Aggregate Totals	
	Riders	% Riders Using Freeway
(1) Pre-project	1,260	1.1
1st week	2,483	2.5
11th week	3,640	3.4
21st week	3,807	3.1

	SCRTD		
	Trips	Riders	Load Factor
(2) Pre-project	35	1,260	70%
1st week	160	2,006	25%
11th week	166	2,657	32%
21st week	131	2,732	42%

	SMMBL		
	Trips	Riders	Load Factor
(3) Pre-project	0	0	--
1st week	20-25	476	43%
11th week	20-25	982	91%
21st week	25	1,075	86%

The Southern California Rapid Transit District's service levels, reflected in the number of daily trips fluctuated during the project, indicated both responsiveness to actual experienced demands and the effects of discontinuing operation of the Century City park-and-ride lot. The service reduction after the 11th week was the result of general budget constraints in fiscal year 1977. Santa Monica Municipal Bus Lines was constrained by the number of buses--10--available for this service.

Figures are not yet available to show the financial results of providing the service associated with the Santa Monica Freeway project. The Southern California Rapid Transit District estimated in March 1975 that its annual operating loss would be $1.6 million.

The Buses Still Run

Santa Monica Freeway bus service has been retained by both the Southern California Rapid Transit District and Santa Monica Municipal Bus Lines since the discontinuance of the exclusive lane.

The results of post-project bus operations are obscured by a series of events: (1) Service curtailments imposed by Southern California Rapid Transit District because of budgetary restaints; (2) a general fare increase; (3) discontinuance of the exclusive lane; and (4) a prolonged strike by the Southern California Rapid Transit District employees. Nevertheless, the rate of recovery of the Santa Monica patronage has run consistently behind the rate of recovery of the system as a whole. This may reflect the greater freedom of choice available to the relatively affluent residents of Westside.

- Table B10: Southern California Rapid Transit District Reports

Santa Monica Freeway Services	Average Daily Riders
21st, and last, week ending 8/9/76	3,807
"Before strike", which began 8/23/76	2,142
"1st day back", which was 9/28/76	772
"7th day back", which was 10/6/76	1,933

The Santa Monica Municipal Bus Lines was not struck. It did, however, feel the impact of the general fare increase and discontinuance of the exclusive lane. It reports a post-project decrease of about 20 percent, followed by a recovery to approximately the project level. Service between Santa Monica and downtown Los Angeles takes about 5 minutes longer. The principal operating effect of the loss of the exclusive lane is reduced reliability of service.

Commuter Computer

Commuter Computer is the trade name of Commuter Transportation Services, Inc., a non-profit organization, supported by Federal, State, and local government agencies, which was formed to assist companies and individuals in establishing a variety of ride-sharing programs in Los Angeles, Orange, Riverside, Ventura, and San Bernardino counties. Persons who send a completed carpool form to Commuter Computer receive a list of carpool candidates who live and work near them and have similar work hours. This service is free of charge.

A feature of the Santa Monica Freeway project was the promotion and use of the Commuter Computer service in forming carpools. This feature continues.

Commuter Computer is promoted in project informational material, newspaper advertising, and the display of its telephone number (380-RIDE) on the changeable electric freeway signs.

Enforcement and Safety

The California Highway Patrol was responsible for enforcement and safety on the Santa Monica Freeway project. Its representatives participated in project planning from the outset. The Zone Commander was a member of the Joint Project Board of Control, and the Loop Coordinator was chairman of the Project Operating Committee and an alternate on the Joint Board.

The principal problem in planning enforcement activities was that of redeploying patrol units in the two California Highway Patrol areas involved so as to double temporarily the number of one-person units assigned to the project area. As many as 24 officers were used on this duty through the 12th week when normal patrols were resumed. The officers assigned to the project area were selected from among those known to be able to handle so-called pressure and lip.

Tactically, it was decided to begin strict enforcement early in the project period. Experience in the San Francisco Bay Area had indicated that a 30-day grace period produced a very high violation rate. On the Santa Monica Freeway, a 10-day grace period was selected, but strict enforcement actually began at the end of the first week. Enforcement was discontinued upon announcement of the decision of the United States District Court on August 9, 1976.

The principal violations involved illegal use of the reserved lanes. The second most numerous violations were those involving speeds over 55 miles per hour.

The violation rate for illegal use of the reserved lanes was 30 to 35 percent on the first day. This was reduced to 18 percent by the end of the first week, with a 1/3-2/3 split between the a.m. and p.m. peaks. By the end of the project, the violation rate was running as high as 18 percent. More than one-half of the violations occurred in the first and final 15 minutes of the periods during which the lanes were reserved.

Although contrary to accepted tactics, during the initial weeks of the project the Patrol made stops using the median for a pull-over lane in order to avoid taking violators across the other lanes to the right shoulder.

As the project statistical data indicate, property damage only accidents increased sharply and remained at a level about double that of the pre-project period. Personal injury accidents also increased markedly in the early weeks of the project. The average rate for the last ten weeks of the project was 3.9 personal injuries per week, as compared to a 2.5 pre-project rate.

Almost twice as many accidents occurred in the afternoon peak period as in the morning peak period. The largest proportion of accidents--82 percent--were rear-end collisions. Nine percent were side swiped, 1.5 percent were broadside, 6.6 percent involved hitting an object, and there was one head-on collision.

The Patrol representative suggests that a reserved lane project, using Lane No. 1, should not be undertaken in the absence of a median area or emergency bays. Space adjacent to the reserved lane is needed for breakdowns, enforcement, and--importantly--as an escape lane for drivers in the event of panic stops ahead of them.

Since the flushing of the reserved lane was a major problem in the operation of the project, the Patrol would have preferred to have had the reserved lane in continous operation from a time before the peak traffic began--say 6 a.m.--until 7 p.m. The decision to reduce the hours of operation in the morning by changing the times from 6 to 10 a.m. to 6:30 to 9:30 was, from this point of view, an error. On the other hand, the Patrol does not favor a 24-hour lane reservation because it considers enforcement impracticable during late night and early morning hours.

Project Financing

Because the project was shutdown at the end of its 21st week of operations, and because cost data is not yet available or in readily usable form, no effort has been made to assemble cost data for this study.

Some costs were, in a relative sense, minimal--such as lane marking and signing--and were absorbed in departmental budgets. Other costs--such as those incurred in providing a higher level of enforcement activity--represent a temporary redeployment of existing resources.

Some physical facilities associated with the project--such as the ramp metering, freeway surveillance, and changeable electric sign systems--were planned and installed without specific regard to the reserved lane project. They would have been used even if there had been no reserved lane project and they continue to be used now that the project is discontinued.

The operating costs of the participating carriers were met through the provision of additional funds under existing transit service subsidy programs.

Both the Southern California Rapid Transit District and Santa Monica Municipal Bus Lines were--in view of the elapsed planning time--able to provide vehicles to operate the service from their fleets. The Southern California Rapid Transit District was in the process of buying and taking delivery on a total of 600 new buses financed under the Urban Mass Transportation Act of 1964. It was anticipated that the capital costs of the park-and-ride lots would be met through a combination of county funds and Federal Aid to Urban Systems (FAUS) funds.

Marketing and project evaluation costs were to be met largely through a demonstration grant of $807,000 from the Urban Mass Transportation Administration (UMTA).

Marketing and Public Information Program

An extensive marketing and public information program was submitted jointly by the project participants to the Urban Mass Transportation Administration, in the form of an application for Federal financial assistance, in April, 1975. The approved demonstration grant project provided $368,000 to cover 100 percent of the estimated cost.

Of the total amount, the California Department of Transportation was allocated $100,000 for activities directed primarily toward automobile users; $268,000 was allocated to the two carriers for activities directed primarily toward transit users. The Project Manager was supplied by the Southern California Rapid Transit District, which legally was the grantee, and project funds were administered by the Joint Project Board of Control.

The marketing and public information program was carried out over a period of approximately six months. It began two months before the opening of the project. The principal elements of the program were:

- 100,000 brochures explaining the project to automobile users and describing the Commuter Computer Service;
- Commuter Computer sign-up booths;
- Use of advertising media to reach both automobile and transit users;
- Use of 11 two-member Mobile Information Teams to disseminate information in major employment and shopping centers and in downtown Los Angeles; and
- Production and distribution of schedules and maps regarding transit services.

One problem which arose in the administration of the program as a Federally funded demonstration grant project was the unwillingness of the Urban Mass Transportation Administration to accept the standard advertising agency practice of receiving a 15 percent commission on media placements. The Southern California Rapid Transit District finally decided to use general revenue funds to pay for commissionable placements.

Funds originally budgeted for commissionable placements were reallocated, with the approval of the Urban Mass Transportation Administration, to defray the costs of a telephone information service to answer citizen complaints and deal with their specific problems. This service, provided at the insistence of the City of Los Angeles, started two weeks before the project began and was continued for one month thereafter. The telephone bank was manned by professional staff members of the California Department of Transportation and representatives from the Mayor's office and Commuter Computer. At its peak, the telephone bank was served by as many as 20 lines. The largest number of calls--a total of 833--occurred on March 15, 1975, the first day of operation.

Data Collection and Evaluation Program

Because of the pilot nature of the Santa Monica Freeway project and the possible application of the techniques being tested to similar situations in the Los Angeles area and nationally, the data collection and evaluation program was a major interest and concern of the project participants and the United States Department of Transportation.

The application for a demonstration grant submitted to the Urban Mass Transportation Administration in April 1975 outlined an extensive data collection program involving all of the agencies participating in the freeway project. The approved demonstration grant budget provided $235,000 for this purpose.

Subsequently, the Federal Highway Administration embarked on the initial phase of a $100,000 before-and-after home interview survey designed to ascertain attitudes toward carpooling and urban mass transportation and to establish a data base on behavior to be used to identify changes resulting from the Santa Monica Freeway project.

During the same period, the Urban Mass Transportation Administration, acting through the Department of Transportation's Systems Center, used Service and Methods Demonstration Program funds to enter into a contract with SYSTAN, Inc., of Los Altos, for the development of a detailed evaluation plan for the Santa Monica project. This plan, which drew upon much of the material on data collection developed earlier by the project participants, covered nearly 150 pages.

The data collection and evaluation process, which was to be funded wholly by the U.S. Department of Transportation, was expected to cost about $1.2 million. This is, of course, substantially more than would be required if it were not for the experimental and demonstrative nature of the project and the wide interest in preferential treatments for high occupancy vehicles.

Public And Official Reactions

The project participants were not unaware of potential adverse public reaction to the Santa Monica Freeway project. The California Department of Transportation's District 7, in its July, 1974, report on a Program for Preferential Treatment for High Occupancy Vehicles in the South Coast Air Basin, identified this clearly. The Report says (and this is a direct quote):

> Preliminary estimates indicate delay for single occupant vehicles in some corridors could be as much as 10 minutes until a significant modal shift takes place. At least initially there will be a relatively low volume of buses and carpool vehicles utilizing the preferential facilities, something in the range of 200 vph. If significant delay is induced this will undoubtedly cause some adverse reaction. This will be the most difficult aspect of the program and one which must be anticipated.

It is clear, however, that the intensity of the negative public reaction was not expected. This reaction arose during the planning period, it was magnified by the events of Mad Monday, and it has continued with little abatement since. It will adversely affect future projects.

The telephone information center received 833 calls on the first day of project operations, of which 149 were for information only, 80 expressed views favorable to the project, and 604 expressed views unfavorable to the project.

Although calls dropped off after the first day and were evenly divided in opinion, they rose in volume again, and became largely negative, when in the second week the local press adopted a hostile attitude toward the project and called for its abandonment.

The newspapers, led by the Los Angeles Times, waged a continuing editorial campaign against the project and gave prominent news coverage to its critics.

Citizen reaction, in public statements, letters to the editor, and testimony in hearings before the Traffic Committee of the Los Angeles City Council, ranged from thoughtful criticism to the use of such terms as "...deprivation of constitutional rights...", "...discrimination against equal gas taxpayers...", and the alliterative "...dazzling display of dishonest and distorted statistics...". The opponents of the project formed the Citizens Against Diamond Lanes, while its supporters formed the Friends of the Diamond Lanes.

Citizens reactions were exacerbated by the constant and publicly-expressed opposition of both elected and appointed officials of the City of Los Angeles and Los Angeles County.

On June 18, 1976, the Automobile Club of California asked the Director of the California Department of Transportation to eliminate the reserved land and to test other approaches to preferential treatment for high-occupancy vehicles.

The Transportation Committee of the California Assembly twice considered, and rejected, a bill to prohibit the California Department of Transportation from continuing the Santa Monica Freeway Diamond Lanes project.

Pacific Legal Foundation vs. Burns*

In the meantime, the fate of the Diamond Lanes was being decided in the United States District Court for the Central District of California. On August 9, 1976, Judge William Matthew Byrne, Jr., announced that the California Department of Transportation and the federal Urban Mass Transportation Administration had failed to comply with the requirements of the California Environmental Quality Act and the National Environmental Policy Act and that the court would enjoin further operation of the project pending compliance. Final judgement was entered September 10, 1976.

Project enforcement ended with Judge Byrne's announcement on August 9, 1976. By August 16th, the signs and other devices necessary to the operation of the

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* Pacific Legal Foundation is a non-profit corporation with its principal place of business at Sacramento. Judge Byrne found that PLF did not have standing in this case. However, the standing of the second plaintiff, Zer Yaroslavsky, was not questioned. Although Mr. Yaroslavsky acted in his private capacity, he is a member of the Los Angeles City Council. Donald Burns is secretary of the California Business and Transportation Agency. The suit was filed April 10, 1976 and final judgement entered September 10, 1976.

exclusive lanes had been removed. Neither the metered ramps nor the transit services provided by the two participating carriers were affected by the decision.

On October 20, 1976, it was announced that the California Department of Transportation and the Urban Mass Transportation Administration would appeal to the United States Court of Appeals for the Ninth District. Whatever the outcome of these appeals, few local observers expect the diamond lanes to become operational again.

Judge Byrne did not reach the merits of the project itself. In effect, he held that the California Department of Transportation had not complied with the procedural requirements of the California Environmental Quality Act and that the funding of the marketing and evaluation phases of the project could not be severed from the operation of the project, so that the Urban Mass Transportation Administration grant was a major federal action significantly affecting the environment and thus subject to the procedural requirements of the National Environmental Protection Act.

The decision contains much of interest to attorneys working in this area and underscores the need for professional persons and administrators to be sensitive to the procedural mandates of environmental protection laws and regulations during project planning.

WHY DID THE PROJECT FAIL?

Why did the Diamond Lane project fail? It has to be called a failure. Whatever the statistics show--and they are neither conclusive nor impressive--the fact is that the project ended before it could accomplish its purpose of demonstrating, over a reasonable period of time, a local solution to the mandate of the Clean Air Act of 1970 and a local alternative to the orders of the Environmental Protection Agency pursuant to that Act.

No one who was interviewed for this case study expects the Santa Monica Freeway Diamond Lanes to sparkle again. On the contrary, the implementation of the other projects in the SCAG Short-Range Transportation Plan of April 10, 1974, are generally preceived as impracticable. The use of a new median lane of the San Diego Freeway as a diamond lane was killed by the Governor of California who opened it to all traffic. Violations of the ramp bypass lanes have been on the increase.

Significant Reasons

The detailed answer to this question remains in the future--for a doctoral dissertation or a reportorial bestseller. Certainly it must await the evaluation by SYSTAN. At this time, however, there is nearly general agreement among those who were involved in supporting or destroying the project on seven major points.

1. The single most important factor in the development of opposition to the project was that it took existing freeway lanes out of general use. Many felt strongly that they had paid for the lanes and were entitled to use them. To a few this feeling was so intense that they perceived of the reservation of the exclusive lanes as a constitutional issue.

2. Closely allied to the first point was the negative reaction to disincentives to the use of private automobiles. The program was perceived by many as one in which there was a hidden ideological objective of forcing individuals out of their own cars. The culprits were, of course, "Sacramento" and "Washington". This was the thrust of two major editorials in the Los Angeles Times: Dishonesty with Diamond Lanes (6/16/76) and "Sin and the Diamond Lanes" (6/24/76).

3. The Diamond Lanes appeared empty, while adjacent lanes were heavily congested. This was based on two facts: (1) the reserved lanes were carrying 450 vehicles per hour per lane, about 50 percent of normal capacity and 40 percent of pre-project use; and (2) in order to improve transit service, additional buses were put into use, and SCRTD's load factor dropped from 70 percent to as low as 25 percent during the critical first week.

4. Ramp delays at some locations were perceived as unreasonable. For example, the average delay during the project period at La Cienega was 5.3 minutes and the average weekly maximum delay was 10.6 minutes. Corresponding pre-project were 4.5 and 6.0 minutes.

5. The Santa Monica Freeway is now generally conceded to have been a poor choice for the first project. A less visible project, involving a less-heavily traveled routes (including those on surface streets, as well as on the freeway, probably would have been more readily accepted by the general public.

6. The California Department of Transportation appeared insensitive to local problems and issues. This view is by no means confined to those who opposed the project. It was, however, a favorite subject of press comment and the expressions of public officials of the county and city.

7. The project did not have the support of local elected officials. Local elected officials were given little part in the development of the project. Once it became clear that there was strong popular opposition to the project, a few local elected officials jumped on the bandwagon and escalated the issues and the unfavorable public response to them. Elected officials who might have favored the project then found it prudent to remain silent.

Additional Considerations

Many lesser points and observations were made during the interviews upon which this case study is largely based. The more significant of these are noted below:

- The disincentives diminished the freedom of most freeway users; the incentives affected only a small number of persons.

- The city had viewed the freeway system as a relief valve for the surface routes; the project reversed this.

- The most influential persons in the city are in the project area--many of them tend to be well-to-do and articulate. Professionals who need their automobiles after reaching downtown Los Angeles. No group in the city is less dependent upon public transportation.

- Everything now is measured in reference to the Santa Monica Diamond Lanes, which forms a negative basis of comparison for subsequent projects.

SOME NEWSPAPER COMMENTS

The Los Angeles Times, the Los Angeles Herald-Examiner, and the Santa Monica Outlook opposed the Santa Monica Freeway Diamond Lanes project editorially.

- On March 9, 1975, a Times editorial said of the SCAG plan, "There are several good ideas for an almost instant impact on making better use of existing transit. Foremost among those is broader use of preferential freeway lanes for buses and carpools..."

- On March 16, 1976, the Herald-Examiner proclaimed the "Diamond Idea is Worthless Bauble...Instead of carets, Los Angeles's new 'diamonds' can be measured in collisions, confusion, and caustic comments from motorists..."

- On March 25, 1976, the Outlook, in its third editorial opposing county financial support for transit operations on the project, said "Diamond Lane Express is a spectacular, and potentially tragic flop."

- On April 7, 1976, the Times counseled "Patience..Patience... We don't know--no one knows--if the experiment will work...A little more patience can do no harm."

- On May 6, 1976, in a signed article in the Wall Street Journal, Roy J. Harris, Jr., said: "The experiment has been greeted by the populus with the same enthusiasm that some colonials once gave the Stamp Act--with sabotage, with cheating and deception, with Lawsuits." Harris writes that Bill Andrews, Editor of the Los Angeles Times "...says he personally opposed the project from the beginning, fearing that such programs might be used as cheap substitutes for rapid transit systems. After getting stuck in the crush one day, he recalls letting off some steam, though he says he never personally ordered up critical stories."

- On June 11, 1976, the Times called the project "A Total Flop" and said "The time has come to chuck the Diamond Lanes... This experiment....doesn't work. It has not achieved its purpose."

- On June 16, 1976, in an editorial headed "Dishonesty with Diamonds", the Times charged that the California Department of Transportation statistics were not correct and that the department was concealing its true intentions. The 9-month evaluation, it says, "...supports our belief that the diamond lanes should be scrapped forthwith."

- On June 24, 1976, another Times editorial, "Sin and the Diamond Lanes" answered an article, run opposite the editorial page, by Andriana Gianturco, Director of the California Department of Transportation. The editorial says that the project is ineffective and that Caltrans is not telling the whole truth--that the objective is ideological, to force individuals out of their cars.

- On June 28, 1976, the Herald-Examiner refers to "The Terrible 100 Days" and called for an end to the delay in closing down the project.

- On August 10, 1976, the Herald-Examiner stated that United States District Judge Byrne's ruling was "...a victory for the people over oppressive government. And it was a triumph of common sense over social engineering."

SUMMARY: THE PLANNING OF INCENTIVE-DISINCENTIVE PROJECTS

In May 1976, Graham O. Smith, research assistant in the office of the mayor of Los Angeles, presented a paper at a symposium held by the Transportation Research Board and the Urban Mass Transportation Administration. Drawing on his personal familiarity with and participation in the Santa Monica Diamond Lanes project, Mr. Smith was quoted as saying:

- A fundamental characteristic of /incentive-disincentive/ measures is that they invariably carry a disproportionate number of negative impacts. ...It is our central thesis that the potential for generation of public antagonism by these unfamiliar new measures is so great that equal attention must be given to this negative aspect during pre-implementation planning as is normally given to the planning of more orthodox project elements.

- The on-going institutions and agencies which have planned and administered transportation planning in the past are too narrowly constituted to perform this new and more sensitive role, and it will be desirable to adopt a new structure...which will represent those imposed upon as well as those benefited, and which will have the capability of locating and assigning values to factors which have tended to be ignored in the past, for the purpose of developing contingency mitigation measures.

Mr. Smith then made a series of observations, which summarize clearly the lessons of the Diamond Lanes:

- There will be great difficulty in anticipating all negative impacts of these measures, and yet it is critical to try to account for all of them.

- Negative impacts must not only be located, but dealt with.

- Arbitrariness, or perhaps an appearance of arbitrariness and inequity, seems inherent in measures which impose on some citizens and favor others.

- Complexity, confusion, and ignorance will invariably threaten the project's survival.

Mr. Smith recommends that elected officials or their representatives be included on the planning and implementation teams for such projects. This can serve to keep the elected officials informed and gain their active support in case of controversy. It also provides the expert help required to identify the less obvious effects of the project and assign values to them.

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2. Patrick Barry, Marketing Representative, Southern California Rapid Transit District.

3. C. Gary Bork, Senior Engineer, Freeway Operation Branch, California Department of Transportation, District 7.

4. Robert E. Camou, Associate Traffic Engineer, Department of Traffic, City of Los Angeles..

5. Patrick Conway, Assistant Transportation Planner, Southern California Rapid Transit District.

6. Vince Desimone, Transportation Planning Engineer, Automobile Club of Southern California.

7. Jack R. Gilstrap, General Manager, Southern California Rapid Transit District.

8. Roy S.W. Gregory, Director of Marketing and Communications, Southern California Rapid Transit District.

9. Ray Hebert, Urban Affairs Writer, Los Angeles Times.

10. J. F. Hutchison, Director of Transportation, City of Santa Monica (Santa Monica Municipal Bus Lines).

11. Irvin L. Morhar, Road Commissioner, County of Los Angeles.

12. T. K. Prime, Traffic Engineer, Department of Traffic, City of Los Angeles.

13. W. B. Russell, Lieutenant, California Highway Patrol.

14. Graham O. Smith, Research Associate, Office of the Mayor, City of Los Angeles.

15. Jack Stubbs, Assistant General Manager, Southern California Rapid Transit District.

16. Paul Taylor, Advance Planner, Southern California Rapid Transit District.

Appendix C

CASE STUDY: LOS ANGELES, CALIFORNIA/ SPRING STREET CONTRA-FLOW BUS LANE

INTRODUCTION

The Southern California Rapid Transit District (SCRTD) has operated bus service in a contra-flow bus lane in downtown Los Angeles for several years. Transit officials believe that the benefits of using this lane for transit purposes warrant its continuation. City traffic department officials disagree.

Project Description

The easternmost lane of Spring Street, a four-lane one-way southbound street in the Los Angeles central business district, has been reserved between Olympia Boulevard and Macy Street--a distance of approximately 1.5 miles--for the exclusive use of northbound express and local transit buses since May 16, 1974. The lane is delineated by a lane divider stripe and signs attached to traffic cones. It is reserved at all times.

Project Objectives

The stated purpose of the Spring Street contra-flow bus lane is to facilitate the movement of transit buses northbound through the central business district.

Project Participants

There are two project participants. The City of Los Angeles reserved the lane and is responsible for signing, maintenance, and enforcement. The Southern California Rapid Transit District (SCRTD); a regional transit agency and the largest transit operator in the Los Angeles area, is the other participant. The SCRTD operates more than 2,300 buses and serves a population estimated at 7 million persons.

PROJECT BACKGROUND

The 11-mile San Bernardino Busway began operation in July 1973 and was opened for its full length in Jaunary 1974. This facility reduced travel times for transit riders from El Monte and intermediate stations by ten minutes or more and resulted in a substantial increase in transit use. More recently the busway was also opened to carpools of 3 or more.

From the busway's inception, consideration had been given to the ways in which the movement of transit vehicles between the busway and points of origin and destination in downtown Los Angeles could be expedited. First choice of Southern California Rapid Transit District had been the use of 1st and Spring Streets. When this proved unacceptable to the City of Los Angeles, the alternative was the use of contra-flow lanes on a one-way pair: Main Street and Spring Street.

Reservation of street lanes for the use of Southern California Rapid Transit District buses was opposed by the city's Department of Traffic. However, the City Council enacted an ordinance providing for a contra-flow lane on Spring Street. The use of Main Street was not authorized because of construction on that street.

The city of Los Angeles set up the contra-flow lane, which went into use by the Southern California Rapid Transit District on May 16, 1974. It is used by a number of routes in addition to those which operate over the San Bernardino Busway and by both local and express services.

Project Planning

Once the use of Spring Street was decided upon, minimal planning was required. The greatest part of the effort was expended in talking with merchants and others who might be affected by, or object to, the contra-flow lane.

The project manager for Southern California Rapid Transit District interviewed an estimated 52 businesspeople on the east side of Spring Street before the project started. Some 34 of the persons with whom contact was made were favorable to the project or had no objections to it. Eighteen were opposed for one or more of the following reasons:

- The contra-flow lane would interfere with the loading and unloading of merchandise.
- The contra-flow lane would interfere with customer access. It should be noted, however, that parking was not legally permitted on this section of Spring Street prior to the project.
- The congregation of persons at bus stops would result in littering and congestion. Waste containers proved an answer to the littering problem and the Southern California Rapid Transit District relocated bus stops when necessary to alleviate congested conditions at entrances to places of business.

PROJECT OPERATIONS

The City of Los Angeles Department of Traffic and the Southern California

Rapid Transit District both evaluated the Spring Street project late in the summer of 1974. They arrived at contradictory conclusions.

Evaluation by the L.A. Department of Traffic

The L.A. Department of Traffic concluded that the speed of all vehicles on Spring Street, including that of buses using the contra-flow lane instead of Main Street, has been decreased as a result of the contra-flow lane. There were three specific conclusions.

First, the department has stated that overall traffic speeds have decreased on Spring Street. The Spring Street speeds are lower than those on Main Street were before the contra-flow lane was installed. Some of the northbound buses formerly ran on Main Street.

- Table C1: Peak Period Speeds

	Before	After
Spring Street (Southbound)	20 MPH	16 MPH
Main Street a.m.	22 MPH	no change
p.m.	17 MPH	no change

Second, San Bernardino busway vehicles must travel 6 miles farther to reach Spring Street from their downtown terminal than they traveled to reach Main Street. It takes 19.2 minutes for Busway vehicles to clear the downtown area in the p.m. peak, rather than the previous 12.4 minutes.

Third, the average bus speed in the contra-flow lane during p.m. peak is 21 percent under the average bus speed on Main Street before the contra-flow lane was installed--a reduction from 9.6 MPH to 7.6 MPH.

Evaluation by the SCRTD

The Southern California Rapid Transit District concluded that the speed of its buses moving northbound out of the downtown area has been increased as a result of the contra-flow lane. There were two specific conclusions.

First, the average bus speed in the contra-flow lane was recorded as 8.6 MPH, which is 1.3 MPH faster than the former Main Street route and saves 1.9 minutes.

Second, the average speed of buses moved from Hill Street to the contra-flow lane is increased from 7.1 MPH to 8.6 MPH, and involves a savings of 1.8 minutes.

Discussion

It is evident that the two agencies are counting differently, though it is not at all clear what the differences are. Nor, since the basic difference is in stating the average bus speeds northbound on Main Street during the p.m. peak at a time before the contra-flow lane was installed, it is likely that the differences will now be reconciled.

The transportation planning engineer for the Automobile Club of Southern California suggests that the contra-flow works satisfactorily because there is not much congestion at present in downtown Los Angeles.

In any event, responsible transit officials agree that the contra-flow lane has not greatly increased bus speeds. They believe, however, that the lane should be continued because in their opinion it has increased the reliability and safety of transit operations in the downtown area and is perceived as a significant improvement by transit users.

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Interviews

1. Vince Desimone, Transportation Planning Engineer, Automobile Club of Southern California.

2. Jack R. Gilstrap, General Manager, Southern California Rapid Transit District.

3. Jack Stubbs, Assistant General Manager, Southern California Rapid Transit District.

4. Allan Styffe, Project Manager (Operations Staff Analyst), Southern California Rapid Transit District.

Appendix D

CASE STUDY: MIAMI, FLORIDA; I-95/N.W. 7th AVENUE ORANGE STREAKER BUS-CARPOOL SYSTEMS DEMONSTRATION*

INTRODUCTION

During the period from 1970-1971, the Florida Department of Transportation (FDOT) studied various means to increase the capacity of I-95. They decided to construct one additional lane in each direction. At the same time, the U.S. Department of Transportation (DOT) had chosen a large midwestern city as the site of a project to demonstrate a lane for high occupancy vehicles which was to be reserved by signs only and exclude physical barriers. When the city selected withdrew from the demonstration, the Federal Highway Administration contacted FDOT about transferring the project to Miami.

The Florida DOT, the Dade County Metropolitan Transit Agency, and the University of Florida Transportation Research Center drew up a proposal to construct the two additional lanes for the use of high-occupancy vehicles. Later a park-and-ride lot and bus flyover were added to the proposal. Realizing that construction would require several years, FDOT's Office of Multi-Modal Planning, consulting with the Transportation Research Center then looked at short range alternatives. When they learned that the Urban Mass Transit Administration (UMTA) was looking for a demonstration site for bus pre-emption of traffic signals, a proposal to use N.W. 7th Avenue for the demonstration was submitted as part of the entire package in July 1972. Project approval was given at the end of 1972.

Project Description

The I-95/N.W. 7th Avenue Orange Streaker project was designed as a three and one-half year demonstration, beginning with operations on N.W. 7th Avenue in Miami, a major north-south arterial, from August 25, 1974 to March 12, 1976. Interstate 95 is a parallel facility on which two 12-foot wide bus/carpool (3 or more occupants) lanes were constructed, one on each side of the median. Outbound carpools were allowed on July 14, 1975, and in both directions in December 2, 1975, with bus operations switching from 7th Avenue to I-95 on March 15, 1976. This case study concerns only the 7th Avenue portion of the demonstration.

Project Objectives

The objectives of the project and the evaluation of the N.W. 7th Avenue bus priority system are listed in Table D1 on the following pages. The list is drawn

*This case study draws heavily from the separate works by Wattleworth and Michalopoulos cited on page xx.

Table D1

PROJECT OBJECTIVES

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1. PROJECT OBJECTIVES

   - Encourage the use of public transit;
   - Reduce bus travel time for express buses operating on an arterial street;
   - Reduce schedule variability for express buses operating on an arterial street;
   - Effect a modal shift from autos to express buses operating on an arterial street; and
   - Increase the passenger carrying capability of N.W. 7th Avenue.

2. EVALUATION OBJECTIVES

   - Assess the public reaction to the express bus service on N.W. 7th Avenue;
   - Measure the reduction in bus travel time as a function of the various bus priority systems;
   - Measure the reduction in schedule variability as a result of the various bus priority systems;
   - Measure the increase in transit patronage as a result of the transit improvements;
   - Measure the modal shift from autos to buses and assess their interaction;
   - Measure the effect of the Park 'n' Ride Facility on transit patronage;
   - Measure the increase in passenger carrying capability on N.W. 7th Avenue during each of the operational stages;
   - Estimate the effect of the various bus priority systems on auto operational characteristics;

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xx Joseph A. Wattleworth et al., Preliminary Evaluation of Some Bus Priority Strategies on N.W. 7th Avenue in Miami (Gainesville: University of Florida Transportation Research Center, June 1976), pp. 4-5.

- Assess the extent of violations by autos of the reserved bus lane;
- Evaluate the bus priority system control equipment performance; and
- Assess the economic viability of the express bus operations on N.W. 7th Avenue.

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from a work by Wattleworth referenced in the table, which is a primary source document.

Project Participants

The project was funded by the Service and Methods Demonstration Program of the Urban Mass Transportation Administration (UMTA) with the local share provided by the Florida Department of Transportation and Dade County. Participating agencies included those listed below, while UMTA contracted with the University of Florida Transportation Research Center to evaluate the project.

- Table D2: Orange Streaker Project Participants

  (1) The Florida Department of Transportation (FDOT)

  - Mass Transit Operations Division
  - Road Operations Division

  (2) U.S. Department of Transportation (DOT)

  - Urban Mass Transportation Administration (UMTA)
  - Federal Highway Administration (FHWA)

  (3) Metropolitan Dade County

  - Metropolitan Transit Agency
  - Department of Traffic and Transportation
  - Public Safety Department
  - Department of Planning
  - Department of Public Works

  (4) The City of Miami

  - Police Department

  (5) The City of North Miami

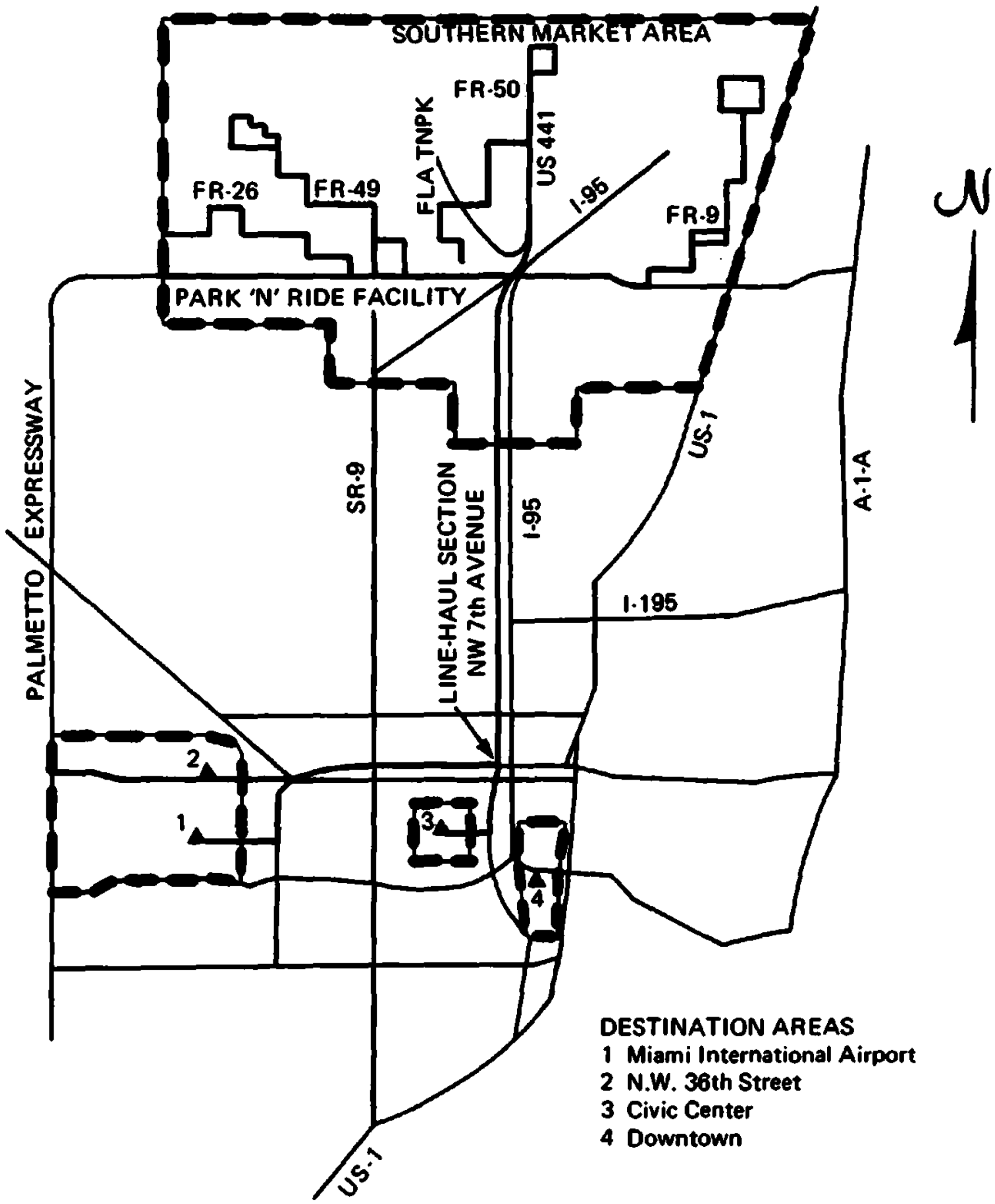
  - Police Department

No formal coordinating committee or other mechanism was created to direct and monitor project operations. The FDOT project engineer coordinated project activities and occasional project-wide meetings were held.

PROJECT AREA

The project was designed to draw from a fairly dense residential area (3,080 persons per square mile) in the northern part of Dade County, Florida. A close view of the project area is presented in Figure D1. A park-and-ride lot (for

Figure D1
ORANGE STREAKER PROJECT AREA**



**Wattleworth, *Bus Priority Strategies*, p. 2.

967 cars) and a bus terminal were constructed adjacent to the Golden Glades Interchange, the intersection of I-95, the Palmetto Expressway, the Florida Turnpike and US 441 (7th Avenue). Some bus feeder service was provided to the lot. Express buses originating at the park-and-ride lot served four destinations, with no intermediate stops:

- Miami central business district;
- Civic Center Area (a major medical/governmental complex);
- Miami International Airport; and
- N.W. 36th Street employment area (adjacent to the airport).

The N.W. 7th Avenue project was very complex. Four different bus priority systems, in addition to the "before" condition, were evaluated.

PROJECT BACKGROUND

The introduction to this discussion includes the essential background to the project. However, there were additional features which should be examined before evaluating the results.

Project Staging

There were four operational stages during the project, each of which had a different character. The stage, inclusive dates, and related descriptions are shown in Table D3 on the following page.

Signal Preemption

For the bus priority phase, buses and traffic signals were equipped with OPTICOM traffic signal preemption system, which operates as indicated below.

- Table D4: OPTICOM Traffic Signal Preemption Sequence

  (1) A high-intensity light beam is transmitted by an emitter installed on the bus; this activates a receiver at the intersection which again transmits a signal to the controller to announce the bus presence. The detection distance can be established at varying distances and it was 1,800 feet for N.W. 7th Avenue.

[xx] Panos G. Michalopoulos, "Bus Priority System Studies", Traffic Engineering 46, no. 7 (July, 1976), p. 46.

Table D3

PROJECT OPERATIONAL STAGES[xx]

STAGE	DATES	DESCRIPTION
0	1/1/74 to 8/18/74	"Before" condition, No Bus Priority System
1	8/19/74 to 1/19/75	Bus Preemption of Traffic Signals, Buses Operating in Mixed-Mode on N.W. 7th Avenue
2	1/20/75 to 12/8/75	Reserved Bus Lane with Bus Preemption of Traffic Signals
3	12/12/75 to 12/27/75	Reserved Bus Lane with Signal Progression
	12/28/75 (AM only)	Reserved Bus Lane with Signal Progression
	1/26/76 to 3/1/76	Reserved Bus Lane with Signal Progression
4	12/28/75 to (PM only)	Reserved Bus Lane with Signal Progression Bus Preemption of Traffic Signals
	12/29/75 to 1/25/76	Reserved Bus Lane with Signal Progression Bus Preemption of Traffic Signals
	3/2/76 to 3/12/76	Reserved Bus Lane With Signal Progression Bus Preemption of Traffic Signals

[xx] Wattleworth, Bus Priority Strategies, p. 10.

(2) If the signal is green when the bus is detected, it is held on green for the bus. This hold can be limited in time and the maximum limit for N.W. 7th Avenue was 90 additional seconds.

(3) If the signal is red when the bus is detected, a green signal is provided as soon as the minimum cross street green time has been displayed.

(4) When the bus passes through the intersection, right of way can be transferred to the cross street and normal operation resumes in 7 seconds.

Within the ten mile project corridor, 7th Avenue features 35 signalized intersections (all equipped with OPTICOM); three distinct road geometrics, thus the bus lane had three different configurations, as shown in Figure D2. The reversible bus lane was delineated by overhead electrical signs displaying either a bus only message or red "X".

PROJECT OPERATIONS

The principal project operations that require examination include: (1) marketing and public involvement; (2) operating results; and (3) safety and enforcement). Each is considered in the discussion which follows.

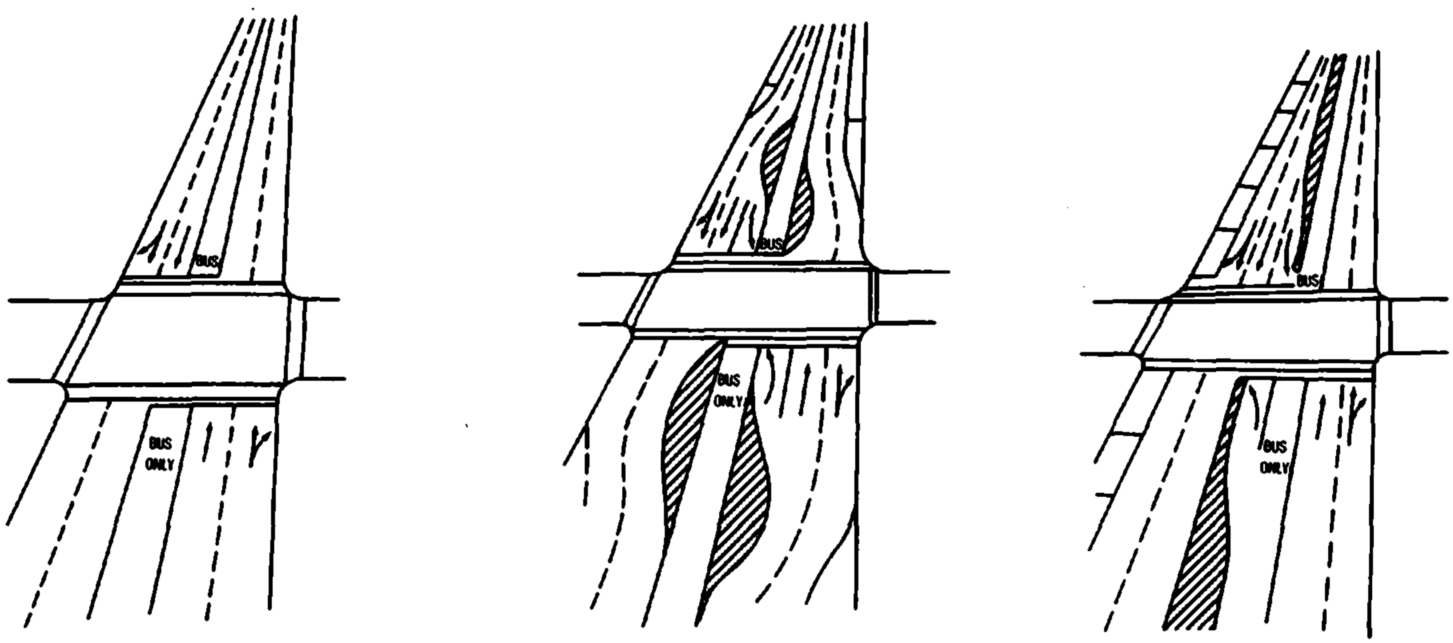
Marketing and Public Involvement

Although there were no formal efforts made to involve citizens in planning for the Orange Streaker project, there was an extensive public information campaign. The total marketing budget for the N.W. 7th Avenue phase of operations was $40,000.

A distinctive name--Orange Streaker--and logo were given to the four bus routes that originated at the Golden Glades lot and traveled 7th Avenue. There was a special ceremony for the inauguration of the service, with free rides provided during the first week. During the summer of 1974, 170,000 flyers giving route and schedule information were mailed to residents of the market area.

Media coverage of the opening of the project was fairly extensive, particularly when the reversible bus lane was opened. In addition, a full page advertisement containing route and schedule information was placed in the major newspaper. Radio spots advertised the new service. A television commercial was broadcast from August through December, 1974. Billboards also carried messages about the Orange Streaker from July 1974 to March 1975. Flyers were distributed to employers and MTA information booths set up in the employment centers served by the bus routes.

Figure D2
LANE CONFIGURATION SECTION ON N.W. 7TH AVENUE



Typical Intersection Layout Between
5th Street & 79th Street
– Five Lanes

- No left turn; 6:00 - 9:30 A.M.
  3:00 - 6:30 P.M.
- No parking; 7 - 9 A.M. inbound
  7 - 6 A.M. outbound

Typical Intersection Layout Between
NW 79th Street & NW 119th Street
– Seven Lanes

- Left turns permitted at signalized intersections; at all other places, left turns prohibited from 6 - 9:30 A.M. and 3 - 6:30 P.M.
- No parking at mouths of signalized intersection

Typical Intersection Layout Between
NW 119th Street & Golden Glades
Interchange – Six Lanes Divided

- Left turns allowed
- No parking any time on the inbound side

**Wattleworth, *Bus Priority Strategies*, p. 9.

The project was fairly well received, except for merchant and motorist opposition to the prohibition of left turns and the removal of parking on 7th Avenue at the signalized intersections between 79th and 119th Streets and for the length of the street above 119th.

Operating Results

The general operating results compiled during the project are shown below, with additional data presented throughout the discussion.

- Table D5: Orange Streaker Project Operating Results[xx]

Operating Stage:	0	1	2	3 and 4
Total number of persons using 7th Avenue	2124	2991	2601	2517
Bus passengers	0	673	751	735
Buses--% of traffic stream	0%	1.4%	1.8%	1.9%
Bus passengers - % of total passengers	0%	22.5%	29%	29.2%
Auto occupancy	1.3	1.29	1.28	1.28

Number of buses	26
Increase in bus passengers (May 1974 to February 1976)	37.3%

- Table D6: Orange Streaker Travel Times. Project data tend to indicate that the bus priority measures of signal preemption and reserved lanes are generally effective in reducing transit travel times. As can be seen below, bus travel times improved (with only one exception) in phases for which data are presently available.[xx]

(1) 7th Avenue Lane Configuration	AM Peak (Minutes) Stage 0	Stage 1	Stage 2
Five Lanes	12.6	10.6	9.4
Seven Lanes	7.3	5.7	4.5
Six Lanes	6.4	4.9	4.6

[xx] Wattleworth, Bus Priority Strategies, p. 14.

[xx] Ibid.

(2) 7th Avenue Lane Configuration

7th Avenue Lane Configuration	PM Peak (Minutes) Stage 0	Stage 1	Stage 2
Five Lanes	15.0	10.2	10.4
Six Lanes	6.5	6.0	5.1
Seven Lanes	8.3	5.7	4.9

The Transportation Research Center preliminary evaluation printed out that the single exception to improved bus travel times occurred in an area where left turns and parking are prohibited. The center's report states that this is the kind of situation "...where...success of the exclusive land depends on motorist compliance with the traffic regulations."[xx] The strong need for adequate enforcement of traffic regulations implemented for bus priority purposes is underscored and the center's report goes on to suggest that "...unless a high degree of motorist cooperation can be anticipated, the benefits of bus priority measures..." are not likely to materialize.[xx]

Equipment problems complicated the evaluation of delays to autos using 7th Avenue. The OPTICOM equipment performed satisfactorily, with only 3% of the maintenance calls for the project due to the preemption equipment. There were problems with the traffic signals; however, the rate of maintenance calls for 7th Avenue was twice the county-wide rate.

A reduction in auto travel times on 7th Avenue occurred with each successive phase until Stage 4. For inbound travel on N.W. 7th Avenue in the morning peak, the travel times were as follows:[xx]

- Stage 0 - 27.3 min.
- Stage 1 - 25.1 min.
- Stage 2 - 23.7 min.
- Stage 3 - 21.0 min.
- Stage 4 - 22.4 min.

There was no significant adverse effect on autos traveling on cross streets for the first two stages.

Safety and Enforcement[xx]

Responsibility for enforcement was divided among the Dade County Public Safety Department, City of Miami Police Department and the City of North Miami Police Department.

[xx] Wattleworth, Bus Priority Strategies, p. 22.

[xx] Ibid.

[xx] Ibid., p. 25.

[xx] Ibid., pp. 30-32.

Safety was a problem for Orange Streaker operations. With data available only for the second stage, the signal preemption with the reserved bus lane, there were a total of 42 accidents involving buses. Thirty-three of these had no personal injuries, while there were nine accidents with personal injuries. The accident rate of 280 accidents per million vehicle miles is approximately five times higher than the national average of 55.5 accidents per million vehicle miles for city buses.

Most accidents were "cut-offs", that is, automobiles attempting left turns colliding with buses approaching from the rear.

SOURCES

Documents

1. Michalopoulos, Panos G. "Bus Priority System Studies". Traffic Engineering 46, no. 7 (July, 1976).

2. Wattleworth, Joseph A.; Kenneth G. Courage; Robert L. Siegel; and Charles E. Wallace. Preliminary Evaluation of Some Bus Priority Strategies on N.W. 7th Avenue in Miami. Gainesville: University of Florida Transportation Research Center, June 1, 1976.

Appendix E

CASE STUDY: MIAMI, FLORIDA: U.S. I/SOUTH DIXIE HIGHWAY BLUE DASH DEMONSTRATION PROJECT

INTRODUCTION

The U.S. 1/South Dixie Highway is the key artery linking downtown Miami and the Central Miami area with the suburban southwestern section of Dade County. Throughout the length of the project (5.5 miles) South Dixie is a six lane divided arterial, with heavy commercial strip development on both sides, multiple cross streets and curb cut access points.

Project Description

The U.S. 1/South Dixie Highway Transportation Demonstration Project (commonly referred to as the "Blue Dash") originally featured three major components: (1) a contra-flow bus lane; (2) a concurrent-flow carpool lane (2 or more occupants); and (3) traffic signal improvements giving increased "green time" to through traffic. The project operates during morning and afternoon peak periods only. It was initiated on July 22, 1974, with a demonstration period scheduled to last for one year funded jointly by the Florida Department of Transportation and Metropolitan Dade County. Federal participation was limited to capital assistance for routine bus acquisition.

Project Goal

The principal goal of the project was to increase the person-throughput of South Dixie without increasing the number of vehicles or causing undue travel time delays or safety hazards. Originally designed to carry 40,000 vehicles per day, the highway has experienced a five to ten percent increase in average daily travel per year to the current volume of 60,000 vehicles on an average day.

Project Participants

The concept that became the Blue Dash project was originally discussed early in February of 1973, shortly after public opposition had halted several freeways planned for Dade County, including a major upgrading of U.S. 1/South Dixie Highway. During the next several months the concept gradually took more definite form, gathering impetus from long lines at gasoline stations in south Florida during the fuel crisis in the winter of 1973-1974.

An *ad hoc* committee, consisting of representatives from the agencies named below was formed to coordinate project initiation and implementation.

- Table E1: Blue Dash Project Participants
  - Florida Department of Transportation;
  - Dade County--Department of Traffic and Transportation;
    - --Metropolitan Transit Agency;
    - --Office of Transportation Administration;
    - --Public Safety Department;
    - --Public Works Department;
  - Miami Police Department
  - South Miami Police Department; and
  - Coral Gables Police Department.

A proposal was completed in January of 1974, with subsequent meetings almost weekly from that time through the early stages of the project in July-August of 1974.

Organizational Arrangements

Coordination between the Florida Department of Transportation (FDOT) and Metropolitan Dade County was outlined in a formal agreement, which set forth the responsibilities and duties of each sponsor. Formal agreements also were necessary between the County and each of the three local jurisdictions through which the project passed in order to arrange enforcement by local police officers.

Interagency coordination was achieved mainly through the ad hoc committee mentioned above, which continued to meet throughout the demonstration period to review project data and discuss operational problems. In addition, there were two persons with staff responsibility, a full-time project coordinator from the County Office of Transportation Administration (a special section within the County Manager's Office) and a part-time Project Engineer from the Florida Department of Transportation.

PROJECT OPERATIONS

Yellow safety poles (set up and taken down each peak period) delineated the contra-flow lane from the two traffic lanes in the non-peak direction. Yellow poles, originally used to separate the carpool lane, were eliminated permanently when a trial period with no separators showed only a slight increase in violations. Two large overhead signs at either end of the project inform motorists about the bus and carpool lanes.

"No left turn" signs are posted at all intersections, with reversible overhead signs displaying "MTA Buses Only" in the bus direction and "Lane Closed" in the non-peak traffic direction. The carpool lane is delineated by overhead and post-mounted signs. Special signals at either end of the project provide buses with a green indication a few seconds before general traffic to give the bus an opportunity to cross over into or out of the contra-flow lane.

Operating Results

The data summarized below represents a one year period starting July 22, 1974. The results for the demonstration period should be compared with a later discussion on "Project Adjustments".

- Table E2: Blue Dash Operating Results

	Before	After	% Change
(1) Peak period traffic volume			
persons	20,250	22,640	+12
vehicles	14,674	14,330	- 2
vehicle occupancy	1.38	1.6	+14
(2) Travel times			
general lanes	18:12	19:36	+ 7
bus	18:12	9:00	-50
carpool	18:12	12:12	-33
(3) Bus patronage (# runs)	10	61	+500
avg. daily riders	365	1955	+365
(4) No. of carpools	2641	4012	+ 52
% carpools	18	28	+ 55

(5) Directional (peak/off-peak) split on South Dixie Highway before implementation 65%/35%

(6) Carpool violation rate (# of single occupant cars/total vehicles in carpool lane) 6%-8%

Financial Information

The Blue Dash project budget is summarized on the following page for the demonstration period.

• Table E3: Blue Dash Project First Year Budget

(1) Capital Cost

Parking lot improvements	$116,000	
Signs and posts for lane restriction	270,281	
Installation of bus shelters and signs	60,800	
Signal equipment purchase and installation, and additional paving	119,100	
Safety attenuators	60,000	
TOTAL		$626,181

(2) Operating Cost (approximate)

Enforcement	65,000	
Placing of posts, shelter maintenance	275,000	
Operating subsidy for bus service	917,260	
Staff salaries	58,650	
Advertising, promotion	38,850	
TOTAL		$1,354,760

(3) Evaluation	32,500
(4) TOTAL Project Cost (approximate)	$2,013,441

Placement and removal of safety poles demarcating the contra-flow lane and blocking off turning movements twice a day was particularly expensive and requires special comment.

Because of the traffic congestion and hazards posed during the setting up and taking down operation, and the confusion among motorists caused by operation signs visible before or after project hours, the coordinating committee decided to minimize set up/take down time by maximizing personnel for the work crews. From project commencement in July to November, safety poles were also in use for the carpool lane. Thus, initial personnel requirements were for four crews of two each, or 16 persons/day (8/peak). Even after the elimination of the carpool posts, the bill for these activities for the demonstration year was $275,000.

Complementary Techniques and Facilities

As mentioned previously, the Blue Dash project involved signalization improvements designed to increase green time for through traffic on South Dixie Highway. This improvement was not limited to the length of the contra-flow lane, but extended 18.5 miles and benefited all highway users, and probably because a factor in increasing public acceptance of the entire project.

Park-And-Ride Lots

To stimulate transit patronage and carpooling, four park-and-ride lots were established in sections of suburban shopping center lots along the Blue Dash bus routes. One 200 car lot was constructed a short distance from the southern terminus of the contra-flow lane and exclusive carpool lanes, in a fairly dense area (Dadeland) of apartment buildings, a regional shopping center and some single family dwellings. Parking is free, and the lot is used to capacity almost every day mostly by transit patrons, but some carpool staging also takes place there.

It appears that all of these lots are important project elements. The Dadeland bus stop alone accounts for 16% of ridership. A 200 car carpool parking lot on the fringe of the central business district charges a nominal fee for parking, but also has a 100% utilization rate.

Shelters and schedule information are provided at most major Blue Dash stops. An off-street bus terminal, on the fringe of the central business district, was constructed to funnel not only Blue Dash buses but most bus routes entering the downtown through one facility.

Enforcement And Safety

The Blue Dash Project was in many ways a bold experiment. Since the South Dixie Highway is a major arterial with concentrated strip commercial development on either side and multiple curb cuts and cross streets, there was some doubt on the part of citizens and traffic experts that a contra-flow lane on such a busy street could be successful.

The project required a special enforcement effort. Left turns were prohibited along the entire length of the contra-flow lane, and "ground loops", (which divert left-turn traffic to a series of right turns) were marked by signs. Maps of the ground loops for all intersections were provided to enforcement officers and the project coordinator's office to handle public inquiries. Proper enforcement was necessary not only to eliminate left turns in front of contra-flow buses, but also to keep carpool violators out of the exclusive carpool lane.

Patrolling the project corridor required approximately seven officers from the County and two more from each of the affected jurisdictions. To avoid diverting police from what might be considered more essential law enforcement duties, officers on overtime were used, reimbursed from project funds.

Enforcement was greatly facilitated by the presence of a median with left turn bays at the signalized intersections which, due to the turn prohibition, police were able to use to pull over offenders. The turn bays also provided storage space for disabled buses and cars.

The enforcement effort seemed to be effective, not only in achieving a low carpool violation rate (6-9%) but also for ensuring safety. While accidents increased from 148 to 245 in comparable nine month periods, most of them were minor and there were no bus-automobile fatalities. In addition, the "before" figure includes only accidents on South Dixie Highway, whereas the "after" figure includes the Highway and ground loops. Also, it has been suggested that the high level of enforcement resulted in the official recording of a number of minor accidents that might previously have been settled privately. There were a comparatively large number of accidents early in the project; accidents declined as more people became aware of the project.

The enforcement effort was not without its costs, however. As can be seen in the project budget, total enforcement expenses for the first year of operation came to approximately $133,000.

Project Adjustments

The high costs of enforcement and post placement were the major factors in the Dade County decision to modify the configuration several months after the one-year demonstration phase expired. For a six month trial period, the buses began running in the carpool lane while the contra-flow lane was eliminated. This cut crew requirements in half, to four persons at the peak, while enforcement could be handled as part of routine patrol duties. This resulted in a $180,000 per year savings.

Bus travel times increased and patronage dropped from 2,000/day to 1,700. It is not clear, however, how much of the patronage decline is due to the travel time factor, since ridership tends to decrease slightly during the summer months anyway. In addition, the change in lane configuration necessitated the elimination of the northernmost bus stop at South Miami which had been handling 14.4% of the daily ridership. The contra-flow lane was not reinstituted at the expiration of a six-month trial period.

Marketing and Public Information

The Blue Dash project was begun before the Dade County Citizen Involvement Program was fully operational and as a consequence there was no formal effort to directly involve citizens in the project planning. There was, however, a public information effort.

Because of the novelty of this type of improvement in the Miami area, there was extensive media coverage both before the project opened and during the first week of operations. The day before the demonstration began, a full-page advertisement in the newspaper gave information about bus routes, location of park-and ride lots, road configuration and a complete schedule. This same information was contained in flyers mailed to residents of the target market area shortly before project operation began. Schedules were also placed in major buildings in the three employment centers served by the buses.

As part of the marketing strategy, a special identity for the six bus routes utilizing the contra-flow lane was created by designating the entire service with a distinctive name--the Blue Dash--and logo. (Differentiation between routes was made by the conventional route number-destination method.)

In addition to the public information program detailed above, marketing efforts consisted mainly of carefully monitoring ridership by route and run, travel times, a special Blue Dash on-board ridership survey and a County-wide on-board transit survey two months after project commencement.

Routes and schedules were adjusted on the basis of this information. The original marketing decisions on level of service were based on the philosophy of making the service as attractive as possible, offering two to seven minute headways in the peak hours. Service was cut later as patronage stablized and low-occupancy runs could be identified.

Data Collection and Evaluation Program

Dade County conducted a comprehensive evaluation effort during the one year demonstration period. An evaluation design listed all data collection tasks, citing the agency responsible for the work item, manpower required, frequency of data collection and approximate cost.

According to some project participants, one of the key factors in the project's successful achievement of objectives with no major operational problems was the quick recycling of the data back to the regular meetings of the ad hoc coordinating committee. The data collected, combined with the observations of project participants, provided a valuable input into refining project operations.

Major adjustments could be implemented in stages, with each stage evaluated and reported to the committee. The example of the carpool lane delineation posts have already been mentioned. Some enforcement officers felt that the posts were contributing to accidents because carpool lane users were waiting for the short breaks in the line of posts at each intersection to exit from the lane so spacing between the posts was gradually lengthened. When no significant increase in lane violation was detected, the posts were eliminated for a trial period, then permanently. A similar procedure was followed regarding a shortening of the daily hours of operation.

The Impact of Blue Dash on Rapid Transit Planning

U.S. 1/South Dixie is the most heavily traveled arterial feeding the downtown and Civic Center employment areas. Because of this congestion, county transportation officials gave high priority to improving people movement in the corridor, notwithstanding the fact that this corridor was also proposed for the first stage of Dade County's high-capacity rapid transit system, then under preliminary engineering.

Some metropolitan areas, also contemplating construction of fixed guideway rapid transit systems, have been reluctant to develop priority treatment projects in proposed rail corridors, fearing that a successful project would jeopardize their chances for federal funding. However, UMTA's subsequent grant of $15 million to Dade County for final rapid transit design illustrates that such concerns are groundless. A priority treatment project is at best an interim solution when travel demand in a particular corridor is significant enough to warrant high-capacity, fized guideway transit.

The above considerations do not minimize the importance of interim solutions, however, since the ten to fifteen year lead time for implementation of fixed guideway transit offers ample opportunity for improving auto and transit flow in the intervening period. The comparatively brief implementation time required (seven to eight months of concentrated activity for the Blue Dash project) is one of the principal advantages connected with priority techniques.

The Blue Dash has been credited by some observers as one of the factors behind the strong public support for the rapid transit system. The general feeling was that the County was taking positive action with the resources currently available and not simply relying on long-term solutions. Although opposed by some of the public (notably non-priority users and people living adjacent to the project corridor) an informal survey conducted by the Miami Herald shortly after project initiation showed most respondents in favor of the project.

General Observations

There are a few observations worthy of concentrated attention when considering implementation of a project similar to Blue Dash. They include the following three items:

- It is evident from the Blue Dash operating results (Table E2) that the project was successful in moving more people in fewer vehicles with significant travel time savings for priority users.

- The project illustrates the importance of careful planning for operations and enforcement for a contra-flow arterial project.

- The Blue Dash also emphasizes the value of a well-thought out evaluation effort, with particular attention paid to reporting of data at early stages to facilitate project adjustments.

Appendix F

CASE STUDY: MINNEAPOLIS, MINNESOTA NICOLLET AVE. PEDESTRIAN MALL AND TRANSITWAY (NICOLLET MALL)

INTRODUCTION

Since 1967, Nicollet Mall has satisfied the general goal of enhancing the attractiveness of the principal retail shopping street of Minneapolis. While a specific assessment of the transportation benefits of the associated transitway is not possible, the project as a whole exemplifies the need to approach downtown problems on a systematic basis. It also provides an outstanding example of business leadership in the revival of a central business district threatened with obsolescence.

Project Description

Eight blocks of Nicollet Avenue between Washington Street and 10th Street in downtown Minneapolis have been reconstructed as a pedestrian mall and transitway. Transit vehicles and taxicabs use a 24-foot, two-lane serpentine roadway. The remainder of the 80-foot right-of-way is for pedestrian use.

Special features of the mall include heated bus stop shelters, fountains, planters, directory kiosks, bicycle racks, a self-service post office, a weather recording station, and specially designed street furniture. Electric snow melters are embedded in the pavement in parts of the pedestrian area. Overhanging signs are prohibited.

A planned three-block extension of Nicollet Mall, south to 13th Street, will connect it with the proposed Loring Greenway, the central unifying element in the design of the Loring Park development district, a nine-block area which is being redeveloped for predominantly residential uses.

Project Objectives

The objectives of the Nicollet Mall project were to enhance the attractiveness of Nicollet Avenue as the principal retail shopping street of Minneapolis by:

- Improving circulation facilities for patrons;
- Creating new opportunities for effective promotion of the retail area as a whole; and
- Adding new attractiveness to the retail area, in terms of beauty, excitement, and interesting features.

Project Participants

The project participants are:

- The Downtown Council of Minneapolis, an organization of downtown businesspersons, who saw the need for action, financed the initial planning studies, and developed local financial and political support for the project;

- The City of Minneapolis, which handled project construction and now maintains the mall; and

- The Metropolitan Transit Commission, which as the successor to the formerly privately-owned transit system operates regular service and a downtown circulation system over the mall.

PROJECT AREA

Nicollet Avenue is the spine of the Minneapolis central business district, an unusually compact downtown area which is the largest retail store and commercial office center in the upper Midwest.

Downtown Minneapolis has more than 500 retail stores, including four major department stores, and records retail sales of $400 million per year. The area also provides 11 million square feet of commercial office space and 3,500 hotel rooms.

There are 95,000 persons employed downtown. Approximately 180,000 others visit the area on a typical week day. Seventy-five thousand persons come into the area by public transportation daily while virtually all of the remaining 200,000 come by private automobile.

A second-level pedestrian Skyway system, first opened in 1962, connects eleven blocks on each side of Nicollet Mall. The facility, which is being expanded, handles 125,000 pedestrian trips on a typical winter day.

A downtown circulation system, using Minibuses, operates along Nicollet Mall and carries about 2,000 riders a day. Six regular bus routes also use the transit way, while other routes use exclusive contra-flow lanes on parallel Marquette and Second Streets. Total daily ridership on lines using the Nicollet Mall transitway is 32,000 persons.

PROJECT BACKGROUND

During 1955, the nation's first fully enclosed regional shopping center was under construction in a Minneapolis suburb and General Mills decided to move its corporate headquarters away from downtown Minneapolis.

On September 1, 1955, a group of businesspersons formed the Downtown Council of Minneapolis and as a first action successfully focused attention on the need to strengthen the city's planning function. It next gave new impetus to the Gateway redevelopment project at the northern end of the central business district.

Project Planning

In May 1957, the Downtown Council formed a temporary committee to study the needs of Nicollet Avenue. Nicollet Avenue was then fifty years old and would soon become obsolescent unless steps were taken to prevent it from doing so.

The committee viewed the solution to the problem as one of strengthening downtown as a whole, rather than of competing with suburban shopping centers. If Nicollet Avenue could be rejuvenated, commercial office construction would be stimulated, and this in turn would improve the retail market and make it more attractive to both local and regional shoppers.

The Downtown Council accepted the views of its committee and engaged Barton-Aschman Associates, Inc., to work with a permanent Nicollet Avenue committee on three tasks: (1) a detailed survey of existing conditions; (2) formulation of a set of objectives; and (3) identification of a range of alternative ways to meet those objectives.

The Barton-Aschman report, financed by the Downtown Council, was published in 1960 as Nicollet Avenue: Principles and Techniques for Retail Street Improvement. The purpose of the report was to lay the foundation for further consideration of the possibilities of improving Nicollet Avenue. The report identified four specific planning objectives:

1. To improve pedestrian circulation in terms of efficiency and comfort;

2. To improve access and encourage mass transportation usage;

3. To create new opportunities for promotion of the retail area and the central business district; and

4. To encourage private investment by creating a stable environment.

The report pointed out that due to its use as a commercial street and the availability of parallel one-way streets, Nicollet Avenue was the least heavily used of the north-south in the central area. A 50-foot street on an 80-foot right-of-way, Nicollet Avenue carried between 11,000 and 12,000 vehicles a day, at the rate of 1,000 vehicles an hour during peak periods. At midday, 12 percent of the vehicles were trucks. The street carried a light transit load--about 200 buses a day.

In the six-block area between 4th and 10th Streets there were only 89 legal parking spaces. There were no curb cuts except those giving access to midblock alleys. Most of the buildings had off-street loading and unloading with access from an alley. Those without off-street loading and unloading generally were located at street corners and were not dependent upon Nicollet Avenue for vehicular access.

Barton-Aschman then suggested, without recommendation, five possible treatments. These were:

1. A modified public street, treated cosmetically, but left open to pedestrian and vehicular traffic;

2. A modified public street, with below ground or elevated concourses at intersections;

3. A mall, from which all vehicles, including cross-traffic, would be excluded;

4. A series of plazas, in which vehicles would be excluded within blocks, but the cross streets remain open; and

5. A series of plazas, combined with a transitway.

The report was first presented to a group of business leaders, representing 10-15 of the largest downtown firms. This group agreed, apparently unanimously, on the plaza-transitway concept.

A member of the committee then personally discussed the report, the plaza-transitway alternative, and a proposal to finance the project through assessments on benefiting property with virtually every retailer and property owner in the affected area. The result was that more than 80 percent expressed agreement with the project and the plaza-transitway alternative. The process took approximately one year.

By the time a consensus was reached, the Downtown Council was ready to take the next step: to engage Barton-Aschman again--this time to prepare a general plan based on the preferred alternative. The second planning report, A Plan for Nicollet Avenue in Downtown Minneapolis, was submitted to the Downtown Council in December 1961 which proposed an eight-block development between Washington and 10th Streets and established guidelines for final design. The estimated cost ranged from $979,000 to $1,780,000.

The committee again went door-to-door to explain and obtain support for the project. When for the second time more than 80 percent of the retailers and property owners expressed agreement with the project and the assessment principle, the Downtown Council called in Lawrence Halprin and Associates to prepare architectural plans and renderings for each side of each block. After another round with tenants and owners, the Downtown Council was ready to ask the city to proceed with the development of Nicollet Mall. City Council gave its approval, and planning thereafter was financed by city funds.

The planning process had taken three years. Four more years of planning--physical, legal, and financial--and construction would be necessary before the mall could officially open in November 1967.

Final Planning and Design

Final planning and design were performed by a team of five consulting firms under the direction of the City Engineer. Construction drawings were complete by April 1966. The final design was materially influenced by three factors:

- Insistence by the head of the largest downtown department store that:
  - Only top-quality construction was acceptable; and
  - Design be based on high aesthetic standards in keeping with an urban setting.
- Nearly all of the space under the right-of-way was occupied by utilities, so that:
  - The need for access became a determining factor in the location of surface features; and
  - Underground systems had to be brought into first class condition to permit the mall to remain as undisturbed as possible in the future.
- Special work had to be done on the foundations of many of the buildings facing Nicollet Avenue because of basements which extended out under the right-of-way.

Construction Activities and Costs

Construction began in July 1966. The project officially opened in November 1967, with final work, principally planting, completed in the spring of 1968. Construction was delayed initially because of unsatisfactory responses to invitations to bid. Although most of the speciality work was let out on competitive bids, the city itself finally assumed the role of general contractor.

A major concern during construction was the possible effect of construction activities on retail business. Special efforts were made to ensure free access to each retail establishment at all times. During actual construction, the activity attracted visitors to the street and pedestrian safety turned out to be a major problem. This was handled by adequate handrails and lighting and by emphasizing safety considerations to the contractors on the job.

The Downtown Council and individual store managers have all agreed that retail sales were not adversely affected during the construction period.

The high range of the 1961 estimate of costs was $1,780,000. Actual costs were $3,839,435, of which $2.5 million was spent on sub-surface work. The final cost breakdown is shown below.

- Table F1: Nicollet Mall Construction Costs

Electrical and lighting	$1,160,576
Sidewalks	744,690
General construction	721,312
Landscape structures	453,194
Planting	108,244
Granite	90,400
Cast stone	53,135
Other	77,614
	$3,409,165
Engineering (12.6%)	430,270
Total Project Cost	$3,839,435

PROJECT FINANCING

As indicated below, the costs of developing the Nicollet Mall were met by (1) special assessments and (2) Federal grants under programs administered by the Housing and Home Finance Agency.*

Special assessments	$2,758,785
Federal grants	1,063,105
Adjustments to balance	17,545
	$3,839,435

The methods for using each of these funding sources is examined in the following discussion.

A. Special Assessments. Chapter 430, Land for Streets and Parks, of the Minnesota statutes (the Elwell Law) provides for the assessment of the costs of certain public improvements against benefited properties.

The Elwell Law was amended in 1963, at the request of the city, to permit cities of the first class (which includes Minneapolis) to:

- Limit the use by private vehicles on congested streets in central business districts; and

* In 1966, HHFA became the principal constituent of the newly-established Department of Housing and Urban Development (HUD).

- Designate pedestrian malls.

The City Council may permit the use of a pedestrian mall by public mass transportation carriers and taxicabs and grant special access permits when a property does not have access to some other street or alley for loading and unloading. Assessments may cover both the initial improvement costs and annual costs there thereafter.

The principal question to be determined once the basic authority was granted by the legislature was how the assessments would be applied. It was finally decided to create two benefit zones:

- Zone 1 for properties facing on the mall; and
- Zone 2 for properties within approximately a block of, but not facing on, the mall.

Within each zone, assessments are based on a frontage-first floor area formula and tapered on the basis of distance from the 100 percent location at Nicollet Mall and 8th Street.

Under the assessment plan, the capital costs of the project will be amortized over a 20-year period. Annual operating costs are also assessed. These are currently about $500,000, of which $100,000 is for electricity for street lighting, heating bus shelters, and snow melting.

B. Federal Grants. Grants totaling $1,063,105, or 28 percent of total project costs, were made available under two Federal Housing and Home Financing Agency (HHFA) programs:

- Under Section 3 of the Urban Mass Transportation Act of 1964, the HHFA Office of Transportation* made a capital grant of $513,266 to cover two-thirds of the costs of providing the public transportation features of the mall including:
  - Construction of a 24-foot dual bus lane;
  - Shelters at bus loading points, benches, and related features;
  - Equipment for heating shelters and melting snow in adjacent areas; and

---

* This was one of five initial grants, which were announced simultaneously, under the Urban Mass Transportation Act of 1964. The HHFA Office of Transportation is the original predecessor of the Urban Mass Transportation Administration (UMTA) in the Department of Transportation (DOT).

- - Traffic signalization, including mid-block bus-pedestrian controls and bus-actuated signals at intersecting streets.*

- The capital grant was later increased by $52,464 to meet increased construction costs. Matching funds (one-third) were provided through the special assessments previously described.

- The Housing and Home Finance Agency subsequently made a grant of $497,375 under the Urban Beautification Program to assist in providing street furniture and other surface features that were not related to the transitway.

The anticipated benefits of the Federally-financed portion of the project, as outlined in the city's grant application, were that:

- Bus speeds would double (in peak periods they would increase from 4 to 8 mph); and

- Transit patronage would increase, particularly during off-peak shopping periods.

A CURRENT EVALUATION

Nicollet Mall is clearly achieving the purposes for which it was built. However, business groups and city officials alike agree the Mall is not a panacea. They see it as one important part of a larger system designed to make persons want to come downtown.

General Benefits

It is impossible to attribute specific benefits to the Mall itself, for Nicollet Mall is but one part of a wider effort, which began with the formation of the Downtown Council in 1955, to strengthen the city's central business district. That the effort as a whole has been successful is indicated by these facts:

- Between 1963 and 1975 approximately $400 million were spent for rehabilitation and new construction in downtown Minneapolis;

- A number or retail establishments on the Mall lead the nation in recent sales growth;

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* It was decided to eliminate the signal preemption system because of the adverse effect it would have on bus traffic on the intersecting streets. The midblock signals were ineffective in controlling pedestrian movement across the transitway and have been abandoned.

- The downward sales trend in some buying groups has been reversed;
- Small stores are growing in number and sales volume, resulting in a reversal of the trend away from downtown retail locations to suburban shopping centers; and
- New stores and headquarters offices are seeking locations in downtown Minneapolis--and they insist on being on both the Mall and the Skyway.

Impact on Public Transportation

So many factors have been at work, including a major effort under public ownership to make transit more attractive and substantial changes in downtown routing, that it is impossible to isolate any single impact or even to find meaningful data.

Overall, Metropolitan Transit Commission riders have increased from 45 million in 1970 to 63 million in 1973. Standing loads ware common on the routes using the Mall at midday, as well as during the morning and afternoon peaks.

One surprising fact is that because of random pedestrian movement on the Mall, bus times between Washington and 10th Streets have actually dropped by a minute or two. This is not enough to adversely affect bus operations, however. Nor does it appear to bother the bus riders, who enjoy looking out over the constant activity on the Mall.

SOURCES

Documents

1. Aschman, Frederick T. "Nicollet Mall: Civic Cooperation to Preserve Downtown's Vitality." Planners Notebook 1, No. 6, September 1971.

2. Barton-Aschman Associates, Inc. Nicollet Avenue Study: Principles and Techniques for Retail Street Improvement. Prepared for the Downtown Council of Minneapolis, Evanston, June 19, 1960.

3. Barton-Aschman Associates, Inc. Plan for Nicollet Avenue in Downtown Minneapolis. Prepared for the Downtown Council of Minneapolis, Evanston, December 1961.

4. City of Minneapolis, Office of City Coordinator. Loring Park Development Progress Report. Minneapolis, June 1975.

5. Downtown Council of Minneapolis, Nicollet Mall, The Upper Midwest's Largest Shopping Center. No publisher, no date.

Interviews

1. Leonard Alick, General Superintendent of Transportation, Twin Cities Area Metropolitan Transit Commission (MTC).
2. Carl Burkhardt, Director of Operations and Traffic, MTC.
3. Scott Dickson, Senior Research Assistant, MTC.
4. Richard Dreher, Assistant to the President, Dayton Company.
5. O. D. Gay, Executive Vice President, Downtown Council of Minneapolis.
6. Fred T. Heywood, Staff Research, MTC.
7. John R. Jamieson, Director of Transportation Development, MTC.
8. David Koski, Traffic Engineer, City of Minneapolis.
9. Willard Little, Director of Routes, Schedules, and Planning, MTC.
10. Robert Moffitt, Director, Planning and Development, City of Minneapolis.
11. Ray Neetzel, Senior Transportation Analyst, MTC.
12. Al Porte, Subscription Bus Service Coordinator, MTC.
13. Perry Smith, Assistant City Engineer, City of Minneapolis.
14. Clayton Sorenson, City Engineer, City of Minneapolis.
15. Harry W. Springer, General Manager, MTC.

Appendix G

PREFERENTIAL SIGNS AND MARKINGS

Contents | Page

SOURCE: U.S. Department of Transportation, Federal Highway Administration, Transit and Traffic Engineering Branch.

1. FHWA Notice N 5160.8 (March 17, 1975)

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

SUBJECT	FHWA NOTICE
Changes in the Manual on Uniform Traffic Control Devices to Provide Pavement Marking and Signs for Preferential Lane-Use Control	N 5160.8 March 17, 1975

1. PURPOSE. To notify all Federal Highway Administration (FHWA) elements and member departments of the American Association of State Highway and Transportation Officials (AASHTO) of changes in Parts II and III of the Manual on Uniform Traffic Control Devices (MUTCD), 1971 edition, establishing new standards for a unique symbol to be used in pavement marking and on regulatory signs.

2. BACKGROUND. Various State highway departments and local jurisdictions have developed various new signs and markings for designating priority bus and carpool lanes due to the lack of appropriate standard signs and markings in the current MUTCD. In addition, the increased importance now being placed on the use of multioccupancy highway vehicles and energy conservation, has prompted the development of a unique pavement marking symbol and regulatory signs. These devices will be used when a lane is established as a preferential use lane for a particular class or classes of vehicles such as buses, carpools, taxis, etc.

   Requests for official changes in the MUTCD were considered by the National Advisory Committee on Uniform Traffic Control Devices (NAC), and revisions to current standards were recommended to and approved by the Federal Highway Administrator.

3. ACTION

   a. The following new section, Section 3B-20, "Preferential Lane Markings," is to be added immediately after Section 3B-19, MUTCD:

      When a lane is assigned full- or part-time to a particular class or classes of vehicles, the preferential lane markings shall be used. Preferential lane markings are intended to help convey the message that such lanes are to

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be used only by certain vehicles which are identified on the Lane-Use Control Signs. Signs or signals shall be used with the preferential lane markings to convey the specific lane-use restrictions (Section 2B-17).

The preferential lane marking shall be an elongated diamond formed by white lines at least 6 inches in width symmetrical about its longitudinal and transverse axes. The diamond shall be at least 2 1/2 feet in width and 12 feet long and shall be placed coincident with the longitudinal center of each restricted lane.

The frequency with which the marking is placed is a matter for engineering judgment based on prevailing speed, block lengths, distance from intersections, and other considerations necessary to adequately communicate with the driver. Spacing as close as 80 feet may be appropriate for a city street, while a spacing of 1,000 feet may be appropriate for a freeway.

Word markings may be used to supplement, but not substitute for, the preferential lane markings.

b. The first sentences of the first paragraph of Section 2B-17, "Lane-Use Control Signs," are changed to read as follows:

Lane-Use Control Signs shall be used where turning movements are required, where unconventional turning movements are permitted from specific lanes at an intersection, or where preferential lane-use roadways are established. The standard size of signs R3-5 to 9 shall be 30 inches by 36 inches when mounted overhead, and 30 inches by 30 inches when post mounted.

After the last paragraph of Section 2B-17, add:

The following provide guidance for a jurisdiction in implementing traffic controls for preferential lanes:

1.a. Signs used for preferential lanes should follow the standard regulatory signing principles, black legend on white background, rectangular and reflectorized or illuminated, if applicable during periods of reduced visibility.

b. Lane marking symbols used to designate preferential lanes should be incorporated in the body of the signs, as a white symbol on a black background (Section 3B-20).

2. Sign size, location, and spacing are dependent upon the conditions under which it is used, but should be consistently applied.

3.a. While the legend format of Signs R3-10, R3-11, R3-12, R3-13, R3-14, and R3-15 should be retained, other messages may be used to fit a specific preferential lane-use operation.

b. For post mounting applications, Sign R3-11 should be located adjacent to the preferential lane. For overhead applications Sign R3-14 should be located directly over a preferential lane for effective guidance and control.

c. The message format of Sign R3-11 should have the following sequence:

TOP LINES = lane(s) applicable (e.g., CENTER LANE, CURB LANE, RIGHT 2 LANES, THIS LANE).

MIDDLE LINES = applicable vehicles (e.g., BUSES ONLY, BUSES AND CAR-POOLS, BUSES AND RIGHT TURNS ONLY).

BOTTOM LINES = applicable time and day (e.g., 7 AM - 9 AM, 4 PM - 6 PM, MON-FRI).

d. The message format of Sign R3-14 should have the following sequence:

TOP LINES	* applicable vehicles (e.g., BUSES ONLY, BUSES AND CAR-POOLS, BUSES AND RIGHT TURNS ONLY).
BOTTOM LINE	* applicable time and day (e.g., 7 AM - 9 AM, 4 PM - 6 PM, MON-FRI). The time and day are separated by a down arrow.

e. Symbolization should be included in the body of both signs, preferably in the top left quadrant, similar to the parking sign, R7-107.

4.a. Overhead Lane-Use Control Signals and changeable message signs should also be integrated into the operational requirements for contraflow lanes, reversible lanes and where periodic changes occur in regulations affecting the motorists.

b. Where signals are used to control lane usage, signs may be used to supplement the signals.

5. Appropriate lane striping, word messages and symbology, should be used for marking preferential lanes, serving as additional notice to the motorist of these unusual regulations.

6. Advance notification of preferential lane-use roadways is desirable. RESTRICTED LANE AHEAD signs, R3-10 for post mounting and R3-13 for overhead mounting, may be used for this purpose.

7. At the end of a section to which a preferential lane applies, RESTRICTED LANE ENDS signs shall be used, R3-13 for post mounting applications and R3-15 for overhead mounting applications.

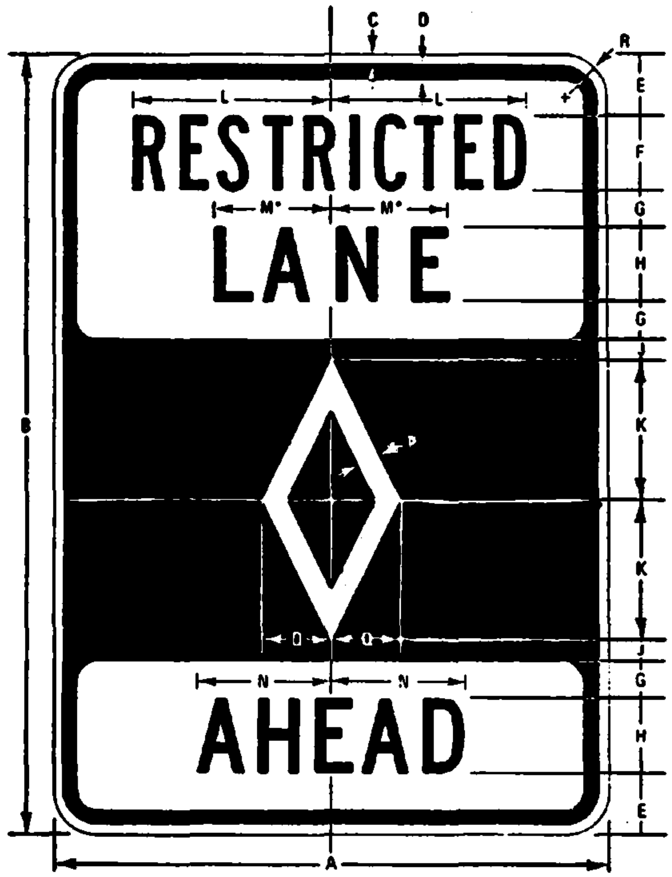
c. The suggested target date for full compliance with Section 3B-20, "Preferential Lane Markings," and Section 2B-17, "Lane-Use Control Signs," is January 1, 1976.

d. Official MUTCD Rulings M-26 (Chng.) and Sn-61 (Chng.), which reflect these changes, will be published in the next volume of Official Rulings on Requests for Interpretations, Changes and Experimentations.

e. The Office of Traffic Operations is preparing design specifications for Signs R3-10, R3-11, R3-12, R3-13, R3-14, and R3-15 as additions to the STANDARD HIGHWAY SIGNS booklet.

David M. Baldwin
for J. J. Crowley, Director
Office of Traffic Operations

2. Sign R3-10 ("Restricted Lane Ahead")



R3-10

SIGN	DIMENSION (INCHES)							
	A	B	C	D	E	F	G	H
MIN & STD EXPWY FWY	30 36 48	42 60 84	1/2 5/8 3/4	3/4 7/8 1-1/4	3-1/4 4-1/2 6	48 68 88	2 3 4	4C 6C 8C

SIGN	DIMENSION (INCHES)							
	J	K	L	M	N	P	Q	R
MIN & STD EXPWY FWY	1-1/4 2 3	7-1/2 10 15	10-3/8 15-1/2 20-3/4	6 9 12	8-3/4 10-1/2 14	1-1/8 1-1/2 2-1/4	3-3/4 5 7-1/2	1-7/8 2-1/4 3

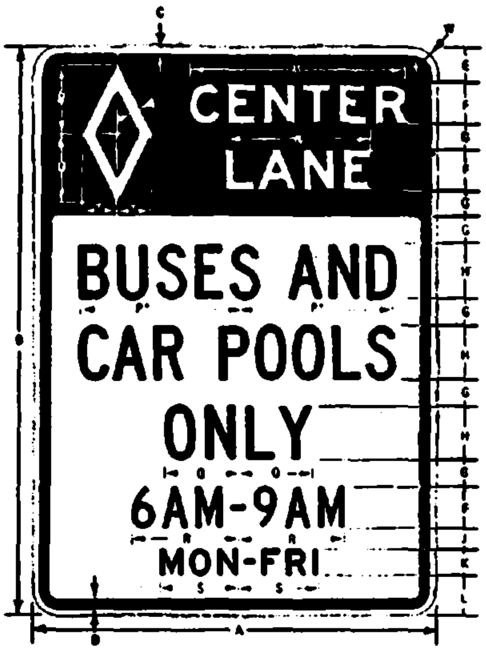
COLORS

LEGEND-BLACK (NON-REFL)
BACKGROUND-WHITE (REFL)
SYMBOL-REFL WHITE ON BLACK

*INCREASE SPACING 100%

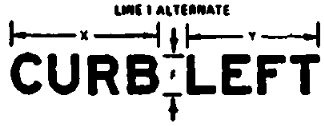
23a

3. Sign R3-11 ("Center Lane: Buses and Carpools Only")



R3-11

LINE 1 ALTERNATE



LINE 4 ALTERNATE

SIGN	DIMENSION (INCHES)									
	A	B	C	D	E	F	G	H	J	K
MIN & STD	30	42	1/2	3/4	2-1/2	30	2	40	1-1/2	20
EXPWY	42	60	5/8	7/8	4	40	3	80	2	30
FWY	54	84	3/4	1-1/4	5	60	4	80	3	40

SIGN	DIMENSION (INCHES)									
	L	M	N	P	Q	R	S	T	U	V
MIN & STD	3	14-3/8	9-5/8	12	5-1/2	VAR	VAR	2-1/2	5	3/4
EXPWY	3	19-1/8	12-3/4	18	8-1/4	VAR	VAR	3-3/4	7-1/2	1-1/8
FWY	6	28 , 4	19-1/4	24	11	VAR	VAR	5	10	1-1/2

SIGN	DIMENSION (INCHES)			
	W	X	Y	Z
MIN & STD	1-7/8	10	8-7/8	48
EXPWY	2-1/4	13-3/8	11-3/4	68
FWY	3	20	17-3/4	88

COLORS

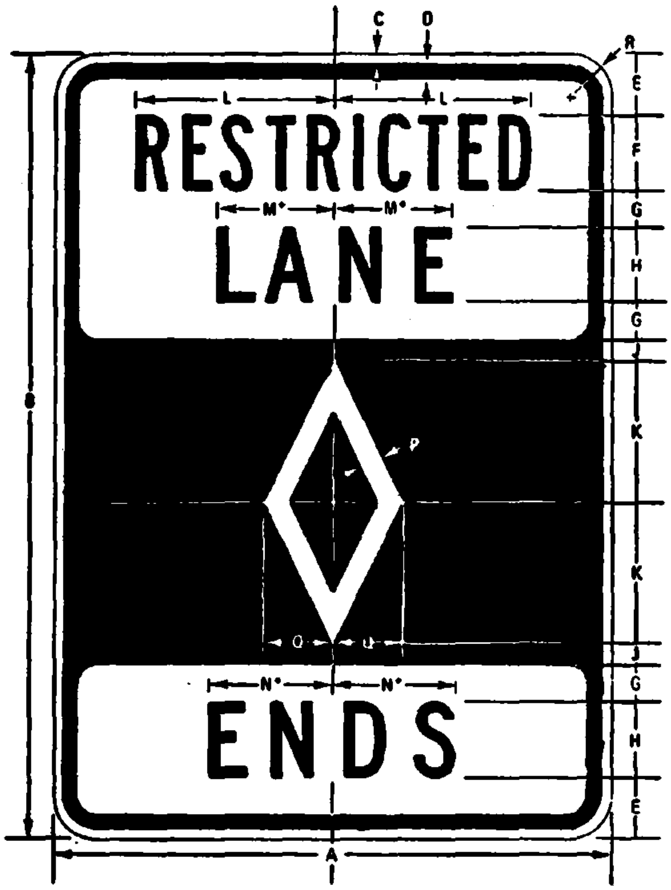
TOP
SYMBOL AND LEGEND—WHITE (REFL)
BACKGROUND—BLACK (NON-REFL)

BOTTOM
LEGEND—BLACK (NON-REFL)
BACKGROUND—WHITE (REFL)

*REDUCE SPACING 25%
**OPTICALLY LOCATE SYMBOL AND TOP LEGEND

23b

4. Sign R3-12 ("Restricted Lane Ends")



R3-12

SIGN	DIMENSION (INCHES)							
	A	B	C	D	E	F	G	H
MIN & STD	30	42	1/2	3/4	3-1/4	4B	2	4C
EXPWY	36	60	5/8	7/8	4-1/2	6B	3	6C
FWY	48	84	3/4	1-1/4	6	8B	4	8C

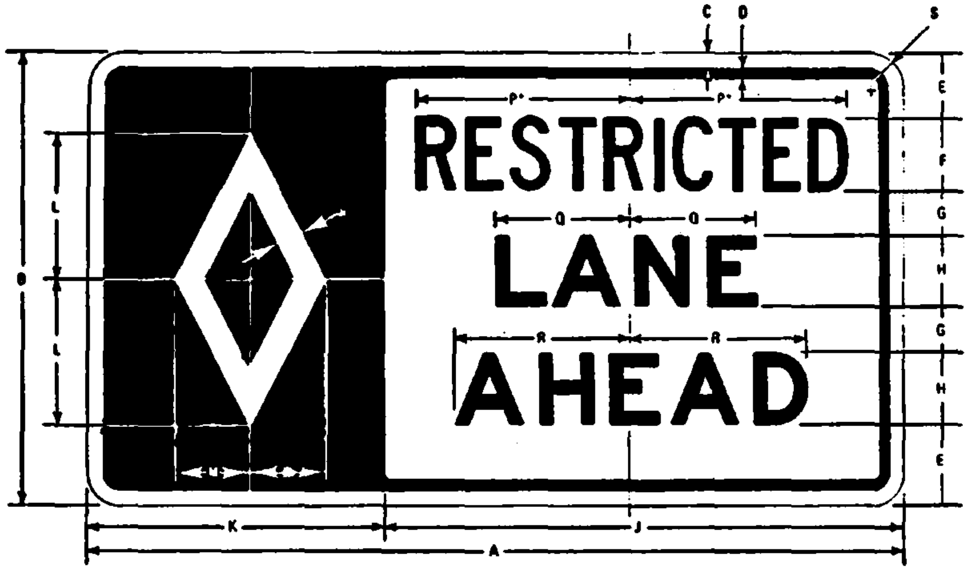
SIGN	DIMENSION (INCHES)							
	J	K	L	M	N	P	Q	R
MIN & STD	1-1/4	7-1/2	10-3/8	6	6-1/2	1-1/8	3-3/4	1-7/8
EXPWY	2	10	15-1/2	9	9-3/4	1-1/2	5	2-1/4
FWY	3	15	20-3/4	12	13	2-1/4	7-1/2	3

COLORS
LEGEND—BLACK (NON-REFL)
BACKGROUND-WHITE (REFL)
SYMBOL—REFL WHITE ON BLACK

*INCREASE SPACING 100%

23c

5. Sign R3-13 ("Restricted Lane Ahead")



R3-13

SIGN	DIMENSION (INCHES)								
	A	B	C	D	E	F	G	H	J
MIN & STD	66	36	5/8	7/8	5-1/2	6C	3-1/2	6D	42
EXPWY	84	48	3/4	1-1/4	7	8C	5	8D	54
FWY	102	60	1	1-1/2	9	10C	6	10D	66
SIGN	DIMENSION (INCHES)								
	K	L	M	N	P	Q	R	S	
MIN & STD	24	12	6	2	17	9-5/8	13-1/8	2-1/4	
EXPWY	30	16	8	2-1/2	22-1/2	12-3/4	17-7/16	3	
FWY	36	20	10	3	28	16	21-3/4	3-3/4	

COLORS
LEGEND–BLACK (NON-REFL)
BACKGROUND–WHITE (REFL)
SYMBOL–WHITE (REFL)

*REDUCE SPACING 50%

6. FHWA Notice N 5160.13 (July 17, 1975)

U. S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

SUBJECT	FHWA NOTICE
Alternative Messages for Preferential Lane-Use Control Sign R3-14.	N 5160.13 July 17, 1975

1. PURPOSE. To inform all Federal Highway Administration and State highway organizations of permissible alternative messages which may be used on highway sign R3-14 to notify motorists of preferential lane-use regulations.

2. COMMENTS

 a. The use of restricted lanes on freeways to provide preferential treatment for certain classes of vehicles is gaining wide acceptance among highway agencies. The legend shown on sign R3-14 (FHWA Notice N 5160.11, May 14, 1975, 1972 Standard Highway Signs Booklet Supplement) was intended as a typical legend only and not to be construed as a mandatory sign message. Experience with various sign messages indicates that the term "4 RIDER" in the example legend for sign R3-14 "4 RIDER CARPOOLS" may be confusing to drivers. The term "4 RIDER" has been interpreted by some drivers to mean that a carpool with four or more members can use a preferential lane even though the number of persons riding on a particular day may be less than four. Because of such misinterpretations agencies should consider use of more appropriate legends such as "VEHICLES WITH 4 OR MORE PERSONS."

 b. Other alternate messages for portions of the legend on sign R3-14 may be found on page 4 of FHWA Notice N 5160.8, March 17, 1975, "Changes in the Manual on Uniform Traffic Control Devices to Provide Pavement Marking and Signs for Preferential Lane-Use Control."

J. J. Crowley, Director
Office of Traffic Operations

DISTRIBUTION: Headquarters
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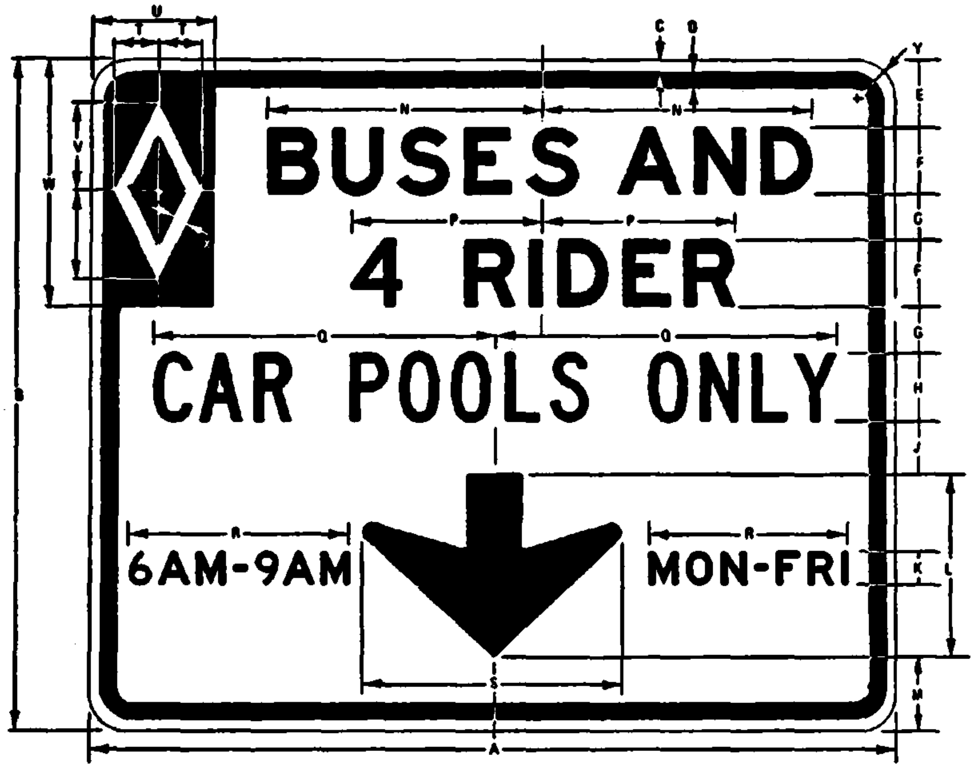
Divisions

OPI: HTO-21

7. Sign R3-14 (Buses and 4 Rider Car Pools Only")



R3-14

SIGN	DIMENSION (INCHES)									
	A	B	C	D	E	F	G	H	J	K
MIN & STD	72	60	1	1-1/2	6	6D	4	6C	4-1/2	3C
EXPWY	96	72	1-1/4	1-3/4	8	8D	6	8C	4-1/2	4C
FWY	108	84	1-1/2	2	10	10D	6	10C	4	5C

SIGN	DIMENSION (INCHES)									
	L	M	N	P	Q	R	S	T	U	V
MIN & STD	16-1/2	7	23-1/2	16-1/2	31	VAR	22-1/2	4	11	8
EXPWY	16-1/2	7	31-1/2	21-3/4	41	VAR	22-1/2	5	15	10
FWY	22	8	39	27	51	VAR	32	6	18	12

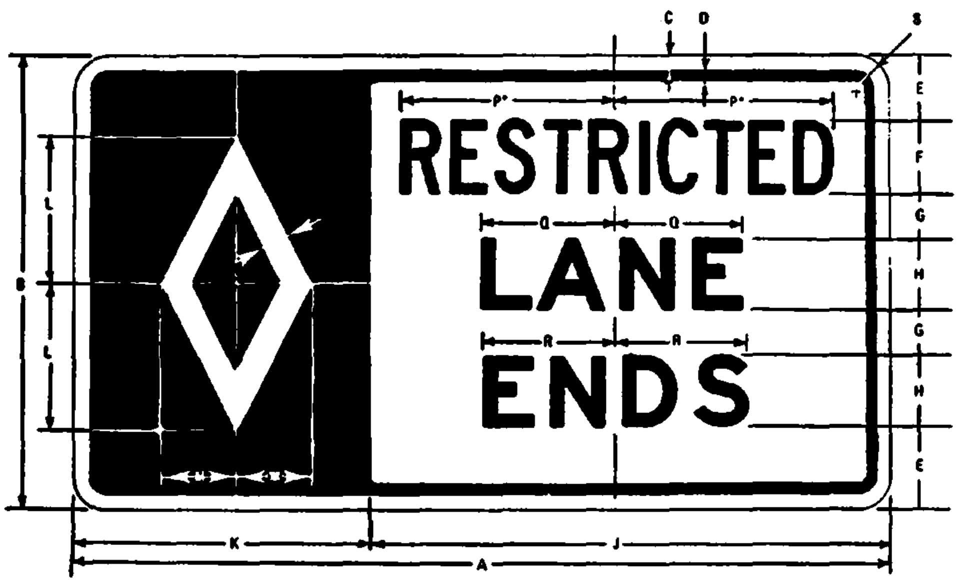
SIGN	DIMENSION (INCHES)		
	W	X	Y
MIN & STD	22	1-1/4	3-3/4
EXPWY	30	1-1/2	5
FWY	36	2	6

COLORS
LEGEND-BLACK (NON-REFL)
BACKGROUND-WHITE (REFL)
SYMBOL-REFL WHITE ON BLACK

*SEE MUTCD FOR DESIGN

23a

8. Sign R3-15 ("Restricted Lane Ends")



R3-15

SIGN	DIMENSION (INCHES)								
	A	B	C	D	E	F	G	H	J
MIN & STD	66	36	5/8	7/8	5-1/2	6C	3-1/2	6D	42
EXPWY	84	46	3/4	1-1/4	7	8C	5	8D	54
FWY	102	60	1	1-1/2	9	10C	6	10D	66
SIGN	DIMENSION (INCHES)								
	K	L	M	N	P	Q	R	S	
MIN & STD	24	12	6	2	17	9-5/8	9-3/4	2-1/4	
EXPWY	30	16	8	2-1/2	22-1/2	12-3/4	13	3	
FWY	36	20	10	3	28	16	16-1/4	3-3/4	

COLORS
LEGEND—BLACK (NON-REFL)
BACKGROUND—WHITE (REFL)
SYMBOL—REFL WHITE ON BLACK

*REDUCE SPACING 50%

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GLOSSARY

This glossary is a brief review of key terms of particular interest that are used throughout the Manual on Priority Techniques for High Occupancy Vehicles.

The terms in this glossary are adapted from standard usage to meet the needs of a diverse audience. Administrators and technical personnel require a common basis for communication. The usage (hence meaning) of each term therefore may be specific to the Manual. The definitions used are not necessarily the same as those used in other approaches to urban transportation systems improvement.

All terms in this glossary should be reviewed as a part of the background preparation for project implementation. It is particularly important that the terms be understood in the context of discussions presented in each of the Manual's component documents.

GLOSSARY

ACTIVITY CENTER - A major aggregation of commercial, industrial, institutional and/or residential development. They include not only Central Business Districts but also areas such as commercial/industrial parks, airport areas, or medical center/university residential complexes.

ACTIVITY CENTER TECHNIQUES - Priority techniques implemented on city streets within activity centers. These include, among others, reserved lane/circulation systems, transit malls, and bus street terminals.

ARTERIAL - Any heavily traveled non-freeway street that connects urban residential areas with major commercial, industrial, or other employment areas.

ARTERIAL APPLICATIONS - Those techniques employed on heavily traveled non-freeway streets connecting urban and suburban residential areas with major commercial or industrial areas and other traffic generators: (1)concurrent and contra-flow reserved lanes; and (2) signal pre-emption.

CAPACITY - The maximum number of vehicles or persons which can be handled in a travel lane of a particular facility under prevailing conditions for a given mixture of vehicles (autos, buses, trucks, etc.) and at a given level of service. Adjusting any one of the preceding factors will affect the capacity.

CONCURRENT FLOW LANE - Reserved lanes in which traffic flows in the same direction as the rest of the traffic on the same side of the center line.

CONTRA-FLOW LANE - Reserved lane in which traffic flows in the opposite direction as the rest of the traffic on the same side of the roadway center line.

DEMAND - The actual number of persons or vehicles that want to use a facility (when the facility is at capacity) or the number of persons or vehicles who are using a facility (when the facility is at less than capacity).

DESIGN FUNCTION - Developing specifications for project designs within the constraints set by the planning function. A feedback loop should exist between planning and design functions.

DESIGN PHASE - The third project phase, during which detailed design specifications are prepared according to constraints set by the project plan (prepared during the Project Planning phase).

EVALUATION PHASE - The sixth and final project phase, during which project performance is measured and modified as needed.

FREEWAY APPLICATIONS - Those techniques employed on or within freeway rights-of-way: (1) separated facilities; (2) concurrent flow and contra-flow reserved lanes; (3) priority freeway access control including by-pass lanes on metered ramps, or exclusive use ramps.

GOAL - Broad statement of desired results.

HIGH OCCUPANCY VEHICLE - Any motorized vehicle carrying at least two persons, such as a carpool, vanpool or bus.

INSTALLATION PHASE - The fourth project phase, during which project facilities are installed.

MEDIAN LANES - Reserved lanes in the center of a roadway where traffic flows in reversible directions with the peak traffic flows.

MINI-TERMINAL - An off-street facility at major transit route convergence points that can provide a protected area for bus loading and unloading, with minimal traffic interference. If the area is large enough, space can be provided for buses to pass one another without each bus in a platoon having to wait for those ahead.

MISCELLANEOUS APPLICATIONS - A category of priority techniques which, in this Manual, are conceived to be applied on an individual problem-specific basis (which is distinct from systematic application to freeway, arterial, or urban center corridor). Common alternatives include: (1) isolated signal modifications; (2) off-street transit terminals; (3) toll plaza applications; (4) carpool staging areas; (5) preferential carpool lots; and (6) transit operations.

NON-USERS - Those whose circulation and/or access may be affected by a priority treatment project but who do not directly benefit from it (i.e., non-high occupancy vehicle motorists and passengers, pedestrians, or adjacent property owners). Non-users may be using the same facility, parallel routes, or cross streets.

OBJECTIVE - Declarative statement of intent in operational terms which can be used as specific guidance to the project team. It is a limited aim toward which effort is directed, partially fulfilling a project goal.

OPERATING PHASE - The fifth project phase, during which project facilities are operated and monitored on a day-to-day basis.

PHYSICAL OPPORTUNITIES - Transportation system characteristics which may allow project implementation without taking away space from non-users (e.g., available right-of-way, abandoned rail right-of-way, wide shoulders, etc.).

PLANNING FUNCTION - Setting constraints on project designs. A feedback loop should exist between planning and design functions.

POLICY OPPORTUNITIES - Where a adopted goals or policies might allow project implementation where no apparent physical expansion opportunities exist and where other alternatives including a "do nothing" alternative are less desirable.

PROGRAM - A series of projects or the administrative framework for projects involving priority techniques.

PROGRAM MANAGER - An appointed representative of the chief executive who acts on top management guidance, takes overall responsibility and authority for project planning and management, and advises policy makers regarding project status with respect to the project plan and budget.

PROJECT - A formal effort to respond to a particular transportation problem by applying one or more priority technique(s) and, if needed, any other measures which contribute to an acceptable solution. The approach suggested in this Manual is that of a multi-disciplined project team, acting under an appointed Program Manager. A project can be a relatively short-term effort directed at a specific objective under constraints fixed by management that relate to resources, time, and possibly public expectations.

PROJECT ACTIVITY PLAN - A formal document used to structure project team activities. At minimum, the project activity plan should indicate the project scope, objectives, start and completion dates for all activities, the responsible individual(s), and a detailed budget.

PROJECT PHASE - A time interval that permits administrative control of priorities, costs, and timing within fixed technical requirements and management constraints. Each project progresses through six separate but interrelated phases: (1) Sketch Planning; (2) Project Planning : (3) Design; (4) Installation; (5) Operation; and (6) Evaluation.

PROJECT PLANNING - The second project phase, during which the project team identifies and recommends constraints on the remaining phases to meet a variety of regulatory and operational requirements.

PROJECT TEAM - A multi-disciplined group that assists the Program Manager; the team should be broadly representative of the technical specialties that are involved, and should include transportation planners, highway and traffic engineers, transit operators, and enforcement officers. Provision also should be made for the participation of citizens, business representatives, and civic groups.

SIGNAL PREEMPTION - A technique which allows a certain class of vehicles (in this case, high occupancy vehicles) to alter a given signal cycle to its advantage -- i.e., so that a vehicle's passage through the intersection is facilitated with respect to the general traffic.

SKETCH PLANNING PHASE - The first project phase; Sketch Planning is the process of identifying problems, opportunities for improvement, and comparing alternative project proposals.

SUPPORT FACILITIES - Are the non-roadway stationary facilities which accommodate transfers and parking operations for vehicles using a priority treatment facility.

SUPPORT SERVICES - The related services connected with a priority treatment project such as carpool programs, feeder/distribution bus services, or rapid rail connections.

USERS - Describes those who use and directly benefit from the service of a priority treatment project. That is, users are in the high occupancy vehicles using the facility.

Annotated Bibliography

I. MAJOR DESIGN REFERENCES

This part of the bibliography contains the basic design publications which should be consulted by those planning a priority treatment project. It is recognized that most jurisdictions will already have many of these documents, so they are provided only as a checklist. Purchasing information is provided. In addition to the ones listed, the appropriate city, county, and state standards and ordinances pertaining to roadway or bus operation designs should also be consulted.

American Association of State Highway and Transportation Officials. Policy on Design of Urban Highways and Arterial Streets. Washington, D.C.: 1973. (For sale: AASHTO, 444 No. Capital St. N.W. Suite 225, Washington, D.C. 20001. $12.00)

This describes AASHTO adopted standards for the designs of urban arterial and highway designs.

Box, Paul C., and Joseph C. Oppenlander. Manual of Traffic Engineering Studies. 4th edition. Arlington, Va.: Institute of Transportation Engineers, 1976. (For sale: Institute of Transportation Engineers, P.O. Box 9234, Arlington, Va. 22209. $20.00)

A guide for data collection and analysis of surface transportation problems, designed especially for smaller communities without large traffic engineering departments. Companion to Transportation and Traffic Engineering Handbook.

Highway Capacity Manual 1965. (Highway Research Board Special Report 87) Washington, D.C.: National Academy of Sciences-National Research Council, Highway Research Board, 1966. (For sale: Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue Washington, D.C. 20418. $8.00 paper cover. $10.00 hard cover)

This is a practical guide to capacity analysis. It permits determination of the capacity, service volume, or level of service which will be provided by either a new highway design or an existing highway, under specified conditions. Alternately, given a certain traffic demand, the design necessary to accommodate that demand at a given level of service can be determined.

Institute of Transportation Engineers. Transportation and Traffic Engineering Handbook, edited by John E. Baerwald. 3rd edition. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1976. (For sale: Institute of Transportation Engineers, P.O. Box 9234, Arlington, Va. 22209. $27.50)

A complete handbook which covers most of the basic subject area transportation engineers should be familiar with. The text is divided into 23 chapters each of which describes a different aspect of transportation engineering. Each chapter is written by a top authority in the subject area.

Levinson, Herbert S., et al. Bus Use of Highways: A State of the Art. (National Cooperative Highway Research Program Report 143). Washington, D.C.: National Academy of Sciences - National Research Council, Highway Research Board, 1973. (For sale: Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418. $16.00)

This report describes the state of the art on the bus use of highways up to 1973. More than 200 examples of bus priority are reviewed and analyzed.

Levinson, H.S., Crosby L. Adams, and William F. Hoey. Bus Use of Highways: Planning and Design Guidelines. (National Cooperative Highway Research Program Report 155). Washington, D.C.: National Academy of Sciences - National Research Council, Transportation Research Board, 1975. (For sale: Transportation Research Board, National Academy of Sciences, 2101 Constitution Avenue, Washington, D.C. 20418. $7.60)

This report is the second phase of research on bus use of highways. Design guidelines include roadway geometrics, traffic control, and bus operation components of preferential bus facilities.

Pinnel-Anderson-Wilshire and Associates, Inc. Traffic Control Systems Handbook. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1976. (For sale: U.S. Government Printing Office, Washington, D.C. 20402. Stock Number 050-001-00114-4. $12.00)

This comprehensive state-of-the-art document on traffic control systems includes basic discussions of priority techniques traffic controls. Signal preemption, ramp metering, freeway monitoring and variable message signing are among the priority techniques subject areas covered.

Smith, Wilbur and Associates. Bus Rapid Transit Options for Densely Developed Areas. Washington, D.C.: U.S. Department of Transportation, Office of the Secretary, Federal Highway Administration, and Urban Mass Transportation Administration, 1975. (For sale: U.S. Government Printing Office, Washington, D.C. 20402. Stock Number 050-001-0089 $3.50)

This report describes and evaluates alternative bus rapid transit systems in densely developed areas without freeways. It reviews the state-of-the-art, identifies significant options and technologies, and assesses their cost, service and community impacts.

U.S. Department of Transportation, Federal Highway Administration. Manual on Uniform Traffic Control Devices for Streets and Highways. Washington, D.C.: U.S. Government Printing Office, 1971. Official Revisions and Official Rulings on Requests issued as appropriate. (For sale: U.S. Government Printing Office, Washington, D.C. 20402. Stock Number 5001-0021. $3.40)

A compilation of nationally adopted standards and guidelines concerning traffic control devices. Devices covered include regulatory, warning and guide signs, pavement markings, traffic and pedestrian signals, and construction and maintenance traffic controls. Developed with the cooperation of the American Association of State Highway Officials and the National Joint Committee on Uniform Traffic Control Devices.

II. PRIORITY TECHNIQUES REFERENCES

Listed below are articles, conference addresses, and publications directly pertaining to the techniques subject area. The subdivisions are -- general, freeway techniques, arterial techniques, activity center techniques and miscellaneous techniques.

GENERAL

This section lists documents which cover more than one type of priority technique as well as major documents on transportation systems management, carpooling and vanpooling.

Expanded Transportation Service; Proceedings of the 1975 National Conference on Areawide Carpooling. Houston, Texas, December 8-10, 1975. Sponsored by the City of Houston CarShare Program; U.S. Department of Transportation, Federal Highway Administration; and U.S. Federal Energy Administration. Washington, D.C.: U.S. Government Printing Office, 1976. (GPO 1976-211-173/592)

Emphasizes interaction of areawide carpooling with long-term transportation planning.

Feasibility and Evaluation Study of Reserved Freeway Lanes for Buses and Carpools; Summary Report. Prepared for U.S. Department of Transportation, Office of Secretary of Transportation, Federal Highway Administration, and Urban Mass Transportation Administration. Springfield, Va.: National Technical Information Service, 1971. (Full Report Available from NTIS, PB 198-648, $3.00)

Early overview of priority treatment. Purpose of research was to determine feasibility of such techniques and to develop a plan for a demonstration project.

Forstater, Ira, and Ed Twomey Vanpooling: A Summary and Description of Existing Vanpool Programs. Washington, D.C.: U.S. Environmental Protection Agency, Office of Transportation and Land Use Policy, 1976.

Presents data on known vanpool programs as of December 1975 to allow analysis and comparison of various approaches to vanpooling.

Institute of Traffic Engineers, Committee 4M3. Ways to Enhance Transit Movement on Surface Streets; Summary of Questionnaire Results. Prepared by the University of Florida ITE Student Chapter; K.G. Courage Faculty Advisor. n.p.: Florida ITE Student Chapter, 1976.

Analysis of survey results on priority treatment techniques in the U.S. and Canada. Based upon voluntary responses, so is lacking several major projects.

INTERPLAN Corporation. Information on Transportation System Management Actions. Prepared for U.S. Department of Transporation, Urban Mass Transportation Administration. Santa Barbara, Calif.: 1976.

Section II, "Preferential Treatment of High-Occupancy Vehicles," relates the TSM actions to priority treatment of high-occupancy vehicles.

INTERPLAN Corporation. Transportation System Management: State of the Art. Prepared by Barbara Ibarra Keyani and Evelyn S. Putnam. Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration, 1977.

Presents state of the art information on 31 specific TSM actions in these categories: improving vehicular flow, preferential treatment of high-occupancy vehicles, reducing peak-period travel, parking management, promoting non-auto or high-occupancy auto uses, transit and paratransit service improvements, and transit management efficiency measures.

Morin, Donald A. "The Traffic Engineers' Challenge - Preferential Treatment for High Occupancy Vehicles." Paper read at 45th Annual Meeting of Institute of Traffic Engineers, August 1975, Seattle, Washington,

States that creation of roads does not reduce traffic congestion. Encourages positive approach by traffic engineers for priority treatment for high occupancy vehicles.

Muzyka, Ann. "Bus Priority Strategies and Traffic Simulation," pp. 39-49. Better Use of Existing Transportation Facilities; Proceedings of the Seventh Summer Meeting of the Transportation Research Board in Cooperation with the Florida Department of Transportation, August 6-7, 1974, Jacksonville, Florida. (TRB Special Report 153). Washington, D.C.: National Academy of Sciences-National Research Council, Transportation Research Board, 1975. ($9.80)

Discusses SCOT (Simulation of Corridor Traffic), a recently developed computer model that simulates traffic flow to predict effect of implementing candidate bus priority strategies on traffic performance.

NATO Committee on the Challenges of Modern Society. Bus Priority Systems. (CCMS Report no. 45) United Kingdom: U.K. Department of Environment, Transport and Road Research Laboratory, 1976.

Presents international, U.K., France, Canada and U.S.A., perspective and examples of priority treatment. Attempts to encourage use of bus priority schemes as a way to move people in urban environments.

Pratt, R.H., Associates Inc. Low Cost Urban Transportation Alternatives: A Study of Ways to Increase the Effectiveness of Existing Transportation Facilities; Executive Summary. Kensington, Md.: U.S. Department of Transportation, Office of the Secretary, 1973.

Summarizes results of the study on improving utilization of existing investment in transportation capital facilities. Techniques include both reduction of peak period demands and increase in carrying capacity of existing facilities.

Pratt, R.H., Associates Inc. Low Cost Urban Transportation Alternatives: A Study of Ways to Increase the Effectiveness of Existing Transportation Facilities. 2 vols. Kensington, Md.: U.S. Department of Transportation, Office of the Secretary, 1973.

Vol. I: Results of a Survey and Analysis of Twenty-one Low Cost Techniques.
Vol II: Results of Case Studies and Analysis of Busway Applications in the United States.

Vol. II concludes that exclusive bus lanes are capable of processing large volumes of passengers, often with substantial cost and time savings and can be operational within a relatively short time span. Analyzes applicability of the bus lane concept in a variety of environments. Data is provided on Federal funding for bus lanes.

Pratt, R.H., Associates Inc. Traveler Response to Transportation System Changes; A Handbook for Transportation Planners. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1977.

Includes traveler response to 10 transportation changes: Pool/bus priority lanes, variable work hours, carpooling encouragement, buspools/vanpools, area auto restraints, auto facility pricing, transit scheduling/frequency, bus routing/coverage, transit fare changes, and transit marketing/amenities.

Rothenberg, Morris J., and Fred A. Wagner. "Evaluation Criteria Related to Bus and Carpool Traffic Operational Incentive Projects." Sponsored by U.S. Department of Transportation, Federal Highway Administration. Working Draft for Discussion at 1975 FCP Research Conference, Minneapolis, Minnesota, September 1975.

Presents framework for a flexible plan to assist state and local governments evaluate carpool and bus traffic operational incentives. Discusses evaluation criteria in terms of measures of effectiveness and data collection requirements.

Rowe, S.E. "Commuter Computer; A Regional Car-Van-Bus Pool Program." Western ITE (November-December 1975).

Describes the Commuter computer program in the Southern California area.

Scheiner, James I., and Stephan A. Keiper. "Implementation of a Carpool Information Project: Innovative Approaches Improve Results." Presented at the 55th Annual Meeting of the Transportation Research Board, Washington, D.C. January 1976.

Carpooling study in Wilkes-Barre, Pa., 1974-1975. Found that automatic enrollment and transit pre-processing were important factors in increasing carpooling.

Transportation System Management, Conference Proceedings, Minneapolis, November 7-10, 1976. (TRB Special Report 172). Sponsored by the U.S. Department of Transportation, Urban Mass Transportation and the Federal Highway Administration, in cooperation with the Institute of Transportation Engineers Washington, D.C.: National Academy of Science-National Research Council, Transportation Research Board, 1977.

Conference on TSM regulations, their implementation and effects from metropolitan planing perspective. Includes case studies of cities implementing TSM.

U.S. Department of Transportation, Federal Highway Administration, Double Up, America; Car Pool Kit: Ride-Sharing Information for Employers. Washington, D.C.: 1975.

Part of a complete carpool kit for employers. Includes Federal aid available, carpool matching approaches, statistics on economic advantages to carpooling, and information on other available information materials.

U.S. Department of Transportation, Federal Highway Administration. Federally Coordinated Program of Highway Research and Development. Washington, D.C.: Annual.

Presents an overview of the research and development accomplishments and significant milestones of the Federal Highway Administration's Office of Research and Development.

U.S. Department of Transportation, Federal Highway Administration Improving Urban Mobility Through Better Transportation Management. Prepared by Barbara K. Reichart. Washington, D.C.: 1975.

Brochure illustrates low-cost options to improve urban mobility.

U.S. Department of Transportation, Federal Highway Administration. Preferential Facilities for Carpools and Buses; Seven Reports. Washington, D.C.: U.S. G.P.O., 1976. (050-001-00112-8; $1.10)

Reprints reports on seven preferential facilities for carpools and buses in Portland, Boston, Hartford, Miami, Honolulu, San Francisco, and Los Angeles.

U.S. Department of Transportation and the Highway Users Federation. How to Pool It; A Ride Sharing Manual for Employers. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration. May 1975.

Discusses ride sharing, including; management's role, types of ride pools, program planning, marketing, and legal aspects.

U.S. Department of Transportation. Transportation Systems Center. Priority Techniques for High Occupancy Vehicles; State of the Art Overview. Washington, D.C.: U.S. Department of Transportation, Office of the Secretary, Transportation Systems Center, Urban Mass Transportation Administration, and Federal Highway Administration, 1975. (Report available from: Mr. R.V. (Bud) Giangrande, Transportation Systems Center, Kendall Square, Code 151, Cambridge, Ma. 02142)

Includes priority techniques for both freeways and arterial-city streets, as well as evaluative overview of priority techniques. Appendix A: "Summary of Selected Characteristics of 17 Freeway-Related Priority Techniques".

U.S. Department of Transportation, Transportation Systems Center. Service and Methods Demonstration Program; Annual Report, 1975. Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration, 1975.

Describes and compares recently completed and current demonstration projects based upon project objectives. Appendices A-E (pp. 73-144) include case studies of Shirley Highway Express Bus Program, Minneapolis Urban Corridor, Miami's I-95, New Jersey Approach to Lincoln Tunnel, and Marin County U.S. 101.

U.S. Department of Transportation, Urban Mass Transportation Administration. A Directory of Research Development and Demonstration Projects. Washington, D.C.: Annual.

This annual publication contains descriptions of current research, development and demonstration (RD&D) projects sponsored and funded by the U.S. Department of Transportation's Urban Mass Transportation administration (UMTA). Many paratransit projects are included.

/ U.S. Department of Transportation, Urban Mass Transportation Administration, Federal Highway Administration. Transportation System Management: Bibliography of Technical Reports. Prepared by Richard L. Oram. Washington, D.C.: 1976.

Annotated bibliography of technical reports on TSM. Categorized into - General, Preferential Treatment, Traffic Operations, Parking Management, Transit Improvements, Transit Management, Pooling/Paratransit, Pedestrians and Bicycles, and Demand Management.

III. FREEWAY TECHNIQUES

This section lists sources of information on freeway access, reserved lanes and separated facilities.

Bather-Ringrose-Wolsfeld, Inc. Final Report for the I-35W Urban Corridor Demonstration Project. Prepared for Metropolitan Council, St. Paul. Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation, 1975.

Study of Bus-On-Metered Freeway System in Minneapolis-St. Paul Region.

Bigelow-Crain Associates. San Bernadino Freeway Express Busway Evaluation; Second Year Report. Prepared for Southern California Association of Governments. Menlo Park, Calif.: 1975.

Covers the operational and economic status of the San Bernadino Freeway Express Busway (SBFEB), which is an 11-mile exclusive use facility. Includes technical engineering description of the facility, as well as the public's reaction to the design.

California. Department of Transportation. The Evaluation Report on the Santa Monica Freeway Diamond Lane Project After 21 Weeks of Operation. Sacramento, Calif.: 1976.

Analysis and findings of information gathered by Caltrans during 21 weeks of Santa Monica Diamond Lane operation.

California. Department of Transportation. Preferential Lanes for High-Occupancy Vehicles; A Final Report to the California Legislature. Sacramento, Calif.: 1975.

Reports on priority treatment projects to date and recommends further support of such projects.

California. Department of Transportation. District F. Program for Preferential Treatment for High Occupancy Vehicles on the South Coast Air Basin. Los Angeles, Calif.: 1974.

Regional approach to alter freeway trip character in the L.A. area in order to bring about improved air quality and energy conservation. Valuable background discussion of need for improved transit management in Southern California, includes the legal mandate.

Carlson, Glen C., et. al. "Results of the Bus-On-Metered Freeway Evaluation – I-35W, Minneapolis." Traffic Engineering (March 1976).

Summarizes final report on project, one of 11 Urban Corridor Demonstration Projects of U.S. DOT, UMTA.

Deuser, Bob. Interstate 95 Exclusive Bus/Car Pool Lanes Demonstration Project. Sponsored by U.S. Department of Transportation, Florida Department of Transportation, and Metropolitan Dade County. Miami, Fla.: Department of Transportation, 1976.

Describes I-95 priority treatment project.

Everall, Paul F. Urban Freeway Surveillance and Control: The State-of-the-Art. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1972.

The aim of this report is to provide information that will be of assistance to traffic engineers in selecting, designing, implementing, operating, and evaluating urban freeway control systems. The document introduces the reader to freeway problems that can be solved by surveillance and control techniques. Measures and methods to document operational problems to aid the analyst in determining what surveillance and control systems should be considered are discussed. Solutions to freeway problems, along with descriptions of the detailed hardware requirements are presented. A summary of existing freeway ramp control projects is presented, and a benefit-cost study of their effectiveness is provided.

Goodell, Robert G.B. Bypass Lanes for Carpools at Metered Ramps; Summary Report. Sacramento, Calif.: California. Department of Transportation, 1975.

Analyzes 13 bypass ramps in operation, based on effectiveness in forming car pools, operational problems, public reaction, and enforcement required.

Goodell, Robert G.B. "Preferential Access for Multioccupant Vehicle at Metered On-Ramps." Traffic Engineering (September 1974).

Describes the successful first attempt in the greater Los Angeles area for increased use of carpools, defined as a vehicle with two occupants.

Link, Dan. "Freeway Contraflow Bus Lanes: Some Policy and Technical Issues." Traffic Engineering (January 1975).

Policy and design issues of increasing use of existing facilities through contraflow bus lanes.

Link, Dan. "Planning for Bus/Carpool By-Passes at Metered Freeway Ramps." Traffic Engineering (November 1975).

Based upon experience in Los Angeles area.

Masher, D.P., et al. Guidelines for Design and Operation of Ramp Control Systems. Prepared for the National Cooperative Highway Research Program, Transportation Research Board. Menlo Park, CA: Stanford Research Institute, 1975.

This report is intended as a guide to designers of ramp metering control systems. It is aimed at the working traffic engineer who has had a minimum of freeway operations experience. The emphasis is on practical and proven techinques, not on research or on experimental procedures. The report provides guidance in determining whether a proposed metering system is potentially effective. Assuming that cost and related criteria are met, guidelines are given for the design, implementation, and operation of systems using three types of metering: Pretime, Locally Actuated, and Centralized/Interconnected. Multiple-System Metering is also treated briefly. A final chapter cites the benefits and costs of ramp metering at a number of existing locations and describes techniques for a specific cost benefit study.

McDonald, George L. "The Success of the El Monte-Los Angeles Busway." Transit Journal (August 1975).

Claims success of El Monte-Los Angeles Busway proves that Southern Californians will ride public transit when given a decent alternative, and that success is tied to ability of public agencies to cooperate.

Smith and Locke Associates, Inc. The Operation and Management of the Shirley Highway Express Bus-On-Freeway Demonstration Project; Final Report. Sponsored by the Northern Virginia Transportation Commission. Washington, D.C.: U.S. Department of Transportation, Urban Mass Transportation Administration, 1976.

Concise overview of a successful priority treatment project.

Southern California Rapid Transit District. Busway Operating Manual. n.p.: n.d.

Operating guide for the El Monte Busway.

University of California. Institute of Transportation and Traffic Engineering. Simulation of Freeway Strategies (FREQ3CP): User Documentation. Prepared by Khosrow Ovaici, et al. Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, 1975.

Examines freeway entrance control techniques, with emphasis on preferential treatment of multi-passenger vehicles. The computerized model, FREQ3CP, assists in evaluation of alternative priority entry control strategies. An updated edition is forthcoming.

IV. ARTERIAL TECHNIQUES

This section lists sources of information on arterial reserved lanes and signal pre-emption. Many of these sources could also be applied to activity center and miscellaneous techniques.

Ben-Akiva, Moshe E., and Terry J. Atherton. "Choice Model Predictions of Carpool Demand: Methods and Results." Paper presented at the 56th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1977.

Presents methodology and results of an application of disaggregate choice models for predicting carpool demand. Concludes that the most significant change in travel behavior can be predicted when parking policies combine disincentives for driving alone with incentives for carpooling.

Ebersole, J. Glenn, Jr. "The Cases for and Against Bus-Carpool Lanes in Pennsylvania," pp. 115-121. Compendium of Technical Papers; 46th Annual Meeting of the Institute of Transportation Engineers, Baltimore, August 15-19, 1976. Washington, D.C.: Institute of Transportation Engineers, 1976.

Presents a summary of the analyses of the traffic operational and safety problems associated with exclusive lane operations on several Philadelphia and Pittsburgh expressways and arterials.

Erdman, John W., and Edward J. Panuska. "Exclusive Bus Lane Experiment." Traffic Engineering (July 1976).

Study in Baltimore of exclusive bus lanes on two-directional urban arterials with roadway width limited to two lanes in each direction. Concludes is detrimental to both auto and bus movements.

Exclusive Bus Lane Study. Baltimore, Md.: Baltimore, Department of Transit and Traffic, and Maryland Mass Transit Administration, 1975.

Studies impact of EPA Transportation Control Strategies with respect to exclusive bus lanes as a means of reducing emissions in the Baltimore Metropolitan Area. Recommends development of additional Park N Ride lots.

Kuykendahl, Jerome. "Priority Lanes and the Operating Agency." Paper read at APTA Western Conference, San Francisco, Calif., May 7, 1975.

Uses the Golden Gate Bridge, Highway and Transportation District, as a case in favor of bus priority treatment.

Lopatin, Marc. "Moving More People with Fewer Vehicles." Traffic Engineering (February 1976).

Discusses success of Dixie Highway priority treatment and use of variable signs for contra-flow lanes.

Ludwick, John S., Jr. Bus Priority Systems: Simulation and Analysis. McLean, Va.: Mitre Corporation, 1976.

Concludes that benefit to buses should be weighed in context of cross-street travel time. Stresses value of far-side bus stops as superior to near-side bus stops, and that buses with frequent stops have greater potential for improvement due to priority treatment than express buses.

Mac Gowan, C. John. "Bus Priority and Bus Preemption in the Urban Traffic Control System."

Examines the Urban Traffic Control System (UTCS) in combination with the Bus Priority System (BPS). Concludes that significant reduction in bus delays (as much as 35%) are to be gained from installation of signal preemption, at only minor increase in auto delays (.03 to 2.5%).

Miller, Craig, and Robert Deuser. "Issues in Busway and Bus/Car Pool Lanes Enforcement." Prepared for the 55th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1976.

Looks at enforcement agency cooperation and planning, legal and judicial compatibility, and enforcement techniques and strategies.

Miller, Gerald K. and Melinda A. Green. An Analysis of Computer Van Experience. Prepared for U.S. Department of Transportation, Urban Mass Transportation Administration. Washington, D.C.: The Urban Institute, 1976.

This report analyzes the planning, organization and operation of commuter van programs (often called vanpools) in the U.S. and Canada. More than 30 existing operations have been examined and classified by considering the major organizational arrangements for providing the service. The potential benefits van commuting generates for the users, employers and community are discussed, and the paper presents guidelines on the demand environment and indicates the service characteristics that are likely to be important in attracting riders. Major legal issues including public regulation, competition with bus transit, liability and insurance and implications of driver compensation are also reviewed. The potential for widespread van programs and the proposals for large-scale, areawide van service are also discussed.

Miller, Gerald K. and Melinda A. Green. Guidelines for the Organization of Commuter Van Programs. Prepared for U.S. Department of Transportation, Urban Mass Transportation Administration. Washington, D.C.: The Urban Institute, February 1976.

This is the follow-up report to An Analysis of Commuter Van Experience. This document describes the major stages in the development of a company sponsored commuter van program including: The investigation of program feasibility, the promotion and organization of the service, and the operation and administration of an on-going operation. Seven detailed case studies which are representative of the major types of commuter van services are presented in the Appendix.

Mufti, Rasin K., Lawrence S. Golfin, and Charles D. Dougherty. "Modal Choice Analyses of an Exclusive Bus/Carpool Lane." Paper presented at the 56th Annual Meeting of the Transportation Research Board, Washington, D.C. January 1977.

Uses mathematical model (Modal Choice Analysis) to study effects on an exclusive bus/carpool lane on modal choices along the U.S. Route 30 Corridor in Camden County, New Jersey. Concludes that the carpool is the "least significant mode in the Market area."

Riley, Daniel I. and Associates. The Potential for Carpooling in the I-90 Corridor. n.p.: Puget Sound Council of Governments and Washington State Department of Highways, 1975.

Results of analyses of auto occupancy and carpool potential of I-90 in Seattle area. Uses computer model to predict carpool demand.

Robertson, H. Douglas. "Miami's Bus-Car Pool Project Will Move the Greatest Number of People, with Least Delay at Lowest Cost and with Greatest Convenience." Traffic Engineering (January 1974).

An economic analysis of additional bus-car pool lanes in Dade County.

Rose, Harry S., and David H. Hinds. "U.S. 1/South Dixie Highway Contraflow Bus Lane and Carpool Lane Demonstration Project." Presented at the 55th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1976.

Discusses results of one year evaluation of 5.5 mile section of South Dixie Highway, including bus and auto travel times, auto occupancy and traffic volume changes, enforcement, safety, and three surveys of system users.

Sperry Systems Management Division. Urban Traffic Control and Bus Priority System: Vol I. Design and Installation. Prepared for U.S. Department of Transportation, Federal Highway Administration. Great Neck, N.Y.: 1972.

(This volume is one of a series of three comprising the complete final report on this R&D effort. The others are: Report FHWA-RD-73-10, Vol. II. Operator's Manual; and Report FHWA-RD-73-11, Vol. III. Maintenance Manual.)

This report presents a comprehensive review of the system design studies, analyses, traffic surveys, geometric surveys and tradeoff studies which are conducted in conjunction with the UTCS?BPS program, which resulted in the selection of system components and parameters comprising the first-generation UTCS/BPS centralized computer-based traffic control system. This report serves as a guide in design and specifying a traffic control system when on-street design considerations affecting a specific application are taken into account.

Sperry Systems Management Division. Urban Traffic Control System Hardware: A Specifications Checklist. Prepared for U.S. Department of Transportation, Federal Highway Administration. Washington, D.C.: U.S. Department of Transportation, 1976.

This manual presents a compilation of Urban Traffic Control System/Bus Priority System (UTCS/BPS) equipment specifications which have been generalized and condensed into a checklist format. The format provides a rapid means of checking equipment specifications which have been prepared, or are in the process of being prepared, for a similar traffic system.

Status of the Urban Corridor Demonstration Program; November 1975. Washington, D.C.: U.S. Department of Transportation, Office of the Secretary, Federal Highway Administration, and Urban Mass Transportation Administration, 1975.

Evaluates urban corridor studies in 8 cities: Cincinnati, Dallas, Dayton, Louisville, Minneapolis, New York, Philadelphia, and Washington, D.C. This Phase II report compares the various projects, documents preliminary cost-impact evaluation, and summarizes findings to date.

Seward, Samuel R., and Robert N. Taube. A Methodology for Evaluating Bus-Actuated Green Signal Preemption Systems. Milwaukee, Wisc.: University of Wisconsin and Milwaukee, Department of City Development, n.d.

Models impact of bus actuated signal preemption systems upon delay experienced by buses at signalized intersections. Develops a methodology to evaluate installation of these systems in any location, based primarily on revenue-cost ratio.

Taube, Robert N., and Samuel R. Seward. Development of Warrents and Planning of Guidelines for Bus Actuated Signal Preemption Systems. Milwaukee, Wisc.: Department of City Development, 1976.

Presents methodology to justify bus signal preemption on an intersection by intersection basis by providing manually calculated, single intersection results.

Wattleworth, Dr. Joseph A., et al. "Evaluation of Some Bus Priority Strategies on N.W. 7th Avenue in Miami." Paper presented at the 56th Annual Meeting of the Transportation Research Board, Washington, D.C., January 1977.

Evaluates bus priority treatment on urban streets in Miami, Fla. includes discussion of signal pre-emption.

Wattleworth, Dr. Joseph H., et al. Preliminary Evaluation of Some Bus Priority Strategies on N.W. 7th Avenue in Miami. Prepared for: Florida, Department of Transportation, U.S. Department of Transportation, Urban Mass Transportation Administration, Metropolitan Dade County, 1976.

Summarizes Phase I of the I-95/N.W. 7th Avenue Priority treatment project.

V. ACTIVITY CENTER TECHNIQUES

This section cites sources of information on downtown distribution plans for reserved lanes and bus street terminals. The General, Freeway Techniques, Arterial Techniques, and Miscellaneous sections should also be reviewed.

Hirsh, Michael S. "Giving the Bus Priority: Considerations and Benefits." Transit Journal (February 1976).

Examines four types of arterial bus priority treatments within the central business district: traffic signal preemption, exclusive median lanes, exclusive curb lanes, and bus-only streets.

Lovett, D.C. Overview of Experimental Bus Priority systems. McLean, Va.: Mitre Corporation, 1975.

Focuses on several experimental bus priority systems (BPS) of the bus detection and traffic signal adjustment type, both in the United States and foreign countries. Each BPS is reviewed, including objectives of the system, priority strategy, reported results, and equipment needed to implement the strategy.

Smith, Wilber, and Associates. Downtown Distribution Plan; Express Busway. Los Angeles, Calif.: Southern California Rapid Transit District, 1973.

Report on design alternatives for downtown distribution of El-Monte Express Busway services in Southern California.

VI. MISCELLANEOUS TECHNIQUES

This section cites sources on bus operation improvements and isolated signal modifications General, Freeway Techniques, Arterial Techniques and Activity Center sections should also be reviewed.

O'Connel, John M. "Low Cost Improvements to Surface Transit Systems." M.C.E. thesis, Villanova University, 1973.

Examines the economic and operational characteristics of existing surface transit systems and vehicles, operational changes, and benefit-cost analyses of such changes.

Standards for the Design and Maintenance of Bus Related Road Improvements. St. Paul, Minn.: Metropolitan Transit Commission, 1975.

Design standards adopted by the Transportation Advisory Council of the Metropolitan Council, developed as part of the Hennepin County Route-Ridership Improvement Project Standards cover design vehicle, street related improvements, bus actuation of signals, bus shelters, and park/kiss ride facilities.

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UC Transportation Task Force

The guidance of Transportation Task Force members continues to ensure that the urgent needs which have been identified by members of the consortium will be satisfied. The members of the Transportation Task Force are:

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*Mr. Lubliner became Task Force Chairperson, and Mr. Katner became Chairperson of the Urban Consortium, as of January, 1977. Most of the Manual's development took place prior to that time.

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The support of the USDOT Research and Development Policy Analysis Division in the Office of the Secretary, the Federal Highway Administration (FHWA), and the Urban Mass Transportation Administration (UMTA) has been invaluable in the work of the Transportation Task Force of the Urban Consortium and the PTI staff. Federal repersentation consisted of:

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